THESIS

MAKING UP FOR THE MUNCHIES? EXAMINING CANNABIS-RELATED EATING AND COMPENSATORY BEHAVIORS AMONG UNDERGRADUATES

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ABSTRACT

MAKING UP FOR THE MUNCHIES? EXAMINING CANNABIS-RELATED EATING AND COMPENSATORY BEHAVIORS AMONG UNDERGRADUATES

Food and alcohol disturbance (FAD) refers to a phenomenon whereby individuals engage in compensatory behaviors such as caloric restriction, exercise, or purging to offset calories associated with alcohol consumption or to enhance the effects of alcohol. FAD is well-documented amongst college student populations in the United States, however, there remains a gap in the literature with regards to compensatory behaviors in response to other types of substance use, such as cannabis. Cannabis use has become increasingly prevalent among U.S. college students in the past decade, coincident with recent trends towards recreational legalization. Cannabis interacts with the endogenous cannabinoid system (ECS), which plays a critical role in regulating appetite and energy balance, and many individuals who use cannabis report increased appetite or motivation for food, colloquially referred to as “the munchies.” Existing literature on the relationship between cannabis use and disordered eating behaviors is limited in scope and has yielded mixed findings, and no study to date has specifically examined engagement in cannabis-related compensatory behaviors in undergraduate populations.

Overall, the aims of this study were to (1) develop a measure of compensatory behaviors in response to cannabis use (2) examine associations between engagement in cannabis compensatory behaviors and eating disorder symptomatology, consequences related to cannabis use, and binge eating under the influence of cannabis. The Compensatory Eating and Behaviors in

Response to Alcohol Consumption Scale (CEBRACS) was adapted with a focus on cannabis use and "the munchies" and survey items were piloted in a sample of undergraduates at Colorado State University. Modifications were made to survey items and formatting according to pilot participant and subject matter expert feedback. Participants (n = 519) were subsequently recruited from undergraduate samples at Colorado State University and the University of Wyoming (mid-size and large, legal and non-legal recreational status) and completed the final survey in addition to measures related to cannabis use frequency, eating disorder symptoms, and binge eating under the influence of cannabis. Exploratory and confirmatory analyses were utilized to identify the underlying structure of the scale and yielded three factors consistent with previous FAD literature: Enhancement, Diet/Exercise Compensation, and Extreme Weight Loss Behaviors (EWLB). Binge eating under the influence of cannabis was positively associated with all three factors but eating disorder symptoms were only significantly associated with the Diet/Exercise factor. Enhancement and Diet/Exercise Compensation factors were positively associated with cannabis consequences after controlling for covariates, whereas there was a negative relationship for the EWLB factor, which was shown to be mediated through reduced cannabis use frequency. Findings from the present study provides initial evidence for the adaptation and validation of a three-factor Compensatory Eating and other Behaviors in Response to Cannabis Scale (CECBS), furthermore highlighting nuanced relationships between cannabis-related compensatory behaviors and eating disorder symptomatology, cannabis-related binge eating, and cannabis consequences, which may have important clinical implications for cannabis harm reduction as well as the prevention and treatment of cannabis use disorder and eating disorders.

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Introduction

Cannabis

Pharmacology and History

Cannabis refers to a genus of flowering plants of the *Cannabaceae* family, which include the species *Cannabis sativa*, *indica*, and *ruderalis* (McPartland, 2018). Over 100 phytocannabinoids have been identified in the cannabis plant (Filipiuc et al., 2021), including the primary psychoactive component delta-9-tetrahydrocannabinol (THC). THC and other phytocannabinoids target the endogenous cannabinoid system (ECS), a complex neuromodulatory system comprised of endogenous cannabinoids (anandamide [AEA], 2-Arachidonoylglycerol [2-AG]), cannabinoid receptors (CB1, CB2), and enzymes (Lu & Mackie, 2016). The ECS is involved in a variety of processes in the central nervous system, including memory (Marsicano & Lafenêtre, 2009), mood (M. N. Hill & Gorzalka, 2009), stress (Micale & Drago, 2018), reward (Spanagel, 2020), sleep (Kesner & Lovinger, 2020), and appetite (Cota et al., 2003), furthermore playing a critical role in regulating neural development and neurotransmission (Cohen et al., 2019; Lu & Mackie, 2016).

The ECS also regulates a several peripheral nervous system functions (Zou & Kumar, 2018), including immune (Klein et al., 2003), gastrointestinal (Srivastava et al., 2022; Storr & Sharkey, 2007), and nociceptive functioning (Cravatt & Lichtman, 2004). THC is a partial agonist at CB1 and CB2 receptors (CB1/2Rs) (Pertwee, 2008), whereas cannabidiol (CBD), another prominent constituent phytocannabinoid, acts as a negative allosteric modulator at these receptors (Peng et al., 2022). While most studies on the pharmacology of cannabis focus on THC or CBD in isolation, cannabinoids are hypothesized to work synergistically, facilitating an "entourage effect" (Christensen et al., 2023; LaVigne et al., 2020; Simei et al., 2023).

As one of the earliest cultivated plants in human history, cannabis has long been used as a drug for medicinal and recreational purposes (Zuardi, 2006). Indigenous to China (Zuardi, 2006), cannabis was first brought to the Americas in the 16th century (Warf, 2014). Cannabis, or "marijuana," made its way to the United States after the Mexican Revolution in the early 20th century, facing several waves of legal measures intended to restrict the sale, distribution, and possession of the drug thereafter, which disproportionately targeted Latino and African American communities (Warf, 2014). After decades of criminalization, California was the first state to legalize cannabis for medical use in 1996 (Fedorova et al., 2022), whereas Colorado became the first to legalize recreational cannabis 16 years later (Calonge, 2018). Recreational cannabis legalization has since become prevalent across the United States, despite cannabis remaining federally illegal, and recreational use has increased in turn (Caulkins, 2024; Farrelly et al., 2023).

The 2022 National Survey on Drug Use and Health reported that 61.9 million individuals aged 12 and older used cannabis in the past year (NSDUH, 2022), with daily cannabis use outpacing daily drinking (Caulkins, 2024). 38.2% of individuals in the 18-25 age range reported past-year cannabis use (NSDUH, 2022), consistent with literature demonstrating increases in recreational cannabis use among college students in legal states, despite age limits for purchase (Bae & Kerr, 2020; Barker & Moreno, 2021; Gunadi et al., 2022; Kerr et al., 2017; Reed et al., 2024), however some literature also suggests increasing prevalence of cannabis use in non-legal states over time (Kerr et al., 2017). Despite the growing availability and popularity of cannabis, research has historically been limited because of federal scheduling. Federal law stipulates the use of government furnished flower cannabis or pharmaceutical grade isolates (i.e. Dronabinol, Epidiolex) in research (USDA, 7 CFR Part 990) which fail to reflect the increasing potency and variety of products available on the legal market (Stuyt, 2018). Conducting research on legal market cannabis use and associated outcomes may generate knowledge to help individuals make informed decisions about their use.

Benefits and risks

Cannabis has been used therapeutically for its anxiolytic, analgesic, antiemetic, anti-inflammatory, orexigenic, and anticonvulsant effects(Bar-Sela et al., 2019; K. P. Hill et al., 2017; Maayah et al., 2020; Stockings et al., 2018). Many individuals also use cannabis for sleep, despite mixed findings regarding efficacy (Winiger et al., 2021). Beyond medical use, recreational cannabis use may promote relaxation, increase enjoyment of daily activities, enhance social connections, and facilitate spiritual experiences (Osborne & Fogel, 2008). Individuals may also use cannabis as a substitute for other drugs that are perceived to have comparatively worse risk profiles, such as alcohol and opioids (Lau, 2015; Mok et al., 2023; Reiman, 2009).

Although research remains limited, there are a number of risks that have been attributed to cannabis use. Cannabis intoxication is associated with acute deficits in cognitive performance, particularly for verbal recall and working memory (Bourque & Potvin, 2021; Preuss et al., 2023). There are mixed findings on the effects of long-term cannabis use on cognitive functioning (Kroon et al., 2021). Acute anxiety and panic attacks are among the most common adverse effects reported by cannabis users (Hoch et al., 2015). Some studies have also indicated that cannabis use may precipitate psychotic episodes, the risk of which may be increased by adolescent cannabis use and a family history of schizophrenia and psychotic spectrum disorders (Kiburi et al., 2021; Ksir & Hart, 2016). Cannabis use disorder (CUD) has also been included in the DSM-5, with reported prevalence estimates as high as 10% (Connor et al., 2021). While heavy cannabis use may not result in physical dependence in the traditional sense, the associated withdrawal syndrome may include symptoms such as irritability, anxiety, sleep disturbance, decreased appetite, and depressed mood (Bonnet & Preuss, 2017). Heavy cannabis use has furthermore been associated with the incidence of cannabinoid hyperemesis syndrome (a cyclic vomiting disorder), however prevalence estimates remain unknown (Sorensen et al., 2017). Smoked cannabis may also contribute to issues with respiratory functioning (Hall & Degenhardt, 2014), and the cardiovascular effects of cannabis may also pose a risk for individuals predisposed to cardiovascular disease (Dabiri & Kassab, 2021).

Subjective and physiological effects

As cannabinoid receptors are distributed widely throughout the body and brain, individuals may experience a plethora of subjective and physiological effects. Some of the notable physiological effects associated with THC include increased heart rate and dry mouth (Schwope et al., 2012). Common subjective effects include sleepiness, time dilation, time slowing, thinking, anxiety, euphoria, thirst (which may be attributable to dry mouth), and hunger (Green et al., 2003; Karschner et al., 2011; Schwope et al., 2012; Spindle et al., 2018). There is some evidence that subjective effects may vary as a function of route of administration. Edible cannabis products have more often been associated with self-reported aversive (i.e. paranoia) or low arousal effects (i.e. sleepiness) (Ewusi Boisvert et al., 2020; Farmer et al., 2019), despite mixed findings regarding differences in intoxication and impairment compared to smoked cannabis (Bidwell et al., 2022a; Spindle et al., 2021).

Many individuals experience increased appetite and appreciation for food while under the influence of cannabis, colloquially referred to as “the munchies” (Abel, 1971; Haines & Green, 1970; Tart, 1970). The munchies are a rather common phenomenon (Kruger et al., 2019; Lee et al., 2021), with one study reporting that 86% of cannabis users experienced the munchies in the past 30 days (Lee et al., 2021). Early human laboratory studies revealed that smoked cannabis (<5% THC) increased caloric consumption as well as a preference for palatable foods (i.e., high sugar or fat content), which might be referred to as "unhealthy" or "junk" foods (Foltin et al., 1986, 1988; Mattes et al., 1994). In another study of cannabis users, 77% reported eating "unhealthy" food while under the influence, indicating that they were more likely to eat unhealthily and eat more while intoxicated compared to other occasions (Kruger et al., 2019), evoking a sense of disinhibited eating (Kirkham, 2005). More recently, Roberts et al. (2019) developed a scale to capture experiences eating under the influence of cannabis and found evidence for both hedonic (e.g., food tastes better) and appetitive (e.g., increased motivation to eat) aspects (Roberts et al., 2019). Although increased frequency of cannabis use was associated with lower appetitive sub-scores, the opposite association was found for hedonic sub-scores (Roberts et al., 2019).

The underlying mechanism of "the munchies" is thought to involve stimulation of CB1Rs expressed in the periphery (such as the vagus nerve) and brain regions responsible for regulating appetite and reward (Harrold & Williams, 2003; Pucci et al., 2021). While homeostatic eating is related to hunger, which is driven by physiological cues to promote energy balance, hedonic eating refers to eating for pleasure (Saper et al., 2002). Consistent with this, THC has been shown to increase food intake as well as preference for sugary and high fat foods in rats (Hume et al., 2022), even inducing hyperphagia in some cases (Williams et al., 1998). Preclinical studies using genetic knockout models and pharmacological inhibition of peripheral CB1Rs indicate that the endogenous cannabinoid system is required for the orexigenic effect of the gut peptide ghrelin (Kola et al., 2008, 2013; Lim et al., 2013; Senin et al., 2013), which is the primary appetite-stimulating hormone in the body, playing a critical role in both energy balance and food reward

(Perello & Dickson, 2015). Although smoked and oral cannabis (THC) have also been shown to increase total plasma ghrelin levels in cannabis users (Farokhnia et al., 2020; Riggs et al., 2012), the correlation between cannabis-induced plasma increases in ghrelin and appetite has yet to be fully explored.

Despite strong evidence from both preclinical and human literature suggesting cannabis increases appetite and motivation to eat for pleasure, the associated health effects are unclear. Gibson et al. (2023) found that while non-cannabis users overall scored higher on the Healthy Diet Index, there were no significant differences in total calories consumed and cannabis users reported eating more fruits and vegetables as well as salty snacks on use days compared to other days (Gibson et al., 2023). Notably, the National Health and Nutrition Examination Survey (1988-2015) reported that while cannabis users had higher caloric intake and lower diet quality (more high salt and high fat foods, less fruits and vegetables), there were no significant differences in BMI or other measures of nutritional status (Gelfand & Tangney, 2021; Smit & Crespo, 2001). While some studies have also observed this negative relationship between cannabis use and BMI (Beulaygue & French, 2016; Clark et al., 2018), this has not replicated in all samples (Gibson et al., 2023).

One theoretical explanation for this paradoxical finding focuses on the relationship between diet and the ECS, suggesting that increased consumption of omega-6 fatty acids (relative to omega-3), which is characteristic of the Standard American diet, upregulates eCB signaling, stimulating CB1Rs to promote increased food consumption and metabolic dysfunction (Clark et al., 2018). Clark et al. (2018) argues that cannabis induces downregulation of CB1Rs as a mechanism of tolerance, which may be counteracting the effect of diet on eCBs (Clark et al., 2018). Peripheral CB1Rs play a critical role in regulating energy balance, which may also explain the observed lower prevalence of diabetes among cannabis users (Penner et al., 2013; Rajavashisth et al., 2012). While it is also possible that individuals who use cannabis may engage in health promoting behaviors (e.g. improved diet on non-use days, exercise) to compensate for dietary choices made under the influence, there do not appear to be substantial differences in health behaviors between cannabis users on non-user days and non-users (Gibson et al., 2023).

