### State of Alabama

### 10/15/2019

### Bertha K Madras, PhD Testimony on Marijuana Legalization

Promoted as a relatively harmless substance, advocates for marijuana have effectively persuaded voters and legislators in certain states to medicalize, normalize and legalize the drug. Nationally and globally, changing the legal status of marijuana has, appropriately, catalyzed passionate debates on the cost-benefit of legalization. This debate falls under the rubric of public health/safety. It needs to be informed by rigorous science on the known and unknown consequences of marijuana on brain, body and behavior. The health and safety of this and future generations are at stake.

My testimony is based on scientific evidence, my perspective that of a concerned citizen. I acknowledge that not all users respond to the drug in the same way. Not all studies agree on the adverse consequences or potential benefits of marijuana. Some research focuses on a single potential benefit, but ignores a list of detrimental consequences, the efficacy-safety equation that drives approval of medicines. Decades-old reports claiming marijuana to be a relatively benign drug are increasingly irrelevant in 2019.

My testimony has six segments: (A) Marijuana potency and composition. (B) Users and trends; (C) Acute effects of marijuana; (D) Long term consequences of marijuana use; (E) Consequences to others; (F) The state of states that legalized marijuana. The scientific findings described below are gleaned from two World Health Organization reports[[1]](#endnote-1),[[2]](#endnote-2) a National Academies of Sciences, Engineering, Medicine report,[[3]](#endnote-3) meta-analyses, reviews, and other articles in high quality biomedical journals. Currently, the search term “marijuana” in the PubMed database of primary source biomedical articles yields over 31,170 manuscripts. By necessity, the list of references is limited.

**(A) MARIJUANA POTENCY AND COMPOSITION**

Consider how the wild-type marijuana plant has evolved into commercial products in our unregulated, chaotic marketplace, whether in states with legal marijuana or not. THC is the main psychoactive, intoxicating, addictive, anxiogenic and psychosis-producing substance in marijuana. (1) THC levels rose dramatically over the past two decades (from a concentration of ~3% to current levels of >17%.[[4]](#endnote-4) (2) Even more extreme have been new methods to concentrate THC in marijuana, by extracting it with solvents (e.g. butane) to create butane hash oil, wax, dabs, or shatter, raising THC levels to even higher, unprecedented levels. These can deliver amounts of THC in marijuana to astonishingly high potencies, in excess of 70% THC.[[5]](#endnote-5) What are the consequences? Among the significant adverse effects associated with dabs are psychosis, neurotoxicity, and cardiotoxicity.[[6]](#endnote-6),[[7]](#endnote-7),[[8]](#endnote-8) These unregulated preparations are being vaped and inhaled by an ever-increasing number of people, including youth. On October 11, 2019, the CDC updated its oversight of the vaping lung disease crisis.[[9]](#endnote-9) It found that of the 1,299 cases and 26 deaths, most patients reported a history of using THC containing products. It recommended that the public not use vaping e-cigarettes or vaping products with THC dabs (marijuana concentrate). (3) Selective breeding has not only raised THC content but reduced cannabidiol (CBD) concentrations, producing marijuana with ratios of THC:CBD > 100 and many-fold higher than ratios in native plants of the past. The change in this ratio has consequences, as CBD reportedly attenuates anxiety and psychosis induced by THC.[[10]](#endnote-10),[[11]](#endnote-11) (4) Although the marijuana industry has operated in an environment of state taxing and regulating their products, it has succeeded in petitioning state governments to unshackle regulations that could reduce the appeal of marijuana. Stores and dispensaries are swamped with high potency THC and edibles. The consequences are becoming clearer: vaping lung injuries, emergency department mentions of psychosis, and others.[[12]](#endnote-12),[[13]](#endnote-13)

**Summary**

* **Marijuana Medicalization, Normalization, Legalization is associated with increased THC potency.** The stronger the marijuana (higher THC) and higher frequency of use, the probability increases for: (1) psychosis to appear, (2) age of onset of schizophrenia to be lower, (3) impairment of brain function, (4) traffic accidents, (5) addiction.
* **THC in marijuana**, the standard measure of marijuana potency, currently is 3-25 times higher than marijuana potencies of the 1960s to the 1990s.
* **THC levels in** **concentrates** (butane hash oil, wax, dabs, shatter) are as high as 80%.
* **THC:CBD ratios have risen** to >100 even though CBD possibly attenuates the adverse effects of THC.
* **Vaping lung disease** is largely attributable to THC vaping, according to CDC.

1. **USERS AND TRENDS IN STATES WITH LEGAL MARIJUANA**

Of all illegal drugs in Schedule 1 of the federal Controlled Substance Act (CSA: high abuse liability, no currently accepted medical use), marijuana ranks first as the most commonly used legal (at state level)/illegal drug in the United States. How did we arrive at this point in our history? The shifting legal environment for marijuana in the U.S. is traceable to a 1996 California ballot initiative that approved use of marijuana for various medical conditions. Thereafter, medicalization proliferated in other states and spawned a derivative movement to legalize all use of marijuana. With legal status and social acceptability of marijuana ascendant, the marijuana industry began advertising, marketing, creating products to enhance palatability and potency[[14]](#endnote-14) and expand modes of delivery, including vaping.[[15]](#endnote-15),[[16]](#endnote-16),[[17]](#endnote-17)

