PREDICTORS OF DAILY MARIJUANA USE AMONG A NATIONAL SAMPLE OF US
YOUTH

By

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Dedicated to Mummy, Buwa, Babu, Fuwa and Jijumuwa

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LIST OF ABBREVIATIONS

ADD	Attention Deficit Disorder
ADHD	Attention Deficit Hyperactivity Disorder
AGFI	Adjusted Goodness of Fit Index
AOR	Adjusted Odds Ratio
CFI	Comparative Fit Index
CI	Confidence Interval
DAWN	Drug Abuse and Warning Network
GFI	Goodness of Fit Index
MTF	Monitoring the Future
NH	Non-Hispanic
N-MAPSS	National Monitoring of Adolescent Prescription Stimulants Study
NSDUH	National Survey on Drug Use and Health
RBA	Risk Behavior Assessment
REF	Reference Group
RMSEA	Root Mean Square Error of Approximation
SAM	Substance Abuse Module
SAMHSA	Substance Abuse and Mental Health Administration
SES	Socio-economic status
SAM	Substance Abuse Module
THC	Tetrahydrocannabinol
VIF	Variance Inflation factor
YRBS	Youth Risk Behavior Survey

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Marijuana is legal for medical and recreational purposes in an increasing number

of states in the United States. With this legalization, an increased availability of

marijuana and a decreased perception of harm from its regular use have occurred

especially among adolescents, both of which may increase the likelihood of regular

marijuana use. Regular marijuana use, commonly defined as daily use, during

adolescence has been associated with an increased vulnerability to neurobiological,

psychosocial and other adverse health outcomes. To prevent these effects, it is

important to understand factors that influence current daily marijuana use among youth

who have already initiated marijuana use. Recognizing this need, this dissertation

aimed to analyze, among youth who had initiated marijuana use: 1) the individual-level

factors, 2) the sex- and racial/ethnicity-specific individual-level factors, and 3) the

relationship-level factors, both direct and indirect effects, that influence current daily

marijuana use.

Data came from the National Monitoring of Adolescent Prescription Stimulants

Study (N-MAPSS; PI Linda B. Cottler), a cross-sectional study conducted from 2008 to

2011 which examined a broad range of risk factors for prescription stimulant use and

misuse among 11,048 youth aged 10 to 18 years from 10 US metropolitan areas using

an entertainment-venue intercept method. Our analyses included youth from 13 to 18

years of age. Sociodemographic, mental health and behavioral factors (lifetime and

current use of substances such as tobacco, alcohol, marijuana and other drugs), and

parental and peer-related variables were assessed and included in these analyses. The

main outcome of the study was current daily marijuana use, defined as use on 20 or

more days in the past 30 days. Current daily marijuana use was compared with no

current marijuana use (Chapters 3 and 4) and with current non-daily marijuana use

(Chapter 5).

This dissertation provides an in-depth understanding of the influence of

individual- and relationship-level factors on current daily marijuana use among youth

who initiated marijuana use. Findings can be used to help target prevention efforts to

the specific risk factors for daily marijuana use among teens.

CHAPTER 1
INTRODUCTION

1.1 Epidemiology of Youth Marijuana Use

Marijuana is the most commonly used federally prohibited drug in the United

States. The 2016 National Survey on Drug Use and Health (NSDUH) reported that 48.5%

of the US population (12 years or older) endorsed lifetime marijuana use. Further, the

past-month prevalences of marijuana use were reported to be 6.5%, 20.8% and 7.2%

among the age groups 12 to 17, 18 to 25 and 26 and older, respectively in 2016

(SAMHSA, 2017). Although the rates of use are higher among 18 to 25 year olds

compared to other age groups, marijuana use among adolescents is a particular public

health concern because brain development continues throughout adolescence and into

early adulthood (Gogtay et al., 2004). During these developmental stages, the brain is

more susceptible than a mature brain to adverse effects of substances such as marijuana

that can alter brain structure and functioning (Dinieri and Hurd, 2012). Moreover,

adolescence is the period of highest risk of substance initiation and experimentation.

Nearly one-half of high school seniors reported marijuana use at least once in their

lifetime (Johnston et al., 2016).

The health effects associated with marijuana use have been widely debated,

though adverse effects associated with marijuana use during adolescence and adverse

effects of regular use have been consistent in the literature (Azofeifa, 2016). In

epidemiology, most studies define regular marijuana use as daily or almost daily use (Hall

and Degenhardt, 2009). Short-term effects of marijuana use among youth include

impaired short-term memory that diminishes the ability to learn and retain information,

reduced motor coordination that increases the risk of motor vehicle accidents and injuries,

altered judgment increasing the likelihood of risky behaviors, paranoia and psychosis when used in higher doses (Volkow et al., 2014). The Drug Abuse Warning Network (DAWN) reported an increase in emergency department (ED) visits in which individuals indicated marijuana use in the medical record; 13% of such visits were made by youth between 12 and 17 years of age (DAWN, 2013). Moreover, the long-term or regular use of marijuana may cause more detrimental effects such as cannabis use disorder. About 17% of those who begin use in adolescence and about 25-50% of those who use marijuana regularly become addicted to the drug (Hall and Degenhardt, 2009). Other identified effects of long-term or regular use range from poor educational outcomes, altered brain development, cognitive impairment, respiratory problems (e.g. chronic bronchitis), diminished satisfaction in life achievement to risk of mental problems such as schizophrenia, particularly among those with a predisposition to such disorders (Volkow et al., 2014).

Currently, twenty-nine states and the District of Columbia have passed some form of marijuana legalization; eight states and the District of Columbia have passed marijuana legalization laws for recreational purposes (Kilmer and MacCoun, 2017). With the increase in marijuana legalization in a growing number of states, there is a potential for increase in availability of marijuana. Recent years have also shown a decrease in perception of harm of regular use among adolescents (Johnston et al., 2016). The proportion of high school seniors who perceived regular marijuana use as harmful declined from 58.3% in 2000 to 31% in 2016. The prevalence of daily marijuana use, defined by the Monitoring the Future (MTF) study as use of marijuana on 20 or more occasions in the past 30 days, escalated by grade level with 0.7%, 2.5% and 6% of 8th,

10th and 12th grade students reporting daily marijuana use, respectively in 2016. Further, daily marijuana use exceeded daily tobacco use among 10th (2.5% vs 1.9%) and 12th (6.0 vs 4.8%) grade students (Johnston et al., 2016).

Not all youth who use marijuana progress to daily marijuana use. Research indicates that about 10% of those who initiate marijuana use become daily users (Hall and Degenhardt, 2014). Also, a majority of research has focused on the risk and protective factors of youth marijuana use by comparing lifetime or past 30-day use versus no use (SAMHSA, 2014) and neglected to make a distinction among marijuana users. The assumption that marijuana-using populations are homogeneous can be misleading; there are different types of users depending on the frequency of use. For instance, among marijuana-using college students, daily or nearly daily users were different from those who used a few times in a month, with daily users having more risk factors and consequences compared to the other groups (Pearson et al., 2017).

Our review indicated that the major public health concern lies in the adverse consequences associated with regular use (daily) more than with lifetime or current use. The NSDUH definition for daily marijuana use, use on 20 or more days in the last 30 days, is a conservative measure of daily marijuana use. This definition has been used for reporting daily marijuana use for several years in the literature. By using this definition of current daily marijuana use, we could identify risk factors specific to such use. The risk factors identified could then be incorporated in prevention programs to reduce the public health consequences associated with such use. Therefore, this dissertation intended to identify individual- and relationship-level factors specific to current daily marijuana use

among youth who had initiated marijuana use, using a national sample of youth and the NSDUH definition.

1.2 Definition of Daily Marijuana Use

Studies differ in their definition of daily marijuana use. For instance, the annual cross-sectional national surveys on adolescent substance use, the National Survey on Drug Use and Health (NSDUH) and the Monitoring the Future (MTF), differ in their definitions of daily use. The NSDUH defines past month daily or almost daily marijuana use as use on 20 or more days in the past 30 days; the MTF defines daily use as use on 20 or more occasions in the past 30 days. According to the MTF definition, 20 or more occasions can occur over a weekend or it may possibly occur as one occasion per day. Other studies with small sample sizes defined daily use as having used every day or used on at least 6 days in a week (Conroy et al., 2016; Silins et al., 2014). Further, studies have also used different terms such as use, frequent use or regular use with varying definitions and have focused on specific risk factors (Tu et al., 2008; Griffin et al., 2002; Creemers et al., 2010; van der Pol et al., 2013; Farhat et al., 2011). Tu and colleagues (2008) defined heavy use as having used 10 or more times in the past 30 days; Griffin and colleagues (2002) defined regular use as having used on a monthly basis or more frequently; van der Pol and colleagues (2013) defined frequent use as having used on at least three days in a week for at least 12 months. Given this landscape, it is difficult to compare and replicate findings from different studies. Thus, risk factors specific to daily marijuana use remain unclear.

1.3 Conceptual Framework

Research indicated that social learning theory has been widely applied to explain deviant behavior including substance use among adolescents. Along with the individual-

level factors that have been found to be associated with marijuana use among youth, social learning theory focuses on relationship-level factors, such as parental and peer influence on youth marijuana use. According to the social learning theory, children initially learn social norms and skills from their parents but as they reach adolescence, they begin to model the norms and skills from their peers. As youth mature, their associations with peers become more important and peers become more influential than parents to their behavior. If they associate with deviant peers, this may cause additional detachment from parents increasing the likelihood of their involvement in deviant behavior such as substance use (Akers et al., 1979). Parental variables that are associated with marijuana use among youth include family disruption (Low et al., 2012), parental tobacco or marijuana use (Miller et al., 2013; Swift et al., 2008), poor parental monitoring (Dever et al., 2012; White et al., 2006), low parental attachment (Heavyrunner et al., 2010), and living with divorced or separated parents (Mandara et al., 2011). Peer variables associated with youth marijuana use include peer marijuana use (Ali et al., 2011; Pinchevsky et al., 2012), having substance-using peers (Korhonen et al., 2008; Perkonigg et al., 2008; Mrug et al., 2010), and affiliation with deviant peers (Hampson et al., 2008).

Individual-level factors that are associated with youth marijuana use include poor academic performance (Tu et al., 2008), anxiety (Marmorstein et al., 2010), depression (Pacek et al., 2012; Tu et al., 2008), conduct disorder (Wymbs et al., 2012), aggressive behavior (Farhat et al., 2011; Korhonen et al., 2008), attention problems (King et al., 2011), impulsivity (Heavyrunner-Rioux and Hollist, 2010), antisocial personality disorder (Perkonigg et al., 2008), tobacco use (Guxens et al., 2007; Korhonen et al., 2008; Tu et al., 2008), alcohol use (Guxens et al., 2007; Korhonen et al., 2008; O'Connell et al., 2011;

Perkonigg et al., 2008; Tu et al., 2008), lack of extracurricular activities (Perez et al., 2011) and positive attitudes and perception towards marijuana use (Hayaki et al., 2010; King et al., 2012; Morrison et al., 2010; Stephens et al., 2009). Early onset of marijuana use has also been linked with regular marijuana use among youth (Terry-McElrath and O'Malley, 2011; Sagar et al., 2015).

Another widely applied model in substance use is the socio-ecological model. In 2014, the Substance Abuse and Mental Health Services Administration (SAMHSA) Center for the Application of Prevention Technologies (2014) listed important risk and protective factors associated with youth marijuana use utilizing a socio-ecological framework. That framework included four levels of factors: individual, relationship, community and societal. Community-level factors (neighborhoods, work places, schools and institutions) and societal-level factors (culture, norms and access, historical trauma, media, and laws and policies) are also very important in predicting substance use. However, the influences of these factors are more distal compared to individual- and relationship-level factors.

Given that the findings of most research have shown the importance of the youth's own characteristics and the characteristics of their important relationships, this dissertation focused only on individual- and relationship-level factors that may affect current marijuana use.

Figure 1-1. Socio-ecological model

Table 1-1. Terms and definitions used for daily marijuana use in different studies

Study	Term used	Definition
NSDUH	Daily or almost daily use	Use on 20 or more days in the past 30 days
MTF	Daily use	Use on 20 or more occasions in the past 30 days
Silins et al., 2014	Daily use	Use everyday
Conroy et al., 2016	Daily use	At least 6 days in a week
Tu et al., 2008	Heavy use	Use 10 or more times in the past 30 days
Griffin et al., 2002	Regular use	Use on a monthly basis or more frequently
Creemers et al., 2010	Regular use	Use on at least 4 occasions in the past four weeks
Johnson et al., 2015	Frequent use	Use 20 to 39 times in the past 30 days
van der Pol et al., 2013	Frequent use	Use on at least 3 days per week for at least 12 months
Farhat et al., 2011	Current frequent use	Use at least 3 times in the past 30 days

CHAPTER 2
DATA SOURCE

2.1 National Monitoring of Adolescent Prescription Stimulants Study (N-MAPSS)

Data used in the three papers herein came from the National Monitoring of

Adolescent Prescription Stimulants Study (N-MAPSS) (PI Dr. Linda B. Cottler). N-

MAPSS was conducted under the contract with Pinney Associates, Inc., with the

funding provided by Shire Development LLC and Noven Pharmaceuticals. The main

objective of this study was to investigate the prevalence of and risk factors for misuse,

abuse, and diversion of prescription stimulants among youth. N-MAPSS was a cross-

sectional study that was conducted in urban, suburban and rural areas of 10 US cities in

four waves: Fall 2008, spring 2009, fall 2010 and spring 2011. These cities were

selected on the basis of prescription stimulant use patterns. The IMS Health database

contains records of prescriptions dispensed at each retail pharmacy in the US. Using

the 2008 database, states with the highest volume of stimulant prescriptions were

identified and the cities within those states with the highest volume of stimulant

prescriptions were selected. Four cities from the eastern US (Boston, MA; New York,

NY; Philadelphia, PA and Tampa Florida) , three cities from the central US (St Louis,

MI; Cincinnati, OH and Houston, TX) and three cities from the western US (Denver, CO;

Los Angeles, CA and Seattle, Washington) were included in the study (Figure 2-1).

Recruiters/trained interviewers approached 21,444 youth for participation at

shopping malls, movie theatres, arcades, libraries, skate parks, parks and sports and

recreational centers using an entertainment-venue intercept method. This method

allowed the capturing of a large and diverse sample of youth by recruiting individuals

from popular venues where they often visit or gather. Eligibility criteria included youth

between 10 to 18 years of age residing in urban, suburban or rural areas in the selected cities. These areas were categorized based on city limits, proximity to city limits and population density. Eligibility criteria excluded those who were college students, non-English readers, and those who were cognitively impaired or did not know of their zip code (Cottler et al., 2013). Among 21,444 youth, a quarter did not stop to listen to their introduction, 10% stopped but refused to participate in the study and 21% were ineligible due to their age or zip code. Out of 11,468 youth who participated, 3.7% were eliminated because of untruthful responses, duplicates, incompletes, and ineligibility. A total of 11,048 youth 10 to 18 years of age was included in the final sample which represented a participation rate of 86.7% (Cotter et al., 2013).

Trained interviewers obtained verbal consents from each participant for anonymous interviews and provided verbal guidance to 10 to 12 year olds through the survey whereas it was self-administered among 13 to 18 year olds. Participants took about 20-30 minutes to complete the survey and received a remuneration of a gift card worth $10 from a national electronics store upon completion. The study protocol was approved by Washington University in St. Louis and the University of Florida Institutional Review Boards (Cottler et al., 2013; Lasopa et al., 2015; Wang et al., 2015; Striley et al., 2016).

2.2 Assessment

The N-MAPSS survey was developed by the Epidemiology and Prevention Research Group (EPRG), led by Dr. Linda Cottler and her team at the Washington University School of Medicine (WUSM). The survey questions were adapted from the Substance Abuse Module (SAM) (Horton et al., 2000) and the Washington University Risk Behavior Assessment (RBA) (Shacham and Cottler, 2010) and it consisted of two

parts. Along with questions that asked youth to identify the stimulants by name and formulation, Part One covered questions that assessed sociodemographic and mental health variables of youth. Sociodemographic variables that we used for this dissertation were age, sex, race/ethnicity, family structure and grades in school. Mental health variables that we used were the self-reported diagnosis of ADD/ADHD, and symptoms of anxiety, conduct disorder and depression.

After the completion of Part One, Part Two covered questions that assessed lifetime and current use of stimulants and opioids as well as other substances such as tobacco, alcohol, and marijuana. Behavioral variables that were used in this dissertation included current tobacco use, current alcohol use, current marijuana use including current daily use, the age of marijuana initiation and lifetime other drug (cocaine or crack, heroin, club drugs like ecstasy, hallucinogens like LSD or mushrooms, anabolic steroids, methamphetamine or inhalants) use. Additionally, other questions that assessed parental warnings against substance use and peer substance use were added in Part Two of Waves Three and Four. Parental warning questions used in this dissertation included how often parents or guardians had warned youth to not use marijuana or alcohol or to smoke or chew tobacco and if youth had ever gotten alcohol from their parent. Youth were also asked if anyone in their household smoked cigarettes or cigars or used chewing tobacco, snuff or dip. Peer substance use questions included the number of youth's close friends that have tried marijuana, smoke cigarettes or chew tobacco and if they had ever gotten alcohol from their friends.

Current marijuana use status: The main outcome of interest in this study was current marijuana use (past 30-day use) among youth who have used marijuana. We

excluded 10 to 12 year olds due to low rates of self-reported marijuana use. To assess the outcome variable, all participants were asked if they had ever used marijuana. Only those who responded "yes" were included in the analyses. These participants were further asked, "In the last 30 days, how many days did you use marijuana?" The responses for this question were categorized into zero days, one to two days, three to five days, six to nine days, ten to nineteen days, twenty to twenty-nine days and all thirty days. For our analyses, we categorized use of marijuana on "zero days in the last 30 days" as "No current use", use of marijuana on "one to two days, three to five days, six to nine days, or ten to nineteen days in the last 30 days" as "Current non-daily use" and use of marijuana on "twenty to twenty-nine days and all thirty days in the last 30 days" as "Current daily use". Chapters 3 and 4 included youth 13 to 18 years of age who had initiated marijuana use from all four waves of N-MAPSS (n=3,155). Parental and peer-related variables that I used for chapter 5 were only added in Waves Three and Four of N-MAPSS. Therefore, chapter 5 included youth 13 to 18 years of age who had initiated marijuana use from last two waves (n=1,586).

