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Marijuana Use Among Adults in the United States: Comparing Correlates of Use, Assessing Impact of Education, and Evaluating Use and Health amid Justice-Involved Populations

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MARIJUANA USE AMONG ADULTS IN THE UNITED STATES: COMPARING CORRELATES OF USE, ASSESSING IMPACT OF EDUCATION, AND EVALUATING USE AND HEALTH AMID JUSTICE-INVOLVED POPULATIONS

by

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ABSTRACT

Over the past two decades, there have been significant changes in state-level policies (i.e., decriminalization, medicalization, legalization) in the U.S. regarding marijuana use. Prior research has found a relationship between marijuana policies and decreased perceived risk as well as increased prevalence of use. In light of these historical shifts, the public health implications of marijuana use deserve increased attention by researchers so that we can discern patterns of use, evaluate risk, and inform intervention. This dissertation has three aims: (1) investigate how correlates of use prevalence versus use frequency vary; (2) offer a theoretical explanation as to why more education is associated with less frequent marijuana use utilizing a specific hypothesis from Human Capital Theory, and (3) determine if the association between justice-involvement and marijuana use is mediated by social integration and poor health. Data are analyzed from 41,685 U.S. civilians; noninstitutionalized population aged 18 or older who participated in the 2018 National Survey on Drug Use and Health. The NSDUH provides information on use of alcohol, tobacco, and illicit drugs as well as data on mental health among members of the noninstitutionalized population of the U.S. aged 12 years old or older. Logistic and zero-inflated negative binomial regression analysis are used to assess aims. In accordance with Aim 1, health and behavioral correlates of marijuana use vary depending on how use it quantified. Respondents who use marijuana with greater frequency, compared to those who use infrequently, are more likely to experience adverse health and behavioral associations. With regard to Aim 2, findings indicate that education allows individuals to merge health-producing behaviors into a practical, healthy lifestyle. Concerning Aim 3, justice-involvement was found to

be associated with marijuana use because justice-involved people have worse health. Implications and directions for future research are discussed.

KEY WORDS: marijuana use; correlates; human capital; education; justice-involved

To my grandmother, Joan Pomykacz

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Getting to this stage in my career would not have been possible without the constant support and relentless encouragement of my family, friends, and mentors.

So, if you ever get tired of calling me Doctor just remember, this was all your fault.

Thank you all.

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CHAPTER ONE: BACKGROUND AND INTRODUCTION

Introduction

Since 1996, state-level marijuana policy has undergone drastic changes in the U.S. (Keyes et al., 2016; Davis et al., 2016; National Academics of Sciences, Engineering, and Medicine, 2017). At the time of this study, thirty-three states and the District of Columbia have passed some form for medical marijuana legislation (MML) (Drug Policy Alliance, 2019). MMLs eliminate state-level penalties for the possession, use, and cultivation of medical marijuana. States that have medical marijuana legislation protect doctors from prosecution for prescribing the drug and require that a patient have a doctor's approval for use. In addition, eleven states and the District of Columbia have passed legislation for adult-use of recreational marijuana (Drug Policy Alliance, 2019).

Prior research has found a relationship between marijuana policies (i.e. decriminalization, medicalization, and legalization) and decreased perceived risk (Schuermeyer et al., 2014) as well as increased use (Cerda, Wall, Keyes, Galea, & Hasin, 2012). Importantly, data from the National Survey on Drug Use and Health (NSDUH), a leading epidemiological surveillance tool, indicates that the prevalence of past year marijuana use among young adults has increased from 27.5% in 2007 to 34.8% in 2018 (SAMHSA, 2019). While some studies suggest states with MML have higher rates of marijuana use than in states that do not (Wall et al., 2011; Hasin et al., 2015; Stolzenberg, D'Alesso, & Dariano, 2015), others show no change in rates of marijuana use after MML implementation (Harper, Strumpf, & Kaufman, 2012; Keyes et al., 2016). Additionally, while rates of use have increased in some states with MML, abuse and dependence of marijuana was not more prevalent among marijuana users in these states (Cerda et al. 2012).

In the face of on-going national- and state-policy trends toward medicalization and legalization, it is important to determine if these policies carry unintended health and social consequences associated with marijuana use (Cerda et al., 2012; Compton et al., 2016; Korn et al., 2018; Pacek, Mauro, & Martins, 2015; Volkow et al.,2014; Volkow et al., 2016; Wu, Zhua, & Swatrza, 2016).

Owing to the changing state-level policies and the increase in marijuana use, there are a few areas of inquiry that should be explored. First, with most people who use marijuana doing so moderately and not experiencing harmful outcomes, comparing users to nonusers is problematic (Room et al., 2010; Temple et al., 2011). Instead, researchers should focus on frequent or high-risk marijuana use as those individuals are more likely to experience adverse health and social consequences (Arria et al., 2016; Nelson et al., 2015; Pardini et al., 2015; Schauer et al. 2016; Terry-McElrath et al., 2017; Volkow et al., 2014). Second, prior research clearly shows that higher levels of educational attainment are associated with less substance use and fewer risk taking behaviors (Chen et al., 2017; Cerda 2017; Han et al., 2018; Homel, Thompson, & Leadbeater, 2014; Lynskey & Hall, 2000; Richmond-Rakerd, Slutske, & Wood 2017; Schauer et al., 2016; Terry-McElrath et al., 2017). However, the research linking educational attainment and substance use is largely atheoretical making it difficult to understand how education works to limit marijuana use (Cerda, 2017; Hammersley, 2011; Verweij, Huizink, Agrawal, Martin, Lynskey, 2013). Third, a substantial portion of the U.S. population has had contact with the criminal justice system with more than ten million arrests recorded annually (Uniform Crime Report, 2017a) and roughly 6.6 million persons under correctional supervision (Kaebel & Cowhig, 2018). These justice-involved populations are at heightened risk for substance using

behaviors, including marijuana, (Fearn et al., 2016; Freeman et al., 2017; Vaughn et al., 2012). The extant literature on justice-involvement and substance use behaviors is limited, as little research assesses why persons with a history of justice-involvement are at increased risk for substance use.

National Survey on Drug Use and Health

This dissertation relies on data from the 2018 public use data file of the National Survey on Drug Use and Health (NSDUH). The survey is sponsored by the Center for Behavioral Health Statistics and Quality (CBHSQ) within the Substance Abuse and Mental Health Services Administration (SAMHSA). The NSDUH has been conducted periodically since 1971 and the 2018 survey is the 38th in the series. The NSDUH is a leading source of epidemiological surveillance data on substance use in the U.S., providing information on use of alcohol, tobacco, prescription drug use and misuse, and marijuana and other illicit drugs among the U.S. civilian, noninstitutionalized population aged 12 years old or older.

The sample is based on independent, multistage area probability sample of each state and the District of Columbia. The sample is stratified by creating state sampling regions (SSRs) within each state. The SSRs were created so that each region formed produced approximately the same number of interviews during each data collection period. This design divided the United States into a total of 750 SSRs, including 36 in California; 30 each in Florida, New York, and Texas; 24 each in Illinois, Michigan, Ohio, and Pennsylvania; 15 each in Georgia, New Jersey, North Carolina, and Virginia; and 12 each in the remaining 38 states and the District of Columbia.

The primary stage of selection was census tracks, with tracts aggregated within SSRs until each met the minimum dwelling unit requirement (150 or 250 in urban areas and 100 or 200 in rural areas). The secondary stage of selection was census block groups. The block groups were required to have the same minimum number of dwelling units as the census tracts from which they were selected. Then one census block group was selected per census tract with probability proportionate to a composite size measure. The tertiary stage of selection took form in area segments where each census block group was partitioned into small geographic areas composed of adjacent blocks. This was necessary because census block groups generally exceeded the minimum dwelling unit requirement. One segment was selected within each sampled census block group with probability proportionate to size. Additionally, the sample design oversamples youths aged 12 to 17 years old and young adults aged 18 to 25 years old.

The NSDUH data were collected from respondents using a combination of computer-assisted face-to-face interviewing by a trained interviewer and computer-assisted self-interviewing. The field investigators visited each sample address to determine dwelling unit eligibility and to select the sample of respondents. After, they conducted a screening interview to identify and record all survey-eligible individuals residing at the address. Then the computer selected a sample of individuals to be interviewed based on the parameters specified for that area segment and a random number specified for that address. The use of computer-assisted face-to-face and self-interviewing techniques were intended to offer respondents a high level of privacy and confidentiality while responding to questions, increasing the likelihood that they respond honestly to illicit drug use and other sensitive behaviors. Respondents who completed the full interview were given $30 in cash for their time (SAMSHA, 2019). The actual, achieved sample

size for the 2018 NSDUH was 67,791 respondents, with weighted screening and interview response rates of 73.30% and 66.56% respectively.

Dissertation Research

The current study uses a three-paper format to investigate marijuana use among adults with three distinct yet related goals in mind. First, I aim to investigate how correlates of marijuana use vary based on how use is measured: Chapter 2 "Correlates of Marijuana Use: Comparing Use Prevalence to Use Frequency." In line with previous literature, it is hypothesized that the correlates related to marijuana use will vary depending on how use is measured. In light of changing policy and increases in the prevalence of marijuana use, it is important for researchers to understand the potential correlates for high-risk use as they can influence public health as well as tailor intervention and prevention strategies (Han et al., 2018; Monte et al., 2015).

Second, I aim to offer a theoretical explanation as to why increased educational attainment is associated with less marijuana use: Chapter 3, "Educational Attainment and Frequent Marijuana Use: A Human Capital Approach." Guided by human capital theory (Mirowsky & Ross 2003; 2015) I hypothesize that respondents with higher educational attainment will report less frequent marijuana use, in part because education influences the ability to make healthier life choices and reduces involvement in risky behaviors.

Third, I assess the association between justice-involvement and frequency of marijuana use: Chapter 4, "Evaluating Marijuana Use and Health Amid Justice-Involved Populations." Consistent with previous literature, it is hypothesized that poor health and a lack of social

integration will mediate the relationship between justice-involvement and frequency of marijuana use. This is based on prior research that shows justice-involved populations are at increased for poor health outcomes (Bronson & Berzofsky, 2017; Bronson, et al., 2017; Freeman et al., 2017; Maruschak et al., 2016) and that justice-involvement negatively impacts social integration (Massoglia et al. 2011).

Finally, Chapter 5 will provide a summary of key findings across the three papers, discuss contributions to literature as well as directions for future research.

CHAPTER TWO: CORRELATES OF MARIJUANA USE: COMPARING USE PREVALENCE TO USE FREQUENCY (PAPER 1)

Introduction

The landscape of marijuana use is changing in the United States, with many states moving toward decriminalization and legalization for medical and recreational purposes. Marijuana is the most commonly used substance in the U.S. after alcohol and tobacco (Substance Abuse and Mental Health Services Administration [SAMHSA], 2019). According to the National Survey on Drug use and Health (NSDUH), marijuana prevalence has increased over the past decade with more than one-third (34.8 percent) of emerging adults aged 18 to 25 being past year users in 2018 (SAMHSA, 2019). Likewise, the 2018 Monitoring the Future Survey (MTF), a national survey funded by the National Institute of Drug Abuse to measure alcohol and drug use and related attitudes, estimates that about one-in-twelve young adults aged 19 to 28 are daily marijuana users. This is the highest level of daily use ever observed among young adults since the 1980s when the MTF began tracking use (Schulenberg et al., 2019). In the face of on-going state-level policy changes and increases in the prevalence of marijuana use, it is important understand the health-related and social consequences associated with marijuana use (Cerda et al., 2012; Compton et al., 2016; Korn et al., 2018; Pacek, Mauro, & Martins, 2015; Volkow et al.,2014; Volkow et al., 2016; Wua, Zhua, & Swatrza, 2016).

The majority of the existing research has focused on the impact of changes to marijuana legislation on marijuana use prevalence among adolescents and adults (Han et al., 2018; Hasin et al., 2015; Hasin et al., 2017; Martins et al., 2016; Pacula et al., 2015; Wen, Hockenberry, & Cummings, 2015). However, given that marijuana use is so widespread in the U.S., looking at

just prevalence is problematic because it breaks respondents up into two groups: users and non-users. While this may make sense when looking at substance use that is uncommon (e.g. cocaine, heroin, and methamphetamine), it is illogical to do this when substance use is commonplace. When substance use is widespread, assessing the correlates of users versus non-users does not reveal pertinent information regarding the patterns of marijuana use. For instance, the 2018 NSDUH estimates that the prevalence of past year alcohol use among young adults is 79.7% (SAMHSA, 2018). With a majority of young adults using alcohol, researchers are prompted to identify the characteristics associated with problematic use which, typically takes form through understanding correlates of frequent use (e.g. heavy drinking and binge drinking).

Since marijuana use is commonplace in the U.S., comparing users versus non-users does not reveal as much information as looking at frequency of use (Asbridge et al., 2014; Johnson, 2014; Temple, Brown, & Hine, 2011). Prior research also suggests that the correlates associated with use may vary depending on how marijuana use is measured (Macleod et al. 2004; Temple et al., 2011). Prevalence measures of marijuana use can lead to inferential errors (Johnson, 2014) and they fail to explain the distinct differences between users (Temple et al., 2011). If researchers want to determine the health and behavioral correlates of marijuana use, it is logical to use frequency measures over prevalence measures as only a fraction of those who use will go on to problematic use and experience adverse outcomes (Room et al., 2010; Temple et al., 2011).

Research has shown that in terms of health and social markers, differences between infrequent and controlled marijuana users versus non-users are often negligible (Asbridge et al., 2014; Hathaway 2004; Homel, Thompson, & Leadbeater, 2014; Korn et al., 2018; Maggs et al., 2015). Frequency measures vary between studies (Temple et al., 2011) but, generally speaking,

infrequent users are those who used a few times a month to a few times a year (Homel et al., 2014 [a few times a month to a few times a year]; Korn et al., 2018 [1-20 occasions in the past year]; Maggs et al., 2015 [1-6 occasions in past month]). Controlled marijuana users are defined as individuals who take precautions to lower the risks associated with cannabis use (Fischer et al., 2017; Hathaway, 2004; Lau et al., 2015). These precautions can include avoiding high-frequency use (e.g. daily or near daily use) as well as not engaging in risky behaviors (e.g. impaired driving).

Researchers acquire better and more comprehensive results when measuring marijuana use in terms of frequency (Asbridge et al., 2014; Johnson, 2014; Temple et al., 2011). Prior research consistently shows that heavy marijuana use is associated with a number of negative health and social measures (Arria et al., 2016; Nelson et al., 2015; Pardini et al., 2015; Schauer et al. 2016; Terry-McElrath et al., 2017; Volkow et al., 2014). For example, in a contemporary longitudinal study, Korn and colleagues (2018) found that when compared to non-users, frequent marijuana users (20 or more occasions in the past year) had higher risk of reporting more depressive symptoms, psychosomatic symptoms, and unhealthy weight control behaviors. In another study investigating marijuana use among first-year college students, heavy and moderate marijuana users had poorer physical and mental health outcomes, injuries, illness, as well as emotional and psychological distress (Arria et al., 2016). Previous research as also linked heavy marijuana use to chronic diseases, such as cancer and heart disease, as well as lower life satisfaction and reduced physical activity (Greydanus et al., 2013; Schauer et al., 2016; Volkow et al., 2014). Additionally, frequent marijuana use is associated with an increased risk for abuse and dependence (Nelson et al., 2015; Pardini et al., 2015).

Along with the damaging health characteristics associated with frequent marijuana use, prior studies have also established several social characteristics related to heavy use. These include engaging in risky driving behaviors (Korn et al., 2018; Li, Simons-Morton, Gee, & Hingson, 2016; Robertson, Woods-Fry, & Morris, 2016), unemployment and lower income (Schauer et al., 2016), low school achievement (Arria et al., 2016; Homel, Thompson, & Leadbeater, 2014; Korn et al., 2018; Maggs et al., 2015), and criminal behavior (Schauer et al., 2016).