**Use.** One outcome of this shift in marijuana status is a steep rise in past-year marijuana use from 11.0% (or 25.8 million) in 2002 to 15.9% (or 43.5 million) in 2018 among U.S. populations aged 12 or older. The most noteworthy increases are among teenagers and young adults of child-bearing and child-rearing ages.[[18]](#endnote-18) Focusing on teenagers, perception of harm among them is the lowest it has been for decades, and since 2009, marijuana use among teenagers has surpassed cigarette use.[[19]](#endnote-19) Annual overall marijuana prevalence was 23.9% in 2018, following a significant increase in 2017, with 11%, 28%, and 36% for grades 8, 10, and 12, respectively. Daily marijuanaprevalence rates are 1%, 3%, and 6%, respectively, which is 3, 2 and 4 times higher than for halfpack-a-day smoking in these grades. In states with no legalized marijuana (medical or full legal access), youth (12-17 years) use rates are lower than in states with access to marijuana. Since 2010, past month marijuana use among 18-25 year olds increased 19.4%, and those 26 years and above, use increased 65%. In 2017, 600,000 people started using marijuana, a 25% increase of new initiates since 2010. Among 18-25 year olds, the increase was 44% and among those 26 and older, it was 150%. Currently, there are 4.4 million Americans with a marijuana use disorder. [[20]](#endnote-20)

**Vaping of Marijuana**. Vaping is another emerging public health threat, accelerated by legalizing marijuana. One recent study showed increased use by 14–18 year olds with newer forms of consumption—vaping and edibles.[[21]](#endnote-21) The 2018 survey of high school students (Monitoring the Future or MTF), showed a dramatic rise in vaping of nicotine, marijuana and flavors by adolescents, some of the largest absolute increases MTF has ever tracked for any substance.7 Marijuana vaping increased 4.4%, 12.4%, and 13.1%, in the three grades.

**Marijuana Use Rising Among Pregnant Women.** Pregnant women are another group showing a disconcerting increase in use. Nonmedical marijuana use has risen significantly in this cohort, especially during the critical first and second trimester.[[22]](#endnote-22) Overall, the perceived risk of using marijuana in the U.S. has declined steeply, while at the same time, research showing detrimental effects of marijuana use has risen sharply.

**Marijuana Use Rising Among Parents and offspring.** Marijuana use is rising among parents, [[23]](#endnote-23),[[24]](#endnote-24) and offspring use is higher if parents use.[[25]](#endnote-25),[[26]](#endnote-26),[[27]](#endnote-27) Transmission of marijuana use from parent to offspring could arise from quality of parenting, parental marijuana use.

**Summary**

* **Perception of harm.** The perception that marijuana is harmless among high school students is higher now than ever before in U.S. history.[[28]](#endnote-28)
* **Legalization increases marijuana use.** More youth/young adults, pregnant women are using marijuana, and using daily than ever before.[[29]](#endnote-29)
* **Marijuana** **use is higher in states that legalized marijuana.** Use continues to rise above the national average among youth aged 12–17 and young adults in Colorado, Washington, Oregon, Alaska, and the District of Columbia (Washington, DC) with legalized marijuana (NSDUH, 2006-2017).
* **More first-time young users.** CO is the #1 state for first-time youth marijuana use, a 65% increase in the years since legalization (NSDUH, 2006-2017).
* **Marijuana access is easy in legal states**. About 62% of Oregon 11th graders have reported “very easy” access to marijuana, with many of them reporting marijuana acquisition coming primarily from friends.[[30]](#endnote-30)
* **Marijuana use is rising among pregnant women**
* **Marijuana use is rising among parents and offspring**
* **Marijuana vaping.** Marijuana vaping has increased dramatically among youth in the past three years, and may reverse the trend of smoking cessation.

1. **ACUTE EFFECTS OF MARIJUANA**

**Health and safety:Deaths and Emergencies.** Deaths related to marijuana are low, but are not inconsequential, and increasingly focused on cardiac-related deaths or [[31]](#endnote-31),[[32]](#endnote-32) marijuana-related traffic fatalities, a growing threat to highway safety.[[33]](#endnote-33),[[34]](#endnote-34) The risk of being involved in a traffic accident doubles or more after marijuana use,[[35]](#endnote-35),[[36]](#endnote-36) and combined alcohol and marijuana confer a greater risk than for either drug alone. Visits to hospital emergency departments related to marijuana use alone or combined with other substances have risen significantly.[[37]](#endnote-37) All age ranges are affected and include children and teens.

Unintentional marijuana ingestion by children is a serious public health concern and is well-documented in many studies and case reports. The most common ingestion by children reportedly is resin (concentrated marijuana with high THC levels), followed by cookies and marijuana cigarettes. Other exposures included passive smoke, medical marijuana, candies, beverages, and hemp oil. Lethargy is most commonly present, followed by impaired balance and coordination, rapid heart rate, and muscle weakness.[[38]](#endnote-38),[[39]](#endnote-39) Among youth, common presentations include acute intoxication, hyperemesis, depression and acute physical injuries from impaired psychomotor function.[[40]](#endnote-40) In adults, common causes are involvement in accidents,[[41]](#endnote-41) acute psychotic reactions,[[42]](#endnote-42),[[43]](#endnote-43) hyperemesis,[[44]](#endnote-44) intoxication, and heart attacks in people with cardiovascular risks or disease.[[45]](#endnote-45),[[46]](#endnote-46) The increase in emergency department visits may be related to the increase in THC content in marijuana. Vaping that delivers high THC content, and edibles which affect children and inexperienced users disproportionately contribute to emergencies .[[47]](#endnote-47)