Overall, N-MAPSS consisted of a large and diverse sample of youth from urban, suburban and rural areas across 10 US cities. It included a significant proportion of youth who endorsed marijuana use and provided a rich source of factors associated with marijuana use among youth.
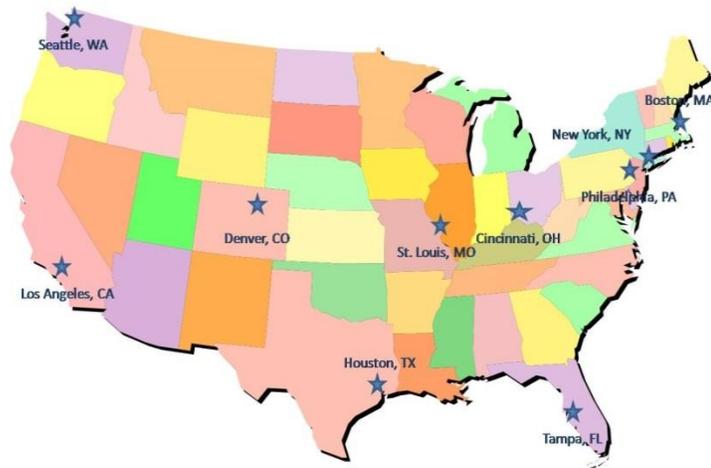
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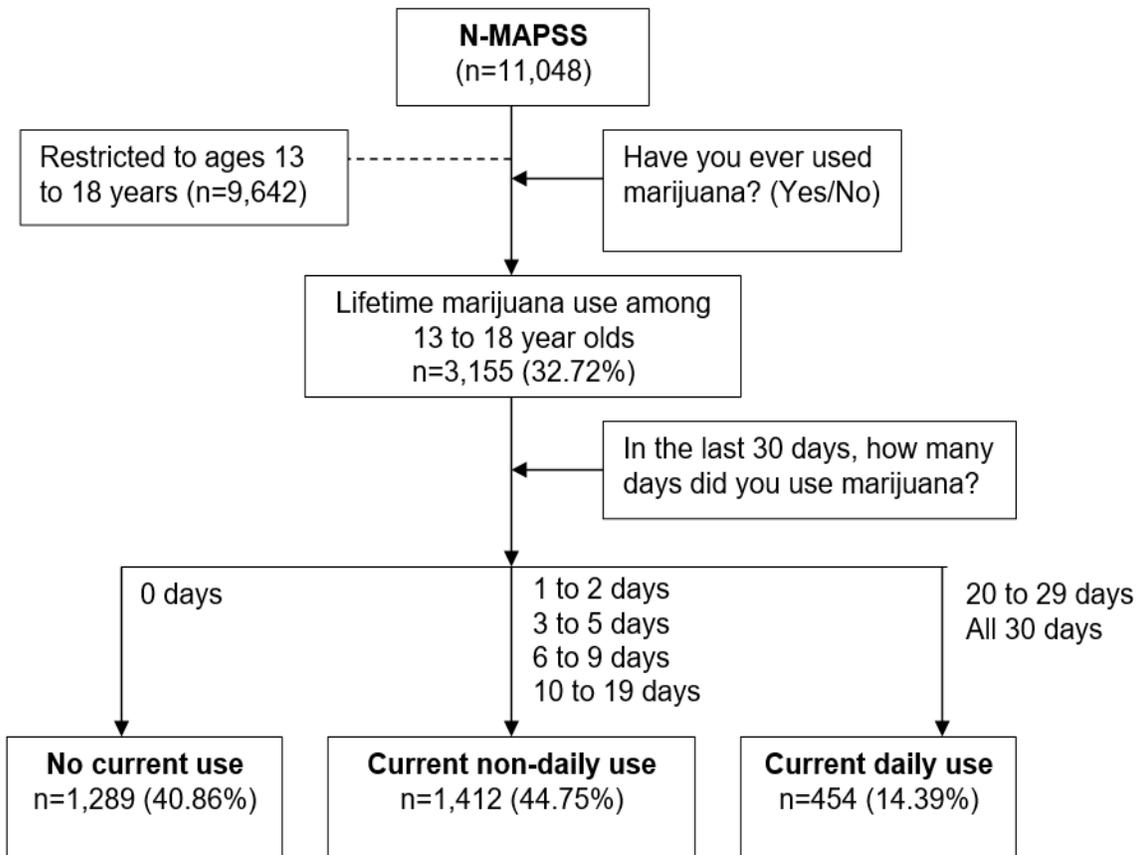
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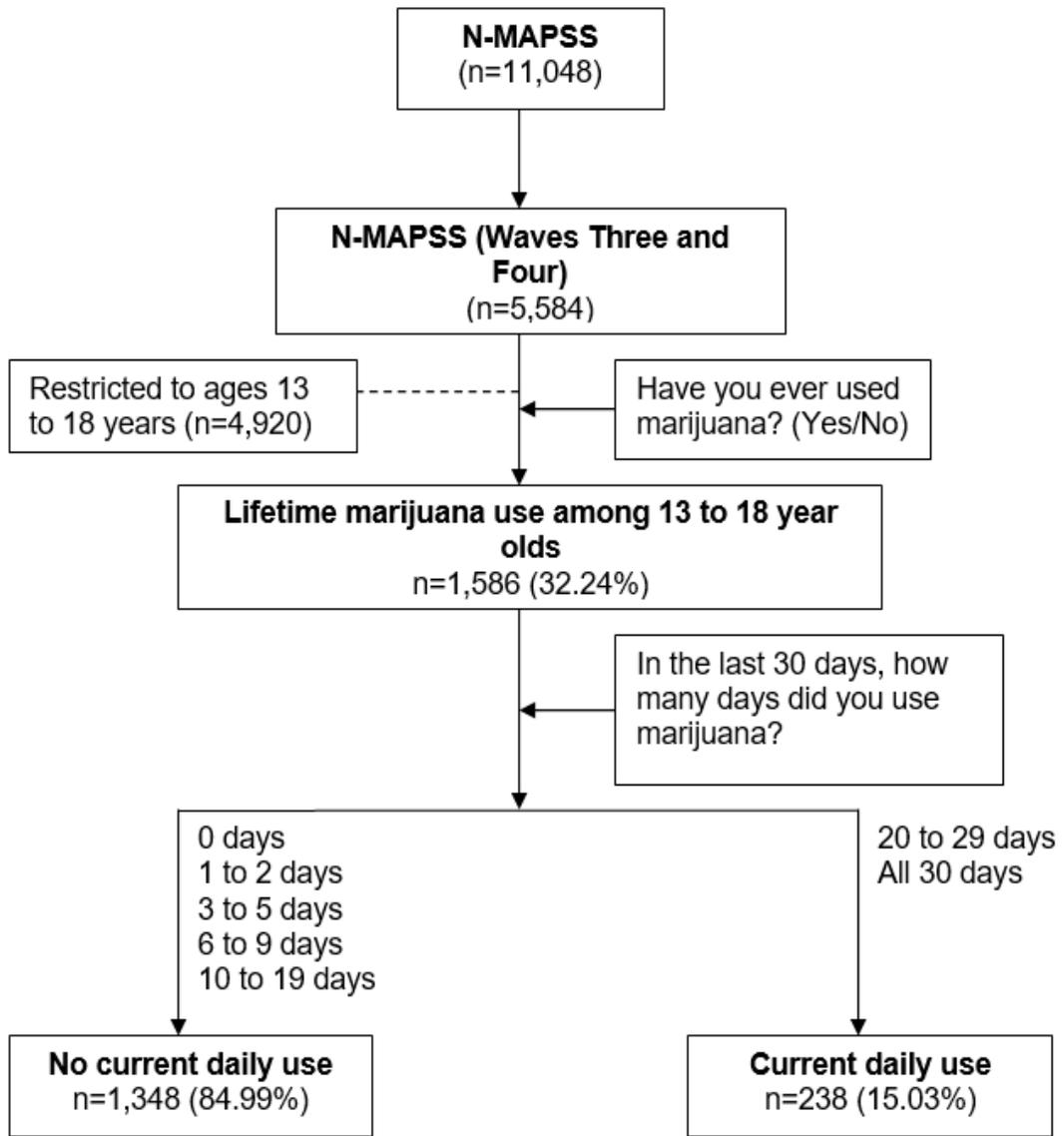
Figure 2-3. Flow chart for outcome measures for Chapter 5

CHAPTER 3
INDIVIDUAL-LEVEL FACTORS ASSOCIATED WITH CURRENT DAILY MARIJUANA
USE AMONG US YOUTH WHO HAD INITIATED MARIJUANA USE

3.1 Background

Marijuana use is common among US youth. Adolescence, generally considered

to range from ages 10 to 19 (Mackay and Duran, 2007), is a critical period for various

types of drug initiation and experimentation including marijuana (SAMHSA, 2011).

According to the 2016 National Survey on Drug Use and Health (NSDUH), about 6.5%

of youth aged 12 to 17 years reported marijuana use in the past month (SAMHSA,

2017). Another national survey among youth, the Monitoring the Future (MTF) survey of

2016, found the prevalence of past month marijuana use to be 5.4%, 14.0% and 22.5%

among 8th, 10th and 12th grade students, respectively. These findings evidence an

increase in marijuana use by grade level among adolescents. Moreover, nearly one-half

of high school students reported marijuana use at least once in their lifetime by the time

they graduated from high school. Additionally, almost 70% of the high school seniors

reported perceiving regular marijuana use as not harmful (Johnston et al., 2016).

The use of marijuana among youth has generated significant public health

concern due to adverse developmental, neurobiological, psychosocial and behavioral

outcomes associated with its use. Research has consistently found these adverse

outcomes among youth who endorse regular or heavy marijuana use (Azofeifa, 2016).

Since brain development continues until early adulthood, exposure to

tetrahydrocannabinol (THC), a major psychoactive ingredient in marijuana, during

adolescence may cause structural and functional changes resulting in developmental

and neurobiological alterations (Dinieri and Hurd, 2012; Lisdahl et al., 2014). Early age

of marijuana initiation and regular marijuana use have also been associated with developing cannabis use disorder (Hall and Degenhardt, 2009). Further, other identified effects of long-term or regular use range from poor educational outcomes, cognitive impairment, respiratory problems (e.g. chronic bronchitis), diminished satisfaction in life achievement to risk of mental problems such as schizophrenia, particularly among those with a predisposition to such disorders (Volkow et al., 2014; Hall and Degengardt, 2014).

Based on prior research, some individual-level factors have been shown to predict marijuana use among youth. Sociodemographic factors such as age, sex, race/ethnicity, family characteristics and academic performance have been found to predict youth marijuana use. The MTF study clearly indicated that older adolescents are more likely to use marijuana compared to younger ones: rates of use increased by grade level among 8th, 10th and 12th grade students (Johnston et al., 2016). Regarding sex, males have been consistently found to have higher rates of marijuana use compared to females. However, sex differences in use substantially declined in the period from 1999 to 2013 (Johnson et al., 2015). Similar changes are observed in the association between race/ethnicity and marijuana use among adolescents. Until the early 1990s, white high school students were more likely to use marijuana than Blacks, but this trend narrowed substantially by the early 2000s. Then by 2013, current marijuana use prevalence was higher among Blacks, Hispanics and American Indians compared to Whites (Johnson et al., 2015). Asian Americans continued to have the lowest prevalence of marijuana use among population groups (Johnson et al., 2015; Shih et al., 2010).

Other factors reduce or increase the risk of marijuana use among youth. For example, living with both parents is a protective factor (Mandara et al., 2011; Musick et al., 2008; Vogel et al., 2015) whereas having divorced/ separated parents (Mandara et al., 2011) and being raised without a biological father (Swift et al., 2008) are risk factors for youth marijuana use. Further, youth who used marijuana were more likely to report poor academic performance including poor school grades (Homel et al., 2014; Tu et al., 2008) and not completing high school (Horwood et al., 2010; Silins et al., 2014) compared to those who did not.

Individual behavioral risk factors such as the use of tobacco, alcohol and other illicit drugs and age of marijuana initiation have also been shown to affect youth marijuana use. Youth who used marijuana compared to their counterparts were more likely to endorse use of tobacco (Guxens et al., 2007; Korhonen et al., 2008; Tu et al., 2008; Nelson et al., 2015), alcohol (Guxens et al., 2007; Korhonen et al., 2008; O'Connell et al., 2011; Perkonigg et al., 2008; Tu et al., 2008), and other drugs (Hall and Degenhardt, 2007). Early initiation of marijuana has also been associated with increased risk of regular marijuana use (Terry-McElrath and O'Malley, 2011; Sagar et al., 2015). Moreover, marijuana-using youth had higher likelihood of reporting symptoms of anxiety (Marmorstein et al., 2010), depression (Pacek et al., 2012; Tu et al., 2008; Wright et al., 2016), conduct disorder (Wymbs et al., 2012), aggressive behavior (Farhat et al., 2011; Korhonen et al., 2008), and attention problems (King et al., 2011; Sibley et al., 2014) compared to their counterparts.

While the majority of research on marijuana use among youth has been focused on understanding the risk factors associated with lifetime or past 30-day use versus no

use, to our knowledge no national studies specify individual-level risk factors associated with current daily marijuana use and non-daily use among those who have already initiated use. Research indicates that about 10% of those who initiate marijuana use become daily users (Hall and Degenhardt, 2009). As noted, most health consequences occur due to regular marijuana use during adolescence and several epidemiological studies define regular marijuana use as daily or almost daily use (Hall and Degenhardt, 2009), it is important to focus on determining factors specific to current daily marijuana use among youth who have initiated marijuana use.

Prior research shows that definitions of daily marijuana use vary between studies. The annual cross-sectional national study on substance use, NSDUH, defines past month daily or almost daily marijuana use as use on 20 or more days in the past 30 days while the MTF study defines daily use as use on 20 or more occasions in the past 30 days. Other studies have defined daily marijuana use as having used every day (Silins et al., 2014) or having used at least 6 days in a week (Conroy et al., 2016). In addition to daily use, studies have also chosen to measure heavy use, regular use or frequent use; some of these definitions are comparable with daily use. For instance, in one study, frequent use was defined as having used 20 to 39 times in the past 30 days (Johnson et al., 2015); however, other definitions of frequent use include having used on at least 3 days per week for at least 12 months (van der Pol et al., 2013) and having used at least 3 times in the past 30 days (Farhat et al., 2011). Heavy use has been defined as having used 10 or more times in the past 30 days (Tu et al., 2008), having used on a monthly basis or more frequently (Griffin et al., 2002) and having used on at least 4 occasions in the past four weeks (Creemers et al., 2010). Given this landscape,

it is difficult to compare and replicate findings from different studies. Thus, risk factors specific to a standard definition of current daily marijuana use among youth remain unclear.

Therefore, the main objective of this analysis was to determine the individual-level factors that predict, among youth who had initiated marijuana use, current daily marijuana use, and non-daily use versus no current use (use on zero days in the past 30 days). Consistent with the NSDUH survey, we defined current daily marijuana use as having used the substance on 20 or more days in the past 30 days. We tested the same individual-level factors that have been found to be associated with youth marijuana use in the literature to determine factors that predict current daily marijuana use. We hypothesized that individual-level factors such as early age of initiation, poor grades, current use of tobacco, current use of alcohol, lifetime use of other drugs, having depressive and anxiety symptoms, conduct disorder symptoms, and ADD/ADHD predict daily marijuana use among youth who had initiated marijuana use. Further, we hypothesized that alcohol and drug use in general would be related, such that lifetime and current use would be most predictive of daily marijuana use.

3.2 Methods

Data were drawn from the National Monitoring of Adolescent Prescription Stimulants Study (N-MAPSS; PI LB Cottler); a cross-sectional study that aimed to determine the prevalence of and risk factors for use, misuse and diversion of prescription stimulants among youth. N-MAPSS recruited a total of 11,048 youth 10 to 18 years of age from shopping malls, movie theatres, arcades, libraries, skate parks, parks, sports and recreational centers using an entertainment-intercept venue method from urban, suburban and rural areas of 10 US cities. Trained interviewers obtained

verbal consent from each participant for anonymous interviews and the survey was self-administered among 13 to 18 year olds. Participants took about 20-30 minutes to complete the survey. The survey was conducted in four waves from 2008 to 2011. Participants received a remuneration of a gift card worth $10 from a national electronics store upon survey completion. The study protocol was approved by Washington University in St. Louis and the University of Florida Institutional Review Boards (Cottler et al., 2013; Lasopa et al., 2015; Striley et al., 2017; Wang et al., 2015).

3.2.1 Sample

The sample was restricted to 13 to 18 year olds (n=9,642) due to low rates of self-reported marijuana use among 10 to 12 year olds. Participants were asked if they had ever used marijuana. Only those who responded "yes" were included in the current analyses (n=3,155; 32.72%).

3.2.2 Measures

3.2.2.1 Current marijuana use

The main outcome of interest in this study was current marijuana use (past 30-day use) among youth who had previously initiated marijuana use. Participants who reported having ever used marijuana were asked about their age they first used marijuana. They were further asked, "In the last 30 days, how many days did you use marijuana?" The responses for this question were categorized into zero days, one to two days, three to five days, six to nine days, 10 to 19 days, 20 to 29 days and all 30 days. For our analyses, we categorized use of marijuana on "zero days in the last 30 days" as "No current use", use of marijuana on "one to two days, three to five days, six to nine days, and 10 to 19 days in the last 30 days" as "Current non-daily use"; use of

marijuana on "20 to 29 days and all 30 days in the last 30 days" were categorized as "Current daily use".

3.2.2.2 Sociodemographic factors

Sociodemographic variables included in the analyses were self-reported age, sex, race/ethnicity, self-reported school grades, and family structure. Age remained as a continuous variable; sex was categorized into male or female; race/ethnicity was categorized into Non-Hispanic White, Non-Hispanic Black, Hispanic, Asian/Asian American and other races (Alaskan Native/Eskimo, American Indian, Middle Eastern, Pacific Islander, Biracial or multiracial); self-reported grades in school variable was categorized into "As or Bs" or "Cs or worse" and family structure was categorized into lived with both mother and father, lived with either mother or father, or lived with others (foster parents, relatives or other).

3.2.2.3 Behavioral factors

Behavioral variables included in the analyses were current use of tobacco, current use of alcohol, lifetime use of other drugs, and age of marijuana initiation. To assess the current use of tobacco, participants were first asked if they ever smoked a cigarette. Those who responded "yes" were asked if they still smoked cigarettes every day or some days. Youth who responded that they currently smoked cigarettes every day or some days were categorized as current tobacco users. Similarly, to assess current alcohol use, participants were asked if they had ever had a beer, a glass of wine or any other alcoholic drink, not just a sip. Those who responded "yes" were asked on how many days they drank in the last 30 days. Those who responded one or more days were categorized as current alcohol users. Lifetime use of other drugs was assessed by asking if they had ever tried cocaine or crack, heroin, club drugs like ecstasy,

hallucinogens like LSD or mushrooms, steroids, methamphetamine or inhalants. Youth who reported having ever used any of these drugs were categorized as having lifetime other illegal drug use.

3.2.2.4 Mental health factors

Mental health problems included in the analyses were having ADD/ ADHD, and symptoms of anxiety, conduct disorder and depression. Having been diagnosed with ADD/ADHD was assessed using a yes/no question, "Has a doctor ever told you or your parents that you have Attention Deficit Disorder (ADD) or Attention Deficit Hyperactivity Disorder (ADHD)?" Anxiety symptoms were assessed by asking if youth had ever felt worried or stressed for 6 months or more. Similarly, conduct disorder symptoms were assessed using two items: if youth had ever (1) gotten into a lot of trouble at home or at school or run away from home overnight or (2) used or threatened someone with a weapon. Depression symptoms were assessed using two items: in the last 12 months, if youth had two weeks or more when they (1) lost interest in things or (2) felt down or depressed.

Overall, 55 youth had missing data for variables of interest; therefore, we deleted those observations leaving complete data for 3,100 youth.

3.3 Statistical Analyses

Descriptive statistics of sociodemographic, behavioral and mental health characteristics were calculated by current daily use, current non-daily use and no current use using F-tests and chi-square tests with the significance level set at a p-value of < 0.05. Then, unadjusted odds ratios were estimated by creating 13 bivariate logistic regression models for each individual-level factor and the outcome of interest. We then assessed for multicollinearity to identify redundant variables for omission using a

regression model that included all variables to estimate Variance Inflation Factors (VIF).

A VIF coefficient below 10 was desired (Davis et al., 1986). The variables included in

our model indicated VIF coefficients less than two, resulting in low to no

multicollinearity.

Further, a multinomial logistic regression model was conducted to determine the

effects of individual-level factors associated with current daily marijuana use and current

non-daily marijuana use compared with no current marijuana use (reference group). All

the individual-level factors that were pre-selected are important variables in marijuana

use among youth in the literature and thus, were included in the full regression model.

