
Epidemiology, Health Implications, and Resilience Factors in Adolescent Marijuana Use: A Comprehensive Review

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Abstract: *Background:* Marijuana is a very common illicit drug used across the United States and around the world. It has many adverse effects on adolescents and societal health. Among adolescents, it can cause chronic brain damage and psychoactive effects. This literature review aims to discuss topics concerning the epidemiology of marijuana use, adverse health consequences, and risk and protective factors. In addition, the concept of resilience was explored in-depth. *Review:* Most marijuana users start in their adolescence. As the legal and social perspective of marijuana is beginning to change, many adolescents are beginning to view marijuana as harmless. However, marijuana use has negative effects on adolescents, such as on their brain development and neurocognitive functions. To prevent adolescents from engaging in marijuana use, researchers have identified risk and protective factors. In our review, we identified more risk factors for marijuana use than protective factors. Understanding these factors can help in developing intervention approaches and nurturing positive adaptation skills. Finally, regarding resilience and marijuana use, two levels could be identified, namely asset and contextual resource levels. *Conclusion:* The prevalence of marijuana use was found to be increasing among adolescents. In addition, the adverse consequences of marijuana use on adolescents were found to be pronounced, with both long- and short-term effects. Lastly, extensive insights were gained on the risk and protective factors related to marijuana use. Further research in relation to marijuana use and adolescents should look into ethnicity differences, social and economic costs, as well as analyzing resilience-associated protective factors that can aid in developing preventive interventions regarding marijuana use.

Keywords: Adolescents, Cannabis, Marijuana, Health Consequences, Risk Factors, Protective Factors, Resilience

1. Introduction

Marijuana (also known as cannabis) is a psychoactive drug obtained from the cannabis plant. If consumed, it can affect one's mood and nearly every body organ, and not only does it affect the person taking the drug but society as well. In many countries, the possession and/or sale of this drug is illegal. The United States is one of many countries where the general use, sale, or possession of marijuana is illegal under federal law. However, various states have liberalized laws regarding marijuana use on a state-level. In Colorado and Washington, recreational use of the drug has been liberalized since 2012, with many states following suit. Because of this liberalization, the access to this drug has become easier for many people, including adolescents. Adolescents are at a critical stage of life development and while marijuana may have its positives, there are also negatives which, if left unchecked, could

hamper the performance of adolescents not only at school but in their normal day to day function. Hence, the necessity of exploring this topic. In view of this, this literature review aims to investigate various studies concerning the epidemiology of marijuana use, adverse health consequences, and risk and protective factors. In particular, resilience was explored in-depth.

2. Epidemiology of Marijuana Use in Adolescents

In the United States, the recreational use of the psychoactive drug marijuana (also known as cannabis) first became legalized in Colorado and Washington in 2012, and since then, more states have followed suit and changed their respective laws. Despite this, the use, sale, and possession of

this drug (a Schedule I controlled substance) remain illegal at the federal level [14]. Under the Adult Use of Marijuana Act (AUMA), the recreational use of marijuana became legal in California in 2016. Moreover, the commercial sale and distribution of marijuana at California state-licensed facilities became legal from January 1, 2018.

According to the 2018 National Survey on Drug Use and Health (NSDUH) conducted by the Substance Abuse and Mental Health Services Administration [22], an estimated 43.5 million Americans aged 12 or older used marijuana in the past year. Approximately 3.1 million marijuana users were aged 12–17 (adolescents), corresponding to 12.5 percent of the total population (1 in 8 adolescents). The estimated number of marijuana users among adolescents in 2018 was similar to the estimate in 2017. Regarding the initiation of marijuana use, the estimated number among adolescents was 1.3 million, reflecting approximately 3,700 new uses each day [22].