**Compromised function.** Marijuana intoxication impairs memory, judgment, decision-making to compromise function in various settings (academia, home, workplace), with significant impact on health, safety and life goals. Marijuana acutely impairs critical functions of the brain, such as learning, memory, and problem solving. These effects may persist for days after intoxication wears off. Use before or during school hours can compromise school performance and educational achievement. Daily use is particularly risky for academic performance and daily use is rising.[[48]](#endnote-48),[[49]](#endnote-49),[[50]](#endnote-50)  Marijuana intoxication can also compromise judgment sufficiently to increase the probability of engaging in risky behaviors such as unsafe sex.[[51]](#endnote-51). Intoxication and disturbances in consciousness are characterized by euphoria and disinhibition, temporal showing (a sense that time is passing very slowly, and/or experience of a rapid flow of ideas), auditory, visual, or tactile illusions, hallucinations with preserved orientation, depersonalization, de-realization, interference with personal functioning, increased appetite, dry mouth red conjunctiva, tachycardia, altered perception, affect or behavior, other psychophysiological functions, anxiety or agitation, suspiciousness or paranoid ideation. Some first-time marijuana users become very anxious, have panic attacks, experience hallucinations and vomit, prompting some to seek medical care. Marijuana can impair short-term memory, planning, decision-making, response speed, accuracy, judgement, attention reaction time. Less experienced users undergo stronger intoxicating effects on attention, concentration. Occasional smokers at higherrisk for impairment of skills for work in safety-sensitive positions or operating a means of transportation. Abstinence in experienced users can disrupt attention and concentration. Marijuana impairs coordination, interfere with driving, increase risk of injuries. Complex human/machine performancecan be impaired as long as 24 h after smoking a moderate dose of cannabis. There is also some evidence that marijuana can trigger coronary, other cardiovascular events (stroke) in younger marijuana smokers, who are otherwise at low risk.

**Summary**

**Deaths.** Deaths directly due to marijuana are low but majority are cardiac-related deaths or traffic fatalities.

**Marijuana-related traffic accidents, fatalities.** A growing threat to highway safety, the risk doubles or more after marijuana use, and alcohol combined with marijuana a greater risk.

**Hospital emergencies**. Children, youth and adult visits to emergency departments is a growing problem. Unintentional marijuana ingestion children, emergencies related to marijuana use alone or combined with other substances have risen significantly. Common presentations among youth include acute intoxication, hyperemesis, depression and acute physical injuries from impaired function, possibly related to increased THC content in marijuana, vaping, and edibles. In adults, common causes are involvement in accidents, psychotic reactions, intoxication, hyperemesis and heart attacks.

**Compromised function.** Marijuana intoxication impairs memory, judgment, decision-making to compromise function in various settings (academia, home, workplace). The impact on health, safety and life goals is significant (see below).

1. **LONG TERM CONSEQUENCES OF MARIJUANA USE**

**Marijuana or cannabis use disorder.** Marijuana or cannabis use disorder can develop after regular, heavy marijuana use. It is commonly thought that marijuana use disorder is rare, an assumption based on findings of 25 years ago. Older risk data showed approximately 1 in 10 among those who ever use marijuana developed addiction, 1 in 6 among adolescent users, and 1 in 3 among frequent, daily users. More recent national data estimate that between 11% and 30.5% of current users have a cannabis use disorder,**[[52]](#endnote-52)**,**[[53]](#endnote-53)** 19.5% of lifetime users meet criteria for a use disorder, of whom 23% harbor severe symptoms (⩾6 criteria). Of these, 48% are not functioning (e.g., employed). Marijuana use disorder is not rare and can be severe. A withdrawal syndrome (physical and psychological) is well documented in marijuana dependence.[[54]](#endnote-54),[[55]](#endnote-55) Regular, heavy marijuana use during adolescence is associated with more severe and persistent negative outcomes than use during adulthood. Concerns about the risks of adolescent use, especially heavy use, focus on the developing adolescent brain,[[56]](#endnote-56),[[57]](#endnote-57) poor educational outcome,[[58]](#endnote-58) school dropout, cognitive impairment and lower IQ, [[59]](#endnote-59) lower life satisfaction and achievement[[60]](#endnote-60), and addiction to marijuana and other drugs.[[61]](#endnote-61),[[62]](#endnote-62) The risk for developing addiction to marijuana is 2-4 times higher in young people, especially in heavy users and progression to addiction can be rapid as surface within 1 year of initiation. [[63]](#endnote-63) The risks of using other drugs is also higher in marijuana users.[[64]](#endnote-64) The demand for marijuana addiction treatment is increasing globally.

