Current Trends in Marijuana Methods of Ingestion and Associated Problems Among Young Adult Marijuana Users

Maryia M. Schneider

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CURRENT TRENDS IN MARIJUANA METHODS OF INGESTION AND ASSOCIATED PROBLEMS AMONG YOUNG ADULT MARIJUANA USERS

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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has been approved as meeting the requirement for the Degree of Doctor of Philosophy in College of Education and Behavioral Science in Department of School Psychology, Program of School Psychology

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ABSTRACT


The legal status of marijuana in the United States has been ever changing in the last few years, with many states legalizing marijuana for medicinal as well as recreational use—leading to increasing numbers of retail outlets. This rise in retail outlets has led to diversified methods of marijuana ingestion. The current study sought to understand the effect of methods of ingestion on frequency of use, problematic use, marijuana use motives, mental health, and marijuana use trajectories measured over five years. Additionally, the current study sought to understand the effect of contextual factors on method of ingestion and source of marijuana as well as transitions in methods over five years. Finally, this study strived to understand differences in endorsed reasons for choosing certain methods of ingestion. MANCOVA, Chi-square, Fisher’s Exact, and Ordinal logistical regression analyses were conducted on a sample of 257 participants. The current study found that method of ingestion was not significantly related to frequency of use, problematic use, use motives, mental health, nor use trajectories. This study did find significant relationships regarding certain contextual factors as well as endorsed reasons for choosing certain methods of ingestion. These results serve as a foundation in understanding the relationship between methods of ingestion and associated problems, to help support prevention and intervention strategies and mitigate negative results of marijuana use.
Keywords: Marijuana, Methods of Ingestion, Potency, Dabbing, Vaping, Smoking, Oral, Concentrates, Edible, Flower.
ACKNOWLEDGEMENTS

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To Dr. Phillips, I cannot express how thankful I am for your persistent belief in me. Even through the tribulations I faced throughout this process, your support was constant and your dedication to this dissertation as well as guiding me through grad school has been evident every step of the way. I am incredibly grateful to have gone through this incredible, but difficult, process with you.

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CHAPTER I
INTRODUCTION

Attitudes towards marijuana in the United States have been changing over the last few years (Gallup, 2017). This has given rise to multiple states legalizing marijuana use for adult medicinal and recreational use. It is still very unclear what effect this legalization will have on state economics, legal systems, and public health. Rates of marijuana use among Americans is high, with 38.7% of young adults ages 18-25 reporting marijuana use in the past year and 22.1% reporting use in the past month (Substance Abuse and Mental Health Services Administration, 2019). Rates of marijuana use among school-aged youth are increasing, with 16.7% of youth ages 12-17 reporting use in the past year, and 6.6% reporting use in the past month (Substance Abuse and Mental Health Services Administration, 2019). These numbers may be even higher, as several states have legalized marijuana for medicinal and/or recreational purposes following this annual publication. A body of evidence specific to recreational marijuana use is urgently needed to guide, prioritize, and evaluate public health and policy efforts (Allen et al., 2017).

When considering marijuana use, it is important to discuss changes in methods of ingestion over recent years, as more methods have become accessible to users with the changing legalization climate. The following introduction outlines a study that examines current trends and associated problems related to marijuana use ingestion among young adult marijuana users.
Significance of the Problem

Marijuana is the most commonly used, federally illicit drug in the United States. Attitudes towards marijuana have become increasingly more accepting, with 64% of adults in favor of recreational use (Gallup, 2017). These increasingly accepting attitudes have given rise to legalization of marijuana for both medical and recreational use. As of May 2020, marijuana is legal for adult recreational use in 11 states and the District of Columbia, and medicinally legal in 46 states with considerable state-to-state variation in the regulations and laws in each state (National Conference of State Legislatures, 2020). The changing legal status of marijuana in the United States has led to increasing diversity and availability of methods of ingestion, as well as increased potency in the marijuana.

Currently, minimal research exists on the effects that methods of marijuana ingestion may have on different outcomes. Looking into effects of method of ingestion becomes increasingly important as marijuana becomes legal for adult recreational use in more states. Method of marijuana ingestion has the potential to influence one’s use (e.g. ability to vape or use edibles in public, leading to increased frequency), and research is needed to understand these possible influences and guide prevention and intervention strategies as well as public policy.

Marijuana is defined as a “Schedule 1” substance by the Federal Drug Enforcement Agency. A “Schedule 1” substance is defined as a substance with no accepted medical use and a substantial risk of addiction (Comprehensive Drug Abuse Prevention and Control Act, 1970; Federal Controlled Substance Act, 1970). Ninety-two million (28.6%) Americans ages 12-25 reported marijuana use in the past month. Approximately 1.6 million (6.5%) adolescents reported marijuana use in the past month.
in 2017, similar to the percentages in 2015 and 2016. In contrast, 7.6 million (22.1%) young adults ages 18-25 were current users of marijuana in 2017, which is higher than the percentages between 2002 and 2016 (Substance Abuse and Mental Health Services Administration, 2018). These numbers are alarming, especially given that the legal age of consumption for marijuana in states with recreational use is age 21. In addition to high prevalence rates for adolescents, research has shown there is a high level of similarity in the median age of initiation for marijuana, with a median age of onset across multiple countries between 18 to 19 years of age (Degenhardt et al., 2008). These numbers are concerning for school psychologists, as many adolescents will begin using marijuana during high school. School psychologists are in prime positions to aid in prevention and intervention efforts across multiple settings for those who are starting use before high school graduation.

Marijuana refers to the dried leaves, flowers, stems, and seeds harvested from the *Cannabis sativa* or *Cannabis indica* plant. Delta-9-tetrahydrocannabinol (THC) is the primary proactive ingredient in marijuana (National Institute on Drug Abuse, 2018), giving marijuana its mind-altering effects. Marijuana is comprised of many cannabinoids unique to the plant. There are several subclasses of cannabinoids that are most commonly studied including THC and Cannabidiol (CBD). CBD does not produce mind-altering effects. Researchers, including the National Institute of Health (NIH) are exploring the possible uses of CBD for medical treatment (National Institute on Drug Abuse, 2018b). While related to THC, CBD is not the focus on the current study. Marijuana can be consumed in many ways, including: smoking (inhaling via small pipes/joints/blunts/water pipes), vaping (inhaling a smokeless vapor associated with marijuana), dabbing
(ingesting a more concentrated form of marijuana), oral (edible), and sublingually/topically (applying tinctures/creams to the skin). Methods of ingestion have been changing rapidly in the new legalization climate. In addition, many forms of marijuana are being used, including marijuana (flower), dabs (highly concentrated forms), edibles, and topical formulations. Marijuana dispensaries or retail stores are motivated to increase sales through increasing the variety of products available to consumers (Borodovsky, Crosier, Lee, Sargent, & Budney, 2016; Pacula, Kilmer, Wagenaar, Chaloupka, & Caulkins, 2014; Pacula, Powell, Heaton, & Sevigny, 2015).

Many adverse short- and long-term consequences of marijuana use have been identified through research. Marijuana has been associated with cognitive (e.g., Solowij et al., 2002; Tapert, Schweinsburg, & Brown, 2008), psychological (e.g., Hall & Pacula, 2003; Kalant, 2004), and injury-related factors (e.g., Hall & Pacula, 2003). Long-term, chronic marijuana use is associated with marijuana dependence, as well as tolerance and withdrawal symptoms (Budney & Hughes, 2006; Budney, Moore, Vandrey, & Hughes, 2003; Chen, Storr, & Anthony, 2009; Copersino et al., 2006; Davis, Smith, Morphew, Lei, & Zhang, 2016; Hasin et al., 2015; Hasin et al., 2017; Karila et al., 2014; Katz, Lobel, Tetelbaum, & Raskin, 2014; Kouri & Pope, 2000; Volkow, Baler, Compton, & Weiss, 2014; Wen, Hockenberry, & Cummings, 2015). Regular marijuana smokers report pulmonary concerns (e.g., Owen, Sutter, & Albertson, 2014; Tashkin, Baldwin, Sarafian, Dubinett, & Roth, 2002). Research has consistently found long-term marijuana use to be associated with cognitive deficits across multiple areas (see Crane, Schuster, Fusar-Poli, & Gonzalez, 2013 and Solowij & Battisti, 2008 for reviews), neurological changes (see Broyd, van Hell, Beale, Yücel, & Solowij, 2016 for a review), and numerous
psychosocial factors (e.g., education, psychological; Agrawal, Neale, Prescott, & Kendler, 2004; Fergusson & Boden, 2008; Hall, 2009; Hall & Degenhardt, 2007; Heitzeg, Cope, Martz, Hardee, & Zucker, 2015; Lynskey & Hall, 2000; Patton et al., 2002; Volkow et al., 2014). These studies have failed to assess the role method of ingestion could have on frequency, problematic use, motives for use, and general mental health outcomes.

In the last decade, research on the developmental trajectories of marijuana use has been increasing. This research uses group-based developmental trajectory methods to understand longitudinal patterns of substance use and identify subgroups of users (Kosty, Seeley, Farmer, Stevens, & Lewinsohn, 2016; Scholes-Balog, Hemphill, Evans-Whipp, Toumbourou, & Patton, 2016). This research is important as it can identify subgroups of youth who will escalate to regular and heavy use, and risk factors associated with these chronic patterns. Studies have found between three and seven developmental trajectory patterns of marijuana use from adolescence to adulthood, with large samples delineating more developmental trajectories (e.g. Homel, Thompson, & Leadbeater, 2014; Schulenberg et al., 2005; Terry-McElrath et al., 2017; Windle & Wiesner, 2004). Across these developmental trajectory studies, it was found that between 8.3-28% of those who initiate marijuana use escalate to monthly or more frequent use (Brook, Zhang, Leukefeld, & Brook, 2016; Ellickson, Martino, & Collins, 2004; Flory, Lynam, Milich, Leukefeld, & Clayton, 2004; Homel et al., 2014; Scalco & Colder, 2017; Scholes-Balog et al., 2016; Terry-McElrath et al., 2017). Many of these studies found that early, high level marijuana users had less favorable outcomes compared to other, lower use trajectory groups (e.g. Ellickson, Martino et al., 2004; Homel et al., 2014). Many risk
factors have been associated with chronic heavy or increasing developmental trajectories including: emotional dysregulation (Brook et al., 2016); aggressive and antisocial behavior (Passarotti, Crane, Hedeker, & Mermelstein, 2015); conduct problems (Ellickson, Martino et al., 2004; Flory et al., 2004; Hix-Small, Duncan, Duncan, & Okut, 2004; Scalco & Colder, 2017; Windle & Wiesner, 2004); psychiatric disorders (Flory et al., 2004; Windle & Wiesner, 2004); temperament (Scalco & Colder, 2017); novelty seeking (Brook et al., 2016; Ellickson, Martino et al., 2004; Flory et al., 2004; Hix-Small et al., 2004; Passarotti et al., 2015), to name a few. None of these studies have sought to understand the role method of ingestion may have on subgroup membership.

Studies have shown contextual factors (e.g., availability, price) of a substance have many influences on individual use as well as the population as a whole. Research has found substantial decreases in the price of marijuana since its legalization (Caulkins, Kilmer, MacCoun, Pacula, & Reuter, 2011; Hall & Lynskey, 2016). Across states where marijuana is legal, there is considerable variation in their laws regarding the number of dispensaries. Studies have found higher dispensary density to be related to higher likelihood of using a variety of methods of ingestion (e.g. Borodovsky et al., 2016, 2017; Daniulaityte et al., 2015). The allowance of home cultivation also varies by state, but research has found home cultivation to be associated with higher likelihood and younger age of onset of marijuana edible use among youth ages 14 to 18 (Borodovsky et al., 2017). Methods of marijuana ingestion available in a location can depend on its legal status, and research is needed to identify emerging trends to inform timely prevention and policy measures, as well as minimize potential dangers of certain methods (Daniulaityte
et al., 2015; Gourdet, Giombi, Kosa, Wiley, & Cates, 2017; Schauer, King, Bunnell, Promoff, & McAfee, 2016).

As increasing methods of marijuana ingestion become available, researchers have explored reasons for selecting certain methods of ingestion. These studies have found that marijuana users endorsed unique reasons for preferring a method of ingestion that vary by the specific methods studied (e.g. safer to use, stronger intoxication effect, is easily accessible, less side effects; Giombi, Kosa, Rains, & Cates, 2018; Lee, Crosier, Borodovsky, Sargent, & Budney, 2016; Loflin & Earleywine, 2014). Further research is necessary in this area to understand if these endorsed reasons for preferring a method of ingestion vary across all methods of marijuana ingestion, as well as if they vary across other variables including gender, age, and legal status of marijuana.

**Purpose Statement**

Building off of two social-cognitive/contextual developmental models proposed by Mayes and Suchman (2006; presented in chapter two), this descriptive, cross-sectional study sought to understand how young adult marijuana users have transitioned from one method of marijuana ingestion to another method, how contextual factors might play into their choice of method, and how reasons for using particular methods differ. In addition, this study examined how these factors may be associated with marijuana use and associated psychological problems. Primary methods of marijuana ingestion were as follows: joints, blunts (cigar sized joints), hand pipe, bong (water pipe), hookah, vaporizer (e.g. volcano, vape pen), dab rigs, edibles, and other. Primary types of marijuana ingested included: marijuana (flower), concentrates/dabs, edibles, and other. Demographics were important to this study in order to help identify characteristics and
factors contributing to significant differences across outcomes, transitions, patterns, and reasons for using certain methods. The specific research questions and hypotheses addressed by this study are:

Q1  Are certain methods of marijuana ingestion related to higher frequency of use and problematic use?

H1  Methods of ingestion with immediate effects (i.e. smoking, vaping, dabbing) and potential higher potency (i.e. vaping, dabbing, oral) lead to increased frequency of use and problematic use.

Q2  Are certain methods of ingestion related to specific motives for use?

H2  Motives for marijuana use vary by primary method of ingestion, and methods with immediate effects and higher potency are related to coping motives for use.

Q3  Are certain methods of ingestion associated with negative mental health outcomes?

H3  Methods of ingestion with immediate effects (i.e. smoking, vaping, dabbing) and potential higher potency (i.e. vaping, dabbing, oral) lead to worse general mental health outcomes (e.g. anxiety and depression).

Q4  Are certain methods of ingestion related to historical and current patterns of use in terms of frequency and transitions in methods from age of onset to current use?

H4  Chronic and escalating marijuana use patterns are related to methods of ingestion with immediate effects and potential higher potency. Additionally, users with multiple transitions between methods of ingestion are related to chronic and escalation marijuana use patterns.

Q5  Are primary methods of ingestion influenced by contextual factors (e.g., availability or awareness of methods)?

H5  Primary method of ingestion is influenced by availability (e.g. legal status).

Q6  Are endorsed reasons (e.g. safety, type of high, price) for using certain methods different across methods of marijuana ingestion?

H6  Marijuana users endorse distinct reasons (e.g. safety, type of high, price) for utilizing certain methods of ingestion.
Delimitations

This research study has several delimitations. The participants for this study were self-selected among people recruited through a web forum, which can increase the potential for non-generalizable results. Since the survey was anonymous and no IP addresses were collected, it was not possible to identify repeat respondents, if any. Compensation was not provided for completing the survey, aside from participants recruited through MTurk who received a small monetary incentive. Limited or no compensation is a method known to discourage deception and repeat responses (Bowen, Daniel, Williams, & Baird, 2008). Compensation was provided to participants recruited through MTurk as it is required as a part of using their platform. Furthermore, the data for this study were self-reported; however, there is substantial support for the reliability and validity of self-reported data on substance use behaviors (Adair, Craddock, Miller, & Turner, 1995), and data obtained via web-based self-administration (Miller et al., 2002). Another delimitation of this study is the cross-sectional nature of the data. Longitudinal studies are required to understand causal relationships between methods of marijuana ingestion and associated problems.

Summary

With increasing numbers of states legalizing marijuana for medical as well as recreational use, a thorough understanding of methods of ingestion is necessary as methods of ingestion are becoming increasingly diversified and accessible. The current study is increasingly important, as marijuana is legalized in more states across the United States, to help further the research based on marijuana as well as any potential negative
outcomes that could arise from its legalization. This research can be used to inform prevention and intervention programs for youth as well as young adults.
CHAPTER II

REVIEW OF THE LITERATURE

Prevalence and Legal Status

In the United States, marijuana is the most commonly used, federally illicit drug. As of 2018, 43.5 million Americans ages 12 or older were currently users of marijuana, an increase of nearly 20 million since 2017 (Substance Abuse and Mental Health Services Administration, 2018; Substance Abuse and Mental Health Services Administration, 2019). Attitudes towards marijuana use have been changing over the last few years, with increasing numbers of individuals in favor of legalization of marijuana for recreational use (Gallup, 2017). This has given rise to multiple states legalizing marijuana use for adult medicinal and recreational use. It is still unclear how legalization will affect legal systems, state economies, social service systems, and public health.

Historical Background

Prior to 1970, marijuana was legal in the United States, and was dispensed through physicians and pharmacists for various medical purposes. In 1937, the Federal Marijuana Tax Act was passed. This act did not prohibit the distribution of marijuana. If one obtained a federal stamp and paid an annual tax or license fee, they were able to distribute medicinal marijuana. However, there was no application process and the stamps were unavailable. This effectively outlawed the growth and distribution of marijuana in the United States (Carliner, Brown, Sarvet, & Hasin, 2017; McKenna, 2014; Pacula, Chriqui, Reichmann, & Terry-McElrath, 2002). In 1970, the Federal Drug
Enforcement Agency defined marijuana as a “Schedule 1” substance, with the 1970 Comprehensive Drug Abuse Prevention and Control Act, more commonly known as the Federal Controlled Substances Act of 1970. This act placed all controlled substances into five categories, or schedules related to their potential for abuse as well as recognized medical usefulness. A “Schedule 1” substance is defined as a substance with no accepted medical use and a high risk of addiction (Comprehensive Drug Abuse Prevention and Control Act, 1970; Federal Controlled Substances Act, 1970). This act made the use of marijuana illegal in the United States and implied that there was no currently accepted medical use for marijuana.

Current Legal Status

Currently as of May 2020, marijuana is legal for adult recreational use in 11 states and the District of Columbia, and medicinally legal in 46 states with considerable state-to-state variation in the specific provisions of the laws (National Conference of State Legislatures, 2020). A list of the states and their approved laws related to marijuana can be found in Table 1. Marijuana is still classified as a “Schedule 1” substance and considered federally illegal, however, on January 4th, 2018 Attorney General Jefferson B. Sessions issued a memorandum regarding marijuana enforcement, rescinding previous nationwide guidance specific to marijuana enforcement, the Cole memorandum. Sessions stated that enforcement of applicable marijuana laws, regulations, and appropriations will be determined by prosecutorial discretion (Sessions, 2018).
<table>
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As marijuana use has become legal in many states, attitudes towards marijuana have become increasingly more accepting. The percentage of U.S. adults in favor of legal recreational use has been steadily increasing with a majority of Americans in favor of legalization since 2013, and currently resides at 64% in favor of recreational use. This is a drastic change from the 12% of Americans in favor of legalization in 1969 (Gallup, 2017). This increasingly favorable view of marijuana is also reflected on surveys completed by adolescents in the U.S. In the Monitoring the Future (MTF) study, adolescents who perceived moderate or great risk in occasional marijuana use decreased between 1991 and 2015, from 84.0% to 53.8% (Keyes, et al., 2016). Similar trends were observed in the National Survey on Drug Use and Health (NSDUH), with almost half of 12th graders reporting no or slight perceived harm in using marijuana once or twice a week—an increase of almost 25% from 2006 (Azofeifa et al., 2016; Pacek, Mauro, & Martins, 2015; Sarvet et al., 2017). Although perceived risk in marijuana use is decreasing among those ages 12-17, rates of marijuana use in this group have not...
increased. However, there has been an increase in use for those ages 18 and older (Azofeifa et al., 2016).

**Prevalence**

Approximately 2 million (7.9%) adolescents ages 12-17 in the U.S. report using illicit drugs in the last month in 2017, while 8.3 million (24.2%) young adults ages 18-24 reported illicit drug use. As stated previously, the most commonly used illicit drug among these age groups is marijuana, with 9.2 million (28.6%) Americans ages 12-25 reporting marijuana use in the past month. Approximately 1.6 million (6.5%) adolescents reported marijuana use in the past month in 2017; this number is similar to the percentages in 2015 and 2016. However, 7.6 million (22.1%) young adults ages 18-25 were current users of marijuana in 2017; this number has increased and was higher than the percentages between 2002 and 2016 (Substance Abuse and Mental Health Services Administration, 2018). In comparison, 2.5 million (9.9%) adolescents ages 12-17 drank alcohol in the last month, with estimates of current alcohol use among adolescents decreasing over the last 15 years. For young adults, 19.3 million (56.3%) reported alcohol use in the last month, which has been relatively stable over the last 15 years (Substance Abuse and Mental Health Services Administration, 2018). Past month marijuana use among adolescents appears relatively stable, while alcohol use has been decreasing. For young adults, past month alcohol use has been relatively stable, however past month marijuana use has been increasing. These trends are concerning given that marijuana is still illegal for recreational use in many states across the United States, and similar to alcohol, the legal age of consumption for marijuana in places where it is legal is 21.
Little research has been completed with states that have passed recreational marijuana laws, and the research that does exist shows mixed results regarding increases in adolescent marijuana use after passing of medical and/or recreational marijuana laws. Carliner and colleagues (2017) reported that studies looking into the relationship between changes in adolescent marijuana use and passing of medical marijuana laws (MMLs) found there was no effect of MMLs on prevalence of adolescent use. However, another study found perceived harmfulness among eighth and 10th graders in Washington decreased 14.2% and 16.1% respectively, while marijuana use increased 2.0% and 4.1% post legalization, while in Colorado no differences in perceived harmfulness or past-month use were found (Cerdá et al., 2017). Colorado has developed a committee to monitor concerns related to marijuana. In their most recent summary, marijuana use was found to have been stable among high school students since 2005, and middle school students since 2011. However, they found increased edible use, 27.8% to 35.6%, from 2015 to 2017 (Retail Marijuana Public Health Advisory Committee, 2018). Additional trends demonstrate increases in marijuana-related emergency department visits especially among adolescents ages 12-17, increases in hospital admissions where patients received a marijuana related substance use disorder diagnosis, increases in marijuana exposure poison center calls, and a significant increase (tripling between 1999 and 2010) in marijuana metabolites in the blood of fatal accident drivers (Brady & Li, 2014; Davis, Mendelson et al., 2016; Wang et al., 2017; Zhu & Wu, 2016).

**Defining Marijuana and Methods of Ingestion**

Marijuana refers to the dried leaves, flowers, stems, and seeds harvested from the *Cannabis sativa* or *Cannabis indica* plant. Delta-9-tetrahydrocannabinol (THC) is the
primary proactive ingredient in marijuana (National Institute on Drug Abuse, 2018). This ingredient is what gives marijuana its mind-altering effects, and what makes it attractive to users because this effect can function as a reinforcer. The reinforcing effects of THC are mediated by cannabinoid CB1 receptor through the activation of the mesolimbic dopamine system, otherwise known as the brain’s reward system which mediates a range of reinforcing stimuli (Cooper & Haney, 2009). The strength of the desirable or mind-altering effect is determined by multiple factors including the dose or potency as well as the method of ingestion used (Budney & Borodovsky, 2017). Marijuana with higher levels of THC generally delivers higher levels of the desirable or mind-altering effects than lower potency marijuana. Therefore, marijuana users are more likely to ingest higher potency marijuana, because of its higher reinforcing effects. Higher potency marijuana can increase the chances of cannabinoid-induced behavior and physiological dependence (Cooper & Haney, 2009; Cooper & Haney, 2009b). Average potency for flower samples in the state of Colorado in 2017 was 19.6%, while for concentrate products the potency was on average 68.6%. Of note, there were some outlier concentrate products with potency at 90% or above (Orens, Light, Lewandowski, Rowberry, & Saloga, 2018).

In addition to dose/potency, the method of marijuana ingestion contributes to the level of intoxication of the marijuana user (see Table 2 for a summary of the speed of and length of intoxication effect for each method of ingestion; Abrams et al., 2007; Corral, 2001; Huestis, 2007; Huestis, Henningfield, & Cone, 1992; Isbell et al., 1967; Lemberger, Crabtree, & Rowe, 1972; Perez-Reyes et al., 1973). Marijuana can be administered via smoking, vaping, dabbing, orally, and sublingually/topically and these methods of ingestion have been changing rapidly in the new legalization climate.
diversity may be partially influenced by marijuana dispensaries, or retail stores, that are
motivated to increase sales through increasing the variety of products available to
consumers (Borodovsky et al., 2016; Pacula et al., 2014; Pacula et al., 2015).

