A Scoping Review of Risk and Protective Factors for Negative Cannabis Use Consequences

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ABSTRACT

OBJECTIVE: Numerous reviews have examined risk and protective factors for alcohol-related negative consequences, but no equivalent review of risk and protective factors exists for cannabis-related negative consequences (CRNCs)-a gap filled by the present study. This scoping review examined survey-based research of risk and protective factors for CRNCs such as neglecting responsibilities, blacking out, or needing more cannabis.

METHODS: Three databases (PubMed, PsycINFO, and Google Scholar) were searched for peer-reviewed manuscripts published between January 1, 1990, and December 31, 2021. A qualitative synthesis was performed using the matrix method and the results were organized using the socioecological model as a framework.

RESULTS: Eighty-three studies were included in the review. There was considerable variation in measures and operationalizations of CRNCs across studies. Risk factors were identified in the *intrapersonal* (depression, social anxiety, PTSD, impulsivity, sensation seeking, motives, expectancies), *interpersonal/community* (trauma, victimization, family and peer substance use, social norms), and *social/policy* (education, employment, community attachment, legalization, availability of substances) domains of influence. Protective behavioral strategies were a robust protective factor for CRNCs. Males consistently reported more CRNCs than females, but there were no differences observed across race.

CONCLUSIONS: Future research should identify person- and product-specific patterns of CRNCs to refine theoretical models of cannabis misuse and addiction. Public health interventions to reduce the risk of negative consequences from cannabis should consider utilizing multilevel interventions to attenuate the cumulative risk from a combination of psychological, contextual, and social influences.

KEYWORDS: Marijuana, cannabis, consequence, problem, misuse, review

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From policy to practice, there have been notable changes in the public perception of cannabis use including public support for state-level changes in the medicalization and legalization of cannabis throughout the United States,[1,2] and changes in modes of consumption including the rise of "vaping" THC.[3,4] Not surprisingly, as attitudes toward cannabis use (or marijuana use) have become more favorable, the prevalence of cannabis use has increased from 10.4% in 2002 to 15.4% in 2017,[5] and among adults in the United States, cannabis use disorder (CUD; being unable to stop using cannabis despite it causing health and social problems) treatment rates have increased. Cannabis use has been linked to long-term adverse health outcomes including vaping-induced lung injury, cardiovascular problems, and mental illness.[6-8] Therefore, identifying what factors are associated with the proximal consequences of cannabis use is an important step toward developing prevention and intervention programs that can interrupt the progression toward disorder (eg, cannabis use disorder) and potential downstream negative outcomes.

Cannabis-related negative consequences (CRNCs) are defined here as the harmful effects for users in the psychological (needing more cannabis to get high, etc.), interpersonal (getting into fights with friends or family, etc.) and social (being late for school/work, etc.) domains.[9] While there are merits to examining the associations between substance use and specific consequences—such as driving under the influence—most research tends to aggregate negative consequences to ascertain the global burden of substance use on overall health and well-being. Self-report assessments measuring CRNCs include, among others, the Marijuana Problem Scale (19-items; example "Has marijuana ever caused you to neglect your family"),[10] the Marijuana Problem Index (29-items, example "Passed out or fainted suddenly"),[11] the Cannabis Problems Questionnaire (27-items, example "Have you felt more antisocial after smoking?"),[12] and the Marijuana Consequences Questionnaire (50-items, example "I haven't been as sharp mentally because of my marijuana use"),[13] Reviews of psychometric properties and the application of

these scales in community and clinical practice are available elsewhere.[14,15]

Some of the aforementioned scales assessing CRNCs have been adopted from research investigating alcohol-related negative consequences (ARNCs) with "marijuana" being substituted for "alcohol" in some cases. As such, it is pertinent to consider the breadth of evidence explaining experiences of ARNCs as this has likely influenced the existing work done to document and describe experiences of CRNCs. To date, there have been several reviews of ARNCs, or problem alcohol use, across multiple populations (youth, college students, adults, treatment seeking populations, clinical populations, etc.). Zucker et al [16] reviewed early developmental processes in relation to underage drinking and problem drinking while other researchers have focused on predictors of co-occurring problems involving alcohol[17] or initiation of alcohol in adolescence leading to future problem alcohol use.[18] Grigsby et al[19] documented risk and protective factors for ARNCs among adolescents noting important psychological (eg, impulsivity and sensation seeking), interpersonal (eg, peer use, family history) and societal influences (eg, media exposure) as well as differences by demographic characteristics (such as sex or gender and race or ethnicity). Not surprisingly, most reviews on ARNCs have focused on college student populations[20-23] as these are the peak years for risky alcohol use behavior and diagnosis of alcohol dependence.[24]

This is not the first review to explore the causes and consequences of cannabis use though many have focused on a narrow set of adverse physical, behavioral, or social outcomes. A review of neuropsychological studies[25] found that adolescents who use cannabis heavily tend to have disadvantaged attention, learning, and processing speed; subtle abnormalities in brain structure; increased activation during cognitive tasks despite intact performance; and compromised objective indicators of sleep quality. Gordon et al[26] described the extant evidence base indicating that cannabis has physical health effects on humans—particularly diseases of the liver—aside from mental and behavioral health, and societal morbidity. Blavos et al[27] reviewed cannabis use among college students and identified 7 studies assessing CRNCs measured as academic problems, legal issues, enrollment disruptions and unsafe sexual practices and a few that focused on substance-related traffic risk, including driving while high or riding with a driver who was high. Two of the studies examined neurobiological consequences and reasons for cannabis use, and one focused on physical health outcomes. One meta-analysis[28] identified cannabis use frequency and quantity had a medium-sized association with consequences although there were high levels of heterogeneity and differences across the self-report measure used. Pearson[28] concluded that additional factors—psychological, behavioral, and social correlates of substance (ie, risk and protective factors)—are likely important in predicting who does and does not experience CRNCs. As such, this review fills an important gap in the literature by synthesizing existing research focused on risk and protective factors for CRNCs in non-institutionalized populations across multiple domains of functioning using standardized measures (described above). In addition to explaining factors that might contribute to risk for experiencing CRNCs beyond cannabis use behavior itself, this review can assist practitioners with identifying potential intervention targets.

Organization and categorization of results in this review are guided by asocial-ecological framework.[29] The social-ecological model considers the complex interplay between individual, relational, community, and societal factors in predicting and explaining health behaviors. Moreover, this model can benefit practitioners by identifying intervention targets for reducing cannabis use and related consequences by summarizing the independent and combined contributions of individual (eg, expectancies, motives, beliefs, and attitudes), relational (eg, peers, family, teachers), community (eg, media messaging, school, and work policies), and societal factors (eg, media, policy, built environment) that influence the likelihood of experiencing CRNCs. This is crucial for the development of community-based intervention programs. While the social ecological model can inform social or policy intervention targets—changes beyond the individual level—it does not provide guidance on specific variables within those levels of influence that should be targeted. As such, identifying mediators (ie, a variable that explains the process through which 2 variables are related) and moderators (ie, variables that influence the strength or direction of a relationship between 2 variables) at various levels of influence can increase the efficacy of interventions and improve our ability to customize them for specific populations or across contexts.