**Changes in brain development and brain function.** Youth are at higher risk for all adverse consequences.Marijuana impact on cognitive performance persists after the acute intoxication phase, and is more profound among heavy marijuana users who use over long period, particularly if use was initiated during adolescence. The developing adolescent brain undergoes significant changes in anatomy, function, and circuit formation, which last until at least the mid-20s. During this period, external influences can have a major impact on brain development. Early, heavy, long-termexposure to THC affects the developing brain, as shown by animal and human research.Unfortunately, the endocannabinoid system, the very system targeted by THC, plays an important role in forming brain connections. THC interferes with this process, and conceivably explains how THC changes brain connections and brain circuits. In utero, THC can interfere with formation of connections between nerve cells and connections among different brain regions,[[65]](#endnote-65) including regions that are implicated in addictive processes.Some research has linked prenatal THC exposure to compromised problem-solving, memory, planning, impulsivity, and attention in the child.[[66]](#endnote-66) A recent study within in the Adolescent Brain Cognitive Development (ABCD) program showed that marijuana exposure in utero was associated with psychosis-proneness in the children.[[67]](#endnote-67) In adolescents who regularly use marijuana, brain imaging has revealed changes in brain regions implicated in learning andmemory. Cognitive testing has revealed a significant decline in IQ over time.[[68]](#endnote-68),[[69]](#endnote-69) Research suggests that memory and attention are impaired with heavy use, and impairments persist if use persists long after adolescence,[[70]](#endnote-70),[[71]](#endnote-71)but the reversibility or irreversibility or the impact of these effects remain uncertain, especially after drug cessation. Nonetheless, starting heavy and ongoing marijuana use during adolescence increases the risk of degraded school performance and early quitting of school, which may be central or contribute to negative life outcomes, such as lower income, higher unemployment, greater dependence on welfare, and increased criminal behavior.[[72]](#endnote-72)

**Long-term Cognitive Effects of Marijuana.** Marijuana impairs working memory, planning and decision-making, response speed, accuracy and latency motivation, motor coordination, mood and cognition. Recent abstinent marijuana users (7 hours to 20 days) may experience impairment in attention, concentration, inhibition and impulsivity during the period of THC and metabolites are eliminated.[[73]](#endnote-73) Heavy, use of marijuana for long periods of time leads to greatest residual deficits in executive function. In real world situations, in the context of work and everyday life,use is associated with impaired cognitive function, mood, lower alertness, and slower response, though marijuana users self-report no more workplace errors than controls. At the beginning and end of work week, users experience working memory problems at the start, and psychomotor slowing and poorer episodic recall at the end of the working week, possibly 'hangover'-type effect which may increase with frequency of use. Effects can persist even after one month. Cannabinoidsare detectable in blood of chronic daily marijuana smokers during sustained abstinence, reflecting persistent cognitive impairment for that period of time. Marijuana continues to impair executive functions, with chronic, heavy marijuana users showing the most enduring deficits. Decision-making, planning, concept forming are the most prominent and durable deficits, but verbal fluency (information retrieval from memory) may or may not persist at this point. Decrements in function are correlated with initiation of cannabis use during adolescence.

### Marijuana Associated with Amotivation, Employment Compromise as a Function of Length of Use. Swedish men 18-20 and followed to age 40 who used marijuana had increased risk of unemployment and need for welfare assistance.[[74]](#endnote-74) These results were corroborated in New Zealand, by correlating heavy use with poorer educational outcomes, lower income, greater welfare dependence and unemployment, and lower relationship and life satisfaction.[[75]](#endnote-75)

**Marijuana and education.** Marijuana impairs learning and memory during, and for days after use, with cumulative effects; learning in a school environment may be compromised for a considerable period during the school year. Marijuana useis associated with poor grades and with high drop-out rates, with those dropping out of school engaging in high rates of frequent marijuana use. Environmental and other risks factors add to the complexity of this association.

**Early initiation of heavy marijuana use.** Adolescent initiation isassociated with lower income, lower college degree completion, greater need for economic assistance, unemployment, and use of other drugs.

### Marijuana is a Risk Factor for Psychosis and Other Psychiatric Disorders.[[76]](#endnote-76) The link between marijuana use in vulnerable populations psychoses and schizophrenia is strengthening over time.[[77]](#endnote-77) It is likely that marijuana exposure is a "component cause" that interacts with other factors to precipitate schizophrenia or a psychotic disorder, but is neither necessary nor sufficient to do so alone. Marijuana use is a risk for psychosis or schizophrenia in a number of ways: Strength and frequency of use are major factors.[[78]](#endnote-78), [[79]](#endnote-79), [[80]](#endnote-80), [[81]](#endnote-81),[[82]](#endnote-82)

* Marijuana or THC produce a range of transient schizophrenia-like positive, negative and cognitive symptoms in some healthy individuals.
* In those harbouring a psychotic disorder/schizophrenia, marijuana can worsen symptoms, trigger relapse and have negative consequences on the course of the illness.
* Symptoms of schizophrenia increase with frequency of marijuana use and strength (THC concentration).
* With heavy marijuana use, susceptible individuals in the general population develop a psychotic illness which is preceded by, and associated with age of onset of use, strength of THC in the marijuana, frequency of use and duration of use.[[83]](#endnote-83),[[84]](#endnote-84),[[85]](#endnote-85)
* Marijuana use is associated with lowering the age of onset of schizophrenia.[[86]](#endnote-86),[[87]](#endnote-87)
* Marijuana use disorder is associated with other and potentially severe major mental illnesses and substance use disorders.[[88]](#endnote-88),[[89]](#endnote-89)
* Marijuana-induced psychosis requiring a hospital visit predicts conversion to schizophrenia over time. Conversion to schizophrenia is higher than for other substances including alcohol and opioids.[[90]](#endnote-90)
* Heavy marijuana use may arise from some of the same factors that predict increased risk of mental illness, rather than being a cause.
* Marijuana use is associated with increased rates of depression, anxiety, and suicide. There is a moderate statistical association between cannabis use and an increased risk for the development of depressive disorders and this increases with increased frequency of use.[[91]](#endnote-91) There was moderate evidence of a statistical association between regular cannabis use and increased incidence of social anxiety disorder and of suicidal ideation with any cannabis use, and suicide attempts. Reverse causation and shared risk factors cannot be ruled out as explanations of these statistical associations

