Marijuana Use in Adolescents

- No disclosures
- No conflicts of interest

Marijuana Use in Adolescents

Goals:
1. Provide data about cannabis
2. Review adolescent brain development
3. Delineate specific concerns re cannabis in young populations
4. Review synthetic marijuana
Marijuana Use in Adolescents:
Statistics
NIDA. Monitoring the Future: 2016 Survey

Percent of Students Reporting Use of Marijuana in Past Year, by Grade

Past-Year Use of Marijuana Among 12th Graders for Medical Marijuana States vs. Others
Marijuana Use in Adolescents: Iowa Statistics

Marijuana Use in Adolescents: Vocabulary

- Vocabulary associated with cannabis
  - Synonyms: Marijuana, pot, reefer, buds, grass, weed, dope, ganja, herb, boom, gangster, Mary Jane, sinsemilla, joint, blow, blunt, green, doobie, kilobricks, Thai sticks, hash
Marijuana Use in Adolescents: Vocabulary
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  • Synonyms: BHO, wax, shatter, crumble, honey oil, dabs, budder

Marijuana Use in Adolescents: Science
• Cannabis
  • Genus of flowering plants with 3 species: Cannabis sativa, Cannabis indica and Cannabis ruderalis
  • Contains several cannabinoids and several isomers of THC (delta-9-tetrahydrocannabinol)
  • THC: principal psychotropic substance (@20% by wgt)
  • Medical marijuana debate in Iowa: Medical treatment with cannabidiol for epilepsy (Dravet syndrome)

Marijuana Use in Adolescents: Consumption
• Cannabis Consumption
  • Smoked as dried flowers and seeds
  • Concentrated into a waxy substance
  • Ingested as food product (eg, brownies, truffles)
  • Taken in liquid or mouth spray as medication
Marijuana Use in Adolescents: Iowa Statistics

Marijuana Use in Adolescents Pharmacokinetics

- Absorption
  - Faster if smoking/vaping
    - Tar, CO, NO, cyanide: 3-5x > tobacco smoker
    - Ammonia: >20x >tobacco smoker
  - Slower if eaten

- Distribution
  - Half-life in blood and urine: 3-4 days
    - Highly lipid soluble – deposits in fat cells
    - Average duration of positive drug testing
      - Dependent on frequency and intensity of use
      - Heavy user can test positive for up to 60 days
    - Average results of UDS
      - Peak levels: 100-200 ng/mL (10-25 min after smoking)
      - After 3 hours: <5 ng/mL
Marijuana Use in Adolescents: Detection

Marijuana Use in Adolescents: THC Concentration
- THC Concentration
  - Average THC concentration in dried seeds/flowers: 3-5%
  - Average THC in hashish oil: 20%
  - "Medicinal marijuana"/Dabs: THC up to 80-90%

Marijuana Use in Adolescents: Edible Marijuana
- 20-40% of all sales in Colorado ($25-50MM)
- Problems with edibles:
  - Tolerance from smoking doesn't apply
  - GI absorption: Higher than lung absorption
  - Effect may not kick in 1-2 hours
  - Marijuana Enforcement Division: Recommended serving size is 10 mg of THC
  - ASE: High heart rate, mouth dryness, paranoia
Marijuana Use in Adolescents

Colorado Hospital Statistics

Figure 1. Children under 1 year of age: rates of hospitalizations (HS) and emergency department (ED) visits with poisoning-related to marijuana in Colorado.

Figure 2. Rates of hospitalizations (HS) and emergency department (ED) visits with poisoning-related to marijuana in Colorado.
Marijuana Use in Adolescents
Iowa Statistics

Marijuana Use in Adolescents

Marijuana Use in Adolescents
Marijuana Use in Adolescents:

Adolescent Development

- Physiological Changes: Delayed sleep and awakening
- Pubertal Changes: Primary and secondary sex characteristics
- Cognitive Changes: Increased emotionality and risk taking, especially in early/middle adolescence
- Social Changes: Distancing from parents and increased time with peers


Marijuana Use in Adolescents:

