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Early Onset Marijuana Use and Adult Mental Health

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ABSTRACT

EARLY ONSET MARIJUANA USE AND ADULT MENTAL HEALTH

By

Christine Murphy Andrews

April 11, 2016

INTRODUCTION: The impact of marijuana use has become a national topic with the increase in state's legalizing or decriminalizing the use of the drug. To understand the impact this new trend may have on the population, it is necessary to characterize the interaction between marijuana use and health outcomes. Previous research has focused on the acute effects of marijuana on mental health and longitudinal impacts of marijuana use in the adolescent population. However there are no previously published studies on the impact of early onset marijuana use on adult mental health.

AIM: This study aims to determine the prevalence of early onset marijuana use and if there is a statically significant association between early onset marijuana use (<14 years old) and increased prevalence of adverse mental health outcomes in adult life.

METHODS: This study was conducted using data from the 2014 National Survey on Drug Use and Health. The study population included 41, 285 participants 18 or older at the time of the cross-sectional survey. Adult mental health outcomes were modeled for both early onset marijuana users and non-early onset marijuana users using a multiple logistic regression model to calculate both adjusted and unadjusted odds ratios (AOR's, OR's) with 95% confidence intervals. Statistical analysis was performed to examine the association between early onset marijuana use and negative adult mental health outcomes including serious mental illness, any mental illness and lifetime depressive episodes.

RESULTS: This study found that in adults aged 18 and older the prevalence of early onset marijuana use was 8.3%. The prevalence of early onset marijuana use varies by gender, with a prevalence of 5.1(95% CI 4.7-5.2) for males and 3.3(95% CI 3.1-3.5) for females. Early onset marijuana use had a statistically significant association with all three indicators of poor adult mental health. The AOR for early onset marijuana use and serious mental illness was 2.3(95% CI 1.972-2.758). The association between early onset marijuana use and adult depressive episode had an AOR of 2.1(95% CI1.906-2.389).

DISCUSSION: These findings suggest that early onset marijuana use is a risk factor for adverse mental health outcomes in adulthood. Consistent with findings from other nationally representative surveys, the prevalence of early onset marijuana use is higher in males than females. Early onset marijuana use is associated with increased odds of past year serious mental illness and past year any mental illness. This suggests that legislature considering marijuana legalization must also consider policies addressing under age use of the drug. Further longitudinal research is needed to father assess the association between early onset marijuana use and adult mental health.

EARLY ONSET MARIJUANA USE AND ADULT MENTAL HEALTH

by

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APPROVAL PAGE

EARLY ONSET MARIJUANA USE AND MENTAL HEALTH IN ADULT LIFE

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Author's Statement Page

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1. <u>Introduction</u>

1.1 Background

The impact of the use of marijuana or cannabis has become a topic of popular debate as states begin to shift towards legislature legalizing or decriminalizing the sale of the drug. While marijuana has existed in the United States since the American Revolution as a byproduct of the hemp trade, it was not until the early 20th century that Mexican immigrants introduced the use of marijuana as a recreational drug[1,2]. Similar to opiates and cocaine, marijuana was available both from pharmacies and over the counter. Alongside the cultural shift of Prohibition, states began outlawing marijuana and by 1925, 26 states had passed laws prohibiting its sale[3]. Marijuana became a Schedule I drug with the passing of the federal Controlled Substances Act in 1970[3]. Schedule I drugs meet the following criteria: high potential for abuse and no current justification for medical use[4] Possession and sales of Schedule I drugs is classified as a federal felony.

Over the last decade, multiple states have begun introducing legislation to either allow the direct sale of marijuana, decriminalize possession of the drug or allow the drug to be used for medicinal purposes[2]. Unlike pharmaceuticals, relatively few clinical trials have been conducted on the medicinal use of marijuana leading to a lack of knowledge in the potential health benefits or harm as well as correct dosing and potency levels[3]. Past research on marijuana has focused on the impacts of its recreational use and prevalence primarily from a cross-sectional view. Within the job setting, marijuana use has been linked to higher rates of absenteeism and occupational injuries[5]. In adolescents, marijuana has been associated with a

higher likelihood of dropping out of school, decreased academic performance and a drop in IQ over time[6,7]. While numerous associations between marijuana use and poor health outcomes have been established, there is a lack of data on the effects of early marijuana use on adult mental illness[8]. Additionally, while many studies have linked marijuana use to an increase in psychosis, few have examined the impact of marijuana on less acute mental illness in the adult population[9]. This study will focus on determining if there is an association between early onset marijuana use and mental health outcomes in adult life, using data from the SAMHSA NSDUH 2014 public-access file.

1.2 Research Questions

     1. What is the prevalence of early onset marijuana use in the United States population?

     2. Does the prevalence of early onset marijuana use vary between men and women?

     3. Is there an association between early onset marijuana use (<14 years old) and adverse mental health outcomes in adult life?

1.3 Research Aims

     This study aims to determine the prevalence of early onset marijuana use and if there is a statically significant association between early onset marijuana use (<14 years old) and increased prevalence of adverse mental health outcomes in adult life.

1.4 Research Hypotheses

H_a: Adults who reported first onset of marijuana use before the age of 14 years old will have an increase in adverse mental health outcomes in their adult life.

H_o: Adults who reported first onset of marijuana use before the age of 14 years old will not have an increase in adverse mental health outcomes in their adult life.

2. Review of the Literature

2.1 Marijuana

Marijuana or cannabis is an illicit drug derived from the dried flowers, stems and leaves of the Cannabis sativa, or the hemp plant[4]. Marijuana is most commonly found as a shredded dry mixture resembling tobacco, but can also be in an oil or resin form[4]. The drug is typically smoked, ingested in a food, or used as a tea. The use hand-rolled cigarettes (joints), pipes and water pipes (bongs) are the most common ways to smoke marijuana[3]. The effects of marijuana depend on many different factors including the dose used, the method of use, the setting of use, the user's previous experiences with cannabis and the expectations of the user[10]. The effects of cannabis range from euphoria, relaxation, and perception changes including the intensification of sense such as smell and taste[11]. The majority of marijuana users report that they use in order to achieve this "high" and the increased sociability it provides when used in a group context. The marijuana 'high' has an onset about 30 minutes after a cannabis dose is taken and lasts for about 1 to 2 hours[3].