Most marijuana users started during their adolescence; it is considered a “gateway” drug for other substance use. Keyes et al. [8] conducted a cross-sectional survey regarding the trends of onset and sequence of alcohol, cigarette, and marijuana use among adolescents. Their study indicates that the trend of marijuana as the first substance use among adolescents is increasing. The United States is an ethnically diverse nation. However, the 2018 NSDUH did not explore the complicated picture of ethnic group differences, particularly among adolescents. Johnson et al. [7] investigated the prevalence of marijuana use among teenagers of different ethnic backgrounds in Washington. They found a lower prevalence of marijuana use among Whites and Asians, whereas marijuana use was high among American Indians/Alaska Natives, Blacks, and Hispanics/Latinos. Thus, future research is needed to explain these differences in marijuana use among Whites, Asian Americans, African Americans, and Hispanics.

As public acceptability and the law changes, most adolescents—unsurprisingly—are beginning to perceive marijuana as harmless. According to the 2018 NSDUH, only 34.9 percent of adolescents believed the potential risk of weekly marijuana use [22], which was lower than reported from 2015 to 2017. In contrast, the figure was at 79.6 percent for cocaine use. Accumulated evidence suggests that long-term marijuana use can lead to substance addiction. Specifically, among adolescents, it can trigger many problematic health issues. In the 2018 NSDUH report, the estimated number of adolescents meeting the DSW-IV criteria for marijuana use disorder was about 512,000—representing 2.1 percent of adolescents aged 12 to 17 [22]. Hence, any perception that marijuana is harmless should be addressed.

Numerous initiatives have been started to address health issues. Healthy People 2020 is a national initiative seeking to improve Americans’ health. Its goal regarding substance abuse is to “reduce substance abuse to protect the health, safety, and quality of life for all, especially children.” (Healthy People 2020). Among other things, the initiative seeks to “increase the proportion of adolescents never using substances,” with a goal of increasing the proportion of “at

risk adolescents aged 12 to 17 years who, in the past year, refrained from using marijuana for the first time” (Healthy People 2020). Briefly, the target was set at 96.3 percent, 2 percent up from a baseline of 94.3 percent. To achieve this goal, primary care providers need to initiate the screening, brief intervention, and referral to treatment (SBIRT) protocol in clinical settings for adolescents [11] and deliver early intervention and provide treatment to adolescents who are at risk of developing substance use disorders [1].

3. Consequences of Marijuana Use and Abuse

Marijuana use has both its positives and negatives. Marijuana is a drug that derives as a crude product of the *Cannabis sativa* plant, which consists of over 60 cannabinoids [5]. The non-psychotomimetic cannabidiol (CBD) is attributed for its therapeutic use, such as in the treatment of severe nausea and vomiting due to cancer chemotherapy [10], weight loss–associated anorexia, chronic inflammatory and neuropathic pain syndrome, and neurological disorders [10, 19]. On the other hand, the plant’s major active ingredient is tetrahydrocannabinol (THC) [5], which is responsible for psychoactive effects.

The common methods of marijuana consumption include smoking, vaporizing, and edibles (i.e., cannabis-infused food, drinks, and candies) [20]. Edibles are very popular among young adults, according to a qualitative Colorado-based study [13]. However, the onset of marijuana effects through edibles compared to smoking and vaporizing is somewhat delayed due to first-pass metabolism, so youths tend to consume more. Marijuana-related pediatric emergency department visits have reportedly significantly increased in recent years, with the majority of cases being related to the ingestion of edibles [2, 24]. Significant marijuana acute toxicity has been reported to include encephalopathy, coma, and respiratory depression [29].

According to a study by Mokrysz, et al. [16], adolescents were found to be more vulnerable to the adverse effects of marijuana than adults. Following marijuana use, adolescents were reported to be less stoned and had fewer psychotomimetic symptoms than adults; however, marijuana caused problems in response inhibition accuracy among adolescents, not adults. In testing marijuana desire, the adolescent group did not show a typical satiety effect after the administration of cannabis, and instead, they wanted more. These findings may be related to the increasing use of marijuana among adolescents.