Adolescent Brain Development

- Adolescent Brain Processes:
  1. Proliferation
  2. Pruning
  3. Myelination
- Processes enable functional maturation of neural pathways in cortex and subcortical areas

Alcohol. 2010. 44:15-26

Marijuana Use in Adolescents:

Adolescent Brain Development

- Proliferation: Rapid growth of gray matter and formation of new connections
  - Maximal Frontal/Parietal Lobe Gray Matter Volume
    - 10-11 yrs in females, 12 yrs in males
  - Maximal Temporal Lobe Gray Matter Volume
    - 16.7 yrs in females, 16.5 yrs in males
  - Maximal Prefrontal Cortex Gray Matter Volume
    - Occurs in late adolescence (>21yrs)

Trends in Neuroscience. 2006
Marijuana Use in Adolescents: Adolescent Brain Development

- Pruning: Gray matter maturation in which new synaptic connections are formed and others are eliminated
  - Inverted U-shaped developmental curve from childhood to adolescence to adulthood
  - Decreased gray matter volume, especially in PFC
  - Influenced by environmental experiences

  Trends in Neuroscience. 2004

Marijuana Use in Adolescents: Adolescent Brain Development

- Myelination: Progressive enclosure of axons with myelin to speed communication among neurons and stabilize connections
  - Significantly increased cortical white matter from adolescence and into adulthood
  - Increased connectivity of subcortical regions (hippocampus, amygdala, areas with high sex steroid receptors)

  Guerra, Alcohol. 2010.

Marijuana Use in Adolescents: Adolescent Brain Development

- Brain development progresses from
  - Lower to higher brain centers
  - Brain stem to the cerebral cortex
  - Caudal to rostral direction
  - In adolescence, “mismatch” occurs
  - “Bottom-up” thinking trumps “top-down” thinking
  - “Reward” areas of brain trumph “decision-making” areas

  Casey and Jones. JAACAP. 2010.
Marijuana Use in Adolescents: Adolescent Brain Development

Marijuana Use in Adolescents: Adolescent Development

FIGURE 1: Illustration of different developmental courses for sensation seeking and impulsivity. Note: (A) rate of sensation seeking and impulsivity as a function of age (adapted from Steinberg et al. 43); (B) plot of patterns of activity in four regions (adapted from several studies during a right-hand control task across development (adapted from Galvan et al. 16 and Galvan et al. 6); fMRI functional magnetic resonance imaging.

Marijuana Use in Adolescents: Adolescent Development

* What happens when a potentially vulnerable adolescent brain is exposed to substances?
* Research shows:
  1. Gateway Drug Theory
  2. Serious Biopsychosocial Consequences
  3. Disconnect between Adolescent Views and Parental/Guardian Views
Marijuana Use in Adolescents: Gateway Theory

- Definition: Use of a less dangerous drug leads to use of and dependence on harder drugs
- **Younger** age of onset of alcohol/tobacco/MJ:
  - Increased probability of alcohol dependence as adult
  - Increased probability of cannabis dependence as adult
  - Increased probability of progression to “party” drugs or “hard” drugs
  - [NIH Longitudinal Alcohol Epidemiologic Survey, 1992](#)

Marijuana Use of Adolescents: Gateway Theory

- Confounding Factors:
  - Parental substance use
  - Parental divorce
  - Gender of child
  - Childhood sexual abuse
  - Disruptive behavior diagnoses (ADHD/ODD/CD)
  - Peer influences
  - Socio-cultural influences
  - [NIH Longitudinal Alcohol Epidemiologic Survey, 1992](#)

Marijuana Use of Adolescents: Gateway Theory:

- Evidence supporting Gateway Theory:
  - Australian Twin Register Study
    - Volunteer sample of twins born between 1964-1971
    - Interviewed by phone re lifetime substance use/dependence, age of onset and comorbidities
    - 4010 pairs in 26-34 yo range
    - 622 MZ and DZ same-sex twins discordant for THC use
Marijuana Use in Adolescents: Gateway Theory

- Australian Twin Register Study: Results
  - Twin with early cannabis abuse relative to co-twin:
    - Elevated lifetime rates of other drug use: OR 2.34-5.15
    - Elevated lifetime illicit drug abuse/dependence: OR 1.96-3.98
    - Elevated lifetime alcohol dependence: OR 1.85
  - Lynskey et al. JAMA. 2003