Eating Disorders and Substance Use Disorders

The developmental trajectories of substance use and eating disorders show substantial similarities, in that disordered eating and substance use are associated with increased risk of developing eating disorders and substance use disorders in adulthood, respectively (McCabe et al., 2018; Merline et al., 2004; Schulenberg et al., 2016; Steinfeld & Torregrossa, 2023). The developmental period from adolescence to early adulthood is associated with distinct bodily changes (i.e. puberty) and oftentimes increased risk-taking behavior, including substance use. Adolescents may also be increasingly exposed to societal messaging regarding beauty standards, with thinness ideal predominating in Western countries (Espinoza et al., 2019; A. J. Hill et al., 1992). Internalization of beauty ideals has been shown to predict disordered eating and low self-esteem among adolescents in a 16-month longitudinal study (Espinoza et al., 2019). Disordered eating may include behaviors that deviate from normative eating behaviors yet do not meet full criteria for an eating disorder. Nonetheless, disordered eating during adolescence often persists into adulthood, serving as a critical risk factor for the development of eating disorders (Neumark-Sztainer et al., 1998; Rohde et al., 2015).

There is evidence that body dissatisfaction, dieting, and extreme weight-loss behaviors are associated with increased prevalence of substance use among adolescents, particularly alcohol, cannabis, and tobacco use (Bartlett et al., 2023; Beato-Fernandez et al., 2007; Bornioli et al., 2019; Brown et al., 2015; Crow et al., 2006; French et al., 1995; Garry et al., 2003; Linardon et al., 2023;

Ross & Ivis, 1999). While most studies found significant sex differences, with stronger relationships between disordered eating and substance use for females (Bartlett et al., 2023; Beato-Fernandez et al., 2007; Bornioli et al., 2019; Brown et al., 2015; Ross & Ivis, 1999), others found minimal differences or conversely, demonstrated stronger associations for males (Crow et al., 2006; French et al., 1995; Pisetsky et al., 2008). Regarding the temporal relationship between disordered eating and substance use, a prospective study by Field et al. (2002) indicated that among adolescent girls, weight concerns predicted beginning to smoke, getting drunk, binging, and purging behaviors a year later (Field et al., 2002).

The positive relationship between disordered eating and substance use is mirrored in studies with adult samples as well (D. Anderson et al., 2006; Krahn et al., 1992; Linardon et al., 2023; Ranson et al., 2002). In a study of young adult women, increased severity of dieting behaviors was associated with a greater prevalence of alcohol, tobacco, and cannabis use (Krahn et al., 1992). Disordered eating is also associated with body dissatisfaction in midlife and older adults, particularly among women (K. L. Jackson et al., 2014; Marcus et al., 2007; Matsumoto & Rodgers, 2020; Samuels et al., 2019). Life transitions and weight-gain associated with aging may also represent risk factors for disordered eating among midlife adults, in addition to media exposure regarding the beauty standards of aging (Goodman et al., 2018; Hefner et al., 2014; Samuels et al., 2019). While substance use disorder prevalence typically tends to decrease with age (Vasilenko et al., 2017), substance use during adolescence and young adulthood is associated with increased risk of developing a SUD later in life (McCabe et al., 2018; Merline et al., 2004; Schulenberg et al., 2016; Steinfeld & Torregrossa, 2023).

Individuals who meet clinical criteria for eating disorders (EDs) also appear to be at increased risk of substance use relative to non-ED controls (Bahji et al., 2022; Castro-Fornieles et al., 2010; Devoe et al., 2021; Fouladi et al., 2015; Harrop & Marlatt, 2010; Lock et al., 2001), with some studies suggesting a greater prevalence of substance use disorders (SUDs) among those who engage in binge-eating (e.g. binge eating disorder, bulimia) compared to those who predominantly restrict (Castro-Fornieles et al., 2010; Fouladi et al., 2015; Herzog et al., 2006; Mann et al., 2014; Qeadan et al., 2023; Root et al., 2010; Ross & Ivis, 1999; Stock et al., 2002; Wiederman & Pryor, 1996)(Wiederman & Pryor, 1996; Wiederman & Pryor, 1996a, Ross & Ivis, 1998; Stock et al., 2002; Herzog et al., 2006; Castro et al., 2010; Root et al., 2011; Mann et al., 2014; Fouladi et al., 2015; Qeadan et al., 2023), which may be related to common underlying factors such as behavioral impulsivity (Kane et al., 2004).

Eating Disorders and the Endocannabinoid System

Given the role of the ECS in regulating appetite and influencing the reward value of food (Jager & Witkamp, 2014), there has been research interest in exploring the link between eating disorders and the endocannabinoid system (Mir et al., 2023). Endocannabinoids (eCBs), particularly anandamide (AEA), have been shown to stimulate food intake via CB1Rs in midbrain and hypothalamic brain regions in rodents (Kirkham et al., 2002). AEA levels may furthermore be upregulated by short-term fasting and normalize during refeeding, however the opposite association is seen in long-term food restriction (Hanuš et al., 2003; Kirkham et al., 2002). Conversely, human studies have found increased AEA levels in individuals with anorexia (AN) and binge eating disorder (BED) but not bulimia nervosa (Monteleone et al., 2005; Yagin et al., 2020). However, Baenas et al. (2023) observed increased AEA levels among individuals with higher BMI, with and without a binge eating diagnosis, compared to healthy controls and individuals with AN respectively (Baenas et al., 2023). BMI may be a confounding factor in these studies, as blood eCB levels have been shown to correlate with BMI (Silvestro et al., 2020).

Other research has instead emphasized CB1R availability. Frieling et al. (2009) observed elevated blood CB1R mRNA in individuals with AN and BN, which was negatively correlated with several constructs of eating disorder symptomatology such as drive for thinness and perfectionism (Frieling et al., 2009). Similarly, another study found increased CB1R availability in different brain regions in individuals with AN and BN compared to healthy controls (Gerard et al., 2011). This upregulation of CB1Rs in AN may represent a compensatory mechanism to restore eCB signaling or a potential predisposing factor (Gerard et al., 2011). In contrast Ceccarini et al. (2016) observed a negative correlation between BMI and CB1R availability in homeostatic brain regions (e.g. hypothalamus) in both healthy controls and individuals with food intake disorders (FID), while a negative correlation between BMI and CB1R availability in mesolimbic brain regions was only found amongst individuals with FID, including those who met criteria for AN, BN, feeding disorders related to loss of appetite (FD), and obesity (OB) (Ceccarini et al., 2016). This suggests a potential role for the endocannabinoid system in the dysregulation of hedonic processes in eating disorders. Additionally, loss of appetite is a recognized but less commonly reported symptom of cannabis withdrawal syndrome which may be attributed to CB1R downregulation (Sexton et al., 2019), prompting the need to rule out CWS when evaluating individuals for eating disorders (Chesney et al., 2014).

Several studies have also explored the relationship between gene polymorphisms in the ECS and eating disorders. Monteleone et al. (2009) identified higher frequencies of single nucleotide polymorphisms (SNPs) in the genes encoding CB1Rs (CNR1) and the fatty acid amide hydrolase (FAAH) enzyme among individuals with AN and BN compared to healthy controls

(Monteleone et al., 2009), which presented with a synergistic effect in those with AN, however a previous study observed no such association (Müller et al., 2008). Another study found different haplotypes of the CNR1 gene were associated with restrictive and binge-purge subtypes of AN respectively (Siegfried et al., 2004). A recent genome-wide association study found an association between cannabis use initiation and AN, with and without binge eating (Munn-Chernoff et al., 2021), which may be related in part to genetic risk factors within the ECS.

Cannabis and Disordered Eating

While there is substantial literature suggesting that substance use and disordered eating are interrelated and may later precipitate pathology in the form of substance use or eating disorders, the specific relationship between cannabis use and disordered eating remains understudied. In two large cross-sectional studies of adolescents, higher prevalence rates of cannabis (and alcohol) use were observed amongst individuals who engaged in extreme or unhealthy weight control behaviors (i.e., self-induced vomiting, using diet pills) compared to controls (Neumark-Sztainer et al., 1998; Vidot et al., 2016). It is possible that individuals may engage in binge-eating while under the influence, leading to greater engagement in extreme weight control behaviors, however the directionality of this association cannot be determined from a cross-sectional design. In general, rates of cannabis use have been estimated to be higher amongst individuals with EDs who engage in binge eating, however cannabis use has not been found to consistently predict binge eating (Corte & Stein, 2000; Fouladi et al., 2015; Stock et al., 2002; Vogeltanz-Holm et al., 2000; Wiederman & Pryor, 1996). A recent study in a clinical sample of individuals with binge eating found that cannabis use frequency did not predict binge eating frequency nor engagement in compensatory behaviors, despite 40% of the sample reporting daily cannabis use (Wilkinson et al., 2024). A subsequent study conducted a latent class analysis with a sample of individuals with BED and found no significant differences in binge eating or compensatory behavior frequency according to alcohol and cannabis use patterns (Wilkinson et al., n.d.). Yet, these findings are somewhat limited as eligibility criteria required a high frequency of binge eating and the majority of participants did not live in states where cannabis is recreationally legal (Wilkinson et al., n.d.).

It is also possible that the association between cannabis use and binge eating may be better explained by a latent variable, such as loss of control overeating. Maynard et al. (2023) demonstrated that loss of control over eating mediated the relationship between cannabis-related problems and eating pathology (as measured by the EDE-Q) in a sample of college students (J. Latner et al., 2014; Maynard et al., 2023). Loss of control over eating has emerged as a salient construct associated with eating pathology and holds further relevance for cannabis use, as “the munchies” may increase motivation for food even if actual food consumption doesn’t necessarily meet criteria for a binge episode (Latner et al., 2014; Latner et al., 2007). This finding is mirrored in samples of bariatric (i.e., weight loss) surgery recipients. In a sample of bariatric surgery recipients, 32% reported cannabis use in the past 30 days (Vidot et al., 2016), and there was a higher prevalence of loss of control over eating and other maladaptive eating behaviors (e.g., eating when anxious or lonely) among cannabis users compared to non-users (Vidot et al., 2016). Furthermore, 21% of cannabis users reported increased cannabis use post-surgery, and this subset of individuals scored higher on eating disorder symptomatology, such as shape and weight concerns, and food addiction (Vidot et al., 2016). Another study examining post-operative cannabis use reported prevalence rates of 14%, and post-operative cannabis use was associated with increased symptoms of anxiety as well as maladaptive eating behaviors up to 4 years post-surgery (Miller-Matero et al., 2024). More specifically, weekly cannabis use was associated with binge eating and loss of control over eating (Miller-Matero et al., 2024). Nonetheless, there are conflicting findings regarding the relationship between postoperative cannabis use and weight loss outcomes in bariatric patients (Huang et al., 2023; Miller-Matero et al., 2024).These results point again to loss of control over eating as a potential vulnerability factor underlying the relationship between cannabis and disordered eating behaviors. Further exploration of the relationship between cannabis and disordered eating behaviors across different samples is warranted, especially given the increasing prevalence of cannabis use and bariatric surgery in the United States.

In exploring the co-occurrence of eating disorders and cannabis use disorder, a meta-analysis found that 14.5% of individuals with eating disorders had a lifetime history of cannabis use disorder, but there were no substantial differences in prevalence across individuals with anorexia nervosa (AN), bulimia nervosa (BN), and binge eating disorder (BED; Bahji et al., 2019). In a study examining psychiatric comorbidities amongst individuals with BED and subtypes of BN (previously referred to as purging [BN-P] and non-purging [BN-NP] in the DSM-IV, whereby the non-purging subtype refers to individuals who engage in compensatory fasting and excessive exercise behaviors), one thing that set individuals with BN-NP apart from BN-P was a higher lifetime prevalence of cannabis use disorder (CUD) (Jordan et al., 2014). Consistent with this, a case report of a teenager with AN (binge-purge subtype) indicated increased appetite for sugary foods after cannabis use and engagement in compensatory behaviors such as excessive exercise as a result (Karayilan & Erol, 2013). More recently, Pedersen et al. (2024) conducted a secondary analysis in a sample of undergraduates with high risk drinking behaviors and observed that sex moderated the relationship between CUD symptoms and screening positive for an ED, whereby males who screened positive for an ED reported more CUD symptoms compared to females (Pedersen et al., 2024). More broadly, individuals who screened positive for an ED reported greater frequency of cannabis use and severity of CUD (Pedersen et al., 2024). Alcohol-related variables were not associated with screening positive for an ED, however (Pedersen et al., 2024). The SCOFF questionnaire was used to screen for EDs (Morgan et al., 2000), and although this brief questionnaire does not distinguish between different subtypes (AN, BN, BED, etc.), individuals who screened positive for CUD were more likely to endorse loss of control over eating. Together, these findings point to a possible connection between cannabis use disorder, loss of control overeating, and general eating pathology, however further research is needed to disentangle this association.

In considering the relationship between cannabis use and disordered eating, it is also important to recognize potential therapeutic benefits. The endocannabinoid system (ECS) in energy balance and metabolism has emerged as a treatment target for eating disorders, given its role in energy balance and metabolic processes (Marco et al., 2012). THC has historically been used to treat anorexia/cachexia associated with cancer and HIV (Badowski & Yanful, 2018), thus some studies have considered its utility in treating anorexia nervosa (AN). Dronabinol, a synthetic form of THC, has also been shown to promote weight gain and reduce compulsive behaviors in individuals with chronic AN (Andries et al., 2014, 2015; Graap et al., 2018). In a small pilot study, Avraham et al. (2017) found that while plant-derived THC did not promote weight gain in patients with anorexia, individuals reported improved psychological functioning, such as reduced depression and increased self-efficacy and self-care (Avraham et al., 2017). Scharmer et al. (2020) conducted a study on cannabis expectancies amongst people with AN and individuals reported positive expectancies, including reduced restriction and compensatory behaviors (Scharmer et al., 2020). Nonetheless, further research is needed to determine the potential therapeutic effects of cannabinoids like THC in AN as well as other eating disorders (Rosager et al., 2021).