Table 2

<table>
<thead>
<tr>
<th>Method of Ingestion</th>
<th>Speed of Intoxication</th>
<th>Length of Effects</th>
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</thead>
<tbody>
<tr>
<td>Smoking</td>
<td>Immediate</td>
<td>1 to 4 hours</td>
</tr>
<tr>
<td>Vaping</td>
<td>Immediate</td>
<td>1 to 4 hours</td>
</tr>
<tr>
<td>Dabbing</td>
<td>Immediate</td>
<td>1-2 hours strong, then 3-4 medium</td>
</tr>
<tr>
<td>Oral</td>
<td>Delayed</td>
<td>Over 6 hours*</td>
</tr>
<tr>
<td>Topical</td>
<td>**</td>
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</table>

*Note: *depending on the dose ingested; **no information available

When smoking marijuana, one uses small pipes, joints, blunts, or water pipes to
inhale smoke created from the burning of the flower form of marijuana. The effects of
smoking marijuana can be felt almost immediately as the THC passes from the lungs
directly to the blood stream, which then carries the chemical to the brain (National
Institute on Drug Abuse, 2018). These effects last approximately 1 to 4 hours (Huestis et
al., 1992). Smoking marijuana also produces negative or undesirable effects, including
the delivery of known carcinogens into the body and numerous alterations in lung
functioning (Tashkin et al., 2002).

Marijuana can also be ingested by using electronic-cigarettes (e-cigarettes) and
other vaping devices. These devices heat liquid (often in cartridge form) or solid
preparations of marijuana and other substances to create a smokeless vapor with
psychoactive compounds (e.g. nicotine, THC) that the user inhales. When vaping, the
effects of the ingested marijuana can be felt immediately, similar to smoking marijuana,
and it has a similar duration (Abrams et al., 2007). Vaping reduces carcinogenic toxins
that are typically consumed when inhaling combustible marijuana and tobacco smoke
because one is inhaling the vapors, rather than the actual smoke (Van Dam & Earleywine, 2010). Vaping has been perceived as a healthier alternative and less risky than traditional methods of consuming tobacco and marijuana (Camenga et al., 2015). However, as discussed below, recent research has shown that many patterns of lung injury have been reported with vaping (Henry et al., 2020).

Dab(s) is a colloquial term that refers to a more concentrated form of marijuana, butane hash oil (BHO). BHO is created through the extraction of THC using butane as a solvent from the flower form of marijuana (Meier, 2017). This form resembles a hard, wax-like concentrate. BHOs can reach THC levels anywhere from 70% to 90%, compared to flower forms which have ranges that are nearly 10 times lower. “Dabbing” is the term used to describe the ingestion of BHO, while “dab” is the oil/wax placed on a heated glass or titanium rod (as part of a “dab rig”), typically heated with a blow torch. This vaporizes the substance, allowing the user to inhale the vapors (Loflin & Earleywine, 2014). This method of marijuana ingestion also has similar effects to smoking in regard to how quickly the effect is felt, however, the effects of this method are typically much stronger and remain stronger longer due to the higher levels of THC. Morean, Kong, Camenga, Cavallo, and Krishnan-Sarin (2015) found that adolescents who vape marijuana most often use highly potent oil, wax, or liquid preparations.

Edibles refer to marijuana infused products that one is able to ingest orally. These can include products such as baked goods, drinks, and candy. The effects of this method of ingestion can be delayed in comparison to smoking and vaping. Often, the effects may not be felt for 30 minutes to an hour, because it must first be digested. This method of ingestion delivers less THC into the blood stream than smoking and vaping, however
because of the delayed effect, individuals may consume more THC than intended which can lead to unexpected highs (Allen et al., 2017; National Institute on Drug Abuse, 2018). Additionally, the effects of orally ingesting marijuana can last over 6 hours depending on the dose ingested (Lemberger et al., 1972). These products historically have been frequently inaccurately labeled, with variable doses of marijuana’s proactive ingredient THC (Vandrey et al., 2015). Most edible products currently in the market lack empirically based packaging regulations, proactive ingredient levels, and safety standards (Benjamin & Fossler, 2016; Cao, Srisuma, Bronstein, & Hoyte, 2016). In some states where marijuana use is legal, there are laws in place to limit the attractiveness of edibles to youth and require child-resistant packaging, due to increases in edible marijuana overdoses among children and adolescents (Wang et al., 2016).

Another method of administration for marijuana is sublingually or topically. This involves applying lotion, balm, a transdermal patch, oil, or spray to the skin. It appears that many of these topical methods include cannabidiol (CBD), which is a type of cannabinoid that tends to be non- or less psychoactive compared to THC. One form of CBD (Epidiolex) was recently approved by the Food and Drug Administration (FDA) for medical use to treat two forms of severe epilepsy (Gottlieb, 2018; National Institute on Drug Abuse, 2018b). However, since this is a rapidly developing method of administration for marijuana, limited research is available regarding the many forms this topical administration can take.

A body of evidence specific to recreational marijuana use is urgently needed to guide, prioritize, and evaluate public health and policy efforts (Allen et al., 2017). Regulatory processes in states that allow marijuana determine how products can be
created, distributed, and accessed. These regulations can influence marijuana use age of onset, frequency and quantity of use, as well as the progression to problematic marijuana use (Budney & Borodovsky, 2017). The following review will provide the theoretical background for a study that will examine current trends and associated problems related to marijuana ingestion among young adult marijuana users.

**Theoretical Background**

As mentioned earlier, there is a high level of similarity in the median age of onset for marijuana use (Degenhardt et al., 2008). This suggests that there may be similar paths certain individuals take to their initiation of use, as well as potential development of substance use problems. Mayes and Suchman (2006) have proposed a developmental pathway to initiation of substance use among adolescents (Figure 1; added with permission from Dr. Mayes), as well as the progression of substance use in adolescence into dependence (Figure 2; added with permission from Dr. Mayes). These models include many mechanisms that contribute along these paths and are associated with greater likelihood of negative outcomes.

In Figure 1, a set of pathways leading to the initiation of substance use in adolescence is shown. These pathways include individual as well as contextual factors. They propose that genetic factors can mediate the initiation of substance use through the individual development of emotional and behavioral capacities. This part of the model draws from Bandura’s social cognitive theory of self-regulation (Bandura, 1991). Self-regulation and control are influenced by contextual factors such as family environment, peers, and school. Mayes and Suchman (2006) state that as a child develops, these prior experiences (e.g. individual development, effect of contextual factors) can lead to
positive or negative adaptations to their environment. They propose that as a child enters adolescence, their peers influence on substance initiation can be strongest and the availability of a drug can shift an adolescent away or towards drug initiation (Mayes & Suchman, 2006).

Figure 1. Model for initiation of substance use in adolescence

*Note: From Mayes and Suchman (2006, p. 611)*

Mayes and Suchman (2006) also proposed a second developmental pathway model for the progression to substance dependence/addiction (see Figure 2). Similar to the first model, this model includes many individual factors (e.g., genetics, psychosocial) and some contextual factors (e.g. peers, school) on the path to substance dependence. Mayes and Suchman state that from initial use, there are multiple mediating factors that can increase or decrease an individual’s likelihood of developing substance dependence.
These initial mediating factors include genetic vulnerability for addiction as well as mood disorders, in addition to problem behaviors. From these initial mediating factors, contextual factors such as peer/school influence an individuals’ path to substance dependence. Compared to the first model, this model has a limited number of components that draw from the social cognitive theory. More credence could be given in this model to an individual’s self-development across many of the factors included, through their self-regulation of their motivation and actions which can contribute to the development of substance use disorders (Bandura, 1991; Mayes & Suchman, 2006).

Figure 2. Model for the progression to substance use and dependence
Note: From Mayes and Suchman (2006, p. 613)

Both of these models presented by Mayes and Suchman (2006) are multilevel approaches that consider individual (e.g. genetic vulnerability, emotional regulation) and contextual factors (e.g. peers, family, school) that can lead an individual to initiation of
substances in adolescence, and continued drug use leading to substance dependence. In the first model, the present study will expand upon the contextual factors considered as well as include method of ingestion as a possible influence on initiation of substance use (see Figure 3; adapted with permission from Dr. Mayes). Mayes and Suchman (2006) included availability of drugs in their model, however, it is important to consider legal status, price, and awareness of substances. Furthermore, the availability of certain methods of ingestion needs to be considered as a possible mechanism that can contribute to initiation of substance use. In the second model, the multilevel approach considers individual (e.g., genetic vulnerability, problem behavior) and some contextual (e.g., peers, school) factors in the development of substance use disorders; however, more information needs to be included regarding contextual factors as well as methods of ingestion (McCory & Mayes, 2015). Similar to the adaptations in the first model, this study will expand upon the continued influence of additional contextual factors, as well as explore the effects methods of ingestion may have on trajectories leading to substance dependence (see Figure 4; adapted with permission from Dr. Mayes). With the rise of legalization of marijuana across the United States, contextual factors and an understanding of the effects of method of marijuana ingestion become an increasingly vital components in this multilevel approach to research.
Figure 3. Adapted model for the initiation of substance use in adolescence

Note: Adapted from Mayes and Suchman (2006, p. 611)

Figure 4. Adapted model for the progression to substance use and dependence

Note: Adapted from Mayes and Suchman (2006, p. 613)
The proposed study described in the following paragraphs will highlight the importance of exploring how methods of ingestion and additional contextual factors within these developmental pathway models influence drug use initiation and addiction. It is important for researchers to consider all factors that can influence these paths. By continuing to increase the research based on these factors, prevention and intervention programs can continue to be tailored and improved.

**Associations of Marijuana Use**

A multitude of adverse consequences of marijuana use have been identified in previous research, including both short- and long-term effects. The negative consequences cover a range of areas of functioning including health, education, psychosocial functioning, and employment status (Hall & Degenhardt, 2015; Rigucci et al., 2016; Volkow et al., 2014).

**Short Term Health Effects**

Marijuana use results in acute impairments in both memory and attention. These impairments can persist and worsen with increasing years of regular use and early initiation (Solowij et al., 2002; Tapert et al., 2008). Acute effects of anxiety, panic reaction, and psychotic symptoms have been reported, especially by first time users (Hall & Pacula, 2003; Kalant, 2004). Deficits in motor coordination have also been noted as an acute effect of marijuana use. Marijuana users have been noted to have higher rates of hospitalization for all causes of injury than non-users (Gerberich et al., 2003).

Marijuana has been implicated in increasing the risk of injury or fatality while driving (Hall & Pacula, 2003; Hall, Renström, & Poznyak, 2016). According to Brady and Li (2014), marijuana is the most frequently reported illicit drug in connection with
impaired driving and accidents. Marijuana use results in deficits in motor, cognitive, and behavioral performance that can increase accident risk (Ramaekers, Berghaus, van Laar, & Drummer, 2004; Røgeberg & Elvik, 2016), with the effects becoming more marked with increases in THC dose. Research suggests that using marijuana before driving increases accident risk by 2 to 3 times (Ramaekers et al., 2004). Driving simulation studies have found a relationship between driving performance and blood THC concentration (Lenné et al., 2010), with recent smoking and blood concentration levels of 2 to 5 ng per milliliter being associated with substantial impairment (Hartman & Huestis, 2013). The risk of injury and fatality crashes is further increased because of a link between marijuana use and failure to use seatbelts (Liu, Huang, & Pressley, 2016).

New research that has been emerging has highlighted a relationship between e-cigarette/vaping devices and acute, severe respiratory distress. Many patterns of lung injury, including multiple forms of pneumonia and hemorrhaging hypersensitivity pneumonitis, diffuse alveolar hemorrhage, acute lung injury and acute eosinophilic pneumonia, organizing pneumonia, lipoid pneumonia, as well as giant cell interstitial pneumonia, have been associated with vaping (Henry et al., 2020). The Centers for Disease Control and Prevention (CDC; 2020) has termed the syndrome e-cigarette, or vaping, product use-associated lung injury (EVALI). As of February 18, 2020, the CDC reported a total of 2,807 patients hospitalized with EVALI, with reports from all 50 states and the District of Columbia. Sixty-eight deaths have been confirmed across the United States as a result of EVALI (CDC, 2020). The majority (82%) of individuals who vaped and experienced EVALI reported having used products with THC or CBD, with 33% of them using exclusively THC containing products. Fifty-seven percent of the EVALI
patients reported using nicotine-containing products, with 14% reporting exclusive use of
nicotine-containing products (CDC, 2020).

**Long Term Health Effects of Chronic Use**

One of the most well-known long-term effects of chronic marijuana use is
Cannabis Use Disorder (CUD; formerly called Marijuana Abuse/Dependence). CUD is
categorized by biopsychosocial impairments that increase in severity with frequent and
heavy use (Hasin et al., 2013; Hasin et al., 2015; Sherva et al., 2016). Rates of CUD have
increased over the last decade, especially in states with legalized marijuana (Hasin et al.,
2015; Hasin et al., 2017; Wen et al., 2015). Studies have reported that the risk of
dependence is around 9% for those who have ever used marijuana, with increases to one
in six for those who initiate use in adolescence (Anthony, Warner, & Kessler, 1994; Chen
et al., 2009; King & Chassin, 2007; Lopez-Quintero et al., 2011; Volkow et al., 2014),
and 25 to 50% for daily users (Hall & Degenhardt, 2009; Hall & Pacula, 2003; van der
Pol et al., 2013). Chen and colleagues (2009) reported that those who initiate in
adolescence are 2 to 4 times more likely to report symptoms of marijuana dependence
within 2 years after initiation. Additional research found that 19.5% of lifetime marijuana
users meet criteria for DSM-5 CUD, with 23% who were symptomatically severe, of
these 48% were not functioning in major roles (e.g., work; Hasin et al., 2016). Multiple
studies have shown that higher potency products can increase the probability of
experiencing desirable effects from marijuana use. Higher potency products (e.g.,
concentrates) paired with methods that can be considered less harmful (e.g, less
carcinogens), could facilitate easier paths to escalating and problematic use patterns
Tolerance and withdrawal symptoms are commonly reported with long term use. Marijuana users can develop a tolerance to the effects of THC, which leads to increased dose, frequency, or potency to reach the same desired effect (Maldonado, 2002).

Withdrawal symptoms typically occur when one stops or cuts back on their marijuana use (Budney & Hughes, 2006; Kouri & Pope, 2000) and can be reversed with the ingestion of THC (Budney & Hughes, 2006; Budney, Vandrey, Hughes, Thostenson, & Bursac, 2008; Lichtman, Fisher, & Martin, 2001). Typical withdrawal symptoms include sleep difficulty, restlessness, physical symptoms such as shakiness or tremors, sweating, fever, chills, and headaches, decreased mood and appetite, in addition to increased irritability, anger, anxiety or nervousness, and depression (Budney & Hughes, 2006; Karila et al., 2014; Katz et al., 2014; Kouri & Pope, 2000). Individuals who experience withdrawal symptoms typically experience a functional impairment of normal daily activities (Allsop et al., 2012; Davis, Smith et al., 2016; Karila et al., 2014; Katz et al., 2014;). Typically, withdrawal symptoms occur 1 to 2 days after an individual has stopped heavy use. They are most intense during the first week of abstinence, with effects that can persist as long as a month (Budney et al., 2003; Copersino et al., 2006; Davis, Smith et al., 2016; Elkashef et al., 2008; Hall et al., 2016; Kouri & Pope, 2000; Milin, Manion, Dare, & Walker, 2008).

Marijuana use has also been found to have long-term effects on physical health. Additional research on the health effects of marijuana has found that regular marijuana smokers report more symptoms of chronic bronchitis than non-smokers (Tashkin et al.,
It has been reported that immunological competence is also impaired by marijuana use, increasing risks for respiratory infections and pneumonia (Owen et al., 2014; Tashkin et al., 2002). Marijuana use has been associated with inflammation of airways, airway resistance, and lung hyperinflation in regular heavy users, but not infrequent users (Pletcher, et al., 2012; Tashkin, 2013).

Cancer risk for marijuana users has been implicated, but research has not consistently reported an association. It is possible that marijuana use may cause cancers due to containing the same carcinogen, at higher levels, as tobacco smoke (Callaghan, Allebeck, & Sidorchuk, 2014; Hashibe et al., 2005), however evidence has suggested risk of cancer is lower with marijuana than with tobacco (Hashibe et al., 2006). Marijuana has also been implicated with cardiovascular risks, with research showing association with vascular conditions that increase the risk of myocardial infarction (Mittleman, Lewis, Maclure, Sherwood, & Muller, 2001), stroke, and transient ischemic attacks during marijuana intoxication (Thomas, Kloner, & Rezkalla, 2014) due to THC producing a dose-related increase in heart rate (Jones, 2002).

Research has consistently shown deficits in verbal learning, memory, and attention in regular marijuana users (Solowij et al., 2002; Solowij & Pesa, 2012; see Crane et al., 2013 and Solowij & Battisti, 2008 for reviews). Marijuana has been shown to impair the neural connectivity of the precuneus, which is involved in functions such as alertness and awareness, and the fimbria, which is an area in the hippocampus important in learning and memory (see Broyd et al., 2016 for a review; Zalesky et al., 2012). It has been found to affect certain subcortical networks, specifically those that process habits and routines (Filbey & Yezhuvath, 2013). Marijuana use has also been associated with
reduced functional connectivity in the prefrontal networks responsible for executive functioning (e.g. inhibitory control and working memory; Renard et al., 2016). Renard and colleagues (2016) found chronic marijuana use altered the prefrontal cortex (PFC) structure and impaired cortical synaptic plasticity in the hippocampus-PFC circuit, and imaging studies have shown deceased activity in the prefrontal regions and reduced volumes in the hippocampus (Batalla et al., 2013). Furthermore, past work has found an association between frequent use of marijuana from adolescence into adulthood and significant declines in IQ, with effect sizes ranging from -.11 to -.038 (a loss equivalent up to approximately 6 IQ points; Meier et al., 2012).

Research has also consistently shown that deficits in cognitive functioning and changes to brain structures are related to the duration and frequency of marijuana use (a dose-dependent response), the age of initiation, and the estimated cumulative dose of THC (Solowij et al., 2002; Solowij & Pesa, 2012; see Crane et al., 2013 and Solowij & Battisti, 2008 for reviews). In other words, the negative effect of marijuana on cognition and functional connectivity of the brain is increasingly prominent if use starts in adolescence and is regular or chronic and heavy (Zalesky et al., 2012). These findings are consistent with preclinical findings that indicate the cannabinoid systems play a prominent role in synapse formation during brain development and can be impaired with exposure to marijuana in adolescence (Gaffuri, Ladarre, & Lenkei, 2012).

**Psychosocial Effects of Marijuana Use**

Marijuana has been associated with poor educational attainment among school children (see Lynskey & Hall, 2000 for a review; Degenhardt, Hall, & Lynskey, 2001; Ellickson, Tucker, Klein, & Saner, 2004; Fergusson, Boden, & Horwood, 2015; Volkow
et al., 2014). Early marijuana use has been associated with impaired performance in school, increased risk of dropping out of school, in addition to lower chances of pursuing post-secondary training (Bray, Zarkin, Ringwalt, & Qi, 2000; Horwood et al., 2010; Lynskey & Hall, 2000; Meier et al., 2012). Ellickson, Bui, Bell, and McGuigan (1998) found that marijuana use before the age of 15 was related to dropping out of high school, even after adjusting for confounding variables. As noted earlier, marijuana use beginning in adolescence is related to cognitive impairments (Meier et al., 2012), which can lead to failure to learn in school and interfere with the capacity to achieve educational goals. This leads to poor grades and possibly dropping out of school (Lynskey & Hall, 2000).

Across multiple cross-sectional (Compton, Gfroerer, Conway, & Finger, 2014; Cunradi, Ames, & Xiao, 2014; De Simone, 2002) and longitudinal studies (Fergusson & Boden, 2008) that have adjusted for sociodemographic characteristics, marijuana use has been associated with negative employment outcomes. Specifically, marijuana use has been associated with future job loss (Compton et al., 2014), reduced likelihood of employment (Cunradi et al., 2014), and difficulties at work (Degenhardt et al., 2001). Fergusson and Boden (2008) found that increasing levels of marijuana use from ages 14 to 21 was related to higher unemployment at data points between ages 21 and 25. Heavy marijuana use has also been associated with lower income, and greater need for socioeconomic assistance (Brook, Lee, Finch, Seltzer, & Brook, 2013; Fergusson & Boden, 2008).

Research conducted in a number of countries has shown that early marijuana use can predict increased risk of using other illicit drugs, even though not all who use marijuana go on to use heavy drugs (Agrawal et al., 2004; Hall & Degenhardt, 2007;
Swift et al., 2012). Swift and colleagues (2012) found those who reported weekly and daily marijuana use were consistently reporting amphetamine, cocaine, and ecstasy use at two to three times the rate of those who reported occasional use of marijuana. The order in which the illicit drugs are used aligns with the prevalence of different types of illicit drugs used in the adult population of the country (Degenhardt et al., 2010). Twin studies have shown that a twin who uses marijuana before age 17 is more likely to have used sedatives, hallucinogens, stimulants, and opioids than a twin who did not use marijuana (Ellickson, D’Amico, Collins, & Klein, 2005; Ellickson, Tucker et al., 2004; Lynskey et al., 2003).

**Marijuana Use and Mental Health**

Long-term research on adolescent marijuana users has shown they report greater negative emotionality than healthy controls between the ages of 13 and 23 (Heitzeg et al., 2015). Moreover, this negative emotionality remained elevated rather than decreasing with age as in the healthy controls. Chronic marijuana use has also been associated with both blunted and hyperactive stress responses (Cuttler et al., 2017). Cuttler et al. (2017) found healthy controls had increases in cortisol levels under a stress-provoking situation, however, the same increase was not found in active marijuana users.

Regular marijuana use has been associated with increased risk of anxiety and depression (Patton et al., 2002), although the literature is mixed, as well as lower satisfaction with life (Brook et al., 2013; Fergusson & Boden, 2008). Moore et al. (2007) completed a meta-analysis on the relationship between marijuana use, anxiety, and depression. Outcomes across included studies were not consistent, with marijuana resulting in a modest association; however, many studies did not adequately control for
confounding variables. Research has found that adolescents undergoing treatment for withdrawal symptoms from marijuana had at least one comorbid diagnosis of anxiety or depression and greater marijuana use was associated with increased depressive and anxiety-like symptoms (Dorard, Berthoz, Phan, Corcos, & Bungener, 2008). Genetic studies have found CUD shared genetic risk with depression (Carey et al., 2016; Sherva et al., 2016). Additional genetic research suggests common causes underlying the comorbidity between CUD and depression (Hodgson et al., 2016), or a causal effect of CUD on depression (Smolkina et al., 2017). Henquet, Krabbendam, de Graaf, ten Have, and van Os (2006) found marijuana use at baseline predicted increased risk of manic symptoms in patients diagnosed with bipolar disorder in a 3-year follow-up. Clinical studies have found individuals diagnosed with bipolar disorder who continue to use marijuana have increased frequencies of manic episodes and are less satisfied with their lives than those who do not use marijuana (Silberberg, Castle, & Koethe, 2012).

Marijuana use has been associated with psychotic symptoms as well as psychotic disorders, especially among individuals with a preexisting genetic vulnerability (Brook, Brook, Zhang, Cohen, & Whiteman, 2002; Caspi et al., 2005; Charilaou et al., 2017; Hall, 2009; Volkow et al., 2014). A meta-analysis of longitudinal research looking into the relationship between psychotic symptoms and marijuana found that the relationship between psychotic symptoms or psychotic disorders among those who had used marijuana was higher in regular users, with a dose-response relationship between frequency of use and risk for developing psychotic symptoms or a psychotic disorder (Moore et al., 2007). Another meta-analysis showed that individuals who were at high risk for psychosis had higher rates of marijuana use and CUD, as well as higher rates of
positive psychotic symptoms (e.g., unusual thought content, suspiciousness; Carney, Cotter, Firth, Bradshaw, & Yung, 2017). Heavier marijuana use, greater drug potency, and early initiation have all been found to negatively affect the disease trajectory through earlier than average age of first-episode psychosis (i.e., by advancing the time of a first psychotic episode by 2 to 6 years; Di Forti et al., 2013; Large, Sharma, Compton, Slade, & Nielssen, 2011).