- Similar results in other studies
  - Netherlands Twin Register: 6228 twins born between 1965-1980
    - 219 same-sex twin pairs discordant re MJ use
    - Higher rate of alcohol, party, and other drugs
  - At time of interviews, THC was legal in Netherlands but not in Australia, so associations between THC and drug use outcomes NOT solely due to legal status Lynskey. Behavioral Genetics. 2006

- Christchurch, NZ, Study: 1265 children born in 1977
  - 25-year Longitudinal Study
  - Association between THC and illicit drug use: dose dependent
  - Younger users more susceptible to THC effects
  - Other factors: Sexual abuse and novelty seeking
  - Fergusson et al.
Marijuana Use in Adolescents: Biopsychosocial Consequences

- Consequences of Marijuana Intoxication:
  - Euphoria and disinhibition
  - Anxiety/Agitation
  - Altered sense of time
  - Distorted perceptions/Derealization
  - Impaired coordination/reaction time
  - Difficulty with thinking/problem solving
  - Problems with learning/memory
  - Mistrust/Paranoid delusions/Hallucinations

- Consequence of Teen Marijuana Dependence:
  - Decreased motivation
  - Increased likelihood of dropping out of school/job
  - Persistent problems with learning and memory
Marijuana Use in Adolescents: Biopsychosocial Consequences

- Possible Physical Consequences from THC:
  - Cannabinoid Hyperemesis Syndrome
  - Tachycardia, arrhythmias, HTN
  - Deaths from cardiac/cerebral ischemia
  - Chronic bronchitis, COPD
  - Elevated visceral fat deposition/insulin resistance
  - Gingival proliferation
  - Nasopharyngeal tumors

Marijuana Use in Adolescents: Colorado Statistics

Marijuana use and driving (2-5G) among adolescents and young adults.

Marijuana Use in Adolescents: Biopsychosocial Consequences

- Marijuana and Driving in Adolescence
  - 2/3 of US trauma center admissions: MVAs with 60% of patients positive for drugs and/or alcohol
  - DUI with marijuana surpassed rates of DUI with alcohol within past 5 years
    - Kelly et al., Drug and Alcohol Review. 2004
  - One joint/blunt equivalent to BAC of 0.5
  - Driving features most impacted by MJ: Reaction time/Divided-attention tasks/Lane-positioning
  - Increased fatalities when EtOH + THC combined
Marijuana Use in Adolescents: Biopsychosocial Consequences

Marijuana and Driving:
- CO statistics
  - Legal limit for impaired driving with MJ: 5ng/ml

Marijuana Use in Adolescents: Biopsychosocial Consequences

Marijuana and Driving:
- WA statistics
  - 2009-2013: Number of positive THC/carboxy-THC screens increased from 19-29% to 25-40%.
  - 56% of positive results were >5ng/ml

Marijuana Use in Adolescents: Colorado Statistics

<table>
<thead>
<tr>
<th>Marijuana use during pregnancy and breastfeeding (n=191)</th>
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<tbody>
<tr>
<td>Effects on exposed offspring</td>
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<td>Addictive problems</td>
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Marijuana Use in Adolescents: Biopsychosocial Consequences

- Cannabis and Psychosis: Early Research
  - FA Ames in 1950s:
    - Exposed medical staff to controlled doses of cannabis
    - Delusions/VH at lower doses
    - Paranoia at higher doses

Marijuana Use in Adolescents: Cannabis and Psychosis

- Andreasson Study (Sweden):
  - Longitudinal study of 45,570 male Swedish conscripts
  - Followed 15 years
  - Evaluated for frequency of cannabis use
  - Controlled for other psychiatric diagnoses and socioeconomic level
  - Results:
    - High consumers of cannabis (>50 uses): RR of schizophrenia = 6.0, 95% CI 4.0-8.9