Substance use and compensatory diet, exercise, and other weight control behaviors

Over the past 15 years, a growing body of research has been dedicated to a phenomenon referred to as "drunkorexia" (Wilkerson et al., 2017), "weight-conscious drinking" (Piazza-Gardner & Barry, 2013), "food and alcohol disturbance" (FAD; Choquette et al., 2018), and "alcoholimia" (Thompson-Memmer et al., 2019). Historically, conceptions of this phenomenon have emphasized the use of restrictive dieting (e.g., skipping meals, eating low calorie foods), exercise, and purging (e.g. vomiting, using laxatives) behaviors to compensate for calories associated with alcohol consumption, however restriction targeted at enhancing the effects of alcohol (e.g., getting more drunk, faster) has been cited as another common motive (Rahal et al., 2012; Ward & Galante, 2015). For the sake of simplicity, the acronym for food and alcohol disturbance, "FAD," will be used going forward, as this term encompasses both weight and enhancement-motivated behaviors (Choquette, Rancourt, et al., 2018). Several studies have found that engagement in FAD behaviors for caloric compensation and enhancement motives is associated with increased quantity and frequency of alcohol use, frequency of binge drinking, hazardous drinking, and alcohol use disorder symptoms (Buchholz & Crowther, 2014; Choquette et al., 2020; E. M. Hill & Mazurek, 2023; Meinerding et al., 2022). FAD has also been associated with eating disorder symptomatology, body dissatisfaction, and disordered eating attitudes across both caloric compensation and enhancement motives (Azzi et al., 2021; Herchenroeder et al., 2023; E. M. Hill & Lego, 2020; E. M. Hill & Nolan, 2021). Notably, a recent longitudinal study found that FAD-remission was associated with fewer alcohol-related consequences, but eating disorder risk persisted (Ritz, Mauny, Leconte, et al., 2024). Therefore, although FAD isn't classified as an eating disorder, it falls on the spectrum of disordered eating and may be a risk factor for both eating and alcohol use disorders (Hunt & Forbush, 2016; Ritz, Mauny, Leconte, et al., 2024).

Initial measures of FAD behavior included one or two items inquiring about caloric restriction in anticipation of drinking and associated motives (Burke et al., 2010), but several scales have been developed since, including the 21-item Compensatory Eating and Behaviors in Response to Alcohol Consumption Scale (CEBRACS; Rahal et al., 2012), the 52-item Drunkorexia Motives and Behaviors Scale (DMBS; Ward & Galante, 2015), and 25-item College Eating and Drinking Behaviors Scale (CEDBS) (Landry et al., 2017), all of which account for motives related to caloric compensation and enhancing the effects of alcohol. The DMBS and CEDBS capture additional motives, such as saving money on alcohol, conforming to social norms, and avoiding feeling sick, however these appear to be relatively less common (K. A. Berry et al., 2024; Burke et al., 2010; Vogt et al., 2022; Ward & Galante, 2015). Restricting food intake before drinking has been associated with more consequences related to alcohol consumption, such as blacking out, binge drinking, driving while under the influence, and getting into physical fights (Buchholz et al., 2018; Giles et al., 2009; Landry et al., 2017; R. M. Simons et al., 2021; Tuazon et al., 2019; Vogt et al., 2022). Engagement in purging behaviors (e.g. self-induced vomiting) has also been associated with negative alcohol-related consequences (D. A. Anderson et al., 2005). This increased risk may be partially attributed to the pharmacokinetics of alcohol under a food-restricted or fasted state. Alcohol is absorbed through the stomach and small intestine, whereafter it enters the bloodstream (Mitchell et al., 2014), and fasting (i.e., drinking on an empty stomach) quickens absorption (DiPadova et al., 1987), leading blood alcohol concentration to peak sooner (i.e. getting drunker, faster). This may potentiate the detrimental effects of binge drinking by increasing the risk of black outs, memory lapses, and other consequences (Burke et al., 2010), making this pattern of behavior an important public health concern.

Most existing studies on FAD have employed the CEBRACS, however the psychometric properties of this scale have been under scrutiny in recent years due to inconsistent findings from studies attempting to validate the factor structure (Choquette, 2017; Choquette et al., 2020; Meinerding et al., 2022; Rahal et al., 2012; Ritz et al., 2023; Shepherd et al., 2023). Rahal et al. (2012) originally proposed a 4-factor structure for the 21-item CEBRACS, encapsulating Alcohol Effects, Bulimia, Diet and Exercise, and Restriction (Rahal et al., 2012). A subsequent psychometric evaluation by Choquette (2017) suggested the removal of the restriction subscale to yield a 19-item scale, yielding a 3-factor structure (Choquette, 2017), which was corroborated by another study (Choquette et al., 2020). Choquette et al. (2020) additionally presented a time-based scoring approach, whereby factors are grouped according to whether behaviors occurred before, during, or after alcohol use (Choquette et al., 2020). The CEBRACS has also been translated into Italian and French and the factor structures were re-examined among the respective populations (Pinna et al., 2015; Ritz et al., 2023). The Italian version yielded a 5-factor structure (Alcohol Effects; Laxative Use; Dietary Restraint [low-calorie food intake] & Exercise; Diuretic Use; Restriction [extreme dietary restriction] & Vomiting; Pinna et al., 2015) and the French version yielded a 4-factor structure (enhancement of the effects of alcohol, dietary restraint and exercise, purging and vomiting and extreme fasting; Ritz et al., 2023), which may reflect cultural differences in the manifestation of FAD. More recently, Meinerding et al. (2022) tested the original factor structure as well as the time-based structure and did not find support for either (Meinerding et al., 2022), suggesting that expansion or revision of items may be necessary. Although the CEDBS (3-factor structure: Quicker Intoxication, Offset Calories, and Alternative Methods) has greater psychometric support (Landry et al., 2017, 2022), it only captures behaviors prior to drinking episodes, whereas both the CEBRACS and DMBS capture FAD behaviors before, during, and after drinking (Choquette, Rancourt, et al., 2018; Meinerding et al., 2022). Furthermore, despite issues with factor structure, endorsement of CEBRACS items has consistently been associated with alcohol and disordered eating related variables (Meinerding et al., 2022).

Findings from qualitative literature have indicated that individuals continue to engage in FAD behaviors despite perceived or experienced negative consequences (K. Berry & Looby, 2024; Vogt et al., 2022). Recently, Berry & Looby (2024) conducted a qualitative study examining FAD expectancies among a sample of undergraduates, which revealed themes including perceived Appearance/Weight-Related Benefits, Alcohol Enhancement/Intoxication, Mood Improvement, Social Approval and Connectedness (i.e., facilitating social approval and connectedness), Negative Physical Consequences, Cognitive and Behavioral Impairment, and Negative Affect (K. Berry & Looby, 2024). Positive expectancy effects towards FAD have been shown to predict engagement in harmful drinking patterns as well as disordered eating (Schultz et al., 2021).

While the majority of studies on FAD have been conducted in undergraduate student populations in the United States, FAD behaviors have been documented among adolescents and a broad range of adults (Griffin & Vogt, 2021; Moeck & Thomas, 2021), as well as in other countries such as Italy (Laghi et al., 2020, 2021a, 2021b; Lupi et al., 2017; Pinna et al., 2024), Canada (Roosen & Mills, 2015), the United Kingdom (Vogt et al., 2022), France (Choquette, Ordaz, et al., 2018; Ritz et al., 2023), Spain (Zaragoza Martí et al., 2015), Australia (Knight et al., 2017; Powell-Jones & Simpson, 2020), and Lebanon (Azzi et al., 2021; Gerges et al., 2022). Prevalence rates vary significantly across studies, which may be attributed in part to different operational definitions and measures being used as well as the study populations (Berry et al., 2024). For studies using versions of the CEBRACS, prevalence estimates of caloric compensation and enhancement motives ranged from 11.3 to 81.3% and from 6.5 to 79.8% respectively among samples of current drinkers (Berry et al., 2024). Bryant et al. (2012) found that up to nearly 50% of college students who drink alcohol engaged in FAD with caloric compensation motives at least 25% of the time when drinking (Bryant et al., 2012). While several studies have suggested that FAD is more common amongst women than men, particularly for caloric compensation motives (Buchholz et al., 2018; Choquette, Ordaz, et al., 2018; Giles et al., 2009; Hahn et al., 2022), others have found no significant difference (Azzi et al., 2021; Horvath et al., 2020). Furthermore, a systematic review compared scores on two different measures of FAD motives and behaviors (CEBRACS versus DMBS) among college students found no significant gender differences (Speed et al., 2022). Thus, gender differences in FAD may be shifting over time as well as differ across populations.

Beyond associations with alcohol problems and disordered eating related-constructs, FAD has been associated with difficulties in psychosocial functioning as well as stress and anxiety-related pathology. In a sample of adolescents (17-20), engagement in FAD was negatively associated with theory of mind and positively associated with a lack of emotional awareness (Laghi et al., 2021a). However, FAD was only associated with emotion dysregulation in a sample of undergraduates before controlling for eating disorder symptoms, alcohol use, and BMI (Horvath et al., 2020). Nonetheless, elements of emotion dysregulation, such as expression suppression, have been shown to positively predict FAD in other samples (Pompili et al., 2022). FAD may therefore represent a maladaptive coping strategy for regulating emotions or responding to stress for some individuals. Hill & Mazurek (2023) conducted a study exploring the relationship between FAD and "wine mom" culture (i.e., using wine to self-medicate or cope with parenting related stressors) and found that stress, body dissatisfaction, and "wine mom" drinking correlated with FAD as well as problematic alcohol use in a sample of mothers (Hill & Mazurek, 2023). Moreover, high baseline cortisol was shown to predict FAD behaviors in women but not men in one study (Oswald et al., 2021), and another found that PTSD symptoms predicted engagement in FAD behaviors even after controlling for concerns regarding weight and shape in a sample of undergraduates (Michael & Witte, 2021), altogether providing further evidence for the relationship between stress and FAD

More recently, research has pointed to the role of social support as a protective factor against FAD. Herchenroeder et al. (2023) found that loneliness significantly predicted alcohol problems in a sample of undergraduates, specifically for individuals who reported higher levels of engagement in FAD (Herchenroeder et al., 2022). Moreover, Murley et al. (2024) demonstrated a relationship between anxiety, social media use, and FAD amongst undergraduates, whereby anxiety mediated the relationship between social media use and FAD (Murley et al., 2024).This relationship was found to be further moderated by social support, however, this relationship was not significant for individuals with higher levels of social support (Murley et al., 2024). Similarly, Pompili et al. (2022) found that social support was protective against FAD amongst undergraduates in Italy during the COVID-19 pandemic (Pompili et al., 2022). In a study exploring risk factors for FAD amongst undergraduate students, Gates & Stough (2021) found that generalized anxiety was associated with both weight and enhancement-related FAD, and adverse childhood experiences were associated with enhancement-related FAD (Gates & Odar Stough, 2022). Another study found that attachment insecurity (anxious, fearful-avoidant) moderated the relationship between childhood maltreatment and FAD amongst undergraduates (Ritz, Mauny, Montcharmont, et al., 2024). Therefore, FAD may represent a maladaptive coping mechanism for which individuals who struggle with interpersonal functioning may be especially vulnerable (Laghi et al., 2021a).

Compensating for the Munchies?

Alcohol is unique amongst recreational substances in that it is ingested and has caloric value, presenting an obvious justification for individuals to engage in compensatory behaviors for both enhancement and weight-related motives. However, there remains a gap in the literature regarding compensatory behaviors and use of other substances, such as cannabis. Although cannabis itself does not have caloric value (except if used in edible form), many individuals experience increased appetite (particularly for palatable foods) under the influence of cannabis, or "the munchies," as previously discussed, for which they may attempt to compensate through diet, exercise, or other weight control behaviors (Choquette et al., 2018). While the limited existing literature on cannabis use and disordered eating has yielded mixed findings (Maynard et al., 2023; Wilkinson et al., 2023, 2024), no study to date has explored engagement in compensatory behaviors specifically related to cannabis "munchies" among undergraduate students, as well as whether such behaviors are associated with cannabis use consequences or eating disorder symptoms. Exploring these associations is particularly timely given increasing rates of cannabis use amongst the young adult population (*National Survey on Drug Use and Health (NSDUH)*, 2022), as well as the trend of adolescents and young adults being heavily exposed to appearance and eating related content on social media, which has been shown to contribute to and exacerbate eating disorder symptomatology (Dondzilo et al., 2024).

As enhancement-related effects are another often cited motive for food and alcohol disturbance, it is also worthwhile to explore whether this effect is salient for cannabis use and explore potential consequences. While the effects of smoked cannabis are unlikely to be affected by food intake, cannabis has poor oral bioavailability and the onset of effects is significantly delayed in comparison to smoked cannabis (Bidwell et al., 2022b; Chayasirisobhon, 2020), thus individuals may fast or reduce food intake prior to taking “edibles” to achieve faster absorption and intoxication (Lunn et al., 2019). In some cases, this could be a protective behavioral strategy, as the delayed onset of edible cannabis products may prompt individuals to use more, which may ultimately lead to adverse experiences (Farmer et al., 2019). It is also possible that individuals may endorse enhancement expectancy effects about restricting food intake before or while under the influence of smoked cannabis, even if those expectancies are inaccurate (Berry & Looby, 2024). Although less is known about the effects of reducing food intake on cannabis intoxication and associated consequences, evidence from preclinical literature demonstrated that fasting is associated with increased plasma cannabinoid levels and reduced locomotor activity in rats treated with intraperitoneal THC (Wong et al., 2014), which may represent psychomotor impairment. Ultimately, further research is needed to elucidate potential patterns of diet and other weight control behaviors related to cannabis use, both for caloric and enhancement related motives, and whether such behaviors might be associated with cannabis-related consequences and/or eating disorder symptomatology, paralleling findings from FAD literature.