Collectively, the research that assesses frequency measures of marijuana use is vital to understanding the correlates associated with high-risk use. Prevalence measures of use do not provide adequate information on the populations that are at risk for adverse health and behavioral characteristics because most Americans who consume the substance do so in a moderate, controlled manner (Room et al., 2010; Temple et al., 2011). Also, the studies that examine correlates of frequent marijuana use allow researchers to distinguish differences between types of users (Temple et al., 2011). Instead of focusing attention on the differences between users and non-users, scholars should place emphasis on characteristics that are correlated with frequent use as these populaces are at an increased risk for use-related concerns (Arria et al., 2016; Nelson et al., 2015; Pardini et al., 2015; Schauer et al. 2016; Terry-McElrath et al., 2017; Volkow et al., 2014). Understanding the correlates associated with frequent marijuana use can help inform marijuana policy discussions and guide future research (Han et al., 2018). The goal of the current research is to evaluate how correlates of marijuana use vary depending on how use is measured (e.g. prevalence or count).

Current Research.

This chapter, "Paper 1: Correlates of Marijuana Use: Comparing Use Prevalence to Use Frequency," utilizes a large and recent sample of U.S. adults to answer the following research questions:

RQ1: What are the characteristics associated with marijuana use prevalence and marijuana use frequency?

In line with previous literature, it is hypothesized that the correlates related to marijuana use will vary depending on how use is measured. Further, relevant associations are likely to yield distinctive characteristics associated with frequency measures of marijuana use that are not found while examining prevalence measures.

Methods

Sample.

Data for the current study are the National Survey on Drug Use and Health (NSDUH), sponsored by the Center for Behavioral Health Statistics and Quality (CBHSQ) within the Substance Abuse and Mental Health Services Administration (SAMHSA). The survey has been conducted periodically since 1971 and provides information on use of alcohol, tobacco, and illicit drugs as well as data on mental health among members of the U.S. civilian, noninstitutionalized population aged 12 years old or older. The sample is based on independent, multistage area probability sample of each state and the District of Columbia. The data were collected from respondents using a combination of computer-assisted face-to-face interviewing and computer-assisted self-interviewing by a trained interviewer. These interviewing techniques

were intended to offer respondents a high level of privacy and confidentiality while responding to questions, increasing the likelihood that they respond honestly to illicit drug use and other sensitive behaviors (SAMSHA, 2019).

Data were collected from 67,791 respondents in 2018. During this period, the weighted screening and interview response rates were 73.30% and 66.56% respectively. Since this research is focused on adults, the analytic sample was restricted to respondents aged 18 and older, giving a total sample of 40,745 respondents. Further information on NSDUH methodology can be found at Center for Behavioral Health Statistics and Quality (2018).

Variables.

Marijuana Use.

Several measures associated with marijuana use in the past year are included in this study. First, we utilize a measure of marijuana use prevalence in the past year (0 = did not use in past year or never used marijuana; 1 = used within the past year). Second, we include a count measure of marijuana use in the past year. This measure was recoded so that 0 indicates that the respondent did not use in past year or never used marijuana and 1-365 were the reported number of days in the past year that a respondent used marijuana.

Sociodemographic.

In order to compare the correlates of marijuana use for prevalence versus frequency, all variables are treated as categorical measures. The sociodemographic characteristics include age (1 = 18 to 25 years old; 2 = 26 to 34 years old; 3 = 35 to 49 years old; 4 = 50 years old and

older), gender (0 = female; 1 = male), race/ethnicity (1 = non-Hispanic white; 2 = non-Hispanic black; 3 = Hispanic; 4 = other), sexual identity (1 = heterosexual/straight; 2 = lesbian or gay; 3 = bisexual), educational attainment (1 = less than high school; 2 = high school graduate; 3 = some college credit/Associate's degree; 4 = college graduate), marital status (1 = married; 2 = widowed; 3 = divorced or separated; 4 = never been married), and religiosity. To measure importance of religious beliefs respondents were asked to indicate their level of agreement with the following statement, "Your religious beliefs are a very important part of your life." This measure was recoded so that 0 = strongly agree/disagree and 1 = agree/strongly agree. To measure religious attendance, respondents were asked, "During the past 12 months, how many times did you attend religious services? Please do not include special occasions such as weddings, funerals, or other special events in your answer." This measure was recoded so that 0 = 0 to 24 times and 1 = 25 times or more. Also, the current study also includes military service (0 = no, respondent was never in the armed forces; 1 = yes, the respondent was ever in the armed forces), and geographic residence (1 = live in a large metro, 2 = live in a small metro, 3 = live in a non-metro) as sociodemographic characteristics.

In addition, a measure of justice involvement was included in this study. Respondents were asked, "Not counting minor traffic violations, how many times during the past 12 months have you been arrested and booked for breaking a law?", "Were you on probation at any time during the past 12 months?", and "Were you on parole, supervised release, or other conditional release from prison at any time during the past 12 months?". These three measures were combined and dichotomized to give a measure of the subpopulation of justice involvement in the past year (0 = no; 1 = yes).

Furthermore, a measure of state medical marijuana legislation (MML) is included in this study. This measure was created by NSDUH and indicates whether respondents were living in a State in which a law allowing use of marijuana for medical reasons had been passed at the time of the interview. This measure was dichotomized so (0) if the respondent was in a State in which a law or initiative allowing the use of marijuana for medical reasons had not been passed at any time during the survey year; or the respondent was in a State where a law or initiative allowing the use of marijuana for medical reasons had been passed during the survey year but after the interview date and (1) if the respondent was in a State where a law or initiative allowing the use of marijuana for medical reasons had been passed on or before the interview.

In addition to sociodemographic characteristics, the current study also includes measures for socioeconomic status. These variables include employment status (1 = full-time employment; 2 = part-time employment; 3 = unemployed; 4 = other [including not in the labor force]), and family income (1 = less than $20,000; 2 = $20,000-$49,999; 3 = $50,000 – $74,999; 4 = $75,000 or more). As well, a measure of participation in a government assistance program is included in this study. Respondents were asked if they received supplemental security income, food stamps, cash assistance, and non-cash assistance within the past year. These measures were combined and dichotomized so that 0 indicates no, the respondent did not receive government assistance and 1 indicates yes, the respondent received supplemental security income, food stamps, cash assistance, or non-cash assistance.

Health-related indicators.

Furthermore, the current study includes measures of behavioral health status. These measures include overall self-reported health (0 = excellent, very good, or good; 1 = fair to poor), health insurance status (0 = no; 1 = yes, respondent was covered by private insurance, Medicare, Medicaid, military, or other health insurance), and disability status. To measure a disability related to activities of daily living (ADL) respondents were asked, "Because of a physical, mental, or emotional condition do you have serious difficulty (a) concentrating, remembering, or making decisions; (b) walking or climbing stairs; or (c) dressing or bathing?". To measure a disability related to instrumental activities of daily living (IADL), respondents were asked, "Because of a physical, mental, or emotional condition, do you have serious difficulty doing errands alone such as visiting a doctors' office or shopping?". Both measures of disability were coded (0 = no,1 = yes).

Additionally, a measure of major depressive episode [MDE] (0 = no; 1 = yes) is included in this study. NSDUH assesses MDE in the past 12 months based on assessments of individual diagnostic criteria from the DSM-IV (American Psychiatry Association, 1994). A respondent was classified as having a MDE in the past year if they reported experiencing at least five out of the nine criteria used to define an adult as having had MDE, where at least one of the criteria is a depressed mood or loss of interest or pleasure in daily activities. The 9 criteria are as follows: depressed mood most of the day, marked diminished interest or pleasure in all or almost all activities most of the day, unintentional changes in weight, insomnia or hypersomnia, psychomotor agitation or retardation, fatigue or loss of energy, feelings of worthlessness,

diminished ability to think or concentrate or indecisiveness, and recurrent thoughts of death or recurrent suicide ideation.

Substance Use.

The current study also includes measures related to substance use including prescription drug misuse (0 = no prescription pain killer, sedative, stimulant, or tranquilizer misuse in the past year; 1 = yes psychotherapeutic misuse in the past year), illicit drug use other than marijuana (0 = no cocaine, hallucinogenic, heroin, inhalant, methamphetamine, or psychedelic use in the past year; 1 = yes illicit drug use in the past year), and past month heavy alcohol use (0 = no; 1 = yes). Prescription drug misuse was defined the use of any prescription drug in a way a doctor did not direct respondents to use them. This can include using it without a prescription, using it in greater amounts, more often, or longer than directed, or using it in any other way a doctor did not direct respondents to use it. Heavy alcohol use was defined by the NSDUH as drinking five or more drinks on the same occasion for males or drinking four or more drinks of the same occasion for females on each of five or more days in the past 30 days.

Analysis.

In order to account for NSDUH's complex multistage sampling design, analysis were conducted using the SVYSET and SVY commands in STATA 16.0. These commands allowed STATA to consider survey design effects, including stratification and weight variables and the primary sampling unit, when estimating test statistics. Initial analysis presents weighted descriptive statistics for prevalence and count measures of marijuana use and measures of correlates for the full sample.

The current study examines how correlates of marijuana use vary based on how use is measured. To accomplish this, a multivariable logistic regression is applied to assess odds ratios of correlates for marijuana use prevalence among adults. Then, a multivariable zero-inflated negative binomial regression is executed to examine incident rate ratios of factors associated with number of days of marijuana use among adults. The data approximated a negative binomial distribution, as supported by evidence of overdispersion (Heilbron, 1994). Furthermore, 83.55% of the marijuana use data consisted of zero counts. The zero-inflated negative binomial regression is the appropriate statistical test because respondents whom have never used marijuana as well as those whom have not used marijuana in the past year are included as zeros. The excess of zeros means that this measures is considered overdispersed (Hilbe, 2007; Long & Freese, 2006) thus, the analysis used is accurate. During this phase of the analysis, all controls were treated as categorical measures.

Results

Prevalence and frequency of marijuana use among adults.

Weighted sample characteristics for the 40,745 adult respondents included in this study are shown in Table 1. This analysis has two key dependent measures: 1) marijuana use prevalence and 2) marijuana use frequency. With regard to marijuana use prevalence, an estimated 16.45% of adults in the sample have used marijuana or hashish within the past year. In regards to marijuana use frequency, the weighted mean is estimated to be 20.95 days of use within the past year.

Table 1 also describes the sociodemographic, socioeconomic, and behavioral health characteristics of the entire sample. Concerning sociodemographic characteristics, approximately 14% of the sample are between the ages 18 to 25 years old, 48% are male, 65% non-Hispanic White, 95% are heterosexual or straight, and 12% have less than high school educational attainment. Furthermore, about 52% of the sample is married, 69% indicate that religious beliefs are important to them, 26% go to a religious service 25 times or more during the past year, 9% are or were ever in the armed forces, and 55% live in a large metropolitan. Only about 2% of the sample are justice-involved and 65% live in a State that has some form of medical marijuana legislation. In respect to the socioeconomic characteristics included in this study, approximately 50% of the sample are employed full-time, 15% make less than $20,000 a year, and 17% participated in a government assistance program. In recognition of the behavioral health characteristics included in this research, about 13% of the sample reported fair to poor health, 90% have health insurance coverage, 14% have issues with ADL and 5% with IADL. An estimated 7% of the sample have had a MDE within the last year, 6% have misused prescription drugs, 9% have used an illicit drug other than marijuana, and 7% have engaged in heavy alcohol use within the last month.

Table 1: Sample Characteristics (N = 40,745)

Measure	Coding	Weighted Percent or Mean
Dependent Measures		
Marijuana Use Prevalence	Respondent used within the past year	16.45%
Marijuana Use Frequency (count)	Number of days respondent used in the past year Range (0 – 365)	20.95 (mean)
Sociodemographic Characteristics		
Age	1 = 18 to 25 years old	13.60%
	2 = 26 to 34 years old	16.03%
	3 = 35 to 49 years old	24.49%
	4 = 50 years old and older	45.88%
Gender	Male	48.48%
Race/ethnicity	1 = non-Hispanic White	64.50%
	2 = non-Hispanic Black	11.73%
	3 = Hispanic	15.86%
	4 = Other	07.91%
Sexual Identity	1 = Heterosexual/straight	94.66%
	2 = Lesbian or Gay	01.94%
	3 = Bisexual	03.40%
Educational Attainment	1 = Less than high school	11.64%

Measure	Coding	Weighted Percent or Mean
	2 = High school graduate	24.62%
	3 = Some college/Associate's degree	31.30%
	4 = College graduate	32.44%
Marital Status	1 = Married	51.90%
	2 = Widowed	05.66%
	3 = Divorced or separated	13.78%
	4 = Never been married	28.67%
Religiosity		
Religious Beliefs are Important	1 = Agree/Strongly Agree	68.59%
	0 = Strongly Disagree/Disagree	31.41%
Religious Service Attendance	1 = 25 times or more	25.70%
	0 = 0 to 24 times	74.30%
Military Service Status	Yes, respondent was ever in the armed forces	09.18%
Geographic Residence	1 = Live in a large metro	55.35%
	2 = Live in a small metro	30.21%
	3 = Live in a non-metro	14.44%
Justice-Involvement	Yes, respondent was arrested, on parole/supervised release, or probation in the past 12 months	02.46%

Measure	Coding	Weighted Percent or Mean
Medical Marijuana State Status	Yes, the respondent lives in a State in which a law allowing use of marijuana for medical reasons had been passed at the time of the interview	64.71%
Socioeconomic Characteristics		
Employment Status	1 = Full-time employment	50.26%
	2 = Part-time employment	13.08%
	3 = Unemployed	03.99%
	4 = Other	32.68%
Family Income	1 = Less than $20,000	15.26%
	2 = $20,000-$49,999	29.11%
	3 = $50,000-$74,999	15.62%
	4 = $75,000 or more	40.01%
Government Assistance	Yes, respondent received supplemental security income, food stamps, cash assistance, or non-cash assistance in the past 12 months	17.28%
Behavioral Health Characteristics		
Self-Reported Health	1 = Fair to poor	13.48%
	0 = Excellent, Very good, Good	86.52%
Health Insurance Status	Yes, respondent is covered by private insurance, Medicare, Medicaid, military, or other health insurance	90.37%

Measure	Coding	Weighted Percent or Mean
Disability Status		
Activities of Daily Living (ADL)	Yes, respondent has difficulty with ADL	14.31%
Instrumental Activities of Daily Living (IADL)	Yes, respondent has difficulty with IADL	05.18%
Major Depressive Episode (MDE)	Yes	07.26%
Prescription Drug Misuse	Yes	06.35%
Illicit Drug Use other than Marijuana	Yes	08.69%
Heavy Alcohol Use (past month)	Yes	06.69%

Correlates of marijuana use prevalence among adults.

Results from the logistic regression analysis for marijuana use prevalence and correlates are represented in the second column of Table 2. The results indicate that the sociodemographic correlates associated with decreased odds of marijuana use prevalence are age, race/ethnicity, religiosity, and geographic residence. When compared to those who are 18 to 25 years old, the odds of engaging in marijuana use during the past year decreases for each age category (OR = 0.76 for 26-34 years old; OR = 0.54 for 35-49 years old; OR = 0.34 for 50 years old and older). Likewise, respondents who are Hispanic (OR = 0.58) and Other race/ethnicity (OR = .072) were less likely than non-Hispanic Whites to engage in marijuana use during the past year. Additionally, respondents who agree that their religious beliefs are important to them (OR = 0.64), those who attend church 25 times or more in the past year (OR = 0.47), and those who live in a non-metro (OR = 0.76) are at a decreased odds for marijuana use prevalence.

Results from this analysis also show that the socioeconomic characteristic, employment status, as well as the behavioral health characteristics, health insurance status and prescription drug misuse, are associated with decreased odds of marijuana use prevalence. With regard to employment status, respondents who indicate that they are other or not in the workforce are significantly less likely to engage in marijuana use compared to those who are employed full-time (OR = 0.78). Respondents who are covered by health insurance (OR = 0.80) and those that indicate misusing prescription drugs (OR = 0.44) are also at decreased odds for reporting past year marijuana use.

In addition to the factors that are associated with decreased odds for marijuana use prevalence, the logistic regression also indicates characteristics that are correlated with increased odds of use. The sociodemographic characteristics that are linked to increased odds of marijuana use prevalence are gender, sexual identification, educational attainment, marital status, justice-involvement, and medical marijuana state status. Results of the analysis show that compared to females, respondents who are male (OR = 1.39) have increased odds of any marijuana use within the past year. Also, respondents who are bisexual (OR = 1.55) compared to those who identify as heterosexual or straight are at increased odds for marijuana use prevalence. Additionally, respondents who have some college education or an Associate's degree (OR = 1.36), or are college graduates (OR = 1.25) have increased odds for any marijuana use in the past year compared to those with less than high school educational attainment. In regard to marital status results show that compared to those who are married, respondents who are divorced or separated (OR = 1.58), or those who have never been married (OR = 1.75) are at increased odds for past year marijuana use. Furthermore, respondents who are justice-involved (OR = 1.44) and respondents who reside in a state that has some form of medical marijuana legislation (OR = 1.34) are at increased odds of marijuana use in the past year.