- Van Os Study (Netherlands):
  - Longitudinal population-based study 1997-99
  - 4045 individuals psychosis-free at baseline
  - 59 with psychotic symptoms at baseline
  - Any baseline use of THC predicted psychosis: OR=2.76, 95% CI 1.18-6.47 and severe psychotic symptoms: OR=24.17, 95% CI 5.44-107.46
  - Effect of baseline THC increased over time, with >50% of psychotic symptoms attributed to THC use
  - If baseline psychosis AND THC: Risk 54.7% cf to 2.2% without THC
  - Van Os. Am J Epidemiology. 2002
Marijuana Use in Adolescents:
Cannabis and Psychosis

Arseneault, et al Study (Dunedin, New Zealand)
- General population birth cohort study from 1972-73
- 1037 individuals born with 96% F/U at age 26
- Tertiles for cannabis use at ages 15 and 18
- Cannabis use <15 yo:
  - Four times more likely to have schizophreniform dx at age 26
  - BUT nonsignificant when controlled for psychotic sx at age 11

Henquet Study, Germany:
- Four-year prospective study
- 2,437 14-24yo rated as with or without predisposition for psychosis on M-CIDI
- Results:
  - Increasing cannabis consumption associated with increased risk of psychosis
  - Adjusted for age, sex, SES, urbanicity, childhood trauma, baseline predisposition for psychosis, use of other drugs - OR=1.53  Henquet. BMJ. 2005.

Stefanis Study, Greece
- Longitudinal prospective study from 1983 birth cohort
- 3500 19-yo self-reported via Community Assessment of Psychic Experiences
- Controlled for traumatic life events
- First use of cannabis < 16 yo associated with much stronger positive/negative psychotic symptoms than after 16 yo  Stefanis et al. Addiction. 2004
Marijuana Use in Adolescents: Cannabis and Psychosis

- Adjacic-Gross et al Study, Switzerland
  - Prospective community study within 1978 birth cohort
  - 292 males and 299 females sampled initially at 20 yo and again at 30 yo
  - Schizotypal symptoms associated with regular cannabis use in adolescence: OR=2.29, 95% CI 1.32-2.97
  - Schizophrenia nuclear symptoms mainly related to alcohol: OR =1.84 or polysubstance abuse OR=2.35

- Miettunen Study, Finland
  - 6330 15-16yo adolescents
  - Self-reported questionnaire of prodromal psychotic symptoms and drug use (PROD)
  - Controlled for disruptive behavior disorders
  - Cannabis abuse correlated with having >2 positive and negative symptoms of schizophrenia: OR=2.23, 95% CI 1.70-2.94

- Meta-Analysis
  - 11 studies of psychosis
  - 5 adult population-based cohorts
  - 2 birth cohorts
  - Conclusions:
    - Increased risk of any psychotic outcome if cannabis ever used: OR: 1.41, 95% CI 1.20-1.65 (pooled adjusted OR)
    - Results consistent with dose-response effect with most frequent cannabis use conferring OR=2.09, 1.54-2.84 Moore et al. Lancet. 2007
Marijuana Use in Adolescents: Cannabis and Psychosis

Meta-Analysis Conclusions:

- “The evidence is consistent with the view that cannabis increases risk of psychotic outcomes independently of confounding and transient intoxication effects…We conclude that there is now sufficient evidence to warn young people that using cannabis could increase their risk of developing a psychotic illness later in life.” Moore et al. Lancet. 2007.
Marijuana Use in Adolescents: Drug Interactions

- Cannabis Drug Interactions
  - THC + Uppers (amphetamines/cocaine): ↑ heart rate/blood pressure, possible heart damage
  - THC + Downers (BZD/BBT/EtOH/Opioids/Muscle relaxants/CNS depressants/Antihistamines): ↑ sedation and CNS depression
  - THC + EtOH: Significantly ↑ rate of fatal MVAs

Marijuana Use in Adolescents: Medical Marijuana EBM

- Promising EBM
  - CBD for epilepsy (Dravet syndrome)
- Low-to-Moderate-Quality Evidence:
  - Chronic pain (diabetic neuropathy/cancer)
  - Multiple sclerosis/Paraplegia
- Low-Quality Evidence:
  - Nausea from chemotherapy
  - Tourette syndrome
  - Irritable bowel disease
- Very-low Quality Evidence:
  - Depression/Anxiety
  - Sleep disorders
- No Evidence:
  - Glaucoma
  - AIDS-associated anorexia/cachexia/Wasting syndrome
Marijuana Use in Adolescents