Current study

Experiencing recurring CRNCs is likely indicative of a pattern of misuse, and potentially an early warning sign of addiction and future diagnosis of CUD.[30] Describing the methods, measures and correlates used to study the incidence, prevalence, and etiology of CRNCs can guide clinical and public health professionals in developing screening and early intervention protocols for cannabis users experiencing use related negative consequences. The goal of the present review is to examine the literature on risk and protective factors for CRNCs (ie, problematic cannabis use) in observational research with community populations.

Methods

The PRISMA for Scoping Reviews (PRISMA-ScR) statement[31] has been followed where applicable to ensure accuracy and transparency of this review and its methodology (Supplemental Table 1). No protocol was published in advance. Computer-based searches of Google Scholar, PubMed, and PsycINFO were conducted to search for publications between

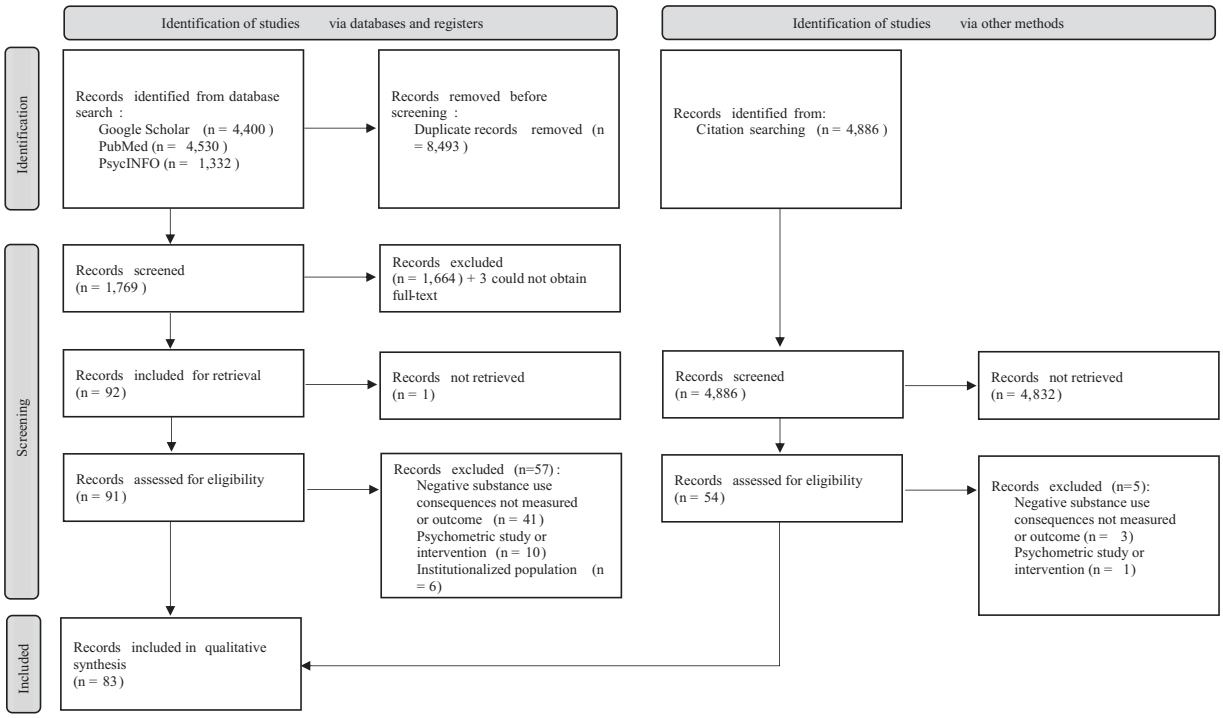

Figure 1. PRISMA flow chart.

January 1, 1990, and December 31, 2021 (see Supplemental Table 2 for sample search strategy). We combined search terms for cannabis use (marijuana, cannabis, THC), negative consequences (abuse, misuse, problem, problematic, "negative consequence"), and study design (survey, questionnaire, self-report). Additionally, we searched the "cited by" articles in Google Scholar of validated CRNC scales described in the introduction. The combination of reference and keyword searches increases the likelihood of identifying articles using validated and non-validated measures of CRNCs. A total of 83 manuscripts were included in the final review. Figure 1 provides a flow diagram for the literature search and selection process.

The following inclusion criteria were used to select articles for the review: (1) the outcome was cannabis-related negative consequences, (2) the data were from observational research with any time frame (cross-sectional, prospective, retrospective), (3) the sample was non-clinical, and (4) the work was published in an English language peer-reviewed journal. Articles were excluded if (a) authors reported consequences of alcohol use or other drugs (eg, stimulants, opioids, hallucinogens) as the sole outcome, (b) CRNCs were a predictor of other health or behavior outcomes, (c) the study reported results of an intervention or treatment to reduce CRNCs, or (d) the article was a methodological study, experimental study, or a non-peer reviewed work. Studies that defined the outcome of interest as a risky behavior (eg, escalation of use, transition from one drug to another) were not considered as we were not interested in frequency or quantity of use as the outcome, but rather in the negative consequences that result from cannabis use (eg, accidents, injuries, neglecting responsibilities). Articles were screened at the title and abstract stage by 2 co-authors and the at the full-text stage by the lead author. Differences of views about inclusion were resolved through discussion and consensus with the other authors.

Data extraction and information synthesis

We consulted the Matrix Method guidelines[32] for data extraction and information synthesis of the literature. The lead author and 2 co-authors abstracted author names and year of publication, study design (cross sectional, follow-up with data from 2 time points or longitudinal with data from 3 or more time points), sample characteristics (sample size, age, sex or gender, race or ethnicity), hypothesized predictors, mediators, moderators, and covariates, measurement and operationalization of negative consequences, and a summary of the main findings. We structured the results section and associated tables using the social-ecological model as a framework. As such, themes of risk and protective factors for CRNCs are presented within the theoretical domain (eg, level of influence) of the appropriate predictor including intrapersonal factors (those influencing behavior such as knowledge, attitudes, beliefs, mental health, and personality), interpersonal factors (social norms and relationships with family and peers), and social/policy factors (community attachment, drug use policy and availability, social determinants of health). We also investigated the influence of frequency and quantity of use. Finally, we explore gender and racial/ethnic differences in (a) predictors of CRNCs and (b) types and patterns of CRNCs experienced.

Results

Cannabis-related negative consequences (CRNCs) were the main outcome of all studies; however, some reports described the outcome as "cannabis abuse," "problem use," "cannabis use problems," "cannabis misuse," or "problematic cannabis use." When interpreting the findings of this review there are 2 important considerations; first, a combination of validated, investigator-modified, and investigator-created self-report measures were used (Table 1), and the conceptualization and operationalization of CRNCs varied as a result—like review findings for alcohol-related negative consequences.[19] Second, negative consequences were observed over different time periods (ie, past week, past month, past year, etc.) and settings (ie, school based, community based). As shown in Table 1, the majority of studies (n = 83) identified in this review were cross-sectional (75.9%). The main findings of studies are presented in Supplemental Table 1.