Pilot Study

The current study built upon findings from a pilot survey. As the aim of the project was to explore how the construct of FAD might map onto cannabis use, an existing measure, The Compensatory Eating and Behaviors in Response to Alcohol Consumption Scale (CEBRACS; **Appendix D**), was adapted with a focus on compensation for cannabis-related “munchies” (Choquette et al., 2020; Meinerding et al., 2022), with consultation from several subject matter experts. This measure was chosen as it is the most widely used measure in the FAD literature and because it includes a time-based element, as individuals may engage in compensatory behaviors in anticipation of, during, and/or after experiencing the munchies (Shepherd et al., 2023).

The original CEBRACS is a 21-item measure capturing compensatory diet, exercise, and bulimic behaviors related to alcohol enhancement and caloric compensation (Rahal et al., 2012). Participants are asked to report the frequency of their engagement in behaviors over the past 3 months on a 5-point (1-5) Likert scale (Rahal et al., 2012). Although no specific factor structure has been replicated and deemed a suitable fit (Choquette et al., 2020; Meinerding et al., 2022), the time-based element offers a significant advantage over existing scales, given the hypothesized incidence of loss of control over eating while under the influence of cannabis that may fuel compensatory behaviors (Maynard et al., 2023). Survey items were adapted to reflect cannabis use (e.g., Please indicate how frequently you have experienced any of the following while eating under the influence of cannabis in the past 3 months) and additional items were added to further explore behaviors related to enhancement (e.g., prolonging high) and compensatory motives during cannabis use (i.e. eating low calorie foods while under the influence), both to capture a wider range of potential behaviors and account for pharmacological differences in cannabis and alcohol.

The survey was piloted in the Colorado State University Psychology Subject Pool in the Spring semester of 2024. To screen for participants who use cannabis and experience the munchies, participants were first asked which types of cannabis products they use regularly (i.e., flower, concentrates, edibles, not a regular user), and the frequency in which they experienced “the munchies” using a Likert scale (Never [1], Rarely - 25% of the time [2], Sometimes - 50% of the time [3], Often - 75% of the time [4], Almost all the time [5]), where the munchies were defined as “feelings of hunger and craving for food experienced under the influence of cannabis.” Individuals who endorsed regular cannabis use were presented with adapted CEBRACS questions. Questions were presented per product type (i.e., flower, concentrates, edible) to capture potential differences in route of administration and potency. Questions regarding compensating for the munchies were presented to those who endorsed experiencing the munchies more than 25% of the time when using cannabis. These individuals were additionally presented with compensatory-related questions. Questions targeting enhancement motives (e.g. “Eaten less to get higher”) were only presented for individuals who reported regular use of edible cannabis products, due to the association between food consumption and absorption of oral cannabis (Lunn et al., 2019). Additional items related to enhancement motives such as prolonging a high were also included. Individual items about eating low calorie and low-fat foods before use and while under the influence were also included (previously one item for “before” use), as individuals may opt to make such foods more accessible to decrease overall caloric consumption when experiencing the munchies.

Participants were also asked four questions adapted from the Eating Disorder Examination Questionnaire assessing frequency of binge-eating under the influence of cannabis munchies in the past 3 months (e.g., “Eaten what other people would regard as an unusually large amount of food”) using a 5-point Likert scale (Never, Rarely, Sometimes, Often, Almost all of the time), which is separate from the core survey but may be a relevant association to explore. Participants were given the opportunity to optionally provide more information about their cannabis use and eating patterns as well as give feedback on the questions at the end of the survey section via open-ended text response. The Eating Disorder Examination Questionnaire Short Form was also used to explore associations between cannabis related compensatory behaviors and general eating disorder symptoms (Prnjak et al., 2020).

Among individuals who endorsed using cannabis regularly (n = 134), 50.3% reported regular use of flower cannabis (n = 79), 38.2% edibles (n = 66), and 42% concentrates (n = 60), and 35% of the sample endorsed regular use of multiple product types. 66.2-79.4% of these individuals endorsed experiencing the munchies at least 50% of the time when using cannabis, depending on product type, with the lowest level of endorsement being for flower cannabis and the highest for concentrates. Individuals who reported experiencing the munchies at least sometimes (50% of the time) when using cannabis then answered questions about frequency of binge eating while under the influence of the specific cannabis products they endorsed using as well as questions related to compensatory and enhancement-related eating behaviors. Overall, there were no notable differences in endorsement binge eating while under the influence of cannabis concentrates (n = 54), edibles (n = 48), or flower (n = 53). 50-54.7% of participants reported eating what other people would regard as an unusually large amount of food, 41.6-46.6% reported a sense of loss of control overeating, 16.7-27% reported feeling sick after eating, 22.6-38% reported feeling guilty afterwards because of its effect on shape or weight at least sometimes while eating under the influence of a given cannabis product.

68.3% of individuals who were presented with questions related to compensating for the munchies (n = 101) endorsed engaging in at least one behavior on some level across all timepoints, and 36% of these individuals scored above threshold (> 15 out of 36) on the Eating Disorder Examination Questionnaire short form. There were few notable differences in endorsement of items related to compensatory behaviors across different types of cannabis products. Across the board, very few (n = 3) individuals endorsed any purging or bulimic behaviors (e.g. self-induced vomiting, laxatives, diuretics). Higher rates of endorsement were present for exercise as a compensatory mechanism as well as eating low calorie/fat foods and drinking low calorie beverages. For individuals who reported regularly using edibles (n = 62), questions about restricting food intake for enhancement purposes were presented regardless of whether they endorsed experiencing the munchies, and overall, rates of enhancement motives were relatively low for both “before” and “during” timepoints (9-15%), primarily clustered within the same individuals. While the sample size for the pilot study was too small to make any conclusions, these findings provide some preliminary evidence for undergraduates engaging in FAD-like behaviors related to cannabis use, warranting further investigation.

Current Study

Given the increasing prevalence of cannabis use across the United States, concurrent with trends towards recreational legalization, further research is needed to elucidate the relationship between cannabis use and other health behaviors to prevent potential harms. The relationship between cannabis use and disordered eating behaviors remains understudied, and the question remains whether behaviors associated with Food and Alcohol Disturbance (FAD) may also apply to cannabis use, with a focus on “the munchies.” The current study leverages a cross-sectional design to examine the incidence of cannabis-related eating and compensatory behaviors by surveying a sample of undergraduates enrolled in introductory psychology at Colorado State University and the University of Wyoming. The aims of this study were to (1) Develop an initial measure of cannabis-related compensatory diet, exercise, and other weight control behaviors through adapting an existing measure of food and alcohol disturbance (FAD), with a focus on compensating for “the munchies” and enhancing the effects of cannabis (2) Examine associations between compensatory behaviors, cannabis use consequences, cannabis-related binge-eating, and eating disorder symptomatology.

Based on these aims, the following hypotheses were generated:

Hypothesis 1: There will be distinct factors underlying compensatory eating and other behaviors related to cannabis. I predict that at least two factors will emerge, related to enhancing drug effects (e.g. "getting higher") and compensating for calories associated with using cannabis and getting "the munchies" (e.g., "skipping one or more meals to make up for calories consumed"), consistent with existing literature on FAD.

Hypothesis 2: Engagement in cannabis compensatory behaviors will be associated with cannabis consequences, binge eating under the influence of cannabis, and eating disorder symptomatology. Specifically:

Hypothesis 2a: Eating disorder symptoms (EDEQ global scores) and engagement in binge-eating under the influence of cannabis will have direct, positive effects on cannabis compensatory behaviors (CECBS) scores.

Hypothesis 2b: Cannabis compensatory behaviors (CECBS scores) will positively predict number of cannabis consequences endorsed (BMACQ scores).

Methods

Participants and Procedure

Participants were recruited from the undergraduate psychology subject pool, which includes students enrolled in introductory psychology and research methods courses, at Colorado State University and the University of Wyoming (~N = 1400). Cannabis is illegal for both medical and recreational use in Wyoming, thus recruiting from these populations may capture variability in cannabis use patterns in part as a function of access. That said, while cannabis is legal for recreational and medical purposes in Colorado, recreational use is not legal for those under the age of 21, thus differences between use patterns among undergraduates in legal and non-legal states may capture variability resulting from overall attitudes toward cannabis in those states. Participants completed the survey online using a computer or mobile device. In compliance with APA guidelines, participants were provided information regarding the study's purpose, potential benefits and risks of participation, and compensation. Individuals were also informed that their participation is voluntary, and they may terminate the survey at any point, however this may result in not obtaining class credit. They were also informed that survey responses will be completely anonymous and no identifiable information will be collected, and data will be stored on a secure server that only authorized personnel have access to.

Exclusion criteria included being under the age of 18 years old, not having used cannabis at least once per month in the past 3 months and never having experienced "the munchies" (66-79% of participants in the pilot reported experiencing the munchies at least 50% of the time, depending on the type of cannabis product). The minimum target sample size was 300, which is estimated to be sufficient for exploratory factor analysis (Boateng et al., 2018; Velicer & Fava, 1998).

Measures

Demographics

Participants were asked to self-report age, sex assigned at birth, gender identity, race, ethnicity, sexual orientation, employment status, and household income.

Cannabis use patterns, consequences, and use disorder symptoms

The 8-item Cannabis Use Disorder Identification Test-Revised (CUDIT-R; Adamson et al., 2010) was used to capture cannabis use frequency in addition to serving as an initial measure of convergent validity (Boateng et al., 2018) (**Appendix A**). The CUDIT-R includes items related to cannabis use disorder symptomatology including questions about frequency, consequences from use, and difficulty stopping or controlling use in the past 6 months using a 5-point (0-4) Likert scale (Adamson et al., 2010). Scores upwards of 13 have been associated with meeting DSM-IV criteria for CUD, however Schultz et al. (2019) found that scores greater than 6 differentiated undergraduate students with cannabis problems from those without (Schultz et al., 2019). The CUDIT-R has shown reliability and validity as a measure of cannabis problems across different samples (Mezquita et al., 2022; Schultz et al., 2019).

The Brief Marijuana Consequences Questionnaire (BMAC-Q; 20 items) is a 20-item version of the original 50-item Marijuana Consequences Questionnaire (Simons et al., 2012), which was used to assess negative consequences related to cannabis use (Bravo et al., 2019). The items for this scale are dichotomous (Yes = 1, No = 0), as participants are asked to endorse whether they have experienced a given consequence in the past month (Bravo et al., 2019), with the cumulative score representing the total number of consequences endorsed. It has shown reliability and validity as a measure of cannabis consequences across a variety of undergraduate samples (Bravo et al., 2019, 2021; Hatch et al., 2023; **Appendix B**).

Eating Disorder Symptomatology

The Eating Disorders Examination Questionnaire (EDEQ, 28 items) was used to assess eating disorder symptoms, capturing concerns over body image and disordered eating behaviors (C. G. Fairburn & Cooper, 1993). Questions are presented in a variety of formats, whereby participants are asked to answer questions about the frequency and intensity of symptoms, with the global score indicating degree of severity (Fairburn & Beglin, 2008; Fairburn & Cooper, 1993).

The questionnaire has four subscales (Restraint, Eating Concern, Shape Concern, and Weight Concern) which are scored based on the mean and then summed and averaged to generate a global score (Aardoom et al., 2012). This scale has shown reliability, validity, and sensitivity in detecting eating disorder symptoms (Fairburn & Beglin, 2008; Fairburn & Cooper, 1993; **Appendix C)**. For the purposes of this study, the global score was used for analyses, which has previously been shown to discriminate between patients with eating disorders and healthy controls (Meule et al., 2024).

CECBS scale

Following the piloting of the survey, the selection criteria were adjusted to specifically include individuals who report experiencing "the munchies" at least "rarely (25% of the time)" and at minimum endorse using cannabis monthly or less in the past 6 months, to increase the sample size and capture a broader range of use patterns, as individuals may have different criteria for what constitutes "regular" use of cannabis. Participants were also asked to indicate which product types they have used in the past 3 months (flower, edible, concentrates), however the stratification of questions by product type was amended to reduce complexity, as few differences were notable, with items presented per time-point instead ("before", "during", or "after" use) and include full sentences for each item with reference to motives. To account for potential differences according to product type or route of administration, participants were asked to answer items for whichever cannabis product applies and later specify after the time-based block of questions (i.e., flower, concentrates, edibles) if they endorse having used multiple products in the last 3 months. Furthermore, the language for the items related to the munchies and calorie compensation was amended to improve comprehension and more closely mirror the wording of the original

CEBRACS (e.g., “make up for” calories instead of “compensate”). These changes were made to improve clarity, as some respondents from the pilot survey reported finding the wording confusing.

Changes were also made to individual items. As individuals who reporting eating “low calorie” foods also consistently endorsed eating low-fat foods and drinking low-calorie beverages, these items were collapsed into one question (i.e., “I have eaten low-calorie foods and/or drank low calorie beverages to make up for calories I anticipate consuming when I have munchies”). An additional question was added to capture planned behaviors such as restricting access to calorically dense foods (i.e., “I have made sure that calorically dense foods that I could eat when I get the munchies are not readily available to me”). Another item presented “during” use was added to capture use of smoked cannabis (i.e. flower or concentrates) to avoid calories associated with edibles during use (“I have planned to smoke or vape cannabis instead of taking an edible to avoid the extra calories in edibles”). As endorsement of purging-related behaviors (e.g., self-induced vomiting or “make myself vomit”) was low in the pilot sample, items related to purging behaviors were added to “before” and “during” timepoints to determine whether low endorsement is due to low incidence or if purging behaviors may be more common at other time points across use. The final survey includes 30-items, not including questions about route of administration or binge eating under the influence and may be referred to as the Cannabis-Related Eating and Compensatory Behaviors Scale (CECBS) going forward. See **Appendix E** for survey items.

Data Analysis

Data Handling and Preparation

Prior to testing hypotheses, data were analyzed to determine if there were systematic patterns of missingness. The Missing Completely at Random (MCAR) test was used to determine if significant differences exist between complete and incomplete data. As large amounts of missing data may influence the factor structure and model fit, participants who were missing more than 50% of items in the CECBS scale were excluded (Tabachnick et al., 2019). Additional missing data may be handled using additional techniques as appropriate (e.g., maximum likelihood estimation). Assumptions for statistical analyses and the presence of outliers were evaluated using histograms as well as skew and kurtosis values, and bivariate correlations conducted to test for multicollinearity (Kline, 2023).