**Marijuana Use Is Associated with Addiction to Other Drugs.** Marijuana use associated with 6.2 times (620%) higher risk of developing any substance use disorder, 9.2 times higher risk for developing a marijuana use disorder, 2.7 times higher risk for alcohol use disorder, and 2.6 fold risk of developing other drug use disorder. Age of onset of use, International surveys (France, United States, Australia) show that the prevalence of a substance use disorder for drugs other than marijuana, is higher in adolescents who initiate marijuana use, and early age of initiation is important factor. Age of onset of use, in three twin studies showed that early marijuana initiation associated with higher addiction to other drugs in adulthood. Marijuana use associated with greater nicotine addiction in adolescents. Frequency of marijuana use accounted for 25-44% of variance for 4 measures of adolescent nicotine dependence.

**Long Term Marijuana Use and Health**.[[92]](#endnote-92) Lung: Long-term marijuana smoking produces symptoms of chronic and acute bronchitis, as well as microscopic injury to bronchial lining cells. Large airway inflammation, increased airway resistance, and lung hyperinflation are associated with marijuana smoking, and regular marijuana smokers report more symptoms of chronic bronchitis than non-smokers.[[93]](#endnote-93)Smoking marijuana may also reduce immunological responses of the respiratory system, increasing the likelihood of acquiring respiratory infections, including pneumonia.[[94]](#endnote-94) Heart, strokes: Long-term, heavy marijuana smoking can potentially trigger myocardial infarctions and strokes in young marijuana users.[[95]](#endnote-95) Marijuana combined with tobacco*:* Smoking a mix of marijuana and tobacco may increase the risk of cancer and other respiratory diseases; challenging to discern whether marijuana smokers have a higher risk, over and above that of tobacco smokers. Testicular cancer*:* There is very limited research on testicular cancer and marijuana use. Adolescent marijuana use was associated with a rare but fast-growing form of testicular cancer in young men. Any lifetime use of marijuana reportedly doubled the risk for this cancer in a case-control study; another found risk to increase with frequent use and earlier initiation of use.[[96]](#endnote-96),[[97]](#endnote-97) Cannabis Hyperemesis Syndrome (CHS or excessive vomiting): Heavy, long term marijuana use triggers excessive vomiting, nausea, and abdominal pain which can be relieved by bathing in hot water after cessation of cannabis use.[[98]](#endnote-98) CHS patients present similarly to cyclic vomiting syndrome patients with the exception that cannabis use is required to make the diagnosis. Following legalization, the prevalence of cyclic vomiting presentations to Denver Health and the University of Colorado Hospital increased 1.92-fold.

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**Summary**

* **Marijuana or cannabis use disorder.** Marijuana or cannabis use disorder can develop after regular, heavy marijuana use. More recent national data estimate that between 11% and 30.5% of current users have a cannabis use disorder.
* **A withdrawal syndrome** (physical and psychological) is well documented in marijuana dependence.
* **Adolescents’ regular, heavy marijuana use.** It isassociated with more severe and persistent negative outcomes than use during adulthood, including on the developing adolescent brain, poorer educational outcomes, school dropouts, cognitive impairment, lower IQ, lower life satisfaction and achievement, and addiction to marijuana and other drugs.
* **Changes in brain development and brain function.** Marijuana impact on cognitive performance persists after the acute intoxication phase, and is more profound among heavy marijuana users who use over long period, particularly if use was initiated during adolescence. Early, heavy, long-termexposure to THC also affects the developing brain.
* **Marijuana.** Marijuana impairs working memory, planning and decision-making, response speed, accuracy and latency motivation, motor coordination, mood and cognition. Decrements in function are correlated with initiation of cannabis use during adolescence.
* **Marijuana is associated with amotivation as a function of length of use.**
* **Marijuana and education.** Marijuana impairs learning and memory during, and for days after use, with cumulative effects
* **Early initiation of heavy marijuana use.** Adolescent initiation isassociated with lower income, lower college degree completion, greater need for economic assistance, unemployment, and use of other drugs.
* **Marijuana is a risk factor for psychosis and other psychiatric disorders.** The link between marijuana use in vulnerable populations psychoses and schizophrenia is strengthening over time.
* **Marijuana use is associated with addiction to other drugs.** Marijuana use associated with a much higher risk of developing any substance use disorder.
* **Long term marijuana use affects health:** Long-term marijuana smoking produces symptoms of chronic and acute bronchitis, as well as microscopic injury to bronchial lining cells. Long-term, heavy marijuana smoking can potentially trigger myocardial infarctions and strokes in young marijuana users. There is limited research on the association between testicular cancer and marijuana use. **Hyperemesis syndrome (excessive vomiting)** Heavy, long term marijuana use triggers excessive vomiting in some individuals, relieved by frequent, hot bathing.