Cannabis use behaviors (Age of onset, frequency & quantity of use, product type)

There was no evidence of a linear, or dose-response, association between frequency of cannabis use (number of times used over a predefined time frame) and experience of CRNCs across 3 longitudinal,[33-35] 2 cross-sectional[36,37] studies. Age of initiation was discussed in several cross-sectional studies,[38-43] but the association between age at first use and the risk of experiencing CRNCs remains unclear with no evidence of direct effects. Frequency of use was a significant mediator for substance use motives[44] and experiencing CRNCs in another cross-sectional study. Frequency of use reduced the significant association between urgency and cannabis problems to non-significance in one cross-sectional study[45] and Luba et al 's[46] cross-sectional analysis showed that as the level of savoring (ie, the ability to recognize and appreciate positive experiences) decreased, the association between frequency of cannabis use and related consequences increased. High potency THC concentration was associated with increased odds of experiencing CRNCs among adolescents in a longitudinal study[47] and young adult college students in a cross-sectional study,[48] but potency did not predict dependence scores in another cross-sectional study of adults.[49] One cross-sectional analysis[50] identified a frequency-by-quantity interaction where CRNCs decreased as frequency increased, and vice versa while another cross-sectional study found wide variation in perceptions, use, and CRNCs.[51] Two longitudinal studies[52,53] and 2 cross-sectional studies[36,37] suggest severity of CRNCs may be a function of cannabis product use, product types, and patterns. Lastly, one cross-sectional study reported young adults endorsing CUD criteria reported more types of cannabis related problems,[54] and another longitudinal study showed that problems grow as individuals transition from adolescence to young adulthood.[55]

Intrapersonal influences

Anxiety and depression. Experiencing stressful life events and reporting higher perceived stress is associated with more CRNCs and were moderated by level of emotion dysregulation in one cross-sectional study.[56] Multiple forms of anxiety were investigated in relation to CRNCs; however, all studies were cross-sectional in nature. There is limited and mixed evidence to support social anxiety as a direct predictor of CRNCs.[57,58] Social anxiety may moderate the association between social norms and cannabis use problems,[59] and one study reported social anxiety was indirectly associated with cannabis-related problems through solitary use frequency.[60] Social anxiety was also associated with CRNCs via underutilization of protective behavioral strategies (ie, planned behaviors to decrease the use of cannabis) and serial effects with cannabis use frequency and peak quantity[61] as well as the effect on negative and positive affect and sequential effects on frequency of use and problems.[62] For men, but not women, the association between social anxiety symptoms and cannabis use problems may be mediated by safety behaviors—cognitive or behavioral strategies used to mitigate social anxiety, such as avoiding eye contact.[63] Anxiety sensitivity might also be a correlate of CRNCs[64] though evidence is scant. One study identified symptom severity of obsessive-compulsive disorder (OCD) as a significant correlate of CRNCs after adjusting for stress, depression, and general anxiety[65] while another study found features of schizotypy a were associated with CRNCs cross-sectionally and prospectively.[33] Psychological factors were examined in several studies as a predictor and mediator of CRNCs. Depression and depressive symptomology were a significant predictor of CRNCs in one longitudinal study[34] and across 3 cross-sectional studies[58,60,66] and was a confounder of associations in a cross-sectional study.[67]

Impulsivity and sensation seeking. Impulsivity is acting, or tending to act suddenly, without careful forethought of the outcome of ones' actions that has been conceptualized as a multidimensional construct comprising elements of a state (thoughts or behaviors unique to a point in time) and trait (a pattern of characteristics that generalize across time).[68] Several cross-sectional studies described an association between higher scores on self-reported impulsivity measures and the experiences of CRNCs.[44,57,69-71] Sensation seeking—the trait of seeking novel and intense experiences—was also significantly associated with CRNCs[45,70,72] with one exception, a significant, negative association to CRNCs among persons with relatively low use of protective behavioral strategies (ie, acting as a mediator for the risk and protective factors of cannabis consequences).[73] There were no longitudinal studies investigating this relationship identified in our search.

Motives and expectancies. Substance use motives refer to reasons for using drugs, such as coping with distress or enhancing a positive mood, whereas expectancies represent "if-then" contingencies regarding the outcome of a substance use behavior. Motives were generally categorized as positive (including social and enhancement motives) and negative (including conformity and coping motives). One longitudinal study showed CRNCs

Table 1. Authors and year of publication, CRNC scale used, research design/setting, and sample characteristics for studies included in review.

AUTHORS/YEAR	SCALE FOR DV OF INTEREST	COUNTRY & SETTING	SAMPLE CHARACTERISTICS	THEMATIC DOMAIN
Longitudinal Studies (presented alphabetically)				
Anderson et al[81]	MRAPI (Modified Rutgers Alcohol Problem Index)	USA, Community	n=434; Age: age 12 at baseline and age 25 at time 4; 48% female; Ethnicity: 90% non-Hispanic White	Intrapersonal
Brown et al[33]	Cannabis Use Problems Identification Test (CUPIT), MACQ	USA, Community	n=230; Age: M=24.6 (SD:3.1); 50% female; Ethnicity: unknown	Frequency/Quantity of use Intrapersonal
D'Amico et al[101]	Cannabis Use Disorder Identification Test Short-Form (CUDIT-SF), MACQ	USA, Community	n=758; Age: 21.6 (SD=0.8); 49.2% female; Ethnicity: 44.1% Hispanic	Interpersonal Societal/policy Gender differences
Dyar et al[107]	CUDIT-R	USA, Community	n=321; Age: M=20.76 (SD:3.34); 77.9% female; Ethnicity: 33.6% African-American	Societal/policy Gender differences
Goodhines et al[35]	Adapted Severity of Dependence Scale	USA, High School	n=217; Age: M=19.33 (SD=1.11); 70% female; Ethnicity: 72% White	Intrapersonal
Hines et al[47]	CAST	USA, Community	n=1087 Age: M=16.7 (SD:3.0); 53.3% female; Ethnicity: 94.7% White	Frequency/Quantity of use
Kogan et al[113]	Investigator created measure	USA, Community	n=505; Age: M=20.3; 100% male; Ethnicity: 100% African American	Societal/policy
Metrik et al[34]	Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR) criteria	USA, Workplace	n=361; Age: M=33.56 (SD:9.44); 7% female; Ethnicity: 80.0% White	Intrapersonal Interpersonal
Oesterle et al[112]	DSM-IV Diagnostic Interview Schedule	USA, Elementary	n=808; Age at last time point: M=33 (SD=0.52); 9.0% female; Ethnicity: 47% White	Societal/policy
Pacheco-Colón et al[94]	Structured Clinical Interview for DSM IV	USA, Community	n=401; Age: M=15.4 (SD=0.72); 55.9% female; Ethnicity: 76.8% White	Intrapersonal
Patterson et al[74]	CUDIT	USA; College	n=1870; Age: M=20.7 (SD=1.9); 63.6% female; Ethnicity: 69.1% White	Intrapersonal Gender differences
Ramirez et al[96]	Marijuana-harm IAT, CUDIT-R	USA, Community	n=187; Age: M=20.3 (SD=1.8); 56% female; Ethnicity; 57.8% White	Intrapersonal
Simpson et al[52]	CAST	USA, Community	n=1007; Age: M=19.2 (SD=0.8); 36.7% female; Ethnicity: 48.2% Hispanic	Frequency/quantity of use
Steers et al[97]—Study 2	RMPI	USA, College	n=352; Age: M=18.00 (SD=0.33); 54% female; Ethnicity: 77% White	Intrapersonal
Swann et al[55]	CUDIT-R	USA, Community	n=552; Age: $M_{baseline}$=18.92 (SD=1.34); 100% male; Ethnicity: 51.5% African-American	Frequency/quantity of use
Tucker et al[53]	CUDIT-SF, MCQ	USA, Middle School	n=2258; Age: M=20.67 (SD=0.70); 54.38% female; Ethnicity: 45.20% Hispanic	Frequency/quantity of use
Tucker et al[104]	MCQ	USA, Middle School	n=671; Age: M=19 (SD=0.70); 51.4% female; Ethnicity: 42.3% Hispanic	Societal/policy
White et al[11]	RMPI	USA, Community	College n=326; 52.7% female; Noncollege n=221; 49.3% female; Ethnicity: Unknown	Frequency/quantity of use Gender differences