The consequences of chronic marijuana abuse include neurocognitive changes and cannabinoid hyperemesis syndrome (CHS). In a study by Volkow et al. [26], chronic marijuana abuse was found to possibly contribute to neurocognitive change via decreased dopamine brain reactivity. A systemic review has summarized the adverse effects of marijuana use at the neuropsychological, neuroanatomical, and neurotransmitter levels [15] and these

include short-term effects (e.g., impaired short-term memory, impaired motor coordination, high-dose related paranoia, and psychosis) and long-term consequences (e.g., addiction, brain damage, poor school performance, cognitive impairment, decreased life satisfaction, increased risk in chronic bronchitis, and chronic psychosis disorders) [15, 25]. To investigate the impact of substance use—including marijuana use—on adolescent brain development and neurocognitive functions, and the relationship between substance use and psychopathology, the National Institute of Health (NIH) launched a large-scale adolescent brain cognitive development (ABCD) study in September 2015—the largest longitudinal cohort study on the effects of substance use on the developing adolescent brain. Moreover, this study also expands our understanding of the risk and protective factors of substance use, including marijuana use.

The Centennial Institute at the Colorado Christian University [6] recently published a comprehensive report about the economic and social costs of legalized marijuana and marijuana use. The key findings from their report indicate that there is a connection between marijuana use and other substance use such as alcohol; the ratio of under the influence of marijuana use was found to be as high as 27 percent on a daily basis; marijuana users tended to be less physically active, which is associated with increased medical costs; lower educational attainment was found among marijuana users;

cost estimates from light users to heavy users were between \$650 to \$2,200 per year; and the electricity used by the marijuana industry could power 32,355 homes in 2016. The findings of this report encourage further investigation on the effects of marijuana use in the community.

4. Risk and Protective Factors

The use of marijuana among adolescents can be very problematic. The development stage of adolescents at this point in their lives is unique socio-psychologically, characterized by an undefined status, increased decision making, and increased school pressure and self-identity, and physiologically, characterized by hormones and brain regions experiencing dynamic changes. Because of this, this age group is very vulnerable to marijuana exposure. The first step in the prevention of marijuana use is to identify and understand the risk and protective factors. The Center for the Application of Prevention Technologies (CAPT) [21] has systemically summarized risk and protective factors into four levels using the socio-ecological model, namely the individual level, relationship level, community level, and societal level (Table 1). Collectively, community resources, school environments, family dynamics, peers' pressure, and social influence can all be considered as risk factors and protective factors at different levels [21].

Table 1. Risk Factors and Protective Factors for Marijuana Use in Adolescents (SAMHSA, 2014).

	Risk factors	Protective factors
Individual level	Poor school performance	
	Truancy	
	Conduct disorder symptoms at early age	
	Self-control and attention problems at early age	
	Impulsivity	
	Antisocial personality disorder	
	Depression	
	High sensation seeking	
	Anxiety	
	Aggressive behavior	Intention not to use marijuana
	Bullying perpetration (females)	Higher religiosity
	Delinquency attitudes	Good sleep habits
	Positive attitudes toward marijuana use	
	Intention to use marijuana	
Belief that marijuana relaxes and reduces tension		
Perception of norms and easy to access and greater availability		
Positive attitudes towards drugs		
Bars visiting		
Cigarette smoking at early age		
Alcohol at early age and intoxication		
Family dysfunction (divorced or separated parents)		
Higher parental education and income		
Higher socio-economic status	Father communication	
Parental use	Parental monitoring	
Parental incarceration	Monitoring at early age (Latinas)	
Single mom family	Mother's disagreement of marijuana use	
Relationship level	Alcoholic father	Living with married mother
	Smoking parents	Effective parent-child communication
	Low level of parental monitoring	High level of parental monitoring
	Homeless and foster parental history	Parental support
	Poor economic status	Fewer friends using marijuana
	Peer's using marijuana	
	Deviant friends	

	Risk factors	Protective factors
Community level	Friends who smoke Normative beliefs about peer's using Popularity Competitive sports player Neighborhoods disorders Poverty of neighborhood Availability and or opportunities to use Community norms Community permissive of substance use neighborhood (crime and drug dales) metropolitan areas low levels of school commitment	Cohesion of neighborhood Good academic performance in middle schools
Societal level	Male gender Popular media Discrepancy of parent-child 2 nd generation Immigrant status	High subjective social status Religious beliefs and practices