Aim 1: Confirm the factor structure of the Cannabis-Related Eating and Compensatory Behaviors Scale (CECBS)

Previously, five-factor, four-factor, and three-factor solutions have been proposed for the original CEBRACS scale, in addition to a factor structure stratified by time point (before, during, after use) (Choquette et al., 2020; Meinerding et al., 2022; Pinna et al., 2015; Rahal et al., 2012). Thus, EFAs were conducted for both full scale and time-based approaches to determine the number of factors and whether the factor structure differs across time points. Results from EFAs were considered in terms of which approach is superior in terms of model fit as well as interpretability. An oblique rotation was used rather than orthogonal as factors (particularly across timepoints) are likely to be correlated with one another (Devellis & Thorpe, 2021). EFAs were evaluated using fit indices such as eigenvalues, scree plots, factor loading patterns (Devellis & Thorpe, 2021).

Thereafter, the data were reexamined for confirmatory factor analysis (CFA), using the factor structure resulting in the best fit from the EFAs, as per recommendations from Schmitt et al. (2018) (Schmitt et al., 2018). CFA involves more model constraints to promote parsimony and may provide further evidence of model fit, which may be replicated in future studies (Schmitt et al., 2018). Comparative fit index (CFI), root mean square approximation of error (RMSEA), and standardized factor loadings were used to evaluate model fit (additional items may be removed based on factor loadings), and *ω* was subsequently be calculated to determine internal reliability of the resultant scale (McDonald, 1999). Guidelines for what constitutes a good fit vary, although a CFI or TLI above either .90 or .95 is thought to represent very good fit (Hu & Bentler, 1999; Kline, 2011), and RMSEA and SRMR values of .06 or lower are thought to indicate a close fit, .08 a fair fit, and .10 a marginal fit (Browne & Cudeck, 1992; Hu & Bentler, 1999). Chi-square values that are closer to zero and not significant are suggestive of good fit (Kline, 2011). For the present EFA and CFA analyses, a model building approach was used, starting with the least amount of constraints then testing model improvement under different conditions, such as removing items that failed to load on any factor or had significant cross-loading (Finch, 2020; Meinerding et al., 2022). Factor analytic decisions were also guided by theory, drawing from existing FAD literature (Stanton et al., 2023). A weighted-least squares (WLSMV) estimator was used for EFAs and CFAs, as it is designed for use with ordinal data and is robust to violations of normality (Li, 2016; Mîndrilă, 2010). To demonstrate initial convergent validity of the measure, correlations between the resultant factors and CUDIT-R scores were tested, as the AUDIT (from which it was based off of) was used as a convergent validity measure for the original CEBRACS scale (Rahal et al., 2012).

Aim 2: Examine association between CECBS scores, cannabis consequences, cannabis-related binge eating, and eating disorder symptomatology

After estimating a CFA for the scale (i.e., measurement model; Kline, 2023), structural equation modeling was used to examine hypothesized the associations between CECBS scores, cannabis-related binge eating (CBE; adapted EDEQ items), cannabis use consequences (BMACQ), and eating disorder symptomatology (EDEQ). The first model included EDEQ and CBE as latent factors predicting CECBS factors and in the second model. Sex (binary factor) and BMI were also tested as covariates in the first model to account for their potential influences on eating disorder symptoms (Rø et al., 2012; Smith et al., 2017). The second model included CECBS latent variables predicting BMACQ. As BMACQ represents a count variable, negative binomial and poisson distributions were considered, depending on the dispersion statistic. Sex, BMI, data collection site, and typical cannabis use frequency (from CUDIT-R) were tested as covariates, given the established association between cannabis use frequency and consequences (Gunn et al., 2020). An additional exploratory model was run to test cannabis use frequency as a mediator between the CECBS factors and BMACQ cannabis consequences. The Baron & Kenny approach was not feasible given the outcome was a highly skewed count variable, thus indirect effects were estimated using the product of coefficients method and delta standard errors (Cheng et al., 2021).

Model assumptions were evaluated by examining histograms as well as skew and kurtosis values, and bivariate correlations were conducted to test for multicollinearity (Kline, 2023). The aforementioned fit guidelines (Chi-squared, RMSEA, CFI, SRMR) were used to evaluate the adequacy of the proposed models (Kenny, 2020), and modification indices were considered to refine the models as necessary.

Results

The aims of this study were to 1) determine the factor structure of the Cannabis-Related Eating and Compensatory Behaviors Scale (CECBS) and 2) examine associations between CECBS scores, cannabis consequences, cannabis-related binge eating, and eating disorder symptomatology. A total of 519 participants met inclusion criteria and completed the survey (mean

Age = 19.37, SD = 1.67; 74.9% Assigned Female at Birth; mean BMI = 23.79, SD = 4.77). Most participants self-identified as cisgender women (70.7%), white (80.9%), and heterosexual (67%). Of this sample, only 157 undergraduates (30.3%) were recruited from the University of Wyoming, thus data collection site was tested as a covariate. Descriptive statistics of sample demographics are presented in **Table 1**. Of the full sample, 501 (96.5%) provided responses to all the CECBS scale items and 85.5% reported experiencing "the munchies" at least 50% of the time when using cannabis (range 1-5, Mean = 3.69, SD = 1.02). Little's MCAR test (R package: naniar) was used to assess missingness patterns in variables of interest and was not statistically significant, suggesting data is missing completely at random (MCAR). Complete cases were used for exploratory factor analysis (EFA) and maximum likelihood estimation was used for subsequent statistical tests.

Aim 1: Determine the factor structure of the Compensatory Eating Behaviors in Response to Cannabis Scale (CECBS)

Exploratory Factor Analysis

Model fit indices for the EFAs are presented in **Table 2**. The EFA model estimating across all timepoints demonstrated superior fit to the model stratified by timepoint (i.e., before, during, and after cannabis use) based on high eigenvalues (> 1) and excellent fit indices (CFI = 0.991, TLI = 0.989, RMSEA = 0.050, SRMR = 0.049), in addition to reducing complexity to support interpretability. Examination of model fit indices (i.e., CFI, TLI, RMSEA, SRMR) and eigenvalues suggested that a 4-factor model was appropriate, yet poor loading for the fourth factor and theoretical inconsistency indicate superiority of a 3-factor model (**Figure 1**).

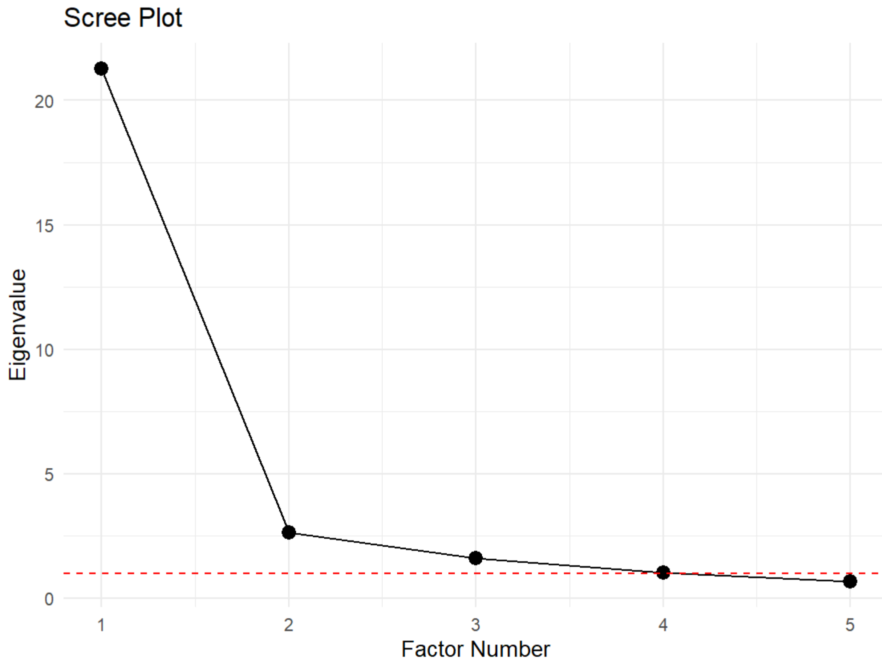

Figure 1. Scree Plot for Exploratory Factor Analysis, suggesting three factors is appropriate

No items were found to have poor factor loadings (<.32) however items with significant cross loadings (more than 1 factor loading > 0.4; e.g., "I have planned to smoke or vape cannabis instead of taking an edible to avoid the extra calories in edibles.") and highly correlated items (> .90) were considered for removal (e.g., similar items related to getting "high faster" versus "higher"), however a series of EFAs with items sequentially removed yielded slightly worse fit statistics and exacerbated issues with cross-loading (i.e., items with more than one factor loading > .3 and difference between loadings < .15). Furthermore, the high correlations observed between certain items were consistent with behaviors present at multiple timepoints, thus the original 30-item scale was retained for further refinement via the CFA. **Table 3** presents factor loadings for the corresponding EFA.

Confirmatory Factor Analysis

The 30 CECBS items were examined using the three-factor solution from the EFA, using data from the full sample. The three-factor structure demonstrated an excellent fit (χ^2 (402) =806.2, $p = 0.000$; CFI = 0.992; TLI = 0.991; RMSEA = 0.045; SRMR = 0.051) for the 30-item CECBS. The three factors map onto constructs previously described in the CEBRACS literature: Enhancement, Diet/Exercise Compensation, and Extreme Weight-Loss Behaviors (Choquette et al., 2020). Modification indices suggested freeing constraints and allowing cross-factor loading for 5 items, including the item with the poorest fit from the EFA and items that were highly correlated with one another (i.e., redundant items related to getting "high faster"). Removing these items improved model fit (χ^2 (129) =532.5, $p = 0.000$; CFI = 0.993; TLI = 0.993; RMSEA = 0.044; SRMR = 0.046). The resultant 25-item scale demonstrated excellent internal consistency within each factor (Enhancement omega = .97; Extreme Weight-Loss Behaviors omega = .97; Diet/Exercise omega = .95). There was a significant correlation between the Enhancement factor and both the Diet/Exercise (0.732) and Extreme Weight-Loss Behaviors factors (0.832), which were also highly correlated with one another (0.709). **Table 4** presents the standardized factor loadings for the final 25-item model (Enhancement = 6 items, Diet/Exercise = 10 items, Extreme Weight Loss Behaviors [EWLB] = 9 items). The 25-item scale is presented in Appendix F.

While overall item endorsement rates were rather low, with a mean sum total score of 31.34 (SD = 11.06) across the full 25-item scale (range 25-125), 50% of the sample endorsed engaging in at least one behavior at least 25% of the time. The maximum total sum score was 88 (mean response of 3.52 for each item out of 1-5 range), suggesting engagement in a number of behaviors more than 50% of the time. The mean score was 7.17 for the Enhancement subscale (SD = 3.1; maximum 27 out of 6-30 score range), 14.47 for Diet/Exercise (SD = 7.09; maximum 46 out of 10-50 score range), and 9.85 (SD = 3.36; maximum 33 out of 9-45 score range). The Diet/Exercise factor had some of the highest rates of endorsement, with 48% of individuals endorsed engaging in one or more behaviors at least 25% of the time compared to 21% for Enhancement-related behaviors and 11.6% for EWLB. Spearman's rank correlation test revealed small to moderate significant correlations between CECBS factors and Cannabis Use Disorder Identification Test (CUDIT-R) scores (Enhancement $r = 0.226$, Diet/Exercise $r = 0.306$, Extreme Weight-Loss Behaviors $r = 0.114$, $p < 0.001$). **Table 5** presents descriptive statistics (mean, SD, median, range), skew, and kurtosis values for each factor.

The individual items with the highest endorsement rates came from the Diet/Exercise factor, with the greatest being for exercising before using cannabis to compensate for anticipated munchies (Mean = 1.61, SD = 1.08), followed by eating low calorie/fat foods (Mean = 1.5, SD = 1.01) and eating less than usual during one or more meals before using cannabis (Mean = 1.49, SD = 0.93). Of the items from the Enhancement factor, the item with the highest rate of endorsement pertained to eating less than usual during one or more meals to get higher (Mean = 1.31, SD = 0.79). Rates of endorsement were overall very low for the EWLB factor, but the item with the highest endorsement rates was for self-induced vomiting before cannabis use in anticipation of the munchies (Mean = 1.12, SD = 0.5), whereas the lowest rate of endorsement was found for diuretic use to compensate after experiencing the munchies (Mean = 1.06, SD = 0.34). **Table 6** presents correlations between items and both factor and total scale sum scores, descriptive statistics (mean, SD, median, range), skew, and kurtosis values for each item.

Aim 2: Examine association between CECBS scores, cannabis consequences, cannabis-related binge eating, and eating disorder symptomatology

Measurement Model

An initial measurement model was estimated using full information maximum likelihood estimation, with latent factors for the CECBS subscales (Enhancement, Diet/Exercise, and Extreme Weight-Loss Behaviors), eating disorder symptoms (global EDEQ score), and cannabis-related binge eating (CBE). The initial model presented with a good fit to the data (CFI = .975, TLI = .974, SRMR = .086, RMSEA = .053) and modification indices. Standardized factor loadings (ranging from .589-.989) and standardized correlations between factors (ranged from .158-.841) were all significant and positive, thus no modifications were made at the measurement model level. **Table 7** presents the correlation matrix for the measurement model latent variables.