(Continued)

Table 1. (Continued)

AUTHORS/YEAR	SCALE FOR DV OF INTEREST	COUNTRY & SETTING	SAMPLE CHARACTERISTICS	THEMATIC DOMAIN
Follow-up Studies (presented alphabetically)				
Goodhines et al[92]	MACQ	USA, College	n = 83; Age: M = 19.33 (SD = 1.11); 70% female; Ethnicity: 72% White	Intrapersonal
Moitra et al[79]	Marijuana Problem Scale (MPS), Reasons for Marijuana Use (RMU), Timeline Follow-back measure	USA, Community	n = 226; Age: Range = 18-25; 44.7% female; Ethnicity: 66.8% non-Latinx White	Intrapersonal
Cross-sectional Studies (presented alphabetically)				
Amiet et al[83]	Cannabis Use Problems Identification Test (CUPIT)	USA, Community	n = 329; Age: M = 25.95 (SD: 3.29); 40.4% female; Ethnicity: 77% Caucasian	Intrapersonal
Arias-de la Torre et al[110]	Cannabis Abuse Screening Test (CAST)	Spain, Community	n = 1674; Age: Range = 15-35; 27.5% female; Ethnicity: 100% Spanish	Societal/policy Gender differences
Brackenbury et al[82]	DAST-10	USA, College	n = 357; Age: M = 20.3 (SD = 1.5) 71.1% female; Ethnicity: 94.5% Caucasian	Intrapersonal Interpersonal
Bravo et al[73]	Marijuana Consequences Questionnaire (MACQ)	USA, College	n = 2093; Age: Med = 19; 60.2% female; Race: 70.4% White Ethnicity 80.2% Not Hispanic or Latino	Intrapersonal
Bravo et al[38]	MACQ	USA, College	n = 2129; Age: M = 19.95 (SD = 3.66); 59.2% female; Ethnicity: 60.4% Non-Hispanic White	Intrapersonal Gender differences
Buckner et al[66]	Marijuana Problems Scale (MPS)	USA, College	n = 1009; Age: M = 20.2 (SD = 2.0); 79.7% female; Ethnicity: 76.1% Non-Hispanic White	Intrapersonal
Buckner et al[60]	MPS	USA, College	n = 265; Age: M = 18.7 (SD = 1.2); 62.3% female; Ethnicity: 78.1% Caucasian	Intrapersonal
Buckner et al[61]	Brief Marijuana Consequences Questionnaire (B-MACQ)	USA, College	n = 102; Age: M = 19.6 (SD:1.6); 80.4% female; Ethnicity 91.2% Hispanic/Latinx	Intrapersonal
Bujarski et al[80]	Cannabis Problems Questionnaire (CPQ)	Australia, Community	n = 118; Age: M = 29.84 (SD = 12.41); 33.9% female; Ethnicity: 74.1% Australia as birthplace (White)	Intrapersonal Gender differences
Caldeira et al[54]	Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) criteria	USA, College	n = 1253; Age: Range = 17-20; 51.4% female; Ethnicity: 72.4% White	Frequency/quantity of use
Callaghan et al[50]	Alcohol Use Disorder and Associated Disabilities Interview Schedule-5 (AUDADIS-5)	USA, Community	n = 36 309; Age: Range = 18-65+; 51.8% female; Ethnicity: Unknown	Frequency/quantity of use
Cavalli and Cservenka[56]	Marijuana Problem Scale (MPS)	USA, Community	n = 852; Age: M = 26.88 (SD: 6.71); 37% female; Ethnicity: 65.5% White	Intrapersonal

(Continued)

Table 1. (Continued)