We cannot neglect the factor of medical marijuana law (MML) change (i e., marijuana liberalization) that can affect the levels of risk and protective factors, such as the availability of marijuana and individual perception of norms. Current evidence supports the hypothesis that state-level MML changes, individual norms, and perceptions of harm are associated with an increase in the initiation of marijuana use. Sarvet et al. [23] conducted a systematic review and meta-analysis regarding the effects of MMLs on marijuana use prevalence among adolescents, and their research indicated a significant increase in marijuana use after the liberalization of MMLs. Future study is needed to explore and delineate these phenomena and may warrant policymakers to change laws and protect the youth by limiting access to marijuana. In conclusion, we have identified more risk factors for marijuana use than protective factors. Understanding both risk and protective factors among adolescents is a pivotal step in developing intervention approaches and nurturing positive adaptation skills in the context of significant adversity.

5. Implications for Practice

Resilience is “a dynamic process encompassing positive adaptation within the context of significant adversity” [12]. The concept of resilience emerged due to a paradigm shift from a medical model of identifying problems to a more strengths-based approach based on emphasizing internal and external strengths [28]. By definition, resilience reflects the capacity to overcome adversity and return to the state of homeostasis [3]. From a psychological perspective, resilience consists of three domains: risk factors, protective factors, and vulnerability factors [3], while the process model of resilience consists of four phases: confrontation with risk factors, activation of protective factors, interaction of protective factors, and possible outcomes [3].

Previously, we have reviewed the risk and protective factors in terms of marijuana use among adolescents, and resilience was found to be positively associated with protective factors and negatively related to risk factors/vulnerability factors. To be resilient from marijuana use, an individual must demonstrate positive adaptation through an amplification of protective factors. The three

models approach of compensatory, protective, and challenge have been used in guiding resilience research [30].

In terms of resilience of marijuana use, many researchers have examined whether family functioning (e g., support, monitoring, education, etc.) may show protective influences such as helping youth to retain positive adaptation when exposed to risks. In their study, Murray et al. [17] suggested that resilience can be gained and reinforced by focusing on self-regulation—systematically taught cognitive and emotional coping skills acquired during adolescence. In addition, from an ecological perspective, resilience can be reinforced through educating caregivers to model, coach, and reinforce, as well as supporting self-regulation skills development and the establishment of a co-regulation model [17]. This can be reflected among the protective factors in the relationship level, such as father communication, parental monitoring, parental support, mother's disagreement of marijuana use, effective parent-child communication, etc. This approach has also been explained as a compensatory model of resilience theory.

Similarly, Kliewer and Parham's two-year longitudinal study [9] investigated low-income, urban-dwelling African Americans to study the role of promotive factors, including parental support, goal-directness, religious coping, and emotion regulation, in the initiation of marijuana use. The Personal Experience Inventory (PEI) was used for the self-report data entry for adolescents. In their study, they found the following characteristics of abstainers: younger, good self-control of emotions, and religious beliefs. The strengths of this study include its longitudinal design, focusing on a particular ethnic group (i e., low-income, African American adolescents), evaluation of the initiation of marijuana use, and investigation of promotive factors associated with the concept of resilience.

To better understand the profile of someone who is “cannabis-resilient,” Andreas et al. [4] conducted a cross-sectional study among 19,303 middle and high school students from 82 schools in Norway. They found that proactive parent-child relationships, no close relationships with peers using marijuana, low delinquency, beliefs of drug use harm, and no tobacco and alcohol use were all key characteristics of being “cannabis-resilient.” [4] The

limitations of this study include its cross-sectional design (i.e., phenomena description), student self-report accuracy, and that the skills used to reject marijuana use were not explored.