Model 1

First, a latent variable structure tested hypothesized paths between EDEQ and Cannabis Binge-Eating variables and CECBS latent variables. To account for shared variance among related constructs, residual covariances between CECBS factors as well as between cannabis binge-eating and EDEQ factors were included. Sex, BMI, cannabis use frequency, and data collection site (University of Wyoming or Colorado State University) were included as covariates predicting all latent variables, however this yielded a worse model fit compared to the measurement model (CFI = 0.968, TLI = 0.966, RMSEA = 0.054, SRMR = 0.086). As there were no significant associations between data collection site and any of the latent variables, site was excluded as a covariate to promote parsimony, which resulted in a marginal improvement in model fit (CFI = 0.969, TLI = 0.967, RMSEA = 0.054, SRMR = 0.086). Sex was significantly associated with all latent variables, whereas BMI and cannabis use frequency were only associated with EDEQ and CBE, respectively. A revised model was tested in which sex remained as a covariate for all latent variables and BMI was retained only for EDEQ and CBE, resulting in a marginally improved model fit (CFI = 0.970,

TLI = 0.968, RMSEA = 0.053, SRMR = 0.088), however this fit was not significantly improved compared to the base model with no covariates included (CFI = 0.975, TLI = 0.974, RMSEA = 0.053, SRMR = 0.086). Given the negative impact including sex as a covariate had on model fit indices, the model was adjusted such that sex correlated with, rather than predicted, latent variables, which yielded a well-fitting final model (CFI = 0.975, TLI = 0.973, RMSEA = 0.053, SRMR = 0.085). **Table 8** includes the model building approach and the final standardized model estimates (excluding correlations with sex for clarity) are presented in **Figure 2**.

Figure 2. Eating disorder symptoms (EDEQ global scores) was significantly and positively associated with Diet/Exercise compensation factor scores but not Extreme Weight Loss Behaviors (EWLB) or Enhancement factors. Binge-eating under the influence of cannabis was significantly and positively associated with scores on all scale factors, however. Estimates are standardized.

The mean EDEQ global score was 1.67 (SD = 1.5) and the mean CBE sum score was 8.65 (SD = 3.88). Consistent with hypotheses, CBE was positively associated with CECBS Diet/Exercise (b = .755, p < .001), Enhancement (b = .551, p < .001), and Extreme Weight-Loss Behavior (b = .797, p < .001) latent variables. However, EDEQ was only positively associated with the Diet/Exercise (b = .298, p < .001) factor, not Enhancement (b = .073, p = .403) or extreme weight loss behavior (b = -.113, p = .347) factors. All CECBS factors were moderately and positively correlated with one another, suggesting shared covariance. EDEQ and CBE were also significantly and positively correlated (b = .252, p < .001). There was also a significant positive correlation between Sex and Enhancement (r = .054, p = .009), Diet/Exercise (r = 0.044, p = .002), and Extreme Weight-Loss Behaviors factors (r = 0.056, p = .027), where males scored marginally higher than females Conversely, there were negative correlations between Sex and EDEQ (b = -0.118, p < .001) and CBE (r = -.049, p < .001) scores, suggesting marginal sex differences whereby females scored higher than males on these measures. Unstandardized and standardized estimates for the final model are presented in **Table 9**.

Model 2

The mean number of cannabis consequences endorsed (BMACQ score) was 4.42 (SD = 4.5). First, a latent variable structure tested hypothesized paths between CECBS latent variables and sum score of cannabis consequences (BMACQ total sum). As the variance of the variable was much greater than the mean (i.e., overdispersion), a negative binomial distribution was used. However, testing this structure using individual items from latent factors resulted in model non-convergence, even after increasing iterations, testing different estimators (MLR vs ML), and adjusting for potential zero-inflation. Thus, to reduce model complexity, sum scores of the CECBS latent factors were used to predict BMACQ scores in a path analysis, with Sex, BMI, data collection site (UWyo or Colostate), and cannabis use frequency as covariates (AIC = 2312.4, BIC

= 2349.5, Loglik = -1147.2). As there were no significant effects of Sex or BMI on cannabis consequences, they were dropped as covariates, however this path model did not offer improved fit over the model with all covariates included (AIC = 2314.1, BIC = 2342.9, Loglik = -1150.0, LRT p = .06). As the difference in model fit was marginal, the reduced model was chosen for parsimony. **Table 10** includes the path model building approach (LRT represents stepwise model comparisons), and the final log-transformed model estimates (incidence rate ratios [IRRs]) are presented in **Figure 3.**

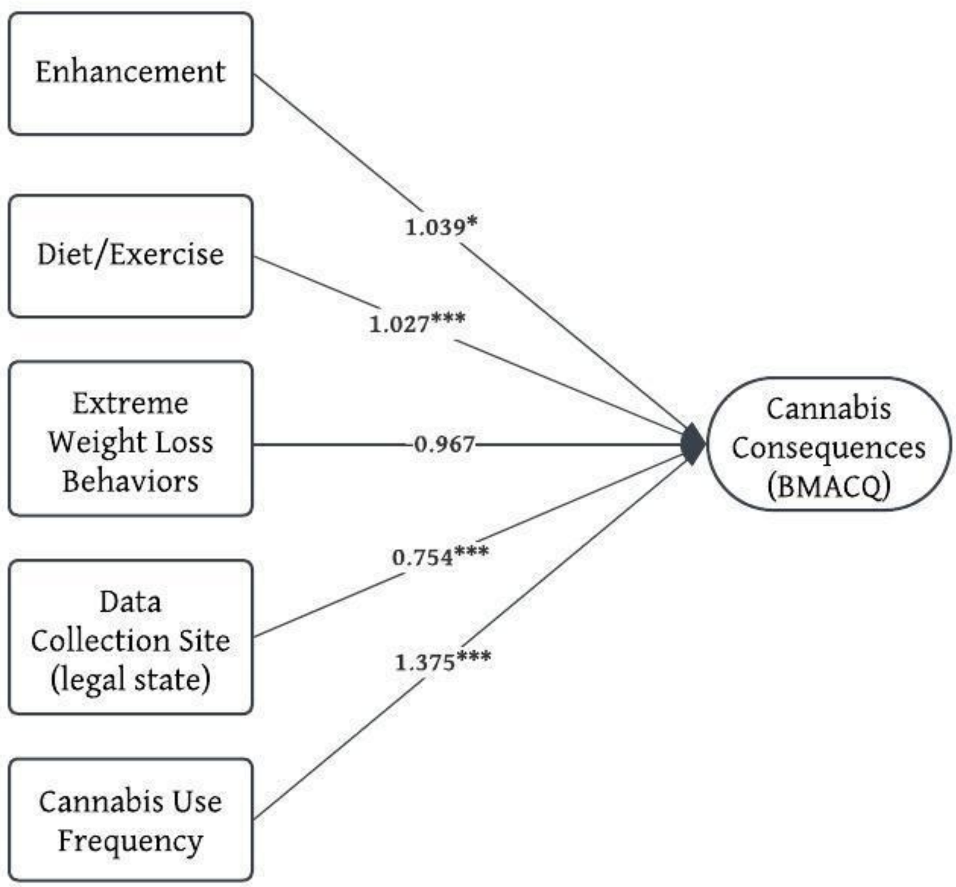

Figure 3. CECBS factors are significantly associated with increased cannabis consequences (BMACQ) after controlling for data collection site (not included in diagram). Estimates were logarithmically transformed to represent incident rate-ratios.

Two out of three CECBS factors were significantly associated with cannabis consequences (BMACQ), which is partially consistent with our hypotheses. Enhancement (b = .038, IRR = 1.039, p = .011) and Diet/Exercise (b = .027, IRR = 1.027, p < .001) were associated with a marginal increase in cannabis consequences (~3% increase in number of consequences per unit), whereas Extreme Weight-Loss Behaviors was not significantly associated with consequences after controlling for data collection site and cannabis use frequency (b = -0.034, IRR = 0.965, p = .065). There was also a significant negative association between data collection site and consequences (b = -0.282, IRR = 0.754, p = .005), where individuals recruited from CSU had 24.6% decrease in number of consequences compared to those at UWyoming, controlling for CECBS factors and cannabis use frequency. Greater cannabis use frequency was also associated with increased cannabis consequences (b = 0.318, IRR= 1.375, p < .001), with a one unit increase in frequency corresponding to a 37.5% increase in the number of consequences endorsed. Unstandardized and log-transformed (IRR) model estimates are summarized in **Table 11**.

An additional exploratory path analysis was run to test cannabis use frequency as a mediator between CECBS factors and cannabis consequences, controlling for data collection site. While the mediation model demonstrated worse fit (AIC = 1109.1, BIC = 11072.8, Loglik = -5489.6), it yielded significant relationships that pointing to potential underlying potential mechanisms. The direct effects of Enhancement (p = .011) and Diet/Exercise (p < .001) factors on cannabis consequences remained significant, with non-significant indirect effects through cannabis use frequency. In contrast, the indirect effect of the Extreme Weight Loss Behaviors (EWLB) factor on BMACQ through cannabis use frequency was significant (b = -0.012, p = .037), with a direct effect trending towards significance (b = -0.034, p = .065), suggesting partial mediation whereby EWLB indirectly reduce cannabis consequences through association with lower cannabis use frequency. Log-transformed and unstandardized model estimates are summarized in **Table 12**.

Discussion

A growing body of literature has demonstrated a functional relationship between alcohol use and disordered eating behaviors, termed Food and Alcohol Disturbance, however whether this phenomenon applies to other substances such as cannabis remains an understudied question. There are mixed and limited findings regarding the relationship between cannabis use and disordered eating more broadly (Corte & Stein, 2000; Jordan et al., 2014; J. D. Latner et al., 2007; Miller-Matero et al., 2024; Pedersen et al., 2024; Vidot et al., 2016; Wilkinson et al., 2023), and there is a need for further research on the relationship between cannabis use and FAD-like behaviors, specifically with respect to "the munchies." The present study aimed to develop of an initial measure of compensatory behaviors related to cannabis use, adapted from the Compensatory Eating and Behaviors in Response to Alcohol Consumption Scale (CEBRACS) measure of FAD, as well as explore associations with eating disorder symptomatology, binge eating under the influence of cannabis, and consequences related to cannabis use.

There was a high prevalence rate of experiencing "the munchies," with 85.5% of participants reporting experiencing the munchies at least 50% of the time when using cannabis. Factor analyses in the present study resulted in a 25-item scale consisting of three interrelated factors within the Compensatory Eating and other Behaviors in Response to Cannabis Scale (CECBS) scale, corresponding to Enhancement, Diet/Exercise, and Extreme Weight-Loss Behaviors (EWLB), dimensions which have previously been identified in FAD literature CEBRACS (Choquette et al., 2020; Rahal et al., 2012). Consistent with previous findings, the majority of participants in the sample endorsed experiencing the munchies at least 50% of the time when using cannabis (Lee et al., 2021). While there were relatively low rates of endorsement for CECBS items across the full sample, half the sample endorsed engaging in one behavior at least 25% of the time when using cannabis in the past 3 months. The Diet/Exercise factor had the greatest endorsement rates compared to other factors, consistent with previous FAD literature (K. A. Berry et al., 2024), with nearly half of the sample endorsing engagement in one or more behaviors at least 25% of the time when using cannabis in the past 3 months. The most common behaviors endorsed was using exercise and eating low calorie/low fat foods to compensate for anticipated munchies before using cannabis, which has also been documented in FAD literature (Palermo et al., 2021). Enhancement-related and EWLB prevalence rates were comparatively lower (21% and 11.5% respectively), however these estimates still fall within the wide range of prevalence rates captured in the existing FAD literature (K. A. Berry et al., 2024). CECBS scale factors were also moderately correlated cannabis use disorder symptoms (CUDIT-R scores), providing initial evidence for convergent validity.

Findings also demonstrated moderate positive associations between eating disorder symptomatology and both the Enhancement and Diet/Exercise factors, but not EWLB, while binge-eating under the influence of cannabis was positively associated with all scale factors, with coefficients indicating medium effect sizes. Together, these results provide initial evidence of concurrent validity while highlighting cannabis-related compensatory behaviors as being distinct from general eating pathology and highly related to the context of cannabis use. There were also small sex differences, suggesting individuals assigned male at birth score higher on all CECBS factors than females. These differences were still present even when cannabis use frequency was controlled for, despite previous literature suggesting individuals assigned male at birth use cannabis at a greater frequency than females. These findings stand in contrast to existing FAD literature, which previously suggested that males tend to score higher on enhancement-related factors whereas females score higher on compensation-related factors (Giles et al., 2009), however recent findings have not yielded significant sex differences (Speed et al., 2022). The literature on sex differences in cannabis use and disordered eating is comparatively limited, however Pederson et al. (2024) observed an association between screening positive for an eating disorder and self-reported cannabis use disorder symptoms in male but not female undergraduate students (Pedersen et al., 2024). Thus, the role of sex differences in cannabis-related eating and compensatory behaviors warrants further investigation, and the CECBS scale should be assessed for measurement invariance by sex assigned at birth as well as other relevant demographic variables (e.g., age, gender, race, ethnicity).

Findings also provided initial evidence of concurrent validity, with positive associations between Enhancement and Diet/Exercise factors and cannabis consequences (measured by the Brief Marijuana-related Consequences Questionnaire [BMACQ]) after controlling for data collection site and cannabis use frequency, consistent with initial hypotheses. These results are also consistent with previous findings revealing that increased cannabis consequences are associated with food restriction on cannabis use days (Shute et al., 2025). In investigating the association between CECBS factors and cannabis consequences, effect sizes were rather small after controlling for cannabis use frequency, suggesting that most of the variability in cannabis consequences are attributable to cannabis use patterns rather than engagement in compensatory behaviors. Although eating before alcohol use is a common protective behavioral strategy (Pearson, 2013), the effects of food intake and restriction on cannabis consequences is a novel area of research that may hold important implications for cannabis harm reduction.

Notably, one of the consequences captured in the BMACQ refers to weight-gain associated with cannabis use, which raises the question of whether some of the behaviors included in the CECBS scale may be interpreted as protective to some extent, particularly with respect to cannabis-related binge eating (e.g., eating less before using cannabis to avoid overeating). Previous literature has identified "the munchies" as a common negative consequence of cannabis use, furthermore suggesting that highlighting the dissonance between "the munchies" and other valued health behaviors (e.g., eating a balanced diet) may be a target for motivational enhancement therapy (MET) or personalized feedback interventions (PFI) (Lee et al., 2021). Enhancement-motivated behaviors may also have the potential to serve as either protective or dysfunctional. As previously described, reducing food intake before cannabis use may be helpful for reducing the delayed onset of edible cannabis products and deter individuals from taking more (Farmer et al., 2019). Alternatively, this may lead to faster onset of peak drug effects which may confer some risks, particularly in the context of simultaneous use with alcohol, which is highly prevalent in this population (K. M. Jackson et al., 2020). Enhancement motives for cannabis use have been associated with increased risk of CUD (Gex et al., 2024), however further investigation is needed to determine whether these behaviors may contribute to additional reinforcement mechanisms.