Marijuana's active agent is the chemical delta-9- tetrahydrocannabino, known as THC[3]. THC is a psychoactive chemical affecting the mind and the body through ingestion or inhalation. THC impacts the cannabinoid receptors in the brain when it attaches to them after initiation through the bloodstream. The activity of nerve cells is impacted by THC including receptors for memory, pleasure, thought, coordination, concentration and temporal ability. This leads to short terms effects such as memory-loss, disabled perception, difficulty in concentration and learning and loss of coordination[3]. Long-term marijuana use can lead to physical dependence

and withdrawal symptoms after discontinuation. Recent studies have shown that marijuana is more addictive than previously believed, with 1 in 11 or 9% of cannabis users becoming dependent at some point in their lifetime[12,13].

Marijuana use has also been linked to physical symptoms and disease. Similar to smoking, marijuana use leads to an increased risk of cancers of the head, neck, lungs and respiratory tract due to the carcinogens and toxins inhaled during use[1]. Other respiratory health problems marijuana smokers are at risk for include asthma, emphysema and COPD[14]. Marijuana use during pregnancy has been associated with delays in fetal development and low birth weight. Preliminary research also suggests that marijuana use during pregnancy can contribute to the risk of rare forms of cancer in the child including neuroblastoma[15]. Additionally research has shown an association between prenatal marijuana use and malformation in the neurological pathways moderating the emotional functioning of the fetus[16].

Impact on the Brain

A large amount of animal research has focused on the direct impact that marijuana has on the brain and neurological system through the dopamine pathways. Dopamine, a neurotransmitter in the brain, impacts movement, motivation, reward and addiction. Most addictive drug use increases dopamine in the brain, flooding the dopamine pathways and engaging the pleasure seniors and positive feedback loop[17]. Studies on the impact of marijuana on the release of dopamine in the human brain are mixed. Two recent studies reported an increase in dopamine in the human brain after cannabis use[18,19]. Conversely, a recent study on

the impact of recreational doses of marijuana concluded that recreational cannabis use does not release significant amounts of dopamine into the brain[20]. A systematic review examined and evaluated studies on the impact marijuana has on dopaminergic signaling in the human brain. While some studies showed hat the active agent of marijuana, THC, has been associated with increased levels of dopamine in the brain, other studies concluded there is no impact from marijuana use on dopamine pathways [21]. The review concluded that more research is needed into the actual effects marijuana has on the human brain because of conflicting study reports and a lack of standardization in the research methods used across the studies reviewed. Recent studies cited in the systematic review suggested that while there is little evidence to support that acute marijuana use impacts the dopamine receptors in the human brain, chronic marijuana use reduces both dopamine synthesis and dopamine release capacity[22].

Marijuana Prevalence

Marijuana has grown to become the most popular and widely spread illicit drug in the United States. Results from the 2013 National Survey on Drug Use and Health (NSDUH) find that 19.8 million or 7.5% of persons aged 12 or older were current users of marijuana, an increase from a rate of 5.8% in 2002[23]. Marijuana was the most reported illicit drug of current use for all age categories, with young adults having the highest prevalence rates of current marijuana use at 19.1% (Abuse, n.d.). The rate of current use of marijuana was higher in males(7.9%) than females(6.2%). The daily use of marijuana has rapidly increased in the U.S. with 5.7 million persons aged 12 or older reporting daily use in 2013 compared to 3.1 million reporting daily use

in 2006. The amount of daily or almost daily users in the U.S. represented 41.1% of marijuana users.

Marijuana dependence continues to contribute to the burden of disease in the United States. In 2013, 4.2 million persons reported marijuana dependence or abuse. The rate of marijuana dependence or abuse has remained similar from 2002(1.8%) to 2013(1.6%). Marijuana related medical emergencies have increased 21% from 2009 to 2011, with 456,000 marijuana related medical emergencies reported in 2011[2]. Currently, little research has been done on the cause of the increase-it is unknown whether it is due to increased marijuana potency, increased use of marijuana or other factors. Some studies have found a recent increase in the potency of THC content in marijuana being sold in the United States, suggesting that new users may experience a high risk for adverse effects during use[24].

2.2 Mental Health

Mental health and its impact on the global burden of disease is a relatively new focus of public health interest. Historically, mental health disorders have not been a health priority, both globally and nationally, with little funding being allotted for the study and treatment of behavioral health disease. Prevalence and incidence rates for mental health disorders have been difficult to obtain due in part to a lack of reporting and little to no mental health resources available to diagnose and treat psychiatric diseases[25]. Typically healthcare services for mental health disorders have been segregated from the larger pool of healthcare resources, falling behind both communicable and chronic disease.

Research in the last 15 years has begun to gain a better perspective on the prevalence of mental health disorders at the population level. In the most recent prevalence study (when) conducted by the National Institute of Mental Health (NIMH), the prevalence of any mental illness(AMI) among U.S. Adults is 18.1%[26]. The NIMH defines "Any Mental Illness" as a mental, behavioral or emotional disorder that meets DSM-IV criteria and has been diagnosed within the past year[26]. The NIMH reports that serious mental illness (SMI), or mental illness that results in serious functional impairment has a prevalence of 4.2% representing about 9.8 million adults in the U.S[27].

With the shift in focus from the burden of disease mortality to the burden of disease morbidity, mental health disorders have begun to receive attention. The burden of mental health disorders far outweighs its allocated recourses, both internationally and within the United States. The true costs of mental health disorders are hard to determine due to various under identified key components[28]. Economically, mental health disorders create a cost burden in indirect costs such as loss of productivity, loss of income, and cost of social support in addition to upfront costs for diagnosis and treatment. Similar to rising healthcare costs due to chronic disease, the burden of mental health disorders falls on the population as a whole.