Results from this analysis also show that certain socioeconomic and behavioral health characteristics are correlated with an increased odds of marijuana use prevalence. The socioeconomic characteristic related to increased marijuana use prevalence is participation in a government assistance program (OR = 1.22). Furthermore, the behavioral health characteristics that are associated with increased odds of marijuana use prevalence are self-reported health, disability status, MDE, illicit drug misuse, and past month heavy alcohol use. Respondents who

self-report fair to poor health (OR = 1.27), those who have issues with ADL (OR = 1.20), and those who had a MDE within the past year (OR = 1.70) are more likely to engage in marijuana use. In addition, results of this logistic regression also show that respondents who engage in illicit drug use other than marijuana (OR = 10.43) and those who engage in heavy alcohol use (OR = 2.63) were also at increased odds for marijuana use prevalence.

Correlates of marijuana use frequency among adults.

Results from the zero-inflated negative binomial regression analysis for marijuana use frequency and correlates are represented in the third column of Table 2. The results indicate that the sociodemographic correlates associated with decreased count of marijuana use frequency are age, race, educational attainment, and religiosity. With regard to age, respondents who are 50 years old or older have a lower count of marijuana use frequency compared to those ages 18 to 25 years old (IRR = 0.78). Likewise, compared to respondents who are non-Hispanic White, respondents who are Hispanic have a significantly lower count of marijuana use frequency (IRR = 0.81). It is important to note that both the age and the race variables contain categories which are associated with an increased likelihood of marijuana use frequency. These categories will be discussed further below. To continue, respondents who are college graduates have a lower count of marijuana use frequency compared to respondents who have less than high school educational attainment (IRR = 0.65). Additionally, respondents who agree that their religious beliefs are important to them (IRR = 0.82), and those who attend church 25 times or more in the past year (IRR = 0.52) have a lower incidence predicted count for marijuana use frequency.

Results from this analysis also show that the behavioral health characteristics, health insurance status and prescription drug misuse, are associated with decreased count of marijuana use frequency. Controlling for all other variables in the model, respondents who have health insurance have a lower count of marijuana use frequency that is 0.85 times less than those who do not have insurance. Moreover, respondents who misuse prescription drugs have a lower count of marijuana use frequency that is 0.86 times less than those who do not misuse prescription drugs controlling for all other variables in the model.

Along with the correlates that are associated with a decreased count of marijuana use frequency, the zero-inflated negative binomial logistic regression also indicates characteristics that are correlated with increased counts of use. As previously mentioned, the sociodemographic characteristics age and race both include categories that are associated with decreased and increased marijuana use frequency. While those who are 50 years old and older have a decreased count of marijuana use (IRR = 0.78), respondents who are ages 26-34 years old have an increased count of marijuana use frequency (IRR = 1.11) compared to those ages 18-25 years old. With respect to race, compared to those who identify as non-Hispanic White, respondents who identify as Hispanic have a decreased count of marijuana use (IRR = 0.81), while respondents who identify as non-Hispanic Black have an increased count of marijuana use frequency (IRR = 1.26).

Other sociodemographic characteristics that are associated with increased marijuana use frequency are gender, sexual identity, marital status, geographic residence, and medical marijuana state status. The results indicate that identifying as male (compared to female) and bisexual (compared to heterosexual/straight) are associated with higher frequency of marijuana

use by 57% and 48% respectively. In addition, compared to respondents who are married, those who are divorced or separated and those who have never been married are correlated with higher frequency marijuana use by 33% and 26% respectively. Furthermore, respondents who live in a small metropolitan and those who live in a state with some form of medical marijuana legislation have higher count of marijuana use frequency that is 1.16 times and 1.26 times higher than for those living in a large metropolitan or a state without medical marijuana legislation respectively.

Results of the zero-inflated negative binomial regression also indicate that certain socioeconomic and behavioral health characteristics are correlated with higher count of marijuana use frequency. In recognition of the socioeconomic correlates associated with more frequent marijuana use, participation in a government assistance program is associated with higher frequency of marijuana use by 28%. Likewise, issues with ADL, illicit drug use, and past month heavy alcohol use are correlated with higher frequency of marijuana use by 17%, 82%, and 19% respectively.

Table 2: Correlates of Marijuana Use in the past 12 months among adults in the United States (N = 40,745)

Characteristics	Logistic Regression of Marijuana Use Prevalence Odds Ratio (95% CI)	Zero-Inflated Negative Binomial Regression of Use Frequency Incident Rate Ratio (95% CI)
Age		
18 - 25 years old	1.00 (ref.)	1.00 (ref.)
26 - 34 years old	0.76 (0.69, 0.83)***	1.11 (1.01, 1.22)*
35 - 49 years old	0.54 (0.47, 0.62)***	1.10 (0.98, 1.23)
≥ 50	0.34 (0.29, 0.40)***	0.78 (0.65, 0.95)*
Gender		
Female	1.00 (ref.)	1.00 (ref.)
Male	1.39 (1.27, 1.52)***	1.57 (1.37, 1.80)***
Race/ethnicity		
non-Hispanic White	1.00 (ref.)	1.00 (ref.)
non-Hispanic Black	1.08 (0.92, 1.26)	1.26 (1.12, 1.43)***
Hispanic	0.58 (0.51, 0.66)***	0.81 (0.72, 0.93)**
Other	0.72 (0.64, 0.81)***	1.07 (0.88, 1.29)
Sexual Identity		
Heterosexual/straight	1.00 (ref.)	1.00 (ref.)
Lesbian or Gay	1.35 (0.99, 1.83)	1.04 (0.82, 1.33)
Bisexual	1.55 (1.30, 1.84)***	1.48 (1.21, 1.81)***
Educational Attainment		

Characteristics	Logistic Regression of Marijuana Use Prevalence Odds Ratio (95% CI)	Zero-Inflated Negative Binomial Regression of Use Frequency Incident Rate Ratio (95% CI)
Less than high school	1.00 (ref.)	1.00 (ref.)
High school graduate	1.12 (0.97, 1.29)	1.08 (0.95, 1.24)
Some college/Associate's degree	1.36 (1.16, 1.60)***	1.05 (0.95, 1.17)
College graduate	1.25 (1.07, 1.47)**	0.65 (0.55, 0.76)***
Marital Status		
Married	1.00 (ref.)	1.00 (ref.)
Widowed	0.85 (0.61, 1.19)	0.96 (0.66, 1.41)
Divorced or separated	1.58 (1.37, 1.81)***	1.33 (1.06, 1.66)*
Never been married	1.75 (1.58, 1.94)***	1.26 (1.09, 1.46)**
Religiosity		
Religious Beliefs are Important		
Disagree	1.00 (ref.)	1.00 (ref.)
Agree	0.64 (0.58, 0.70)***	0.82 (0.74, 0.90)***
Religious Service Attendance		
0 to 24 times	1.00 (ref.)	1.00 (ref.)
25 times or more	0.47 (0.41, 0.53)***	0.52 (0.42, 0.63)***
Military Service Status		
No	1.00 (ref.)	1.00 (ref.)
Yes	0.83 (0.66, 1.04)	1.04 (0.83, 1.31)
Geographic Residence		

Characteristics	Logistic Regression of Marijuana Use Prevalence Odds Ratio (95% CI)	Zero-Inflated Negative Binomial Regression of Use Frequency Incident Rate Ratio (95% CI)
Live in a large metro	1.00 (ref.)	1.00 (ref.)
Live in a small metro	0.91 (0.82, 1.01)	1.16 (1.02, 1.32)*
Live in a non-metro	0.76 (0.66, 0.87)***	0.99 (0.84, 1.16)
Justice-Involvement		
No	1.00 (ref.)	1.00 (ref.)
Yes	1.44 (1.20, 1.73)***	1.08 (0.96, 1.21)
Medical Marijuana State Status		
No	1.00 (ref.)	1.00 (ref.)
Yes	1.34 (1.23, 1.46)***	1.26 (1.13, 1.40)***
Employment Status		
Full-time employment	1.00 (ref.)	1.00 (ref.)
Part-time employment	1.16 (0.94, 1.42)	0.95 (0.80, 1.12)
Unemployed	1.16 (0.99, 1.35)	0.99 (0.81, 1.21)
Other	0.78 (0.71, 0.87)***	0.88 (0.76, 1.02)
Family Income		
Less than $20,000	1.00 (ref.)	1.00 (ref.)
$20,000-$49,999	0.92 (0.81, 1.03)	0.99 (0.87, 1.13)
$50,000-$74,999	0.91 (0.80, 1.04)	1.02 (0.86, 1.21)
$75,000 or more	0.91 (0.81, 1.02)	0.91 (0.76, 1.10)

Characteristics	Logistic Regression of Marijuana Use Prevalence Odds Ratio (95% CI)	Zero-Inflated Negative Binomial Regression of Use Frequency Incident Rate Ratio (95% CI)
Government Assistance		
No	1.00 (ref.)	1.00 (ref.)
Yes	1.22 (1.08, 1.38)**	1.28 (1.11, 1.47)**
Self-Reported Health		
Excellent, Very good, Good	1.00 (ref.)	1.00 (ref.)
Fair to poor	1.27 (1.12, 1.43)***	1.13 (0.96, 1.34)
Health Insurance Status		
No	0.80 (0.70, 0.92)**	0.85 (0.77, 0.94)**
Yes	1.00 (ref.)	1.00 (ref.)
Disability Status		
ADL		
No	1.00 (ref.)	1.00 (ref.)
Yes	1.20 (1.03, 1.40)*	1.17 (1.03, 1.33)*
IADL		
No	1.00 (ref.)	1.00 (ref.)
Yes	0.95 (0.75, 1.19)	1.09 (0.90, 1.33)
Major Depressive Episode (MDE)		
No	1.00 (ref.)	1.00 (ref.)
Yes	1.70 (1.49, 1.95)***	1.13 (0.98, 1.31)

Characteristics	Logistic Regression of Marijuana Use Prevalence Odds Ratio (95% CI)	Zero-Inflated Negative Binomial Regression of Use Frequency Incident Rate Ratio (95% CI)
Prescription Drug Misuse		
No	1.00 (ref.)	1.00 (ref.)
Yes	0.44 (0.33, 0.59)***	0.86 (0.76, 0.97)*
Illicit Drug Use other than Marijuana		
No	1.00 (ref.)	1.00 (ref.)
Yes	10.43 (7.97, 13.64)***	1.82 (1.58, 2.10)***
Heavy Alcohol Use (past month)		
No	1.00 (ref.)	1.00 (ref.)
Yes	2.63 (2.28, 3.03)***	1.19 (1.02, 1.40)*

Table includes odds ratios, incidence-rate ratios, and 95% confidence intervals ($p < 0.05$ = *, $p < 0.01$ = **, $p < 0.001$ = ***).

Discussion

The present study examined the sociodemographic, socioeconomic, and behavioral health correlates of marijuana use prevalence and use frequency utilizing a national sample of U.S. adults. Prior research suggests that the correlates associated with use may vary depending on how marijuana use is measured (Macleod et al. 2004; Temple et al., 2011). The study extends such research by comparing use prevalence and frequency utilizing a large and recent sample of adults. The present findings partially support my hypothesis as the correlates associated with marijuana use differ based on how use is quantified. Additionally, the current study highlights adverse health and behavioral characteristics associated with frequent marijuana use. These relationships are of utmost importance for social science researchers to investigate as the findings can help to discern new patterns, evaluate risk, and inform intervention.

Sociodemographic differences.

The results of the current study point to key differences among sociodemographic characteristics associated with marijuana use across models. For example, in the logistic model age stays relatively consistent with those over the age of 26 being at a decreased risk for marijuana use. However, in the count model those aged 26 to 34 years old are at an increased risk for use frequency compared to those aged 18 to 25 years old. Furthermore, there was no significant finding for respondents aged 35 to 49 years old. Similar to the logistic model, the count model shows that those aged 50 years old or older have a decreased risk for marijuana use. These findings suggest that the odds of being a marijuana user decreases with age which is consistent with previous literature (Homel et al., 2014; Johnston et al., 2016; Terry-McElrath

2017). However, the results of this study also indicate that the frequency at which individuals use vary between age groups.

In addition, race/ethnicity also varied across models. For instance, being non-Hispanic Black did not significantly predict the likelihood of being a marijuana user in the logistic model. However, being non-Hispanic Black did significantly predict the number of marijuana using days in the count model. Additionally, identifying as Other race/ethnicity was associated with decreased odds of being a marijuana user while there was no significance found for marijuana use frequency. These results imply that the risk for marijuana use prevalence and frequency fluctuate according to one's race/ethnicity and are in line with previous literature (Wu, Zhu, Swartz, 2016).

Another sociodemographic correlate that differed for prevalence versus frequency is educational attainment. In the logistic regression, having some college or an Associate's degree significantly predicted being a marijuana user. Though this characteristic did not significantly predict marijuana use frequency in the ZINB regression. Also, being a college graduate significantly predicted being a marijuana user in the logistic regression but was associated with decreased marijuana use frequency in the ZINB regression. These findings suggest that having some college or an Associate's degree and being a college graduate increase the likelihood of marijuana use prevalence. However, being a college graduate is related to less frequent marijuana use which is constant with prior literature (Korn et al., 2018; Maggs et al., 2016). It is possible that individuals who are college graduates participate in harm-reduction strategies, such as decreasing frequency, when participating in marijuana use.

Additionally, the associations between marijuana use and geographic residence also changed between the prevalence and frequency models. For example, living in a small metro compared to living a large metro was associated with increased frequency of marijuana use but not prevalence. Also, living in a non-metro was associated with decreased odds of use prevalence but no significant finding was found for use frequency.

The final sociodemographic characteristic that differed between the analyses for use prevalence and use frequency is justice-involvement. Being involved in the criminal justice system significantly predicted the likelihood of being a marijuana user versus a nonuser in the logistic regression. However, being justice-involved did not predict the number of marijuana using days in the ZINB regression. So while justice-involved populations are more likely to be marijuana users, it does not necessarily mean that they use more frequently than the general population. This finding was surprising given that prior literature established that heavy marijuana use is associated with involvement in criminal activity (Schauer et al., 2016). This could be due to the fact that justice-involved populations are monitored by the criminal justice system and often times have to participate in drug testing (O'Connell, Brent, & Visher, 2016).

Socioeconomic differences.

The results of the analyses indicate variations in risk for marijuana use among a single socioeconomic characteristic. Respondents who indicated that they were other-employed have decreased odds of being a marijuana user compared to those who are employed full-time. Yet, this characteristic was not significant in the count regression. Those who are other employed to not differ significantly from those who are employed full-time on marijuana use frequency.

Given that previous studies show that being unemployed is associated with higher frequency of marijuana use (Schauer et al., 2016; Volkow et al., 2014), these results are unexpected.

Behavioral health difference.

In addition to the sociodemographic and socioeconomic correlates that vary based on how use is quantified, the results of this study also point to key differences among behavioral health characteristics. For instance, respondents who self-report fair to poor overall health have an increased risk for being marijuana users according to the logistic regression. However, this characteristic was not significant within the ZINB regression. Those who self-reported fair to poor overall health did not differ significantly on marijuana use frequency compared to individuals who report excellent, very good, or good health. Likewise, respondents who indicated they had a MDE within the past year are significantly more likely to be marijuana users. Though, having a MDE within the past year was not significantly related to marijuana use frequency. These trends could be explained by the self-medication hypothesis (Khantzian, 1997). Individuals with bad health may use marijuana to cope with their physical and mental health issues but do not use the substance frequently.

Limitations.

There are several limitations of this study that should be considered by readers. First, the NSDUH is a cross-sectional study, thus causal associations should not be inferred. While the goal of the current research was not to identify the causal sequence of the correlates related to marijuana use, longitudinal data would allow a more precise assessment of the relationships. Second, all measures were self-reported. Asking respondents about their substance use

behaviors, criminal involvement, as well as physical and mental health can lead to dishonestly when reporting. However, research indicates that self-reported substance use data are reliable and valid (Johnston & O'Malley, 1985; O'Malley, Bachman, & Johnston, 1983). Additionally, NSDUH methodology takes several steps to address self-report bias, including collecting data via ACASI methods, as well as including pictures and trade/generic names for prescription drugs (Center for Behavioral Health Statistics and Quality, 2018b).