Research into the associations between self-harm, suicidal ideation, suicide attempts, and marijuana use has been inconclusive. More than weekly marijuana use was associated with increased likelihood of reporting suicidal ideation, but only in males (van Ours, Williams, Fergusson, & Horwood, 2012). In contrast, another study found that marijuana was associated with self-harm only in females (Patton et al., 1997).

**Motives for Use**

Negative outcomes related to marijuana use often vary person to person. Similarly, marijuana users often report a range of reasons, or motives, for using marijuana. Past studies have shown that certain motives are related to increased risks across many psychosocial factors. It is possible that motives for using may also differ based on the method of ingestion used. Much of the past work on motives for using marijuana has focused on delineating these motives, as well as how they vary both between and within individuals (Bonn-Miller, Zvolensky, & Bernstein, 2007). Some of the more common motives found to be significant in research are coping, experimentation, and social motives. Studies have found that coping, enhancement, social, enjoyment, boredom, altered perception, relative low-risk, sleep/rest, and expansion motives for use are associated with increased frequency of marijuana use.
A study by Bonn-Miller and Zvolensky (2009) found associations between marijuana dependence and higher motivation to use marijuana for multiple reasons including enhancement, conformity, and coping. A more recent study found greater endorsement of using marijuana to cope to be associated with greater problematic use (Phillips, Lalonde, Phillips, & Schneider, 2017). Lee and colleagues (2009) also found experimentation and availability motives for use to be associated with less use. Davis, Arterberry, Bonar, Bohnert, and Walton (2018) found conformity and passion motives to be associated with greater frequency of use. This finding is unique in that it highlights the importance of assessing passion for marijuana use, as obsessive passion has been shown to predict frequency of use and related consequences. These studies evaluated the relationship between marijuana use motives, frequencies of use, and problematic use; however, none of these studies addressed the relationship of use motives with methods of ingestion.

Undoubtedly, marijuana has been associated with a plethora of negative effects and outcomes both in the short- and long-term. Unfortunately, a major limitation of these studies is that chronic heavy or regular marijuana users differ from non-users in a variety of ways that are reflected through baseline differences (e.g., more likely to use alcohol, differ in risk-taking behaviors; Hall, 2015). So, while it has been noted marijuana is associated with many negative outcomes, causal evidence is lacking. Furthermore, a number of the negative outcomes mentioned above noted increased negative effects as the frequency of marijuana increased but have failed to assess the role method of ingestion may have had in those increased negative effects (e.g. Agrawal et al., 2006; Cooper & Haney, 2009; Fergusson et al., 2003; Solowij et al., 2002; Tapert et al., 2008).
Additional research is needed to see if methods of marijuana ingestion are associated with frequency of use, problematic use, motives for use, and general mental health ratings, in the current legalization climate with increasingly diversified methods of ingestion.

**Patterns/Trajectories of Marijuana Use**

Understanding the factors involved in long-term marijuana use can help delineate youth who will initiate, experiment, and remain stable low users or phase out of substance use altogether versus the small proportion of youth who will escalate to regular and heavy use. This research is important as it can lead to targeted prevention and intervention strategies for substance use disorders (Scalco & Colder, 2017). Research using group-based developmental trajectory methods has shown considerable heterogeneity within populations in longitudinal patterns of substance use, where subgroups can be defined through patterns in timing, magnitude, and duration of risk (Kosty et al., 2016; Scholes-Balog et al., 2016). These developmental trajectories are able to identify the subgroups of youth who increase the frequency of their use over time and escalate from more infrequent users to regular and chronic, heavy users. This information can be used to provide targets for direct and intense prevention and intervention efforts.

Studies historically have found between three and seven developmental trajectory patterns of marijuana use from adolescence to adulthood (e.g. Homel et al., 2014; Schulenberg et al., 2005; Terry-McElrath et al., 2017; Windle & Wiesner, 2004). Previous research on developmental trajectories will be discussed to outline past findings and the associated risk factors to relate this work to changes in methods of ingestion. Though select studies are highlighted below, a summary of this research, including the
age and number of participants, years followed, number of classes, and class descriptions, can be found in Table 3.

Developmental Trajectories

Three developmental trajectory groups have been identified in numerous studies. Non-users, early users, and late onset users were identified in two separate studies following participants from adolescents until young adulthood (Flory et al., 2004; Scholes-Balog et al., 2016). In another study, trajectory groups of abstainers, occasional users, and frequent users were identified in a cohort followed from adolescence until young adulthood (Homel et al., 2014). Kosty and colleagues (2016) followed participants from adolescence until adulthood and classified participants into the classes of persistent increasing risk, maturing out with increasing risk then decreasing risk, and stable low risk.

Two studies have identified four trajectory groups. Following participants from early adolescence until young adulthood, Scalco and Colder (2017) identified classes consisting of: non-users, experimenters, early initiator-increasing users, and sharp increasing users. Four developmental trajectories were also found following a sample of students from early adolescence until adulthood. The trajectories were early onset with heavy use that decreased with age, light but persistent use, steady increase from age 13 to 23, and occasional use (Ellickson, Martino et al., 2004).

Five developmental trajectories have been identified by three separate studies. Passarotti and colleagues (2015) followed adolescents over 6 years. They revealed non-users, three trajectory classes of non-escalating users (low users, medium users, and high users) as well as one escalating user trajectory. Another study that followed participants
from early adolescence to early midlife found the trajectory groups of chronic users/decreasers, quitters, increasing users, chronic occasional users, and nonusers/experimenters (Zhang, Brook, Leukefeld, & Brook, 2016). Windle and Wiesner (2004) followed high school students through early adulthood, and found five developmental trajectory groups – high chronic, increasers, decreasers, experimental users, and abstainers.

Additionally, three studies have identified six to seven trajectory classes. Participants followed from mean age 14 until mean age 43 by Brook and colleagues (2016) resulted in six developmental trajectory classes of marijuana use: chronic/heavy users, increasing users, chronic/occasional users, decreasers, quitters, and nonusers/experimenters. Using data from the Monitoring the Future Study, Schulenberg et al. (2005) examined high school seniors through age 24 to understand developmental trajectories. In this study, six trajectory groups were delineated: chronic, decreased, increased, fling, rare, and abstain. Finally, Terry-McElrath and colleagues (2017) followed participants from high school to age 50 and found seven developmental trajectories of marijuana use. The trajectories were: non-users, two shorter-term use classes, and four classes with longer-term moderate or heavy use.

Across these studies, 5-28% of those who initiated marijuana use escalated to monthly or more frequent use (e.g., Schulenberg et al., 2005; Terry-McElrath et al., 2017). Furthermore, many of these studies found that early, high level marijuana users had less favorable outcomes compared to other, lower use trajectory groups (e.g. Ellickson, Martino et al., 2004; Homel et al., 2014; Terry-McElrath et al., 2017). The transition to high school seems to be a period of high risk for marijuana initiation, and
early initiation is followed by divergent trajectories over time, meaning the relationship between initiation and escalation is complex (Scalco & Colder, 2017). An understanding of the risk factors associated with escalating heavy use is important to identify adolescents who will benefit from more targeted intervention at an earlier age.
### Table 3

**Summary of studies regarding patterns/trajectories of marijuana use**

<table>
<thead>
<tr>
<th>Study</th>
<th>N</th>
<th>Ages Followed</th>
<th>Number of Classes</th>
<th>Class Descriptions (Percentage of participants in each class)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flory et al., 2004</td>
<td>481</td>
<td>Ages 11-12 until 20-22</td>
<td>3</td>
<td>Non-users (<em>) Early Onset (</em>) Late Onset (*)</td>
</tr>
<tr>
<td>Homel et al., 2014</td>
<td>632</td>
<td>Ages 15 until 25</td>
<td>3</td>
<td>Abstainers (31%) Occasional Users (44%) Frequent Users (25%)</td>
</tr>
<tr>
<td>Kosty et al., 2016</td>
<td>816</td>
<td>Ages 14 until 30</td>
<td>3</td>
<td>Stable Low Risk (84%) Maturing Out (9%) Persistent Increasing Risk (7%)</td>
</tr>
<tr>
<td>Scholes-Balog et al., 2016</td>
<td>852</td>
<td>Ages 12 until 21</td>
<td>3</td>
<td>Abstainers (62%) Early Onset Users (11%) Late Onset Occasional Users (27%)</td>
</tr>
<tr>
<td>Ellickson, Martino et al., 2004</td>
<td>5,833</td>
<td>Age 13 until 29</td>
<td>4</td>
<td>Occasional Light Users (53%) Early Light Users (5%) Stable Light Users (17%) Steady Increasers (25%)</td>
</tr>
<tr>
<td>Scalco &amp; Colder, 2017</td>
<td>755</td>
<td>Ages 11 until 18</td>
<td>4</td>
<td>Non-user (33%) Experimenter (38%) Early Initiator-Increasing (14%) Sharp Increasing (15%)</td>
</tr>
<tr>
<td>Passarotti et al., 2015</td>
<td>1,204</td>
<td>Ages 15 until 22</td>
<td>5</td>
<td>Never/Non-Users (22%) Low Users (29%) Medium Users (24%) High Users (8%) Escalating Users (17%)</td>
</tr>
<tr>
<td>Windle &amp; Wiesner, 2004</td>
<td>1,205</td>
<td>Ages 15 until 23</td>
<td>5</td>
<td>Abstainers (82%) Experimental Users (9%) Increasers (4%) Decreasers (3%) High Chronics (2%)</td>
</tr>
<tr>
<td>Zhang et al., 2016</td>
<td>548</td>
<td>Ages 1-10 until mean age 43</td>
<td>5</td>
<td>Nonusers/Experimenter (40%) Chronic Occasional Users (26%) Increasing Users (7%) Quitters (19%)</td>
</tr>
<tr>
<td>Brook et al., 2016</td>
<td>548</td>
<td>Ages 14 until 43</td>
<td>6</td>
<td>Nonusers/Experimenter (35%) Quitters (22%) Decreasers (14%) Chronic/Occasional Users (20%) Increasing Users (5%) Chronic/Heavy Users (4%)</td>
</tr>
</tbody>
</table>
Table 3, continued

<table>
<thead>
<tr>
<th>Study</th>
<th>N</th>
<th>Years Followed</th>
<th>Number of Classes</th>
<th>Class Descriptions (Percentage of participants in each class)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schulenberg et al., 2005</td>
<td>19,952</td>
<td>Ages 18 until age 24</td>
<td>6</td>
<td>Abstain (47%) Rare (28%) Fling (6%) Decreased (7%) Increased (5%) Chronic (5%)</td>
</tr>
<tr>
<td>Terry-McElrath et al., 2017</td>
<td>9,831</td>
<td>Ages 18 to 50</td>
<td>7</td>
<td>Non-Users (44%) Early YA** Moderate Users (22%) YA** Moderate Users (12%) Persistent Moderate Users (6%) Early YA** Heavy Users (6%) YA** Heavy Users (5%) Persistent Heavy Users (5%)</td>
</tr>
</tbody>
</table>

Note: * not reported by the study; ** YA = Young Adult

Risk Factors Associated with Chronic/Heavy Use Developmental Trajectories

Research has shown certain risk factors are associated with chronic heavy or increasing marijuana use from adolescence to young adulthood. Chronic heavy and increasing marijuana users were distinguished from lower or non-users by demographic variables such as: male gender (e.g. Ellickson, Martino et al., 2004; Juon, Fothergill, Green, Doherty, & Ensminger, 2011; Silins et al., 2013; Terry-McElrath et al., 2017), pubertal development at baseline (Scalco & Colder, 2017), low religious commitment (Jackson, Sher, & Schulenberg, 2008; Silins et al., 2013; Terry-McElrath et al., 2017), race/ethnicity with inconsistent results (Ellickson, Martino et al., 2004; Silins et al., 2013), and marriage (Schulenberg et al., 2015; Staff et al., 2010). These distinguishing variables also included factors related to individual as well as parental levels of education including adolescent school performance or commitment (Flory et al., 2004; Passarotti et al., 2015), not attending college (Nelson, Van Ryzin, & Dishion, 2015; Passarotti et al., 2015), and higher parental education (Ellickson, Martino et al., 2004; Passarotti et al.,
2015; Terry-McElrath et al., 2017). Peer influence, substance use, and delinquency were also associated with chronic heavy and increasing trajectories (Ellickson, Martino et al., 2004; Flory et al., 2004; Hix-Small et al., 2004; Passarotti et al., 2015; Scalco & Colder, 2017). Finally, a number of psychological and personality factors have been identified in more heavy users, including emotional dysregulation (Brook et al., 2016), aggressive and antisocial behavior (Passarotti et al., 2015), conduct problems (Ellickson, Martino et al., 2004; Flory et al., 2004; Hix-Small et al., 2004; Scalco & Colder, 2017; Windle & Wiesner, 2004), psychiatric disorders (Flory et al., 2004; Windle & Wiesner, 2004), temperament (Scalco & Colder, 2017), novelty seeking (Brook et al., 2016; Ellickson, Martino et al., 2004; Flory et al., 2004; Hix-Small et al., 2004; Passarotti et al., 2015), and co-morbid substance use (Brook et al., 2016; Jackson et al., 2008; Passarotti et al., 2015; Silins et al., 2013; Terry-McElrath et al., 2017). Many important risk factors have been identified, however, no studies to date have sought to understand if method of ingestion could be a risk factor for chronic heavy or escalating use.

Research on the longitudinal course or pattern of marijuana use is an area that is currently growing. With increasing social acceptance and legalization of marijuana in the United States today, it is likely that the age of onset could become increasingly younger and these developmental trajectories could change. Continued understanding of patterns of marijuana use during adolescence and emerging adulthood is needed, specifically in terms of why some abstain, maintain low levels, escalate their use over time, or decrease/quit their use altogether. Risk factors for heavy use developmental trajectories have been discovered in the research, however, there are still risk factors that need to be investigated. In this continually changing legal climate, method of marijuana ingestion is
a critical area to research as it is quickly changing. Information about patterns of marijuana use frequency, quantity, and method of ingestion, particularly among emerging adults, is needed to improve understanding of health consequences related to marijuana use and for public health planning (Tucker, Ellickson, Orlando, Martino, & Klein, 2005).

In addition to increasing the understanding of the frequency of marijuana use in developmental trajectories it will be important to also consider transitions in method of ingestion. Often times we think about how individuals move across substances, starting with tobacco and alcohol, and perhaps to illicit drugs. However, the transitions within a specific type of drug have been studied less, specifically for illicit drugs and methods of use within a specific type of drug. The developmental trajectory research presented earlier assessed marijuana use from early adolescence until adulthood. In that time, many transitions in methods of ingestion could occur for various reasons and coincide with increases in the frequency of marijuana use. Some of these reasons could be related to availability, perceptions, as well as context. This information is important for increasing knowledge about marijuana use, especially as the legal status of marijuana in the United States is shifting and the availability of methods is increasing.

**Contextual Factors**

The availability, or ease/difficulty of accessing a substance, has many influences on individuals as well as the population as a whole. Availability of a substance can be affected by many different factors, including the monetary price or cost of the product as well as the amount of effort and time required to obtain the product. The increasing number of states that have legalized medicinal and recreational marijuana has likely affected these factors. Mair, Freisthler, Ponicki, and Gaidus (2015) found the addition of
one dispensary per square mile was cross-sectionally associated with a 6.8% increase in marijuana hospitalizations with a marijuana abuse/dependence code. This study is one example of how contextual factors (e.g. price, availability) can affect marijuana use. Additional studies in key contextual areas are outlined below.

**Monetary Price**

The changing legal status of marijuana in the United States has had an effect on the monetary price of marijuana. Research has shown that there have been substantial decreases in the price of marijuana when compared to its pre-legalization cost (Caulkins et al., 2011; Hall & Lynskey, 2016). Past research on alcohol and tobacco has shown a clear relationship between the price of the product and frequency of use across populations (Chaloupka, Cummings, Morley, & Horan, 2002; Chaloupka, Straif, & Leon, 2011; Pacula et al., 2014). Since each state is responsible for drafting laws and regulations regarding marijuana, tax rates, manufacturing sales, and purchase levels will need to be considered individually for each state (Budney & Borodovsky, 2017). The aforementioned factors will need to be regulated while also considering how black markets related to marijuana will change in response to these factors (Caulkins et al., 2011).

**Ease of Access**

The regulations that have been passed by states regarding marijuana use are highly variable, with many different provisions. Currently, some states provide access to marijuana through retail stores or medical dispensaries. Due to the variations in marijuana regulation laws, some states permit a limited number of medical dispensaries (e.g. Connecticut), while others permit much larger numbers (e.g. Colorado). Larger
numbers of outlets available to purchase marijuana can lead to higher availability through lowering consumer travel time and cost of transportation (Budney & Borodovsky, 2017). Borodovsky and colleagues (2016, 2017) found longer periods of marijuana legalization and higher marijuana outlet (recreational and medical) density were related to higher likelihood of lifetime vaping and edible use for youth ages 14 to 18 in states with legal recreational marijuana use as well as adults in states with legal medicinal marijuana use. In fact, they found that higher marijuana outlet density was associated with younger age of onset of vaping in addition to doubling the likelihood of youth trying vaping and tripling the likelihood of trying edibles. Of 634 adults who were past-year marijuana users in Colorado, 70% tried a new marijuana or hashish product during the first year that recreational marijuana was legal in Colorado (Allen et al., 2017). In this study, trying new products the year after recreational marijuana was legalized in Colorado was associated with greater odds of experiencing an unexpected high after controlling for many variables including current use and amount of marijuana consumed in the past month (Allen et al., 2017). The CDC reported that 50% of EVALI patients provided data on the product source. Sixteen percent of the individuals reported acquiring products only from commercial sources (recreational and/or medical dispensaries, vape or smoke shops, stores, and pop-up shops), while 78% reported obtaining products from informal sources (family/friends, dealers, online, or other sources). Six percent of individuals reported acquiring products from both commercial and informal sources (Centers for Disease Control and Prevention, 2020).
Home Cultivation

Another way in which regulations can affect these factors is through provisions that allow individuals to grow marijuana ("home cultivation"). Home cultivation provides easier access to marijuana. While there may be policies regulating home cultivation in states where marijuana is legal, home cultivation presents many challenges in terms of enforcement as well as preventing excessive growth of marijuana (Budney & Borodovsky, 2017). Research on medical marijuana laws and their effect has found that home cultivation was predictive of last month as well as heavy use (Pacula et al., 2015). Borodovsky and colleagues (2017) also found home cultivation to be associated with higher likelihood and younger age of onset of marijuana edible use among youth ages 14 to 18. Among persons ages 12 and older, higher percentages of participants were reporting marijuana was easier to access. Participants also reported more frequently buying and growing marijuana versus getting it for free and sharing it (Azofeifa et al., 2016).

Awareness

In the last few years, research on the prevalence of marijuana information on social media has been increasing. Studies analyzing tweets on Twitter have found significantly greater numbers of tweets regarding edibles and dabs in states that allow recreational and/or medical use of marijuana (Daniulaityte et al., 2015; Lamy et al., 2016; Lamy et al., 2018), as well as pro-marijuana (i.e. plans to use, health benefits, legalization) tweets among those younger than 20 years of age (Cavazos-Rehg et al., 2015). Specifically, Lamy and colleagues (2018) found tweets regarding dabs to be between seven and 16 times higher in states that allowed recreational use of marijuana.
versus states where it is illegal. Furthermore, they found the tweets regarding edibles to be generally positive themed, while the tweets regarding dabs promoted it as a safe method. Cavazos-Rehg, Zewdie, Krauss, and Sowles (2018) further analyzed tweets regarding edibles and found that nearly half normalized marijuana use or plans to consume. Individuals who promoted edibles were more likely to be between the ages of 17 and 24 years old. Another study (Cavazos-Rehg et al., 2016) that analyzed tweets about high-potency marijuana found that common themes included discussions surrounding intense high and/or extreme effects (i.e. physiological and psychological) from dabbing (22%) as well as excessive/heavy dabbing (15%).

Several studies have examined YouTube videos on edibles and dabs. Overall, they demonstrated that such information was easily accessible, and many videos provided educational information (e.g. instructions, warnings; Krauss et al., 2015; Krauss, Sowles, Stelzer-Monahan, Bierut, & Cavazos-Rehg, 2017). A study regarding marijuana related posts on Reddit found the volume of posts on dabs increased significantly from 2010-2016 (Meacham, Paul, & Ramo, 2018). These studies highlight a number of important points, including how easy it is to access information on methods of marijuana ingestion, how younger individuals tend to broadcast their use of certain methods through “posts” on social media, as well as changing trends in volumes of posts related to certain methods of ingestion.

As social acceptability and legalization of marijuana are shifting, availability and awareness of different methods of ingestion are new areas of research that need to be explored. Methods of marijuana ingestion in states where marijuana is legal are different than those where it is currently illegal (Daniulaityte et al., 2015), and social media posts
regarding certain methods of ingestion have been changing over the years (Meacham et al., 2018). Research is needed to identify emerging trends due to changing marijuana legalization policies, to inform timely prevention and policy measures, and minimize potential dangers of certain methods of use to consumers (Daniulaityte et al., 2015; Gourdet et al., 2017; Schauer et al., 2016).

**Reasons for Using Specific Methods of Ingestion**

As increasing methods of marijuana ingestion become available, the reasons why specific methods of ingestion are used or not used is becoming an increasingly important question. These reasons could potentially effect population level statistics including age of onset, frequency, and quantity of use. More evidence is necessary to guide regulatory processes in states to determine how products can be created, distributed, and accessed to ensure safety in regards new methods of use (Budney & Borodovsky, 2017).

In focus groups (N = 62) conducted in Denver, Colorado, and Seattle, Washington, Giombi and colleagues (2018) found that edible marijuana users endorsed many reasons for liking edibles, including being smoke-free, more discreet, longer high, less intense high, and enjoying the taste. Participants in this study also endorsed many reasons for disliking edibles, many of which were related to edibles being unpredictable and variable in potency. Loflin and Earleywine (2014) assessed reasons why 357 participants ages 18 to 71 preferred dabs to flower methods of marijuana ingestion. They found that participants endorsed some reasons (e.g., different kind of high, stronger intoxication effect, effects last longer, and fewer “hits” needed) more than others (safer to use, less side effects, and price). This finding is interesting as it found that some preferences for dabs are associated with its potency and the stronger intoxication effect.
This could mean that individuals who use dabs might be at a higher risk for substance use disorders as reasons for using this method are related to a stronger intoxication effect. Another study by Lee and colleagues (2016) assessed 2910 participant’s perceptions of effects for those who prefer smoking or vaping marijuana. Those who smoke reported different reasons compared to those who vape. Specifically, participants who preferred vaping over smoking endorsed reasons of healthier, better tasting, produced better effects, and more satisfying (Lee et al., 2016). This suggests that endorsed reasons for using a method of ingestion may differ depending on one’s primary motive for using marijuana (e.g., for social purposes, to experiment, coping).

Methods with more positive perceptions that are also more readily available may influence patterns of use in the United States (Lee et al., 2016), and currently research is extremely limited in this area. Research regarding methods of marijuana ingestion is needed to identify emerging trends in this new legalization landscape, to inform timely prevention and policy measures, and minimize potential dangers of certain methods of ingestion to consumers (Daniulaityte et al., 2015; Gourdet et al., 2017; Schauer et al., 2016).

**Summary**

Utilizing and elaborating on the social-cognitive/contextual developmental models proposed by Mayes and Suchman (2006) for the developmental paths into substance use and dependence, this cross-sectional study sought understand the influence of contextual factors and methods of marijuana ingestion within these two models. The current study sought to evaluate whether methods of marijuana ingestion were associated with frequency of marijuana use over the last 30 days, problematic marijuana use, as well
as mental health outcomes. Furthermore, this study sought evaluate if marijuana users endorsed distinct reasons (e.g. safety, price, different type of high) for their primary method of ingestion. This study sought to understand if availability of methods influenced the primary method of ingestion chosen by participants. Finally, this study sought understand if certain methods of ingestion were associated with chronic and escalating patterns of marijuana, both of which are associated with increased negative short- and long-term outcomes.