There are multiple reports on the monetary costs of mental health illness both globally and within the U.S. The Agency for Healthcare Research and Quality (AHRQ) reported mental disorders as one of the top five most costly conditions in terms of direct medical spending, rising in costs from $35.2 billion to $57.5 billion over a 10 year period[29]. It is estimated that persons with serious mental illness that an individual reduction of earnings of $16, 306 in a 12 month period, which generalizes to an annual loss of $193.2 billion in the U.S. general

population per year[28]. The World Health Organization (WHO) recently estimated the global cost of mental health disorders to be $2.5 trillion with a projected increase to $6 trillion by 2030[30].

Anxiety

The most frequent mental health disorder addressed in the primary care setting is generalized anxiety disorder. Generalized anxiety disorder is categorized by anxiety, tension and psychosomatic symptoms such as sleep disturbances and weight loss that persist for 6 months of longer[31]. A systematic review of the prevalence and incidence literature for anxiety disorders internationally concluded that the best estimate for prevalence of 1-year and lifetime prevalence of all anxiety disorders was 10.6% and 16.6% respectively[32], The prevalence of generalized anxiety disorder was found to be 2.6% for 1-year prevalence and 6.2% for lifetime prevelence[32]. The small ratios between 1-year and lifetime prevalence of both all anxiety disorders and generalized anxiety disorder seems to suggest that the majority of people experience anxiety disorders on a continuous or reoccurring basis.

The prevalence of anxiety disorders in the United States continues to be the highest of any mental health disorder in recent surveys. The 2005 National Comorbidity Survey reported a lifetime prevalence of 28.8% for any anxiety disorder in the United States[33]. The age category of 30 to 44 years old reported the highest anxiety lifetime prevalence at 35.1% , while 18 to 29 and 45 to 59 reported a lifetime prevalence of 30.2% and 30.8%, respectively[33]. Older adults(60 and above) reported much lower rates of anxiety, with a lifetime prevalence of 15.3%[33]. A study of gender differences and anxiety disorders in the United States concluded that the lifetime and 1-year prevalence ratios between males and females were 1:1.7 and 1:1.79, respectively[34]

Few studies have been done recently on the economic costs of anxiety disorders both globally and in the United States. In the 1990's the economic costs of anxiety disorders in the United States were estimated to be 42.3 billion a year, approximately one-third of the S148 billion spent annually on healthcare[35]. A more recent study on the cost of mental health disorders in Europe found that anxiety disorders accounted for €74.4 billion of a total of €798billion spent on brain disorders in 2010[36].

Depression

Depression is one of the most common mental health disorders in the world and is characterized by feelings of intense sadness, lack of appetite, loss of sleep and in severe cases thoughts and actions of suicide[37]. Currently, the WHO estimates that globally, 300 million people suffer from depression[37]. Additionally, the WHO categorizes depression as the third most important cause of disease burden in their 2004 report on the burden of global illness[38] A recent study on the occurrence of depression across cultures concluded that while lifetime prevalence of depression was greater in high income countries than low or middle income countries, 1-year prevalence of depression had no significant difference[39].

A recent study of lifetime prevalence of mental health disorders in the United States concluded that depression has a lifetime prevalence of 16.6%[33]. The highest lifetime prevalence of depression was in the 30 to 44 age range with a prevalence of 19.8%[33]. The 45 to 59 and the 18 to 29 age ranges reported lifetime prevalence's of 18.8% and 15.4%, respectively[33]. Again, older adults reported the lowest lifetime prevalence of depression at 10.6%[33]. The National

Institute of Mental Health report a 1-year prevalence of adult major depression as 6.6%[40]. The prevalence of major depression is higher in females than males at 8.2% and 4.8%, respectively[40]

The economic costs attributed to depression by the WHO are the highest out of any mental disorder. In the US, depression accounts for 3.75% of all DALYs and 8.3% of years lived with disability (YLDs)[41]. Recently, the WHO classified depression as the fourth leading cause of disability globally and projected that by 2020 it will become the second leading cause of disability[42] Several studies have quantified the equivalent monetary loss attributed to days of work missed due to depression, with ranges from $30.1 billion to $55.5 billion[42]. Economic costs of depression have increased in the US by 21.5% ($173.2 billion to $210.5 billion) between 2005 and 2010[43]

2.3 Mental Health and Marijuana Use

Marijuana use has long been associated with outcomes related to mental health status in both adults and adolescents including depression, anxiety and psychosis[14]. Current research has yielded conflicting results on whether incidence of mental disorders increases with marijuana use. A recent study of US high-school students found that when controlling for social economic status (SES), chronic marijuana use was still associated with poor mental health[6]. Additionally, the study found that the association became insignificant when controlling for the use of tobacco and alcohol, suggesting a difficulty in identifying the impact of marijuana versus that of tobacco and alcohol.

A cohort study of young adults recruited their freshman year of college examined the association between marijuana use in college and mental health outcomes 10 years post-

matriculation. The study separated the cohort into groups describing their trajectory of marijuana use which included Non-Use, Low-Stable, Early-Decline, College-Peak, Late-Increase and Chronic. The study found that both the Late-Increase and Chronic group of marijuana users reported significantly lower mental health 10 years post-matriculation than the other groups[8].

A cross-sectional interview study of young adults (18-30) examined the association between the level of marijuana use and mental health disorders. The sample included 1, 072 non-users and 521 users of which 252 were categorized as marijuana dependent and 269 were not[44]. The study concluded that both dependent and non-dependent users have higher odds of having mood disorders compared to the general population (OR 17.75 p<0.001 and 8.91 p<0.001 respectively)[44] When adjusted for childhood adversity and other substance use, the dependent marijuana group have significantly higher odds of having a mental health disorder than the non-dependent group(OR=2.40 p<0.001)[44].