Interestingly, Extreme Weight-Loss Behaviors were not significantly associated with cannabis consequences after controlling for cannabis use frequency. A subsequent mediation analysis revealed that EWLBs were instead associated with reduced cannabis consequences through reduced cannabis use frequency, in contrast to hypotheses. While findings may have been influenced in part by low endorsement of EWLB and low prevalence of eating disorder symptoms in the sample, it is possible that individuals who engage in EWLBs may report reduced cannabis use frequency because of the expected effects of cannabis on appetite, and in particular, binge-eating. Previous work by Scharmer et al. (2020) suggests that cannabis users with eating disorder (ED) symptoms have expectancies regarding the potential therapeutic utility of cannabis for ED symptoms yet also report expectancies of increased binge eating (Scharmer et al., 2020). These expectancies were not associated with increased cannabis use frequency or problems, however (Scharmer et al., 2020). Further research is needed to disentangle the relationship between cannabis-related compensatory behaviors and cannabis consequences in both non-clinical and clinical ED populations.

Results point to a potentially nuanced bidirectional relationship whereby individuals may modulate their substance use as a function of the expected effects on appetite and weight, which may extend beyond “the munchies.” For example, while the present study screened for individuals who endorsed experiencing “the munchies,” individuals who don’t experience the munchies may also choose to use cannabis to avoid calories from alcohol. Similarly, there is evidence to suggest cannabis may serve as a harm reduction substitute for alcohol for some individuals, and while not captured in the present study, the interaction between cannabis use and FAD is a potential future direction (Gunn et al., 2022). Moreover, while the present study did not report on qualitative data collected in the survey, responses from participants reflected additional uses of cannabis related to eating behaviors, such as use of cannabis to increase appetite and support weight gain to reach muscular body ideals (“bulking”) or to reduce gastrointestinal distress and support adequate nutrition. The present study demonstrates a relationship between cannabis use and the constructs underlying FAD, however additional work is needed to explore the diverse range of experiences individuals have with regards to cannabis use and eating behaviors as well as evaluate potential risks and benefits. To this end, future research may draw on methodology that may capture other relevant individual or contextual factors influencing cannabis use and eating behaviors, such as drawing on qualitative and ecological momentary assessment methods.

Furthermore, emerging research suggests that cannabis eating experiences may vary according to use motives and context, which were not explored in the present study. Davies-Owen et al. (2025) found that social use motives were associated with reduced cannabis-related appetitive and hedonic eating (Davies-Owen et al., 2025), noting that social context may influence eating behaviors above and beyond the effects of cannabis. Similarly, social context has been shown to influence affective experiences during cannabis use events (Denson et al., 2023), which may in turn influence compensatory behaviors. Furthermore, level of cannabis use has been found to be positively associated with hedonic but not appetitive eating, highlighting a potential role for tolerance to the appetitive effects of cannabis (Davies-Owen et al., 2025). While the present study found nuanced associations between CECBS factors and cannabis use frequency, further work is needed to elucidate the role of tolerance mechanisms in the munchies and degree of engagement in compensatory behaviors.

Findings from the present study raise several questions with important clinical implications. For one, does engaging in compensatory behaviors to accommodate cannabis use contribute to increased risk for CUD and EDs over time? And if so, what behaviors are associated with greater risk, and how might individuals instead moderate their cannabis use to reduce potential consequences related to the munchies? Further work is also needed to understand the potential functional impairment and affective experiences associated with engagement in different behaviors represented in the CECBS scale, which may additionally serve to inform motivation-based therapeutic interventions.

Strengths and Limitations

The present study offers several strengths. First and foremost, this study generated findings in a relatively novel area of research surrounding cannabis use and compensatory behaviors, which may inform future lines of research. Regarding methodology, the sample population was relevant to the construct of interest, consisting of undergraduates from two large public universities in non-legal and legal recreational cannabis states, and previous literature has demonstrated increasing rates of cannabis use amongst college-aged adults as well as increased prevalence of food and alcohol disturbance (FAD) (K. A. Berry et al., 2024; K. M. Jackson et al., 2020; Shepherd et al., 2023). Additionally, while the scale was an adaptation of the CEBRACS and initial changes were made based on existing cannabis literature, the survey was piloted in a small sample of undergraduates and feedback was also solicited from subject matter experts, informing the development and refinement of the survey items to improve content validity (Devellis & Thorpe, 2021). Advanced statistical techniques were also used to demonstrate relationships between CECBS factors and related constructs.

Nonetheless, there are several limitations to the current study which warrant interpreting findings with caution. Firstly, the study is limited by a small sample size as well as a lack of demographic diversity. The small sample size also posed a limitation to the factor analysis process. To validate the factor structure, a CFA should be replicated in a larger, more nationally representative sample, as well as in clinical samples (e.g., individuals diagnosed with cannabis use disorder [CUD] and/or eating disorders [EDs]). There were also rather low levels of endorsement of individual items, thus replication in a larger, more demographically diverse sample would serve to elucidate whether low levels of endorsement are population specific. Polysubstance use with alcohol is also very common in this population, which was not explicitly examined in the present study. Given the scale was adapted from the CEBRACS, an alcohol measure, exploring associations between CEBRACS and CECBS scores in alcohol and cannabis co-users is a notable area for future exploration. Another limitation is that route of administration (i.e., oral vs smoked) and THC dosage were not included in models for the purposes of the present study, which may be relevant for edible cannabis use and enhancement-related motives.

Conclusion

In summary, the present study provides initial evidence for the development and validation of a three-factor Compensatory Eating and other Behaviors in Response to Cannabis Scale (CECBS), in addition to highlighting distinct patterns of cannabis-related compensatory behaviors linked to eating disorder symptomatology, cannabis-related binge eating, and cannabis consequences. Findings from the present study underscore the nuanced ways in which cannabis use can interact with eating behaviors, emphasizing important future research directions, particularly regarding potential sex differences and contextual, motivational, and affective factors that may influence the relationship between cannabis use and eating behaviors. Further investigation of cannabis-related compensatory eating behaviors may have important clinical implications, potentially informing harm reduction strategies and enhancing understandings of CUD and eating disorder risk.

Tables

Table 1. *Sample Demographics*

Age, mean (S.D.)	19.37 (1.61)
Gender, n (%)	
Cisgender Man	135 (26%)
Cisgender Woman	367 (70.7%)
Non-binary/Gender expansive	17 (3.3%)
Sex assigned at birth, Female, n (%)	389 (74.9%)
Sexual Orientation	
Straight/Heterosexual	348 (67%)
Gay	2 (0.4%)
Lesbian	14 (2.7%)
Bisexual	90 (17.3%)
Pansexual	6 (11.6%)
Queer	5 (1.0%)
Sexually Fluid	2 (0.4%)
Asexual	3 (0.6%)
Two or more sexual identities	23 (4.4%)
Questioning	22 (4.2%)
Prefer not to answer	4 (0.8%)
Race/Ethnicity, n (%)	
Asian	7 (1.3%)
Black or African American	13 (2.5%)
Native American/Indigenous	1 (.2%)
Hispanic/Latino	19 (3.7%)
Middle Eastern	1 (0.2%)
White	420 (80.9%)
Two or more races/ethnicities	58 (11.1%)

Table 2. *Exploratory Factor Analysis for CECBS model fit*

Across timepoints					
Model Factors	**Eigenvalues**	**CFI/TLI**	**RMSEA**	**SRMR**	**χ 2**
1	21.3	.966/.963	0.090	0.134	χ^2 (405) = 2071.8, $p < .001$
2	2.64	.981/.978	0.070	0.082	χ^2 (376) = 1311.6, $p < .001$
3	**1.59**	**.991/.989**	**0.050**	**0.049**	**χ^2 (348) = 783.3, $p < .001$**
4	1.03	.994/.992	0.042	0.034	χ^2 (321) = 602.0, $p < .001$
5	0.683	.997/.996	0.031	0.025	χ^2 (295) = 435.7, $p < .001$

By timepoint

Before cannabis use

Model Factors	Eigenvalues	CFI/TLI	RMSEA	SRMR	χ 2
1	9.44	.970/.965	0.119	0.117	χ^2 (63) = 522.9, $p < .001$
2	1.05	.982/.973	0.103	0.076	χ^2 (53) = 334.8, $p < .001$
3	0.853	.989/.995	0.078	0.029	χ^2 (42) = 130.9, $p < .001$
4	0.453	.998/.995	0.046	0.017	χ^2 (32) = 65.49, $p < .001$
5	0.310	1.00/1.00	0.00	0.008	χ^2 (23) = 20.18, $p < .001$

During cannabis use

Model Factors	Eigenvalues	CFI/TLI	RMSEA	SRMR	χ 2
1	7.44	.976/.969	0.130	0.110	χ^2 (35) = 329.8, $p < .001$
2	1.02	.991/.984	0.093	0.033	χ^2 (26) = 139.0, $p < .001$
3	0.491	.997/.984	0.059	0.020	χ^2 (18) = 49.53, $p < .001$
4	0.309	1.00/.998	0.032	0.010	χ^2 (11) = 16.76, $p = .115$
5	0.285	1.00/.997	0.042	0.006	χ^2 (5) = 9.390, $p = .0945$

After cannabis use

Model Factors	Eigenvalues	CFI/TLI	RMSEA	SRMR	χ 2
1	5.491	.985/.976	0.155	0.108	χ^2 (14) = 182.9, $p < .001$
2	0.801	.997/.993	0.087	0.018	χ^2 (8) = 38.20, $p < .001$
3	0.318	1.00/1.001	0.00	0.199	χ^2 (3) = 0.638, $p = .857$

Table 3. *Exploratory Factor Analysis Factor Loadings*

Item	Factor 1	Factor 2	Factor 3
	Before cannabis use		
I have eaten less than usual during one or more meals to get higher	**0.927***	-0.010	0.00
I have eaten less than usual during one or more meals to get high faster	**0.973***	-0.001	-0.021
I have skipped one or more meals to get higher	**0.868***	0.079	0.043

I have skipped one or more meals to get high faster	**0.893***	0.044	0.077
I have eaten less than usual during one or more meals to make up for calories I anticipate consuming when I have the munchies	0.494*	-0.016	**0.563***
I have skipped one or more meals to make up for calories I anticipate consuming when I have the munchies	0.468*	-0.019	**0.622***
I have exercised to make up for calories I anticipate consuming when I have the munchies	0.226*	0.092	**0.618***
I have eaten low-calorie foods and/or drank low calorie beverages to make up for calories I anticipate consuming when I have munchies	0.371*	-0.019	**0.709***
I have made sure that calorically dense foods I could eat when I get the munchies are not readily available to me	0.346*	0.068	**0.559***
I have planned to smoke or vape cannabis instead of taking an edible to avoid the extra calories in edibles	0.393*	**0.457***	0.101
I have made myself throw up to make up for calories I anticipate consuming when I have the munchies	0.011	**0.796***	0.258*
I have used laxatives to make up for calories I anticipate consuming when I have the munchies	0.098	**0.882***	0.007
I have used diuretics to make up for calories I anticipate consuming when I have the munchies	0.133	**0.880***	0.006
During Cannabis use			
I have eaten less than usual to get high faster	**0.632***	0.402*	0.001
I have not eaten at all to get high faster	**0.585***	0.424*	0.08
I have eaten less than usual to get higher	**0.723***	0.336*	-0.085
I have not eaten at all to get higher	**0.677***	0.444*	-0.102*

I have eaten less than usual to prolong a high	**0.615***	0.430*	0.022
I have not eaten at all to prolong a high	**0.584***	0.468*	0.028
I have eaten low-calorie foods and/or drank low calorie beverages to make up for calories I consume while I have the munchies	0.254*	0.165*	**0.656***
I have made myself vomit to make up for calories I consume while I have the munchies	-0.086	**0.884***	0.255*
I have used laxatives to make up for calories I consume while I have the munchies	0.057	**0.955***	-0.044
I have used diuretics to make up for calories I consume while I have the munchies	0.072	**0.948***	-0.074
After cannabis use			
I have eaten less than usual during one or more meals to make up for calories I consumed when I had the munchies	-0.011	0.275*	**0.798***
I have exercised to make up for calories I consumed when I had the munchies	-0.030	0.316*	**0.734***
I have eaten low-calorie foods and/or drank low calorie beverages to make up for calories I consumed when I had the munchies	0.064	0.274*	**0.642***
I have skipped one or more meals to make up for calories I consumed when I had the munchies	0.054	0.231*	**0.759***
I have made myself vomit to make up for calories I consumed when I had the munchies	-0.078	**0.899***	0.223*
I have used laxatives to make up for calories I consumed when I had the munchies	0.094	**0.827***	0.077
I have used diuretics to make up for calories I consumed when I had the munchies	0.193	**0.843***	-0.043

Table 4. *Confirmatory Factor Analysis Standardized Factor Loadings*

Item	Enhancement	Extreme Weight-Control	Diet/Exercise	Standard Error (SE)	R^2
	Before cannabis use				
I have eaten less than usual during one or more meals to get higher	**0.849***	-------	-------	0.024	0.721
I have skipped one or more meals to get higher	**0.904***	-------	-------	0.022	0.817
I have eaten less than usual during one or more meals to make up for calories I anticipate consuming when I have the munchies	-------	-------	**0.892***	0.016	0.796
I have skipped one or more meals to make up for calories I anticipate consuming when I have the munchies	-------	-------	**0.918***	0.015	0.843
I have exercised to make up for calories I anticipate consuming when I have the munchies	-------	-------	**0.795***	0.025	0.633
I have eaten low-calorie foods and/or drank low calorie beverages to make up for calories I anticipate consuming when I have munchies	-------	-------	**0.911***	0.017	0.830
I have made sure that calorically dense foods I could eat when I get the munchies are not readily available to me	-------	-------	**0.826***	0.024	0.683
I have made myself throw up to make up for calories I anticipate consuming when I have the munchies	-------	**0.944***	-------	0.019	0.891