### CONSEQUENCES TO OTHERS

### Driving and accidents. Marijuana impairs driving ability and confers a higher risk for motor vehicle accidents and is implicated in traffic fatalities. [[99]](#endnote-99),[[100]](#endnote-100),[[101]](#endnote-101),[[102]](#endnote-102),[[103]](#endnote-103) Drivers may try to compensate by slower driving and increasing their following distance. On highways, marijuana is the most frequently reported illicit drug in connection with impaired driving and accidents, including fatal accidents. In the U.S., (2013), 62.6% of fatally injured drivers were tested for drugs and more than one-third (34.7%) were positive for marijuana. In some other nations, marijuana is considered a significant cause of increased roadside accidents. Marijuana used combined with alcohol increases impairment risk more than either drug. Marijuana has also been implicated in fatal injuries among US pilots.[[104]](#endnote-104)

**Marijuana in the workplace.**  In the case of workplace rules and medical recommendations, the legal and scientific basis for marijuana use is inconsistent and is not yet evidence-based. Marijuana effects on cognition in work and everyday life, or whether off-site marijuana use endangers a worker or his colleagues while at work, has not been systematically investigated. One study that examined an association between marijuana use and cognitive performance, mood and human error at work found that marijuana use was associated with impairment in both cognitive function and mood, though marijuana users self-reported no more workplace errors than controls. Users also displayed lower alertness, slower response organization, working memory problems at the start, and psychomotor slowing and poorer episodic recall at the end of the working week. Subtle effects on cognitive function may be exacerbated with fatigue or work-related demands. During an economic downturn, marijuana use was recently shown to increase unemployment among users.

There is ample evidence indicating that neurocognitive impairment from marijuana persists from hours to weeks. Even after the euphoria wanes along with cognitive incapacity, residual effects may persist. A return to a non-intoxicated state does not ensure a full return of neurocognitive function. In a summary of the dilemmas that medical marijuana has created for the workplace, it was pointed out that ensuring safety of workers who are under the influence or who recently consumed marijuana is not possible and prohibition of marijuana use while on duty in the workplace may be considered a responsible standard. Yet marijuana persists in the body longer than the day of use. Total prohibition of medical marijuana use may expose an employer to legal claims of disabilities requiring marijuana, although there is uncertainty as to how laws can or will be enforced. A rationale mechanism for physician documentation of approved medical condition, the necessity of the drug, dosing, route of administration, and estimated treatment duration would assist employers in accommodating this unusual situation, which does not permit other psychoactive drugs e.g. alcohol or tobacco in the workplace. Many questions persist regarding marijuana in the workplace: (1) whether marijuana can be used at home prior to work; (2) whether dose and concentration of THC, route of administration, serum THC levels predict impairment; (3) Whether impairment measures and standards can be established; (4) whether the workplace atmosphere is endangered. Marijuana legalization has had serious ramifications for businesses across legalized states. Increased marijuana availability and use has also increased the number of employees testing positive for marijuana in the workforce.

**Healthcare costs.** Since legalization in Colorado, the following parameters have increased in number. Each of them impacts healthcare and hospital costs: Traffic fatalities: 32% increase; Driving under influence of marijuana: 45% increase; Marijuana Emergency Department mentions: 29% increase; Marijuana-related hospitalizations: 38% increase; Marijuana-only poison exposures: 72%, in under 12 years old; Marijuana-THC concentrating lab explosions: 167% increase.

**Prenatal Exposure.** The maternal use of cannabis during pregnancy and potential harm to the fetus is causing concern.[[105]](#endnote-105),[[106]](#endnote-106) Consistent with this, the American College of Obstetricians and Gynecologists recommends advising pregnant women and women contemplating pregnancy about potential risks of prenatal marijuana use in order to discourage use.[[107]](#endnote-107) A meta-analysis showed that infants born to women who used marijuana while pregnant were more likely to be anemic, have low birth weight, and require neonatal intensive care.[[108]](#endnote-108) Exposure to marijuana *in utero* is also associated with impaired executive functioning in school. [[109]](#endnote-109)

**Multigenerational substance abuse.** Recent national surveys and other research have revealed that parental use of marijuana is strongly associated with adolescent offspring use of marijuana. [[110]](#endnote-110),[[111]](#endnote-111),[[112]](#endnote-112),[[113]](#endnote-113),[[114]](#endnote-114),[[115]](#endnote-115),[[116]](#endnote-116),[[117]](#endnote-117),[[118]](#endnote-118) Regardless of mechanisms, public policy should be aware and consider the significant influence of parenting, parental marijuana use, and the poor prognosis of early marijuana initiators.[[119]](#endnote-119),[[120]](#endnote-120) Substance use prevention among adolescents is a public health imperative, because early initiation of marijuana use is associated with more severe symptoms and consequences,[[121]](#endnote-121),[[122]](#endnote-122),[[123]](#endnote-123),[[124]](#endnote-124) includingmarijuana and other substance use disorders,[[125]](#endnote-125) cognitive impairment,[[126]](#endnote-126),[[127]](#endnote-127)  preclinical or clinical symptoms of psychosis,[[128]](#endnote-128),[[129]](#endnote-129) and co-morbidities with affective disorders, anxiety and personality disorders.

**Child abuse and neglect.**[[130]](#endnote-130)Marijuana use was shown to be related to frequency of child physical abuse, to physical neglect.