AUTHORS/YEAR	SCALE FOR DV OF INTEREST	COUNTRY & SETTING	SAMPLE CHARACTERISTICS	THEMATIC DOMAIN
Cohen et al[106]	Cannabis Use Disorders Identification Test–Revised (CUDIT-R)	USA, Community	n = 163; Age: M = 40.4 (SD = 14.3); 23% female; Ethnicity: 67.1% White	Societal/policy
Davis and Arterberry[90]	Rutgers Marijuana Problem Index (RMPI)	USA, Community	n = 524; Age: M = 23.8 (SD = 9.0) 12% female; Ethnicity: 86% White	Intrapersonal
Destrée et al[69]	Cannabis Use Problems Identification Test (CUPIT)	USA, Community	n = 329; Age: M_{Males} = 25.83 (SD = 3.27); Age $M_{Females}$ = 26.12 (SD = 3.31); 40.4% female; Ethnicity: 82.1% White	Intrapersonal
Dias et al[102]	Cannabis Abuse Screening Test (CAST)	Portugal, High School	n = 529; Age: Range = 14-21; 46.1% female; Ethnicity: 100% Portuguese	Interpersonal Gender differences
Di Blasi et al[57]	CUPIT	USA, College	n = 671; Age: M = 23.23 (SD = 2.55); 69.4% female; Ethnicity: 100% Caucasian	Intrapersonal
Drazdowski et al[91]	Reduce Annoyed Guilty Start Scale (RAGS)	USA, College	n = 529 Age: M = 16.90(SD: 1.26); 46.1% female; Ethnicity: 57% White	Gender differences Racial/ethnic differences
Ecker and Buckner[59]	MPS	USA, College	n = 230; Age: M = 19.68 (SD = 1.34); 63.0% female; Ethnicity: 92.6% non-Hispanic/ Latino	Intrapersonal Interpersonal
Ecker et al[103]	MPS	USA, College	n = 103; Age: M = 21.2 (SD = 2.4); 78.6% female; Ethnicity: 86.4% White/Caucasian	Interpersonal Racial/ethnic differences
Estoup et al[109]	Alcohol and Drug Use Consequences Questionnaire	USA, High School	n = 262; Age: M = 16 (range: 13-19); 36% female; Ethnicity: 45% Caucasian	Societal/policy
Farris et al[64]	MPS	USA, Community	n = 103; Age: M = 21.2 (SD = 4.32); 35.9% female; Ethnicity: 100% non-Hispanic White	Intrapersonal
Feingold et al[39]	DSM-5 SUD criteria	USA, Community	n = 11 272; Age: 18 years and older; 43.10% female; Ethnicity; 73.50% White	Interpersonal
Feinstein and Newcomb[98]	CUDIT-R, DAST	USA, Community	n = 300; Age: M = 26.8 (SD = 8.25); 100% female (lesbian, bisexual, queer women); Ethnicity: 76.67% NH White	Interpersonal
Fond et al[99]	Cannabis Abuse Screening Test (CAST), Alcohol Use Disorder Identification Test (AUDIT)	France, College	n = 10 985; Age: M = 21.8 (SD: 3.3); 68.4% female; Ethnicity: 100% French	Interpersonal Gender differences
Gunn et al[37]	MACQ	USA; College	n = 1390; Age: M = 19.8 (SD = 1.34); 62% female Ethnicity: 69% White	Frequency/quantity of use
Hamonniere et al[95]	CUDIT, MPS	USA, Community	n = 157; Age: M = 26.9 (SD:9.6); 43.3% female; Ethnicity: unknown	Intrapersonal
Brooks Holliday and Pedersen[114]	CUDIT-R	USA, Community	n = 734; Age: M = 28.29 (SD = 3.39); 12.40% female Ethnicity: 76.29% White	Societal/policy Gender differences Racial/ethnic differences
Horváth et al[75]	CAST	USA, Community	n = 538; Age: M = 29.24 (SD: 7.55); 29.58% female; Ethnicity: 100% Hungarian	Intrapersonal

(Continued)

Table 1. (Continued)

AUTHORS/YEAR	SCALE FOR DV OF INTEREST	COUNTRY & SETTING	SAMPLE CHARACTERISTICS	THEMATIC DOMAIN
Jordan et al[100]	Brief Marijuana Consequences Questionnaire (B-MACQ)	USA, College	n = 1107; Age: M = 20.26 (SD: 3.32); 68.8% female; Ethnicity: 66.5% White	Intrapersonal
Kentopp et al[72]	MACQ	USA, College	n = 8141; Age: M = 20.4 (SD = 4.19); 66.9% female; Ethnicity: 64.7% Caucasian	Intrapersonal
Lawn et al[43]	Diagnostic and Statistical Manual of Mental Disorders Fifth Edition (DSM-5) CUD criteria	USA, Community	n = 274; Age: Range = 16-29; 49.6% female; Ethnicity: 64.6% White	Frequency/quantity of use
Lee et al[76]	RMPI	USA, College	n = 634; Age: M = 18.0 (SD = 0.33); 57.9% female; Ethnicity: 67.5% Caucasian/White	Intrapersonal
Luba et al[46]	Cannabis Associated Problem Scale	USA, Community	n = 195; Age: M = 27.7 (SD unknown); 72.7% male; Ethnicity: 68.7% White	Frequency/quantity of use Gender differences
Meier[48]	MACQ	USA, College	n = 821; Age: M = 22.6 (SD = 6.3) 65.1% female; Ethnicity: 78.7% White	Frequency/quantity of use
Millar et al[42]	Diagnostic and Statistical Manual of Psychiatric Disorders (DSM 5) criteria	Ireland, Community	n = 2979; Age: 15 and older; 35.6% female; Ethnicity: 100% Irish	Frequency/quantity of use
Montes and Napper[89]	RMPI	USA, College	n = 211; Age: M = 18.92 (SD = 0.96) 47.4% female; Ethnicity: 72.0% White	Intrapersonal Interpersonal
Montes et al[88]	B-MACQ	USA, College	Study 2: n = 2077; Age: M = 19.99 (SD:2.91); 61.20% female; Ethnicity: unknown	Intrapersonal
Mueller et al[63]	MPS	USA, Community	n = 279; Age: M = 30.95 (SD:7.37); 44.3% female; Ethnicity 65.6% White	Intrapersonal
Neugebauer et al[84]	MACQ	USA, College	n = 2128; Age: M = 19.95 (SD = 3.66); 59.2% female; Ethnicity: 60.4% Non-Hispanic White	Intrapersonal
Parnes et al [85]	MACQ	USA, College	n = 2091; Age: M = 19.92 (SD = 3.50); 60.2% female; Ethnicity: 64.8% White	Intrapersonal Gender differences
Pearson and Bravo[86]	CUDIT-R	USA, College	n = 1123; Age: M = 20.32 (SD = 3.54); 69.3% female; Ethnicity: 65.27% Non-Hispanic White	Intrapersonal Gender differences
Pearson et al[51]	MACQ	USA, College	n = 8141; Age: M = 20.40 (SD = 4.19); 66.9% female; Ethnicity: 64.7% White	Frequency/quantity of use
Pearson et al[70]	MACQ	USA, College	n = 2129; Age: M = 19.95 (SD = 3.66); 59.2% female; Ethnicity: 60.4% White	Intrapersonal
Pearson et al[78]	MACQ	USA; College	n = 43; Age: Median = 20; 72.1% female; Ethnicity: 83.7% White	Intrapersonal
Petrucci et al[67]	MPS, CUDIT-R	USA, College	n = 1168; Age: M = 20.54 (SD: 3.60); 68.2% female; Ethnicity: 68.8% White	Intrapersonal
Phillips et al[58]	RMPI	USA, College	n = 300; Age: M = 20.32 (SD = 0.82); 60% female; Ethnicity: 69% White/Caucasian	Intrapersonal Gender differences

(Continued)

Table 1. (Continued)