Adjusted odds ratios with 95% confidence intervals were reported. All analyses were

performed using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA).

3.4 Results

Table 3-1 shows the sociodemographic, behavioral and mental health

characteristics by current marijuana use among US youth 13 to 18 years of age who

had initiated marijuana use. Out of 3,100 youth who reported lifetime marijuana use,

41.00% reported no current use, 44.71% reported current non-daily use and 14.29%

reported current daily use. Among youth who had initiated marijuana use in N-MAPSS,

the reported mean age was 16.33 years; 53.55% were male, 44.19% were NH White,

44.13% lived with both mother and father, and 38.23% reported their grades in school

as Cs or worse. Moreover, 29.35% reported current use of tobacco, 60.35% reported

current use of alcohol and 37.68% reported lifetime use of other drugs. The reported

mean age of marijuana initiation was 13.99 years. Further, 20.55% reported having

ADD/ADHD and 35.39%, 23.23%, and 32.32% reported having symptoms of anxiety,

conduct disorder, and depression, respectively.

Bivariate analyses showed that sociodemographic factors such as sex, family structure, and self-reported grades in school were found to be significantly associated with current marijuana use. Compared to non-current marijuana users (48.54%), current daily (72.23%) and current non-daily marijuana users (52.16%) were more likely to be males (p<.05). Compared to non-current marijuana users (32.65%), current daily (53.72%) and current non-daily marijuana users (38.38%) were also more likely to report Cs or worse grades in school (p<.05). Further, non-current (12.98%) and current non-daily marijuana users (12.34%), current daily users (22.57%) were more likely to report living with foster parents, relatives or others (p<.05). Age and race were not significantly associated with current marijuana use (Table 3-1).

All behavioral factors, including current tobacco and alcohol use, lifetime other drug use, and age of marijuana initiation, were significantly associated with current marijuana use. Compared to non-current marijuana users (19.28%), current daily (57.79%) and current non-daily users (29.51%) were more likely to report current tobacco use (p<.05). Similarly, compared to non-current marijuana users (44.77%), current daily (69.41%) and current non-daily users (76.75%) were more likely to report current alcohol use (p<.05) and compared to non-current marijuana users (25.81%), current daily (36.58%) and current non-daily users (75.17%) were more likely to report lifetime use of other illicit drugs (p<.05). Further, current daily marijuana users (12.84 years) compared to current non-daily users (14.09 years) and non-current users (14.29 years) were more likely to report early age of marijuana initiation (p<.05). Among the mental health factors, both having been diagnosed with ADD/ADHD and with symptoms of conduct disorder were significantly associated with current marijuana use. Compared

to non-current (17.55%) and current non-daily marijuana users (18.98%), current daily

marijuana users (34.09%) were more likely to report having been diagnosed with

ADD/ADHD (p<.05) and compared to non-current (19.75%) and current non-daily

marijuana users (20.63%), current daily marijuana users (41.31%) were more likely to

report symptoms of conduct disorder (p<.05). However, symptoms of anxiety and

depression were not significantly associated with current marijuana use (Table 3-1).

Results from the multinomial logistic regression indicated that age, sex, race,

family structure and self-reported school were significant predictors of current marijuana

use. With each year increase in age, youth were 24.00% more likely to be current daily

marijuana users compared to non-current users, holding all other variables constant. In

contrast, with each year increase in age, youth were 13.00% less likely to be current

non-daily marijuana users compared to non-current users, holding all other variables

constant. Compared to non-current marijuana users, current daily and current non-daily

users were more likely to be male (AORs= 2.64 and 1.29), NH Black compared to NH

White (AORs= 1.63 and 1.64), and report living with either mother or father compared to

living with both mother and father (AORs= 1.53 and 1.30) and Cs or worse grades in

school (AORs= 1.49 and 1.23). Moreover, compared to non-current marijuana users,

current daily marijuana users were 1.51 times more likely to be of other races versus

NH White and 1.54 times more likely to report living with foster parents, relatives or

others versus living with both mother and father (Table 3-2).

Both current daily and current non-daily marijuana users were 2.55 and 1.41

times more likely to endorse current tobacco use and 2.78 and 3.04 times more likely to

endorse alcohol use, respectively, compared to non-current marijuana users. Moreover,

current daily and current non-daily marijuana users were 3.99 and 1.34 times more likely to endorse lifetime other drug use, respectively, compared to non-current marijuana users. In addition, with each year increase in age of marijuana initiation, youth were 23.00% less likely to be current daily marijuana users compared to non-current users, holding all other variables constant. Having been diagnosed with ADD/ADHD was also a significant predictor of current daily marijuana use; symptoms of anxiety, conduct disorder, and depression did not significantly predict current marijuana use among youth who had initiated marijuana use (Table 3-2).

3.5 Discussion

To our knowledge, this was one of the first studies to examine individual-level factors associated with current daily marijuana use among US youth who had initiated marijuana use, using a national sample. We used a specific current daily marijuana use definition that is consistent with the national survey —NSDUH— allowing comparison across studies in the future. In this study, almost 30% of the youth reported marijuana use in their lifetime; nearly 15% reported current daily marijuana use, whereas a majority of youth reported either current non-daily marijuana use or no current use. In a review article, Hall and Degenhardt (2009) estimated that approximately 10% of those who initiate marijuana become daily users (Hall and Degenhardt, 2009). The prevalence of current daily marijuana use among our sample of youth who initiated marijuana was higher than the prevalence specified in this review article. This difference in prevalence may be because the review focused on individuals of all age groups while our study only focused on 13 to 18 year olds.

Prior research on marijuana use among youth demonstrated that older adolescents had higher likelihoods of using marijuana compared to younger

adolescents (Johnston et al., 2016). The results of this study were consistent in that among youth who had initiated marijuana use, current daily marijuana use was associated with increasing age. However, current non-daily marijuana use was inversely associated with increasing age. These findings suggest that with increasing age, youth are more likely to be at the extreme ends; either they are more likely to use marijuana daily or not reinitiate use at all once they stop. Research also indicated that compared to females, males had higher odds of marijuana use (Johnson et al., 2015; Johnston et al., 2016) and cannabis use disorder (Haberstick et al., 2014; Hasin et al., 2015) in all age groups including adolescents. Consistent with other studies, we found that among youth who initiated marijuana use, current daily and current non-daily marijuana users were more likely than non-current users to be male. Similar to findings from the study by Johnson and colleagues (2015), current daily and current non-daily marijuana users were more likely to be NH Black compared to non-current users. However, unlike their findings on Hispanics, we found no significant difference in current marijuana use among Hispanics and Asians. However, current daily marijuana users were more likely to be of other races compared to non-current marijuana users.

Additionally, studies have found living with both parents to be protective of youth marijuana use (Mandara et al., 2011; Musick et al., 2008; Swift et al., 2008; Vogel et al., 2015). Our findings were similar for youth who had initiated marijuana use; both current daily and non-daily marijuana users were more likely to live with a single parent; current daily users were also more likely to live with foster parents, relatives or others. Several investigations have demonstrated a positive relationship between poor academic performance and youth marijuana use (Homel et al., 2014; Tu et al., 2008). This

association was consistent with both current daily and non-daily marijuana users reporting lower grades in school than non-current users.

In terms of the relationship between marijuana use and the use of other substances, we found that among youth who had initiated marijuana use, more than a quarter reported current tobacco use and lifetime use of other drugs and more than half reported current alcohol use. Current use of tobacco and alcohol, and lifetime use of other drugs have been found to be the most important factors influencing the risk of current daily and current non-daily marijuana use in this study. This finding was consistent with the body of research exhibiting a positive association between the use of alcohol, tobacco, and other drugs and marijuana use (Guxens et al., 2007; Hall and Degenhardt, 2007; Korhonen et al., 2008; Nelson et al., 2015; O'Connell et al., 2011; Perkonigg et al., 2008; Tu et al., 2008) and supoorted our hypothesis. It is important to note that the likelihood of current daily marijuana use was lower than no current use with increasing age of marijuana initiation. Sagar and colleagues (2015) had also found higher levels of marijuana use among early-onset marijuana smokers compared to late-onset smokers, supporting our findings (Sagar et al., 2015).

Considering self-reported mental health conditions, current daily marijuana users were more likely to report having been diagnosed with ADD/ADHD compared to non-current marijuana users. This association was marginally significant. Although a significant proportion of youth in the study sample reported having symptoms of anxiety, conduct disorder, and depression, in contrast to our hypothesis, this study did not find any association between these mental health characteristics and current marijuana use.

This may have had to do with the nature of our questions for these mental health problems. They did not provide the detail necessary to diagnose these disorders.

These study findings must be interpreted in light of some limitations. First, N-MAPSS was a cross-sectional study that limited our ability to infer temporal associations. Second, the study did not capture patterns of use among marijuana users prior to the past 30 days. Third, the outcome variable, current marijuana use, was divided into three groups, derived from a single question with seven responses and this might have misclassified some youth. Since our focus was current daily marijuana use, we mimicked the same definition used by the NSDUH study. Categorizing use of marijuana on one or two days and 10 to 19 days in the past 30 days in the same category might have resulted in misclassification and caused bias in the study. However, we did not find significant empirical differences in between those groups. We wanted to ensure that we had sufficient sample size in each group and three groups also captured the inherent variation in the data with the least loss of information. Fourth, N-MAPSS did not assess other important individual-level factors including dosage and frequency of marijuana use and clinical diagnosis of cannabis use disorder and mental health disorders.

While there were some weaknesses, the study covered a wide range of important variables including sociodemographic, mental, and behavioral factors that have been associated with youth marijuana use. N-MAPSS is one of the few national studies that has a large and diverse sample of youth with a significant proportion of lifetime marijuana users (much higher than school or household-based studies) (SAMHSA, 2015; Johnston et al., 2016) and it provided an especially rich source for

understanding the risk and protective factors associated with marijuana use. In addition, the use of entertainment-venue intercept method of sampling enabled recruitment of youth not enrolled in and absent from school and home-schooled youth. Such youth are mostly missing in school-based national studies. Moreover, recruiting youth from social venues also might have reduced social desirability bias since parental approval was not required for participation in the study and the survey was anonymous.

3.6 Conclusion

Prevention efforts should be focused on all three marijuana-using groups – no current use, current non-daily use, and current daily use. Among prior initiators, youth with no current marijuana use should receive interventions to reduce the likelihood of reinitiating use. Youth with current non-daily marijuana use should be encouraged to reduce the frequency of use or to stop use by increasing the salience of consequences of daily use. Based on our findings, most of the individual-level factors that predicted current daily and current non-daily marijuana use did not differ (being male, NH Black, living with single parent, reporting poor academic performance, current use of tobacco and alcohol and lifetime use of other drugs); however, the odds were higher among current daily users. Moreover, there are some additional risk factors specific to current daily marijuana use. Such factors were older age, being of other races including Alaskan Native/Eskimo, American Indian, Middle Eastern, Pacific Islander, Biracial or multiracial, living with foster parents, relatives and others, early age of marijuana initiation and having been diagnosed with ADD/ADHD. Prevention efforts should target youth with these risk factors in order to reduce daily marijuana use associated with adverse consequences including the risk of cannabis use disorder, injuries, respiratory problems, psychotic disorders, and changes in brain structure and functioning. Future

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studies should investigate risk factors associated with daily marijuana use using

longitudinal studies which can help determine risks for progression from marijuana

initiation to daily marijuana use among youth.

Table 3-1. Sociodemographic, behavioral and mental health characteristics by current marijuana use among youth 13 to 18 years of age who had initiated marijuana use in N-MAPSS (n=3,100)

Characteristic	Total (n=3,100)	No current use (n=1271; 41.00%)	Current-non daily use (n=1386; 44.71%)	Current daily use (n=443, 14.29%)	p value
Sociodemographic					
Age (Mean ± SD)	16.33 ± 1.36	16.33 ± 1.37	16.21 ± 1.37	16.71 ± 1.28	0.1357
Male gender	1660 (53.55%)	617 (48.54%)	723 (52.16%)	320 (72.23%)	<.0001
Race/Ethnicity					.1484
NH White	1370 (44.19%)	565 (44.45%)	606 (43.72%)	199 (44.92%)	
NH Black	505 (16.29%)	194 (15.26%)	245 (17.68%)	66 (14.90%)	
Hispanic	739 (23.84%)	316 (24.86%)	326 (23.52%)	97 (21.90%)	
Asian/Asian American	122 (3.94%)	60 (4.72%)	45 (3.25%)	17 (3.84%)	
Others	364 (11.74%)	136 (10.70%)	164 (11.83%)	64 (14.45%)	
Family Structure					<.0001
Lived with both mother and father	1368 (44.13%)	622 (48.94%)	599 (43.22%)	147 (33.18%)	
Lived with either mother or father	1296 (41.81%)	484 (38.08%)	616 (44.44%)	196 (44.24%)	
Lived with others	436 (14.06%)	165 (12.98%)	171 (12.34%)	100 (22.57%)	
Self-reported school grades (Cs or worse)	1185 (38.23%)	415 (32.65%)	532 (38.38%)	238 (53.72%)	<.0001
Behavioral					
Current tobacco use	910 (29.35%)	245 (19.28%)	409 (29.51%)	256 (57.79%)	<.0001
Current alcohol use	1871 (60.35%)	569 (44.77%)	962 (69.41%)	340 (76.75%)	<.0001
Lifetime other drug use	1168 (37.68%)	328 (25.81%)	507 (36.58%)	333 (75.17%)	<.0001
Age of marijuana initiation (Mean ± SD)	13.99 ± 1.96	14.29 ± 1.81	14.09 ± 1.86	12.84 ± 2.25	<.0001
Mental Health					
ADD/ADHD	637 (20.55%)	223 (17.55%)	263 (18.98%)	151 (34.09%)	<.0001
Anxiety symptoms	1097 (35.39%)	449 (35.33%)	478 (34.49%)	170 (38.37%)	.3293
Conduct disorder symptoms	720 (23.23%)	251 (19.75%)	286 (20.63%)	183 (41.31%)	<.0001
Depressive symptoms	1002 (32.32%)	419 (32.97%)	429 (30.95%)	154 (34.76%)	.2676

Race/Ethnicity Others: Alaskan Native/Eskimo, American Indian, Middle Eastern, Pacific Islander, and biracial or multiracial; Lived with others: Lived with foster parents, other relatives or other; Lifetime other drug use: Lifetime use of cocaine or crack, heroin, club drugs like ecstasy, hallucinogens like LSD or mushrooms, steroids, methamphetamine or inhalants

Table 3-2. Multinomial logistic regression model of sociodemographic, behavioral and mental health characteristics for current marijuana use among youth 13 to 18 years of age who had initiated marijuana use in N-MAPSS (n=3,100)

Characteristic	Current non-daily use versus No current use AOR (95% CI)	Current daily use versus No current use AOR (95% CI)
Sociodemographic		
Age	0.87 (0.81, 0.93)	1.24 (1.11, 1.37)
Sex (Male versus female)	1.29 (1.10, 1.52)	2.64 (2.02, 3.46)
Race		
NH White	Ref	Ref
NH Black	1.64 (1.28, 2.10)	1.63 (1.10, 2.42)
Hispanic	1.02 (0.83, 1.25)	0.90 (0.65, 1.25)
Asian/ Asian American	0.78 (0.51, 1.19)	1.15 (0.60, 2.21)
Others	1.24 (0.94, 1.62)	1.51 (1.02, 2.23)
Family Structure		
Living with both mother and father	Ref	Ref
Living with either mother or father	1.30 (1.09, 1.55)	1.53 (1.15, 2.03)
Living with others	1.05 (0.81, 1.36)	1.54 (1.07, 2.22)
Self-reported school grades (Cs or worse)	1.23 (1.03, 1.47)	1.49 (1.15, 1.93)
Behavioral		
Current tobacco use	1.41 (1.15, 1.74)	2.55 (1.92, 3.38)
Current alcohol use	3.04 (2.55, 3.61)	2.78 (2.09, 3.71)
Lifetime other drug use	1.34 (1.11, 1.62)	3.99 (3.00, 5.31)
Age of marijuana initiation	1.01 (0.95, 1.06)	0.77 (0.72, 0.83)
Mental Health		
ADD/ADHD	1.06 (0.85, 1.31)	1.35 (1.01, 1.81)
Anxiety symptoms	0.96 (0.80, 1.15)	0.80 (0.61, 1.06)
Conduct disorder symptoms	0.81 (0.66, 1.00)	1.16 (0.87, 1.54)
Depressive symptoms	0.83 (0.69, 1.00)	0.89 (0.67, 1.19)

Race/Ethnicity Others: Alaskan Native/Eskimo, American Indian, Middle Eastern, Pacific Islander, and biracial or multiracial; Lived with others: Lived with foster parents, other relatives or other; Lifetime other drug use: Lifetime use of cocaine or crack, heroin, club drugs like ecstasy, hallucinogens like LSD or mushrooms, steroids, methamphetamine or inhalants
Bold: Significant association

CHAPTER 4
SEX- AND RACE/ETHNICITY- SPECIFIC INDIVIDUAL-LEVEL FACTORS
ASSOCIATED WITH CURRENT DAILY MARIJUANA USE AMONG YOUTH

4.1 Background

Marijuana use among youth poses a significant public health concern, with evidence indicating adverse developmental, neurobiological, psychosocial and behavioral consequences associated with its use (Volkow et al., 2014; Hall and Degenhardt, 2014). Recent data has shown that despite the changing of state marijuana laws in the US, the prevalence of marijuana use in the past year among 8th and 10th grade students has decreased, while that among 12th grade students had not changed in 2016 compared to 2011 (Johnston et al., 2016). Although the prevalence of use did not seem to increase among high school students in 2016, the proportion of youth who perceived regular marijuana use as risky continued to decrease among all grades and almost 40% of the high school students had tried marijuana by the end of high school (Johnston et al., 2016). Therefore, the potential for increase in marijuana use among adolescents due to decreased perception of risk from regular marijuana use still exists.

Research suggests a number of individual-level risk factors are associated with youth marijuana use. Such factors include age (Johnston et al., 2016), sex (Johnson et al., 2015), race/ethnicity (Johnson et al., 2015), family composition (Mandara et al., 2011; Musick et al., 2008; Vogel et al., 2015; Swift et al., 2008), academic performance (Homel et al., 2014; Tu et al., 2008; Horwood et al., 2010; Silins et al., 2014), use of tobacco (Guxens et al., 2007; Korhonen et al., 2008; Tu et al., 2008; Nelson, Ryzin and Dishion, 2015), use of alcohol (Guxens et al., 2007; Korhonen et al., 2008; O'Connell et al., 2011; Perkonigg et al., 2008; Tu et al., 2008), and use of other drugs (Hall and

Degenhardt, 2007; Moss et al., 2014). Moreover, early age of marijuana initiation has been associated with elevated levels of marijuana use (Griffin et al., 2010; Terry-McElrath and O'Malley, 2011; Nelson et al., 2015; Sagar et al., 2015). Further, marijuana use in youth has been associated with mental health problems such as symptoms of ADHD (King et al., 2011; Sibley et al., 2014; Kousha et al., 2012; Barkley et al., 2004), anxiety (Marmorstein et al., 2010), conduct disorder (Wymbs et al., 2012) and depression (Pacek et al., 2012; Tu et al., 2008; Wright et al., 2016).