Research in this area continues to be imperative as states proceed with the legalization of marijuana for medical as well as recreational. The number of marijuana users have steady increased over the last few years for those aged 12 and older (Substance Abuse and Mental Health Services Administration, 2018; Substance Abuse and Mental Health Services Administration, 2019). This increase in the percentage of the population using marijuana, makes it imperative to have a thorough understanding of methods of ingestion as they become increasingly diversified and accessible. The current study becomes increasingly important to help further research on marijuana as well as any potential negative outcomes that can arise from marijuana use as well as continued legalization. Research of this nature can be used to create and inform prevention and intervention programs for youth as well as young adults to mitigate the potential negative influence of marijuana use and legalization.
CHAPTER III

METHODS

Participants and Procedures

The current study sought to understand the effects of method of ingestion as well as contextual factors on marijuana use and associated problems (e.g. frequency of use, problematic use, mental health). In addition, this study sought to understand endorsed reasons for preferring certain methods of ingestion among individuals. Participants included community members recruited primarily through Amazon Mechanical Turk (MTurk), as has been done in prior studies (e.g., Daniulaityte et al., 2017). MTurk is a crowdsourcing marketplace where individuals and businesses can virtually distribute tasks (e.g., data validation, survey participation, and content moderation) to a global workforce. Individuals who complete the tasks are called ‘workers’ on the MTurk platform (Amazon, 2018).

For the current study, a survey created in Qualtrics was placed in a task on MTurk for participants to complete. Within the MTurk platform, a task was created with the title of the dissertation and a short description: “We are currently recruiting community members ages 18-25 to participate in a research study on marijuana use and methods of ingestion. The goal of this study is to learn more about how you are using marijuana.” Keywords were chosen to help participants search for the task, including marijuana, weed, pot, dope, grass, reefer, herb, Mary Jane, concentrates, dabs, edibles, joints, blunts, vaporizers, vaping, and smoking.
To be eligible for the study, potential participants needed to be ages 18-25 and report using marijuana within the last month. Individuals who self-reported meeting the eligibility criteria clicked the Qualtrics survey link included in the task description on MTurk. After completing informed consent online, participants completed a series of measures through Qualtrics. At the end of the Qualtrics survey a code was provided for the participant to manually enter in the MTurk task to show that the participant successfully completed the task. This researcher then reviewed each task to ensure the correct code (provided at the end of the survey) was inputted by the participant in MTurk. Next the researcher approved the participant to be paid through MTurk. Participants were allotted two hours to complete the survey, starting when they clicked on the link in MTurk.

Participation was completely voluntary, anonymous, and compensated ($2.50) based on MTurk guidelines. Data were collected from 6/10/19 – 6/20/19. Participants included individuals from states with and without legal access to medical and/or recreational marijuana. Both female and male participants were recruited, and participation was not limited to certain racial or ethnic groups.

G*Power was used to calculate the necessary sample size to achieve statistical power for this study. Cohen (1992) recommends using a power of .80 to determine necessary sample sizes to reduce error. With this power, the sample size necessary to achieve statistical significance in this study was 196 participants. The power calculation was based on the most complex statistical analysis included in this study, ensuring the sample size was sufficient for all analyses included in this study.
Measures (see Appendix)

Demographics

Age, sex, race/ethnicity, highest level of education, annual family income and education level, employment status, sexual orientation, relationship status, history of family drug use, and current living situation were assessed.

Daily Sessions, Frequency, Age of Onset, And Quantity of Cannabis Use Inventory (DFAQ-CU)

Participants were asked to self-report on marijuana use in their lifetime and within the past month using a modified version of the DFAQ-CU. The DFAQ-CU is a 41-item survey that measures frequency, age of onset, and quantity of marijuana used. The measure has a Cronbach’s alpha ranging from .69 (daily sessions) to .95 (frequency). Internal consistency of the quantity, age of onset, and concentrate factors were .88, .81, and .76 respectively (Cuttler & Spradlin, 2017). Evidence has been provided for the convergent, predictive, and discriminant validity of the factors included in this measure with similar surveys (e.g. Marijuana Smoking History Questionnaire, Cannabis Abuse Screening Test, Cannabis Use Problems Identification Test; Cuttler & Spradlin, 2017).

Rutgers Marijuana Problem Index (RMPI)

Participants completed the RMPI (White, Labouvie, & Papadaratsakis, 2005), which consists of 23 items and assesses negative consequences associated with marijuana use within the last year. Items on this scale are rated from 0 to 3 (“none” to “more than 5 times”) based on the frequency of each consequence for the participant. Sample items include “Kept smoking when you promised yourself not to” and “Neglected your responsibilities.” The RMPI has a Cronbach’s alpha of .91 at age 18, .88 at age 21, and
.85 at age 30 (White et al., 2005). In addition to the RMPI being validated through research, past literature has shown negative consequences of use to be a distinct measure of problem use as well as indicators of substance use problems (White, 1987; White & Labouvie, 1989). Scores on all items were added for a total score.

**Comprehensive Marijuana Motives Measure (CMMM)**

The CMMM (Lee et al., 2009) measured motives for using marijuana. This scale assesses a wide-range of reasons for using marijuana. The original scale includes 12 subscales (Enjoyment, Conformity, Coping, Experimentation, Boredom, Alcohol, Celebration, Altered Perceptions, Social Anxiety, Relative Low Risk, Sleep, and Availability) rated on a 1 to 5 scale (“almost never/never” to “almost always/always”). The CMMM was revised to include an additional subscale, the Social subscale from the Marijuana Motives Measure (Simons, Correia, Carey, & Borsari, 1998), as has been done in other past studies (Phillips et al., 2017). The CMMM has internal consistency ranging from .78 (availability) to .89 (enjoyment, coping) across all subscales. Cronbach’s alpha for the remaining subscales are as follows: .80 for relative low risk, .83 for altered perceptions, .84 for alcohol, conformity, sleep, .87 for celebration, and .88 for boredom, experimentation, social anxiety (Lee et al., 2009). The CMMM has been validated through research comparing it with another 25-item marijuana motives questionnaire (Simons, Correia, & Carey, 2000). Scores for all items on each subscale were totaled for subscale scores.

**General Mental Health Outcomes**

The eight-item Patient Health Questionnaire Depression Scale (PHQ-8; Kroenke & Spitzer, 2002) and the seven-item Generalized Anxiety Disorder Scale (GAD-7;
Spitzer, Kroenke, Williams, & Löwe, 2006) were used as measures for mental health. The PHQ-8 asks participants to rate the number of days in the past two weeks they experienced a particular depressive symptom. The PHQ-8 has an internal consistency of .86, with a score of >10 having an 88% sensitivity and 88% specificity for major depression (Kroenke & Spitzer, 2002). The GAD-7 asks participants to rate the number of days in the past two weeks they experienced a particular symptom of anxiety. The GAD-7 has an internal consistency of .92 (Spitzer et al., 2006), with a score of having an 89% sensitivity and 82% specificity. For both questionnaires the response options range from 0 to 3 (“not at all” to “nearly every day”). Scores on all items for both measures were added for a total score.

**Patterns and Transitions in Marijuana Use**

Developed for use in this study, past marijuana use patterns were assessed by a series of questions focusing on frequency, quantity, and dose (if known) of marijuana use during the past five years. This was assessed by creating a table where participants were able to indicate the frequency and quantity of marijuana used during the years following age of onset, as well as when they started using at their current level of use. Additionally, participants were asked if they changed methods during the years following onset. If participants changed methods, they were asked to write in the reason for changing their method of marijuana ingestion.

**Contextual Factors**

To assess availability of different methods of marijuana ingestion questions were developed for this study including: what is your current state of residence, how easy is it for you to obtain the following forms of marijuana where you currently live, and how
easy is it for you to obtain these materials or devices to use marijuana where you currently live. Two of these questions involved a rating of ease of obtaining specific methods of ingestion (“very easy,” “moderately easy,” “neither easy nor difficult,” moderately difficult,” and “very difficult”). The remaining questions asked the source where the participant purchased/obtained marijuana (e.g. friend, dispensary, dealer, etc.), as well as the current U.S. state of residence of the participant.

**Reasons for Primary Method of Marijuana Ingestion**

The Reasons for Primary Method of Marijuana Ingestion comprises multiple questions that assess the top reason users endorse for their primary method of ingestion, as well as additional reasons. These questions were developed for this study based on previous research that has measured reasons related to specific methods of ingestion (Giombi et al., 2018; Lee et al., 2016; Loflin & Earleywine, 2014). Participants were asked to endorse reasons for their primary method of ingestion as well as methods they use more than 25% of the time.

**Statistical Procedures**

Data were analyzed using SPSS statistical software. A total of 350 participants completed the online consent. Participants who did not consent ($n = 2$) nor complete the survey ($n = 49$), displayed unusual response patterns (i.e. answering every question the same; $n = 25$), or self-reported being older than the study criteria when asked to input age, were excluded from the analyses ($n = 15$).

A total of 261 participants were included in the ensuing statistical analyses. Because participants were required to answer every question (i.e., no option was given to skip items), there were no missing data. Analyses (i.e. independent t-tests and chi-square)
were conducted to assess whether those who were excluded from the final sample (e.g. did not complete the questionnaire) differed on key variables from those who were included. There was a significant difference in mean age between included (23.60) and excluded (24.38) participants ($t_{121.519} = -3.264, p = .05$), which can be explained by the 15 participants who indicated they were within the eligibility age requirements but went on to report ages outside of the eligibility requirements when asked to manually input age. Included and excluded participants differed significantly with ethnicity $X^2 (5, N = 350) = 41.888, p = .000$, with the excluded participants being less than expected numbers for ethnicities of Caucasian, African American, and Asian. There was no significant difference between included and excluded participants regarding gender ($X^2 (2, N = 350) = 3.680, p = .159$). There was a significant difference in highest level of education between included and excluded participants, with excluded participants having lower levels of education (i.e. less than 12th grade, GED, high school diploma, and some college) than expected compared with the included participants ($X^2 (6, N = 350) = 32.934, p = .000$). Frequency of marijuana use over the last 30 days was not significantly different between participants included (13.45) and excluded (13.60) from the analyses ($t_{126.320} = .905, p = .776$).

Responses to questions on marijuana use frequency, age of onset, and total years of use that were deemed outliers were Winsorized (Fuller, 1991) to the highest or lowest reasonable value, determined by the natural cutoffs in the sample and researcher judgment of a realistic maximum value. Responses for marijuana frequency over the last 30 days that were higher than 30 days were decreased to 30. Four participants reported using marijuana before the age of 9 (i.e., ages 4 and 5). These responses were increased
to 9 as it was a natural cut off in the sample. Finally, years of total use were corrected by subtracting current age from age of first use for participants who reported total years of use larger than what would be expected given the ages they self-reported. Descriptive statistics were reported for the entire sample. Mean days of marijuana use in the past 30 days, age of onset, and lifetime use were calculated. Frequencies for primary method of ingestion were calculated for the entire sample. See Table 4 for a summary of the variables that were derived from each measure included in this study. For all demographic variables and marijuana use statistics, all 261 participants were included. A low incidence of dab users \( (n = 4) \) were found in the sample and when examining their marijuana use frequency, they were deemed as outliers and excluded from the remaining analyses, except for the descriptive analyses in RQ4 and RQ6.

Table 4  

<table>
<thead>
<tr>
<th>Measure</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>DFAQ-CU</td>
<td>Frequency of use, primary method of ingestion, secondary methods of ingestion, source of marijuana</td>
</tr>
<tr>
<td>RMPI</td>
<td>Problematic use</td>
</tr>
<tr>
<td>CMMM</td>
<td>Motives for using marijuana</td>
</tr>
<tr>
<td>PHQ-8</td>
<td>Depression</td>
</tr>
<tr>
<td>GAD-7</td>
<td>Anxiety</td>
</tr>
<tr>
<td>Patterns and Transitions</td>
<td>Trajectory classes, frequency and quantity of use over last 5 years, method of ingestion used for last 5 years, transitions in method of ingestion over last 5 years, reasons for transition in method of ingestion</td>
</tr>
<tr>
<td>Contextual Factors</td>
<td>State of residence, perceived ease of access</td>
</tr>
<tr>
<td>Reasons for Primary Method of Ingestion</td>
<td>Endorsed reasons for using a certain method of ingestion</td>
</tr>
</tbody>
</table>
Q1 Are certain methods of marijuana ingestion related to higher frequency of use and problematic use?

The analysis for Research Question One focused on the relationship between method of marijuana ingestion, frequency of use over the last 30 days, and problematic use. Dependent variables were the number of days used over the last 30 days and problematic use. Problematic use was calculated using the total sums from the RMPI. The independent variable for this question was method of marijuana ingestion, which included three levels: smoking, vaping, and oral. A one-way MANCOVA statistical analysis was used to understand these relationships. Covariates for this analysis were gender, age, race, and level of education. The first four assumptions for this MANCOVA analysis were met as there are two continuous dependent variables, a categorical independent variable, at least one continuous covariate, and independent observations. Additionally, there was a linear relationship between the dependent variables of number of days used over the last 30 days and problematic use as assessed by visual inspection of a scatterplot utilizing a loess line fit percentage of 90%.

Q2 Are certain methods of ingestion related to specific motives for use?

The analysis for Research Question Two focused on the relationship between method of ingestion and motives for marijuana use. The dependent variable was marijuana motives scales of enjoyment, conformity, coping, experimentation, altered perceptions, and availability, with the independent variable being methods of marijuana ingestion, which included three levels. A one-way MANCOVA statistical analysis was used to understand this relationship. Covariates for this analysis were gender, age, race, level of education, frequency of marijuana use over the last 30 days, and problematic use.
The first four assumptions for this MANCOVA analysis were met as there are two continuous dependent variables, a categorical independent variable, at least one continuous covariate, and independent observations. Additionally, there was a linear relationship between the dependent variables of motives scales for marijuana use of enjoyment, conformity, coping, experimentation, altered perceptions, and availability as assessed by visual inspection of a scatterplot utilizing a loess line fit percentage of 90%.

Q3 Are certain methods of ingestion associated with negative mental health outcomes?

The analysis for Research Question Three focused on the relationship between method of ingestion and mental health outcomes. Dependent variables were mental health outcomes (i.e., depression [PHQ-8] and anxiety [GAD-7]). The independent variable was methods of marijuana ingestion, which included three levels. A one-way MANCOVA statistical analysis was used to understand these relationships. Covariates for this analysis were gender, age, race, level of education, frequency of marijuana use over the last 30 days, and problematic use. The first four assumptions for this MANCOVA analysis were met as there are two continuous dependent variables, a categorical independent variable, at least one continuous covariate, and independent observations. Additionally, there was a linear relationship between the dependent variables of depression (PHQ-8) and anxiety (GAD-7) as assessed by visual inspection of a scatterplot utilizing a loess line fit percentage of 90%.

Q4 Are certain methods of ingestion related to historical and current patterns of use in terms of frequency and transitions in methods over the last five years to current use?

The Research Question Four analysis consisted of multiple steps. First, individual changes in frequency of use over time were measured using linear mixed models and a
linear growth curve model (Shek & Ma, 2011). This determined individual growth curves (IGC) of use over time based on frequency of marijuana use. This growth measurement variable was then used in a two-step cluster analysis, due to the size of the data set, to determine clusters or classes of individuals with similar growth (e.g. escalating, decreasing). A Fisher’s Exact test statistical analysis was then used to analyze the relationship between trajectory/class membership and current method of marijuana ingestion. Assumptions for this Fisher’s Exact test were met as this analysis comprised of two variables measured at the categorical level with independent observations and collected using cross-sectional sampling. Regarding transitions between methods, descriptive/visual analysis is reported to understand the relationship between endorsed transition reason and method of marijuana ingestion across the five years measured. Additionally, similar analyses used to derive the trajectory groups were used to create classes for transitions in method of ingestion (e.g., no change in method, switching of method). A Chi-square statistical analysis was used to analyze the relationship between trajectory class and transition of method of ingestion class. Assumptions for this Chi-square test of independence were met as this analysis comprised of two variables that were measured at the categorical level with independence of observations. Data were collected using cross-sectional sampling and more than 80% of the cells had counts greater than or equal to five.

**Q5** Are primary methods of ingestion influenced by availability or awareness of methods?

The analysis for Research Question Five was composed of multiple steps. First, participants were grouped by states into three categories: 1) legal marijuana for recreational and medical purposes (n = 11 states, n = 72 participants), 2) legal marijuana
for medical purposes (n = 35 states, n = 155 participants), 3) illegal marijuana for any purpose (n = 4 states, n = 30 participants). This variable was used in a Chi-Square analysis along with method of ingestion to assess their relationship. Assumptions for this Chi-square test of independence were met as this analysis comprised of two variables that were measured at the categorical level with independence of observations. Data were collected using cross-sectional sampling and more than 80% of the cells had counts greater than or equal to five. A Fisher’s Exact test analysis was completed with the source of marijuana (e.g. friend, dispensary, dealer) and legal status groupings. Assumptions for this Fisher’s Exact test were met as this analysis comprised of two variables measured at the categorical level with independent observations and data collected using cross-sectional sampling. Finally, a series of ordinal logistical regressions were used to determine the ease of accessibility for method of ingestion by state legality grouping. In this analysis the independent variable was state legality grouping, which included three levels, with the dependent variable being the perceived ease of access for each method of ingestion. Covariates for this analysis were age, gender, race, and level of education. Assumptions for this series of ordinal logistical regressions were met as the dependent variables were ordinal, the independent variable is categorical, there was no multicollinearity due to just having one independent variable, and the assumption of proportional odds was met for each analysis as assessed by a full likelihood ratio test.

Q6 Are endorsed reasons (e.g. safety, type of high, price) for using certain methods different across methods of marijuana ingestion?

Finally, the analyses for Research Question Six consisted of a Chi-Square analysis and descriptive/visual analysis. This Chi-square analysis comprised of two variables that were measured at the categorical level with independence of observations and data that
were collected using cross-sectional sampling, meaning three assumptions for the Chi-square analysis were met. This Chi-square analysis did not meet the assumption of more than 80% of the cells had counts greater than or equal to five. Therefore, a Chi-Square analysis utilizing the Monte Carlo sampling method (Mehta & Patel, 2011), due to sparse (many cells with less than five) and unbalanced data, was used with primary method of ingestion and endorsed reasons as the variables. Next, descriptive statistics were reported with methods of ingestion used 25% of the time or more and endorsed reasons as the variables. The following figure outlines the research questions proposed in the current study and their relationship with method of ingestion.

![Figure 5. Visualization of research questions proposed in the current study and their relationship.](image-url)
CHAPTER IV

RESULTS

Demographics and Marijuana Use Statistics

Demographic variables of participants included (n = 261) from the analysis are displayed in Table 5. On average participants took 25 minutes to complete the survey. Participants were from the United States, per eligibility requirements. Participants were located in 39 states and Washington D.C. States with the highest percent of participants were: California (n = 36, 14%), Florida (n = 20, 7.8%), Indiana (n = 24, 9.3%), New York (n = 14, 5.4%), and Texas (n = 41, 16%). According to current census data, the percentage of females in this study (73.3%) is higher than U.S. census data of 50.8%. Annual household income is lower than the recorded income from the U.S. census data ($60,293). Finally, ethnicity in this sample is different from the ethnic background of persons completing the U.S. census, with fewer White (U.S. census = 76.5%), fewer Black (U.S. census = 13.4%), more American Indian/Alaska Native (U.S. census = 1.3%), more Asian (U.S. census = 5.9%), fewer Hispanic/Latino (U.S. census = 18.3%), and more Biracial/Multiracial (U.S. census = 2.7%) participants (United States, 2020). Compared to previous studies on marijuana users (i.e., Loflin & Earleywine, 2014; Phillips et al., 2017) this sample differed regarding percentages of females, but not regarding ethnicities, except for studies looking at developmental trajectories where differences in gender and ethnicity were present (i.e., Brook et al., 2016; Flory et al., 2004). Per eligibility requirements, all participants reported marijuana use in the last 30
days, with a mean of 13.47 ($SD = 9.67$) days used in the last 30 (Range = 1-30).

Additional marijuana use statistics are included in Table 6.
Table 5

**Demographic and background characteristics (n =261)**

<table>
<thead>
<tr>
<th>Measure/variable</th>
<th>n (%)</th>
<th>Mean (Range)</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>23.6 (18-25)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>192 (73.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>66 (25.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prefer not to respond</td>
<td>3 (1.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sexual Orientation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gay Male</td>
<td>6 (2.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lesbian</td>
<td>4 (1.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bisexual</td>
<td>62 (23.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heterosexual</td>
<td>186 (71.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asexual</td>
<td>1 (.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prefer not to respond</td>
<td>2 (.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relationship Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>168 (64.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married/Civil Union/Living Together Long-Term</td>
<td>51 (19.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seriously Dating/Exclusive Relationship</td>
<td>39 (14.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Separated/Divorced</td>
<td>3 (1.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Household Income</td>
<td></td>
<td>$30,000 - 40,000</td>
<td></td>
</tr>
<tr>
<td>Current Living Situation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Living Alone</td>
<td>115 (44.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Living with Others</td>
<td>115 (44.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Living in University Housing</td>
<td>15 (5.7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Living in Residential Facility</td>
<td>7 (2.7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staying with Relative or Friend</td>
<td>8 (3.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staying in a Shelter or Homeless</td>
<td>1 (.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Race/Ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>143 (54.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>13 (5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>22 (8.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native American / Alaskan Native</td>
<td>15 (17)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>45 (17.2)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Table 5, continued

<table>
<thead>
<tr>
<th>Measure/variable</th>
<th>$n$ (%)</th>
<th>Mean (Range)</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biracial/Multiracial</td>
<td>23 (8.8)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Highest Level of Education**
- GED              | 1 (.4) |
- High School Diploma | 26 (10) |
- Some College       | 60 (23) |
- Bachelor’s Degree  | 146 (55.9) |
- Advanced Graduate Degree | 27 (10.3) |
- Don’t Know         | 1 (.4) |

**Employment Status**
- Employed Full Time | 191 (72.9) |
- Employed Part Time | 38 (14.5) |
- Unemployed         | 12 (4.6) |
- In School Part Time | 3 (1.1) |
- In School Full Time | 9 (3.4) |
- Working Part Time, School Full Time | 2 (.8) |
- Working Full Time, School Full Time | 2 (.8) |
- Working Part Time and Full Time | 3 (1.1) |
- Working Part Time/Full Time, in School Part Time | 1 (.4) |

**Familial Drug Use**
- No One             | 115     |
- Father             | 108     |
- Mother             | 32      |
- Brother            | 42      |
- Sister             | 18      |
- Other              | 5       |

Most participants described smoking (using a joint, blunt, hand pipe, hookah, or bong) as their primary method of ingestion ($n = 187, 71.6\%$). For 24 participants this was their only method of ingestion, however, 238 participants reported using additional methods of marijuana ingestion more than 25% of the time including smoking ($n = 291$; using a joint, blunt, hand pipe, hookah or bong). Participants selected every method used
25% of the time or more. Additional method of ingestion statistics are included in Table 6. It is important to note that the majority of participants who reported using additional methods of marijuana ingestion 25% of the time reported using multiple methods.

One hundred and ninety-seven (75.2%) of the participants reported their primary form used as marijuana (e.g. flower, bud, herb). Edibles were reported as the primary form of marijuana for 45 (17.2%) participants, with concentrates being used by 19 (7.3%). Two hundred-thirteen participants also reported using other methods over 25% of the time, see Table 6. A small number of participants reported ever having a medical marijuana registry card (n = 57), with many (36 out of 57) reporting using marijuana recreationally and medically. The majority of participants purchased their marijuana from a friend (n = 87, 33.3%), followed by a dealer (n = 73, 28%), retail store (n = 55, 21.1%), medical dispensary (n = 26, 10%), given for free (n = 17, 6.5%), or grown by the participant (n = 3, 1.1%). Additional marijuana use statistics are included in Table 6. See Table 7 for statistics regarding participants included in independent variables excluding participants who endorsed using dabs as their primary method of ingestion (n = 4).


