Marijuana: What Does Science Tell Us?

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State Marijuana Policies

• State Laws related to marijuana are rapidly changing

• 24 States and DC have legalized at least some forms of MJ for medicinal use

• 4 States and DC have legalized or voted to legalize MJ for adult recreational use

• Legalization is expected to be on state ballots in 2016
How Can Science Inform the Policy Debate?

– Drug use trends (epidemiology)
– Impact of state policies on public health outcomes
– How marijuana affects the brain (neurobiology)
– How it affects behavior (e.g. driving)?
– Are the components of marijuana effective medications?
WHAT DOES SCIENCE TELL US ABOUT MARIJUANA USE?
Marijuana is the Most Commonly Used Illicit Drug

Top Drugs among 8th and 12th Graders, Past Year Use

8th Graders

- Marijuana/Hashish: 11.7%
- Inhalants: 5.3%
- Synthetic Marijuana: 3.3%
- Cough Medicine: 2.0%
- Tranquilizers: 1.7%
- Adderall: 1.3%
- Hallucinogens: 1.3%
- OxyContin: 1.0%
- Vicodin: 1.0%
- Cocaine (any form): 1.0%
- MDMA (Ecstasy): 0.9%
- Ritalin: 0.9%

12th Graders

- Marijuana/Hashish: 35.1%
- Adderall: 6.8%
- Synthetic Marijuana: 5.8%
- Vicodin: 4.8%
- Tranquilizers: 4.7%
- Cough Medicine: 4.1%
- Sedatives: 4.3%
- Hallucinogens: 4.0%
- MDMA (Ecstasy): 3.6%
- OxyContin: 3.3%
- Cocaine (any form): 2.6%
- Inhalants: 1.9%
- Salvia: 1.8%
- Ritalin: 1.8%

* Only 12th graders surveyed about sedatives use

Source: University of Michigan, 2014 Monitoring the Future Study
How Many Youth are Using?
(Past Month, %)

Percentage of High School Seniors Using Marijuana Daily

Decreasing Perception of Harms

Relationship Between Medical Marijuana Laws and Use?

• Study results/conclusions vary
• States that legalized for medical purposes have higher rates of use
• Not necessarily causal
• Policies vary by state
• Need to consider state-level risk factors (e.g., home cultivation, dispensaries)

HOW DOES MARIJUANA IMPACT THE BRAIN?
Marijuana Binds Cannabinoid Receptors Located Throughout the Brain

- Brain Development
- Memory & Cognition
- Motivational Systems & Reward
- Appetite
- Immunological Function
- Reproduction
- Movement Coordination
- Pain Regulation & Analgesia
The Reward Circuit

Drugs of abuse increase dopamine in the Nucleus Accumbens

Is Marijuana Addictive?

**Estimated Prevalence of Dependence Among Users**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobacco</td>
<td>32</td>
</tr>
<tr>
<td>Alcohol</td>
<td>15</td>
</tr>
<tr>
<td>Cannabis</td>
<td>9</td>
</tr>
<tr>
<td>Cocaine</td>
<td>17</td>
</tr>
<tr>
<td>Stimulant</td>
<td>11</td>
</tr>
<tr>
<td>Analgesics</td>
<td>8</td>
</tr>
<tr>
<td>Psychedelics</td>
<td>5</td>
</tr>
<tr>
<td>Heroin</td>
<td>23</td>
</tr>
</tbody>
</table>

**Risk for Addiction is Significantly Higher When Starting in Adolescence: Approximately 16% for Marijuana**

* Nonmedical Use; Source: Anthony JC et al., 1994
Marijuana and Cognitive Development

The teen brain is **still developing** and it is especially vulnerable to drug use.

Source: Gogtay et al., PNAS. 2004 101 (21) 8174-8179
Some Studies Suggest Structural Differences in Brains of Regular Marijuana Users versus Nonusers

Early (<18y) Long-Term Cannabis Use Decreases Axonal Fiber Connectivity

Axonal paths with reduced connectivity (diffusion-weighted MRI) in cannabis users than in controls.

Persistent Marijuana Users Show A Significant IQ Drop between Childhood and Midlife

1,037 individuals (0-38 yrs old); marijuana use reported at 18, 21, 26, 32 and 38 yrs old; IQ at 13 and 38 yrs old

Source: Meier MH et al., PNAS Early Edition 2012
HOW DOES MARIJUANA IMPACT LIFE OUTCOMES?

Tetrahydrocannabinol (THC)
Active Ingredient in Marijuana
Similar to Early Alcohol or Tobacco Use, Early Marijuana Use Increases Likelihood of Using Other Drugs

Drug Use in Twin Pairs Discordant for Cannabis Use Before Age 17

Marijuana: Impact on Outcomes

More frequent use in adolescence and adverse outcomes

Silins E et al., The Lancet September 2014.
Marijuana and Mental Illness

Marijuana use increases risk for psychosis in people with specific genetic risk factors

Regular Cannabis Use Increases Schizophrenia Risk in those with AKT1 rs2494732 genotype

Di Forti et al., Biological Psychiatry, 2012.
ARE THERE THERAPEUTIC BENEFITS OF MARIJUANA?
Marijuana as Medicine?

• Promise lies in purified ingredients (e.g., CBD) or synthetic compounds with more selectivity, less adverse effects

• Applications: pain, nausea, wasting, obesity, muscle spasticity, addiction, inflammatory conditions, HIV

• NIH research focuses on THC, CBD, and compounds that alter the function of the endocannabinoid system
Adolescent Brain Cognitive Development (ABCD) Study

Ten year longitudinal study of 10,000 children from age 10 to 20 years to assess effects of drugs on individual brain development trajectories
Summary

- Marijuana is the most commonly used illicit drug in US
- Use generally begins in adolescence
- Wide range of effects on brain, body, and behavior
- Policy landscape changing
- Impact of policies need further research
- Science can/should inform policy