While a majority of youth who initiate marijuana use smoke marijuana occasionally, a subset of youth use it more frequently (Adlaf and Paglia, 2003; Tu et al., 2008). According to the 2016 Monitoring the Future (MTF) survey, about 0.7% of the 8th graders, 2.5% of the 10th graders and 6.0% of the 12th graders reported daily marijuana use (defined as use on 20 or more occasions in the past 30 days). Further, the proportion of daily marijuana users is higher than that of daily cigarette users (Johnston et al., 2016). Characteristics of daily marijuana users identified from MTF were being male and white, non-college bound seniors, from broken homes and having poor school grades (Johnston, 1981). Findings from our recent research have indicated that compared to youth who endorsed no current marijuana use, those who endorsed current daily marijuana use had a higher likelihood of being older, male, Non-Hispanic (NH) Black and individuals of other races compared to NH White and having lived without both parents (Chapter 3). Moreover, youth who endorsed current daily marijuana use were also more likely to report poor academic performance, current use of tobacco and alcohol, lifetime use of other drugs, early age of marijuana initiation and

having been diagnosed with ADD/ADHD. Further research on risk factors for marijuana use in youth is still needed.

A key area of interest for research on marijuana use in youth is sex differences in risk factors for use. Prior research has found that patterns of substance use, frequency of use and use disorder are not equally distributed by sex (McCabe et al., 2007). Males are more likely to use all kinds of illicit drugs compared to females. This disproportion might explain the higher number of emergency department visits and overdose deaths among males compared to females (SAMHSA, 2014; NIDA, 2016). Similarly, like other illicit drug use, among youth marijuana use also exhibits differences by sex. The National Youth Risk Behavior Survey (YRBS) demonstrated that males were significantly more likely to report higher rates of marijuana use than females. However, this difference markedly declined from 1999 to 2013 (Johnson et al., 2015). In 2015, males had a higher prevalence of lifetime marijuana use than females among Black adolescents only; however, the prevalence of current marijuana use was higher in males than in females for all adolescents. Moreover, males were almost twice as likely as females to report daily marijuana use (Johnston, 1981) and 1.4 to 1.8 times more likely to report cannabis abuse or dependence compared to females (Haberstick et al., 2014). Further, females who reported marijuana use 10+ times in the past 30 days were more likely to have poor mental health and academic performance (Tu et al., 2008).

Other correlated factors do not differ by sex. For example, across sex, current marijuana users compared to non-users were more likely to report use of other substances, conduct problems such as fighting or carrying weapons, depressed mood and being less likely to participate in extracurricular activities (Schepis et al., 2011). In

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another study, both males and females who used marijuana 10+ times in the past 30 days were more likely to be older and to report poor economic status and frequent use of tobacco and alcohol. Given the available evidence for both differences and similarities in marijuana use risk factors by sex, it is important to determine if sex differences in other individual-level risk factors for daily marijuana use exist in youth. If so, prevention efforts need to account for such differences.

Similarly, racial differences in marijuana use in youth have been identified (Keyes et al., 2015; Keyes et al., 2017; Johnson et al., 2015; Wu et al., 2015). Throughout the 1900s in the US, White high school students had a higher likelihood of using marijuana than Blacks and Hispanics (Johnson et al., 2015). This trend has changed over time. Presently, Black students (27.1%) are at higher risk for marijuana use, followed by Hispanic (24.5%) and White students (19.9%) as reported in the 2015 YRBS (Kann et al., 2016). In addition, Asian youth tend to have the lowest prevalence of marijuana use among all races (Shih et al., 2010). Similar trends have been reported by the Monitoring the Future (MTF) study (Miech et al., 2016) with some findings indicating an early age of marijuana initiation among minority youth (Kosterman et al., 2000).

Racial/ethnic variation in individual beliefs, family or peer factors, and genetic polymorphisms may contribute to adolescent substance use of all types (Shih et al., 2010). Individual-level factors as they vary by race/ethnicity are understudied; they may modify the effect of race on substance use including daily marijuana use. However, a small group of studies has begun to indicate their importance. An increased risk of substance use among Hispanic youth has been associated with individual-level factors including low resistance self-efficacy (e.g. lack of confidence to say "no" to friends) and

their belief toward and perception of the consequences of substance use; family and school-level factors did not play a role. Keyes and colleagues (2017) used two individual-level factors (sex and parental education) to predict marijuana use among 8th, 10th and 12th grade students by race/ethnicity and found higher parental education was associated with increased current marijuana use among Blacks compared to Whites. While the patterns of marijuana use vary by race/ethnicity, other risk factors may continue to contribute to such patterns of use.

Being from a minority group may increase the likelihood of experiencing drug-related problems. For instance, Black and Hispanic youth are at higher risk of being arrested or facing severe penalties for marijuana-related offenses even though marijuana use rates are comparable to those of Whites (American Civil Liberties Union, 2013; Wu et al., 2013). A study among African American middle and high school students found that marijuana users were more likely to be male and engage in risky behaviors including getting in trouble at school and with police and to attend parties where alcohol and other drugs were available compared to non-users (Vidourek et al., 2017). Moreover, Black and Hispanic youth were at an increased risk of experiencing alcohol-related problems compared to White youth (Witbrodt et al. 2014). Further, Ellickson and Morton (1999) reported that among marijuana users, Hispanics had a higher likelihood of using cocaine and heroin compared to Whites or Blacks (Ellickson and Morton, 1999). Given this evidence suggesting their importance, there is a need to examine other individual-level factors associated with daily marijuana use by race/ethnicity. Findings from such studies may help target particular intervention elements for the minority population.

With a majority of studies being conducted among marijuana users versus non-users, it is also critical to study the variations among daily users versus non-daily users by sex and race/ethnicity. We aimed to determine if different sets of predictive variables were of utility in predicting daily marijuana use by sex and race/ethnicity. Therefore, the current analyses aimed to examine a wide variety of individual-level factors that predict current daily marijuana use among youth who had initiated marijuana use by (1) sex and (2) race/ethnicity separately. We hypothesized that across sex, increasing age, current use of tobacco and alcohol, lifetime use of other drugs, early age of initiation, and symptoms of conduct disorder and depression predict daily marijuana use. Moreover, based on the literature, we hypothesized that the predictive variables would differ by sex, with poor grades and mental health problems being more predictive among females than males. We also hypothesized that among African-American youth, males would have a higher likelihood of current daily marijuana use than females, and that conduct disorder symptoms would be more predictive of current daily marijuana use than among other races.

4.2 Methods

The study sample was obtained from the National Monitoring of Adolescent Prescription Stimulants Study (N-MAPSS), a cross-sectional study that was conducted across 10 US cities. N-MAPSS aimed to examine the prevalence of and risk factors associated with use, misuse and diversion of prescription stimulants among youth. Trained interviewers recruited 11,048 youth between the ages of 10 and 18 years using an entertainment-intercept venue method and participants completed the 20 to 30-minute long survey. The assessment included questions about sociodemographic, behavioral and mental health characteristics, and use of alcohol, tobacco, prescription

drugs, marijuana and other illicit drugs. Data was collected in four waves from fall 2008 to spring 2011. The detailed methodology of N-MAPSS has been reported elsewhere (Cottler et al., 2013; Lasopa et al., 2015; Striley et al., 2017; Wang et al., 2015). The study was approved by the Washington University Institutional Review Board in St. Louis and the University of Florida Institutional Review Board.

4.2.1 Sample

Due to low rate of self-reported marijuana use, youth between 10 and 12 years were excluded from the analyses. Out of 9,642 13 to 18 year olds, analyses only included youth who reported having ever used marijuana (n=3,155; 32.72%). Sex was dichotomized into male and female; 1,692 males and 1,463 females were included in these analyses. Categories for race/ethnicity were Non-Hispanic (NH) White, NH Black, and Hispanic; 1,382 NH Whites, 519 NH Blacks, and 745 Hispanics youth were included in these analyses. We did not study individual-level factors specific to Asian/Asian American and other race/ethnicity such as Alaskan Native/Eskimo, American Indian, Pacific Islander, Middle Eastern, and biracial and multiracial because the sample sizes were small for each and grouping them together would not be appropriate due to cultural differences. However, N-MAPSS participants reporting these races/ethnicities are included in the sex-specific models. For the sex-specific models, all race included models, 32 males and 63 females had missing data for variables of interest, therefore, we deleted those observations leaving complete data for 1,660 males and 1,400 females. Rather than imputing, we chose to delete these incomplete cases. For the race-specific models, 12 NH Whites, 14 NH Blacks and 6 Hispanics had missing data for variables of interest; therefore, we deleted those observations leaving complete data for 1,370 NH Whites, 505 NH Blacks and 739 Hispanics.

4.2.2 Measures

4.2.2.1 Current marijuana use

Current marijuana use was the main outcome variable of the study. Youth who reported having used marijuana in their lifetime were asked their first age of use of marijuana. Further, they were asked "In the last 30 days, how many days did you use marijuana?" Possible responses for this question were zero days, one to two days, three to five days, six to nine days, 10 to 19 days, 20 to 29 days and all 30 days. Since the focus of our study was current daily marijuana use, we categorized use on 20 or more days in the last 30 days as "Current daily use", use on one to 19 days in the last 30 days as "Non-daily use", and use of marijuana on zero days in the last 30 days as "No current use". Current daily marijuana use was defined as use on 20 or more days in the past 30 days which is consistent with the National Survey on Drug Use and Health (NSDUH) definition.

4.2.2.2 Individual-level factors

Potential individual-level factors selected fell into three domains: sociodemographic, behavioral and mental health factors. Sociodemographic factors included age (13 to 18 years), family structure (lived with both parents, lived with either mom or dad, and lived with others including foster parents, relatives or other), and self-reported grades in school (As or Bs and Cs or worse). Behavioral factors included current tobacco use, current alcohol use, and lifetime use of other drugs (any yes to cocaine or crack, heroin, club drugs like ecstasy, hallucinogens like LSD or mushrooms, steroids, methamphetamine or inhalants versus none). Current tobacco use was assessed using two items: (1) "Have you ever smoked a cigarette?" Participants who

responded 'yes' to this question were followed up by asking (2) "Do you still smoke cigarettes every day or some days?" Participants who reported smoking cigarettes every day or some days were classified as having current tobacco use. Similarly, current alcohol use was assessed using two items: (1) "Have you ever had a beer, a glass of wine, or any other alcoholic drink, not just a sip?" Participants who responded 'yes' to this question were followed up by asking (2) "In the last 30 days, on how many days did you drink alcohol?" Participants who reported drinking alcohol on one or more days in the past 30 days were categorized as having current alcohol use.

Finally, mental health factors selected included having been diagnosed with ADD/ADHD and symptoms of anxiety, conduct disorder, or depression. To assess having ADD/ADHD, participants were asked if a doctor had ever told them or their parents that they had Attention Deficit Disorder (ADD) or Attention Deficit Hyperactivity Disorder (ADHD). Symptoms of anxiety were assessed by asking if they had ever felt worried or stressed for six months or more. Symptoms of conduct disorder were examined using two items: (1) "Have you ever gotten into a lot of trouble at home or at school or ran away from home overnight?" (2) "Have you ever used or threatened someone with a weapon?" Participants who responded 'yes' to either of these questions were categorized as having conduct disorder symptoms. Likewise, symptoms of depression were assessed using two items: (1) "In the last 12 months, have you had two weeks or more when you lost interest in things?" (2) "In the last 12 months, have you had two weeks or more when you felt down or depressed?" Participants who responded 'yes' to any of these questions were categorized as having depressive symptoms.

4.3 Statistical Analyses

Descriptive statistics were calculated for the three dependent variable categories (current daily marijuana use, current non-daily use and no current use) stratified by sex and race/ethnicity. Chi-square tests or Fisher tests and F-tests with the significance level set at a p-value of < 0.05 compared factors by sex and race/ethnicity. Unadjusted odds ratios were calculated using bivariate logistic regression models for each individual-level factor. Multicollinearity was assessed to identify redundant variables using a regression model that included all variables by estimating Variance Inflation Factors (VIF). Since all variables included in the model showed a VIF of less than 2 indicating no multicollinearity, we included all the variables in the models. Further, multinomial logistic regression models were used to examine sex- and race/ethnicity-specific individual-level factors associated with current marijuana use status. Final adjusted odds ratios with 95% confidence intervals were reported for each category of sex and race/ethnicity. For factors that were significant in one or the other model by sex or race/ethnicity, we tested for interaction. SAS version 9.4 (SAS Institute Inc., Cary, NC, USA) was used for all analyses.

4.4 Results

4.4.1 Sex Differences

Among 1,660 males, 19.28% endorsed current daily marijuana use; 43.55% endorsed current non-daily marijuana use and 37.17% endorsed no current marijuana use. Bivariate analyses showed that among males, current marijuana use status was significantly associated with race/ethnicity, family structure, grades in school, current tobacco use, current alcohol use, lifetime other drug use, age of marijuana initiation, having been diagnosed with ADD/ADHD, and symptoms of conduct disorder (Table 4-

1). Multinomial logistic regression indicated among males, current daily marijuana users compared to non-current users were 1.21 times more likely to be older and 2.14 and 4.15 times more likely to report current tobacco use and lifetime other drug use, respectively. Current daily marijuana use was 23.00% less likely with increasing age of marijuana initiation compared to no current use. Compared to no current use, current non-daily marijuana use was 10.00% less likely with increasing age and such users were also 1.68 times more likely to be of other races (Alaskan Native/Eskimo, American Indian, Pacific Islander, Middle Eastern and biracial and multiracial) and 28.00% and 25.00% less likely to report symptoms of conduct disorder and depression, respectively. Moreover, among males, both current daily and current non-daily marijuana users compared to non-current users were more likely to be NH Black, and to report Cs or worse grades in school, and current alcohol use (Table 4-2).

Among 1,400 females, 8.54% endorsed current daily marijuana use; 46.04% endorsed current non-daily marijuana use and 45.42% endorsed no current marijuana use. Bivariate analyses showed that among females, current marijuana use status was significantly associated with the family structure, grades in school, current tobacco use, current alcohol use, lifetime other drug use, the age of marijuana initiation, having ADD/ADHD, and symptoms of conduct disorder and depression (Table 4-1). Multinomial logistic regression indicated among females, current daily marijuana users compared to non-current users were 1.83 times more likely to report having ADD/ADHD. Current daily marijuana use was 23.00% less likely with increasing age of marijuana initiation compared to no current use. Current non-daily marijuana use was 15.00% less likely with increasing age compared to no current use. Moreover, among females, both

current daily and current non-daily marijuana users compared to non-current users were more likely to report living with a single parent, and to endorse current tobacco and alcohol use and lifetime other drug use (Table 4-2).

These differences between males and females were then tested for significance. No significant interactions were reported between sex and grades in school and sex and family structure in predicting current marijuana use. The only significantly different odds ratio between the sexes was in self-reported ADD/ADHD diagnosis, with females with ADD/ADHD more at risk of current daily marijuana use than males.

4.4.2 Racial/Ethnic Differences

Among 1,370 NH Whites, 14.53% endorsed current daily marijuana use; 44.23% endorsed current non-daily marijuana use and 41.24% endorsed no current marijuana use. Bivariate analyses showed that among NH Whites, current marijuana use status was significantly associated with sex, family structure, grades in school, current tobacco use, current alcohol use, lifetime other drug use, the age of marijuana initiation, having been diagnosed with ADD/ADHD, and symptoms of conduct disorder (Table 4-3). Multinomial logistic regression indicated among NH Whites, current daily marijuana use compared to no current use was 18.00% more likely with increasing age and 24.00% less likely with increasing age of marijuana initiation. Current daily users were also 2.25 times more likely to be male, and 2.34 and 5.39 times more likely to report current tobacco use and lifetime other drug use, respectively, compared to non-current users. Current non-daily marijuana users compared to non-current users were 1.33 times more likely to report Cs or worse grades in school. Moreover, among NH Whites, both current daily and current non-daily marijuana users compared to non-current users were more likely to report current alcohol use (Table 4-5).

Among 505 NH Blacks, 13.07% endorsed current daily marijuana use; 48.51%

endorsed current non-daily marijuana use and 38.42% endorsed no current marijuana

use. Bivariate analyses showed that among NH Blacks, current marijuana use status

was significantly associated with age, sex, current tobacco use, current alcohol use, and

lifetime other drug use (Table 4-3). Multinomial logistic regression indicated among NH

Blacks, compared to no current use, current daily marijuana use was 76.00% more

likely with increasing age and such users were almost four times as likely to report

current tobacco use. Current non-daily marijuana use compared to no current use was

17.00% less likely with increasing age; such users were almost as three times more

likely to report current alcohol use and 39.00% less likely to report conduct disorder

symptoms. Moreover, among NH Blacks, both current daily and current non-daily

marijuana users compared to non-current users were more likely to be male and report

lifetime other drug use (Table 4-5).

Among 739 Hispanics, 13.13% endorsed current daily marijuana use; 44.11%

endorsed current non-daily marijuana use and 42.76% endorsed no current marijuana

use. Bivariate analyses showed that among Hispanics, current marijuana use status

was significantly associated with sex, family structure, grades in school, current tobacco

use, current alcohol use, lifetime other drug use, having been diagnosed with

ADD/ADHD, and symptoms of anxiety and conduct disorder (Table 4-4). Multinomial

logistic regression indicated among Hispanics, compared to non-current users, current

daily marijuana users were 2.50 times more likely to be male and 2.87 times more likely

to report lifetime use of other drugs. Current daily marijuana use was 26.00% less likely

with increasing age of marijuana initiation compared to no current use. Current non-

daily marijuana use compared to no current use was 19.00% less likely with increasing age; such users were also 36.00% less likely to report anxiety symptoms. Moreover, among Hispanics, both current daily and current non-daily marijuana users compared to non-current users were more likely report current tobacco and alcohol use (Table 4-6).

Considering the differences by race/ethnicity, we noted that the odds ratios in the separate models overlapped. Further testing revealed that no significant interactions were reported between race/ethnicity and age, race/ethnicity and sex, and race/ethnicity and current alcohol use in predicting current marijuana use.

4.5 Discussion

The current study investigated the individual-level factors that varied by sex and race/ethnicity in their associations with current marijuana use status among youth who had initiated marijuana use. We first investigated associations by sex. Among youth who had initiated marijuana use, males were more than twice as likely to endorse current daily marijuana use compared to females (19.28% versus 8.54%). Our finding was consistent with other studies in the literature. Johnston (1981) also found that males were almost twice as likely to endorse daily marijuana use compared to females in an older population of high school seniors (Johnston, 1981). Prior studies pointed to a need to examine daily marijuana use in sex-specific models.

Our analyses found some common individual-level factors that predicted current daily marijuana use in both sexes. For instance, current daily marijuana use was more likely among youth who were older and who reported current tobacco and alcohol use and lifetime use of other drugs among both males and females. Among both, current non-daily marijuana use was also associated with current tobacco use and lifetime other drug use. These findings were in line with previous studies which demonstrated that

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marijuana use in youth and more so, heavy marijuana use has been associated with higher grade level and use of tobacco, alcohol and other substances across both sexes (Schepis et al., 2011; Tu et al., 2008). Current non-daily marijuana use was more likely among younger youth across both sexes than no use. This might suggest that with increasing age, youth tend to make decisions to either use marijuana daily or to stop entirely. They may have tried it, and have decided how it fits or does not fit in their daily routine. Similarly, the age of marijuana initiation was a significant predictor of current daily marijuana use among both sexes. This was in keeping with available study findings that show earlier age of marijuana initiation was tied to increased use (Sagar et al., 2015).

In contrast, some individual-level factors significantly predicted current marijuana use among either males or females. Seven specific predictive factors differed in the sex-specific models predicting current non-daily use, with four predicting current daily use. However, while these factors were significantly predictive in one or the other model by sex, the range of values reported in males and females overlapped. Individual variation reported was greater than variation by sex. Further, there was no significant interaction between sex and these factors except self-reported ADD/ADHD diagnosis in predicting current marijuana use.