Table 6

*Marijuana use statistics (n =261)*

<table>
<thead>
<tr>
<th>Measure/variable</th>
<th>n (%)</th>
<th>Mean (Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiple times per day</td>
<td>30 (11.5)</td>
<td></td>
</tr>
<tr>
<td>Once per day</td>
<td>17 (6.5)</td>
<td></td>
</tr>
<tr>
<td>5-6 times per week</td>
<td>15 (5.7)</td>
<td></td>
</tr>
<tr>
<td>3-4 times per week</td>
<td>28 (10.7)</td>
<td></td>
</tr>
<tr>
<td>2 times per week</td>
<td>37 (14.2)</td>
<td></td>
</tr>
<tr>
<td>2-3 times per month</td>
<td>42 (16.1)</td>
<td></td>
</tr>
<tr>
<td>1-2 times per month</td>
<td>67 (24.7)</td>
<td></td>
</tr>
<tr>
<td>Age of onset</td>
<td>17.66 (9-25)</td>
<td></td>
</tr>
<tr>
<td>Total years of use</td>
<td>5.23 (1-15)</td>
<td></td>
</tr>
<tr>
<td>Age of monthly use</td>
<td>19.07 (9-25)</td>
<td></td>
</tr>
<tr>
<td>Age of daily use</td>
<td>19.29 (9-25)</td>
<td></td>
</tr>
<tr>
<td><strong>Primary method of ingestion</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joint</td>
<td>66 (25.3)</td>
<td></td>
</tr>
<tr>
<td>Blunts</td>
<td>17 (6.5)</td>
<td></td>
</tr>
<tr>
<td>Hand pipe</td>
<td>51 (19.5)</td>
<td></td>
</tr>
<tr>
<td>Bong</td>
<td>35 (13.4)</td>
<td></td>
</tr>
<tr>
<td>Hookah</td>
<td>18 (6.9)</td>
<td></td>
</tr>
<tr>
<td>Vaping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaporizer</td>
<td>28 (10.7)</td>
<td></td>
</tr>
<tr>
<td>E-cigarette device</td>
<td>24 (9.2)</td>
<td></td>
</tr>
<tr>
<td>Oral*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edibles*</td>
<td>18 (6.9)</td>
<td></td>
</tr>
<tr>
<td>Dabbing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dab rig</td>
<td>4 (1.5)</td>
<td></td>
</tr>
<tr>
<td><strong>Secondary methods of ingestion</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joints</td>
<td>94 (39.5)</td>
<td></td>
</tr>
<tr>
<td>Blunts</td>
<td>50 (21)</td>
<td></td>
</tr>
<tr>
<td>Hand pipe</td>
<td>68 (28.6)</td>
<td></td>
</tr>
<tr>
<td>Bong</td>
<td>41 (17.2)</td>
<td></td>
</tr>
<tr>
<td>Hookah</td>
<td>38 (16)</td>
<td></td>
</tr>
<tr>
<td>Vaping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaporizer</td>
<td>30 (12.6)</td>
<td></td>
</tr>
<tr>
<td>E-cigarette device</td>
<td>30 (12.6)</td>
<td></td>
</tr>
</tbody>
</table>
Table 6, *continued*

<table>
<thead>
<tr>
<th>Measure/variable</th>
<th>n (%)</th>
<th>Mean (Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edibles</td>
<td>41 (17.2)</td>
<td></td>
</tr>
<tr>
<td>Dabbing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dab rig</td>
<td>9 (3.8)</td>
<td></td>
</tr>
<tr>
<td>Topical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Topicals</td>
<td>3 (1.3)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CBD oil</td>
<td>1 (.4)</td>
<td></td>
</tr>
</tbody>
</table>

Primary form of marijuana used

<table>
<thead>
<tr>
<th>Measure/variable</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marijuana</td>
<td>197 (75.2)</td>
</tr>
<tr>
<td>Edibles</td>
<td>45 (17.2)</td>
</tr>
<tr>
<td>Concentrates</td>
<td>19 (7.3)</td>
</tr>
</tbody>
</table>

Secondary forms used

<table>
<thead>
<tr>
<th>Measure/variable</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marijuana</td>
<td>135 (63.4)</td>
</tr>
<tr>
<td>Edibles*</td>
<td>72 (33.8)*</td>
</tr>
<tr>
<td>Concentrates</td>
<td>50 (23.5)</td>
</tr>
</tbody>
</table>

*Note.* *More participants endorsed using an oral form of marijuana than an oral method of ingestion*

Table 7

*Statistics for participants included in independent variables for subsequent analyses, excluding dabbers (n =257)*

<table>
<thead>
<tr>
<th>Measure/variable</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grouping by method of ingestion</td>
<td></td>
</tr>
<tr>
<td>Smoking</td>
<td>187 (72.7)</td>
</tr>
<tr>
<td>Vaping</td>
<td>52 (20.2)</td>
</tr>
<tr>
<td>Oral</td>
<td>18 (7)</td>
</tr>
<tr>
<td>Trajectory class</td>
<td></td>
</tr>
<tr>
<td>Heavy</td>
<td>17 (6.6)</td>
</tr>
<tr>
<td>Escalating</td>
<td>97 (37.7)</td>
</tr>
<tr>
<td>Moderate</td>
<td>101 (39.3)</td>
</tr>
<tr>
<td>Low</td>
<td>42 (16.3)</td>
</tr>
<tr>
<td>Transition in methods</td>
<td></td>
</tr>
<tr>
<td>No to low transition</td>
<td>186 (72.4)</td>
</tr>
<tr>
<td>Multiple transitions</td>
<td>71 (27.6)</td>
</tr>
</tbody>
</table>

Groupings by state legality

<table>
<thead>
<tr>
<th>Measure/variable</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illegal</td>
<td>30 (11.7)</td>
</tr>
<tr>
<td>Recreational and medicinal laws</td>
<td>72 (28)</td>
</tr>
<tr>
<td>Medicinal laws only</td>
<td>155 (60.3)</td>
</tr>
</tbody>
</table>
Analysis One: Problematic Use and Frequency of Use

A one-way MANCOVA analysis sought to answer the question of whether certain methods of marijuana ingestion, due to immediate effects and potential higher potency, are related to increase in frequency of use and problematic use. Dependent variables for this analysis were the number of days used over the last 30 days and problematic use (calculated from the RMPI). The independent variable for this analysis was method of marijuana ingestion (3 levels = smoking, vaping, and oral), with covariates of gender, age, race, and level of education. There was no statistically significant difference between methods of ingestion groups on the combined dependent variables after controlling for gender, age, race, and level of education, $F(4, 496) = 1.077, p = .367$, Wilks' $\Lambda = .983$. Because this analysis was not significant, no follow up analyses were conducted.

Analysis Two: Marijuana Use Motives

A one-way MANCOVA analysis was used to answer the question of certain methods of ingestion being related to specific motives (e.g. coping) for use due to higher potency and immediate effects. The dependent variable for this analysis was certain marijuana motives, derived from the subscales of the CMMM, with the independent variable being methods of marijuana ingestion (3 levels = smoking, vaping, and oral). Subscales included in this analysis were enjoyment, conformity, coping, experimentation, altered perceptions, and availability. There was no statistically significant difference between methods of ingestion groups on the combined dependent variables after controlling for gender, age, race, level of education, frequency of marijuana use over the last 30 days, and problematic use, $F(12, 484) = .879, p = .521$, Wilks' $\Lambda = .958$. Because this analysis was not significant, no follow up analyses were conducted.
Analysis Three: Mental Health

This one-way MANCOVA analysis sought to answer the question if certain methods of marijuana ingestion are associated with negative mental health outcomes, derived from the GAD-7 and PHQ-8. Dependent variables for this analysis were mental health outcomes (i.e., PHQ-8 or depression and GAD-7 or anxiety). The independent variable was methods of ingestion (3 levels = smoking, vaping, and oral), with covariates of gender, age, race, level of education, frequency of marijuana use over the last 30 days, and problematic use. There was no statistically significant difference between methods of ingestion groups on the combined dependent variables after controlling for gender, age, race, level of education, frequency of marijuana use over the last 30 days, and problematic use $F(4, 492) = .759, p = .245, \text{ Wilks' } \Lambda = .988$. Since this analysis was not significant, no follow up analyses were conducted.

Analysis Four: Marijuana Use Trajectories and Transitions

Analyses for this research question sought to understand patterns of use over the last five years in terms of frequency of use, in addition to transitions in method of ingestion to see if heavy/chronic and escalating marijuana use patterns are related to methods in ingestion with immediate effects and potential higher potency. For this analysis, the frequency of use variable was recoded to collapse similar frequency use groups (i.e., 0 = no use, 1 = few times per year, 2 = few times per month, 3 = 1-4 times per week, 4 = 5 times per week to more than once per day). First, individual changes in use over time in frequency of use, in addition to transitions in method of ingestion were measured by using a linear growth curve model to determine individual growth curves over time. These growth variables were then used in two-step cluster analyses to
determine classes of individuals with similar growth patterns over time. Three cluster analyses were performed to ensure the classes were the best fit for the data regarding frequency of use. In the first two-step cluster analysis, clusters were determined automatically, which led to a cluster quality falling within the good range, and a ratio of sizes of 2.58. The subsequent two-step cluster analyses were conducted with specified numbers of clusters of three and five, which resulted in cluster qualities falling within the poor ranges. As the cluster analysis with four groups led to the best quality, four use trajectories were chosen. Similarly, the same two-step cluster analysis process was used to determine clusters for transitions in method of ingestion, which resulted in two classes automatically determined. The cluster quality for this analysis fell within the good range, with a ratio of sizes of 2.54. Additional analyses with specified clusters of one and three resulted in cluster qualities falling within the poor range. For both final cluster analyses (i.e. frequency of use and transitions) these groups were assigned numerical values that were used to examine the growth variables across the separate groups throughout the five years measured. Visual analysis via a scatterplot was used to understand how the groups differed across the five years measured (e.g. increasing frequency use, maintaining). Through this, the nature of the groups was discovered (e.g. escalators, heavy users, no transition). See Table 8 for frequencies of participants in trajectory classes.
Table 8

*Classes for use trajectory and transition in methods*

<table>
<thead>
<tr>
<th>Measure/variable</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trajectory Class</strong></td>
<td></td>
</tr>
<tr>
<td>Heavy</td>
<td>46 (17.9)</td>
</tr>
<tr>
<td>Escalating</td>
<td>103 (40.1)</td>
</tr>
<tr>
<td>Moderate</td>
<td>68 (26.5)</td>
</tr>
<tr>
<td>Low</td>
<td>40 (15.6)</td>
</tr>
<tr>
<td><strong>Transition in Methods</strong></td>
<td></td>
</tr>
<tr>
<td>No to Low Transition</td>
<td>186 (72.4)</td>
</tr>
<tr>
<td>Multiple Transitions</td>
<td>71 (27.6)</td>
</tr>
</tbody>
</table>

After these classes were established, a Fisher’s Exact test analysis was conducted to further understand the relationship between method of ingestion and trajectory class. A Chi-square test of independence analysis was conducted to understand the relationship between transition in methods and trajectory class. Descriptive analyses are reported for endorsed transition reason and method of ingestion.

A Fisher’s Exact test analysis was completed to examine the relationship between method of ingestion and trajectory class. The relationship between method of ingestion and trajectory class was not significant $X^2 (6, N = 257) = 6.597, p = .352$, see Table 9 for results.

Table 9

*Results for Fisher’s Exact test analysis for analysis four*

<table>
<thead>
<tr>
<th>Current Method of Ingestion</th>
<th>Trajectory Class</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>Moderate</td>
<td>Escalating</td>
<td>Heavy</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Smoking</td>
<td>27</td>
<td>55</td>
<td>72</td>
<td>33</td>
<td>187</td>
<td></td>
</tr>
<tr>
<td>Vaping</td>
<td>9</td>
<td>9</td>
<td>26</td>
<td>8</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>Oral</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>40</td>
<td>68</td>
<td>103</td>
<td>46</td>
<td>257</td>
<td></td>
</tr>
</tbody>
</table>

A Chi-square test of independence was performed to examine the relationship between trajectory class and transition in method of ingestion. The relationship between
these variables was not significant \( X^2 (3, \ N = 257) = 1.905, \ p = .592 \), see Table 10 for results.

Table 10

Results for Chi-square analysis for analysis four

<table>
<thead>
<tr>
<th>Transition in Method of Ingestion</th>
<th>Trajectory Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>No to Low Transition</td>
<td>29</td>
</tr>
<tr>
<td>Multiple Transitions</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
</tr>
</tbody>
</table>

Due to low frequencies, transition in method of ingestion across the five years measured are reported descriptively to see if there were specific reasons depending on the method of ingestion for transitioning. In this analysis, participants responded to each transition in method of ingestion they had over the course of the five years measured, with many participants having multiple transitions. Regarding smoking, higher frequencies of participants reported “fewer “hits” are necessary” \((n = 28)\), “safer to use” \((n = 26)\), “effects last longer” \((n = 22)\), and “different kind of high” \((n = 21)\) as their reason for transitioning to a smoking method of ingestion, see Figure 6 for additional reasons.

For vaping, higher frequencies of participants reported “friends use/recommended the method” \((n = 14)\) and “fewer “hits” are necessary” \((n = 9)\) as their reason for transitioning to a vaping method of ingestion, see Figure 7 for additional reasons. Regarding dabbing, higher frequencies of participants reported “friends use/recommended the method” \((n = 4)\) and “fewer “hits” are necessary” \((n = 4)\) as their reason for transitioning to a dabbing method of ingestion. For oral methods of ingestion, higher frequencies of participants reported “effects last longer” \((n = 3)\), “safer to use” \((n = 3)\), and “less side effects” \((n = 3)\) as their reason for transitioning. Regarding topicals, reasons for transitions of “effects last
longer” ($n = 1$) and “friends use/recommended this method” were reported ($n = 1$). For additional descriptive results, see Table 11.
Figure 6. Descriptive results for smoking method of ingestion and reason for transitioning
Figure 7. Descriptive results for vaping method of ingestion and reason for transitioning
Table 11

*Descriptive results for method of ingestion and reason for transitioning*

<table>
<thead>
<tr>
<th>Reason for Use</th>
<th>Smoking</th>
<th>Vaping</th>
<th>Dabbing</th>
<th>Oral</th>
<th>Topical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Different kind of high</td>
<td>21</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Stronger intoxication effect</td>
<td>19</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Effects last longer</td>
<td>22</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Fewer “hits” are necessary</td>
<td>28</td>
<td>9</td>
<td>4</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Safer to use</td>
<td>26</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Less side effects</td>
<td>11</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Friends use/recommended this method</td>
<td>14</td>
<td>14</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Family members use/recommended this method</td>
<td>6</td>
<td>6</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tastes better</td>
<td>8</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Is easily accessible</td>
<td>9</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Is less expensive</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Is more discreet</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

As a part of the descriptive analysis, types of transitions between methods were recorded. Out of the 101 participants who reported any transition in method over the past five years, the majority (n = 20) transitioned only within smoking methods of ingestion. A number of participants reported alternating between vaping and smoking over the five years measured (n = 10). A total of eight participants transitioned from vaping to smoking. Seven participants transitioned from both smoking to oral (n = 7) and smoking to vaping methods of ingestion (n = 7). Overall, 50 participants transitioned to a different method of ingestion at the end of the five years measured. In contrast, 43 participants
ultimately transitioned (started with one method, transitioned to different methods, then returned to the original method) to the same method of ingestion they first reported. For additional descriptive results, see Table 12.
Table 12

*Descriptive results for types of transitions (n = 101)*

<table>
<thead>
<tr>
<th>Type of Transitions</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall Different Method of Ingestion</strong></td>
<td></td>
</tr>
<tr>
<td>Alternating vaping and dabbing</td>
<td>3</td>
</tr>
<tr>
<td>Alternating vaping and smoking</td>
<td>10</td>
</tr>
<tr>
<td>Dabbing to smoking</td>
<td>1</td>
</tr>
<tr>
<td>Dabbing, oral, vaping, smoking, vaping</td>
<td>1</td>
</tr>
<tr>
<td>Dabbing, smoking, vaping</td>
<td>1</td>
</tr>
<tr>
<td>Dabbing, smoking, vaping, dabbing, smoking</td>
<td>1</td>
</tr>
<tr>
<td>Dabbing, vaping, oral, smoking</td>
<td>1</td>
</tr>
<tr>
<td>Dabbing, vaping, smoking</td>
<td>1</td>
</tr>
<tr>
<td>Oral, dabbing, vaping, smoking, vaping</td>
<td>1</td>
</tr>
<tr>
<td>Oral, smoking, vaping</td>
<td>3</td>
</tr>
<tr>
<td>Smoking to oral</td>
<td>7</td>
</tr>
<tr>
<td>Smoking to vaping</td>
<td>7</td>
</tr>
<tr>
<td>Smoking, dabbing, smoking, vaping</td>
<td>1</td>
</tr>
<tr>
<td>Smoking, oral, vaping</td>
<td>2</td>
</tr>
<tr>
<td>Smoking, oral, dabbing, smoking</td>
<td>1</td>
</tr>
<tr>
<td>Topical, vaping, smoking</td>
<td>1</td>
</tr>
<tr>
<td>Vaping to dabbing</td>
<td>3</td>
</tr>
<tr>
<td>Vaping to oral</td>
<td>1</td>
</tr>
<tr>
<td>Vaping to smoking</td>
<td>8</td>
</tr>
<tr>
<td>Vaping, smoking, dabbing, smoking</td>
<td>1</td>
</tr>
<tr>
<td>Vaping, topical, vaping, oral</td>
<td>1</td>
</tr>
<tr>
<td><strong>Overall Same Method of Ingestion</strong></td>
<td></td>
</tr>
<tr>
<td>Smoking to different smoking methods</td>
<td>20</td>
</tr>
<tr>
<td>Smoking, dabbing, smoking</td>
<td>4</td>
</tr>
<tr>
<td>Smoking, dabbing, vaping, smoking</td>
<td>2</td>
</tr>
<tr>
<td>Smoking, oral, dabbing, smoking</td>
<td>1</td>
</tr>
<tr>
<td>Smoking, oral, smoking</td>
<td>1</td>
</tr>
<tr>
<td>Smoking, vaping, dabbing, smoking</td>
<td>2</td>
</tr>
<tr>
<td>Smoking, vaping, smoking</td>
<td>3</td>
</tr>
<tr>
<td>Smoking, vaping, smoking, topical, smoking</td>
<td>1</td>
</tr>
<tr>
<td>Vaping, dabbing, smoking, vaping</td>
<td>1</td>
</tr>
<tr>
<td>Vaping, dabbing, vaping</td>
<td>2</td>
</tr>
<tr>
<td>Vaping, oral, vaping</td>
<td>1</td>
</tr>
<tr>
<td>Vaping to different vaping method</td>
<td>3</td>
</tr>
<tr>
<td>Vaping, smoking, dabbing, vaping</td>
<td>1</td>
</tr>
<tr>
<td>Vaping, smoking, vaping</td>
<td>1</td>
</tr>
<tr>
<td>Vaping, smoking, vaping</td>
<td>1</td>
</tr>
</tbody>
</table>
Analysis Five: Contextual Factors

These analyses sought to answer the question if primary methods of ingestion are influenced by availability or perceived ease of access for certain methods of ingestion, with the notion that certain methods of ingestion may be more accessible for individuals, leading to these methods by default being primary methods of ingestion. This question was answered with multiple analyses including a Chi-square test of independence, Fisher’s Exact test, and a series of ordinal logistical regression analyses. Frequencies of participants by state legality grouping are included in Table 13.

Table 13

<table>
<thead>
<tr>
<th>Grouping by state legality</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illegal</td>
<td>30 (11.7)</td>
</tr>
<tr>
<td>Recreational Laws</td>
<td>72 (28)</td>
</tr>
<tr>
<td>Medical Laws</td>
<td>155 (60.3)</td>
</tr>
</tbody>
</table>

A Chi-square test of independence was performed to examine the relationship between method of ingestion and state legality. The relationship between these variables was not significant $X^2 (4, N = 257) = 7.220, p = .125$, see Table 14 for results. To examine the relationship between source of marijuana and state legality a Fisher’s Exact test was performed. The relationship between these variables was significant $X^2 (10, N = 257) = 45.602, p < .001$, and the association was moderately strong (Cohen, 1988) ($Cramer’s V = .298$). For participants in states where marijuana is recreationally legal, more participants purchased marijuana from retail stores/dispensaries than expected if legal status was independent of source of marijuana, with an adjusted standardized residual of 6.3. Additionally, in recreationally legal states fewer participants than expected purchased marijuana from a dealer or friend if legal status of marijuana was
independent of source of marijuana, with adjusted standardized residuals of -3.0 and -2.5, respectively. In states where marijuana was medicinally legal, fewer participants purchased marijuana from retail stores/dispensaries than expected if legal status was independent of source of marijuana, with an adjusted standardized residual of -4.8. More participants than expected in states where marijuana was medicinally legal purchased from a dealer if legal status was independent of source, with an adjusted standardized residual of 2.9 (Agresti, 2013). Of note, three participants purchased from a medical dispensary by crossing state lines. The participants who purchased from a medical dispensary were located in states bordering those with medicinal marijuana laws, see Table 15 for results.

Table 14

\textit{Results for first Chi-square analysis for analysis five}

<table>
<thead>
<tr>
<th>Current Method of Ingestion</th>
<th>Legal Status</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Recreationally Legal</td>
<td>Medicinally Legal</td>
<td>Illegal</td>
<td>Total</td>
</tr>
<tr>
<td>Smoking</td>
<td>49</td>
<td>116</td>
<td>22</td>
<td>187</td>
</tr>
<tr>
<td>Vaping</td>
<td>14</td>
<td>31</td>
<td>7</td>
<td>52</td>
</tr>
<tr>
<td>Oral</td>
<td>10</td>
<td>7</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>73</td>
<td>154</td>
<td>30</td>
<td>257</td>
</tr>
</tbody>
</table>
Table 15

Results for Fisher’s Exact test analysis for analysis five

<table>
<thead>
<tr>
<th>Source of Marijuana</th>
<th>Legal Status</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Recreationally Legal</td>
<td>Medicinally Legal</td>
<td>Illegal</td>
<td>Total</td>
</tr>
<tr>
<td>Purchase from retail store/dispensary for those over age 21 (you PERSONALLY buy it from a retail store/dispensary)</td>
<td>34</td>
<td>17</td>
<td>3</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>(6.3)</td>
<td>(-4.8)</td>
<td>(-1.6)</td>
<td></td>
</tr>
<tr>
<td>Purchase from medical dispensary (you PERSONALLY have a medical marijuana card)</td>
<td>8</td>
<td>14</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>(.4)</td>
<td>(-.4)</td>
<td>(.1)</td>
<td></td>
</tr>
<tr>
<td>Purchase from a dealer</td>
<td>11</td>
<td>54</td>
<td>8</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>(-3.0)</td>
<td>(2.9)</td>
<td>(-.2)</td>
<td></td>
</tr>
<tr>
<td>Purchase from a friend</td>
<td>16</td>
<td>57</td>
<td>13</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>(-2.5)</td>
<td>(1.5)</td>
<td>(1.2)</td>
<td></td>
</tr>
<tr>
<td>It’s given to me for free (friend/family)</td>
<td>3</td>
<td>10</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>(-.9)</td>
<td>(.7)</td>
<td>(.1)</td>
<td></td>
</tr>
<tr>
<td>I grow my own</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>(1.2)</td>
<td>(-.9)</td>
<td>(.2)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>73</td>
<td>154</td>
<td>30</td>
<td>257</td>
</tr>
</tbody>
</table>

Note. Adjusted residuals appear in parentheses below observed frequencies.