Conclusions.

In sum, the results of this study show that the certain correlates associated with marijuana use change according to how use is measured. By comparing the correlates of marijuana use prevalence versus marijuana use frequency, we can see clear differences with regard to risk. For example, the logistic regression analysis indicates that as age increases, the risk of being a marijuana user decreases. However, when we examine the count measure of marijuana use, being 26 to 34 years old increases the likelihood of marijuana use frequency and being 50 years old or older decreases the risk of marijuana use frequency. Additionally, identifying as Black was found to be associated with an increased risk of marijuana use frequency while being a college graduate was associated with a decreased risk. These distinctions are important because most people who use marijuana will not experience problematic use or adverse health and behavioral outcomes (Room et al., 2010; Temple et al., 2011). If researchers want to determine the correlates associated with problematic marijuana use, we must focus our attention on frequency of use rather than prevalence measures. This way we avoid inferential errors (Johnson, 2014) and gain better, more insightful data (Asbridge et al., 2014; Johnson, 2014; Temple et al.,

2011) that emphasizese characteristics that are correlated with frequent use as these populaces are at heightened risk for use-related concerns (Arria et al., 2016; Nelson et al., 2015; Pardini et al., 2015; Schauer et al. 2016; Terry-McElrath et al., 2017; Volkow et al., 2014). Understanding these relationships can help discern new patterns that can be used to tailor intervention and prevention strategies.

CHAPTER THREE: EDUCATIONAL ATTAINMENT AND FREQUENT MARIJUANA USE: A HUMAN CAPITAL APPROACH (PAPER #2)

Introduction

Over the past two decades, there have been significant changes in US policy regarding marijuana use. To date, thirty-three states and the District of Columbia have passed some form of medical marijuana law and eleven states have legalized the recreational use of marijuana (ProCon.org, 2019). Prior research has found a relationship between marijuana policies (i.e. decriminalization, medicalization, and legalization) and decreased perceived risk as well as increased use (Cerda, Wall, Keyes, Galea, & Hasin, 2012; Compton, Han, Jones, Blanco, & Hughes, 2016; Korn, Haynie, Luk, & Simons-Morton, 2018; Pacek, Mauro, & Martins, 2015; Schuermeyer et al., 2014). In light of these historical shifts, the public health implications of changing marijuana policy deserves attention by researchers so that correlates of use can be identified (Han, Compton, Blanco, & Jones 2018; Monte, Zane, & Heard, 2015).

One correlate of marijuana use that has received significant attention is educational attainment (Chen, Yu, Lasopa, Cottler, 2017; Cerda 2017; Han et al., 2018; Homel, Thompson, Leadbeater, 2014; Lynskey & Hall, 2000; Richmond-Rakerd, Slutske, & Wood 2017; Schauer et al., 2016; Terry-McElrath et al., 2017). Those who drop out of high school have greater odds of current and ever use (Schauer et al., 2016; Valkov 2018; Gonzalez et al., 2016) while, those with higher levels of educational attainment are at decreased risk for problematic, heavy use (Pacek, Mauro, & Martins, 2015; Terry-McElrath et al., 2017; Townsend, Fisher, & King 2007). In addition to prevalence, prior research has established that mode of consumption (Schauer et al., 2016) and reason for use (Han et al., 2018) also vary by educational attainment. These findings

suggest that individuals with higher educational attainment are more likely to use marijuana for medical utility and choose consumption methods that are less detrimental to health.

This study will advance our understanding of marijuana use by offering a theoretical explanation as to why more education is associated with less frequent marijuana use utilizing human capital theory. Human capital theory suggests that those with higher education have improved health and are less likely to engage in problematic substance use (Mirowsky & Ross 2003; 2015). Given that previous literature has established that individuals with higher levels of education use less marijuana (Pacek, Mauro, & Martins, 2015; Terry-McElrath et al., 2017; Townsend et al., 2007), are more likely to report medical marijuana use (Han et al. 2018; Lankenau et al., 2018), and use safer methods of consumption (Schauer et al., 2016), testing this theory is a reasonable. Additionally, most of the research on marijuana use is from a public health or criminological perspective (Cerda, 2017; Hammersley, 2011; Verweij, Huizink, Agrawal, Martin, Lynskey, 2013), so this research will offer a unique theoretical framework.

Educational attainment and marijuana use.

The relationship between educational attainment and frequent marijuana use is important to study. Prior research has established that adults with higher levels of education tend to display lower rates of smoking, alcohol consumption, and illicit drug use (Pacek, Mauro, & Martins, 2015; Terry-McElrath et al., 2017; Townssend, Fisher, & King 2007). In terms of marijuana use, the odds of current and ever use are greater among those with less than a high school education compared to those with more education (Gonzalez et al., 2016; Schauer et al., 2016). A recent longitudinal study conducted by Terry-McElrath and colleagues (2017) identified seven latent

classes of marijuana use from ages 18 through 50. Their analysis established that graduating from college was associated with higher likelihood of membership in early and young adult moderate user classes (compared with nonusers), and lower risk for heavy use in early and young adult durations. Likewise, a longitudinal study conducted by Thompson and colleagues (2019) found that adolescent and young adult onset and frequency of marijuana use is associated with poor educational and occupational success. More specifically, the researchers found that early onset use coupled with constant high or increasingly frequent marijuana use are related to lower educational attainment and occupational prestige. Taken together, these studies suggest that adults with higher levels of education have lower frequency of marijuana use.

Motivations for use also vary by educational attainment. In a national study examining the correlates of medical marijuana use, Han and colleagues (2018) found that respondents with high school or more education were significantly more likely to report medical marijuana use (e.g. any medical marijuana use and medical-only marijuana use) in the past year. Moreover, the researchers found that among medical-only marijuana users, respondents that graduated college reported significantly less number of days of marijuana use in the past year. Given that medical marijuana patients typically use medical utility (Lankenau et al., 2018) and experience less use-related problems (Han et al., 2018) educational attainment could offer a logical explanation as to the differences among types of users. In addition to prevalence and motivations for use, prior research has established that modes of consumption also vary by educational attainment. Having a high school education or less is associated with higher odds of past month blunt use. Correspondingly, adults with less than a high school degree have lower odds of ever use of joints (Schauer et al., 2016). Given that motivations for use and modes of consumption are associated

with differentiating potencies (Loflin & Earlywine, 2014) and thus distinguishing adverse health effects (Mariani, Brooks, Haney, & Levin, 2011), these relationships are crucial for researchers to consider when investigating the effect of educational attainment on substance use and health. These studies indicate that those with higher levels of education are more likely to use safer consumption methods and for medical utility when compared to individuals with lower levels of education.

Research clearly shows that educational attainment is associated with marijuana use (Han et al., 2018; Schauer et al., 2016; Terry-McElrath et al., 2017). Nevertheless, prior research also suggests that early marijuana initiation and frequent marijuana use are associated with poorer educational outcomes (Chen, Yu, Lasopa, Cottler, 2017; Cerda 2017; Lynskey & Hall, 2000; Richmond-Rakerd, Slutske, & Wood 2017). For example, Homel, Thompson, and Leadbeater (2014) found that compared to abstainers and occasional users, frequent users were least likely to enroll in postsecondary education. While occasional users did not differ from abstainers regarding enrollment in postsecondary education, they were found to be at increased risk of delaying enrollment and dropping out. In a similar study, late adolescent (aged 19 to 20 years old) frequent marijuana users were less likely than nonusers and infrequent users to attain a bachelor's degree by their mid-20s (Maggs, Staff, Kloska, Patrick, O'Malley, & Schulenberg; 2015). However, it is vital to point out that these differences were reduced to non-significance when controlling for age 18 substance use. Nonusers and infrequent users did not differ in degree attainment. Despite using longitudinal data, these studies are limited in their ability to explain the relationship between educational attainment and marijuana use due to a lack of theoretical

application (Cerda, 2017; Hammersley, 2011; Verweij, Huizink, Agrawal, Martin, Lynskey, 2013).

While longitudinal analysis is outside the scope of this study, these findings are important to consider when investigating the relationship between educational attainment and marijuana use. Research undoubtedly indicates that those with higher levels of education use marijuana less frequently (Pacek, Mauro, & Martins, 2015; Terry-McElrath et al., 2017; Townsend et al., 2007), are more likely to report medical marijuana use (Han et al. 2018; Lankenau et al., 2018), and use safer methods of consumption (Schauer et al., 2016). However, the available literature lacks valid theoretical explanation as to why higher educational attainment is associated with safer use practices. The current study attempts to fill the gap in the literature by relying on a human capital framework to account for this relationship. This is especially important as national- and state- policy trends toward marijuana legalization, which increases access and the potential for unintended health and social consequences (Cerda, Wall, Keyes, Galea, & Hasin, 2012; Compton, Han, Jones, Blanco, & Hughes, 2016; Korn, Haynie, Luk, & Simons-Morton, 2018; Pacek, Mauro, & Martins, 2015; Volkow, Baler, Compton, & Weiss, 2014; Volkow et al., 2016; Wua, Zhua, & Swatrza, 2016).

Theoretical perspective.

Education as human capital.

Mirowsky and Ross's (2003) theory of human capital illuminates the associations between educational attainment and health. The researchers argue that education is the determinant factor of good health. Education increases the ability and effort of an individual to shape and control

their own lives. Education directly enhances health outcomes through the investment in human capital and indirectly by developing an individual's sense of personal control through learned-effectiveness.

Mirowsky and Ross (2003) define human capital as "the productive capacity developed, embodied, and stocked in human beings themselves," (pg.51). In essence, education builds an individual's skills, abilities, and resources that are vital for problem solving. Broadly speaking, education teaches people to learn (Hyman, Wright, and Reed 1975). It develops a capacity to read, write, communicate, analyze, and to think critically. The more years of schooling people have, the better these skills are refined, leading to greater cognitive ability (Mirowsky & Ross 2003). People can use these cognitive skills as a way to achieve a better life. An investment in human capital through educational attainment enhances an individual's *ability* to become effective agents in their own lives.

In addition to education developing the skills and abilities for individuals to become effective agents in their own lives, education also develops the *effort* of individuals to control their own lives. Mirowsky and Ross (2003) state, "Apart from the value of skills and abilities learned in school, the process of learning builds the confidence, motivation, and self-assurance needed to attempt to solve problems. Because education develops competence on many levels it gives people the ability and motivation to shape and control their lives," (pg.52). People with a sense of personal control over their lives are more likely to seek information regarding health in which to regulate their lifestyles. Individuals with higher levels of education have a greater ability to manage and control diverse aspects of their lives. To the extent that people want to achieve good health, people with higher levels of education are proactive in their health

management. They "know more about health and are more likely to initiate preventive behaviors like quitting smoking, exercising, or maintaining a normal weight," (Mirowsky & Ross 2003:pg.66).

Mirowsky and Ross (2003; 2015) argue that educational attainment is crucial for explaining differences in health. Education increases the ability to achieve good health through increased knowledge and a sense of personal control. The researchers state, "Health depends on power: the power of knowledge, the power of critical thinking, and the power to design and direct one's own life toward better ends. Education puts that power in the hands of the individuals," (Mirowsky & Ross 2015: 298). Education develops human capital and these skills and abilities help individuals become active agents in their own lives. People that are proactive towards their health have a greater ability to override the unhealthy lifestyles (Mirowsky 2015; Ross & Mirowsky 2010).

Education as the key to health.

Research analyzing the relationship between educational attainment and health is supportive of human capital theory (Cutler & Lleras-Muney, 2010; Duke & Macmillan 2016; Skalamera & Hummer, 2015). Individuals who are well educated are more likely to report better subjective health, better physical ability, and better mental health (Berkman et al., 2011; Krueger & Chang 2008; Ross, Masters, & Hummer, 2012; Ross & Wu 1995; Skalamera & Hummer, 2015). Prior research has also found that the well-educated live longer than those with poorer education do (Jemal et al., 2008; Olshansky et al., 2012; Ross et al., 2012). Additionally, the benefits of education have been found to go beyond improving socioeconomic status. While it is

true that higher education leads to fulfilling, full-time employment, higher income, and less economic hardship, it also moderates the effect of low income (Cutler & Lleras-Muney, 2010; Mirowsky & Ross, 1998). Likewise, the health benefits of additional education are cumulative whereas the health benefits of additional income taper off after reaching the 65th percentile (Mirowsky & Ross, 2003).

Mirowsky and Ross contend that education is a determinate factor to achieving good health (2003; 2015). The researchers state, "Education, and the sense of control and work creativity it develops, helps individuals to recognize the health risks of the default American lifestyle, evaluate claims about the risks and benefits, coalesce healthy behaviors into a coherent lifestyle, and overcome temptations and obstacles built into the usual way of life," (Mirowsky & Ross 2015:303). This argument is solidified by research that shows that adults with higher levels of educational attainment are less likely to engage in behaviors that are detrimental to health, such as smoking (Garrett et al., 2013), and more likely to engage in healthy behaviors, such as exercise (Kant & Graubard, 2007). Education directly enhances health outcomes through the investment in human capital and indirectly by developing an individual's sense of personal control through learned-effectiveness (Mirowsky & Ross 2003). Ross and Wu (1995) contend that a person's sense of control mediates stress and facilitates beneficial coping mechanisms whereas a lack of personal control has the potential to trigger physiological responses causing physical and mental health problems. Additionally, educational attainment provides people with the skills, ability, resources, and personal agency to achieve an improved, healthier life (Mirowsky & Ross 2015). Berkman and colleagues (2011) conducted a systematic review of health literacy and health outcomes and found that patients with lower literacy rates had worse

health-related knowledge and comprehension, ability to understand labels on medications and to take medicines correctly, as well as lower preventative care.

Human capital theory and marijuana use.

Prior research has established that frequent marijuana use is related to a number of adverse health measures including poor physical and mental health, unhealthy weight control behaviors, emotional and psychological distress, injuries, illness, chronic diseases, reduced physical activity, and lower life satisfaction (Arria et al., 2016; Korn et al., 2018; Greydanus et al., 2013; Schauer et al., 2016; Volkow et al., 2014). In this chapter, I aim to test a specific hypothesis from Human Capital Theory, that education allows individuals to merge health-producing behaviors into a practical, healthy lifestyle (Mirowsky & Ross, 1998). The researchers state, "The human capital theory of learned effectiveness suggests that educated, instrumental people merge otherwise unrelated habits and ways into a healthy lifestyle that consequently behaves as a coherent trait," (Mirowsky & Ross, 1998, pg. 418). Since frequent and heavy marijuana use is associated with a number of negative health and social measures (Arria et al., 2016; Korn et al., 2018; Greydanus et al., 2013; Schauer et al., 2016; Volkow et al., 2014), it is logical that individuals with higher levels of education will abstain from use or engage in controlled marijuana use practices. Controlled marijuana users are defined as individuals who take precautions to lower the risks associated with cannabis use (Fisher et al., 2017; Hathaway, 2004; Lau et al., 2015). These precautions can include avoiding high-frequency use (e.g. daily or near daily use) as well as not engaging in risky behaviors (e.g. impaired driving). Given the aforementioned literature that suggests that individuals with higher educational attainment use

less marijuana (Terry-McElrath et al., 2017), use for the purposes of medical utility (Han et al. 2018), and choose consumption methods that are less detrimental to health (Schauer et al., 2016), empirically testing this theory is logical.

Current research.

This chapter, "Paper 2: Educational Attainment and Frequent Marijuana Use: A Human Capital Approach," utilizes a large and recent sample of U.S.s adults to answer the following research question:

RQ2: Can Human Capital Theory explain the relationship between educational attainment and frequent marijuana use?

Corresponding to previous literature, it is hypothesized that respondents with higher levels of education will exhibit lower frequency of marijuana use, in part because education influences the ability to make healthier life choices and reduce involvement in risky behaviors.

Methods

Sample.