Anxiety

A cohort study of adolescent Australians that followed participants until the age of 29 years concluded that daily use of marijuana contributed to the development of anxiety disorders in young adults. A cohort of adolescents (mean age 14.9–17.4 year) with a sample size of 1,943 were followed over a span of 15 years in their late 20's. Both daily and weekly users in adolescence had higher OR's of having an anxiety disorder at 29 years old, OR 2.5 and 3.2 respectively[45].

A systematic review of literature on the association between marijuana use and anxiety disorders examined 16 studies. High frequency marijuana users were found to have a higher

rate of anxiety disorder, while those with anxiety disorders were also found to have a higher rate of marijuana use[46]. The directionality of the association between marijuana and anxiety was unable to be determined through review of the literature.

A meta-analysis of 31 studies examined the association between marijuana use and anxiety. The 31 studies drew from 10 countries and 112, 000 noninstitutionalized partisans[47] In the analysis a positive association was found between marijuana use and anxiety(OR = 1.24, 95% CI: 1.06-1.45, p = .006; N = 15 studies) and marijuana use disorder and anxiety(OR = 1.68, 95% CI: 1.23-2.31, p = .001; N = 13 studies)[47]. Additionally, the comorbidities of depression and anxiety were positively associated with cannabis use[47]. These findings suggest that heavy and chronic marijuana use that needs treatment is more likely to be associated with anxiety than non-disordered marijuana use.

Depression

A cross-sectional study of adults using Wave I of the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC-I) examined the association between marijuana use and depression stratified by gender. The study divided partisans with depressive disorders (N=3416) into categories determined by their marijuana use. The categories included no use, occasional use and regular use of marijuana over the past year. The Quality of Life questionnaire was used to assess depression. Overall the study found that women who were regular cannabis users reported a high score on the depression scale, while men had no significant differences between users and non-users[48].

A longitudinal study of young adult (18-24) women in Rhode Island examined the change in depression symptoms relative to marijuana use. The partisans (n=332) were randomly chosen from a clinical trial of a marijuana intervention for sexually active, young adult females. After controlling for alcohol use, the study found that there was a positive association between a reduction in marijuana use and a reduction in depression symptoms. Both those who reported mild(b=−0.26; 95% CI:−0.44,−0.08; P=.004) and moderate/severe depression (b = −0.50; 95% CI: −0.68,−0.33; P < .001) had significant reductions in symptoms with a reduction in marijuana use[49].

A meta-analysis of longitudinal studies of the association between marijuana use and developing depression examined data from 14 studies. The total number of subjects included in the qualitative analysis was 76, 058[50]. Positive associations with developing depression were found for both regular and heavy marijuana use. Regular marijuana users had an OR of 1.17(95% CI 1.05-1.30) for developing depression when compared with non-users, while heavy marijuana users had an OR of 1.82(95% CI 1.21–2.16) when compared with non-users[50].

2.4 Early Onset Marijuana Use

Multiple federal national surveys have monitored the use of marijuana in adolescents since the late 1970's. The Monitoring the Future survey, collects an annual, representative sample of public and private secondary school students in the United States. Beginning in 1975, the survey collected data from 12th graders and in 1991 began to collect data from grades 8, 10 and 12. Administered by the University of Michigan, it is supported with grants by the National Institute on Drug Abuse. In the most recent marijuana use prevalence data from the Monitoring

the Future study, lifetime use prevalence for grades 8, 10 and 12 were 15.6%, 33.7% and 44.4%, respectively, in 2014[51]. Current marijuana use, defined as use in the past 30 days, was 6.5% for 8th grade, 16.6% for 10th grade and 21.2% for 12th grade[51]. The prevalence of daily use of marijuana for grades 8, 10 and 12 combined was 3.3% in 2014. When broken down by grade level, daily marijuana prevalence rates were 1.0%, 3.4% and 5.8%, respectively[51]. The Monitoring the Future study does not collect data on age of initiation of marijuana use.

The National Survey on Drug Use and Health (NSDUH), the survey being used for this thesis, is a nationally representative sample of the noninstutionalized United States population age 12 and older. More information on the methodology of this annual survey can be found in the Methods section of this paper. Data from the 2013 NSDUH on early onset marijuana use reports that the prevalence of current marijuana use (past 30 days) was 7.1% in youth ages 12 to 17. When stratified by gender, past month marijuana use for ages 12 to 17 was higher in males at 7.9%, compared to females at 6.2% for 2013. When stratified by age, past month marijuana use prevalence was 1.0% for ages 12 or 13, 5.8% for ages 14 or 15 and 14.2% for ages 16 or 17. The NSDH had no reported data on the daily use of marijuana in the age group 12 to 17 years, although it does ask survey questions about age at first use of marijuana.

The Youth Risk Behavior Surveillance System (YRBSS) also collects annual data on the use of marijuana in youth in grades 9 to 12. The YRBSS is a cross-sectional survey designed and administered annually by the Centers for Disease Control and its state partners. While there is a middle school version of the YRBSS, which surveys students in the age group of interest to this thesis, the middle school survey is not nationally representative at this time and is only available at the state-level estimate[52]. The most recent YRBSS data from the 2013 survey

reported a national lifetime prevalence of marijuana use as 40.7%[53]. For males and females the lifetime marijuana use prevalence was 42.1% and 39.2% respectively[54]. 23.4% of high school students reported currently using marijuana (in the past 30 days), with 25.0% of males reporting current use compared to 21.9% females[53]. Early onset marijuana use captured as having tried marijuana before the age of 13 had a reported prevalence of 8.6%, with 11.1% and 6.2 for males and females respectively[54].