A series of ordinal logistical regression analyses sought to understand if certain methods of ingestion are associated with differing perceived ease of access based on the legal status of marijuana. The dependent variable for this set of analyses was perceived ease of access that differed by method of ingestion (i.e., joints, blunts, hand pipes, bongs [water pipe], hookahs, vaporizers, e-cigarette devices, dab rigs, edibles, and topicals). All analyses had an independent variable of state legality grouping (i.e., recreationally legal, medicinally legal, illegal) with covariates of gender, age, race, and level of education. For joints, blunts, hand pipes, hookah, and e-cigarette devices state legality grouping did not have a statistically significant effect on the prediction of perceived ease of access, see
Table 16 for statistical results. Regarding bongs, state legality grouping did have a statistically significant effect, with a higher level of education (i.e., GED to advanced graduate degree) leading to a 1.409 increase in perceived difficulty. For vaporizers, there was a significant effect, with a higher level of education leading to an increase in perceived difficulty of 1.509. Finally, regarding dab rigs, edibles, and topicals, state legality grouping did have a statistically significant effect with ethnicity significantly contributing to the model. Specifically, being not Caucasian was associated with increased perceived difficulties of 1.214, 1.138, and 1.156 for dab rigs, edibles, and topicals, respectively. For additional statistical results see Table 16.
Table 16

<table>
<thead>
<tr>
<th>Method of ingestion</th>
<th>df</th>
<th>Wald</th>
<th>p</th>
<th>Odds Ratio</th>
<th>CI (95%)</th>
<th>IV/Covariate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joints</td>
<td>2</td>
<td>2.428</td>
<td>.297</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blunts</td>
<td>2</td>
<td>1.635</td>
<td>.442</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand pipes</td>
<td>2</td>
<td>2.769</td>
<td>.250</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bongs</td>
<td>2</td>
<td>9.597</td>
<td>.008*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>5.763</td>
<td>.016*</td>
<td>2.597</td>
<td>1.191 - 5.661</td>
<td>Illegal</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>8.148</td>
<td>.004**</td>
<td>2.129</td>
<td>1.267 - 3.576</td>
<td>Medicinally legal</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>5.572</td>
<td>.018*</td>
<td>1.409</td>
<td>1.060 - 1.874</td>
<td>Level of education</td>
</tr>
<tr>
<td>Hookah</td>
<td>2</td>
<td>5.524</td>
<td>.063</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaporizers</td>
<td>2</td>
<td>9.160</td>
<td>.010*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>7.873</td>
<td>.005**</td>
<td>3.037</td>
<td>1.398 - 6.598</td>
<td>Illegal</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>5.323</td>
<td>.021*</td>
<td>1.827</td>
<td>1.095 - 3.049</td>
<td>Medicinally legal</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>8.068</td>
<td>.005**</td>
<td>1.509</td>
<td>1.136 - 2.005</td>
<td>Level of Education</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>22.830</td>
<td>.001***</td>
<td>1.278</td>
<td>1.156 - 1.414</td>
<td>Ethnicity</td>
</tr>
<tr>
<td>E-cigarette devices</td>
<td>2</td>
<td>4.619</td>
<td>.099</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dab rigs</td>
<td>2</td>
<td>13.189</td>
<td>.001***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>4.297</td>
<td>.038*</td>
<td>2.254</td>
<td>1.045 - 4.861</td>
<td>Illegal</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>12.966</td>
<td>.001***</td>
<td>2.561</td>
<td>1.535 - 4.272</td>
<td>Medicinally legal</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>14.646</td>
<td>.001***</td>
<td>1.214</td>
<td>1.099 - 1.321</td>
<td>Ethnicity</td>
</tr>
<tr>
<td>Edibles</td>
<td>2</td>
<td>20.488</td>
<td>.001***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>9.283</td>
<td>.002**</td>
<td>3.334</td>
<td>1.536 - 7.233</td>
<td>Illegal</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>19.226</td>
<td>.001***</td>
<td>3.191</td>
<td>1.900 - 5.361</td>
<td>Medicinally legal</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>6.685</td>
<td>.010*</td>
<td>1.138</td>
<td>1.031 - 1.255</td>
<td>Ethnicity</td>
</tr>
<tr>
<td>Topicals</td>
<td>2</td>
<td>17.832</td>
<td>.001***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>7.672</td>
<td>.006**</td>
<td>2.972</td>
<td>1.375 - 6.422</td>
<td>Illegal</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>16.911</td>
<td>.001***</td>
<td>2.943</td>
<td>1.759 - 4.922</td>
<td>Medicinally legal</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>8.449</td>
<td>.004**</td>
<td>1.156</td>
<td>1.048 - 1.275</td>
<td>Ethnicity</td>
</tr>
</tbody>
</table>

Note. *p < .05; **p < .01; ***p < .001

Analysis Six: Reasons for Use

A Chi-square test of independence, utilizing Monte Carlo sampling due to sparse (multiple cells with zero or less than five cell counts) and unbalanced data, was
performed to examine the relationship between method of ingestion and reason for use, with the assumption that users endorse distinct reasons for each method of ingestion. The relationship between these variables was significant $X^2 (24, N = 257) = 63.258, p < .001$, based on 10,000 random samples from this data set, using a starting seed of 624,387,341, see Table 17 for results. The association was moderately strong Cramer’s $V = .351$ (Cohen, 1988). Regarding smoking, more participants reported is “easily accessible” as their reason for use than expected if reason for use was independent of method of ingestion, with an adjusted standardized residual of 3.2. Fewer participants reported “recommended by family members” and “is more discrete” as smoking reasons for use than expected if reason for use was independent of method of ingestion, with adjusted standardized residuals of -3.1 and -4.5 respectively. More participants reported “safer to use”, “recommended by family members”, and “is more discreet” as vaping reasons for use than expected, if method of ingestion was independent of reasons for use, with adjusted standardized residuals of 1.9, 3.9, and 3.4, respectively. For vaping, fewer participants than expected reported “effects last longer” and “is easily accessible” as reasons for use if reasons for use was independent of method of ingestion, with adjusted standardized residuals of -1.7 and -2.4 respectively. Regarding oral, more participants reported “effects last longer” and “is more discreet” than expected, if reason for use was independent of method of ingestion, with adjusted standardized residuals of 1.8 and 2.5 respectively. Fewer participants than expected reported “is easily accessible” for oral methods of ingestion if reasons for use was independent of method of ingestion, with an adjusted standardized residual of -1.8, see Table 17 for additional results.
Table 17

*Results for Chi-square analysis for analysis six*

<table>
<thead>
<tr>
<th>Reason for Use</th>
<th>Method of Ingestion</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Smoking</td>
<td>Vaping</td>
<td>Oral</td>
<td>Total</td>
</tr>
<tr>
<td>Different kind of high</td>
<td>15</td>
<td>2</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>(.6)</td>
<td>(-1.1)</td>
<td>(.6)</td>
<td></td>
</tr>
<tr>
<td>Stronger intoxication effect</td>
<td>17</td>
<td>4</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>(.9)</td>
<td>(-.1)</td>
<td>(-1.3)</td>
<td></td>
</tr>
<tr>
<td>Effects last longer</td>
<td>34</td>
<td>5</td>
<td>6</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>(.5)</td>
<td>(-1.7)</td>
<td>(1.8)</td>
<td></td>
</tr>
<tr>
<td>Fewer “hits” are necessary</td>
<td>31</td>
<td>8</td>
<td>1</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>(.7)</td>
<td>(.0)</td>
<td>(-1.2)</td>
<td></td>
</tr>
<tr>
<td>Safer to use</td>
<td>16</td>
<td>9</td>
<td>1</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>(-1.4)</td>
<td>(1.9)</td>
<td>(-.7)</td>
<td></td>
</tr>
<tr>
<td>Less side effects</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>(-1.2)</td>
<td>(1.0)</td>
<td>(.5)</td>
<td></td>
</tr>
<tr>
<td>Friends use/recommended this method</td>
<td>17</td>
<td>5</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>(.1)</td>
<td>(.2)</td>
<td>(-.5)</td>
<td></td>
</tr>
<tr>
<td>Family members use/recommended this method</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>(-3.1)</td>
<td>(3.9)</td>
<td>(-.7)</td>
<td></td>
</tr>
<tr>
<td>Tastes better</td>
<td>9</td>
<td>2</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>(-.3)</td>
<td>(-.4)</td>
<td>(1.2)</td>
<td></td>
</tr>
<tr>
<td>Is easily accessible</td>
<td>34</td>
<td>2</td>
<td>0</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>(3.2)</td>
<td>(-2.4)</td>
<td>(-1.8)</td>
<td></td>
</tr>
<tr>
<td>Is less expensive</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>(1.2)</td>
<td>(-1.0)</td>
<td>(-.6)</td>
<td></td>
</tr>
<tr>
<td>Is more discreet</td>
<td>2</td>
<td>7</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>(-4.5)</td>
<td>(3.4)</td>
<td>(2.5)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(-.2)</td>
<td>(-.9)</td>
<td>(1.8)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>187</td>
<td>52</td>
<td>18</td>
<td>257</td>
</tr>
</tbody>
</table>

*Note.* Adjusted residuals appear in parentheses below observed frequencies.
Descriptive statistics were reported for each method of ingestion used 25% or more of the time, due to having low frequencies across many different cells. For smoking, more participants reported reasons for use of “stronger intoxication effect” \((n = 43)\), “effects last longer” \((n = 46)\), and “is easily accessible” \((n = 37)\). More participants reported certain reasons for using vaping as a method of ingestion including “stronger intoxication effect” \((n = 9)\) and “safer to use” \((n = 9)\). For oral, more participants reported reasons for use of “different kind of high” \((n = 8)\) and “effects last longer” \((n = 13)\). Regarding dabbing, two participants reported a reason of use of “stronger intoxication effect.” For topicals, two participants reported their reason of use was due to topicals being “easily accessible.” A summary of these descriptive statistics can be found in Table 18. Additional reasons described by participants for using smoking, vaping, and oral methods of ingestion are included in Table 19.
Table 18

*Descriptive results of reason for use for methods of ingestion used 25% or more of the time*

<table>
<thead>
<tr>
<th>Reason for Use</th>
<th>Method of Ingestion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Smoking</td>
</tr>
<tr>
<td>Different kind of high</td>
<td>22</td>
</tr>
<tr>
<td>Stronger intoxication effect</td>
<td>43</td>
</tr>
<tr>
<td>Effects last longer</td>
<td>46</td>
</tr>
<tr>
<td>Fewer “hits” are necessary</td>
<td>32</td>
</tr>
<tr>
<td>Safer to use</td>
<td>35</td>
</tr>
<tr>
<td>Less side effects</td>
<td>17</td>
</tr>
<tr>
<td>Friends use/recommended this method</td>
<td>25</td>
</tr>
<tr>
<td>Family members use/recommended this method</td>
<td>6</td>
</tr>
<tr>
<td>Tastes better</td>
<td>10</td>
</tr>
<tr>
<td>Is easily accessible</td>
<td>37</td>
</tr>
<tr>
<td>Is less expensive</td>
<td>4</td>
</tr>
<tr>
<td>Is more discreet</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>292</td>
</tr>
</tbody>
</table>
Table 19

*Additional reasons reported by participants for using certain methods of ingestion*

<table>
<thead>
<tr>
<th>Method of Ingestion/Reason</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Smoking</strong></td>
<td>Able to just light it once and smoke casually</td>
</tr>
<tr>
<td></td>
<td>Because I enjoy the act of smoking and it’s great to share when you smoke</td>
</tr>
<tr>
<td></td>
<td>with friends!</td>
</tr>
<tr>
<td></td>
<td>Enjoy the experience of rolling and smoking</td>
</tr>
<tr>
<td></td>
<td>Easy to share with friends, long lasting, and when you're in the mood</td>
</tr>
<tr>
<td></td>
<td>for a change, the taste is nice</td>
</tr>
<tr>
<td></td>
<td>It’s fast</td>
</tr>
<tr>
<td></td>
<td>Easiest and quickest</td>
</tr>
<tr>
<td></td>
<td>I enjoy smoking and it is easy to sit on a joint and smoke it for 10-15</td>
</tr>
<tr>
<td></td>
<td>minutes as a source of engagement and to get high</td>
</tr>
<tr>
<td></td>
<td>Is comfortable</td>
</tr>
<tr>
<td></td>
<td>It’s comfortable and convenient</td>
</tr>
<tr>
<td></td>
<td>Joint [sic] get you just as high if not higher than blunts and take less</td>
</tr>
<tr>
<td></td>
<td>weed</td>
</tr>
<tr>
<td></td>
<td>Social with friends</td>
</tr>
<tr>
<td><strong>Vaping</strong></td>
<td>It’s weak</td>
</tr>
<tr>
<td><strong>Oral</strong></td>
<td>I don’t need to keep smoking anything I just take on edible and I’m</td>
</tr>
<tr>
<td></td>
<td>good for a couple of hours</td>
</tr>
<tr>
<td></td>
<td>More of a physical high—helps with scoliosis back pain</td>
</tr>
</tbody>
</table>
CHAPTER V
DISCUSSION

This cross-sectional exploratory study aimed to examine current trends and associated problems related to marijuana ingestion among young adult marijuana users. Research questions addressed by this study included understanding the relationship between methods of marijuana ingestion and higher frequency of use, problematic use, motives for use, and mental health outcomes. It was hypothesized that methods of ingestion that were more potent or with immediate effects, would lead to increases in frequency of use, problematic use, negative mental health outcomes, and coping motives for use due to the stronger and immediate intoxication effects. Additionally, the current study sought to understand the relationship of methods of marijuana ingestion on historical and current patterns of use in terms of quantity and transitions in methods over the last five years. Methods of ingestion that were more potent with immediate effects were hypothesized to be related to heavy/chronic and escalating marijuana use trajectories. These same marijuana use trajectories were hypothesized to be related to multiple transitions in method of ingestion over the five years measured in this study. Contextual factors including availability and awareness of methods were examined. It was hypothesized that primary method of ingestion may be influenced by perceived ease of access. Furthermore, endorsed reasons for using certain methods of ingestion were investigated to understand differences across methods of marijuana ingestion. It was hypothesized that certain methods of ingestion (e.g. smoking and vaping) would be
related to endorsed reasons regarding the intoxication effect, while oral methods of ingestion would be related to discrete or better tasting endorsed reasons for use.

Two hundred sixty-one (100%) of the participants in this study reported using marijuana in the last 30 days, per eligibility requirements. Sixty-two (23.7%) participants reported using marijuana on a daily or near daily basis, which is lower than the proportion (35.4%) of heavy past-month users reported by the National Academies of Science, Engineering, and Medicine (2017). The mean age of onset for the current sample was 17.6, which is similar to the age of onset (between 18 to 19 years) found across multiple countries (Degenhardt et al., 2008). Participants in the current study endorsed a variety of primary methods of ingestion as well as primary forms of marijuana ingested. The variety in method of ingestion and marijuana forms used may be partially influenced by marijuana dispensaries or retail stores that are increasing the variety of products available to consumers (Borodovsky et al., 2016; Pacula et al., 2014; Pacula et al., 2015), as 88.5% of the participants in this study lived in a state where marijuana was medically or recreationally legal.

In this study neither problematic use nor frequency of use were found to be significantly related to method of ingestion after controlling for gender, age, race, and level of education. The lack of relationship between method of ingestion and frequency may be related to the fact that previous research has found that method of ingestion, in combination with dose or potency, influence marijuana’s subjective effects (Budney & Borodovsky, 2017). Because some methods have faster effects, individuals may be able to use less frequently and still achieve the same effects one might achieve with higher dosage levels (referred to as “self-titration”). Only 23.7% of participants reported using
marijuana on a daily or near daily basis, which is lower than what has been previously found (35.4%; National Academies of Science, Engineering, and Medicine, 2017). This lower than expected frequency (as evidenced by a moderate negative skewness) could have influenced the effect of frequency of use over the last 30 days in this study, as well as ultimately problematic use, due to higher frequency of use being related to increased problematic use, although variability in days used was high. Furthermore, the current study had lower portions of participants that endorsed using more potent methods of ingestion (i.e., dabbing). These lower numbers could have impacted the effect of problematic use, as emerging research is finding concentrates are related to problematic use (e.g. Meier, 2017). If the current sample had included a greater number of persons who dabbed as their primary method of use, some effect related to frequency and problematic use could have been observed. Knowing if method of ingestion is related to problematic use can be used to influence regulatory processes in states to determine how products can be created, distributed, and accessed, which can influence progressions to problematic use and potentially mitigate negative outcomes (Budney & Borodovsky, 2017). Additionally, information regarding methods of ingestion and their effect on problematic use can be utilized in prevention and intervention programs across all ages, to continue to tailor and improve them. This can decrease the negative effects these methods could have by starting prevention programs and educating youth about possible increased negative effects associated with certain methods of ingestion.

Participants in the current study reported a variety of motives for using marijuana, however, method of ingestion was not significantly related to these motives (i.e. enjoyment, conformity, coping, experimentation, altered perceptions, and availability).
after controlling for gender, age, race, level of education, frequency of use over the last 30 days, and problematic use. The current study utilized motives that are often found to be related to marijuana use in past studies and sought to understand if method of ingestion was related to specific motives for using marijuana. Past research has focused mostly on delineating the motives, how motives vary both between and within individuals, and motives’ relationship to frequency of use as well as problematic use; however, no past research has sought to understand the relationship between motives and methods of ingestion (Bonn-Miller et al., 2007). Past research has found that enjoyment, altered perception, and conformity motives were associated with increased frequency of marijuana use (Bonn-Miller et al., 2007; Davis et al., 2018; Lee et al., 2009). Furthermore, coping motives have been shown to be related to problem marijuana use (Phillips et al., 2017). Method of ingestion has the potential to be related to motives for use as individuals’ motives can differ depending on the method (e.g. smoking as a more social method versus vaping for altered perception due to a stronger intoxication effect). The current study offers preliminary evidence that method of ingestion is not related to motives generally; however, it is unclear whether participants might change their method of ingestion within-the-moment based on fluctuating motives. This finding is important as past studies have shown certain motives for marijuana use are related to increased risk across many psychosocial factors. It is critical to continue to delineate how motives for marijuana use vary both between and within individuals.

Method of ingestion was not significantly related to mental health outcomes, after controlling for gender, age, race, level of education, frequency of use over the last 30 days, and problematic use. Past literature has shown that while marijuana use has been
associated with increased risk of anxiety, depression, and lower satisfaction with life, the literature is mixed (Brook et al., 2013; Fergusson & Boden, 2008; Patton et al., 2002) and many studies do not adequately control for confounding variables (Moore et al., 2007). However, the current study sought to understand if method of ingestion could be a variable that increases risk for depression and anxiety above and beyond marijuana use itself, due to certain high potency forms of marijuana being associated with particular methods of ingestion (e.g., dabbing). Unfortunately, persons using the most potent method (i.e., dabbing) were not recruited adequately for the study, making it difficult to answer this question. Due to the variability of THC levels across different methods of ingestion, it is possible that methods with higher intoxication effects can have a greater effect on mental health. Additional research is needed to understand the complicated relationship between marijuana use and mental health outcomes. Understanding the relationship between marijuana use and mental health is important due to the increasingly positive attitudes towards marijuana in the United States (Gallup, 2017) and the rise of legalization of marijuana for medicinal and recreational purposes.

The current study sought to understand the relationship between of method of ingestion and historic marijuana use frequency trajectories. Research regarding marijuana use trajectories is important to understand factors related to long-term marijuana use, and to help identify individuals who will phase out of substance use versus those who escalate to regular and heavy use. The current study found four trajectories of use based on frequency, which is commensurate with previous research that has historically found between three and seven developmental trajectory patterns of marijuana use (e.g. Homel et al., 2014; Schulenberg et al., 2005; Terry-McElrath et al., 2017; Windle & Wiesner,
Specifically, the current study found trajectory classes that were similar to those found by Passarotti and colleagues (2015). They found trajectory classes of never/non-users (33%), low users (29%), medium users (24%), high users (8%), and escalating users (17%). While this study did not include any non-users of marijuana, the remaining trajectory classes are similar. The current study found comparable numbers with moderate (26.5%) and low users (15.6%); however, it was found that more participants classified as escalating (40.1%) and heavy users (17.9%). Heavy users in the current study comprised of participants who used daily or more than once per day across the five years measured. Moderate and low users included participants who used a few times per month and a few times per year, respectively. Regarding escalators, these participants reported no or infrequent use at the beginning of the five years measured and transitioned to daily or more than once per day use near the end. The higher numbers of participants classified as escalating users is potentially related to average age of onset of the sample (ages 18 to 25) being 17.66. Many users were answering questions related to use after initiating use, with many having increases in frequency of use over the last five years as indicated by the high percentage of participants who were escalators. After deriving the classes, additional analyses did not indicate significant relationships between trajectory class and method of marijuana ingestion nor trajectory class and switching of method of ingestion over the last five years. These findings are important as risk factors for chronic, heavy, and escalating users need to be understood in the continually changing legal climate of marijuana in the United States. Individuals who fall within a higher-use trajectory experience increased negative short- and long- term outcomes associated with marijuana use. Continued research on the association of method of marijuana ingestion
and its relationship with developmental use trajectories is needed to increase understanding of negative consequences related to marijuana use and for public health planning (Tucker et al., 2005). Through this public health planning, prevention and intervention strategies can be targeted to youth who show higher numbers of risk factors (e.g., gender, peer influence, parental education, delinquency, emotional dysregulation) that can affect the marijuana use trajectory they may fall with-in. Knowledge of these specific factors can allow for more targeted interventions for smaller groups of youth, while still providing general prevention and intervention strategies for all youth possibly, leading to a greater impact of the prevention and intervention strategies.

Contextual factors including availability or awareness of methods were evaluated by the current study. No significant relationship between method of ingestion and state legality of marijuana was found. This lack of relationship could be related to a variety of methods of ingestion already being available to marijuana users. However, state legality was significantly related to the source of marijuana (e.g. purchased from retail store, dealer, friend, etc.). This indicates that state legality is related to the source of where marijuana is purchased, although many participants reported purchasing from informal sources, even in states with medical and recreational marijuana laws. These findings are important as they offer preliminary evidence of the relationship between legal status of marijuana and its effect on purchasing outcomes. Higher numbers of retail outlets available to purchase marijuana can lead to higher availability of varieties of methods of ingestion and types of marijuana through lowering travel time and cost of transportation (Budney & Borodovsky, 2017). The current study supports the idea that more retail outlets lead to higher availability of methods and adds that legal status also significantly
affects where the marijuana is purchased. Previous research has found dispensaries per
square mile to be cross-sectionally associated with increases in marijuana hospitalizations
with a marijuana abuse/dependence code (Mair et al., 2015). Higher availability of
methods of ingestion and types of marijuana has the potential to make it easier for youth
to access marijuana. Interestingly, the current study found more than expected
participants in states where marijuana is illegal purchased products from medical
dispensaries. This indicates that consumers are potentially crossing state lines to purchase
products. Due to the participants not listing the states that the marijuana was purchased, it
is difficult to say if the states allow access of medical marijuana for out-of-state residents.
The crossing of state lines to purchase from a retail outlet, ultimately can be viewed as a
safer, but illegal—especially if out-of-state purchases are not legal, alternative to
purchasing from an informal source as retail outlets have regulations for products. As
previously mentioned regarding long-term effects of marijuana use, 16% of e-cigarette,
or vaping, product use-associated lung injury (EVALI) patients reported acquiring
products from retail outlets, while 78% acquired them from informal sources (e.g.,
family, friends, dealers; Centers for Disease Control and Prevention, 2020). The current
study found in states with only medicinal laws (not recreational), more participants ($n = 121$) purchased or were given marijuana from informal sources than retail outlets ($n = 31$). While there may be retail outlets that provide safer products, due to regulations,
many individuals are still purchasing marijuana from informal sources that do not have
regulations. These informal sources have the potential to be dangerous, due to the lack of
regulation.
The current study found some significant relationships between methods of marijuana ingestion and perceived ease of access. In states where marijuana was illegal or only medicinally legal, participants reported higher odds of perceived difficulty accessing bongs, vaporizers, dab rigs, edibles, and topicals. The current study supports the idea that increased retail outlets can influence perceived availability as well as diversity of methods of ingestion and products (Budney & Borodovsky, 2017). Odds of perceiving difficulty in obtaining dab rigs was slightly lower for participants in states where marijuana is illegal compared to medicinally legal. Additionally, as education level increased, participants were more likely to report difficulty in finding certain methods of ingestion. Regarding ethnicity, Caucasian participants had a lower perceived difficulty in obtaining certain methods of ingestion than participants from other ethnicities. This finding could in part, be related to differences in portions of participants from varying ethnic backgrounds across state legality grouping (e.g. more Caucasian in states with recreational marijuana laws). Another potential influence for this finding could be related to participants located in rural versus urban areas, with rural participants from varying ethnic backgrounds requiring increased travel times to access different methods of ingestion. Continued research in availability and ease of access are needed as the prevalence of marijuana outlets as well as information across media forms (e.g. social media, radio) continues to increase. Research has found online posts regarding certain methods of ingestion (e.g. edibles, dabs) to be positive in nature, normalizing marijuana use, and higher in frequency in states that allow recreational use of marijuana (Cavazos-Rehg et al., 2018; Daniulaityte et al., 2015; Lamy et al., 2016; Lamy et al., 2018). As social acceptability and legalization of marijuana continue to shift, research on the
availability and awareness of different methods of ingestion is needed to identify emerging trends due to changing marijuana legalization policies, to inform timely prevention and policy measures, and minimize potential dangers of certain methods of use to consumers (Daniulaityte et al., 2015; Gourdet et al., 2017; Schauer et al., 2016). Using emerging trends to inform prevention strategies and policy measures can affect youth’s awareness of the potential dangers of certain methods (e.g. concentrates being related to problematic use).