Data for the current study are the National Survey on Drug Use and Health (NSDUH), sponsored by the Center for Behavioral Health Statistics and Quality (CBHSQ) within the Substance Abuse and Mental Health Services Administration (SAMHSA). The survey has been conducted periodically since 1971 and provides information on use of alcohol, tobacco, and illicit drugs as well as data on mental health among members of the U.S. civilian, noninstitutionalized population aged 12 years old or older. The sample is based on independent,

multistage area probability sample of each state and the District of Columbia. The data were collected from respondents using a combination of computer-assisted face-to-face interviewing and computer-assisted self-interviewing by a trained interviewer in the respondent's home. These interviewing techniques were intended to offer respondents a high level of privacy and confidentiality while responding to questions, increasing the likelihood that they respond honestly to illicit drug use and other sensitive behaviors (SAMSHA, 2019).

Data were collected from 67,791 respondents in 2018. During this period, the weighted screening and interview response rates were 73.30% and 66.56% respectively. Since this research is focused on adults, the analytic sample was restricted to respondents aged 18 and older, giving a total sample of 40,508 respondents. Further information on NSDUH methodology can be found at Center for Behavioral Health Statistics and Quality (2018).

Variables.

Dependent variable.

Marijuana use.

A count measure of marijuana use within the past year is included in this study. This measure was recoded so that 0 indicates that the respondent did not use in past year or never used marijuana and 1-365 were the reported number of days in the past year that a respondent used marijuana.

Measures associated with human capital theory.

Educational attainment.

In order to test human capital theory, which states that respondents with higher education will exhibit lower levels of drug use (Mirowsky & Ross 2003; 2015), a categorical measure of educational attainment is included in this study. The measure is coded in the following way: 1 = college graduate (respondent is a college graduate or is pursuing a higher degree); 2 = some college credit/Associate's degree (respondent has some college credit, but no degree to Associate's degree); 3 = high school graduate (respondent has high school diploma or GED); 4 = less than high school (respondent has completed 5th grade or less to 11th or 12th grade with no diploma). This was done so we could analyze how the risk of marijuana use varies based on educational attainment.

Health lifestyle.

A number of physical and mental health factors that are associated with educational attainment and marijuana use are controlled for. The following variables are associated with human capital theory because they indicate health-producing behaviors. These measures include past year sexually transmitted disease (0 = no, 1 = yes), and obesity. The obesity measure was created based on the Center for Disease Control and Prevention's definition of obesity based on body mass index (BMI) which is, adult BMI greater than or equal to 30 kg/m2 (CDC, 2020). NSDUH calculated respondents' BMI using their reported height and weight and this formula recommended by the CDC: BMI2 = [WTPOUND2 ÷ (HTINCHE2) 2] × 703. This measure was recoded so BMI less than 30 kg/m2 was 0 and BMI greater than or equal to 30 kg/m2 was 1.

Additionally, the current study also includes measures related to risky behavior and substance use. Human capital theory asserts that education influences the ability to make healthier life choices and reduce involvement in risky behaviors. Thus, including these measures in the analysis was necessary for testing the theory. Risky behavior was measured according to respondent's answer to the following question, "How often do you like to test yourself by doing something a little risky?" This variable was recoded so that 0 indicated the respondent never or seldom test themselves by doing something a little risky and 1 indicated that the respondent sometimes or always test themselves by doing something a little risky.

As well, a measure of perceived marijuana use riskiness was included in this study. Respondents were asked, "How much do people risk harming themselves physically and in other ways when they smoke marijuana once or twice a week?" Respondents could answer "No risk", "Slight risk", "Moderate risk" or "Great risk". For the purposes of this study, this measure was recoded to indicate no perceived risk (0 = moderate or great risk; 1 = no or slight risk).

Measures of substance use in this study include, prescription drug misuse (0 = no psychotherapeutic misuse in the past year; 1 = yes psychotherapeutic misuse in the past year), illicit drug use other than marijuana (0 = no cocaine, hallucinogenic, heroin, inhalant, methamphetamine, or psychedelic use in the past year; 1 = yes illicit drug use in the past year), as well as past month daily cigarette use (0 = no; 1 = yes) and heavy alcohol use (0 = no; 1 = yes). Misuse is defined the use of any prescription drug (prescription pain killer, sedative, stimulant, or tranquilizer misuse in the past year) in a way a doctor did not direct respondents to use them. This can include using it without a prescription, using it in greater amounts, more

often, or longer than directed, or using it in any other way a doctor did not direct respondents to use it. Heavy alcohol use is defined by the NSDUH as drinking five or more drinks on the same occasion for males or drinking four or more drinks of the same occasion for females on each of five or more days in the past 30 days.

Socioeconomic.

The current study also includes measures for socioeconomic status. These variables include employment status (0 = employed part-time, full-time, or other [including not in labor-force]; 1 = unemployed) and family income (1 = less than $20,000; 2 = $20,000-$49,999; 3 = $50,000 – $74,999; 4 = $75,000 or more). As well, a measure of participation in a government assistance program is included in this study. Respondents were asked if they received supplemental security income, food stamps, cash assistance, and non-cash assistance within the past year. These measures were combined and dichotomized so that 0 indicates no, the respondent did not receive government assistance and 1 indicates yes, the respondent received supplemental security income, food stamps, cash assistance, or non-cash assistance. Additionally, a measure of health insurance status (0 = no; 1 = yes, respondent was covered by private insurance, Medicare, Medicaid, military, or other health insurance) was included in this study. Controlling for socioeconomic factors allow us to discern the effect of higher education from associated financial resources while testing the theory.

Sociodemographic.

Several sociodemographic characteristics are controlled for in this study. These include age (0 = 26 years old and older; 1 = 18 to 25 years old), gender (0 = female; 1 = male),

race/ethnicity (0 = non-Hispanic black, Hispanic, or Other race; 1 = non-Hispanic white), sexual identity (0 = lesbian or gay, bisexual; 1 = heterosexual/straight), and marital status (0 = married, widowed, divorced or separated; 1 = never been married). Also, the current study also includes geographic residence (0 = live in a small metro, or live in a non-metro; 1 = live in a large metro).

Analysis.

In order to account for NSDUH's complex multistage sampling design, analysis was conducted using the SVYSET and SVY commands in STATA 16.0. These commands allowed STATA to consider survey design effects, including stratification and weight variables and the primary sampling unit, when estimating test statistics. Initial analysis presents weighted descriptive statistics for the count measure of marijuana use, socioeconomic, measures of health lifestyle, and sociodemographics for the full sample.

The current study models marijuana use as a function of education in order to test a specific hypothesis from human capital theory. If the regression coefficient for marijuana use frequency becomes non-significant once the measures of healthy lifestyle are added to the model they can be viewed as mediating variables. This will test the hypothesis that educational attainment is associated with less frequent marijuana use because education promotes healthy lifestyle choices.

In the first model, I run a zero-inflated negative binomial regression with the count of number of days marijuana was used as the outcome variable, educational attainment, and sociodemographic controls. Given that the marijuana use measure is a count with high rate of zeros (83.15% reporting no use or no use within the past year), utilizing zero-inflated regression

is valid. The data approximated a negative binomial distribution, as supported by evidence of overdispersion (Heilbron, 1994). The zero-inflated negative binomial regression is the appropriate statistical test because respondents whom have never used marijuana as well as those whom have not used marijuana in the past year are included as zeros. The excess of zeros means that this measures is considered overdispersed (Hilbe, 2007; Long & Freese, 2006) thus, the analysis used is accurate. In the second model, I control for associated socioeconomic variables, including employment status, family income, government assistance status, and health insurance status. In the third model, I add healthy lifestyle variables to the models. Because I am testing a specific hypothesis of Human Capital Theory, which is that education promotes healthy lifestyle choices and that is why educational attainment is associated with less frequent marijuana use, controlling for lifestyle choices is essential. Physical health variables include STD status and obesity. Risky behaviors and substance use measures include risky behavior, marijuana risk, prescription drug misuse, illicit drug use other than marijuana, and past month daily cigarette use and heavy alcohol use. It is expected that marijuana use frequency will no longer be associated with educational attainment after controlling for socioeconomic and healthy lifestyle factors.

Results

Sample characteristics.

Weighted sample characteristics for the 40,404 adult respondents included in this study are displayed in Table 3. According to the table, the average number of days that respondents used marijuana within the past year is about 21 days. With regards the focal independent variable, educational attainment, 33% of the sample are college graduates or pursuing a higher

degree. In addition, approximately 31% of respondents have some college credit, but no degree to an Associate's degree, 25% have a high school diploma or GED, and 11% have completed 12th grade or less with no diploma.

Table 3 also describes the socioeconomic, health lifestyle, and sociodemographic characteristics of the entire sample. In terms of socioeconomic factors, an estimated 4% of the sample are unemployed. For total family income, 15% of the sample report making less than $20,000, 29% report making $20,000 to $49,999, 16% report making $50,000 to $74,999, and 40% report making $75,000 or more. Additionally, approximately 17% of the sample participate in one or more a government assistance program in the past year. Also, about 90% of the sample are covered by health insurance.

In regards to healthy lifestyle qualities of the sample, 2% report having an STD in the past year, and 34% are considered obese. Concerning the risky behavior measures included in this study, about 13% report engaging in risky behaviors. With regard to marijuana risk, approximately 48% of the sample report that smoking marijuana once or twice a week carries no to slight risk. In regard to the substance use measures included in this study, approximately 6% of the sample report past year prescription drug misuse, 9% report past year illicit drug use other than marijuana, 11% report daily cigarette use in the past month, and 7% indicate heavy alcohol use in the past month.

Furthermore, sociodemographic characteristics are considered in this study. With respect to age and gender, 14% of the sample are between the ages of 18 to 25 years old and 49% are male. In terms of race and ethnicity, about 65% of the sample are non-Hispanic White. 95% of

the sample identify as heterosexual or straight and 29% have never been married. Additionally, about 55% live in a large metropolitan.

Table 3: Sample Characteristics (N = 40,404)

Measure	Coding	Weighted Percent or Mean
Dependent Measure		
Marijuana Use Frequency (count)	Number of days respondent used in the past year Range (0 – 365)	21.47 (mean)
Independent Measure		
Educational Attainment	1 = College graduate 2 = Some college/Associate's degree 3 = High school graduate 4 = Less than high school	32.56% 31.46% 24.62% 11.37%
Socioeconomic Controls		
Employment Status	1 = Unemployed 0 = Full-time or Part-time employed, Other	04.03% 95.97%
Family Income	1 = Less than $20,000 2 = $20,000-$49,999 3 = $50,000-$74,999 4 = $75,000 or more	15.14% 28.94% 15.61% 40.30%
Government Assistance	Yes, respondent received supplemental security income, food stamps, cash assistance, or non-cash assistance in the past 12 months	17.27%
Health Insurance Status	Yes, respondent is covered by private insurance, Medicare, Medicaid, military, or other health insurance	90.42%

Measure	Coding	Weighted Percent or Mean
Health Lifestyle		
STD	Yes	02.12%
Obesity	Yes	33.72%
Risky Behavior	Yes	12.79%
Marijuana Risk	No	47.84%
Prescription Drug Misuse	Yes	06.40%
Illicit Drug Use other than Marijuana	Yes	08.80%
Daily Cigarette Use (past month)	Yes	11.26%
Heavy Alcohol Use (past month)	Yes	06.79%
Sociodemographic Controls		
Age	1 = 18 to 25 years old 0 = 26 years old and older	13.70% 86.30%
Gender	Male	48.98%
Race/ethnicity	1 = non-Hispanic White 0 = non-Hispanic Black, Hispanic, Other	64.98% 35.02%
Sexual Identity	1 = Heterosexual/straight	94.63%

Measure	Coding	Weighted Percent or Mean
	0 = Lesbian or Gay, Bisexual	05.37%
Marital Status	1 = Never been married	28.76%
	0 = Married, Divorced or separated, Widowed	71.24%
Geographic Residence	1 = Live in a large metro	55.36%
	0 = Live in a small metro, or non-metro	44.64%

Educational attainment and marijuana use frequency.

Results from the zero-inflated negative binomial regression analysis for marijuana use frequency and educational attainment are represented in Table 4. The baseline model, Model 1, shows the relationship between use frequency, education level, and sociodemographic controls. The results of this model show that lower levels of education are associated with more frequent marijuana use. For example, the marijuana use count is 65% higher (IRR = 1.65, CI [1.45, 1.87]) for respondents who have some college education or an Associate's degree than for respondents who are college graduates. Likewise, respondents who are high school graduates (75%) and those with less than a high school education (72%) have higher marijuana use counts compared to respondents who are college graduates (IRR = 1.75, CI [1.53, 2.00] and IRR = 1.72, CI [1.50, 1.98] respectively).

Similar to Model 1, Model 2 indicates that lower levels of education are associated with more frequent marijuana use. More specifically, the marijuana use count is 53% higher (IRR = 1.53, CI [1.34, 1.76]) for respondents who have some college education or an Associate's degree, 54% higher (IRR = 1.54, CI [1.33, 1.79]) for respondents who are high school graduates, and 45% higher (IRR = 1.45, CI [1.25, 1.70]) for respondents who have less than high school education compared to those who have graduated from college.

In Model 2 associated socioeconomic variables are added to the baseline model. Including these factors to the model is crucial for differentiating the effect of higher education from related financial resources while testing Human Capital Theory. The measures added include employment status, total family income, participation in a government assistance

program, and health insurance status. In terms of employment status, the expected marijuana use frequency count is 15% (IRR = 1.15, CI [1.01, 1.30]) higher for respondents who are unemployed than for respondents who are employed full-time, part-time, or other employed. In regards to participation in a government assistance program, results show that respondents who had receive assistance have a 22% higher (IRR = 1.22, CI [1.10, 1.36]) count of marijuana using days compared to respondents who do not receive any assistance. In respect to health insurance status, respondents who have health insurance have an anticipated marijuana use count that is 14% lower (IRR = 0.86, CI [0.79, 0.94]) compared to those who do not have health insurance. When the socioeconomic controls were added to the model, the relationship between educational attainment and frequent marijuana use stayed significant. This indicates that education, not socioeconomic factors, is associated with less frequent marijuana use.

In the fully adjusted model, measures of healthy lifestyle were added to the models. Including these factors to the model is essential for discerning the effect of higher education from related health characteristics while testing Human Capital Theory. The measures added include self-reported STD, obesity, engagement in risky behaviors, perceived marijuana risk, PDM, illicit drug use other than marijuana, daily cigarette use, and past month heavy alcohol use. When these characteristics were added to the model, the relationship between educational attainment and marijuana use became non-significant. Lower levels of educational attainment were no longer associated with high frequency marijuana use.

Engagement in risky behaviors, perceiving the use of marijuana as not risky, illicit drug use, as well as past month daily cigarette use and heavy alcohol use are factors related to a higher expected count of marijuana use frequency (IRR = 1.92, CI [1.33, 2.77]; IRR = 19.60, CI

[15.03, 25.55]; IRR =4.80 , CI [3.57, 6.47]; IRR = 2.98, CI [2.17, 4.10]; and IRR = 3.16, CI [2.15, 4.65] respectively). The socioeconomic controls included in Model 3 closely reflect the findings in Model 2. Being unemployed (42%) and participating in a government assistance program (93%) were measures associated with a higher expected count of marijuana use frequency (IRR =1.42, CI [1.03, 1.95]; IRR = 1.93, CI [1.45, 2.57] respectively).

The sociodemographic controls included in the fully adjusted model mirror the findings from the previous two models. Being between the ages of 18 and 25 (40%), male (110%), and single (85%) are characteristics associated with a higher expected count of marijuana using days compared to adults older than 26, females, and those who are married, divorced or separated, and those who are widowed (IRR = 1.40, CI [1.10, 1.78]; IRR = 2.10, CI [1.61, 2.73]; and IRR = 1.85, CI [1.42, 2.40] respectively). While, identifying as heterosexual/straight (70%) are characteristics related to a lower estimated marijuana use count (IRR = 0.30, CI [0.14, 0.63]).