2.5 Conclusion

The purpose of this research study is to assess whether early onset marijuana use is correlated with negative mental health outcomes in adult life. While the prevalence of marijuana use in youth ages 12 to 17 is widely monitored and reported in the United States, there are few studies outside of the Youth Risk Behavior Surveillance System that collects data on the age of initiation of marijuana use. Previous studies have found associations between marijuana use and poor mental health outcome such as anxiety, depression and psychosis[45–50,55,56]. This thesis will expand on previous research that examined the association between marijuana use and mental health by focusing on a subset of marijuana users (early onset users) and their mental health outcomes in their adult life. An understanding of the relationship between early onset marijuana use and mental health in adult life can help behavioral health clinicians identify those who are at a higher risk for poor mental health outcomes and target individualized interventions to such a population. Focusing on early onset users of marijuana (<14 years) assess an at risk population that if often missed in survey's of high school drug use.

Additionally, assessing the relationship between early onset marijuana use and adult mental health can help legislative bodies make important decisions concerning the legalization of marijuana within the United States.

3. Methods

3.1 Study Sample and Design

The data for this thesis analysis was provided by the Substance Abuse and Mental Health Services Administration (SAMHSA). The data set used was the National Survey on Drug Use and Health (NSDUH), an annual federal survey that is the primary method of data collection on illicit drug, alcohol and tobacco use in the US civilian, noninstutionalized population aged 12 years or older. The NSDUH also includes several modules of questions pertaining to mental health. This cross-sectional complex survey has been conducted by SAMHSA since 1971 through face-to-face or CAI interviews at the participant's place of residence. The residences included in the survey are private households, noninstutionalized group quarters (shelters, dormitories) and military bases. Populations excluded in the survey are the homeless, the institutionalized (jails, hospitals) and active duty military. The survey includes a $50 incentive for participants and includes respondents from all 50 states and the District of Columbia. Publically availed data file for the NSDUH survey from 1979 to 2014 are available on SAMHSA's website. The specific data set analyzed was the publically available 2014 NSDUH SAS file.

The NSDUH is sponsored by SAMHSA and the U.S Department of Health and Human Services. The survey methodology is planned and managed by SAMHSA's Center for Behavioral Health Statistics and Quality. Data analysis is contracted out and done by RTI International. Historically, SAMHSA has presented the NSDUH data in a comprehensive series of reports and detailed tables. The detailed tables are split into substance abuse and mental health and present corresponding prevalence statistics on characteristics of interest. The reports issued by

SAMHSA provide detailed data that focuses on specific topics of interest at the national level. Past topics have included substance abuse and mental health treatment utilization, illicit drug use prevalence and suicide. State level estimates for all survey questions are available for all years the survey was collected.

3.2 Variables of Interest

Variables of interest for this study, along with their presents and a description of what they capture are also detailed in Table 1 in the appendix.

Demographic Variables

Five demographic variables of interest were included in the sample analysis and are displayed in Table 1 in the Results section. One of the variables, sex (IRSEX) was a dichotomous categorical variable and categorized as 1=Male, 2=Female. The remaining four variables were categorical, two were modified and two were unmodified. The two modified categorical variables were education level (EDUCCAT2) and age (CATAG7). The original levels of education were less than high school, high school graduate, some college, college graduate and 12 to 17 year olds. As mentioned previously, data concerning those under the age of 18 was removed from this data subset. The modified education variable did not contain a level for 12 to 17 years old. The original age variable levels were 12 to 13 years old, 14 to 15 years old, 16 to 17 years old, 18 to 20 years old, 21 to 25 years old, 26 to 34 years old and 35 or older. The modified age variable was categorized to 18 to 20 years old, 21 to 25 years old, 26 to 34 years old and 35 or older. The remaining categorical variables, race (NEWRACE2) and income (INCOME) maintained their original levels in the analysis. The variable race(NEWRACE2) contained levels Non-Hispanic White, Non-Hispanic Black/African-American, Non-Hispanic Native American/Alaskan Native,

Non-Hispanic Native Hawaiian/Other Pacific Islander, Non-Hispanic Asian, Non-Hispanic more than one race and Hispanic. The variable income (INCOME) contained the levels Less than $20, 000, $20, 000-$49, 999, $50, 000-$74, 999 and $75, 000 or more.

Independent Variable

The intendant variable used in this analysis was marijuana age of first use (MJAFU). The initial survey questions asked respondents to report their believed first age of marijuana use. SAMHSA later recoded the continuous variable into a categorical variable prior to releasing the public use data set. The variable marijuana age of first use was used unmodified in its categorized recode for this analysis. The categorical levels were 14 years or younger, 15 to 17 years old, 18 years or older, non-user.

Dependent Variables

The three dependent variables used in this analysis were dichotomous categorical variables. Two variables, any mental illness (AMIYR_u) and serious mental illness (SMIYR_U) were unmodified dichotomous categorical variables with levels 0= no and 1=yes. The variable any mental illness(AMIYR_U) captured any mental illness within the past year while the variable serious mental illness (MMIYR_U) captured any serious mental illness within the past year. Both variables are determined by predictive modeling based on participant's responses to a functional impairment scale and a psychological distress scale included in the NSDUH survey. The predictive model produces a variable SMIPP_U, which is then used to determine the classification of the respondent. If SMIPP_U is greater than or equal to 0.0192519810, then the

respondent is classified as having past year AMI (AMIYR_U=1). If If SMIPP_U is greater than or equal to 0.260573529, then the respondent is classified as having past year SMI (SMIYR_U=1).

The variable adult lifetime major depressive episode (AMDELT) was recoded as a dichotomous categorical variable with levels 0=no, 1=yes for ease of analysis. The original levels for AMDELT were 1=yes and 2=no. The depression variable captured lifetime incidence of depression as reported by the participant, based on major depressive episode indicators. In order to be classified as a "yes", the participant had to report experiencing at least five out of the nine criteria used to define an adult as having had MDE in their lifetime, where at least one of the criteria is a depressed mood or loss of interest or pleasure in daily activities. All dependent variables were analyzed using the standard analysis weight, ANALWT_C, as recommended by the survey codebook.