Turning first to the male-specific model, race/ethnicity and grades in school were significant predictors of both current daily and current non-daily marijuana use and mental health problems such as conduct disorder symptoms and depressive symptoms were significant predictors of current non-daily marijuana use among males. Tu and colleagues (2008) found a positive relationship between poor academic performance

and heavy marijuana use among females only; in contrast, findings from the current study showed this association among males only. In our sample, males who currently used marijuana, but used it less than 20 days a month, were less likely to have symptoms of either conduct disorder or depression. However, Tu and colleagues (2008) reported a significant association between poor self-reported mental health among females (Tu et al., 2008), and Schepis and colleagues (2011) reported significant associations between depressed mood and anhedonia and conduct problems across sexes (Schepis et al., 2011). This was one of the first studies to investigate differences among users by current marijuana use status; therefore, these findings should be tested in future studies.

Turning to the female-specific model, single-parent household and having an ADHD diagnosis were both significant predictive factors. While statistically different, both males and females showed wide variation in current marijuana use regardless of their family structure. Moreover, among females, having been diagnosed with ADD/ADHD was predictive of current daily marijuana use. Consistent with all sex-based differences, the confidence intervals around this variable overlapped. However, interaction between sex and self-reported ADD/ADHD diagnosis showed the effect magnitude was significant among females but not among males. This finding was concordant with findings from a previous study (Ottosen et al., 2016) that found higher odds ratio for cannabis abuse or dependence and substance use disorder among girls with ADHD compared to boys with ADHD. This suggests that although the prevalence of ADHD is higher among boys than girls, girls with ADHD are at slightly greater risk for marijuana use than boys (Disney et al., 1999; Ottosen et al., 2016).

Secondly, we investigated associations between individual-level factors and current marijuana use status among NH Whites, NH Blacks, and Hispanics separately. In our sample of youth who had initiated marijuana use, the prevalence of current daily marijuana use was comparable among each race/ethnicity. These findings contrast with those of Johnston that showed Whites as twice as likely as Blacks to report daily marijuana use (Johnston, 1981). These differences in findings may be due to (1) different age groups (We studied youth from 13 to 18 year olds and Johnston's findings were based on high school seniors); (2) our study sample only included youth who had initiated marijuana versus Johnston's sample, which included marijuana users and non-users, and (3) finally, our study findings were more recent than Johnston's and may reflect changes in marijuana use patterns over time (Johnston, 1981).

To date, individual-level factors associated with daily or regular marijuana use in youth by each race/ethnicity group have not been well-studied. The evidence pointed to the potential need to examine daily marijuana use in race-specific models. However, our findings showed that while some factors were statistically significantly different by race/ethnicity, there were no significant interactions between race/ethnicity and those significant variables indicating overlapping confidence intervals among NH White, NH Black and Hispanic estimates. Within a particular race, the variation was greater than the variation between races. Therefore, we found that individual variation was greater than racial variation. Nevertheless, here we discuss the different model findings by race/ethnicity.

Among NH Blacks, NH Whites and Hispanics, current daily marijuana users were more likely to be male and to report current use of tobacco and lifetime use of drugs.

Vidourek and colleagues (2017) found that among African American youth, marijuana users were more likely to be male and attend parties with drugs (Vidourek et al., 2017), which is consistent with our findings. Ellickson and Morton (1999) had found that use of illicit drugs was higher among Hispanics who had used marijuana compared to White youth (Ellickson and Morton, 1999); we did not find such differences by race/ethnicity. Further, among all three races/ethnicities, with each year increase in age of marijuana initiation, the odds of being a current daily marijuana user decreased by 18% to 26%. Several studies have shown that late age of marijuana initiation was protective for increased levels of marijuana use (Griffin et al., 2010; Terry-McElrath and O'Malley, 2011; Nelson et al., 2015; Sagar et al., 2015). Our findings were consistent with these studies.

Moreover, among NH Blacks and Hispanics, current non-daily marijuana use was less likely with increasing age and such users were less likely to be males compared to non-current users. This might suggest that among NH Black and Hispanics who had initiated marijuana use, older and male youth are more likely to either use marijuana daily or to completely stop using it. Current use of alcohol had significant effects on current daily and current non-daily marijuana use among NH Whites and Hispanics only; among NH Blacks, only current non-daily marijuana use was associated with current alcohol use. We also found lower odds for current non-daily marijuana use among NH Blacks and Hispanics with conduct disorder and anxiety symptoms, respectively. More studies need to be done to investigate effects of mental health problems and marijuana use status among youth who have initiated marijuana use.

Age and current use of alcohol were factors that were specific to two race/ethnicity-specific models out of three; however, there was no significant interaction by race/ethnicity and these factors in predicting current marijuana use. Also, given the few differences by race/ethnicity and the high degree of similarity in distributions of factors, these findings should be conservatively interpreted. Future studies of current marijuana use and its predictors should consider whether it is necessary to differentiate by race/ethnicity.

Some limitations of this study should be noted. First, the cross-sectional nature of this study did not allow us to infer causal associations between factors and the outcome; instead, our findings point to important associations. Second, our definition of current daily marijuana use, although in accordance with NSDUH definition, is not ideal. The study did not capture patterns of use among marijuana users prior to the past 30 days. Moreover, since the responses were categorized in certain blocks, we could not differentiate use on 18 or 19 days with use on 20 or more days which might have caused misclassification in the outcome. To ensure sufficient sample size in each outcome group, we categorized the outcomes into three groups. Third, since N-MAPSS was not designed to look at marijuana use but stimulant use, some other important individual-level variables that are associated with youth marijuana use such as socio-economic status (SES), dosage and frequency of marijuana use, and clinical criteria for cannabis use disorder were not assessed in the study. Regardless of these limitations, N-MAPSS was a national study that included a large and diverse sample of youth 10 to 18 years of age and covered numerous significant factors that are associated with youth substance use. Moreover, it utilized a unique method of sample collection,

entertainment-venue intercept that allowed recruitment of youth outside of home or school-based settings which might have reduced social desirability bias in the study.

4.6 Conclusion

To our knowledge, the current study was one of the first studies to examine sex- and race/ethnicity-specific risk factors associated with current daily marijuana use among marijuana users. The current study findings have specific implications for public health professionals for the development of prevention and intervention programs. First, individual-level risk factors associated with current daily marijuana use differ by sex and race/ethnicity; however, the distributions of factors highly overlap among youth who had initiated use. The most consistent factors that are associated with current daily marijuana use were found to be the use of other substances and early age of marijuana initiation regardless of sex and race/ethnicity. Future investigations should expand on these findings by using a larger sample size for each sex or racial group to inform prevention or intervention programs.

Table 4-1. Sociodemographic, behavioral and mental health characteristics by current daily marijuana use among male and female youth 13 to 18 years of age who had initiated marijuana use in N-MAPSS

Characteristic	Male (n=1,660; 53.55%)				Female (n=1,400; 46.45%)			
	No current use (n=617, 37.17%)	Current non-daily use (n=723, 43.55%)	Current daily use (n=320, 19.28%)	p value	No current use (n=654, 45.42%)	Current non-daily use (n=663, 46.04%)	Current daily use (n=123, 8.54%)	p value
Sociodemographics								
Age (Mean±SD)	16.34±1.37	16.26±1.36	16.76±1.31	.5320	16.31±1.37	16.16±1.37	16.59±1.22	.1339
Race/Ethnicity				.0272				.3371
NH White	275 (44.57%)	285 (39.42%)	144 (45.00%)		290 (44.34%)	321 (48.42%)	55 (44.72%)	
NH Black	92 (14.91%)	146 (20.19%)	53 (16.56%)		102 (15.60%)	99 (14.93%)	13 (10.57%)	
Hispanic	161 (26.09%)	174 (24.07%)	68 (21.25%)		155 (23.70%)	152 (22.93%)	29 (23.58%)	
Asian/Asian American	27 (4.38%)	19 (2.63%)	12 (3.75%)		33 (5.05%)	26 (3.92%)	5 (4.07%)	
Others	62 (10.05%)	99 (13.69%)	43 (13.44%)		74 (11.31%)	65 (9.80%)	21 (17.07%)	
Family Structure				<.0001				<.0001
Living with both parents	296 (47.97%)	330 (45.64%)	110 (34.38%)		326 (49.85%)	263 (40.57%)	37 (30.08%)	
Living with either mom/dad	245 (39.71%)	310 (42.88%)	140 (43.75%)		239 (36.54%)	306 (46.15%)	56 (45.53%)	
Living with others	76 (12.32%)	83 (11.48%)	70 (21.88%)		89 (13.61%)	88 (13.27%)	30 (24.39%)	
Grades in school (Cs or worse)	235 (38.09%)	315 (43.57%)	183 (57.19%)	<.0001	180 (27.52%)	217 (32.73%)	55 (44.72%)	.0005
Behavioral								
Current tobacco use	120 (19.45%)	165 (22.82%)	174 (54.38%)	<.0001	125 (19.11%)	244 (36.80%)	82 (66.67%)	<.0001
Current alcohol use	253 (41.00%)	471 (65.15%)	235 (73.44%)	<.0001	316 (48.32%)	491 (74.06%)	105(85.37%)	<.0001
Lifetime other drug use	180 (29.17%)	262 (36.24%)	243 (75.94%)	<.0001	148 (22.63%)	245 (36.95%)	90 (73.17%)	<.0001
Age of marijuana initiation (Mean±SD)	14.16±1.87	13.94±1.94	12.79±2.32	.0001	14.42±1.75	14.25±1.75	12.95±2.08	.0282
Mental Health								
ADD/ADHD	139 (22.53%)	148 (20.47%)	113 (35.31%)	<.0001	84 (12.84%)	115 (17.35%)	38 (30.89%)	<.0001
Anxiety symptoms	175 (28.36%)	189 (26.14%)	106 (33.13%)	.0695	274 (41.90%)	289 (43.59%)	64 (52.03%)	.1148
Conduct disorder symptoms	160 (25.93%)	169 (23.37%)	141 (44.06%)	<.0001	91 (13.91%)	117 (17.65%)	42 (34.15%)	<.0001
Depressive symptoms	163 (26.42%)	160 (22.13%)	90 (28.13%)	.0636	256 (39.14%)	269 (40.57%)	64 (52.03%)	.0277

Race/Ethnicity Others: Alaskan Native/Eskimo, American Indian, Middle Eastern, Pacific Islander, and biracial or multiracial; Lived with others: Lived with foster parents, other relatives or other; Lifetime other drug use: Lifetime use of cocaine or crack, heroin, club drugs like ecstasy, hallucinogens like LSD or mushrooms, steroids, methamphetamine or inhalants

Table 4-2. Multinomial logistic regression models of sociodemographic, behavioral and mental health characteristics for current marijuana use among male and female youth 13 to 18 years of age who had initiated marijuana use in N-MAPSS

Characteristic	Model 1 (Male) (n=1,660; 53.75%)		Model 2 (Female) (n=1,400; 46.45%)	
	Current non-daily use versus No current use AOR (95% CI)	Current daily use versus No current use AOR (95% CI)	Current non-daily use versus No current use AOR (95% CI)	Current daily use versus No current use AOR (95% CI)
Sociodemographics				
Age	0.90 (0.81, 0.99)	1.21 (1.06, 1.38)	0.85 (0.76, 0.94)	1.33 (1.11, 1.59)
Race/Ethnicity				
NH White	Ref	Ref	Ref	Ref
NH Black	2.04 (1.44, 2.88)	1.96 (1.21, 3.17)	1.25 (0.88, 1.79)	1.17 (0.55, 2.49)
Hispanic	1.11 (0.83, 1.49)	0.88 (0.59, 1.33)	0.90 (0.67, 1.21)	0.91 (0.53, 1.59)
Asian/Asian American	0.73 (0.38, 1.38)	1.40 (0.61, 3.20)	0.76 (0.42, 1.36)	0.80 (0.26, 2.45)
Others	1.68 (1.14, 2.46)	1.61 (0.97, 2.67)	0.85 (0.57, 1.26)	1.51 (0.78, 2.90)
Family Structure				
Living with both parents	Ref	Ref	Ref	Ref
Living with either mom/dad	1.11 (0.87, 1.42)	1.34 (0.95, 2.67)	1.54 (1.19, 1.99)	1.83 (1.11, 3.02)
Living with others	0.98 (0.67, 1.43)	1.56 (0.98, 2.48)	1.11 (0.77, 1.60)	1.51 (0.81, 2.81)
Self-reported school grades (Cs or worse)	1.30 (1.03, 1.66)	1.63 (1.18, 2.24)	1.16 (0.89, 1.50)	1.31 (0.83, 2.07)
Behavioral				
Current tobacco use	1.05 (0.78, 1.42)	2.14 (1.50, 3.05)	1.85 (1.39, 2.46)	3.02 (1.85, 4.32)
Current alcohol use	3.19 (2.50, 4.08)	2.48 (1.76, 3.50)	2.89 (2.26, 3.71)	3.87 (2.19, 6.85)
Lifetime other drug use	1.21 (0.93, 1.57)	4.15 (2.92, 5.92)	1.53 (1.15, 2.02)	3.54 (2.14, 5.87)
Age of marijuana initiation	0.97 (0.90, 1.04)	0.77 (0.71, 0.84)	1.08 (0.99, 1.17)	0.77 (0.68, 0.87)
Mental Health				
ADD/ADHD	0.91 (0.69, 1.22)	1.15 (0.81, 1.65)	1.37 (0.98, 1.90)	1.83 (1.08, 3.09)
Anxiety symptoms	0.90 (0.69, 1.18)	0.80 (0.56, 1.14)	0.99 (0.77, 1.26)	0.74 7(0.46, 1.19)
Conduct disorder symptoms	0.72 (0.55, 0.95)	1.08 (0.77, 1.52)	1.03 (0.74, 1.45)	1.39 (0.82, 2.35)
Depressive symptoms	0.75 (0.57, 0.99)	0.79 (0.55, 1.14)	0.89 (0.69, 1.14)	1.08 (0.68, 1.72)

Ref = Reference group; Race/Ethnicity Others: Alaskan Native/Eskimo, American Indian, Middle Eastern, Pacific Islander, and biracial or multiracial; Lived with others: Lived with foster parents, other relatives or other; Lifetime other drug use: Lifetime use of cocaine or crack, heroin, club drugs like ecstasy, hallucinogens like LSD or mushrooms, steroids, methamphetamine or inhalants

Table 4-3. Sociodemographic, behavioral and mental health characteristics and current daily marijuana use among NH White and NH Black youth 13 to 18 years of age who had initiated marijuana use in N-MAPSS

Characteristic	NH White (n=1,370; 44.19%)				NH Black (n=505; 16.29%)			
	No current use (n=565, 41.24%)	Current non-daily use (n=606, 44.23%)	Current daily use (n=199, 14.53%)	p value	No current use (n=194, 38.42%)	Current non-daily use (n=245, 48.51%)	Current daily use (n=66, 13.07%)	p value
Sociodemographics								
Age (Mean±SD)	16.34±1.38	16.35±1.35	16.73±1.32	.5495	16.43±1.38	16.23±1.40	17.26±0.98	.0022
Male sex	275 (48.67%)	285 (47.03%)	144 (72.36%)	<.0001	92 (47.42%)	146 (59.59%)	53 (80.30%)	<.0001
Family Structure				.0004				.0550
Living with both parents	314 (55.58%)	312 (51.59%)	87 (43.72%)		59 (30.41%)	65 (26.53%)	12 (18.18%)	
Living with either mom/dad	195 (34.51%)	229 (37.79%)	71 (35.68%)		96 (49.48%)	145 (59.18%)	37 (56.06%)	
Living with others	56 (9.91%)	65 (10.73%)	41 (20.60%)		39 (20.10%)	35 (14.29%)	17 (25.76%)	
Grades in school (Cs or worse)	150 (26.55%)	189 (31.19%)	97 (48.74%)	<.0001	69 (35.57%)	101 (41.22%)	32 (48.48%)	.1556
Behavioral								
Current tobacco use	149 (26.37%)	217 (35.81%)	133 (66.83%)	<.0001	15 (7.73%)	36 (14.69%)	24 (36.36%)	<.0001
Current alcohol use	292 (51.68%)	472 (77.89%)	161 (80.90%)	<.0001	60 (30.93%)	129 (52.65%)	41 (62.12%)	<.0001
Lifetime other drug use	162 (28.67%)	224 (36.96%)	165 (82.91%)	<.0001	21 (10.82%)	63 (25.71%)	35 (53.03%)	<.0001
Age of marijuana initiation (Mean±SD)	14.39±1.79	14.34±1.75	12.95±2.22	<.0001	14.41±1.96	13.93±2.03	13.02±2.36	.1680
Mental Health								
ADD/ADHD	138 (24.42%)	136 (22.44%)	80 (40.20%)	<.0001	16 (8.25%)	31 (12.65%)	11 (16.67%)	.1305
Anxiety symptoms	190 (33.63%)	217 (35.81%)	73 (36.68%)	.6414	63 (32.47%)	86 (35.10%)	21 (31.82%)	.7983
Conduct disorder symptoms	93 (16.46%)	95 (15.68%)	79 (39.70%)	<.0001	56 (28.87%)	64 (26.12%)	27 (40.91%)	.0634
Depressive symptoms	191 (33.81%)	206 (33.99%)	83 (41.71%)	.1024	58 (29.90%)	72 (29.39%)	15 (22.73%)	.5110

Lived with others: Lived with foster parents, other relatives or other; Lifetime other drug use: Lifetime use of cocaine or crack, heroin, club drugs like ecstasy, hallucinogens like LSD or mushrooms, steroids, methamphetamine or inhalants

Table 4-4. Sociodemographic, behavioral and mental health characteristics and current daily marijuana use among Hispanic youth 13 to 18 years of age who had initiated marijuana use in N-MAPSS

| Characteristic | Hispanic (n=739; 23.84%) | | | p value |
	No current use (n=316, 42.76%)	Current non-daily use (n=326, 44.11%)	Current daily use (n=97, 13.13%)	
Sociodemographics				
Age (Mean±SD)	16.30±1.32	16.01±1.38	16.54±1.28	.4141
Male sex	161 (50.95%)	174 (53.37%)	68 (70.10%)	.0035
Family Structure				.0165
Living with both parents	150 (47.47%)	140 (42.94%)	29 (29.90%)	
Living with either mom/dad	127 (40.19%)	148 (45.40%)	47 (48.45%)	
Living with others	39 (12.34%)	38 (11.66%)	21 (21.65%)	
Grades in school (Cs or worse)	130 (41.14%)	149 (45.71%)	60 (61.86%)	.0016
Behavioral				
Current tobacco use	46 (14.56%)	93 (28.53%)	56 (57.73%)	<.0001
Current alcohol use	140 (44.30%)	222 (68.10%)	75 (77.32%)	<.0001
Lifetime other drug use	96 (30.38%)	131 (40.18%)	74 (76.29%)	<.0001
Age of marijuana initiation (Mean±SD)	14.12±1.80	13.75±1.97	12.53±2.28	.0512
Mental Health				
ADD/ADHD	44 (13.92%)	50 (15.34%)	32 (32.99%)	<.0001
Anxiety symptoms	120 (37.97%)	97 (29.75%)	45 (46.39%)	.0051
Conduct disorder symptoms	63 (19.94%)	79 (24.23%)	48 (49.48%)	<.0001
Depressive symptoms	100 (31.65%)	92 (28.22%)	38 (39.18%)	.1191

Lived with others: Lived with foster parents, other relatives or other; Lifetime other drug use: Lifetime use of cocaine or crack, heroin, club drugs like ecstasy, hallucinogens like LSD or mushrooms, steroids, methamphetamine or inhalants

Table 4-5. Multinomial logistic regression models of sociodemographic, behavioral and mental health characteristics for current marijuana use among NH White and NH Black youth 13 to 18 years of age who had initiated marijuana use in N-MAPSS