The current study sought to understand reasons for transitioning methods of ingestion as well as reasons for using certain methods of ingestion. It was found that the relationship between primary method of ingestion and reason for use was significant, meaning that participants were endorsing specific reasons for using certain methods. This echoes previous research that has found individuals endorse specific reasons for liking certain methods of ingestion. These findings have been important as they have highlighted specific reasons for using that are associated with potency and stronger intoxication effect of certain methods (Loflin & Earleywine, 2014). Similarly, the current study found that “stronger intoxication effect,” “fewer “hits” necessary,” and “effects last longer” were common reasons reported across most methods endorsed in this study. For participants who endorsed using smoking methods of ingestion, common reasons for use were “stronger intoxication effect,” “effects last longer,” “fewer “hits” necessary,” “different kind of high,” and “is easily accessible.” Participants who used vaping methods of ingestion endorsed reasons for use related to “safer to use,” “less side effects,” “family members use/recommended it,” “is more discreet,” “stronger intoxication effect,” and “recommended/used by friends.” For oral methods of ingestion, participants endorsed
reasons for use including “effects last longer,” “different kind of high,” “more discreet,” “stronger intoxication effect,” and “less side effects.” Findings of this nature suggest that endorsed reasons for using certain methods could be a factor related to a higher risk for developing substance use disorders due to reasons being related to stronger intoxication effects. Interestingly, participants endorsed “safer to use” and “less side effects” as reasons for using vaping methods of ingestion. This contradicts emerging research from the CDC (2020) indicating that vaping is related to acute lung distress, particularly when cartridges are bought from informal sources, although vaping is still considered a safer alternative to smoking due to lower levels of carcinogens. Research is still emerging on long-term effects of vaping. Continued research, with large sample sizes is needed in this area to delineate if individuals endorse specific reasons for transitioning between methods or using certain methods. Additionally, continued research in endorsed reason for using certain methods of ingestion is important as methods with more positive perceptions may influence patterns of use in the United States (Lee et al., 2016). Currently, research is extremely limited in this area and future work needs to continue to focus on delineating endorsed reasons for using certain methods of ingestion, as well as how these reasons vary between methods of ingestion and individuals. This research can be used to guide regulatory processes in states to determine how products can be created, distributed, and accessed to ensure safety in diverse methods of ingestion (Budney & Borodovsky, 2017).

**Limitations**

The current research study has several limitations. First, participants of the current study were self-selected among people recruited online, which increases potential for
non-generalizable results. Compared to U.S. census data the current study should be interpreted with caution due to differences in gender and ethnicity; however, compared to some previous research in the field of marijuana studies this study was similar in reported ethnicities of participants. As the survey was anonymous it was not possible to identify repeat respondents. A significant limitation to the current study was the cross-sectional nature of the data collected. To understand causal relationships between methods of marijuana ingestion and associated problems, longitudinal studies are required that measure participants over a range of use (e.g. youth to adulthood).

Statistically, limitations of the current study included large differences in the numbers of participants for each level of the MANCOVA used, which violates one of the assumptions of this statistical procedure and resulted in the removal of dabbing as a method of ingestion. Due to the number of methods endorsed by participants as well as the number of reasons for using certain methods endorsed, there were analyses that did not have sufficient distribution across the cells to be analyzed, leading to some information being presented in a descriptive manner in the current study. Continued research in reasons for using certain methods is needed, as a broad range of reasons were endorsed for each method, including many new reasons that were not included in the original development of the measure for the current study.

Finally, increased numbers of participants are necessary to fully understand endorsed reasons for primary method of ingestion as well as transitions in methods due to the variety of reasons that are endorsed across individuals. Certain methods that are more potent with immediate effects (e.g. dabbing) had low occurrence rates within this sample, which limits the conclusions that can be drawn regarding their effects on associated
problems of use (e.g. problematic use, frequency of use). Due to this low frequency, participants should have been over-sampled to ensure that this method of ingestion could have been included in the analyses.

**Future Directions**

Future research should continue to delineate associations of methods of marijuana ingestion in the continually changing legalization climate in the United States. As marijuana is the most commonly used, federally illicit drug, it becomes increasingly important to understand factors related to increased marijuana use, as it is associated with a plethora of negative outcomes. During the time this dissertation was being drafted, marijuana use for those ages 12 and older increased by nearly 20 million individuals in one year (Substance Abuse and Mental Health Services Administration, 2018; Substance Abuse and Mental Health Services Administration, 2019). Research with higher numbers of participants is needed to try and understand methods of ingestion that are being used less frequently (e.g. dabs) but have the potential to have increased negative outcomes due to potency and immediate effects. It is imperative to continue to identify short- and long-term effects of products with high potency and immediate effects as research is currently lacking.

The developmental course of marijuana use should continue to be monitored, with increased focus on methods of ingestion as a contextual factor that can affect the trajectory. While this study did not find significant results in this area, it was cross sectional in nature, which can result in participants who might not have been able to accurately report marijuana use information over the past five years as compared to participants in longitudinal designs. In this ever-changing legal climate, methods will
continue to be diversified with easier access for younger and younger individuals. This can affect the trajectory of use for these individuals. Therefore, it is important to try and understand factors related to these negative trajectories as soon as possible, because research is lacking behind this ever-changing legalization climate. It is imperative to understand negative outcomes to influence safety standards and regulations (Benjamin & Fossler, 2016; Cao et al., 2016).

In this study, participants endorsed a variety of reasons for using certain methods of ingestion, with many participants writing in new reasons not originally included. Future research needs to continue to understand these reasons for use, and to understand if they are related to any associated problems (e.g. problematic use, negative mental health outcomes) for users. This is important research as it can help understand reasons why someone may choose a certain method (e.g. safer, stronger intoxication effect), because positive perceptions of methods of ingestion that are readily available may influence patterns of use (Lee et al., 2016).

Retail outlets for marijuana are motivated to increase sales through increasing the variety of products available to consumers (Borodovsky et al., 2016; Pacula et al., 2014; Pacula et al., 2015), however, many products lack empirically-based packaging regulations, proactive ingredient levels, and safety standards (Benjamin & Fossler, 2016; Cao et al., 2016). The current study found that high numbers of participants were obtaining marijuana from informal sources (e.g. friends, family, dealers). It is important to continue to understand where marijuana is being purchased as the CDC has found that many patients diagnosed with EVALI had purchased marijuana from informal sources (CDC, 2020). This relationship between EVALI and informal sources of marijuana
highlights the importance of empirically based packaging regulation and safety standards. Recently, a family was arrested for having more than 30,000 vape cartridges of THC as well as nearly 100,000 mason jars filled with THC oil (Salo, 2019, October 2). This family is just one example of an informal source of marijuana, with limited to no regulation and safety standards. As access to a variety of methods of marijuana ingestion continues to grow, a body of evidence is necessary to guide, prioritize, and evaluate public health and policy efforts regarding marijuana (Allen et al., 2017).

**Conclusion**

Overall, the current study found that methods of ingestion (e.g. smoking, vaping, oral) were not related to problematic use nor frequency of use. Methods of ingestion were found to not be significantly related to motives for marijuana use (i.e. enjoyment, conformity, coping, experimentation, altered perceptions, and availability). Furthermore, this study found that methods of ingestion were not significantly related to mental health outcomes (i.e. anxiety and depression). The current study was able to classify participants into four trajectory use classes; however, the classes were not significantly related to method of ingestion. Additionally, differences in individuals transitioning between methods were found, resulting in two transition classes, however these were not significantly related to trajectory classes based on frequency of use and quantity. No relationship was found between state legality status and current method of ingestion; however, state legality status was related to perceived difficulty of obtaining vaporizers, dab rigs, edibles, and topicals. Furthermore, it was found that state legality significantly affected where marijuana was purchased, with many more participants than expected in medicinally legal states continuing to purchase from informal sources.
The current study found that particular reasons for use are endorsed more frequently for certain methods. Specifically, for smoking more common reasons for using included: “stronger intoxication effect,” “effects last longer,” “fewer “hits” necessary,” “different kind of high,” and “is easily accessible.” For vaping methods of ingestion participants endorsed reasons of “safer to use,” “less side effects,” “family members use/recommended it,” “is more discreet,” “stronger intoxication effect,” and “recommended/used by friends.” Finally, for oral methods of ingestion, participants endorsed reasons for use including “effects last longer,” “different kind of high,” “more discreet,” “stronger intoxication effect,” and “less side effects.”

In conclusion, while the current study found some preliminary evidence related to methods of ingestion, as well as differences in endorsed reasons for use for certain methods of ingestion, additional research is needed to establish other factors that may relate to methods of ingestion. Methods of ingestion should be considered when developing prevention strategies as certain methods could be associated with higher rates of negative short- and long-term consequences associated with marijuana use. Methods of marijuana ingestion have the potential to influence use, and research is needed to understand these possible influences to guide intervention strategies as well as public policy.

As a school psychologist, working within the school system, increased knowledge regarding the effect of methods of ingestion and contextual factors with youth can be critical in helping schools choose effective prevention and intervention strategies. Some strategies that could be useful would be general screening, for all students, that seeks to understand general substance use trends within the school. Based on these screenings,
intervention strategies can be tailored to provide youth with information to help increase their knowledge of potential dangers to use (e.g. formal versus informal sources of marijuana, short- and long-term consequence of use). Additionally, youth who show many risk factors related to chronic or heavy use trajectories can receive more specific interventions (e.g. small group or individual) tailored to mitigating some of these risk factors (e.g. emotional dysregulation, peer influence, college attainment). Schools are positioned in a way to influence many youth across the nation, given that the average age of onset for this sample was 17.66. Meaning, there are many youth who are initiating use before the age of 17 who can be affected by strategies utilized in schools.

Furthermore, for school psychologists working in other settings (e.g., private practice, integrated primary care) the use of screening tools can be equally beneficial. While school psychologists in these settings are seeing fewer youth, screening for substance use is equally as important. Youth and their families who present to these settings are seeking intervention services for their family. It is critical to conduct consultation interviews that seek to understand parental as well as youth risk factors, and screen for substance use. Collecting all this information is critical to implement targeted intervention strategies before the youth’s substance use becomes problematic. Families and youth may not report substance use as the reason for seeking services, but it is critical to screen for substance use as it has many short- and long-term effects that can be related to why a family is presenting for services (e.g. changes in memory, learning, negative emotionality, psychotic symptoms). Furthermore, in states where marijuana is legal and there are more retail outlets for purchasing, it may be critical to screen all youth who present for treatment as higher retail outlet density has been associated with a younger
age of onset for certain methods of ingestion (Borodovsky et al., 2017). With increasing numbers of states legalizing marijuana for medical as well as recreational use, a thorough understanding of methods of ingestion is necessary as they are becoming increasingly diversified and accessible. This research can identify any potential negative outcomes that can arise from legalization of marijuana as well as guide, prioritize, and evaluate public health and policy efforts.
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APPENDIX A

SURVEY QUESTIONS
Survey Questions

Participants will first review a description of the study and informed consent. Following this, they will be prompted to indicate their agreement to participate.

Q1 ELECTRONIC CONSENT: Please select your choice below. You may print a copy of this consent for your records. Clicking on the “Agree” button indicates that:
   • You have read the above information
   • You voluntarily agree to participate
   • You are 18 years of age or older and use marijuana at least monthly
     o Agree
     o Disagree

Q2 Are you age 18 or older?
   o Yes
   o No

Q3 Do you currently use marijuana, at least monthly?
   o Yes
   o No

Demographics

Q4 How old are you?

Q5 Which term best describes your ethnicity?
   o Not Hispanic or Latino
   o Hispanic/Latino

Q6 Please indicate your race/ethnicity? (check all that apply)
   o Caucasian / White
   o Black
   o Native American / Alaskan Native
   o Biracial / Multiracial (Please Specify) ______________
   o Asian
   o Pacific Islander / Native Hawaiian
   o Hispanic / Latino
   o Other (Please Specify) ____________

Q7 How would you characterize your current relationship/marital status?
   o Single
   o Married / Civil Union/ Living together long term
   o Seriously dating / exclusive relationship with a partner
   o Separated / Divorced
   o Widowed
Q8 What is your sexual orientation?
   o Gay Male
   o Lesbian
   o Bisexual
   o Heterosexual / Straight
   o Other (Please Specify) ___________
   o Prefer not to respond

Q9 Would you consider the area you live in to be rural or urban?
   o Rural (<2,500 population)
   o Urban Cluster (2,500-50,000 population)
   o Urban (>50,000 population)

Q10 Which of the following best describes your current living situation?
   o Live alone in my own home (e.g., house, apartment, etc.)
   o Live in a household with other people
   o Live in university housing
   o Live in a residential facility where meals and household help are routinely provided by paid staff (or could be if requested)
   o Temporarily staying with a relative or friend
   o Temporarily staying in a shelter or are homeless
   o Other __________

Q11 Are you currently working? (check all that apply)
   ▪ Yes, full time (35 or more hours per week)
   ▪ Yes, part time (less than 35 hours per week)
   ▪ No, currently unemployed
   ▪ Receiving disability (SSI)
   ▪ In school part-time
   ▪ In school full-time
   ▪ Retired
   ▪ Other: __________

Q12 Please describe the highest level of education you have attained.
   o Less than 12th grade and No GED
   o GED
   o High school diploma
   o Some College
   o Bachelor’s degree
   o Advanced graduate degree (e.g. Master’s, Law Degree, MD, PhD, etc.)
   o Don’t know

Q13 Please describe the highest level of education attained by your mom.
   o Less than 12th grade and No GED
   o GED
   o High school diploma
Q14 Please describe the highest level of education attained by your dad.
- Less than 12th grade and No GED
- GED
- High school diploma
- Some College
- Bachelor’s degree
- Advanced graduate degree (e.g. Master’s, Law Degree, MD, PhD, etc.)
- Don’t know

Q15 How would you describe your family’s income when you were a young teen (e.g. 12 – 15 old)? Please include your best guess based upon all income earned by your mom, dad, guardian, etc. for the WHOLE household. Total family income was:
- Under $20,000 per year
- Between $20,000--$30,000 per year
- Between $30,000--$40,000 per year
- Between $40,000--$60,000 per year
- Between $60,000--$80,000 per year
- Between $80,000--$100,000 per year
- Between $100,000--$150,000 per year
- Between $150,000--$200,000 per year
- Between $200,000--$250,000 per year
- Above $250,000 per year

Q16 How would you describe your income currently?
- Under $20,000 per year
- Between $20,000--$30,000 per year
- Between $20,000--$30,000 per year
- Between $30,000--$40,000 per year
- Between $40,000--$60,000 per year
- Between $60,000--$80,000 per year
- Between $80,000--$100,000 per year
- Between $100,000--$150,000 per year
- Between $150,000--$200,000 per year
- Between $200,000--$250,000 per year
- Above $250,000 per year

Q17 Did any members of your immediate family abuse drugs or alcohol while you were growing up? If yes, select the individuals and add others as they apply.
- N/A
- Father
- Mother
- Brother 1
- Sister 1
- Other 1 (write in relation of person): __________
- Other 2 (write in relation of person): __________

Q18 Please rate the severity of drug use by the immediate family members you indicated in the previous question?

<table>
<thead>
<tr>
<th></th>
<th>No consequences</th>
<th>Mild (had some negative consequences, but nothing severe)</th>
<th>Moderate (experienced multiple negative consequences and went to treatment)</th>
<th>Severe (experienced many negative consequences [e.g., went to treatment multiple times, had legal trouble])</th>
</tr>
</thead>
</table>
Daily Sessions, Frequency, Age of Onset, and Quantity of Cannabis Use Inventory (DFAQ)

DFAQ_1 Which of the following best captures when you last used marijuana?
  o 3 weeks ago
  o 2 weeks ago
  o Last week
  o This week
  o Yesterday
  o Today
  o I am currently high

DFAQ_1b How high are you right now?
  o I am not high at all
  o I am a little bit high
  o I am moderately high
  o I am very high
  o I am extremely high

DFAQ_2 Which of the following best captures the average frequency you currently use marijuana?
  o I do not currently use marijuana
  o Less than once a year
  o Once a year
  o Once every 3 to 6 months (2-4 times per year)
  o Once every 2 months (6 times per year)
  o Once a month
  o 2—3 time a month
  o Once a week
  o Twice a week
  o 3—4 times a week
  o 5—6 times a week
  o Once a day
  o More than once a day

DFAQ_3 Which of the following best captures how long you have been using marijuana at this frequency?
  o Less than 1 month
  o 1—3 months
  o 3—6 months
  o 6—9 months
  o 9—12 months
  o 1—2 years
  o 2—3 years
  o 3—5 years
  o 5—10 years
DFAQ_4 Before the period of time you indicated above, how frequency did you use marijuana?
- I did not use marijuana
- Less than once a year
- Once every 3 to 6 months (2-4 times per year)
- Once every 2 months (6 times per year)
- Once a month
- 2—3 times a month
- Once a week
- Twice a week
- 3—4 times a week
- 5—6 times a week
- Once a day
- More than once a day

DFAQ_5 How many days of the past week did you use marijuana?
- 0 days
- 1 days
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days

DFAQ_6 Approximately how many days (0-30) of the past month did you use marijuana?

DFAQ_8 Which of the following best captures your pattern of marijuana use throughout the week?
- I do not use marijuana at all
- I only use marijuana on weekends
- I only use marijuana on weekdays
- I use marijuana on BOTH weekends and weekdays

DFAQ_9 How many hours after waking up do you typically first use marijuana?
- I do not use marijuana at all
- 12—18 hours after waking up
- 9—12 hours after waking up
- 6—9 hours after waking up
- 3—6 hours after waking up
- 1—3 hours after waking up
- Within 1 hours of waking up
With 1/2 hour of waking up
Immediately upon waking up

DFAQ_10 How many times a day, on a typical weekday, do you use marijuana?

DFAQ_11 How many times a day, on a typical weekend, do you use marijuana?

DFAQ_12 What is the primary method you use to ingest marijuana?
- Joint
- Blunts (cigar sized joints)
- Hand pipe
- Bong (water pipe)
- Hookah
- Vaporizer (e.g. Volcano, vape pen)
- E-cigarette device (sold for nicotine)
- Dab rig (e.g. oil rig, hot knives)
- Edibles
- Topicals (e.g., lotions, creams)
- Other __________

DFAQ_13 Which of the following other methods to ingest marijuana do you use regularly (at least 25% of the time you use marijuana)? [Check all that apply]
- Blunts (cigar sized joints)
- Hand pipe
- Bong (water pipe)
- Hookah
- Vaporizer (e.g. Volcano, vape pen)
- E-cigarette device (sold for nicotine)
- Dab rig (e.g. oil rig, hot knives)
- Edibles
- Topicals (e.g., lotions, creams)
- Other __________

DFAQ_14 What is the primary form of marijuana you use?
- None
- Marijuana (e.g. Flower, Bud, Herb)
- Edibles
- Concentrates (e.g. Oil, Wax, Shatter, Butane Hash Oil)
- Other __________

DFAQ_15 Which other forms of marijuana do you use regularly (at least 25% of the time you use marijuana)? [Check all that apply]
- None
- Marijuana (e.g. Flower, Bud, Herb)
- Edibles
- Concentrates (e.g. Oil, Wax, Shatter, Butane Hash Oil)
- Other __________

DFAQ_image Please use the image below to refer to various quantities of marijuana. The image is not to scale; the dollar bill is included to help provide size perspective.

DFAQ_16a In a typical session (e.g., a period devoted to using), how much marijuana (e.g., Flower, Bud, Herd) do you personally use?
  - 1/8 gram (0.125)
  - 1/4 gram (0.25)
  - 1/2 gram (0.5)
  - 3/4 gram (0.75)
  - 1.0 gram
  - 1.5 grams
  - 2.0 grams
  - 2.5 grams
  - 3.0 grams
  - 3.5 grams (1/8 ounce)
  - 7 grams (1/4 ounce)
  - Other __________
  - I don’t know

DFAQ_17a On a typical day when you use marijuana (e.g. Flower, Bud, Herb), how much do you personally use?
  - 1/8 gram (0.125)
  - 1/4 gram (0.25)
  - 1/2 gram (0.5)
  - 3/4 gram (0.75)
  - 1.0 gram
DFAQ_18a How much marijuana (e.g. Flower, Bud, Herb), did you personally use yesterday?
  o 1/8 gram (0.125)
  o 1/4 gram (0.25)
  o 1/2 gram (0.5)
  o 3/4 gram (0.75)
  o 1.0 gram
  o 1.5 grams
  o 2.0 grams
  o 2.5 grams
  o 3.0 grams
  o 3.5 grams (1/8 ounce)
  o 7 grams (1/4 ounce)
  o Other __________
  o I don’t know

DFAQ_19a In a typical week you use marijuana (e.g. Flower, Bud, Herb), how much marijuana do you personally use?
  o 1/8 gram (0.125)
  o 1/4 gram (0.25)
  o 1/2 gram (0.5)
  o 3/4 gram (0.75)
  o 1.0 gram
  o 1.5 grams
  o 2.0 grams
  o 2.5 grams
  o 3.0 grams
  o 3.5 grams (1/8 ounce)
  o 7 grams (1/4 ounce)
  o Other __________
  o I don’t know

DFAQ_20a On a typical day you use marijuana (e.g. Flower, Bud, Herb), how many sessions (e.g., a period devoted to using) do you have?

DFAQ_21a What is the average THC content/potency of the marijuana (e.g., Flower Bud, Herb) you typically use?
DFAQ_16b In a typical session (e.g., a period devoted to using), when you use marijuana concentrates, how many hits do you personally take?

DFAQ_17b On a typical day you use marijuana concentrates, how many hits do you personally take?

DFAQ_18b Yesterday, how many hits of marijuana concentrates did you personally take?

DFAQ_19b In a typical week you use marijuana concentrates, how many grams do you personally use (Please note that a typical concentrate amount = .08 - .10 grams)?
- .05 grams
- .08 grams
- .10 grams
- .20 grams
- Other __________
- I don’t know

DFAQ_20b On a typical day when you use marijuana concentrates, how many sessions (e.g., a period devoted to using) do you have?

DFAQ_21b What is the average THC content/potency of the marijuana (e.g., Flower Bud, Herb) you typically use?
- 0—9%
- 10—19%
- 20—29%
- 30—39%
- 40—49%
- 50—55%
- 60—69%
- 70—79%
- 80—89%
- Greater than 90%
- I don’t know

DFAQ_21c When you eat edibles, how many milligrams of THC do you personally ingest in a typical session (e.g., period devoted to using)? Note: One serving typically
includes 10 milligrams. An example would be one gummy bear, which are usually 10 milligrams each.
  o 5 milligrams
  o 10 milligrams
  o 15 milligrams
  o 20 milligrams
  o Other __________
  o I don’t know

DFAQ_21d What type of edible do you typically consume (e.g. cookies, gummy bear, etc.)?

DFAQ_24 How old were you when you FIRST tried marijuana (in any form)?

DFAQ_23 How many years in total have you used marijuana?

DFAQ_25 Has there been any time in your life when you used marijuana regularly (2 or more times per month for 6 months or longer)?
  o No
  o Yes

DFAQ_25b How old were you when you FIRST STARTED using marijuana regularly (2 or more times per month)?

DFAQ_25c Has there been any time in your life when you used marijuana on a daily or near daily basis for 6 months or longer?
  o No
  o Yes

DFAQ_25cii How old were you when you FIRST STARTED using marijuana on a daily or near daily basis?

DFAQ_26 Which of the following best captures the average frequency that you used marijuana before the age of 16?
  o Never
  o Less than once a year
  o Once every 3 to 6 months (2—4 times per year)
  o Once every 2 months (6 times per year)
  o Once a month
  o 2—3 times a month
  o Once a week
  o Twice a week
  o 3—4 times a week
  o 5—6 times a week
  o Once a day
  o More than once a day
DFAQ_27 Do you have a prescription to use marijuana for medical purposes?
   o No
   o Yes
   o Yes, but I use it for both medical and recreational purposes

DFAQ_27b Which medical condition(s) do you use marijuana to treat?
   o Pain, please describe: __________
   o Muscle spasms
   o Nausea
   o Cancer
   o Seizures
   o HIV/AIDS
   o Glaucoma
   o Other, please describe: __________

DFAQ_27c What percentage of the time do you use marijuana for recreational (rather than medical) purposes?