3.3 Statistical Analysis

All statistical analyses for this study were done in SAS 9.4. The study sample from the 2014 NSDUH contained 67, 901 participants and had an 81.94% response rate. For the purpose of this thesis, analysis was limited to participants 18 and older. This was done in order to examine the data that pertained to adults in the survey. After application of this limitation to the data, the sample size used for analysis was 41, 285.Missing values of dependent variables marijuana age at first use(MJAFU), adult major depressive episode (AMDELT), adult severe mental illness in past year(SMIYR_U) and adult any mental illness in past year (AMIYR_U) were deleted due to their small cell size. All variables in the original public use data set that did not

pertain to the study sample were dropped for ease of SAS analysis. Figure 1 shows the selection process for the study sample.

The research questions addressed in this analysis were (1) What is the prevalence of early onset marijuana use in the United States population?, (2) Does the prevalence of early onset marijuana use vary between men and women?, (3) Is there an association between early onset marijuana use (<14 years old) and adverse mental health outcomes in adult life? Descriptive statistics for this study were conducted using PROC SURVEYFRQ and are detailed in Table 1. Descriptive statistics were conducted for gender, race, age, education level and income. Rao-Scott chi-square analysis, using the CHISQ option in the SURVEYFREQ procedure, was used to identify potential associations and confounders among the demographic variables. PROC SURVEYFREQ, was also used to find the prevalence rates for research questions 1 and 2. The Rao-Scott chi-square analysis was also used to determine if there was a statistically significant association between the independent variable marijuana age of onset(MJAFU) and the selected dependent variables severe mental illness incidence in the past year (SMIYR_U, any mental illness incidence in the past year(AMIYR_U) and major depressive episode incidence in the past year(AMDELT).

Multiple logistic regression modeling was then used to examine research question and to determine the odds ratios of the associations between the independent variable (MJAFU) and the dependent variables (AMDELT, SMIYR_U, AMIYR_U). PRO SURVEY LOGISTIC was used to build the logistic regression models. The NSDUH codebook provided the appropriate weight and strata to include when building the logistic regression model. The weight used was ANALWT_C and the strata used was VESTR. All analyses were conducted at the α=.05 level of

significance. Confounders controlled for in the logistic regression modeling and adjusted odds ratios were age, gender, race, education level and income.

All analysis was done using SAS 9.4. Demographic and descriptive statistics for the study sample are reported in Table 1. The final study sample size was n=41, 285 after those who were under the age of 18 at the time or participation were removed from the sample. SAMHSA provided weights were used to calculate frequencies and percent's. Regarding gender, 48.2% of the sample was male and 51.8% of the sample was female. The racial breakdown of the sample was 65.4% Non-Hispanic White, 11.7% Non-Hispanic Black, 0.5% Native American/Alaskan Native, 0.4% Native Hawaiian/Other Pacific Islander, 5.3% Asian. 1.5% Multi-Racial and 15.3% Hispanic. The majority of participants had a high school degree or higher, 28/9% reported high school graduation while 30.7% reported college graduation. A large majority of the sample was 35 or older (69.7%) due in part to the limiting of the study sample to respondents aged 18 or older. With respect to yearly income, 18.1% reported %20, 000 or less, 31% reported $20, 000 to $49, 999, 16.7% reported $50, 000 to $74, 999 and 34.2% reported $75, 000 or higher.

4. Results

4.1 Descriptive Statistics of Sample

Descriptive statistics pertaining to the sample characteristics by marijuana age of onset can be found in Table 2. The final sample size for early onset marijuana users was 4, 321 and the final sample size of non-early onset marijuana users was 36, 964. The final weighted percent's were 91.7% non-early onset marijuana users and 8.3% early onset marijuana users. Within the study sample (n=41, 285) 4.5 %(95% CI 4.2-4.8) were participants 35 or older who reported early onset marijuana use. The second largest age group to report early onset marijuana use was ages 26 to 34 years with 2.0%(95% CI 1.8-2.1) of the study sample. With respect to gender males with early onset marijuana use made up 5/1%(95% CI 4.7-5.2), while female early onset marijuana users made up 3.3%(95% CI 3.1-3.5). White participants reported the highest early onset marijuana use at 5.9%(95% CI 5.6-6.2), while the next largest racial group to report early onset marijuana use was Hispanics at 1.1%(85% CI 0.99-1.2). Those who were high school graduates and those with some college reported higher rates of early onset marijuana use at 2.7%(95% CI 2.5-2.9) and 2.5%(95% CI 2.3-2.7) respectively. Income levels were split with similar rates of early onset marijuana use being reported in the $20, 000-$49, 999 bracket(2.7% 95% CI 2.5-2.9) and the $75, 000 or greater bracket(2.4% 95% CI 2.2-2.6).

4.2 Bivariate Analysis

Rao-Scott analysis was done on demographic characteristics and the independent variable (MJAFU) to determine if there was any statistically significant association between the two. All demographic variables included (age, gender, race, income and education) were found to have a statistical significance with the independent variable marijuana age at first use (MJAFU) (p<0.0001). As a result of their statistical significance with the independent variable, demographics characteristics were controlled for in later analysis. Table 2 includes the Rao-Scott chi-square analysis of the demographic variables

Rao-Scott chi-square analysis was also performed on the association between the independent variable (MJAFU) and the three outcomes of interest, AMDELT, AMIYR_U and SMYYR_U). Table 3 displays the conclusions of the chi-square testing of deadened variables. The dependent variable any depressive episode in the last year(AMDELT) was found to have a statistically significant association with MJAFU (p<0.0001). Both dependent variables addressing mental illness (any mental illness in last year and severe mental illness in last year) were also found to have a statically significant association with MJAFU (p<0.0001).