Table 4: Zero-Inflated Negative Binomial Regression of Marijuana Use Frequency

	Model 1 N = 42,097	Model 2 N = 42,097	Model 3 N = 40,404
Educational Attainment			
College graduate	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)
Some college/Assoc. degree	1.65 (1.45, 1.87)***	1.53 (1.34, 1.76)***	1.38 (0.90, 2.12)
High school graduate	1.75 (1.53, 2.00)***	1.54 (1.33, 1.79)***	1.12 (0.73, 1.71)
Less than high school	1.72 (1.50, 1.98)***	1.45 (1.25, 1.70)***	0.75 (0.53, 1.05)
Socioeconomic Controls			
Unemployed		1.15 (1.01, 1.30)*	1.42 (1.03, 1.95)*
Family Income			
Less than $20,000		1.00 (ref.)	1.00 (ref.)
$20,000-$49,999		1.04 (0.94, 1.15)	1.07 (0.77, 1.47)
$50,000-$74,999		1.00 (0.89, 1.13)	1.09 (0.70, 1.70)
$75,000 or more		0.90 (0.80, 1.01)	0.83 (0.60, 1.14)
Participation in GAP		1.22 (1.10, 1.36)***	1.93 (1.45, 2.57)***
Health Insurance		0.86 (0.79, 0.94)**	0.76 (0.57, 1.03)
Behavioral Health Controls			
STD			2.71 (1.59, 4.62)
Obesity			0.76 (0.57, 1.00)
Risky Behavior			1.92 (1.33, 2.77)**
Marijuana Risk			19.60 (15.03, 25.55)***

	Model 1 N = 42,097	Model 2 N = 42,097	Model 3 N = 40,404
Prescription Drug Misuse			0.73 (0.51, 1.05)
Illicit Drug Use			4.80 (3.57, 6.47)***
Daily Cigarette Use			2.98 (2.17, 4.10)***
Heavy Alcohol Use			3.16 (2.15, 4.65)***
Sociodemographic Controls			
Young Adult	0.90 (0.83, 0.97)**	0.94 (0.87, 1.02)	1.40 (1.10, 1.78)**
Male	1.51 (1.38, 1.64)***	1.54 (1.41, 1.68)***	2.10 (1.61, 2.73)***
Non-Hispanic White	1.02 (0.93, 1.11)	1.05 (0.96, 1.16)	1.04 (0.82, 1.31)
Heterosexual/Straight	0.71 (0.64, 0.79)***	0.72 (0.65, 0.80)***	0.30 (0.14, 0.63)**
Never Been Married	1.42 (1.30, 1.55)***	1.35 (1.23, 1.47)***	1.85 (1.42, 2.40)***
Live in Large Metro	0.92 (0.85, 1.01)	0.94 (0.86, 1.03)	1.22 (0.89, 1.66)

Table includes incidence-rate ratios and 95% confidence intervals ($p < 0.05$ = *, $p < 0.01$ = **, $p < 0.001$ = ***).

Discussion

The present study employs a human capital framework to examine how educational attainment influences frequency of marijuana use utilizing a national sample of U.S. adults. Prior research suggests that educational attainment is inversely associated with marijuana use frequency where individuals with more education engage in less frequent marijuana use (Han et al., 2018; Schauer et al., 2016; Terry-McElrath et al., 2017). This study extends previous research by utilizing a human capital framework to test this relationship. More specifically, I predicted that lower levels of educational attainment will report more frequent marijuana use, in part because education influences the ability to make healthier life choices and reduce involvement in risky behaviors (Mirowsky & Ross, 1998). The present findings supported my hypothesis; once the lifestyle measures associated with human capital theory were added to the fully adjusted model, education was no longer significant. These findings support human capital theory as education was only associated with marijuana use because education allowed for individuals to engage in healthy life choices and reduced risky behaviors. These relationships are of utmost importance for social science researchers to investigate as the findings can help to tailor intervention and prevention strategies for frequent marijuana use.

Human capital theory and marijuana use.

I hypothesized that education enables individuals to merge health-producing behaviors into a coherent lifestyle. More specifically, lower levels of educational attainment would be associated to higher frequency marijuana use because those individuals do not have the required skills and abilities to make healthier life choices. Prior research has established that marijuana

use is associated with poor health and risk taking behaviors (Pacek, Mauro, & Martins, 2015; Terry-McElrath et al., 2017; Townsend et al., 2007; Han et al. 2018; Lankenau et al., 2018; Schauer et al., 2016). Conversely, education has been found to be associated with good health and less risk taking (Mirowsky & Ross 2003; 2015; Terry-McElrath et al., 2017; Townssend, Fisher, & King 2007). Thus, I hypothesized that higher levels of education would be associated with lower frequency of marijuana use as people with higher education levels are more proactive in their health management.

In model 2, education remained significant after controlling for related measures of socioeconomic status. This indicates that educational attainment is a significant factor for explaining the relationship to frequent marijuana use net the related socioeconomic characteristics. Compared to college graduates, those who have less educational attainment had higher counts of expected marijuana using days. This shows support for Mirowsky and Ross's argument that education, not socioeconomic status, is the key to health (Mirowsky & Ross 1998; 2015). In model 3, my hypothesis was fully supported. Educational attainment was no longer significantly related to marijuana use frequency when I added the measures related to healthy lifestyle. This proves that educational attainment was associated with marijuana use frequency because higher levels of education allow for individuals to merge healthy behaviors into a concise lifestyle.

Limitations.

There are several limitations of this study that should be considered by readers. First, the NSDUH is a cross-sectional study, thus causal associations should not be inferred. While the

goal of the current research was not to identify the causal sequence of the correlates related to marijuana use, longitudinal data would allow a more precise assessment of the relationships. Second, all measures were self-reported. Asking respondents about their substance use behaviors, criminal involvement, as well as physical and mental health can lead to dishonestly when reporting. However, research indicates that self-reported substance use data are reliable and valid (Johnston & O'Malley, 1985; O'Malley, Bachman, & Johnston, 1983). Additionally, NSDUH methodology takes several steps to address self-report bias, including collecting data via ACASI methods, as well as including pictures and trade/generic names for prescription drugs (Center for Behavioral Health Statistics and Quality, 2018b). Finally, key aspects of Human Capital Theory were not able to be measured thus, this research was limited to one element of the theory. For example, the NSDUH does not provide measures related to a respondent's sense of personal control (e.g. responsibility for success and failure as well as denial of success and failures) which, is vital for testing Human Capital Theory in its entirety (Mirowsky & Ross, 1998).

Conclusions.

In sum, the results of this study show that healthy lifestyle choices mediates the relationship between educational attainment and frequent marijuana use. As the measures of socioeconomic status and healthy lifestyle were added to the models, the relationship between educational attainment and marijuana use became non-significant. These findings are important because they highlight the impact health lifestyle characters have on substance use for levels of education. If researchers are interested in lowering the frequency at which people use marijuana,

then our efforts should be focused on educating those with lower educational attainment of the potential health and social risks associated with frequent use. Improving the health behaviors of people with lower educational attainment has the potential to lower the frequency at which they use marijuana as well as improve overall health.

CHAPTER FOUR: EVALUATING MARIJUANA USE AND HEALTH AMID JUSTICE-INVOLVED POPULATIONS (PAPER #3)

Introduction

In 2018, the Bureau of Justice Statistics (BJS) estimated that the total state and federal prison population was 1.47 million prisoners in the United States (Carson, 2020). However, in order to get a better understanding of the correctional system as a whole, researchers must also investigate the population under correctional supervision (Jones, 2018). Individuals who are under correctional supervision are those that are on probation or parole. At the end of 2016, approximately 4.5 million adults were on probation or parole in the United States, almost double the number of adults who are incarcerated (Kaeble, 2018). For the purposes of this study, we refer to the population of people who has been arrested, on probation, or parole as justice-involved.

These populations are important to study with regard to drug use because an overwhelming majority of justice-involved individuals are arrested for a drug offense (Jones, 2018; Sawyer & Wagner, 2019; Uniform Crime Report, 2017a, 2017b). For example, the Federal Bureau of Investigation's annual Uniform Crime Report (UCR) estimated that 1.63 million people were arrested for a drug abuse violation in 2017 (UCR, 2017a). Of these arrests, about 85% were for possession only with marijuana possession being the most common offense (37%) (UCR, 2017b). Additionally, in 2018, 47.1% of the sentenced federal prisoners were serving time for a drug offense (Carson, 2020). According to the 2016 BJS report on probation and parolees in the United States, 24% of those on probation and 31% of those on parole were arrested for a drug offense. For probationers a drug offense was the second highest category of offense type while

for parolees a drug offense was the highest category (Kaeble, 2018). It is well established that justice-involved populations have worse substance use and health outcomes compared to the general public (Fearn et al., 2016; Massoglia & Pridemore, 2015; Solomon, 2006). While adverse behavioral and health associations are not restricted to only justice-involved populations, these outcomes are intensified among these populations (Bronson & Berzofsky, 2017; Bronson, et al., 2017; Freeman et al., 2017; Maruschak et al., 2016).

To illustrate, according to results from the 2007-2009 National Inmate Survey (NIS), 58% of state prisoners and 63% of jail inmates met the threshold for drug dependence or abuse specified by the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) compared to about 5% of the general population (Bronson et al., 2017). Furthermore, 72% of prisoners and 75% of jail inmates reported regular use of drugs during the same period. Regular use was defined as having ever used any drug once a week or more for at least a month. In terms of marijuana use, approximately 63% of prisoners and 64% of jail inmates reported regular use, more than any other drug. Likewise, a recent study conducted by Freeman and colleagues (2017) found that probationers and parolees were two to five times more likely to report past year marijuana, cocaine, hallucinogen, OxyContin, and tranquilizer use compared to non-probationers. Furthermore, a study examining the substance use behaviors of prisoners after being released from prison found that marijuana use was the most commonly used illicit substance post-release with 12% of participants reporting use (Chamberlain et al., 2019). The heightened risk of substance use outcomes among justice-involved populations are important for researchers to investigate, especially in the view of the fact that these populations are more likely to have co-occurring substance use and mental/physical health issues (Freeman et al., 2017;

Sung, Mahoney, & Mellow, 2011). If justice-involved populations resume using drugs after incarceration they risk arrest for violating parole, as well as worsening physical and mental health (Chamberlain et al., 2019).

In addition to increased risk of substance use, justice-involved populations are also at an increased risk for adverse mental and physical health outcomes (Bronson & Berzofsky, 2017; Massoglia, 2008; Massoglia et al. 2011). Prior research consistently shows that justice-involved populations report higher levels of mental health problems (Bronson & Berzofsky, 2017; Vaughn et al., 2012). An estimated 1 in 7 prisoners and 1 in 4 jail inmates met the criteria for serious psychological distress in the past month compared to 5% of the general population. In addition to worse mental health outcomes, justice-involved populations are at heightened risk for physical health conditions (Wilper et al., 2009; Vaughn et al., 2012). They are more likely to suffer from chronic conditions such as asthma, diabetes, and cardiovascular conditions, as well as sexually transmitted diseases (Wilper et al., 2009; Vaughn et al., 2012). According to the 2011-12 NIS, approximately 50% of prisoners and jail inmates reported ever having a chronic condition (Maruschak, Berzofsky, & Unangst 2016). For comparison, only about 29% of the general population reported ever having a chronic condition during the same period. Furthermore, justice-involved populations also report higher rates of infectious diseases compared to the general population (21% of prisoners and 14% of jail inmates versus 5% of general population).

In their review of the literature on incarceration and health, Massoglia and Pridemore (2015) discuss three possible reasons incarceration negatively effects health. First, imprisonment exposes individuals to infectious diseases. The high rates of infectious diseases among prison and jail inmates coupled with the prison environment (e.g. overcrowding, poor health care and

prevention, use and sharing of unsterilized drug injection equipment), puts justice-involved populations at high risk for contracting infectious diseases. Second, imprisonment is an acute and chronic stressor. Justice-involved populations experience increased and daily stress while incarcerated (e.g. shock, lack of privacy, violence) and once they are released, the stressors continue (e.g. stigma, strained relationships with family and friends). The researchers argue that stress negatively affects the immune system, which exposes inmates to adverse physical health consequences (Pridemore, 2014), as well as increasing the risk of psychological problems (Massoglia, 2008). Third, incarceration hinders social integration. Imprisonment disrupts social bonds and limits a person's ability to maintain positive relationships (Braman, 2004; Massoglia et al. 2011). In addition, imprisonment limits employment opportunities (Pager, 2003) and is associated with lower earnings (Sampson & Laub, 2003). These studies provide confirmation that those who are incarcerated are at heightened risk for negative health outcomes.

Collectively, the research that assess justice-involved populations and substance use show that many drug users go to jail or prison (Carson, 2020; Jones, 2018; Kaeble, 2018). Most of these individuals are arrested for a use or possession (Jones, 2018; Sawyer & Wagner, 2019; Uniform Crime Report, 2017a, 2017b) with a majority being arrested for marijuana use or possession. Also, justice-involved people have higher rates of marijuana and other drug use compared to the general population, making them important to study (Fearn et al., 2016; Massoglia & Pridemore, 2015; Solomon, 2006). Furthermore, justice-involved populations also have more mental and physical health problems which, are associated with drug use (Freeman et al., 2017; Sung, Mahoney, & Mellow, 2011; Massoglia & Pridemore, 2015). Because justice-involved populations have high rates of substance use and adverse health outcomes (Bronson &

Berzofsky, 2017; Bronson, et al., 2017; Freeman et al., 2017; Maruschak et al., 2016), they are an important population to study. Understanding the associations of justice-involvement, frequent marijuana use, and health can help inform policy discussions and guide future research (Han et al., 2018).

Not only is justice-involvement associated with poor health and social integration, but marijuana use is also related to these factors. Prior research consistently shows that heavy marijuana use is associated with a number of negative health and social measures (Arria et al., 2016; Nelson et al., 2015; Pardini et al., 2015; Schauer et al. 2016; Terry-McElrath et al., 2017; Volkow et al., 2014). In a study investigating marijuana use among first-year college students, heavy and moderate marijuana users had poorer physical and mental health outcomes, injuries, illness, as well as emotional and psychological distress (Arria et al., 2016). Previous research as also linked heavy marijuana use to chronic diseases, such as cancer and heart disease, as well as lower life satisfaction and reduced physical activity (Greydanus et al., 2013; Schauer et al., 2016; Volkow et al., 2014). Along with the damaging health characteristics associated with frequent marijuana use, prior studies have also established several social characteristics related to heavy use. These include unemployment (Schauer et al., 2016), low school achievement (Arria et al., 2016; Homel, Thompson, & Leadbeater, 2014; Korn et al., 2018; Maggs et al., 2015), and criminal behavior (Schauer et al., 2016).

The current study will build upon the work of Massoglia and Pridemore (2015) by utilizing their arguments to frame the present analysis. The first two points outlined by the researchers suggest that health may be a mediating mechanism for understanding the relationship between justice-involvement and marijuana use. As such, the goal of the current research is to

test if poor health mediates the associations between justice-involvement and frequency of marijuana use. The third point described by the researchers argues that justice-involvement impedes social bonds. Thus, mediating measures of social integration will be included to determine if social integration accounts for the association between justice-involvement and marijuana use.

Current Research.

This chapter, "Paper 3: Evaluating Marijuana Use and Health Amid Justice-Involved Populations," utilizes a large and recent sample of U.S. adults to answer the following research question:

RQ3: Does poor health mediate the association between justice-involvement and frequent marijuana use?

RQ3.1: Does social integration account for the association between justice-involvement and marijuana use?

In line with previous literature, it is hypothesized that poor health will mediate the relationship between justice-involvement and marijuana use. Justice-involvement will be associated with marijuana use because justice-involved people have worse health.

Methods

Sample.

Data for the current study are the National Survey on Drug Use and Health (NSDUH), sponsored by the Center for Behavioral Health Statistics and Quality (CBHSQ) within the Substance Abuse and Mental Health Services Administration (SAMHSA). The survey has been conducted periodically since 1971 and provides information on use of alcohol, tobacco, and illicit drugs as well as data on mental health among members of the U.S. civilian, noninstitutionalized population aged 12 years old or older. The sample is based on independent, multistage area probability sample of each state and the District of Columbia. The data were collected from respondents using a combination of computer-assisted face-to-face interviewing and computer-assisted self-interviewing by a trained interviewer in the respondent's home. These interviewing techniques were intended to offer respondents a high level of privacy and confidentiality while responding to questions, increasing the likelihood that they respond honestly to illicit drug use and other sensitive behaviors (SAMSHA, 2018).

Data were collected from 67,791 respondents in 2018. During this period, the weighted screening and interview response rates were 73.30% and 66.56% respectively. Since this research is focused on adults, the analytic sample was restricted to respondents aged 18 and older, giving a total sample of 41,258 respondents. Further information on NSDUH methodology can be found at Center for Behavioral Health Statistics and Quality (2018).