- Scientific Evidence re Marijuana: Adverse Effects
  - Long-term Use:
    - Diminished life satisfaction and achievement
    - Chronic bronchitis
    - Increased risk of chronic psychotic disorders, including schizophrenia, primarily in persons with vulnerabilities and/or heavy users

Marijuana Use in Adolescents

- Possible Cannabis Drug Interactions
  - THC + SSRI: Mania
  - THC + TCA: ↑HR, delirium
  - THC + Lithium: ↑lithium concentration
  - THC + Antabuse: Hypomania
  - THC + AIDS drugs: ↓effectiveness
  - THC + Viagra: Myocardial infarction
Marijuana Use in Adolescents: Synthetic Cannabinoids

1. Synthetic cannabinoids are also called what? Check all that apply:
   A. Bath salts
   B. Medical marijuana
   C. K2
   D. Cannabin

2. Synthetic cannabinoids, also called K2, spice, or sometimes herbal incense, refer to a growing class of plant-like substances that are either sprayed on, soaked in, or sprayed on plants that can be smoked or sold as dried herbs. Because they are not the same as hemp or marijuana, some people call them "herb" or "fake weed". Other people call them "street THC" or "spice." These substances can affect the brain more powerfully and differently than marijuana. You can learn more about synthetic cannabinoids at the website go to website or google search for "synthetic cannabinoids."
Marijuana Use in Adolescents: Synthetic Cannabinoids

- Synthetic Cannabinoids
  - A growing number of man-made mind-altering chemical sprayed on dried, shredded plant material or vaporized to get high
  - Effects can be unpredictable and severe or even life-threatening.
  - ASE: Seizures, psychosis, death

Marijuana Use in Adolescents: Synthetic Cannabinoids

- Synthetic Cannabinoids (SCB)
  - Originally developed as potential therapeutic drugs
  - Synthesized from 2000s in clandestine labs
  - Marketed to vulnerable populations as “safe and legal alternatives to marijuana”
  - Act atypically
  - Result in tolerance, addiction, withdrawal
Marijuana Use in Adolescents: Synthetic Cannabinoids - Spice

- Users’ reports:
  - Common: Elevated mood, relaxation, altered perception
  - Other experiences: Extreme anxiety, paranoia, hallucinations
- Poison Control Centers reports:
  - Rapid heart rate, vomiting, agitation, confusion, hallucinations
  - Elevated blood pressure, myocardial ischemia, rare myocardial infarctions

Marijuana Use in Adolescents: Synthetic Cannabinoids - Bath Salts

- Synthetic chemicals related to cathinone
- Abused orally, snorted or injected
- Contain 3,4-methylenedioxyxpyrovalerone (MDPV), mephedrone, methylene and/or other compounds
  - Chemically similar to amphetamines/MDMA (Ecstasy)
  - Raise levels of dopamine in brain similar to cocaine
  - BUT >10 times more potent


Marijuana Use in Adolescents: Synthetic Cannabinoids - Bath Salts

- Users Reports:
  - Euphoria
  - Increased sociability
  - Increased sex drive
  - Severe Intoxication:
    - paranoia, agitation, psychosis


- Poison Control Centers Reports:
  - Racing heart, elevated blood pressure, chest pain
  - Paranoia, hallucinations
  - Violent behavior
  - Panic attacks
  - “Excited delirium”
    - Dehydration
    - Breakdown of skeletal muscle tissue
    - Kidney failure
    - Death


- High Abuse and Addiction Potential
  - Rats: Escalation of drug intake similar to methamphetamine addiction
  - Bath salts users report intense cravings
  - Frequent use: tolerance, dependence, and strong withdrawal symptoms

Marijuana Use in Adolescents: Other Drugs

- Drugs not included but with similar effects:
  - Club Drugs: Ketamine, Ecstasy, aka NMDA, Rohypnol
  - Psychedelics: Salvia, peyote buttons, ‘shrooms
  - Hookah flavored tobaccos