4.3 Multivariate Analysis

Logistic regression was done using the PROC SURVEYLOGISTIC common ad in SAS 9.4 Both unadjusted and adjusted odds ratios were found for each dependent variable (AMDELT, AMIYR_U and SMIYR_U). Odds ratios are detailed in Tables 4 and 5. Adjusted odds ratios accounted for the demographic variables that was significant including age, gender, race, income and education level. For the dependent variable any depressive episode in last year (AMDELT), early onset marijuana use a significant predictor (AOR=2.133 95% CI 1.906-2.389

pp<0.0001). Early onset marijuana was also a significant predictor for severe mental illness in the past year (AOR=2.332 95% CI 1.972-2.758 p<0.0001). Early onset marijuana use also had a moderate significance with any mental illness in last year (AOR=1.99 95% CI=1.794-2.208 p<0.0001).

5. Discussion

5.1 Discussion of Research Questions

The purpose of this thesis was to assess the relationship between early onset marijuana use and mental health in adult life. The research questions examined in this study were (1) What is the prevalence of early onset marijuana use in the United States population, (2)Does the prevalence of early onset marijuana use vary between men and women and (3) Is there an association between early onset marijuana use (<14 years old) and adverse mental health outcomes in adult life? This thesis found that in adults aged 18 and older the prevalence of early onset marijuana use was 8.3%, a rate relatively similar to the reported early onset marijuana use prevalence from the 2013 YRBSS(8.8%)[53]. This study also found that the prevalence of early onset marijuana use does vary in regards to gender, with a prevalence of 5.1(95% CI 4.7-5.2) for males and 3.3(95% CI 3.1-3.5) for females. The higher prevalence of early onset marijuana use in males is consistent with previous research findings in nationally representative United States surveys[51,53,57].

After controlling for race, age, gender, income and education level, all three outcome measure for mental illness (serious mental illness, any mental illness and adult depressive episode) were associated with the predicting variable early onset of marijuana use(p value < 0.0001). In individuals who reported an early onset of marijuana use, the crude odds ratio showed a twofold increase in past year major depressive episodes compared to the non-early onset group (COR=2.107, 95% CI =1.891-2.347, p-value <0.001). When adjusted for demographic characteristics, the odds ratio showed a slightly higher than two fold increase in reports of a past year depressive episode (OR=2.133, 95% CI=1.906-2.389, p-vale=<0.001).

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When early onset marijuana use was used as a predictor for past year serious mental illness (SMIYR_U), the adjusted odds ratio found a slightly higher than two fold increase in odds (OR=2.332, 95% CI=1.972-2.758, p-value =<.0001). This finding suggests that early onset marijuana use has the strong association with serious mental illness in the adult life and could be used as a predictor for mental health risk management in the adult population.   The statistical association between past year any mental illness (AMIYR_U) and early onset marijuana use was milder than the other two dependent variables, those who reported early onset use had an adjusted odds ratio of 1.99 compared to those who were not early onset users(95% CI=1.794-2.208, p-value=<.0001).

While past research has shown correlations between marijuana use and acute mental illness in adolescents or young adults, few have addressed the effects of early marijuana use on adult mental health[9,9,56,58]. To our knowledge this study is the first to address early onset use of marijuana and focus on a population who began using marijuana at the age of 14 or young in a nationally representative sample of the U.S. population. These results hold important implications for states considering introducing legislature legalizing the use and sale of marijuana. The associations between early onset marijuana use and adult mental illness found in this study could imply a trajectory for youth raised in states that allow looser access to marijuana. Multiple studies have shown the trickledown effect of substance use from adult to child, indicating that states where marijuana is legal may have a higher prevalence of youth using the drug[1]. The impact on the population's future health should be taken into consideration when drafting legislature on marijuana use.

Additionally, the prevalence of mental health disorders is growing in the United States in both the adolescent and adult populations.[26,59] .Utilizatioon of mental health care is increasing, causing a strain on the under developed behavioral health system[25]. The results of this study suggest that clinicians treating mental health disorders in the adult population can assess the potential for serious mental illness by determine the age of onset of marijuana use in their patient population. These study findings can assist in clinician's assessment and triage of patients with behavior health problems and their potential for more serious mental illness in their lifetime due to their early onset marijuana use.

5.2 Study Strengths and Limitations

This study was conducted using a cross-sectional survey of a nationally representative sample of the U.S. population, therefore results of this study are likely generalizable to the U.S. The large sample size, both weighted and unweighted allowed for in-depth analysis and strong statistical power within the analysis. The data was collected using a computer assisted survey, allowing for clarification of the questions and minimal surveyor bias in the sample. The complex survey designed allowed for strata and weights to be applied in order to make the sample size accurate and statistically strong. The cross-sectional design of the data and this study allows for recall bias in the sample, especially when dealing with the independent variable which asked the respondent to remember youth activities. The cross-sectional design also did not allow for temporality to be established in the analysis of the associations. Additionally, the sensitive nature of the survey questions used might have impacted the answers given by participants. This study relied on self-reported indicators for mental illness, not diagnosis by DSM-V criteria

which may create a bias in accuracy of mental illness in the past year or depressive episodes in the past year.

5.3 Recommendations and Further Research

Further research should address the limitations in this study, including the lack of temporality. A longitudinal cohort study of children that follows them into middle adulthood or beyond would provide the temporal type of data needed. Additionally, a cohort study would allow for better recall of exact age of first marijuana use and would eliminate much of the recall bias present in cross-sectional survey data. Further research should also focus on the comorbidities of early onset marijuana use such as alcohol and tobacco use in order to clarify the impact of marijuana use. More accurate diagnostics for mental illness should be used in future studies, such as medical records or questions such as "Have you ever been told by an MD you have a mental illness?". The outcomes of this study indicate that states with legal use of marijuana should focus on strategies preventing childhood use of the drug and educating the population on the impacts of childhood marijuana use.