Variables.

Dependent Measure.

Marijuana use.

This study includes a count measure of marijuana use in the past year. This measure was recoded so that 0 indicates that the respondent did not use in past year and 1-365 were the reported number of days in the past year that a respondent used marijuana.

Independent Measure.

Justice-involvement.

A measure of justice-involvement was included in the current study. Respondents were asked, "Not counting minor traffic violations, how many times during the past 12 months have you been arrested and booked for breaking a law?", "Were you on probation at any time during the past 12 months?", and "Were you on parole, supervised release, or other conditional release from prison at any time during the past 12 months?". These three measures were combined and dichotomized to give a measure of the subpopulation of justice involvement in the past year (0 = no; 1 = yes).

Measures associated with health of justice-involved populations.

Measures of social integration.

A number of measures of social integration were included in the analysis. These measures include marital and employment status. Marital status was coded for the respondent

being married (0 = never been married, widowed, divorced or separated; 1 = married). Employment status was coded for the participant being employed full-time (0 = employed part-time, unemployed, or other [including not in labor-force]; 1 = full-time employed).

Measures of health status.

The current study also includes health factors that influence marijuana use and health including self-reported health (0 = excellent, very good, or good overall health; 1 = fair to poor overall health), health insurance status (0 = no; 1 = yes, respondent was covered by private insurance, Medicare, Medicaid, military, or other health insurance), and disability status. To measure a disability related to activities of daily living (ADL) respondents were asked, "Because of a physical, mental, or emotional condition do you have serious difficulty (a) concentrating, remembering, or making decisions; (b) walking or climbing stairs; or (c) dressing or bathing?". To measure a disability related to instrumental activities of daily living (IADL), respondents were asked, "Because of a physical, mental, or emotional condition, do you have serious difficulty doing errands alone such as visiting a doctors' office or shopping?". Both measures of disability were coded (0 = no,1 = yes).

Furthermore, a measure of major depressive episode [MDE] (0 = no; 1 =yes) is included in this study. NSDUH assesses MDE in the past 12 months based on assessments of individual diagnostic criteria from the DSM-IV (American Psychiatry Association, 1994). Respondents were asked a set of introductory questions to determine whether they had a two week (or more) period of time during the previous 12 months where they experienced feeling sad, empty, depressed, discouraged, or a loss of interest. If the respondent fit certain criteria based on the

routing logic in these introductory questions, then they were asked questions related to the nine symptoms of MDE. The nine criteria used to define MDE are as follows: depressed mood most of the day, marked diminished interest or pleasure in all or almost all activities most of the day, unintentional changes in weight, insomnia or hypersomnia, psychomotor agitation or retardation, fatigue or loss of energy, feelings of worthlessness, diminished ability to think or concentrate or indecisiveness, and recurrent thoughts of death or recurrent suicide ideation. A respondent was classified as having a MDE in the past year if they reported experiencing at least five out of the nine criteria used to define an adult as having had MDE, where at least one of the criteria is a depressed mood or loss of interest or pleasure in daily activities.

In addition, a measure of suicide ideation is included in this study. Respondents were asked, "At any time in the past 12 months, that is from [DATEFILL] up to and including today, did you seriously think about trying to kill yourself?", "During the past 12 months, did you make any plans to kill yourself?", and "During the past 12 months, did you try to kill yourself?". These three measures were combined and dichotomized to give a measure of the subpopulation of suicidal ideation in the past year (0 = no; 1 = yes).

Sociodemographic controls.

Several sociodemographic characteristics are controlled for in this study. These include age (0 = 26 years old and older; 1 = 18 to 25 years old), gender (0 = female; 1 = male), race/ethnicity (0 = non-Hispanic black, Hispanic, or Other race; 1 = non-Hispanic white), and sexual identity (0 = lesbian or gay, bisexual; 1 = heterosexual/straight). Also, the current study also includes educational attainment (1 = less than high school, 2 = high school graduate, 3 =

some college or an Associate's degree, 4 = college graduate), military service (0 = no, respondent was never in the armed forces; 1 = yes, the respondent was ever in the armed forces), geographic residence (0 = live in a small metro, or live in a non-metro; 1 = live in a large metro) and family income (1 = less than $20,000; 2 = $20,000-$49,999; 3 = $50,000 – $74,999; 4 = $75,000 or more). As well, a measure of participation in a government assistance program is included in this study. Respondents were asked if they received supplemental security income, food stamps, cash assistance, and non-cash assistance within the past year. These measures were combined and dichotomized so that 0 indicates no, the respondent did not receive government assistance and 1 indicates yes, the respondent received supplemental security income, food stamps, cash assistance, or non-cash assistance.

In addition, the current study includes measures related to substance use including prescription drug misuse (0 = no; 1 = yes), illicit drug use other than marijuana (0 = no cocaine, hallucinogenic, heroin, inhalant, methamphetamine, or psychedelic use in the past year; 1 = yes illicit drug use in the past year), and past month heavy alcohol use (0 = no; 1 = yes). Prescription drug misuse is defined the use of any prescription drug (e.g. pain killer, sedative, stimulant, or tranquilizer) in a way a doctor did not direct respondents to use them. This can include using it without a prescription, using it in greater amounts, more often, or longer than directed, or using it in any other way a doctor did not direct respondents to use it. Heavy alcohol use is defined by the NSDUH as drinking five or more drinks on the same occasion for males or drinking four or more drinks of the same occasion for females on each of five or more days in the past 30 days.

Analysis.

In order to account for NSDUH's complex multistage sampling design, analysis was conducted using the SVYSET and SVY commands in STATA 16.0. These commands allowed STATA to consider survey design effects, including stratification and weight variables and the primary sampling unit, when estimating test statistics. Initial analysis presents weighted descriptive statistics for count measures of marijuana use, measures of social integration and poor health, and sociodemographics for the full sample.

The aim of the current study is in determining if poor health and social integration mediates the association between justice-involvement and marijuana use. In order to test for mediation, marijuana use is modeled as a function of justice-involvement. If the regression coefficient for marijuana use becomes non-significant once measures of poor health and social integration are entered into the model they can be viewed as mediating variables.

In our first model, a zero-inflated negative binomial regression with the count of number of days marijuana was used as the outcome variable, justice-involvement, and sociodemographic controls. Given that the marijuana use measure is a count with high rate of zeros (83.65% reporting no use or no use within the past year), utilizing zero-inflated regression is valid. The data approximated a negative binomial distribution, as supported by evidence of overdispersion (Heilbron, 1994). The zero-inflated negative binomial regression is the appropriate statistical test because respondents whom have never used marijuana as well as those whom have not used marijuana in the past year are included as zeros. The excess of zeros means that this measures is considered overdispersed (Hilbe, 2007; Long & Freese, 2006) thus, the analysis used is accurate. In the second model, we add mediating measures of social integration including marital status

and employment status. In the third model, we add mediating health variables including overall health, health insurance status, disability status, major depression and suicidal ideation. As we add the mediating social integration and health factors to the baseline model, the relationship between justice-involvement and marijuana use will become non-significant.

Results.

Sample characteristics.

Weighted sample characteristics for the 41,258 adult respondents included in this study are displayed in Table 5. According to the table, the average number of days that respondents used marijuana within the past year is about 21 days. With regards the focal independent variable, justice-involvement, 2.45% of the sample were arrested, on probation, or on parole within the past year.

Concerning the measures associated with social integration, approximately 52% of the sample are married and 50% are full-time employed. In regard to the health factors included in this study, 13% reported fair to poor overall health, and 90% have health insurance. Pertaining to disability status, 14% of the sample report difficulty with activities of daily living and 5% indicate difficulty with instrumental activities of daily living. Also, an estimated 7% of the sample has had a MDE within the past year and 4% has had suicidal ideation within the past year.

Furthermore, sociodemographic characteristics are considered in this study. With respect to age and gender, 14% of the sample are between the ages of 18 to 25 years old and 48% are male. In terms of race and ethnicity, about 64% of the sample are non-Hispanic White. 95% of

the sample identify as heterosexual or straight. With regard to educational attainment, an estimated 12% of the sample have less than high school education, 25% have graduated from high school, 31% have some college credit or an Associate's degree, and 32% are college graduates. About 9% of the sample were ever in the armed forces and 55% live in a large metropolitan. Approximately 4% of the sample were unemployed. Concerning family income, about 15% made less than $20,000 a year, 29% made between $20,000 and $49,999, 16% made between $50,000 and $74,999, and 40% made $75,000 or more. In addition, about 17% of the sample participated in a government assistance program within the last year. In regard to the substance use factors included in this study, about 6% of the sample report past year prescription drug misuse, 9% report past year illicit drug use other than marijuana, and 7% indicate heavy alcohol use in the past month.

Table 5: Sample Characteristics (N = 41,258)

Measure	Coding	Weighted Percent or Mean
Dependent Measure		
Marijuana Use Frequency (count)	Number of days respondent used in the past year Range (0 – 365)	20.84 (mean)
Independent Measure		
Justice-Involvement	Yes, respondent was arrested, on parole/supervised release, or probation in the past 12 months	02.45%
Social Integration Controls		
Marital Status	1 = Married 0 = Never been married, Divorced or separated, Widowed	51.84% 48.16%
Employment Status	1 = Full-time employed 0 = Part-time employed, Unemployed, Other	50.17% 49.83%
Health Controls		
Self-Reported Health	1 = Fair to poor 0 = Excellent, Very good, Good	13.46% 86.54%
Health Insurance Status	Yes, respondent is covered by private insurance, Medicare, Medicaid, military, or other health insurance	90.37%
Disability Status		
Activities of Daily Living (ADL)	Yes, respondent has difficulty with ADL	14.24%

Measure	Coding	Weighted Percent or Mean
Instrumental Activities of Daily Living (IADL)	Yes, respondent has difficulty with IADL	05.15%
Major Depressive Episode (MDE)	Yes	07.20%
Suicidal Ideation	Yes	04.26%
Sociodemographic Controls		
Age	1 = 18 to 25 years old	13.59%
	0 = 26 years old and older	86.41%
Gender	Male	48.43%
Race/ethnicity	1 = non-Hispanic White	64.34%
	0 = non-Hispanic Black, Hispanic, Other	35.66%
Sexual Identity	1 = Heterosexual/straight	94.68%
	0 = Lesbian or Gay, Bisexual	05.32%
Educational Attainment	1 = Less than high school	11.72%
	2 = High school graduate	24.64%
	3 = Some college/Associate's degree	31.33%
	4 = College graduate	32.31%
Military Service Status	Yes, respondent was ever in the armed forces	09.13%
Geographic Residence	1 = Live in a large metro	55.44%
	0 = Live in a small metro, or non-metro	44.56%

Measure	Coding	Weighted Percent or Mean
Family Income	1 = Less than $20,000	15.28%
	2 = $20,000-$49,999	29.16%
	3 = $50,000-$74,999	15.62%
	4 = $75,000 or more	39.94%
Government Assistance	Yes, respondent received supplemental security income, food stamps, cash assistance, or non-cash assistance in the past 12 months	17.31%
Prescription Drug Misuse	Yes	06.29%
Illicit Drug Use other than Marijuana	Yes	08.61%
Heavy Alcohol Use (past month)	Yes	06.66%

Justice-involvement and marijuana use frequency.

Results from the zero-inflated negative binomial regression analysis for justice-involvement and marijuana use frequency are displayed in Table 6. The baseline model, Model 1, shows the relationship between justice-involvement, marijuana use frequency, and sociodemographic controls. The results of this model show that being justice-involved in the past year is related to higher frequency of marijuana use compared to the general public. More specifically, the marijuana use count is 12% higher (IRR = 1.12, CI [1.02, 1.23]) for respondents who have been arrested, on probation, or parole than for respondents who were not justice-involved.

In Model 2, mediating social integration variables are added to the baseline model. Including these characteristics to the model is vital for differentiating the effect of justice-involvement from related social integration factors. Similar to Model 1, Model 2 indicates that being justice-involved is related to higher frequency of marijuana use. For example, the marijuana use count is 11% higher (IRR = 1.11, CI [1.00, 1.21]) for those who are justice involved compared to the general public. In terms of the social integration characteristics that were added in this model, being married is associated with a decrease in estimated marijuana use frequency. More specifically, respondents who are married have an estimated marijuana use frequency count that is 24% lower (IRR = 0.76, CI [0.67, 0.86]) than respondents who have never been married, divorced or separated, and those who are widowed.

In Model 3, mediating health variables are added to the previous models. In the fully adjusted model, the relationship between justice-involvement and marijuana use frequency was

not significant. Being arrested, on probation, or parole in the past year did not significantly predict expected marijuana use frequency holding social integration, health, and sociodemographic variables constant.

In terms of the health characteristics included in this model, only two were significantly associated with expected marijuana use frequency. Specifically, respondents who had thought about, planned, or tried to take their own life had an estimated marijuana use count that was 20% higher (IRR = 1.20, CI [1.06, 1.35]) than for respondents who did not have suicidal ideation. Conversely, having health insurance is related to a 15% lower (IRR = 0.85, CI [0.77, 0.92]) expected marijuana use frequency count compared to those who do not have health insurance. With regard to the social integration factors included in the model, being married and full-time employed were associated with marijuana use frequency. The fully adjusted model shows that those who are married have an expected marijuana use count that is 24% lower (IRR = 0.76, CI [0.67, 0.87]) than those who are single, divorced or separated, and those who are widowed. Additionally, those who are employed full-time have an estimated marijuana use count that is 10% (IRR = 1.10, CI [1.01, 1.21]).

The sociodemographic characteristics in Model 3 largely reflect the findings in Model 1 and 2. Results of this analysis indicate that being male (IRR = 1.54, CI [1.37, 1.73]), participating in a government assistance program (IRR = 1.21, CI [1.09, 1.35]), engaging in illicit drug use (IRR = 1.77, CI [1.58, 1.97]), and heavy alcohol use (IRR = 1.14, CI [1.03, 1.27]) are associated with higher expected marijuana use frequency. More specifically, males have an expected marijuana use count that is 54% higher than females. Furthermore, those who receive government assistance have an estimated count marijuana use that is 21% higher than those who

do not receive assistance. As well, those who engage in illicit drug use and those who partake in heavy alcohol use have an estimated marijuana use count that is 77% and 14% higher than those who do not respectively.

The results of this analysis also indicates that being a young adult (IRR = 0.91, CI [0.84, 0.99]), identifying as heterosexual (IRR = 0.77, CI [0.69, 0.86]), and being a college graduate (IRR = 0.64, CI [0.54, 0.76]) are all characteristics associated with lower expected marijuana use frequency. Being a young adult is associated with a 9% lower estimated marijuana use count and identifying as heterosexual is related to a 23% lower marijuana use count. Furthermore, being a college graduate is associated with a 36% lower expected marijuana use frequency count compared to those who have less than high school level of education. Results of this analysis also indicate that those who misuse prescription drugs have a 13% lower (IRR = 0.87, CI [0.78, 0.98]) expected count of marijuana use than those who abstain from PDM.