AUTHORS/YEAR	SCALE FOR DV OF INTEREST	COUNTRY & SETTING	SAMPLE CHARACTERISTICS	THEMATIC DOMAIN
Schuster et al[40]	CUDIT-R	USA, Community	n = 76; Age: M = 21.79 (SD = 1.74); 44.74% female; Ethnicity: 63.2% White	Intrapersonal
Simons et al[44]	RMPI	USA, College	n = 831; Age: M = 20.20 (SD = 2.81); 70% female; Ethnicity: 89% White	Intrapersonal
Spradlin et al[65]	MPS, CUDIT-R	USA, College	n = 430; Age: Unknown; 66.1% female; Ethnicity: 69% Caucasian	Intrapersonal
Stautz et al[115]—Study 3	CUDIT-R (1 item); Cannabis Problem Questionnaire	USA, College	n = 115; Age: M = 19.67 (SD = 2.76); 73.9% female; Ethnicity: Unknown	Intrapersonal Gender differences
Steeger et al[49]	Marijuana Dependence Scale (MDS)	USA, Community	n = 300 Age: M = 34.81(SD: 14.90); 42.3% female; Ethnicity: 78% White	Frequency/quantity of use
Struble et al[41]	Cannabis Consequences Checklist	USA, Community	n = 184; Age: M = 28.97 (SD = 6.31); 38.6% female; Ethnicity: 85.5% African American	Intrapersonal Gender differences
Swan et al[36]	B-MACQ, CUDIT-R	USA, College	n = 368; Age: M = 20 (SD:2.06); 71% female; Ethnicity: unknown	Frequency/quantity of use Gender differences
Rømer Thomsen et al[71]	CUDIT-R, DUDIT	Denmark, Community	n = 1930; Age: M = 21.7 (SD = 2.7); 31.2% female; Ethnicity: 100% Danish	Intrapersonal
Trangenstein et al[111]	CUDIT-R	USA, Community	n = 172; Age: *R* = 15-19; 22% female; Ethnicity: 57.56% White	Societal/policy
Walukevich-Diesnst et al.[62]	MPS	USA, College	n = 278; Age: M = 17.1 (SD:2.0); 79.9% female; Ethnicity: 75.5% Non-Hispanic Caucasian	Intrapersonal
Wardell et al[45]	MPS	USA, Community	n = 232; Age: M = 19.75 (SD = 1.06); 52.6% female; Ethnicity: 59% Caucasian	Intrapersonal
Wisener and Khoury[77] [Study 2]	B-MACQ	USA; School	n = 165; Age: M = 20.2 (SD = 1.21); 82.2% female; Ethnicity: Unknown	Intrapersonal
Wilson et al[87]	MCQ	USA, College	n = 8141; Age: Unknown; % female unknown; Ethnicity unknown	Frequency/quantity of use
Wong et al[108]	Severity of Dependence Scale, DSM-5	USA, Community	n = 301; Age: *R* = 18-26; 35% female; 43% Hispanic/Latinx	Societal/policy
Woodruff and Shillington[105]	Addiction Severity Index-Lite (ASI-Lite)	USA, Community	n = 292; Age: M = 35.3 (SD = 12.8); 24% female; Ethnicity: 33.7% non-Hispanic White	Societal/policy
Yurasek et al[93]	Investigator-created items	USA, College	n = 267; Age:M = 19.9 (SD:1.4); 61% female; Ethnicity 67% White	Intrapersonal

Abbreviations: C, cross sectional; F-U, follow-up (2 time points); L, longitudinal (3+ time points).

were associated with positive motives[74] whereas reporting more negative motives, specifically coping motives, were associated with more CRNCs in cross sectional studies[38,44,64,73,75-77] though one cross-sectional study found CRNCs were associated with both positive and negative motives.[78] One longitudinal study of cannabis users[74] reported expansion motives as having the strongest association to CRNCs with conformity motives having a null association with cannabis problems when all motives were modeled simultaneously while another follow-up (2 time point) study indicated coping-related motives prospectively predicted problems.[79] Three cross-sectional studies suggested that motives mediate the association between psychological symptoms and CRNCs[65,80] and hostility and CRNCs.[75] One longitudinal study[81] found that reporting a high number of motives to abstain buffered the influence of negative reinforcement motives on the experience of cannabis-related problems in young adulthood. Only 3 cross-sectional studies examined the role of expectancies with CRNCs. One described how an individuals' expectancies that cannabis causes cognitive and behavioral impairment was negatively associated with cannabis use disorder criteria.[40] The second found that higher scores on the cessation expectancy questionnaire and Marijuana Effects Expectancy Questionnaire predicted higher scores on the Drug Abuse Screening Test (DAST—a self-report assessment that screens for drug abuse and drug dependence disorders) among young adult users.[82] Finally, a latent class analysis of motives and expectancies[83] identified the "high motives and high expectancies" class scored significantly higher than the "low motives and low expectancies" class on the total score and both subscales of the Cannabis Use Problems Identification Test (CUPIT—a self-report assessment that identify present and potential harmful cannabis use), indicating worse problematic cannabis use and impaired control.

Protective Behavioral Strategies (PBS). PBS are behaviors that individuals use before, during, or after initiating substance use to reduce consumption, intoxication, and related adverse outcomes such as blacking out. Examples of PBS include setting limits on how much or how often one uses, not mixing cannabis with other substances, and using only around trusted peers. The measurement used to assess PBS for cannabis misuse across identified studies was the Protective Behavioral Strategies for Marijuana Scale. Across 8 cross-sectional studies there was clear evidence that reporting more PBS is associated with fewer negative consequences from cannabis use.[38,73,78,84-88] PBS were also found to mediate, cross-sectionally, the association between risk factors and CRNCs, such as risk and experience seeking,[84] demographic factors (eg, sexual orientation[85]), and cannabis self-identity,[89] Of note, one study[78] found that no single PBS was significantly associated with CRNCs using a within-subject statistical approach which may suggest that cumulative PBS, rather than specific PBS, are beneficial to reducing CRNCs. No longitudinal investigations of direct relationships between PBS and CRNCs were identified.

Other potential intrapersonal influences. There is emerging evidence from 2 cross-sectional studies that higher scores on measures of refusal self-efficacy might be associated with reduced frequency of CRNCs.[86,90] One longitudinal study[35] and one cross sectional study[91] identified that using cannabis as a sleep aid was associated with past month and past year CRNCs, respectively, but not daily consequences as shown in one follow-up study.[92] Finally, one cross-sectional study indicated that insomnia severity was a predictor of CRNCs in another study and possibly mediated by mood and moderated by gender.[93] Delayed memory was not associated with CUD onset among teens in one longitudinal study,[94] and findings of a cross-sectional study suggest dimensions of repetitive negative thinking is not associated with cannabis use problem severity although dimensions of metacognitive thinking are.[95] In a longitudinal study, cannabis-harm implicit association test scores significantly predicted concurrent risk of CUD and use such that stronger cannabis-harm associations were associated with less use and risk of CUD.[96] Finally, harmonious passion was a stronger predictor of increased consumption than was obsessive passion, whereas obsessive passion was a stronger predictor of CRNCs longitudinally.[97]

Interpersonal influences

Experiences of stigma and trauma. Cross-sectional evidence suggests that unlike internalized stigma (ie, an individual applies negative beliefs of their mental illness to oneself), perceived stigma (ie, an individual's viewpoints on how others discriminated) was not associated with CRNCs,[98] but CRNCs were associated with experiences of general victimization.[81] Lastly, cross-sectional studies suggest exposure to traumatic events (eg, adverse childhood experiences or childhood trauma) is associated with CRNCs[39,99] and may be mediated by negative urgency.[45] In a longitudinal study, posttraumatic stress disorder (PTSD—a psychiatric condition that may affect individuals who see or go through a traumatic event) was prospectively associated with CUD symptoms in a sample of veterans.[34] In a cross-sectional study using a double mediation model,[100] PTSD was associated with use of fewer PBS strategies that in turn was associated with higher cannabis use frequency/quantity, which was associated with more CRNCs.