**Adolescents and other adverse consequences.** Marijuana use prior to the age of 18 and continued until age 38 can reduce I.Q. by 8 points, as Dr. M Meier has stated, reducing his/her ability “to get an education or find or hold a good job”. Other research supports these conclusions: the younger marijuana use begins and the more frequently it is used, the likelihood of getting good grades or graduating high school or college decreases, the probability of earning less, unemployment or on welfare increases. Equally disquieting is a much higher and life-long risk of developing a short-term or a chronic psychosis or schizophrenia if marijuana use is started early. There is no cure for schizophrenia, and a percent of those with the disease do not respond to current medications. Marijuana is a risk factor for developing the disease, for triggering relapse and significantly worse outcomes in individuals.

1. **STATES THAT HAVE LEGALIZED MARIJUANA**

According to NSDUH data, the average rate of regular teen marijuana use in the legalized states of Alaska, Colorado, Oregon, and Washington is 30% higher than the U.S. rate as a whole. Almost a third of all 18–25 year olds in legal states used marijuana in the past month, up from around one-fifth 10 years ago. In Alaska, youth use is up more than 20% since before legalization. In Colorado, use among people 18 and over has risen. In Colorado in 2005–2006, 7.6% of 12–17 year old youth used marijuana in the past month, compared to 9.1% currently (NSDUH, 2006, 2017). A small decline has been found in this age group but still above national averages. Specifically,

* **Youth marijuana use,** **CA, CO, OR, WA.** In 2017, past month marijuana use among youth aged 12-17 was: 7% higher in California than the U.S. average; 40% higher in Colorado than the U.S. average; 60% higher in Oregon than the U.S. average; 39% higher in Washington than the U.S. average.[[131]](#endnote-131)
* **Violent and property crime, CO, OR, WA.** Colorado, Oregon, and Washington all experienced increases in violent crime and property crime in the years following legalization.[[132]](#endnote-132)
* **Traffic fatalities, CA**. The number of fatalities involving a driver testing positive for marijuana in California increased by 34% between 2005 (n=273) and 2015 (n=366).16
* **Traffic fatalities, CO**. After marijuana was legalized in Colorado, marijuana-related traffic deaths increased 151% while overall Colorado traffic deaths increased by 35%.[[133]](#endnote-133)
* **Drug Recognition Expert Investigations, OR**. The total number of Drug Recognition Expert investigations between 2014 and 2016 that resulted in a marijuana-impaired driving outcome increased by 66% in Oregon.[[134]](#endnote-134)
* **Emergency Dept Visits, CA, CO, OR.** California, Colorado, and Oregon all experienced increases in marijuana-related emergency department visits after the commercialization and/or legalization of marijuana. In Colorado, the annual rate of marijuana-related emergency room visits increased 35% between the years 2011 and 2015 (CDPHE, 2017). Central Oregon hospitals saw a nearly 2,000% increase in emergency room visits due to marijuana poisoning, with 434 marijuana-related emergency visits in January 2016 alone, compared to a maximum of 32 visits per month prior to legalization (Kent, 2016). One hospital in Bend, Oregon, also had an increase in marijuana-related emergency room visits from 229 in 2012 to 2,251 in 2015; the average number of marijuana-related emergency room visits per month in the same hospital in 2016 was 552 (Hawryluk, 2017).
* **Poison Control Centers, CO, WA.** Calls to poison control centers have risen 210% between the four-year averages before and after recreational legalization (Rocky Mountain Poison and Drug Center [RMPCD], 2017 and Wang et al., 2017). WA has seen a 70% increase in calls between the three-year averages before and after legalization (Washington State Office of Financial Management [WSOFM], 2017).
* **Traffic Deaths**. Since recreational marijuana was legalized, traffic deaths involving drivers who tested positive for marijuana more than doubled from 55 in 2013 to 138 people killed in 2017, equal to one person killed every 2 ½ days compared to one person killed every 6 ½ days. The percent of all Colorado traffic deaths, marijuana-related, increased from 11.4% in 2013 to 21.3% in 2017.[[135]](#endnote-135) Since recreational marijuana was legalized, marijuana related traffic deaths increased 151% while all Colorado traffic deaths increased 35%.
* **Selling to minors (WA, OR).** In Washington state, of 424 violations among licensed marijuana businesses, 288 violations pertained to selling marijuana to minors and 136 violations were for allowing minors access to a restricted area (Washington State Liquor and Cannabis Board [WSLCB], 2017). In Oregon (2017), a random inspection of 66 licensed marijuana retailers found 16 of the businesses were selling marijuana to minors (Oregon Liquor Control Commission [OLCC], 2018).
* **Suicides.** Colorado toxicology reports an increase in % of adolescent suicide victims testing positive for marijuana (Colorado Department of Public Health & Environment [CDPHE], 2017).
* **School suspensions**. In Anchorage, AK, school suspensions for marijuana use and possession increased more than 141% since it was legalized in 2015 to 2017 (Wohlforth, 2018).
* **Drug testing.** Marijuana urine test results in Washington and Colorado are now double the national average (Quest Diagnostics, 2016). The growing demand for marijuana has made it difficult to find employees who can pass a preemployment drug test
* **Insurance claims** have become a growing concern among companies in legalized states (Hlavac & Easterly, 2016), because if marijuana use is allowed or drug testing ignored, employers are at risk of liability claims when a marijuana-related injury or illness occurs onsite.
* **Worker injuries.** A study conducted in Washington during 2011–2014 found that the percentage of work-related injuries and illnesses was significantly higher (8.9%) among marijuana users than non-users.[[136]](#endnote-136)