Table 6: Zero-Inflated Negative Binomial Regression of Marijuana Use Frequency

	Model 1 N = 41,695	Model 2 N = 41,695	Model 3 N = 41,258
Justice Involved	1.12 (1.02, 1.23)*	1.11 (1.01, 1.21)*	1.09 (0.99, 1.21)
Social Integration Controls			
Married		0.76 (0.67, 0.86)***	0.76 (0.67, 0.87)***
Full-time Employed		1.07 (0.98, 1.17)	1.10 (1.01, 1.21)*
Health Controls			
Fair to Poor Health			1.04 (0.92, 1.18)
Health Insurance			0.85 (0.77, 0.92)***
ADL			1.09 (0.99, 1.22)
IADL			1.15 (0.97, 1.36)
Major Depressive Episode			1.03 (0.91, 1.17)
Suicidal Ideation			1.20 (1.06, 1.35)**
Sociodemographic Controls			
Young Adult	0.98 (0.90, 1.06)	0.91 (0.83, 0.99)*	0.91 (0.84, 0.99)*
Male	1.55 (1.39, 1.72)***	1.54 (1.38, 1.72)***	1.54 (1.37, 1.73)***
Non-Hispanic White	0.98 (0.90, 1.07)	1.00 (0.91, 1.09)	0.98 (0.90, 1.07)

	Model 1 N = 41,695	Model 2 N = 41,695	Model 3 N = 41,258
Heterosexual/Straight	0.74 (0.66, 0.83)***	0.75 (0.67, 0.83)***	0.77 (0.69, 0.86)***
Educational Attainment			
Less than high school	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)
High school graduate	1.05 (0.93, 1.18)	1.04 (0.92, 1.17)	1.05 (0.92, 1.19)
Some college/Assoc. degree	1.02 (0.93, 1.11)	0.99 (0.90, 1.08)	1.01 (0.91, 1.11)
College graduate	0.63 (0.53, 0.74)***	0.61 (0.52, 0.73)***	0.64 (0.54, 0.76)***
Military Service	0.98 (0.81, 1.19)	1.01 (0.83, 1.23)	1.00 (0.83, 1.22)
Live in Large Metro	0.98 (0.89, 1.07)	0.96 (0.88, 1.06)	0.97 (0.88, 1.07)
Family Income			
Less than $20,000	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)
$20,000-$49,999	1.03 (0.92, 1.15)	1.03 (0.92, 1.15)	1.04 (0.93, 1.15)
$50,000-$74,999	0.96 (0.85, 1.08)	0.98 (0.87, 1.12)	1.02 (0.90, 1.16)
$75,000 or more	0.86 (0.75, 0.98)*	0.91 (0.80, 1.03)	0.94 (0.82, 1.08)
Participation in GAP	1.23 (1.10, 1.37)**	1.22 (1.10, 1.35)***	1.21 (1.09, 1.35)**
Prescription Drug Misuse	0.89 (0.79, 0.99)*	0.89 (0.79, 1.00)***	0.87 (0.78, 0.98)*
Illicit Drug Use	1.80 (1.61, 2.01)***	1.77 (1.58, 1.98)***	1.77 (1.58, 1.97)***
Heavy Alcohol Use	1.12 (1.02, 1.24)*	1.13 (1.01, 1.25)*	1.14 (1.03, 1.27)*

Table includes incidence-rate ratios and 95% confidence intervals ($p < 0.05$ = *, $p < 0.01$ = **, $p < 0.001$ = ***).

Discussion

The aim of the current study was to investigate whether social integration and poor health mediates the associations between justice-involvement and frequency of marijuana use utilizing a national sample of U.S. adults. Prior research suggests that many drug users are involved with the criminal justice system and that most of these people are arrested for marijuana use or possession (Carson, 2020; Jones, 2018; Kaeble, 2018; Sawyer & Wagner, 2019; Uniform Crime Report, 2017a, 2017b). Previous research also indicates that justice-involved populations have higher rates of drug use and poor mental and physical health outcomes which, can be co-occurring (Bronson & Berzofsky, 2017; Bronson, et al., 2017; Freeman et al., 2017; Maruschak et al., 2016). This study adds to existing substance use research by exploring the relationships between justice-involvement, marijuana use frequency, social integration and health. The present findings partially support my hypothesis as poor health mediated the relationship between justice-involvement and marijuana use. These relationships are important for social science researchers to explore as the findings can help discover new patterns, evaluate risk, as well as inform intervention and prevention strategies.

Justice involvement and marijuana use.

In their review of literature on the relationships between incarceration and health, Massoglia and Pridemore (2015) argue that being justice-involved was related to poorer health for three primary reasons. Their first two arguments, that imprisonment exposes individuals to infectious diseases and that it is in acute and chronic stressor, points to health being a mediating mechanism to explaining the relationship between justice-involvement and substance use. That

is, justice-involved populations have worse substance use behaviors because they have poorer health compared to the general population. Their third argument, that incarceration disrupts social integration because it causes strain on interpersonal relationships and makes it difficult to join the workforce, points to the mediating effect of social bonds. Individuals who have strong social relationships will use drugs less and have better health outcomes even while incarcerated. Because the measure of marijuana use frequency became non-significant when mediating social integration and health measures were included in model, the argument can be made that justice-involved populations engage in more frequent marijuana use because they have worse social relationships and health characteristics.

I hypothesized that social integration and poor health would mediate the relationship between justice-involvement and marijuana use. I expected that as I added mediating measures of social integration and health characteristics to the baseline model, the relationship between justice-involvement and marijuana use will become non-significant. As the analysis shows, this hypothesis was partially supported. The associations between justice-involvement and marijuana use frequency weakened as we moved across models. In the baseline model, there was a positive association between justice-involvement and marijuana use at the $p<.05$ level. Next as mediating social integration variables are added in model 2, the association between the independent and dependent variable remained significant at the $p<.05$ level. Then in the fully adjusted model, the relationship between justice-involvement and marijuana use frequency was non-significant. These results justify the argument that justice-involvement is associated with marijuana use because justice-involved people have worse health.

Limitations.

There are several limitations of this study that should be considered by readers. First, the NSDUH is a cross-sectional study, thus causal associations should not be inferred. While the goal of the current research was not to identify the causal sequence of the correlates related to marijuana use, longitudinal data would allow a more precise assessment of the relationships. Additionally, there was no way to discern if marijuana use or possession was the reason for a respondent's justice-involvement. Second, all measures were self-reported. Asking respondents about their substance use behaviors, criminal involvement, as well as physical and mental health can lead to dishonestly when reporting. However, research indicates that self-reported substance use data are reliable and valid (Johnston & O'Malley, 1985; O'Malley, Bachman, & Johnston, 1983). Additionally, NSDUH methodology takes several steps to address self-report bias, including collecting data via ACASI methods, as well as including pictures and trade/generic names for prescription drugs (Center for Behavioral Health Statistics and Quality, 2018b).

Conclusions.

In sum, the results of this study show that poor health mediates the relationship between justice-involvement and frequent marijuana use. As the measures of social integration and health status were added to the models, the relationship between justice-involvement and marijuana use became non-significant. These findings are important because they highlight the impact health characteristics have on substance use among justice-involved populations. If researchers are interested in lowering the frequency at which these populations use marijuana, then our efforts should be focused on improving health characteristics among these individuals. Improving the

physical and mental health of justice-involved population has the potential to decrease the frequency at which these populations use drugs.

As more states move toward the legalization of marijuana, access is likely to increase. While this has the potential to increase use among justice-involved populations, it is also possible that arrests for possession and use will decrease. Future research should focus on the health implications marijuana legalization has on justice-involved populations' especially as they transition from incarceration to reentering society.

CHAPTER FIVE: CONCLUSIONS

Key Findings

This study utilized a three-paper format to investigate marijuana use among adults with three distinct yet related goals in mind. First, I aim to investigate how correlates of marijuana use vary based on how use is measured: Chapter 2 "Correlates of Marijuana Use: Comparing Use Prevalence to Use Frequency." Second, I aim to offer a theoretical explanation as to why increased educational attainment is associated with less marijuana use: Chapter 3, "Educational Attainment and Frequent Marijuana Use: A Human Capital Approach." Third, I assess the association between justice-involvement and frequency of marijuana use: Chapter 4, "Evaluating Marijuana Use and Health Amid Justice-Involved Populations." Each paper fills an important niche in extant literature and advances substance use literature.

Paper 1: Correlates of marijuana use: comparing use prevalence to use frequency.

The goal of Paper 1 was to investigate the health and behavioral correlates of marijuana use prevalence versus use frequency. In line with previous literature, I hypothesized that the correlates related to marijuana use will vary depending on how use is measured. Further, I predicted that relevant associations were likely to yield distinctive characteristics associated with frequency measures of marijuana use that are not found while examining prevalence measures. Both arguments were partially supported in the analysis.

By comparing the correlates of marijuana use prevalence versus marijuana use frequency, we can see clear differences with regard to risk. For example, the logistic regression analysis indicates that as age increases, the risk of being a marijuana user decreases. However, when we

examine the count measure of marijuana use, being 26 to 34 years old increases the likelihood of marijuana use frequency. The results of this study indicate that the frequency at which individuals use vary between age groups, which is inconsistent with previous literature that shows that use decreases with age (Homel et al., 2014; Johnston et al., 2016; Terry-McElrath 2017). Likewise, identifying as non-Hispanic Black was not significantly associated with marijuana use prevalence however, this characteristic was significantly related to a higher likelihood of marijuana use frequency. These results imply that the risk for marijuana use prevalence and frequency fluctuate according to one's race/ethnicity and are in line with previous literature (Wu, Zhu, Swartz, 2016). Another sociodemographic correlate that differed for prevalence versus frequency is educational attainment. Being a college graduate significantly predicted being a marijuana user in the logistic regression but was associated with decreased marijuana use frequency in the ZINB regression which is constant with prior literature (Korn et al., 2018; Maggs et al., 2016).

In light of changing policy and increases in the prevalence of marijuana use, it is important for researchers to understand the potential correlates for high-risk use as they can influence public health and inform intervention and prevention strategies (Han et al., 2018; Monte et al., 2015). The results of this manuscript make an important contribution existing marijuana use literature by identifying characteristics associated with high-risk use. More specifically, results indicate that those ages 26 to 34 years old as well as those who identify as non-Hispanic Black are at an increased risk for frequent marijuana use. Future intervention and prevention strategies should pay close attention to these populations as their heightened risk for

use frequency has the potential to expose them to adverse health and social consequences associated with high-risk use.

Paper 2: Educational attainment and frequent marijuana use: a human capital approach.

Extant research indicates that higher levels of educational attainment are associated with less substance use and fewer risk taking behaviors (Chen et al., 2017; Cerda 2017; Han et al., 2018; Homel, Thompson, & Leadbeater, 2014; Lynskey & Hall, 2000; Richmond-Rakerd, Slutske, & Wood 2017; Schauer et al., 2016; Terry-McElrath et al., 2017). However, the research linking educational attainment and substance use is largely atheoretical making it difficult to understand how education works to limit marijuana use (Cerda, 2017; Hammersley, 2011; Verweij, Huizink, Agrawal, Martin, Lynskey, 2013). The goal of Paper 2 was to investigate whether a specific aspect of Human Capital Theory could be used to explain the relationship between education and marijuana use frequency. More specifically, I wanted to determine if healthy lifestyles account for the association between educational attainment and marijuana use. Based on the analysis, these arguments were supported.

The results of this paper show that respondents with a college degree reported less frequent marijuana use compared to other levels of educational attainment. In model 2, education remained significant after controlling for socioeconomic status. This is supportive of Mirowsky and Ross's theory because education, not related measures of socioeconomic status, is the key to health (Mirowsky & Ross 1998; 2015). In the final model, educational attainment was no longer significantly related to marijuana use frequency when I added measures associated with healthy

lifestyle. This proves that healthy lifestyles accounts for the association between educational attainment and marijuana use frequency.

The results of this paper are important for several reasons. First, the analysis shows that education is an important characteristic for understanding substance use behaviors. Second, the results of this study are supportive of the hypothesis from Human Capital Theory which indicates that it is a valid theoretical perspective for explaining substance use in the United States. Third, this paper makes an important contribution to extant substance use literature by explaining why higher education is associated with less frequent marijuana use. If researchers are interested in lowering the frequency at which people use marijuana, then our efforts should be focused on educating those with lower educational attainment of the potential health and social risks associated with frequent use. Improving the health behaviors of people with lower educational attainment has the potential to lower the frequency at which they use marijuana as well as improve overall health.

Paper 3: Evaluating marijuana use and health amid justice-involved populations

Paper 3 builds upon the work of Massoglia and Pridemore (2015) by utilizing their arguments to frame the present analysis. The first two points outlined by the researchers suggest that health may be a mediating mechanism for understanding the relationship between justice-involvement and marijuana use. As such, the aim of this paper was to test if poor health mediates the associations between justice-involvement and frequency of marijuana use. The third point described by the researchers argues that justice-involvement impedes social bonds. Thus, mediating measures of social integration will be included to determine if social integration

accounts for the association between justice-involvement and marijuana use. I hypothesized that poor health and social integration would mediate the relationship between justice-involvement and marijuana use. The results of the analysis partially supported my theory.

When the measures of social integration were added to the baseline model, the relationship between justice-involvement and marijuana use stayed significant. Thus, social integration did not mediate the relationship between the independent and dependent variables. However, when measures of health status were added to the fully adjusted model, the relationship between justice-involvement and marijuana use became non-significant. These findings justify the argument that justice-involvement is associated with marijuana use because justice-involved people have worse health which is in line with prior literature (Bronson & Berzofsky, 2017; Bronson, et al., 2017; Fearn et al., 2016; Freeman et al., 2017; Maruschak et al., 2016; Massoglia & Pridemore, 2015; Solomon, 2006). The results of this study are important because they highlight the impact health characteristics have on substance use among justice-involved populations. Justice-involved populations have high rates of marijuana use frequency primarily because of worse health.

Conclusions

Collectively, these findings have important implications for research and intervention. In Paper 1, I argue that it is important to focus on frequency of marijuana use and not just use. Based on the frequency measure, we know that individuals who are between the ages of 26 to 34 years old and those who are Black use marijuana more often and those who are college graduates use less often. These distinctions are important they emphasizes characteristics that are

correlated with frequent use as these populaces are at heightened risk for use-related concerns (Arria et al., 2016; Nelson et al., 2015; Pardini et al., 2015; Schauer et al. 2016; Terry-McElrath et al., 2017; Volkow et al., 2014).

This dissertation also points to important risk and protective factors associated with frequent marijuana use and health. For example, Paper 2 provides evidence that educational attainment is associated with better health and less frequent marijuana use. Those with higher levels of education are more likely to engage in healthy behaviors and moderate their marijuana intake. Also, the results from Paper 3 highlight the impact health characteristics, not characteristics of social integration, have on substance use among justice-involved populations. If researchers are interested in lowering the frequency at which these populations use marijuana, then our efforts should be focused on improving health characteristics among these individuals. Improving the physical and mental health of justice-involved population has the potential to decrease the frequency at which these populations use drugs. While this has the potential to increase use among justice-involved populations, it is also possible that arrests for possession and use will decrease.

Future Directions for Research

Future research can take form in a number of ways. First, because scholars need to move away from prevalence measures of marijuana use to frequency measures, there is a need for consistent measure of heavy marijuana use. Similar to how the NSDUH defines heavy alcohol use and binge drinking, researchers must find a way to measure frequent marijuana use so that comparisons can be made across studies. Second, although education was found to be a

protective factor for marijuana use frequency, the trend did not flow in the way that was expected. This is an interesting finding that warrants future investigation by researchers. Third, research should focus on the health implications marijuana legalization has on justice-involved populations' especially as they transition from incarceration to reentering society.

APPENDIX
IRB APPROVAL

UNIVERSITY OF CENTRAL FLORIDA

Institutional Review Board
FWA00000351
IRB00001138, IRB00012110
Office of Research
12201 Research Parkway
Orlando, FL 32826-3246

NOT HUMAN RESEARCH DETERMINATION

June 2, 2020

Dear Corey Pomykacz:

On 6/2/2020, the IRB reviewed the following protocol:

Type of Review:	Initial Study
Title of Study:	Marijuana Use Among Adults in the United States: Comparing Correlates of Use, Assessing Impact of Education, and Evaluating Use and Health amid Justice-Involved Populations
Investigator:	Corey Pomykacz
IRB ID:	STUDY00001852
Funding:	None
Grant ID:	None
Documents Reviewed:	• Pomykacz-HRP-251- FORM - Faculty Advisor Scientific-Scholarly Review (1).pdf, Category: Faculty Research Approval; • List of Variables, Category: Other; • UPDATE- IRB Pomykacz 1852 HRP-250-FORM-Request for NHSR.docx, Category: IRB Protocol;

The IRB determined that the proposed activity is not research involving human subjects as defined by DHHS and FDA regulations.

IRB review and approval by this organization is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these activities are research involving human in which the organization is engaged, please submit a new request to the IRB for a determination. You can create a modification by clicking **Create Modification / CR** within the study.

If you have any questions, please contact the UCF IRB at 407-823-2901 or irb@ucf.edu. Please include your project title and IRB number in all correspondence with this office.

Due to current COVID-19 restrictions, in-person research is not permitted to begin until you receive further correspondence from the Office of Research stating that the restrictions have been lifted.

UNIVERSITY OF CENTRAL FLORIDA

Institutional Review Board
FWA00000351
IRB00001138, IRB00012110
Office of Research
12201 Research Parkway
Orlando, FL 32826-3246

Sincerely,

Kamille C. Birkbeck

Kamille Birkbeck
Designated Reviewer

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