Family and friends. One longitudinal study showed that obtaining cannabis from family or friends was associated with reduced odds of experiencing cannabis problems compared to purchasing cannabis for medicinal or recreational purposes.[101] In a cross-sectional study, the number of friends reported using cannabis mediated the relationship between cannabis onset age use and CRNCs.[102]

Social norms. Several cross-sectional studies, but no longitudinal studies, investigated the relationship of social norms and CRNCs. In a college student sample, descriptive norms

(ie, how people behave based on our observations) and injunctive norms (ie, what we think others approve or disapprove of) had unique negative direct effects on CRNCs.[70] In another college sample, for students reporting cannabis use as central to their identity, injunctive norms were positively associated with consequences.[89] Descriptive norms were positively associated with CRNCs for students with a "weak marijuana identity" but were negatively associated with consequences for those with a "strong marijuana identity."[70] Ecker and Buckner[59] identified a significant interaction between social anxiety and peer descriptive norms as well as social anxiety and parental injunctive norms on cannabis use problems while Ecker et al and colleagues found African-American college students reported more permissive perceived parental injunctive norms was related to greater severity of cannabis-related problem severity.[103]

Societal/policy influences

Community membership. Two longitudinal studies,[101,104] one cross-sectional study[105] showed that possessing a medicinal cannabis card (provided by a medical doctor to purchase cannabis for medicinal purposes) was associated with an increased odds of experiencing CRNCs. However, in a cross-sectional study of medicinal users, those reporting use for chronic pain reported fewer problems than those using it for other medicinal purposes.[106]

College cannabis use culture, where affinity for use was greater, mediated the effects of sensation seeking and impulsivity on CRNCs in a cross-sectional analysis.[70] Dyar et al[107] found that among cisgender minority women and minority non-binary individuals, using cannabis with sexual minority women and non-binary individuals, but not with sexual minority men, heterosexual men, or women, was associated with increases in problematic use 6-months later.

Drug use policy and availability. Legalization of cannabis predicted 17% of the variance of CRNCs in a study of young adults, but legalization status did not moderate the association between impulsivity and CRNCs.[69] Individuals with the strongest belief that legalization impacted their attitudes and beliefs about cannabis use reported the greatest number of CRNCs.[108] Estoup et al[109] reported that cannabis legalization and perceived risk of use explained 22% of the variance in reported CRNCs, and perceived risk mediated the association between legalization and consequences. There were no longitudinal studies investigating the effect of legalization on experiences of CRNCs.

One recent longitudinal study found that increases in the total number of cannabis sources (dispensary, retailer, family, friend, stranger/dealer) was associated with increases in CRNCs and cannabis use disorder symptoms.[101] Moreover, the researchers noted that the total number of consequences was significantly greater for persons acquiring cannabis from strangers/dealers or institutions relative to family and friends. A cross-sectional study[110] found that availability and exposure to consumption situations was associated with problematic cannabis use among men, but not women. Finally, exposure to cannabis advertisements on social media platforms was associated with an increased odds of CUD among adolescents in a cross-sectional analysis.[111]

Education, employment, and socioeconomic status. In a longitudinal study, men between 18 and 33 years of age with limited postsecondary education had the highest rates of cannabis-related problems.[112] In another longitudinal study, cannabis use frequency and related problems were strongly related in disadvantaged communities, whereas in less disadvantaged communities, cannabis use quantity and problems were not significantly associated.[113] A cross-sectional study evidenced that psychological consequences from cannabis use were more common among individuals with lower educational attainment.[41] One cross-sectional study[114] reported that income was associated with cannabis use problems, but specific associations were not presented while another cross-sectional study in Spain[110] identified education level and work status as important correlates of problem cannabis use with higher proportions of problem users in the lower education and unemployed categories.

Overall differences by sex and gender

Of the 3 longitudinal studies,[11,74,101] 8 cross-sectional studies[38,55,58,86,91,99,110,115] that explored sex and gender differences, males consistently reported more cumulative negative consequences than females. One moderated mediation analysis found that coping motives had a stronger mediational association between distress tolerance scores and cannabis related problems among distress intolerant women compared to men—though a cross-sectional approach was used.[80] One longitudinal study and one cross-sectional study reported no difference in the experience of CRNCs between men and women.[46,107] Readers should note that the terms sex and gender were used interchangeably across studies and did not necessarily reflect one's sex assigned at birth compared to their preferred identity.

Overall differences by race

While multiple studies controlled for race or ethnicity as a covariate in analyses, only 3 cross-sectional studies investigated race differences in CRNCs.[91,103,114] Drazdowski et al[91] found no differences in past month or past year CRNCs between White and non-White participants. Race moderated the relationship between injunctive norms regarding parents and cannabis-related problem severity for African-American, but not Caucasian college students.[103] Specifically, more permissive perceived parental injunctive norms was related to greater cannabis-related problem severity (but not cannabis use frequency)

for African-American participants. Finally, Brooks Holliday and Pedersen[114] noted significant race differences in cannabis misuse but did not elaborate on specific associations.

Discussion

As there have been no previous literature reviews describing risk and protective factors for negative consequences of drugs other than alcohol, this review builds on extant literature documenting the complexity of interactions that contribute to risk for negative consequences associated with cannabis use behavior. In line with previous reviews,[28] there was a modest, yet varied, association between frequency or quantity of cannabis use and experiences of related negative consequences—a finding also observed with alcohol use consequences.[116] It is likely that the associations between cannabis use frequency and a sum of predefined number of self-reported negative consequence items represents an artificial upper boundary of associations between cannabis use and adverse outcomes[28] or that self-report assessments do not sufficiently capture individual differences in patterns of substance misuse (ie, patterns of consequences may be unique to individuals or there are adverse outcomes that are not being assessed in existing measures leading to underreporting). In examining negative events resulting from cannabis use as independent outcomes, compared with a sum of experiences, researchers may be better positioned to identify person-centered patterns of CRNCs and develop effective secondary prevention programs to reduce immediate risk of harm and chances of escalating to the threshold of CUD. In addition, researchers can characterize cannabis misuse with greater specificity by ascertaining multiple measures of use—including frequency, quantity, and duration of use—that contextualize the patterns of use amongst those experiencing CRNCs.

Similar to reviews on alcohol-related negative consequences,[19] most studies included in the present review investigated intrapersonal (ie, psychological) predictors of CRNCs. Mental health issues, such as anxiety and psychological distress, appear to be important correlates of CRNCs and should be addressed in substance misuse prevention programing. Some individuals undergoing treatment for a substance use disorder might also require services that address concurrent mental illness,[117] a finding that underscores the need to address ongoing mental health concerns among individuals reporting substance misuse.[118] Personality traits might also play an important role in our understanding of who does and does not experience CRNCs as they do in research on alcohol consequences.[19] A review of controlled laboratory studies[119] identified impulsivity as a facilitator and consequence of drug use which suggests that some personality traits, like impulsivity, are exacerbated by drug use and might contribute to more frequent, and perhaps more severe consequences as use escalates. In fact, low levels of impulsivity has been described as a predictor of treatment success.[120] The next logical step in this line of inquiry is to explore whether interventions to lower impulsivity would predict success in secondary prevention interventions to reduce CRNCs among those who do not have a clinical disorder (ie, CUD).