Characteristic	Model 3 (NH White)		Model 4 (NH Black)	
	Current non-daily use versus No current use AOR (95% CI)	Current daily use versus No current use AOR (95% CI)	Current non-daily use versus No current use AOR (95% CI)	Current daily use versus No current use AOR (95% CI)
Sociodemographics				
Age	0.92 (0.83, 1.02)	1.18 (1.01, 1.38)	0.83 (0.70, 0.99)	1.76 (1.28, 2.41)
Male sex	1.03 (0.80, 1.33)	2.25 (1.48, 3.44)	1.70 (1.11, 2.60)	3.76 (1.74, 8.14)
Family Structure				
Living with both parents	Ref	Ref	Ref	Ref
Living with either mom/dad	1.20 (0.92, 1.56)	0.93 (0.61, 1.42)	1.42 (0.89, 2.26)	1.91 (0.82, 4.44)
Living with others	1.17 (0.77, 1.78)	1.32 (0.75, 2.34)	0.84 (0.45, 1.57)	1.38 (0.51, 3.77)
Self-reported school grades (Cs or worse)	1.33 (1.00,1.77)	1.46 (0.97, 2.19)	1.18 (0.77, 1.79)	1.30 (0.67, 2.50)
Behavioral				
Current tobacco use	1.23 (0.93, 1.63)	2.34 (1.55, 3.54)	1.45 (0.72, 2.93)	3.81(1.57, 9.21)
Current alcohol use	3.31 (2.53, 4.32)	2.73 (1.73, 4.32)	2.61 (1.70, 4.01)	1.91 (0.94, 3.88)
Lifetime other drug use	1.16 (0.87, 1.54)	5.39 (3.41, 8.52)	2.37 (1.32, 4.24)	4.26 (2.01, 9.03)
Age of marijuana initiation	1.01 (0.93, 1.10)	0.76 (0.68, 0.84)	0.99 (0.88, 1.11)	0.82 (0.70, 0.96)
Mental Health				
ADD/ADHD	0.85 (0.64, 1.14)	1.02 (0.67, 1.54)	1.42 (0.71, 2.83)	1.13 (0.42, 3.01)
Anxiety symptoms	1.09 (0.83, 1.43)	0.66 (0.43, 1.01)	1.23 (0.78, 1.92)	0.94 (0.45, 1.95)
Conduct disorder symptoms	0.80 (0.56, 1.14)	1.17 (0.74, 1.84)	0.61 (0.38, 0.97)	1.19 (0.58, 2.44)
Depressive symptoms	0.92 (0.70, 1.20)	1.18 (0.78, 1.78)	0.94 (0.59, 1.49)	0.53 (0.24, 1.20)

Ref = Reference group; Lived with others: Lived with foster parents, other relatives or other; Lifetime other drug use: Lifetime use of cocaine or crack, heroin, club drugs like ecstasy, hallucinogens like LSD or mushrooms, steroids, methamphetamine or inhalants

Table 4-6. Multinomial logistic regression model of sociodemographic, behavioral and mental health characteristics for current marijuana use among Hispanic youth 13 to 18 years of age who had initiated marijuana use in N-MAPSS

Characteristic	Model 5 (Hispanic)	
	Current non-daily use versus No current use AOR (95% CI)	Current daily use versus No current use AOR (95% CI)
Sociodemographics		
Age	0.81 (0.70, 0.94)	1.24 (0.99, 1.55)
Male sex	1.18 (0.83, 1.67)	2.50 (1.37, 4.57)
Family Structure		
Living with both parents	Ref	Ref
Living with either mom/dad	1.23 (0.86, 1.75)	1.80 (0.99, 3.28)
Living with others	0.97 (0.56, 1.67)	1.31 (0.59, 2.91)
Self-reported school grades (Cs or worse)	1.09 (0.78, 1.52)	1.51 (0.88, 2.60)
Behavioral		
Current tobacco use	1.95 (1.25, 3.05)	3.41 (1.86, 6.22)
Current alcohol use	2.88 (2.03, 4.11)	2.93 (1.60, 5.37)
Lifetime other drug use	1.19 (0.82, 1.73)	2.87 (1.58, 5.23)
Age of marijuana initiation	0.99 (0.89, 1.09)	0.74 (0.64, 0.84)
Mental Health		
ADD/ADHD	1.19 (0.74, 1.92)	1.85 (0.98, 3.52)
Anxiety symptoms	0.64 (0.44, 0.93)	0.89 (0.48, 1.64)
Conduct disorder symptoms	0.98 (0.64, 1.49)	1.52 (0.84, 2.76)
Depressive symptoms	0.80 (0.54, 1.17)	1.15 (0.63, 2.10)

Ref = Reference; Lived with others: Lived with foster parents, other relatives or other; Lifetime other drug use: Lifetime use of cocaine or crack, heroin, club drugs like ecstasy, hallucinogens like LSD or mushrooms, steroids, methamphetamine or inhalants

CHAPTER 5
INFLUENCE OF PARENTAL AND PEER FACTORS ON CURRENT DAILY
MARIJUANA USE AMONG US YOUTH WHO HAD INITIATED MARIJUANA USE

5.1 Background

Marijuana is legal for medical and recreational purposes in an increasing number

of states in the United States. This legalization may have led to an increased availability

of marijuana and decreased perceptions of harm from its regular use especially among

adolescents, both of which may increase the likelihood of regular marijuana use

(Hopfer, 2014; Johnston, 2016). According to the Monitoring the Future (MTF) 2016

survey, 5.4% of the 8th, 14% of the 10th and 22.5% of the 12th grade students reported

marijuana use in the past month. To develop effective prevention efforts and make

greater impact on youth marijuana use, enhancing focus on both parental and peer

factors is vital. Parents and peers are the closest social circle of individuals during

adolescence and may have important influences on an adolescent's behavior including

substance use (Kandel, 1996; Svensson, 2000). While some research indicated

significant associations between parental influence and adolescent substance use (Etz

et al., 1998; Svensson, 2000), other research found that the impact of parental influence

becomes minimal or insignificant after the consideration of peer-related factors (Peiser

and Heaven, 1996; Bahr et al., 1998).

According to the social learning theory, children and adolescents learn their

social norms through their intimate settings which include their family and friends and

they tend to hold similar attitudes and engage in similar behaviors to those in their social

settings (Akers and Sellers, 2004; Bahr et al., 2005). For example, in case of substance

use, adolescents might be exposed to substance use or may acquire positive attitudes

towards substances via parental use of the substances or parental attitudes towards

drugs. Similarly, they might have higher chances of initiating substance use if their friends take such substance either by imitation or reinforcement. However, as adolescents mature they are more likely to have more frequent and strong interactions with friends than their parents. Association with deviant friends at these stages may lead to detachment with parents and, in turn, result in delinquent behaviors including substance use.

Although prior research indicated that parental and peer influences have shown to have significant associations with substance use, these influences have been defined in different ways across studies, and different variables have been used to concretize these constructs (Hoeve et al., 2009). Parental influence has been measured as parental knowledge/monitoring where parents know where youth were after school or at night or who they are with (Dever et al., 2012; Pinchevsky et al., 2012; White et al., 2006; Yabiku et al., 2010), parental attitudes and perceptions towards drugs (Bahr et al., 2005; King et al., 2012; Musick et al., 2008), parental substance use (Korhonen et al., 2008; Miller et al., 2013; Swift et al., 2008), quality of parent-child relationship (Heavyrunner-Rioux and Hollist, 2010; Juon et al., 2011; Bahr et al., 2005; Evans et al., 2016), and parental warmth and control (Mongro-Wilson, 2007). High parental knowledge/monitoring (Dever et al., 2012; Pinchevsky et al., 2012; White et al., 2006; Yabiku et al., 2010), negative parental attitudes towards drugs (Bahr et al., 2005; King, Vidourek, & Hoffman, 2012; Musick, Seltzer, & Schwartz, 2008), and parental warmth and control (Mongro-Wilson, 2007) are found to be protective factors against youth marijuana use. Poor family management (Ali et al., 2011; Hampson et al., 2008; Mrug et al., 2010; Perkonigg et al., 2008), parental substance use (Korhonen et al., 2008; Miller

et al., 2013; Swift et al., 2008), and low quality of parent-child relationship

(Heavyrunner-Rioux & Hollist, 2010; Juon et al., 2011; Bahr et al., 2005; Evans et al.,

2016) are risk factors for youth marijuana use. To our knowledge, parental warnings

against substance use have not been investigated yet.

Similarly, constructs of peer influence that have emerged to be important in

predicting youth marijuana use are affiliation with deviant peers (Ali et al., 2011;

Hampson et al., 2008; Mrug et al., 2010; Perkonigg et al., 2008) and peer attitude

toward/disapproval of substance use (King et al., 2012; Mason et al., 2014), peer

marijuana use, (Collins et al., 2011; Walker et al., 2011; Ali et al., 2011; Pinchevsky et

al., 2012) and peer substance use (Mrug et al., 2010).

Studies show that similar to marijuana use, parental and peer influences have

also had a significant impact on tobacco and alcohol use among youth. Loke and Mak

(2013) found that among adolescents, having authoritative parents (high control, low

support) were more predictive of cigarette smoking and having conflicts with parents

was more predictive of drinking alcohol whereas having permissive parents was

protective from drinking alcohol. Moreover, having peers who smoked or peers'

invitation to smoke were both predictive of adolescent smoking and drinking (Loke and

Mak, 2013). Youth who took their first sip of alcohol at home, usually parents being the

primary source, were more likely to use substances later (Jackson et al., 2015). Review

studies also reveal the impact of parental monitoring and support, discipline, limiting the

availability of alcohol, and parental disapproval of alcohol use (Ryan et al., 2010) and

alcohol using or deviant peers (Leung et al., 2010) on youths' alcohol use. Likewise,

having peers who smoked and use of tobacco at home has been associated with

current smoking among adolescents with the former influence reducing and latter remaining static across adolescence (Villanti et al., 2011). Moreover, in our earlier chapter, we found that a substantial proportion of marijuana users reported current tobacco and alcohol use and that current tobacco and alcohol use were significant predictors of current daily marijuana use among youth who had initiated marijuana use (Chapter 3). These findings might suggest a potential mechanism by which current tobacco use and current alcohol use may mediate the association between a number of parental and peer factors and current daily marijuana use.

Moreover, a majority of studies have focused on the impact of parental and peer influences on marijuana use versus no use. To our knowledge, the relationship between parental and peer influence and marijuana use among youth who have already initiated marijuana use has been understudied. Therefore, this study aims to test the direct effects of parental and peer factors on current daily marijuana use as well as indirect effects through mediation by current tobacco and alcohol use. Individual-level predictive factors, that were found to be significantly associated with current daily marijuana use in Chapter 3 and are a part of the conceptual model, were included in this test. Generally, we hypothesized that parental influence (lack of parental warnings against substances, use of tobacco in the household, having ever gotten alcohol from a parent) or peer influence (having ever gotten alcohol from a friend and having a higher proportion of close friends who used tobacco or marijuana) would both directly and indirectly affect current daily marijuana use through current tobacco and alcohol use. We also hypothesized that effect of peer influence on current daily marijuana use would be the strongest.

5.2 Methods

Data were derived from the National Monitoring of Adolescent Prescription Stimulants Study (N-MAPSS; PI LB Cottler) which consisted of 11,048 youth 10 to 18 years of age. N-MAPSS was a cross-sectional study that investigated the prevalence of and risk factors for use, misuse, and diversion of prescription stimulants among youth. This study was conducted from 2008 to 2011 in four waves from urban, suburban and rural areas from ten cities across the US. Trained interviewers/recruiters recruited participants from entertainment venues such as shopping malls, movie theatres, parks, arcades, and recreational centers. Youth 10 to 12 years of age were given the option to be verbally guided through the survey while youth 13 to 18 years of age completed the survey on their own. The survey took 20 to 30 minutes to be completed. The study was approved by the Washington University in St. Louis Institutional Review Board and the University of Florida Institutional Review Board. Detailed methods of the study were reported elsewhere (Cottler, Striley, & Lasopa, 2013; Lasopa, Striley, & Cottler, 2015; Striley, Kelso-Chichetto, & Cottler, 2017; Wang, Cottler, & Striley, 2015).

5.2.1 Sample

Parental and peer factors were only included in Waves Three and Four of N-MAPSS (n=5,584). The sample was only restricted to 13 to 18 year olds (n=4,920) due to low rates of self-reported marijuana use among 10 to 12 year olds. Therefore, youth who had initiated marijuana use from Waves Three and Four were included in the analyses (n=1,586).

5.2.2 Measures

Outcome variable. The main outcome of interest in this study was current daily marijuana use status among youth who had previously initiated marijuana use.

Participants who reported having ever used marijuana were further asked about their age at first marijuana use and the number of days they used marijuana in the last 30 days. The responses for the latter question were categorized into zero days, one to two days, three to five days, six to nine days, 10 to 19 days, 20 to 29 days and all 30 days. For our analyses, we categorized our main outcome into two groups: No current daily marijuana use was defined as use of marijuana on "zero to 19 days in the last 30 days" and current daily marijuana use was defined as use of marijuana on "20 to 30 days in the last 30 days". We mimicked the daily marijuana use definition used by the National Survey on Drug Use and Health (NSDUH) study.

Predictors. Parental factors included in the analyses were lack of parental warnings against tobacco, alcohol and marijuana use in the past 12 months, having ever gotten alcohol from parents, and use of tobacco in the household. Lack of parental warnings against tobacco use was assessed using a question, "In the past 12 months, how often has a parent or guardian warned you not to smoke or chew tobacco?" Similarly, lack of parental warnings against alcohol use and marijuana use were assessed by asking "In the past 12 months, how often has a parent or guardian warned you not to use alcohol?" and "In the past 12 months, how often has a parent or guardian warned you not to use marijuana?", respectively. Possible responses for these parental warning questions were "never", "sometimes" and "often". We dichotomized the responses as 0 for having gotten parental warnings sometimes or often and 1 for lack of parental warnings against each substance use. Youth were also asked if they had ever gotten alcohol from their parent and the responses were dichotomized into "yes" or "no". Further, use of tobacco in the household was assessed by asking "Does anyone in your

household smoke cigarettes or cigars or use chewing tobacco, snuff or dip?" and the responses were dichotomized into "yes" or "no".

Peer factors. Peer factors included in the analyses were having ever gotten alcohol from a friend, proportion of close friends who used tobacco and proportion of close friends who used marijuana. Youth were asked if they had ever gotten alcohol from a friend (yes" or "no"). The proportion of close friends who used tobacco was calculated using two questions: (1) "How many close friends do you have?" and (2) "How many of your close friends smoke cigarettes or chew tobacco?" We calculated the proportion of close friends who used tobacco by dividing the number of close friends who smoked cigarettes or chewed tobacco by the total number of close friends youth had. Similarly, the proportion of close friends who used marijuana was calculated for each use by dividing the number of close friends, who tried marijuana, even once, by their total number of close friends.

Individual-level factors included in the analyses were age (13 to 18 years), sex (male, female), race/ethnicity (Non-Hispanic [NH] White, NH Black, Hispanic and other, which included Asian/Asian American, Alaskan Native/Eskimo, Pacific Islander, American Indian, Middle Eastern, multiracial or biracial), living with a single parent or others including relatives or foster parents, self-reported grades in school and age of marijuana initiation. Lifetime use of other drugs (any yes to cocaine or crack, heroin, club drugs like ecstasy, hallucinogens like LSD or mushrooms, steroids, methamphetamine or inhalants versus none) and having been diagnosed with ADD/ADHD, were also assessed.

Mediators. We studied two mediators: current tobacco use and current alcohol use. Current tobacco use was determined using two questions. First, youth were asked, "Have you ever smoked?" Those who responded "yes" to this question were further asked, "Do you still smoke cigarettes every day or some days? Youth who responded they currently smoked cigarettes every day or some days were categorized as current tobacco users. Likewise, current alcohol use was determined using two questions. First, youth were asked, "Have you ever had a beer, a glass of wine or any other alcoholic drink, not just a sip?" Those who responded "yes" to this question were asked "In the last 30 days, on how many days did you drink alcohol?" Responses ranged from "0" to "all 30 days". Youth who responded that they drank on one or more days were categorized as current alcohol users.

5.3 Statistical Analyses

Univariate and bivariate analyses were conducted to report the descriptive statistics of the study sample and to compare characteristics by current daily and no current daily marijuana use among youth who had initiated use. We then assessed correlations among variables that were included in the model. The conceptual model was tested using path analysis in SAS 9.4 (SAS Institute Inc., Cary, NC, USA). First, a full model with all possible paths was tested. Based upon the results of the full path model, paths with no effects were removed and overall model fit compared. The path coefficients, which are β-weights, for both direct and indirect effects of the predictor variables on current daily marijuana use, were calculated. Model fit was assessed using the comparative fit index (CFI) (Bentler, 1990), the Goodness-of-Fit Index (GFI) and Adjusted Goodness-of-Fit Index (AGFI) (Joreskog and Sorbom, 1984), and the Root Mean Square Error of Approximation (RMSEA) (Steiger, 1990). Our final parsimonious

model fit the data with a CFI value higher than 0.95, GFI and AGFI value higher than 0.90 and a RMSEA value lower than 0.05.

5.4 Results

Results in Table 5-1 showed that among a total sample of 1,573 youth who had initiated marijuana use, 14.94% endorsed current daily marijuana use. Overall, the reported mean age was 16.33 years and age of marijuana initiation was14.04 years. Of the sample, 52.70% were male; and 40.24% were NH White, 55.75% reported living with a single parent or others including foster parents, relatives or others, 35.79% reported getting Cs or worse grades in school, 34.52% reported lifetime use of other drugs, and 20.60% reported having been diagnosed with ADD/ADHD. 45.26%, 38.02%, and 33.18% reported not receiving parental warnings against tobacco, alcohol and marijuana use in the past 12 months, respectively; 40.31% reported use of tobacco in the household; and 30.26% and 73.74% reported having ever gotten alcohol from a parent and a friend, respectively. Among the sample, the proportion of close friends who used tobacco was 40.00% and the proportion of close friends who used marijuana was 82.00%; 23.27% reported current use of tobacco and 57.66% reported current use of alcohol. Bivariate analyses indicated that increasing age, male sex, reporting living with a single parent or others and poor school grades, early age of marijuana initiation, lifetime use of other drugs, self-reported ADD/ADHD, use of tobacco in the household, having ever gotten alcohol from a parent, proportion of close friends who used tobacco, proportion of close friends who used marijuana and current tobacco and alcohol use were associated with current daily marijuana use. Lack of parental warnings against tobacco, alcohol, and marijuana use had no significant impact on current daily marijuana use; however, a higher proportion of non-current daily marijuana users

reported receiving parental warnings against all three substances compared to current

daily users. Race and having ever gotten alcohol from a friend were not significant

factors for predicting current daily marijuana use.

Table 5-2 showed correlations between variables used in the model. Correlation

coefficients for all variables were less than 50.00%.

The tested model explained about 22.00% of the variance in current daily

marijuana use (Figure 5-1). Below we discussed the direct and indirect effects of the

predicting variables.

5.4.1 Direct Effects

The direct effect model examined the direct associations between all parental

and peer factors and current daily marijuana use. The standard path coefficients

demonstrated that proportion of close friends who used tobacco had a significant effect

on current daily marijuana use among youth (β=0.10); however, there were no

significant effects of parental factors or any other peer factors on current daily marijuana

use. Current tobacco use (β= 0.08) and current alcohol use (β= 0.01) had significant

direct impact on current daily marijuana use. Similarly, individual-level factors, age (β=

0.14), sex (β= -.09), age of marijuana initiation (β= -0.21), lifetime use of other drugs (β=

0.22) and having been diagnosed with ADD/ADHD (β= 0.06) all had direct effects on

current daily marijuana use (Figure 5-1).