5.4 Conclusion

In conclusion, these findings from a nationally representative sample of U.S. adults aged 18 and older reveal the positive associations between early onset marijuana use (aged 14 or young) and poor mental health outcomes in adult life. Given the findings that early onset marijuana use more than doubles the odds of reporting a past year serious mental illness, legislations considering legalization of marijuana should take into account the exposure of children to the drug. Strategies for the prevention of early onset marijuana use should be

established within the U.S. to address this issue. Mental health clinicians should use assessment

tools to determine if their patient's are at risk for serious mental illness due to their early onset

marijuana use.

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Table 1: Demographic Variables of Interest

Variable Name	Code	Description	Levels	Percent
Sex	IRSEX	Self-reported sex at time of survey	1=Male 2=Female	47.62 52.38
Education Level	EDUCCAT2	Self-reported education level at time of survey	1= Less than high school 2= High school graduate 3=Some college 4=College graduate 5= 12 to 17 years old	10.18 22.68 21.65 20.88 24.61
Age	CATAG7	Self-reported age at time of survey	1= 12-13 years 2= 14-15 years 3= 16-17 years 4= 18-20 years 5= 21-25 years 6= 26-34 years 7= 30 years or older	7.88 8.46 8.27 8.77 14.88 15.18 35.57
Race	NEWRACE2	Self-reported racial/ethnic identity	1= Non-Hispanic White 2= Non-Hospice Black/African American 3= Non-Hispanic Native American/Alaskan Native 4= Non-Hispanic Native Hawaiian/Other Pacific Islander 5= Non-Hispanic Asian 6= Non-Hispanic more than one race 7= Hispanic	60.67 12.11 1.64 0.54 4.26 3.54 17.23
Income	INCOME	Total family income in the past year	1= Less than $20, 000 2= $20, 000-$49, 999 3= $40, 000-$74, 999 4+ $75, 000 or	21.07 31.01 16.26 31.65

Table 2. Descriptive statistics of the analytic sample

Demographic Variable	Frequency n =41285	Percent
Age		
18-20	4, 782	5.44
21-25	8, 139	9.08
26-34	3, 331	15.79
35 or older	20, 033	69.67
Gender		
Male	19, 210	48.17
Female	22, 075	51.83
Race		
White	25, 832	65.36
Black/African-American	4, 862	11.71
Native American/Alaskan Native	669	0.50
Native Hawaiian/Pacific Islander	220	0.38
Asian	1, 818	5.24
Multi-racial	1, 244	1.55
Hispanic	6, 640	15.27
Education Level		
< High School	5, 544	13.13
High School Graduate	12, 389	28.86
Some College	11, 870	27.29
College Graduate	11, 482	30.71
Income Level (U.S. Dollars)		
< 20, 000	9, 129	18.10
20, 000-49, 999	13, 098	30.98
50, 000-74, 999	6, 786	16.72
75, 000 or greater	12, 272	34.20

Source: National Survey on Drug Use and Health, 2014

Table 3. Chi square results of association between demographic characteristics and early onset marijuana use

Demographic Characteristic	Early Onset Use		Non-Early Onset Use		P-Value
	Frequency	Weighted Percent	Frequency	Weighted Percent	
Age					
18-20	621	0.7	4161	4.7	<.0001
21-25	1033	1.1	7106	8.0	
26-34	1105	2.0	7226	13.8	
35 or older	1562	4.5	18471	66.1	
Gender					
Male	2413	5.1	16797	43.2	<.0001
Female	1908	3.3	20167	48.5	
Race					
White	2818	5.9	23014	59.5	<.0001
Black/African-American	464	0.9	4398	10.8	
Native American/Alaskan Native	133	0.07	536	0.42	
Native Hawaiian/Pacific Islander	29	0.3	191	0.34	
Asian	41	0.08	1777	5.2	
Multi-racial	214	0.2	1030	1.3	
Hispanic	622	1.1	6018	14.1	
Education Level					
< High School	896	1.4	4648	11.7	<.0001
High School Graduate	1493	2.7	10896	26.1	
Some College	1246	2.5	10624	24.8	
College Graduate	686	1.6	10796	27.2	
Income Level (US Dollars)					
<20, 000	1199	1.9	7930	16.2	<.0001
20, 000-49, 999	1455	2.7	11643	28.9	
50, 000-74, 999	662	1.3	6124	15.4	
75, 000 or greater	1005	2.4	11267	31.8	

Table 4. Chi square results of association between dependent variables and early onset marijuana use

Dependent Variable	Early Onset Use n=4321		Non-Early Onset Use n=36964		P-Value
	Frequency	Weighted Percent	Frequency	Weighted Percent	
Depressive Episode in Last Year(AMDELT)					
Yes	996	1.87	4920	11.07	<.0001
No	3325	6.45	32044	80.61	
Any Mental Illness in Last Year(AMIYR_U)					
Yes	1353	2.17	6956	13.74	<.0001
No	2968	5.84	30008	75.94	
Severe Mental Illness In Last Year(SMIYR_U)					
Yes	397	0.74	1594	3.45	<.0001
No	**3924**	**7.57**	**35370**	**88.24**	

Table 5. Odds Ratios of Early Onset Marijuana Use and Indicators of Adult Mental Health

Mental Health Variable	Early Onset Use		
	OR	95% CI	P-Value
Depressive Episode in Last Year(AMDELT)	2.107	1.891-2.347	<.0001
Any Mental Illness in Last Year(AMIYR_U)	2.040	1.848-2.252	<.0001
Severe Mental Illness In Last Year(SMIYR_U)	**2.497**	**2.127-2.931**	**<.0001**

Table 6. Adjusted Odds Ratios of Early Onset Marijuana Use and Indicators of Adult Mental Health

Mental Health Variable	Early Onset Use		
	OR	95% CI	P-Value
Depressive Episode in Last Year(AMDELT)	2.133	1.906-2.389	<0.001
Any Mental Illness in Last Year(AMIYR_U)	1.990	1.794-2.208	<.0001
Severe Mental Illness In Last Year(SMIYR_U)	**2.332**	**1.972-2.758**	**<.0001**