Marijuana Use in Adolescents

- Factors influencing teen opinion re marijuana:
  - Legalization of marijuana recreationally in 7 states
  - Legalization of medical marijuana in 24 states
  - Legalization of cannabidiol in 15 states
  - Adolescent views of marijuana as safe increase with legalization

Marijuana Use in Adolescents

- Scientific Evidence re Marijuana: Adverse Effects
  - Long-term Use:
    - Addiction: 9% all users, 17% adolescent users, 25-50% daily users
    - Altered brain development
    - Poor educational outcome with increased likelihood of dropping out of school
    - Cognitive impairment
    - Lower IQ among frequent users in adolescence
    - Volkow. NEJM. 2014.
Marijuana Use in Adolescents: Adolescent vs Parental Views

Adolescent Views:
- Adolescents generally over-estimate parental approval of EtOH and THC use
- >68% of adolescents do NOT believe daily drinking or binge drinking represents "great risk" for harm
- 52.5% of adolescents do NOT perceive great risk in smoking THC once or twice a week

Marijuana Use in Adolescents: Adolescent vs Parental Views

Adolescent Views:
- 65% of 8th graders / 84% of 10th graders rate "very easy" or "fairly easy" access to EtOH
- 48.6% of 12-17 yo rate easy access to THC
- 19.0% of 12-17 yo rate easy access to cocaine
- 12.9% of 12-17 yo rate easy access to LSD
- 11.6% of 12-17 yo rate easy access to heroin
- SAMHSA. NSDUH. 2010.
Marijuana Use in Adolescents: Adolescent vs Parental Views

**Adolescent Views:**
- 89.6% believe parents would strongly disapprove of trying MJ or hashish 1-2 times
- 4.4% who perceive strong parental disapproval use THC
- 32.8% who do NOT perceive strong parental disapproval use THC


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Marijuana Use in Adolescents: Adolescent vs Parental Views

**High-school/College Athletes:**
- Greater acceptance of EtOH abuse by peers
- More binge/heavy drinking than nonathletes
- More drinks provided to them, both at home and in the community
- Male college athletes: 75-93% use EtOH
- Female college athletes: 71-93% use EtOH


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Marijuana Use in Adolescents: Adolescent vs Parental Views

**High-school/College Athletes:**
- Swimming, tennis associated with low substance abuse
- Rare "stimulant stacking" and steroids to enhance performance (cycling, track and field, baseball, gymnastics)
- Higher risks for later abuse/dependence of alcohol and opioids (football, soccer, rugby)
Marijuana Use in Adolescents: Adolescent vs Parental Views

- >50% of parents are unaware when children are abusing substances [Windle, Pediatrics. 2008]
- UM Mott Children’s Hospital National Poll questions:
  1. Nationally, what % of 10th graders do you think have used alcohol in the past 12 months (in quintiles)?
  2. Nationally what % of 10th graders do you think have used marijuana in the past 12 months?
  3. Did your [x-yo] drink alcohol in the last 12 mo?
  4. Did your [x-yo] use marijuana in the last 12 mo?
Marijuana Use in Adolescents: Adolescent vs Parental Views

- **Parental Views:**
  - Parents underestimate their own influence
  - Century Council - 2012 Report: 83% of youth cite parents as leading influence in decision to not drink or only drink occasionally, up from 55% in 2003
  - Parents seek information about teens’ substance use and social norms from other parents

- **Four basic types of parenting:**
  - Authoritarian
  - Permissive
  - Uninvolved
  - Authoritative
Marijuana Use in Adolescents: Adolescent vs Parental Views

- Parenting Styles:
  - Authoritarian, Permissive, and Uninvolved Styles:
    - Associated with increased disruptive behavior disorders
    - Associated with higher risk of substance abuse
  - Authoritarian Style
    - Associated with better communication/relationships
    - Associated with better self-esteem/health in teens
    - Associated with increased high school/college graduation
    - Associated with decreased substance use


Marijuana Use in Adolescents: Realistic Expectations

- Valid, reliable information provided to children, adolescents, parents and the community can make a change!
Questions???