5.4.2 Indirect Effects

The indirect effects tested the mediating effects of current tobacco use and

current alcohol use on the associations between parental and peer factors and current

daily marijuana use. Individual-level factors: age (β= 0.08), sex (β= 0.06), age of

marijuana initiation (β= -0.12), lifetime use of other drugs (β= 0.17), and self-reported

ADD/ADHD (β= 0.12); parental factors: use of tobacco in the household (β= 0.11) and having ever gotten alcohol from a parent (β= 0.05); peer factors: having ever gotten alcohol from a friend (β= 0.06) and the proportion of close friends who used tobacco (β= 0.33) together explained 28.75% of the variance in current tobacco use. The association between use of tobacco in the household and current daily marijuana use was fully mediated by current tobacco use. Similarly, the associations between having ever gotten alcohol from a parent or a friend and current daily marijuana use were fully mediated by current tobacco use. Moreover, current tobacco use partially mediated the association between proportion of close friends who used tobacco and current daily marijuana use (Figure 5-1).

The individual-level factor of age (β= 0.06), parental factor of having ever gotten alcohol from a parent (β= 0.10) and peer factors of having ever gotten alcohol from a friend (β= 0.39) and proportion of close friends who used marijuana (β= 0.09) together explained 26.82% of the variance in current alcohol use. The associations between having ever gotten alcohol from a parent or having ever gotten alcohol from a friend and current daily marijuana use were fully mediated by current alcohol use. The association between proportion of close friends who used marijuana and current daily marijuana use was completely mediated by current alcohol use (Figure 5-1).

5.5 Discussion

Current daily marijuana use has become a serious public health problem. In this study, a significant proportion of youth (14.94%) endorsed current daily marijuana use. Although a number studies have investigated relationships between parental and peer factors and marijuana use, the focus has only been on marijuana users versus non-users. To date, studies have not examined the impact of parental and peer factors on

current daily marijuana use among youth who had initiated marijuana use. The mediating roles of current tobacco use and current alcohol use in the relationship between different parental and peer factors and current daily marijuana use have been understudied. The primary focus of these analyses was to examine the direct and indirect effects of parental and peer factors on current daily marijuana use.

Based on our results in Chapter 3 and based on our conceptual model, we hypothesized that individual, parental, and peer factors would predict current daily marijuana use. Further, we hypothesized that of these three groups of variables, peer influence would most strongly predict current daily marijuana use. The total model was predictive. Several findings were worth highlighting. First, research has shown significant associations between tobacco, alcohol and marijuana use among youth (Guxens et al., 2007; Korhonen et al., 2008; Tu et al., 2008; Nelson et al., 2015; O'Connell et al., 2011; Perkonigg et al., 2008; Tu et al., 2008) and our findings on youth who had initiated marijuana use were consistent with this body of literature. Current tobacco and alcohol use together explained 9% of variance in current daily marijuana use. In our analyses, although a higher proportion of youth who had initiated marijuana use endorsed current alcohol use than current tobacco use, current tobacco use had a greater effect on current marijuana use. This shows an interesting relationship between tobacco and marijuana use; both are smoked substances and may support and reinforce use of each other. A review paper also concluded that the combined effects of nicotine and cannabis boost the rewarding effects of each, even when consumed in lower doses (Viveros et al., 2006).

Second, several studies indicated that parental control (Mongro-Wilson, 2007) and parental substance use (Korhonen et al., 2008; Miller et al., 2013; Swift et al., 2008) had a significant impact on marijuana use among youth. However, in our analyses, parental warnings against any of the substances (tobacco, alcohol or marijuana) were not significantly predictive of current daily marijuana use among youth who had already initiated marijuana use. This suggests that once youth have initiated use, their experience might contradict what their parents have said about the substance; therefore, those warnings may have been found to be unreliable or exaggerated and have had no effect on current daily marijuana use. Parental warnings against all three substances were found to be higher among non-current daily users compared to current daily users in bivariate analyses; however, the effect was insignificant in the conceptual model.

Third, other parental factors including use of tobacco by anyone in the household and having ever gotten alcohol from a parent had no significant direct effects on current daily marijuana use but had indirect effects via current tobacco and/or alcohol use. Prior research found that use of tobacco in the home was significantly associated with current smoking among youth (Villanti et al., 2011) and youth who sipped alcohol at home and had received alcohol from their parents had higher odds of later substance use (Jackson et al., 2015). As noted, use of tobacco in the household and getting alcohol from a parent were both indicative of parental permissiveness towards substance use and potentially of easy availability of tobacco and alcohol. This suggests that normalizing substance use by parents and family in the household may be more consequential to the earliest substance used and less for subsequent drugs used,

including marijuana. Moreover, these measures were directly relevant to tobacco and alcohol; therefore, they might not have had direct effects on current daily marijuana use.

Fourth, peer factors had the strongest effects on current substance use as we hypothesized. The proportion of close friends who used tobacco exerted significant direct and indirect effects via current tobacco use on current daily marijuana use. Prior studies indicated that having peers who smoked tobacco was significantly associated with marijuana use among youth (Mrug et al., 2010; Villanti et al., 2011; Loke and Mak, 2013); our finding was consistent among youth who had initiated marijuana use. Studies have also shown having alcohol-using peers or deviant peers (Leung et al., 2010) or having peers who smoked (Villanti et al., 2011; Loke and Mak, 2013) was associated with alcohol and tobacco use. In our analyses, having ever gotten alcohol from a friend had a significant indirect effect through both current tobacco and alcohol use. This suggests that accessibility of alcohol through friends may increase the likelihood of tobacco and alcohol use, which may increase the likelihood of daily marijuana use. Similarly, the proportion of close peers who used marijuana had a significant indirect effect on current daily marijuana use only via current alcohol use. In our sample, the reported proportion of peer marijuana use was high (82%), reducing variation in the sample; this lack of variation may have hampered our ability to distinguish the true influence of peer marijuana use on daily marijuana use.

Fifth, the individual-level factors such as age, sex, age of marijuana initiation, lifetime use of other drugs and self-reported ADD/ADHD had direct effects on current daily marijuana use. These findings were consistent with our earlier findings in Chapter 3.

The current study had some limitations. First, although collected in waves, the N-MAPSS data was cross-sectional in nature which limited our ability to deduce causality. Second, our outcome variable was categorized into two groups. Youth who used marijuana on zero to 19 days in the past 30 days were all grouped together and remaining youth who used marijuana on 20 or more days in the past 30 days were grouped together. This might have misclassified the outcome variable such that our estimates might have been biased. However, our definition of current daily marijuana use is consistent with one of the major national studies, NSDUH. Third, parental and peer variables that were used in these analyses were different from the measures used in previous studies making it difficult to compare findings. Fourth, peer tobacco and marijuana responses were self-reported by youth and were not verified by the peers themselves which might have introduced bias. Moreover, since N-MAPSS was designed to study risk factors for prescription stimulant misuse among youth, some important parental factors such as parental monitoring, parental attitudes towards drugs, and parent-child relationship and peer factors such as peer attitude toward/disapproval of substance use which were found to be associated with marijuana use among youth in other studies, were not assessed.

Even though there were some limitations, the current study adds to the literature on youth marijuana use in several ways. First, N-MAPSS is one of the few national studies with a large and diverse sample of adolescents. It provided a rich source for understanding individual- and relationship-level risk factors associated with youth marijuana use. Moreover, N-MAPSS utilized an entertainment-venue intercept method for recruitment of youth which enabled it to enroll youth who were absent from school or

home-schooled youth. School-based national studies are more likely to miss these youth. The N-MAPSS sampling technique might have also reduced social desirability bias because youth did not need parental consent to answer questions. When youth answer questions they know their parents or teacher might ask about later, they might be more inclined to prevariate. Approval of parents or teachers was not required for youth who chose to complete the interview.

5.6 Conclusion

Parental and peer factors are important predictors of current daily marijuana use among youth who had initiated marijuana use. Our findings suggest that parental factors were not directly associated with current daily marijuana use; however, parental factors such as the use of tobacco in the household and receiving alcohol from a parent had indirect effects on current daily marijuana use through mediation by current tobacco and/or alcohol use. Among the peer factors, the proportion of close peers who used tobacco was directly associated with current daily marijuana use. Other peer factors, including receiving alcohol from a friend and proportion of close peers who used marijuana or tobacco, had indirect effects on current daily marijuana use through mediation by current tobacco and/or alcohol use.

Based on these findings, prevention programs should target aspects of the home environment. Parental substance use and accessibility through parents are highly correlated with daily marijuana use among youth. As suggested by social learning theory, parental substance use and accessibility of substance from parents as well as from peers, can have significant impact on youth substance use. Youth may hold similar attitudes and engage in similar behaviors as their parents and/or peers via imitation or reinforcement. While parental warnings against substance use may not have an effect

on daily marijuana use among those who have already initiated, parental monitoring of their childrens' social network is important. Having close peers who use substances is significantly predictive of daily marijuana use. Along with parental and peer factors, individual-level factors including older age, being male, having an early age of marijuana initiation, using other drugs, and poor academic performance are all important risk factors associated with youth marijuana use. Each presents a unique target for intervention and on timing. To further our understanding of the importance of these factors, future research should use longitudinal studies to investigate the role of parental and peer-related variables on daily marijuana use among youth who have already initiated marijuana use.

Table 5-1. Characteristics of youth 13 to 18 years of age who had initiated marijuana use overall and by current daily and current non-daily marijuana use in N-MAPSS Waves Three and Four (n=1,573)
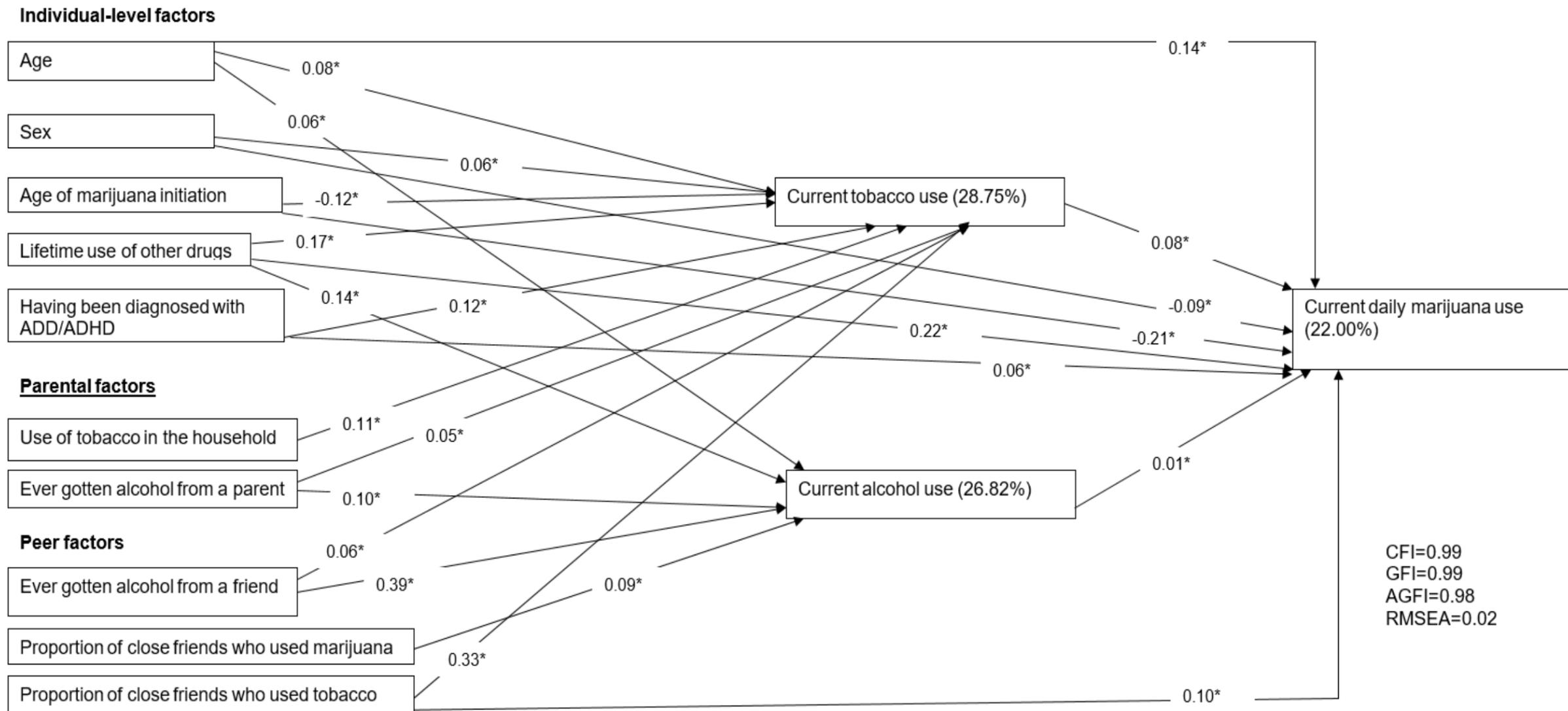
Characteristics	Total (n=1,573)	No current daily use (n=1338; 85.06%)	Current daily use (n=235, 14.94%)	P value
Sociodemographics				
Age (Mean ± SD)	16.33 ± 1.39	16.28 ± 1.39	16.59 ± 1.33	.0017
Male sex	829 (52.70%)	665 (49.70%)	164 (69.79%)	<.0001
Race/Ethnicity				.7610
NH White	633 (40.24%)	542 (40.51%)	91 (38.72%)	
NH Black	279 (17.74%)	241 (18.01%)	38 (16.17%)	
Hispanic	386 (24.54%)	324 (24.22%)	62 (26.38%)	
Others	275 (17.48%)	231 (17.26%)	44 (18.72%)	
Lived with a single parent or others	877 (55.75%)	719 (53.74%)	158 (67.23%)	0.0001
Grades in School (Cs or worse)	563 (35.79%)	438 (32.81%)	124 (52.77%)	<.0001
Age of marijuana initiation (Mean ± SD)	14.04 ± 2.00	14.27 ± 1.83	12.74 ± 2.36	<.0001
Lifetime use of other drugs	543 (34.52%)	367 (27.43%)	176 (74.89%)	<.0001
ADD/ADHD	324 (20.60%)	241(18.01%)	83 (35.32%)	<.0001
Parental factors				
Lack of parental warnings against tobacco use	712 (45.26%)	595 (44.47%)	117 (49.79%)	.1309
Lack of parental warnings against alcohol use	598 (38.02%)	496 (37.07%)	102 (43.40%)	.0651
Lack of parental warnings against marijuana use	522 (33.18%)	446 (33.33%)	76 (32.34%)	.7656
Parental warnings against all three substances	588 (37.38%)	509 (38.04%)	79 (33.62%)	.0099
Use of tobacco in the household	634 (40.31%)	520 (38.86%)	114 (48.51%)	.0054
Ever got alcohol from parent	476 (30.26%)	389 (29.07%)	87 (37.02%)	.0139
Peer factors				
Ever got alcohol from friend	1160 (73.74%)	976 (72.94%)	184 (78.30%)	.0854
Proportion of close friends who used tobacco	0.40 ± 0.38	0.36 ± 0.37	0.64 ± 0.38	<.0001
Proportion of close friends who used marijuana	0.82 ± 0.28	0.80 ± 0.29	0.92 ± 0.22	<.0001
Current tobacco use	366 (23.27%)	248 (18.54%)	118 (50.21%)	<.0001
Current alcohol use	907 (57.66%)	734 (54.86%)	173 (73.62%)	<.0001

Race/Ethnicity Others: Asian/Asian American, Alaskan Native/Eskimo, American Indian, Middle Eastern, Pacific Islander, and biracial or multiracial; Lifetime other drug use: Lifetime use of cocaine or crack, heroin, club drugs like ecstasy, hallucinogens like LSD or mushrooms, steroids, methamphetamine or inhalants

Table 5-2. Correlation coefficients between variables included in the model

Characteristics	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Age	--	-.04	.01	-.02	.41***	0.05	-.00	.08*	.07*	.16***	-.04	.07	.15***	.07*	.08**	.07*	.14***	.08*
2. Sex		--	-.00	-.16***	.12***	-.09**	-.07*	.02	.03	.05	.04	.02	.12***	-.01	-.00	.03	.05*	-.14***
3. Living with either a single parent or others			--	.12***	-.11***	07*	.05*	.05*	.04	.01	.08*	-.01	-.-6*	.05*	.08*	.05*	-.03	.10**
4. Grades in School (Cs or worse)				--	-.17***	.13***	.12***	.02	.04	.00	.04	-.04	-.02	.15***	.09**	.12***	-.00	.15***
5. Age of marijuana initiation					--	-.27***	-.15***	.01	-.01	.03	-.10***	-.05*	.02	-.21***	-.12***	-.22***	-.03	-.27***
6. Lifetime use of other drugs						--	.11***	.01	.03	-.02	.06*	.12***	.22***	.27***	.18***	.32***	.26***	.36***
7. Having been diagnosed with ADD/ADHD							--	-.00	.04	.00	.02	.08*	-.02	.15***	.10***	.20***	.03	.15***
8. Lack of parental warnings against tobacco use								--	.36***	.37***	-.07*	.02	-.02	.01	-.01	-.01	-.06*	0.04
9. Lack of parental warnings against alcohol use									--	.40***	.03	.14***	.04	.03	.02	.05	.03	.05
10. Lack of parental warnings against marijuana use										--	.02	.04	.01	-.00	-.01	.04	-.01	-.01
11. Use of tobacco in the household											--	.07*	.07*	.17***	.06*	.19***	.06*	.07*
12. Ever gotten alcohol from a parent												--	.21***	.09**	.05*	.14***	.21***	.06*
13. Ever gotten alcohol from a friend													--	.17***	.20***	.18***	.47***	.04
14. Proportion of close friends who used tobacco														--	.36***	.45***	.19***	.27***
15. Proportion of close friends who used marijuana															--	.15***	.21***	.15***
16. Current tobacco use																--	.27***	.27***
17. Current alcohol use																	--	.14***
18. Current daily marijuana use																		--

P

* p<.05; ** p<.001; *** p<.0001

Individual-level factors

Age

Sex

Age of marijuana initiation

Lifetime use of other drugs

Having been diagnosed with ADD/ADHD

Parental factors

Use of tobacco in the household

Ever gotten alcohol from a parent

Peer factors

Ever gotten alcohol from a friend

Proportion of close friends who used marijuana

Proportion of close friends who used tobacco

Current tobacco use (28.75%)

Current alcohol use (26.82%)

Current daily marijuana use (22.00%)

0.14*
0.08*
0.06*
0.06*
-0.12*
0.17*
0.14*
0.12*
0.08*
-0.09*
0.22*
-0.21*
0.06*
0.11*
0.05*
0.10*
0.01*
0.06*
0.39*
0.09*
0.33*
0.10*

CFI=0.99
GFI=0.99
AGFI=0.98
RMSEA=0.02

Note: Only significant paths were included in the figure, standardized coefficients were reported; *= p <0.05

Figure 5-1. Direct and indirect effects of individual, parental and peer factors on current daily marijuana use among youth 13 to 18 years of age who had initiated marijuana use (n=1,573)

CHAPTER 6
CONCLUSION

Marijuana is the most commonly used illicit drug by youth in the United States. About 6.5% of 12 to 17 year olds reported marijuana use in the past 30 days (SAMHSA, 2017). Among middle and high school students, the prevalence estimates of past 30-day marijuana use were 5.4%, 14%, and 22.5% among 8th, 10th and 12th grade students indicating an increase by grade level (Johnston et al., 2016). Research indicated that the prevalence has decreased among 8th and 10th grade students and remained static among 12th grade students in 2016 compared to 2011. However, with the legalization of marijuana for medical purposes and adult recreational use in a number of states, views and attitudes towards marijuana among youth may be changing. According to the Monitoring the Future 2016 survey, almost a half of high school seniors used marijuana once in their lifetime and there was a significant decrease in the proportion of youth who perceived regular marijuana use as detrimental (Johnston et al., 2016).