Focusing on resilience at the school level is very promising. Onrust et al. [18] conducted a series of meta-analyses on a school-based intervention program regarding smoking and alcohol and drug use aimed at different stages of adolescents' development—it was the first study that focused on strategies at different developmental stages among adolescents. In early adolescence, the social influence approach was found to be not related to the effectiveness of the program—refusal skill training was found to be minimally related to adverse outcomes of the program [18]. The social norm strategies, however, were related to positive results in this stage [18]. These strategies include norm-focused discussion groups, feedback, and the use of role models [18]. An example of such a strategy would be teaching students that marijuana use is not normal and that most adolescent students at this age do not use this drug. Their findings also suggest that parental involvement is an effective approach in preventing drug use in early adolescence, which is consistent with the CAPT report [21]. In middle adolescence, cognitive behavioral therapy (e.g., teaching students how to cope with stress and anxiety) demonstrated more benefits for students of this age group. Peer education did not present promising data in the study, despite the characteristics of this age group wherein values and beliefs are predominantly influenced by their peers. In contrast, refusal skill training did have a negative influence on substance use [18]. In late adolescence, social influence approach and teaching refusal skills were effective. Health education combined with personal goals also demonstrated an effective prevention strategy. Moreover, basic skills training such as self-control, problem-solving skills, or decision-making skills training were indicated to be effective. Parental involvement and self-control training leads to more positive outcomes as well. Overall, the caring adult's involvement plays a critical role in helping adolescents through all developmental stages to overcome adversity. In addition, the study provides valuable insight regarding age-specific strategies in the resilience of marijuana use.

Watson et al. [27] investigated how school and the community climate, as resources, influence adolescents of a minority sexual identity (i.e., lesbian, gay, bisexual, transgender, and queer, LGBTQ) in term of substance use in Canada. In their study, they found that more community resources correspond to lower odds of marijuana use in girls. The accessible community-level resources for LGBTQs have been identified as activities and groups, advocacy organizations, social meetups, adolescent and young adult health clinics, places of worship, libraries, etc. [27]. This finding has important implications for community-based interventions for resilience, such as the need for more investments in community resources. Although this study demonstrates a valuable insight into the

associations between community resources and marijuana use in sexual minority adolescents at a community level, a limitation of this study is that, with data being from 2013, the study is not reflective of current political and law changes.

Taken together, the resilience of marijuana use can be classified as two levels: asset and contextual resource levels. Asset can be interpreted as individual protective factors such as ability of self-regulation, self-control, use-harm beliefs, etc. whereas resource can be explained as relationships with parents, community resources, and school-based education programs—for instance, parental-child communication, parental monitoring, parental support, etc. In actual situations, there are no significant boundaries between these two levels, however, there is an integration of asset features and resources, and this is called prosocial involvement [30]. In terms of prosocial involvement, encouraging youths to participate in extracurricular activities and be exposed to positive peers are all ways to enhance adolescents' resilience—focusing on protective factors to overcome adversity.

6. Conclusion

The purpose of this review was to investigate the topic of marijuana use and adolescents. In particular, it examined the epidemiology of marijuana use, adverse health consequences, and risk and protective factors. Moreover, it looked at the concept of resilience in-depth. From the research reviewed, several conclusions can be drawn. First, the prevalence of marijuana use is increasing, potentially, among adolescents. Ethnicity difference in marijuana use has been reported and further study is needed to address this disparity. Second, the adverse consequences of marijuana use on adolescents are pronounced and range from short- to long-term effects. Social and economic costs of marijuana use need further study. Third, extensive insights were gained concerning the risk and protective factors related to marijuana use. Analysis of resilience-associated protective factors can aid in the preventive intervention of marijuana use by emphasizing the integration of personal assets and contextual resources-prosocial involvement. Overall, the use of marijuana among adolescents must be carefully investigated in order to ensure the general health and wellbeing of these people.

Abbreviations

AUMA: Adult Use of Marijuana Act

NSDUH: National Survey on Drug Use and Health

SAMHSA: Substance Abuse and Mental Health Services Administration

CAPT: Center for the Application of Prevention Technologies

SBIRT: screening, brief intervention, and referral to treatment

CBD: Cannabidiol

THC: tetrahydrocannabinol

CHS: cannabinoid hyperemesis syndrome
 NIH: National Institute of Health
 ABCD: adolescent brain cognitive development
 MML: medical marijuana law
 PEI: Personal Experience Inventory.

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