What can we learn from Colorado’s experience with medicalization and legalization of marijuana? In 2000, Colorado medicalized marijuana and in 2012, Colorado legalized recreational marijuana, with retail businesses starting in 2014. The Rocky Mountain High Intensity Drug Trafficking (HIDTA) Report found that by 2014, Colorado teens aged 12 to 17 used marijuana at rates 74% higher than the national average (6 times higher than the 12% difference of 2006), even though the legalization amendment specifically prohibited marijuana use below the age of 21. About one-third of the high school students were under the influence during school hours. The high prevalence of use among youth has been declining, but still remains higher than national averages. States moving to legalize or medicalize marijuana promised to block teens from using marijuana, the former Office of National Control Policy (ONDCP) Director G. Kerlikowske stated “In every state, that promise has been broken.” Colorado also leads the nation in frequent marijuana users among 18-25 year olds (62% higher) and adults past the age of 26 (104% higher). Colorado showed an increase in adverse consequences: (1) marijuana-related emergency room visits increased by 57% to about 13,000 visits from 2011- to 2013; (2) marijuana-related hospitalizations increased by 82% from 2008 to 2013 (8,000 admissions); (3) traffic fatalities involving people testing positive for marijuana increased 100% from 2007 to 2012, even though overall traffic fatalities decreased 15%; (4) hospitalizations for childhood marijuana exposures have increased dramatically.

**CONCLUSIONS**

I appreciate the opportunity to testify on the health effects of marijuana. A large body of research on the health consequences of marijuana exists. Deploying the science to develop evidence-based messages for prevention and treatment of marijuana use disorder should be a public health priority, before launching another psychoactive drug experiment on our population.

We cannot fully predict the consequences of marijuana legalization in each state or whether they will differ from Colorado, Washington, California or others. Based on early data from these states, it is clear that legalizing marijuana has been a costly experiment for its citizens. It will take years, if not decades to develop a comprehensive view of the intergenerational consequences of legalizing marijuana. Few predicted that inhaling mostly THC vapors into lungs would lead to a vaping crisis that now forms a hub of activity for the CDC and HHS. This crisis is a repetitious paradigm for how voices of caution are ignored in the face of organized and aggressive advocacy and financial incentives for opioids and now marijuana. I urge the state to be thoughtful and diligent before launching yet another massive human health experiment without informed consent. Based on early data from legal states, we can predict a rise in marijuana use, escalating health and safety consequences, increased use of other drugs, rising health care costs and a cohort of vulnerable youth and families compromised by early initiation and use. As a Colorado health care economist calculated, tax revenue was one quarter of the taxes needed to compensate for rising marijuana costs to the state. History will judge the marijuana industry and rush to legalize. I predict the history will not be kind to those engaged in the industry and their enablers.

**Biography of the author, Bertha Madras**

Bertha Madras, PhD is Professor of Psychobiology, Harvard Medical School (33 years), based at McLean Hospital, where she heads the Laboratory of Addiction Neurobiology and is cross-appointed at the Massachusetts General Hospital. Her research focuses on addiction biology, other neuropsychiatric disorders, and is published in over 200 manuscripts, articles, and books, including “The Cell Biology of Addiction”, and “Effects of Drug Abuse on the Human Nervous System”. With collaborators, she holds 19 U.S. and 27 international patents.

* She is former Deputy Director for Demand Reduction (prevention, treatment) in the White House Office of National Drug Control Policy, Executive Office of the President, a presidential appointment confirmed unanimously by U.S. Senate.
* She catalyzed implementation of Screening, Brief Interventions, Referral to Treatment (SBIRT) on a national scale.
* She was sole author of a commissioned report on “Update of Cannabis and its Medical Use” and co-author of a report “The Health and Social Effects of Nonmedical Cannabis Use” for the World Health Organization.
* She was the sole expert witness for the U. S. Department of Justice which won a landmark Federal Court (Eastern District of California) decision to not marijuana de-schedule marijuana.
* She recently served as a panelist on Narcotics at the Vatican Pontifical Academy of Sciences, and co-authored the final statement.
* In 2017, she was appointed one of six members of the President’s Commission on Combating Drug Addiction and the Opioid Crisis: Gov. Chris Christie (NJ), Gov. Charlie Baker (MA), Gov. Roy Cooper, NC), former Congressman Patrick Kennedy (RI), Attorney General Pam Bondi (FL), Professor Bertha Madras (MA). The Commission Chair Governor Christie asked her to shepherd the final Commission report.
* She is a member of the National Academy of Medicine Collaborative on the Opioid Crisis.
* Her prevention efforts include the development of a Boston, Museum of Science exhibit and CD (licensed by Disney), titled “Changing Your Mind: Drugs in the Brain” and delivery of hundreds of public presentations on the brain, addiction biology, opioids, marijuana other drugs and consequences.
* As an educator, she developed the first addictions course for Harvard Medical School students and an international Course on Cell Biology of Addiction, at Cold Spring Harbor Laboratory, NY.
* She is the recipient of an NIH MERIT award, three Public Service Awards, American Academy of Addiction Psychiatry Founders’ Award, three Research Awards, a National Leadership Award, others. The Better World Report (2006) cited her brain imaging invention as “one of 25 technology transfer innovations (university to industry) that changed the world”.

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