Marijuana use is important to study because it can cause significant adverse developmental, neurobiological, psychosocial and behavioral consequences for youth (Volkow et al., 2014; Hall and Degenhardt, 2014). Current evidence has shown consistent adverse effects of regular marijuana use during adolescence. In most epidemiological studies, regular marijuana use is measured as daily or almost daily use (Hall & Degenhardt, 2009). It has been reported that 10% of individuals who ever used marijuana become daily marijuana users (Hall & Degenhardt, 2014). Several studies have revealed a number of risk and protective factors associated with youth marijuana use; much less research has been done on the risks for daily marijuana use. Since daily marijuana use among youth is of serious concern, it is urgent to address the problem of

current daily marijuana use among youth who have already initiated use and the ways in which daily users are different from non-daily users. Compounding the problem of a lack of research is the lack of consistency in definitions of daily marijuana use across studies. To make the findings comparable, we defined daily marijuana use as the use of marijuana on 20 or more days in the past 30 days, mirroring the National Survey on Drug Use and Health (NSDUH). To develop strategic prevention programs, understanding the factors associated with daily marijuana use among youth is vital. Therefore, this dissertation intended to characterize the factors associated with current daily marijuana use among youth who had initiated marijuana use. First, individual-level factors that predict current daily marijuana use among youth were investigated using multinomial logistic regression. Second, the characteristics of youth who endorsed current daily marijuana use were examined by sex and race/ethnicity. Lastly, the direct and indirect effects of parental and peer factors on current daily marijuana use were studied using path analysis. All analyses used data from the National Monitoring of Adolescent Prescription Stimulants Study (N-MAPSS).

6.1 Main Findings

Results from the first analysis (Chapter 3) showed that 14.29% of youth who had initiated marijuana use endorsed current daily marijuana use. Overall, our sample showed that youth who endorsed current daily marijuana use reported high rates of poor academic performance, current tobacco and alcohol use, lifetime use of drugs and mental health problems including ADD/ADHD and symptoms of conduct disorder. Multinomial logistic regression indicated that behavioral factors such as current tobacco use, current alcohol use, lifetime drug use and early age of marijuana initiation had strong associations with current daily marijuana use. Current daily marijuana users were

also more likely to be older, male and NH Black or individual of other races (Alaskan Native/Eskimo, Pacific Islander, American Indian, Middle Eastern, multiracial or biracial) compared to NH White, and were more likely to report living with a single parent or with foster parents, relatives or others and getting Cs or worse grades in school. Having been diagnosed with ADD/ADHD also independently increased the likelihood of current daily marijuana use. Mental health problems including symptoms of anxiety, conduct disorder, and depression, which were hypothesized to be significant predictors of current daily marijuana use, were not. Our findings are unique because our study sample consisted of only those youth who had initiated marijuana use and comparison was done between current daily marijuana use and no current use. However, we found similar risk factors for daily marijuana use in multiple studies that compared marijuana use to no use. Therefore, prevention efforts should address daily marijuana use among youth accounting for these identified risk factors. Targeting polysubstance users and delaying marijuana initiation may reduce the risk of becoming a daily marijuana user and the adverse consequences associated with daily marijuana use. Moreover, older youth should get booster intervention for subsequent decreases in daily marijuana use.

In our second set of analyses, we stratified youth who had initiated marijuana use by sex and race/ethnicity to describe the characteristics of current daily marijuana users separately. This enabled us to examine factors associated with current daily marijuana use unique to a particular sex and to a specific race/ethnicity. This specification might have provided useful information to help design targeted prevention efforts. We found that the prevalences of current daily marijuana use among males and females were 19.25% and 8.54%, respectively, in our sample. Multinomial logistic regression

indicated that current daily marijuana use was associated with increasing age, current tobacco and alcohol use, lifetime other drug use and early age of marijuana initiation across both sexes. These findings were in line with our hypotheses. Moreover, among males, being NH Black and reporting Cs or worse grades in school were significant predictors of current daily marijuana use; among females, living with a single parent and having been diagnosed with ADD/ADHD were significant predictors of current daily marijuana use. However, we found that the effect magnitudes of these factors showed very similar and overlapping ranges between the sexes, except for self-reported ADD/ADHD diagnosis. Further testing revealed the model differences were not significant except that current daily marijuana users were more likely to report having been diagnosed with ADD/ADHD in the female-only model. This effect was not significant among males. Findings from these analyses show that it may not be important to distinguish risk factors between the sexes except to target women with ADD/ADHD who may be at an additional risk for daily marijuana use.

Next, we studied the influence of individual-level factors on current daily marijuana use among NH Whites, NH Blacks, and Hispanics. We found that the prevalence estimates of current daily marijuana use among NH Whites, NH Blacks, and Hispanics were comparable. Multinomial logistic regression indicated that current daily marijuana use was associated with being male, reporting current tobacco use and lifetime other drug use and early age of marijuana initiation among NH Whites, NH Blacks, and Hispanics. These findings were consistent with our hypotheses, except conduct disorder symptoms were insignificant. Current daily marijuana use was associated with current alcohol use among NH Whites, and Hispanics and with

increasing age among NH Whites and NH Blacks only. When tested for interaction between race/ethnicity and factors that were significant in either one or the other model (age and current alcohol use), we did not find any significant differences between race-specific models. From these findings, it follows that it may not be important to distinguish individual-level risk factors between the races. However, we did not measure other factors such as culture, perception and attitudes towards drugs which might be important in race/ethnicity-specific models. Future investigations should expand on these findings by using a larger sample for each racial group to better inform prevention or intervention programs.

Along with individual-level factors, there have also been reports of parental and peer factors that predicted marijuana use among youth. Thus, we aimed to examine direct and indirect effects (via current tobacco and alcohol use) on current daily marijuana use among youth who had already initiated marijuana use. No non-users were included. Using path analysis, we found that individual-level factors of increasing age, male sex, early age of marijuana initiation, lifetime use of illicit drugs and having been diagnosed with ADD/ADHD significantly predicted current daily marijuana use. Among the parental and peer factors, only the proportion of close friends who used tobacco had a direct effect on current daily marijuana use. A parental factor, use of tobacco in the household, increased the likelihood of current daily marijuana use by the mediating the effect of current tobacco use. Another parental factor, having ever gotten alcohol from a parent, increased the likelihood of current daily marijuana use by the mediating effects of both current tobacco use and current alcohol use. However, parental warnings against tobacco, alcohol or marijuana use did not have significant any

effect on current daily marijuana use. Among peer factors, both current tobacco and/or current alcohol use mediated the relationship between ever getting alcohol from a friend and current daily marijuana use whereas only current alcohol use mediated the relationship between proportion of close friends who used marijuana and current daily marijuana use. Moreover, the proportion of close friends who used tobacco also increased the likelihood of current daily marijuana use by the mediating effect of current tobacco use. Most associations between parental and peer factors and current daily marijuana use were fully or partially mediated by current tobacco and current alcohol use. Most who used marijuana daily also endorsed current alcohol and tobacco use. Since these peer and parental factors affected marijuana use through alcohol and tobacco use, and since most of the youth who used marijuana used one or two of the other drugs, use of any or all are important to prevention efforts. To prevent current daily marijuana use, efforts should target current tobacco and alcohol use and the factors that directly influence the use of these substances, including parental and peer factors. Prevention programs should focus on parental and peer substance use as well as accessibility of substances from parents and peers to decrease the rates of daily marijuana use among youth. Trainings on changing parental and peer behavior, family management practices (communication, engagement, and supportiveness) and increased parental monitoring of their children's social network may be effective in reducing daily marijuana use among youth. Moreover, teaching drug-resistance skills to youth so that they can refuse substance offers made by parents or peers show promise.

Overall, this dissertation has provided tests of the influence of individual- and relationship-level factors on current daily marijuana use by identifying these factors

among teens who had initiated marijuana use. As noted, sociodemographic factors such as male sex and being older and behavioral factors such as current use of tobacco and alcohol, use of other drugs and early age of marijuana initiation were important factors that predicted current daily marijuana use. Moreover, relationship-level factors such as tobacco use in the household, acquiring alcohol from parents or friends, and having many close peers who use tobacco or marijuana were also found to predict current daily marijuana use. It has also provided evidence for the development of preventive efforts to address current daily marijuana use. Since peer factors had stronger effects than parental factors on current substance use, parents should focus on monitoring their childrens' social networks, intervening to limit the influence of substance-using peers. This will likely be more effective than warning them against the use of substances.

6.2 Strengths and Limitations

This dissertation presents one of the first studies to investigate factors associated with current daily marijuana use among teens who had already initiated marijuana use. It utilized a national cross-sectional study, the National Monitoring of Adolescent Prescription Stimulants Study (N-MAPSS) that consisted of a large and diverse sample of youth and a wide range of factors associated with substance use. N-MAPSS used an entertainment-venue intercept method, recruiting youth from shopping malls, parks, recreational centers, movie theatres, arcades, libraries and skate parks. This method enabled the study team to capture youth away from home or school-based settings. This may have reduced social desirability bias in our findings.

Even though this dissertation had several strengths, some important limitations should be noted. First, N-MAPSS data were cross-sectional in nature; therefore, this limits the ability to infer causality between the tested risk factors and outcome variables.

Second, data were measured through self-report. However, self-reported measures of substance use have been found to be highly reliable, about 95% as reliable as biochemical assessments in one study (Hjorthoj et al., 2012). Third, although the definition of current daily marijuana use was consistent with the NSDUH study, this definition is less than ideal. Youth who initiated marijuana use were grouped into three categories in the first two studies and into two groups in the third study; we may have misclassified the outcome variable in some cases. However, use of this definition will allow comparison between these findings and the NSDUH. Fourth, the methodology of the study may also have limited findings on parental and peer influence that other methods might have captured. Social network analysis directly gathers information from peers (Bauman and Ennett, 1996; Ennett et al., 2006); this method might have provided a more reliable measure of peer influence. Peer and parental direct reports would also be more likely to capture influence (Griffin et al., 2000; Martins et al, 2008). Lastly, measures of frequency, quantity, cannabis use disorder, parental substance use, parental and peer attitudes towards marijuana, parental monitoring, and quality of the parent-child relationship were not assessed, all of which might have been important factors for predicting youth marijuana use in our sample.

6.3 Future Research

With an increasing number of states in the US changing marijuana laws to allow medical and/or adult recreational use in recent years, marijuana use continues to rise. We found a number of factors that influence current daily marijuana use among youth who had initiated marijuana use. Future research should assess the associations between individual- and relationship-level factors and current daily marijuana use among youth marijuana initiators using other annual national studies. Findings can then

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be compared. Moreover, longitudinal studies should assess the direction of possible pathways linking the factors and current daily marijuana use to assess causation. Our findings showed significant associations between current daily marijuana use and sociodemographic factors including age and sex and behavioral factors including current use of tobacco and alcohol, use of other drugs and age of marijuana initiation. Mental health problems did not significantly predict current daily marijuana use, except among female youth. Having been diagnosed with ADD/ADHD was associated with current daily marijuana use among girls. More studies should be conducted to study the dynamics and directionality of mental health problems and current marijuana use status. Many studies have found directions both from and to mental health problems from substance use. A number of small studies are using cannabinoids to treat mental distress and specifically, ADHD (Cooper et al., 2017). Parental and peer factors that influence current daily marijuana use should also be examined using longitudinal studies.

This dissertation has not considered the consequences of daily use, but rather risk factors for daily use. Intervention programs should consider risk factors in order to develop prevention strategies against current daily marijuana use and its consequences. The intervention programs that have been implemented targeting identified risk factors should be subject to further rigorous evaluation and replication. This remains a highly relevant and active area of research. Finally, it will be important to extend this research to explore the health outcomes and other negative consequences of daily marijuana use. This remains a significant public health challenge.

NATIONAL MONITORING OF ADOLESCENT PRESCRIPTION STIMULANTS STUDY

Table A-1. N-MAPSS questions used in analyses

Characteristics	Questions in N-MAPSS	Responses
Age	Ques002. How old are you?	Discrete Ranges from 10 to 18
Sex	Ques001. What is your gender?	Dichotomous 1. Male 2. Female
Race/ethnicity	Ques003. Are you Hispanic or Latino? Ques004. Which racial or ethnic group best describes you?	Dichotomous 1. No 2. Yes Categorical 1. Alaskan Native/Eskimo 2. American Indian 3. Asian or Asian-American 4. Black or African-American 5. Middle Eastern 6. Pacific Islander 7. White, Euro-American, Caucasian 8. Biracial or Multiracial 9. Other
Family structure	Ques006. In the last 7 days, who have you lived with?	Categorical 1. Lived with mom and dad at the same time 2. Lived with mom and dad, but not at the same time 3. Lived with mom only 4. Lived with dad only 5. Lived with foster parents 6. Lived with other relatives 7. Lived with others
Grades in school	Ques013. Which of the following best describes your grades?	Categorical 1. Mostly A's 2. Mostly B's 3. Mostly C's 4. Mostly D's 5. Mostly F's 6. No grade or Don't know
Self-reported general health	Ques025. Is your general health excellent, good, fair, or poor?	Categorical 1. Excellent 2. Good 3. Fair 4. Poor
Current tobacco use	Ques120. Have you ever smoked? Ques122. Do you still smoke cigarettes every day or some days?	Dichotomous 1. No 2. Yes Categorical 1. No 2. Yes, I currently smoke cigarettes everyday 3. Yes, I currently smoke cigarettes some days.

Table A-1. Continued

Characteristics	Questions in N-MAPSS	Responses
Current alcohol use	Ques124. Have you ever had a beer, a glass of wine, or any other alcoholic drink, not just a sip?	Dichotomous 1. No 2. Yes
	Ques127. In the last 30 days, on how many days did you drink alcohol?	Categorical 1. 0 2. 1 or 2 3.3 to 5 days 4. 6 to 9 days 5. 10 to 19 days 6. 20 to 29 days 7. All 30 days
Current marijuana use	Ques114. Have you ever used marijuana?	Dichotomous 1. No 2. Yes Categorical
	Ques116. In the last 30 days, how many days did you use marijuana?	1. 0 2. 1 or 2 3.3 to 5 days 4. 6 to 9 days 5. 10 to 19 days 6. 20 to 29 days 7. All 30 days
Age of marijuana initiation	Ques115. At what age did you first use marijuana?	Continuous
Lifetime other drug use	Ques117. Have you ever tried… a. Cocaine or crack b. Heroin c. Club drugs like ecstasy d. Hallucinogens like LSD or mushrooms e. Anabolic steroids f. Cough syrup/purple drank to get high g. Methamphetamine h. Inhalants like gasoline or paint?	Dichotomous for each drug 1. No 2. Yes
ADD/ADHD	Ques030. Has a doctor ever told you or your parents that you have Attention Deficit Disorder (ADD) or Attention Deficit Hyperactivity Disorder (ADHD)?	Categorical 1. No 5. Yes 8. I don't know
Anxiety symptoms	Ques036. Have you ever felt worried or stressed for 6 months or more?	Dichotomous 1. No 2. Yes
Conduct Disorder symptoms	Ques031. Have you ever gotten into a lot of trouble at home or at school or ran away from home overnight?	Dichotomous 1. No 2. Yes
	Ques032. Have you ever used or threatened someone with a weapon?	Dichotomous 1. No 2. Yes
Depressive symptoms	Ques035a. In the last 12 months, have you had 2 weeks or more when you lost interest in things?	Dichotomous 1. No 2. Yes
	Ques035b. In the last 12 months, have you had 2 weeks or more when you felt down or depressed?	Dichotomous 1. No 2. Yes

Table A-1. Continued

Characteristics	Questions in N-MAPSS	Responses
Parental Influence	Ques118a. In the past 12 months, how often has a parent or guardian warned you not to use marijuana?	Categorical 1. Never 2. Sometime 3. Often
	Ques123a. Does anyone in your household smoke cigarettes or cigars or used chewing tobacco, snuff, or dip?	Dichotomous 1. No 2. Yes
	Ques123b. In the past 12 months, how often has a parent or guardian warned you not to smoke or chew tobacco?	Categorical 1. Never 2. Sometime 3. Often
	Ques129. Have you ever gotten alcohol from your parent?	Dichotomous 1. No 2. Yes
	Ques129h. In the past 12 months, how often has a parent or guardian warned you not to use alcohol?	Categorical 1. Never 2. Sometime 3. Often
Peer influence	Ques129e. Have you ever gotten alcohol from your friend?	Dichotomous 1. No 2. Yes
	Ques134. How many close friends do you have?	Discrete Ranges from 0 to more than 10
	Ques135a. How many of your close friends have tried marijuana, even once?	Discrete Ranges from 0 to more than 10
	Ques135b. How many of your close friends smoke cigarettes or chew tobacco?	Discrete Ranges from 0 to more than 10

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BIOGRAPHICAL SKETCH

Shivani R. Khan received her Bachelor of Science in biology from Salem College in Winston-Salem, North Carolina in 2010. After graduation, she worked as a Research Assistant at the Department of Virology (Channing Laboratory) at Brigham and Women's Hospital in Boston, Massachusetts. She joined the Doctor of Philosophy (Ph.D.) program in epidemiology in the College of Medicine and College of Public Health and Health Professions at the University of Florida (UF) in August 2013. She was trained under the mentorship of Catherine W. Striley, Ph.D., M.S.W., M.P.E., an associate professor, who directs the Master of Science in Epidemiology and the Certificate in Psychiatric Epidemiology programs. She received her Ph.D. in epidemiology from the University of Florida in the fall of 2017.

Shivani's research interest lies in substance abuse and mental health problems among youth. Her research focus for dissertation was on predictors of daily marijuana use among US youth. As a Graduate Research Assistant in the Department of Epidemiology at UF, she has gained extensive qualitative and quantitative research experience working on multiple health projects. She was a part of the team that developed widely used assessments, the Substance Abuse Module (SAM-5) and the Diagnostic Interview Schedule (DIS-5). She worked on the Post Earthquake Needs Assessment in Nepal, Haiti Health Study, ASSIST study, and Tics and Tourette Study. She also worked as a Student Assistant at the Department of Health Services Research, Management & Policy at UF. In that capacity, she conducted data analyses using 2014 Florida Behavioral Risk Factor Surveillance System (FBRFSS) and 2015 People with Disability (PWD) survey and prepared the Disability Data Report describing demographic characteristics, health behaviors, health care utilization, chronic illness, and barriers to

care among Floridian older adults with and without disabilities. She worked as a Teaching Assistant for three courses in the Department of Epidemiology at UF.

Shivani has authored and co-authored a number of peer-reviewed journal articles and a book chapter in the field of substance use and presented her research in internal as well as external conferences. In addition, she has received numerous awards including travel grants from (1) NIDA Women and Sex/Gender Differences Junior Investigator, (2) 10th Annual International Women's and Children's Health and Gender Group Conference (InWomen's Conference), (3) Center for Addiction Research & Education, (4) the National Center for Responsible Gaming (NCRG), (4) the Graduate Student Council at UF, (5) Office of Research at UF, and (6) Chair's travel awards. Further, she received scholarships from Summer Institute in Infectious Diseases, University of Washington and University of Florida International Center.