Such associations may not be limited to impulsivity alone as we found evidence that sensation- and risk-seeking might engender problematic cannabis use behaviors as well. As demonstrated previously, sensation-seeking is a quantitatively distinct phenomenon from impulsivity[68] and more work is needed to explore how these unique traits influence problematic cannabis use. To accomplish this, longitudinal studies that can establish baseline personality traits and examine trends over time as individuals initiate and escalate their cannabis use are needed. Motives, but not expectancies, were investigated frequently as a predictor of CRNCs with coping motives emerging as a robust risk factor.[38,73,79] As suggested by mediational findings, individuals using substances to cope with underlying mental health issues are likely at risk for problematic substance use. The only protective factor identified in this review that would be more amenable to modification were protective behavioral strategies (PBS)—a trend that aligns with alcohol research. PBS were generally defined as the approaches individuals used to reduce the quantity and frequency of cannabis use in order to avoid adverse outcomes (ie, CRNCs). Of note, it appears no single PBS reduces the odds of experiencing CRNCs, but that the use of multiple PBS can attenuate the risk of experiencing adverse outcomes following cannabis use. As such, interventions should prioritize the teaching of multiple methods or consider developing individualized plans for users based on their perceived helpfulness of a particular strategy, self-efficacy to employ a specific strategy, and patterns of use. Researchers should also consider investigating other factors (eg, religiosity) that have been identified as protective against alcohol-related consequences,[19,121] but have not been examined in relation to cannabis.

While the literature has documented the influence of peers and family members on substance use initiation and frequency/quantity of use,[122-124] there is significantly less research exploring the role of peer/family influence on experiences of CRNCs. Given the clear association between peer/family use and alcohol consequences[19,125,126] more work is needed to understand the importance of peer and family influences to determine whether family-based or social network interventions could facilitate a reduction in CRNCs among cannabis users. Previous research has described the impact of social and cultural norms in initiation of drug use,[127,128] and findings from this review suggest that social norms also contribute to CRNCs. Injunctive norms may be particularly important for youth who have not fully established their personal and social identity and turn to peers for approval of their beliefs and actions. Conversely, norms-focused interventions (eg, normative feedback) have shown effectiveness at reducing alcohol use and related consequences[129] as well as general substance use[130] and should continue being used to offset pro-drug use social and cultural norms that might influence experiences of CRNCs.

Education and income were 2 important social determinants that had an inverse association with CRNCs. That is, the odds or frequency of CRNCs decreased as education and income increased. Policies addressing these social determinants can have sweeping, downstream effects on health and continued efforts to address ongoing economic disparities can reduce the economic and social costs associated with problematic cannabis use. At the community level, efforts are needed to reduce pro-drug cultures (eg, alcohol and drug use are commonplace in college culture) that promote heavy or more frequent use that can lead for example, to more college students experiencing CRNCs. Similarly, initiatives to protect vulnerable communities, such as sexual and gender diverse populations and veterans from experiences of trauma and stigma, important risk factors for SRNCs identified in the present review, may help mitigate risk for CRNCs. As policies challenging the legality of cannabis and new state-level policies across the US decriminalize or legalize recreational cannabis use; more comparative work is needed to understand the role of policy in the severity of problematic use.

We also investigated demographic differences in CRNCs. Overall, males appear to be at a greater risk of experiencing CRNCs relative to females which aligns with findings that clinical populations in treatment for substance use disorder are disproportionately male.[131] Males, particularly adolescent or young adult males, should be considered a priority population for cannabis misuse interventions aimed at reducing CRNCs. Far more research focusing on sexual and gender minority populations is needed as the evidence to date suggests that correlates and experiences of SRNCs among sexual and gender minority youth and young adults have not been adequately studied. Similarly, there is a dearth of literature examining racial/ethnic differences in CRNCs. The samples for many studies included in this review were majority non-Hispanic White and female therefore more attention should be given to identifying risk and protective factors for CRNCs in racially and ethnically diverse samples.

Limitations of the literature

First, most of the research identified in this review relied solely on self-reported survey-based responses. No studies reported collecting corroborating evidence such as peer or family reports of CRNCs experienced by the user. Additionally, the majority of included studies (75.9%) were cross-sectional limiting our results to describing associations with little confidence that identified risk and protective factors could be described as casual mechanisms of CRNCs. Second, a burgeoning literature examining correlates of simultaneous and concurrent substance use, with an emphasis on consequences of combinations of alcohol and cannabis, was not captured here. A review of poly-substance use research is needed to compare to extant work examining the consequences of alcohol, cannabis, and other drugs independently.

Third, most studies identified and included in this review were comprised of relatively young samples—primarily adolescents and young adults, and most research with young adults sampled college students who may not represent the broader population of young adults. Future research would benefit from examining differences in CRNCs across the lifespan. As evidenced by Schepis et al[132] the prevalence, typology, motives, and risk factors of prescription drug misuse can vary considerably across age groups. Given that most individuals mature out of risky alcohol and substance use in early adulthood,[133,134] users who continue to practice unsafe substance use into middle or late adulthood are likely at increased risk for cannabis use disorder but remain an understudied group.

Limitations of this review and conclusions

This review is not without limitations. First, we did not search for specific substance use consequences—such as driving under the influence—and cannot draw conclusions regarding independent consequences of use as a result. Second, we may not have captured the entirety of literature due to the search terms used, repositories searched, and publication bias leading to an underreporting of null findings. Moreover, we limited our search to self-report studies of CRNCs—akin to previous reviews on alcohol-related negative consequences. Therefore, the scope of other methodological approaches, such as qualitative research, that might provide insights into lived experiences of individuals experiencing cannabis misuse was not described. Third, the time frame for cannabis use and associated consequences varied across studies (eg, past week, past month, past year) and caution should be exercised when considering the nature of the associations between various risk and protective factors with patterns of CRNCs. Lastly, the utilized electronic databases utilized in this review may not have captured earlier research not indexed online.

Notwithstanding the limitations of the existing literature and present review, the findings highlight the need for multi-level strategies public health interventions that can reduce the risk of negative cannabis use consequences to attenuate the cumulative risk of psychological, social, and contextual influences. Importantly, future research should aim to identify relevant protective factors for CRNCs and prioritize the investigation of environmental, interpersonal, and policy factors associated with problematic cannabis use, especially in racially and ethnically diverse populations. Addressing the current gaps in this literature will bolster the effectiveness of future primary and secondary multi-level prevention programs.

Author Contributions

Conceptualization: TG and MF. Literature search: TG, AL, and LA. Data extraction: AL and LA. Data synthesis and Writing – Original Draft: TG. Writing – Review and editing: All authors.

Supplemental Material

Supplemental material for this article is available online.

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