DFAQ_28 Where do you typically get your marijuana?
   o Purchase from retail store/ dispensary for those over age 21 (you PERSONALLY buy it from a retail store/ dispensary)
   o Purchase from medical dispensary (you PERSONALLY have a medical marijuana card)
   o Purchase from a dealer
   o Purchase from a friend
   o It’s given to me for free (friend/family)
   o I grow my own
   o Other __________

DFAQ_29 When you use marijuana, what is the most common strain you use?
   o Indica-dominant
   o Sativa-dominant
   o Hybrid (Indica-dominant)
   o Hybrid (Sativa-dominant)
   o Hybrid (unsure of breakdown)
   o Other __________
   o Do not know

DFAQ_30 Do you think the questions up to this point have accurately measured your current marijuana consumption and your history of marijuana consumption?
   o Yes
   o No
DFAQ_30b Please describe in words any aspects of your marijuana use that were not reflected well in your answers to these questions. What information about your marijuana use would you like to add?
Rutgers Marijuana Problem Index

RMPI_1 Different things happen to people while they are using marijuana or because of their marijuana use. Several of these things are listed below. How many times have the following happened to you while you were using marijuana or because of using marijuana during the LAST YEAR?

<table>
<thead>
<tr>
<th>Event</th>
<th>Never (0)</th>
<th>One or two times (1)</th>
<th>Three to five times (2)</th>
<th>More than five times (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not able to do your homework or study for a test (1)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Got into fights with other people (friends, relatives, strangers) (2)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Missed out on other things because you spend too much money on marijuana (3)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Went to work or school high from marijuana (4)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Caused shame or embarrassment to someone (5)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Neglected your responsibilities (6)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Relatives avoided you (7)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Felt that you needed more marijuana than you used to in order to get the same effect (8)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Tried to control your marijuana use (for example, used only at certain times of the day or in certain places, that is, tried to change your pattern of use) (9)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Had withdrawal symptoms, that is, felt sick because you stopped or cut down on your marijuana use (10)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Noted a change in your personality (11)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Felt you had a problem with marijuana (12)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
RMPI_2 How many times have the following happened to you while you were using marijuana or because of using marijuana during the LAST YEAR?

<table>
<thead>
<tr>
<th>Phenomenon</th>
<th>Never (0)</th>
<th>One or two times (1)</th>
<th>Three to five times (2)</th>
<th>More than five times (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missed a day (or part of a day) of school or work</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(13)</td>
<td>o</td>
<td>o</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wanted to stop using marijuana but couldn’t</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(14)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Suddenly found yourself in a place that you could not remember getting to</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(15)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Passed out of fainted suddenly</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(16)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Had a fight, argument or bad feelings with a friend</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(17)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Had a fight, argument, or bad feelings with a family member</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(18)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Kept using marijuana when you promised yourself not to</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(19)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Felt you were going crazy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(20)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Has a bad time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(21)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Felt physically or psychologically dependent on marijuana</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(22)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Was told by a friend, neighbor or relative to stop or cut down on your</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>marijuana use</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
</tbody>
</table>
Comprehensive Marijuana Motives Measure

MMQ_1 Please select the FREQUENCY below for each question to indicate how often you use marijuana in each situation. How often have you used marijuana…

<table>
<thead>
<tr>
<th>Motive</th>
<th>Almost never or never (1)</th>
<th>Seldom (2)</th>
<th>Sometimes (3)</th>
<th>Often (4)</th>
<th>Almost always or always (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>To enjoy the effects of it (1)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Because you felt pressure from others who do it (2)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>To forget your problems (3)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Because you were experimenting (4)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Because you had nothing better to do (5)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Because you were drunk (6)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>To celebrate (7)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Because you want to alter your perspective (8)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Because it makes you more comfortable in an unfamiliar situation (9)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Because it is safer than drinking alcohol (10)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>To help you sleep (11)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Because it is readily available (12)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Because you would not eat without using marijuana first (13)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Because it helps you enjoy a party (14)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Because it is fun (15)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Because you didn’t want to be the only one not doing it (16)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
</tbody>
</table>
MMQ_2 Please select the FREQUENCY below for each question to indicate how often you use marijuana in each situation. How often have you used marijuana…

<table>
<thead>
<tr>
<th></th>
<th>Almost never or never (1)</th>
<th>Seldom (2)</th>
<th>Sometimes (3)</th>
<th>Often (4)</th>
<th>Almost always or always (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Because you were depressed (17)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Because you were curious about marijuana (18)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Because it increases your appetite (19)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>To be sociable (20)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>To relieve boredom (21)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Because you were under the influence of alcohol (22)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Because it was a special day (23)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Because you want to alter your perspective (24)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>To allow you to think differently (25)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>To make you feel more confident (26)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>To help you eat regularly (27)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Because it is not a dangerous drug (28)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Because it helps make napping easier and enjoyable (29)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Because it helps you enjoy food more (30)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Because you can get it for free (31)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
</tbody>
</table>
MMQ_3 Please select the FREQUENCY below for each question to indicate how often you use marijuana in each situation. How often have you used marijuana…

<table>
<thead>
<tr>
<th>Situation</th>
<th>Almost never or never (1)</th>
<th>Seldom (2)</th>
<th>Sometimes (3)</th>
<th>Often (4)</th>
<th>Almost always or always (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>To feel good (32)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>To be cool (33)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Because it makes social gathering more fun (34)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>To escape from your life (35)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>To see what it felt like (36)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Because you wanted something to do (37)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Because it is part of your meal routine (38)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Because you had gotten drunk and weren’t thinking about what you were doing (39)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Because it was a special occasion (40)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>So you can look at the world differently (41)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Because it relaxes you when you are in an insecure situation (42)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Because there are low health risks (43)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Because you are having problems sleeping (44)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Because it is there (45)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
Generalized Anxiety Disorder Scale (GAD-7)

GAD-7 Over the LAST 2 WEEKS, how often have you been bothered by the following problems?

<table>
<thead>
<tr>
<th>Problem</th>
<th>Not at all</th>
<th>Several days</th>
<th>More than half the days</th>
<th>Nearly every day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeling nervous, anxious or on edge (1)</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not being able to stop or control worrying (2)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Worrying too much about different things (3)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Trouble relaxing (4)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Being so restless that it is hard to sit still (5)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Becoming easily annoyed or irritable (6)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Feeling afraid as if something awful might happen (7)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
</tbody>
</table>
## Patient Health Questionnaire Depression Scale (PHQ-8)

PHQ-8 Over the LAST 2 WEEKS, how often have you been bothered by the following problems?

<table>
<thead>
<tr>
<th>Problem</th>
<th>Not at all</th>
<th>Several days</th>
<th>More than half the days</th>
<th>Nearly every day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little interest or pleasure in doing things (1)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Feeling down, depressed, or hopeless (2)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Trouble falling or staying asleep, or sleeping too much (3)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Feeling tired or having little energy (4)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Poor appetite or overeating (5)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Feeling bad about yourself – or that you are a failure or have let yourself or your family down (6)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Trouble concentrating on things, such as reading the newspaper or watching television (7)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Moving or speaking so slowly that other people could have noticed? Or the opposite – being so fidgety or restless that you have been moving around a lot more than usual (8)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
</tbody>
</table>
Patterns and Transitions in Marijuana Use

In the next few questions you will be asked about your marijuana use over the last five years. For each year you will be asked to estimate the frequency of your use, the amount used on a typical day (if you are able to recall), the primary form of marijuana used, the primary method of ingestion used, and if your primary method changed from one year to the next. If your primary method did not change, select no. If you did not use marijuana at all for a specific year, simply choose “did not use this year” as the response for all questions.

Trajectories_1 For each of the following questions, please think about the ENTIRE year listed on the left when answering each question.

<table>
<thead>
<tr>
<th>Year</th>
<th>State of Residence</th>
<th>Frequency of use</th>
<th>Primary form of marijuana used</th>
<th>Additional forms of marijuana used</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>2017</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>2016</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>2015</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>2014</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Amount Used on a typical day</th>
<th>Primary method used</th>
<th>Additional methods used</th>
<th>Method change</th>
<th>Why did it change?</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>2017</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>2016</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>2015</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>2014</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
</tbody>
</table>

Trajectories_2 Response options for State of Residence
(Select from drop down box of all U.S. states.)

Trajectories_3 Response options for Frequency of use:
  o Did not use this year
  o Less than once a year
  o Once every 3 to 6 months (2—4 times per year)
  o Once every 2 months (6 times per year)
  o Once a month
  o 2—3 times a month
  o Once a week
  o Twice a week
  o 3—4 times a week
  o 5—6 times a week
Once a day
More than once a day

Trajectories_4 Response options for **Primary form** of marijuana used:
- Did not use this year
- Marijuana (e.g. Flower, Bud, Herb)
- Edibles
- Concentrates (e.g. Oil, Wax, Shatter, Butane Hash Oil)
- Other

Trajectories_5 Response options for **Additional forms** of marijuana used:
- Did not use this year
- Marijuana (e.g. Flower, Bud, Herb)
- Edibles
- Concentrates (e.g. Oil, Wax, Shatter, Butane Hash Oil)
- Other

Trajectories_6 Response options for **Amount of marijuana (flower)** used on a typical day:
- Did not use this year
- 1/8 gram (0.125)
- 1/4 gram (0.25)
- 1/2 gram (0.5)
- 3/4 gram (0.75)
- 1.0 gram
- 1.5 grams
- 2.0 grams
- 2.5 grams
- 3.0 grams
- 3.5 grams (1/8 ounce)
- 7 grams (1/4 ounce)
- Other __________
- I don’t know

Trajectories_7 Response options for **Amount of edibles** used on a typical day:
- 5 milligrams
- 10 milligrams
- 15 milligrams
- 20 milligrams
- Other __________
- I don’t know

Trajectories_8 Response options for **Amount of concentrates** used on a typical day:
- .05 grams
- .08 grams
- .10 grams
- .20 grams
- Other
- I don’t know

Trajectories_9 Response options for **Primary method** used:
- Did not use this year
- Joint
- Blunts (cigar sized joints)
- Hand pipe
- Bong (water pipe)
- Hookah
- Vaporizer (e.g., Volcano, vape pen)
- E-cigarette device (sold for nicotine)
- Dab rig (e.g. oil rig, hot knives)
- Edibles
- Topicals (e.g., lotions, creams)
- Other

Trajectories_10 Response options for **Additional methods** used:
- Did not use this year
- Joint
- Blunts (cigar sized joints)
- Hand pipe
- Bong (water pipe)
- Hookah
- Vaporizer (e.g., Volcano, vape pen)
- E-cigarette device (sold for nicotine)
- Dab rig (e.g. oil rig, hot knives)
- Edibles
- Topicals (e.g., lotions, creams)
- Other

Trajectories_11 Did your **primary method of ingestion change** from the year before this?
- Did not use this year
- Yes
- No

Trajectories_12 Response options for **Why did method of ingestion change:**
- Did not use this year
- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other__________
### Contextual Factors

**Contextual_1** What is your current state of residence?  
(Select from drop down box of states.)

**Contextual_2** How easy is it for you to obtain the following forms of marijuana where you currently live?

<table>
<thead>
<tr>
<th></th>
<th>Very easy</th>
<th>Moderately easy</th>
<th>Neither easy nor difficult</th>
<th>Moderately Difficult</th>
<th>Very Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marijuana (e.g., Flower, Bud, Herb) Edibles</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Concentrates (e.g., Oil, Wax, Shatter, Butane Hash Oil)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

**Contextual_3** How easy is it for you to obtain these materials or devices to use marijuana where you currently live?

<table>
<thead>
<tr>
<th></th>
<th>Very easy</th>
<th>Moderately easy</th>
<th>Neither easy nor difficult</th>
<th>Moderately Difficult</th>
<th>Very Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Blunts (cigar sized joints)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Hand pipe</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Bong (water pipe)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Hookah</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Vaporizer (e.g., Volcano, vape pen)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>E-cigarette device (sold for nicotine)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Dab rig (e.g. oil rig, hot knives)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Edibles</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Topicals (e.g., lotions, creams)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
Reasons for Primary Method of Marijuana Ingestion

Reasons_1 Which of the following best captures the top reasons why you use the primary method (Joints) you mentioned earlier to ingest marijuana?
- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________

Reasons_2 Which other reasons capture why you use the primary method (Joints) you mentioned earlier to ingest marijuana? [Check all that apply]
- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________

Reasons_1b Which of the following best captures the top reasons why you use the primary method (Blunts) you mentioned earlier to ingest marijuana?
- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________
Reasons_2b Which other reasons capture why you use the primary method (Blunts) you mentioned earlier to ingest marijuana? [Check all that apply]
- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________

Reasons_1c Which of the following best captures the top reasons why you use the primary method (Hand pipe) you mentioned earlier to ingest marijuana?
- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________

Reasons_2c Which other reasons capture why you use the primary method (Hand pipe) you mentioned earlier to ingest marijuana? [Check all that apply]
- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________
Reasons_1d Which of the following best captures the top reasons why you use the primary method (Bong) you mentioned earlier to ingest marijuana?
- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________

Reasons_2d Which other reasons capture why you use the primary method (Bong) you mentioned earlier to ingest marijuana? [Check all that apply]
- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________

Reasons_1e Which of the following best captures the top reasons why you use the primary method (Hookah) you mentioned earlier to ingest marijuana?
- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________
Reasons_2e Which other reasons capture why you use the primary method (Hookah) you mentioned earlier to ingest marijuana? [Check all that apply]

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________

Reasons_1f Which of the following best captures the top reasons why you use the primary method (Vaporizer or vape pen) you mentioned earlier to ingest marijuana?

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________

Reasons_2f Which other reasons capture why you use the primary method (Vaporizer or vape pen) you mentioned earlier to ingest marijuana? [Check all that apply]

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________
Reasons_1g Which of the following best captures the top reasons why you use the primary method (e-cigarette device; sold for nicotine) you mentioned earlier to ingest marijuana?

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________

Reasons_2g Which other reasons capture why you use the primary method (e-cigarette device; sold for nicotine) you mentioned earlier to ingest marijuana? [Check all that apply]

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________

Reasons_1h Which of the following best captures the top reasons why you use the primary method (Dab rig; e.g., oil rig, hot knives) you mentioned earlier to ingest marijuana?

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
Other ______

Reasons_2h Which other reasons capture why you use the primary method (Dab rig; e.g., oil rig, hot knives) you mentioned earlier to ingest marijuana? [Check all that apply]

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________

Reasons_1i Which of the following best captures the top reasons why you use the primary method (Edibles) you mentioned earlier to ingest marijuana?

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________

Reasons_2i Which other reasons capture why you use the primary method (Edibles) you mentioned earlier to ingest marijuana? [Check all that apply]

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________
Reasons_1j Which of the following best captures the top reasons why you use the primary method (Topicals; lotions, creams) you mentioned earlier to ingest marijuana?
- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________

Reasons_2j Which other reasons capture why you use the primary method (Topicals; lotions, creams) you mentioned earlier to ingest marijuana? [Check all that apply]
- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________

Reasons_1k Which of the following best captures the top reasons why you use the primary method (Other) you mentioned earlier to ingest marijuana?
- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________
Reasons_2 Which other reasons capture why you use the primary method (Other) you mentioned earlier to ingest marijuana? [Check all that apply]

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________

Reasons_3 Which of the following best captures the top reasons why you use the method of Joints 25% of the time to ingest marijuana?

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________

Reasons_4 Which other reasons capture why you use the method of Joints 25% of the time to ingest marijuana? [Check all that apply]

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________
Reasons_3b Which of the following best captures the top reasons why you use the method of Blunts 25% of the time to ingest marijuana

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________

Reasons_4b Which other reasons capture why you use the method of Blunts 25% of the time to ingest marijuana? [Check all that apply]

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________

Reasons_3c Which of the following best captures the top reasons why you use the method of Hand pipe 25% of the time to ingest marijuana

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________
Reasons_4c Which other reasons capture why you use the method of Hand pipe 25% of the time to ingest marijuana? [Check all that apply]
  ▪ Different kind of high
  ▪ Stronger intoxication effect
  ▪ Effect last longer
  ▪ Fewer “hits” are necessary
  ▪ Safer to use
  ▪ Less side effects
  ▪ Friends use/recommended this method
  ▪ Family members use/recommended this method
  ▪ Tastes better
  ▪ Is easily accessible
  ▪ Is less expensive
  ▪ Other __________

Reasons_3d Which of the following best captures the top reasons why you use the method of Bong 25% of the time to ingest marijuana
  o Different kind of high
  o Stronger intoxication effect
  o Effect last longer
  o Fewer “hits” are necessary
  o Safer to use
  o Less side effects
  o Friends use/recommended this method
  o Family members use/recommended this method
  o Tastes better
  o Is easily accessible
  o Is less expensive
  o Other __________

Reasons_4d Which other reasons capture why you use the method of Bong 25% of the time to ingest marijuana? [Check all that apply]
  ▪ Different kind of high
  ▪ Stronger intoxication effect
  ▪ Effect last longer
  ▪ Fewer “hits” are necessary
  ▪ Safer to use
  ▪ Less side effects
  ▪ Friends use/recommended this method
  ▪ Family members use/recommended this method
  ▪ Tastes better
  ▪ Is easily accessible
  ▪ Is less expensive
  ▪ Other __________
Reasons_3e Which of the following best captures the top reasons why you use the method of **Hookah** 25% of the time to ingest marijuana

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________

Reasons_4e Which other reasons capture why you use the method of **Hookah** 25% of the time to ingest marijuana? [Check all that apply]

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________

Reasons_3f Which of the following best captures the top reasons why you use the method of **Vaporizer** 25% of the time to ingest marijuana

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________
Reasons_4f Which other reasons capture why you use the method of Vaporizer 25% of the time to ingest marijuana? [Check all that apply]

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other __________

Reasons_3g Which of the following best captures the top reasons why you use the method of e-cigarette device (sold for nicotine) 25% of the time to ingest marijuana

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other __________

Reasons_4g Which other reasons capture why you use the method of e-cigarette device (sold for nicotine) 25% of the time to ingest marijuana? [Check all that apply]

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other __________
Reasons_3h Which of the following best captures the top reasons why you use the method of Dab rig (e.g., oil rig, hot knives) 25% of the time to ingest marijuana

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other ________

Reasons_4h Which other reasons capture why you use the method of Dab rig (e.g., oil rig, hot knives) 25% of the time to ingest marijuana? [Check all that apply]

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other ________

Reasons_3i Which of the following best captures the top reasons why you use the method of Edibles 25% of the time to ingest marijuana

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other ________
Reasons_4i Which other reasons capture why you use the method of Edibles 25% of the time to ingest marijuana? [Check all that apply]
- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other __________

Reasons_3j Which of the following best captures the top reasons why you use the method of Topicals (e.g., lotions, creams) 25% of the time to ingest marijuana
- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other __________

Reasons_4j Which other reasons capture why you use the method of Topicals (e.g., lotions, creams) 25% of the time to ingest marijuana? [Check all that apply]
- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other __________
Reasons_3k Which of the following best captures the top reasons why you use the method of Other 25% of the time to ingest marijuana

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________

Reasons_4k Which other reasons capture why you use the method of Other 25% of the time to ingest marijuana? [Check all that apply]

- Different kind of high
- Stronger intoxication effect
- Effect last longer
- Fewer “hits” are necessary
- Safer to use
- Less side effects
- Friends use/recommended this method
- Family members use/recommended this method
- Tastes better
- Is easily accessible
- Is less expensive
- Other _________
APPENDIX B

INSTITUTIONAL REVIEW BOARD APPROVAL
DATE: April 17, 2019

TO: Maryia Schneider, MA
FROM: University of Northern Colorado (UNCO) IRB

PROJECT TITLE: [1414592-1] Current Trends in Marijuana Methods of Ingestion and Associated Problems Among Young Adult Marijuana Users
SUBMISSION TYPE: New Project

ACTION: APPROVAL/VERIFICATION OF EXEMPT STATUS
DECISION DATE: April 17, 2019
EXPIRATION DATE: April 17, 2023

Thank you for your submission of New Project materials for this project. The University of Northern Colorado (UNCO) IRB approves this project and verifies its status as EXEMPT according to federal IRB regulations.

Maryia -

Thank you for your extraordinary patience with the UNC IRB process. The protocols and materials outlined in this amended/modified application are clear and thorough. While this is somewhat beyond the purview of IRB, the length of your survey seems like it could exceed the anticipated 20-30 minutes and might create incomplete data - just a consideration that I'm compelled to point out as a result of my review. Also, you may want to add a THANK YOU and perhaps some national, regional or local support services for participants in case needed as a result of completing this survey on marijuana use.

Aside from the above comments, the protocols and materials in this application are verified/approved exempt and you may begin participant recruitment and data collection.

Best wishes with this meaningful and relevant research.

Sincerely,

Dr. Megan Stellino, UNC IRB Co-Chair

We will retain a copy of this correspondence within our records for a duration of 4 years.

If you have any questions, please contact Nicole Morse at 970-351-1910 or nicole.morse@unco.edu. Please include your project title and reference number in all correspondence with this committee.
APPENDIX C

CONSENT FORMS FOR HUMAN PARTICIPANTS IN RESEARCH
Project Title: Current Trends in Marijuana Methods of Ingestion Among Young Adult Marijuana Users  
Researcher: Maryia Schneider, M.A.  
Email: schn8458@bears.unco.edu  
Faculty Researchers: David Hulac, Ph.D. & Kristina Phillips, Ph.D.  
Faculty contact: David.Hulac@unco.edu

**Purpose and Description**

We are currently recruiting community members over the age of 18 to participate in a research study on marijuana use and methods of ingestion. The goal of this study is to learn more about how you are using marijuana, both currently and since you first began using.

As part of this study, you will be asked to fill out a survey that takes approximately 20-30 minutes to complete.

Your participation in this survey is voluntary. You may refuse to take part in the research or exit the survey at any time without penalty. You will be asked to answer questions regarding yourself, your marijuana use over time, and any emotional concerns. Your responses will help us learn more about methods of marijuana ingestion.

Some of the questions concern sensitive information about you. Most people do not experience any discomfort when answering such questions, but others may find answering these questions uncomfortable. There are no foreseeable risks involved in participating in this study.

Your responses to the questions will be anonymous. No identifying information about your responses will be provided to anyone outside of this study. Information that is collected via the survey software program are stored in a single secure data center (not in the cloud). We will not ask any information that identifies you (e.g., your name of social security number) on the survey link. All paper research records will be kept in a locked file; only the researchers will have access to the records. All data will be destroyed three years after study completion.
While there are no direct benefits from participating in this study, there is an indirect benefit of knowing you participated in a study that will support research focused on marijuana use. Participants are financially reimbursed for their participation. The reimbursement for completing the study will be $2.50 paid through Amazon.

If you have questions at any time about the study or the procedures, you may contact Maryia Schneider at schn8458@bears.unco.edu.

Participation is voluntary. You may decide not to participate in this study and if you begin participation you may still decide to stop and withdraw at any time. Your decision will be respected and will not result in loss of benefits to which you are otherwise entitled. Having read the above and having had an opportunity to ask any questions, please sign below if you would like to participate in this research. You may print a copy of this form to retain for future reference. If you have any concerns about your selection or treatment as a research participant, please contact the Office of Research, Kepner Hall, University of Northern Colorado Greeley, CO 80639; 970-351-1910.

ELECTRONIC CONSENT: Please select your choice below. You may print a copy of this consent form for your records. Clicking on the “Agree” button indicates that

- You have read the above information
- You voluntarily agree to participate
- You are 18 years of age or older
- You currently use marijuana at least monthly

☐ Agree  ☐ Disagree
CONSENT FOR HUMAN PARTICIPANTS IN RESEARCH
UNIVERSITY OF NORTHERN COLORADO

Project Title: Current Trends in Marijuana Methods of Ingestion Among Young Adult Marijuana Users
Researcher: Maryia Schneider, M.A.
Email: schn8458@bears.unco.edu
Faculty Researchers: David Hulac, Ph.D. & Kristina Phillips, Ph.D.
Faculty contact: David.Hulac@unco.edu

Purpose and Description

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- You have read the above information
- You voluntarily agree to participate
- You are 18 years of age or older
- You currently use marijuana at least monthly

☐ Agree
☐ Disagree