I have used laxatives to make up for calories I anticipate consuming when I have the munchies	-------	**0.952***	-------	0.014	0.907
I have used diuretics to make up for calories I anticipate consuming when I have the munchies	-------	**0.977***	-------	0.013	0.954
	During Cannabis use				
I have eaten less than usual to get higher	**0.965***	-------	-------	0.010	0.932
I have not eaten at all to get higher	**0.981***	-------	-------	0.010	0.962
I have eaten less than usual to prolong a high	**0.973***	-------	-------	0.010	0.947
I have not eaten at all to prolong a high	**0.991***	-------	-------	0.011	0.982
I have eaten low-calorie foods and/or drank low calorie beverages to make up for calories I consume while I have the munchies	-------	-------	**0.913***	0.016	0.833
I have made myself vomit to make up for calories I consume while I have the munchies	-------	**0.958***	-------	0.017	0.913
I have used laxatives to make up for calories I consume while I have the munchies	-------	**0.932***	-------	0.017	0.924
I have used diuretics to make up for calories I consume while I have the munchies	-------	**0.965***	-------	0.020	0.902
	After cannabis use				
I have eaten less than usual during one or more meals to make up for calories I consumed	-------	-------	**0.912***	0.014	0.832

when I had the munchies					
I have exercised to make up for calories I consumed when I had the munchies	-------	-------	**0.873***	0.017	0.763
I have eaten low-calorie foods and/or drank low calorie beverages to make up for calories I consumed when I had the munchies	-------	-------	**0.827***	0.022	0.684
I have skipped one or more meals to make up for calories I consumed when I had the munchies	-------	-------	**0.894***	0.016	0.799
I have made myself vomit to make up for calories I consumed when I had the munchies	-------	**0.958***	-------	0.017	0.917
I have used laxatives to make up for calories I consumed when I had the munchies	-------	**0.932***	-------	0.020	0.868
I have used diuretics to make up for calories I consumed when I had the munchies	-------	**0.965***	-------	0.018	0.932

Table 5. *Descriptive Statistics for CECBS Factors*

Latent Variable	**Mean (SD)**	**Median**	**Range**	**Skew**	**Kurtosis**
Enhancement (6-30)	8.37 (3.65)	7	23	3.2	10.49
Diet/Exercise (10-50)	14.61 (7.41)	10	38	1.83	2.78
Extreme Weight Loss (9-45)	9.87 (3.37)	9	26	4.73	23.94
Total sum score (25-150)	32.59 (11.84)	26	70	2.46	6.44

Table 6. *Descriptive Statistics and Factor Correlations for CECBS items by factor*

Enhancement							
Item	**Mean (S.D.)**	**Median**	**Range**	**Skew**	**Kurtosis**	**Item-factor correlation (*r*)**	**Item-total correlation (*r*)**
I have eaten less than usual during one or more meals to get higher	1.31 (0.79)	1	4	2.84	8.16	0.907	0.564
I have skipped one or more meals to get higher	1.23 (0.66)	1	4	3.36	12.20	0.851	0.556
I have eaten less than usual to get higher	1.19 (0.59)	1	4	3.56	13.56	0.793	0.526
I have not eaten at all to get higher	1.16 (0.56)	1	4	4.11	17.88	0.741	0.472
I have eaten less than usual to prolong a high	1.16 (0.54)	1	4	3.98	17.81	0.741	0.509
I have not eaten at all to prolong a high	1.12 (0.51)	1	4	4.75	24.29	0.651	0.439
Diet/Exercise							
Item	**Mean (S.D.)**	**Median**	**Range**	**Skew**	**Kurtosis**	**Item-factor correlation (*r*)**	**Item-total correlation (*r*)**
I have eaten less than usual during one or more meals to make up for calories I anticipate consuming when I have the munchies	1.49 (0.93)	1	4	2.06	3.84	0.763	0.751

I have skipped one or more meals to make up for calories I anticipate consuming when I have the munchies	1.42 (0.86)	1	4	2.2	4.5	0.750	0.734
I have exercised to make up for calories I anticipate consuming when I have the munchies	1.61 (1.08)	1	4	1.83	2.48	0.782	0.754
I have eaten low-calorie foods and/or drank low calorie beverages to make up for calories I anticipate consuming when I have munchies	1.5 (1.01)	1	4	2.18	4.08	0.738	0.763
I have made sure that calorically dense foods I could eat when I get the munchies are not readily available to me	1.46 (0.97)	1	4	2.32	4.75	0.696	0.678
I have eaten low-calorie foods and/or drank low calorie beverages to make up for calories I consume while I have the munchies	1.34 (0.77)	1	4	2.45	5.96	0.782	0.754

I have eaten less than usual during one or more meals to make up for calories I consumed when I had the munchies	1.4 (0.83)	1	4	2.23	4.6	0.722	0.686
I have exercised to make up for calories I consumed when I had the munchies	1.43 (0.87)	1	4	2.11	3.83	0.712	0.676
I have eaten low-calorie foods and/or drank low calorie beverages to make up for calories I consumed when I had the munchies	1.48 (0.94)	1	4	2.06	4.57	0.746	0.714
I have skipped one or more meals to make up for calories I consumed when I had the munchies	1.39 (0.85)	1	4	2.33	4.84	0.717	0.679
Extreme Weight-Loss Behaviors							
Item	**Mean (S.D.)**	**Median**	**Range**	**Skew**	**Kurtosis**	**Item-factor correlation (*r*)**	**Item-total correlation (*r*)**
I have made myself throw up to make up for calories I anticipate consuming when I have the munchies	1.12 (0.5)	1	4	4.92	26.93	0.786	0.414
I have used laxatives to make up for calories I	1.11 (0.49)	1	4	5.43	33.53	0.775	0.396

anticipate consuming when I have the munchies							
I have used diuretics to make up for calories I anticipate consuming when I have the munchies	1.1 (0.48)	1	4	5.65	34.8	0.706	0.366
I have made myself vomit to make up for calories I consume while I have the munchies	1.11 (0.45)	1	4	4.57	23.48	0.819	0.438
I have used laxatives to make up for calories I consume while I have the munchies	1.09 (0.43)	1	3	5	25.83	0.721	0.370
I have used diuretics to make up for calories I consume while I have the munchies	1.09 (0.41)	1	4	5.64	35.70	0.703	0.350
I have made myself vomit to make up for calories I consumed when I had the munchies	1.1 (0.43)	1	4	4.88	26.94	0.782	0.413
I have used laxatives to make up for calories I consumed when I had the munchies	1.07 (0.35)	1	3	5.58	32.95	0.635	0.326
I have used diuretics to make up for calories I consumed when I had the munchies	1.06 (0.34)	1	3	6.28	42.28	0.610	0.323

Table 7. *Correlation Matrix for Measurement Model Latent Variables*

Latent Variable	1	2	3	4	5
Enhancement (CECBS)	1.00	--	--	--	--
Diet/Exercise (CECBS)	0.735	1.00	--		--
Extreme Weight Loss (CECBS)	0.841	0.718	1.00	--	--
EDEQ Global	0.414	0.653	0.451	1.00	--
Cannabis Binge Eating (CBE)	0.263	0.541	0.158	0.512	1.00

Table 8. *Model 1 Building Summary*

Step	**Model**	**χ^2 (df)**	**CFI/TLI**	**RMSEA**	**SRMR**
1. Base Model	Latent variables (EDEQ, CBE) predicting CECBS with residual covariances	3002.6 (1214)	0.975/0.974	0.053	0.086
2. Full Model with Covariates	Sex, BMI, cannabis use frequency, and data collection site as covariates for all latent variables	3507.1 (1398)	0.968/0.966	0.054	0.086
3. Reduced Model	Remove data collection site as covariate	3403.2 (1352)	0.969/0.967	0.054	0.086
4. Focused Model	Sex, BMI, cannabis use frequency as covariates for relevant variables	3354.3 (1359)	0.970/0.968	0.053	0.088
5. Final Model	Sex correlated with latent variables rather than predicting them	3092.3 (1260)	0.975/0.973	0.053	0.085

Table 9. *Model 1, Unstandardized and standardized estimates*

Model 1: Unstandardized estimates			
Variables/path	**Estimate**	**SE**	***p***
EDEQ → Enhancement	*b* = 0.073	0.087	.403
EDEQ → Diet/Exercise	*b* = 0.298	0.052	< .001 ***
EDEQ → Extreme Weight Loss Behaviors	*b* = -0.113	0.120	0.347

CBE → Enhancement	*b* = 0.551	0.118	< .001 ***
CBE → Diet/Exercise	*b* = 0.755	0.079	< .001 ***
CBE → Extreme Weight Loss Behaviors	*b* = 0.797	0.185	< .001 ***
Enhancement ↔ Diet/Exercise	*r* = 0.344	0.035	< .001 ***
Enhancement ↔ Restriction	*r* = 0.540	0.049	< .001 ***
Diet/Exercise ↔ Restriction	*r* = 0.369	0.049	< .001 ***
EDEQ ↔ CBE	*r* = 0.252	0.026	< .001 ***
Enhancement ↔ Sex	*r* = 0.054	0.021	.009***
Diet/Exercise ↔ Sex	*r* = 0.044	0.014	.002***
Extreme Weight Loss Behaviors ↔ Sex	*r* = 0.056	0.025	.027*
EDEQ ↔ Sex	*r* = -0.118	0.015	< .001 ***
CBE ↔ Sex	*r* = -0.049	0.012	< .001 ***
Model 1: Standardized estimates			
Variables/path	**Estimate**	**SE**	***p***
EDEQ → Enhancement	*b* = 0.069	0.083	.404
EDEQ → Diet/Exercise	*b* = 0.280	0.049	< .001 ***
EDEQ → Extreme Weight Loss Behaviors	*b* = -0.099	0.105	0.346
CBE → Enhancement	*b* = 0.378	0.08	< .001 ***
CBE → Diet/Exercise	*b* = 0.510	0.049	< .001 ***
CBE → Extreme Weight Loss Behaviors	*b* = 0.502	0.117	< .001 ***
Enhancement ↔ Diet/Exercise	*r* = 0.691	0.036	< .001 ***
Enhancement ↔ Restriction	*r* = 0.817	0.027	< .001 ***
Diet/Exercise ↔ Restriction	*r* = 0.695	0.059	< .001 ***
EDEQ ↔ CBE	*r* = 0.512	0.035	< .001 ***
Enhancement ↔ Sex	*r* = 0.159	0.060	.009 ***
Diet/Exercise ↔ Sex	*r* = 0.161	0.052	.002 ***
Extreme Weight Loss Behaviors ↔ Sex	*r* = 0.153	0.069	0.028 *
EDEQ ↔ Sex	*r* = -0.330	0.038	< .001 ***
CBE ↔ Sex	*r* = -0.189	0.045	< .001 ***

*p < 0.05, ** p < 0.01, *** p < 0.001

Table 10. *Model 2 Building Summary*

Step	Model	Loglik	AIC	BIC	LRT *p*
1. Base Model	Latent variables (CECBS factors) predicting BMACQ	-1169.3	2348.6	2369.3	
2. Full Model with Covariates	Sex, BMI, cannabis use frequency, and data collection site as covariates	-1147.2	2312.4	2349.5	< .001***
3. Reduced Model	Removed Sex and BMI covariates	-1150.0	2314.1	2342.9	.06

*p < 0.05, ** p < 0.01, *** p < 0.001

Table 11. *Model 2, Unstandardized and standardized (log-transformed) estimates*

Variables/path	Estimate	SE	*p*	*IRR*	*95% CI*
Enhancement → BMACQ	*b* = 0.038	0.015	.011*	1.039	[1.009, 1.070]
Diet/Exercise → BMACQ	*b* = .027	0.007	< .001***	1.027	[1.013, 1.041]
Extreme Weight Loss Behaviors → BMACQ	*b* = -0.034	0.018	< .001***	0.967	[0.933, 1.002]
Data collection site → BMACQ	*b* = -0.282	0.100	0.065	0.754	[0.620, 0.917]
Cannabis use frequency → BMACQ	*b* = 0.318	0.052	0.005***	1.375	[1.2.52]

*p < 0.05, ** p < 0.01, *** p < 0.001

Table 12. *Mediation model, Unstandardized and standardized (log-transformed) estimates*

Direct effects	**b**	**SE**	***p***	**IRR**	**95% CI**
Enhancement → BMACQ	0.038	0.015	0.011**	1.039	[1.009, 1.070]
Diet/Exercise → BMACQ	0.027	0.007	<0.001***	1.027	[1.013, 1.041]
EWLB → BMACQ	-0.034	0.018	0.065	0.967	[0.933, 1.002]
Cannabis Frequency → BMACQ	0.318	0.052	0.005***	1.375	[1.23, 1.54]
Indirect effects	**b**	**SE**	***p***	**IRR**	**95% CI**
Enhancement → Cannabis Frequency→ BMACQ	0.008	0.007	0.285	1.008	[0.994, 1.022]
Diet/Exercise → Cannabis Frequency→ BMACQ	0.003	0.002	0.155	1.003	[0.999, 1.007]
EWLB → Cannabis Frequency→ BMACQ	-0.012	0.006	0.037*	0.988	[0.976, 0.999]

*p < 0.05, ** p < 0.01, *** p < 0.001

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Appendices

Appendix A: Cannabis Use Disorder Identification Test-Revised (CUDIT-R)

1. How often do you use cannabis?
   Never (0) Monthly or less (1) 2-4 times a month (2) 2-3 times a week (3) 4+ times a week (4)

2. How many hours were you “stoned” on a typical day when you had been using cannabis?
   Less than 1 (0) 1 or 2 (1) 3 or 4 (2) 5 or 6 (3) 7 or more (4)

3. How often during the past 6 months did you find that you were not able to stop using cannabis once you had started?
   Never (0) Less than monthly (1) Monthly (2) Weekly (3) Daily/almost daily (4)

4. How often during the past 6 months did you fail to do what was normally expected from you because of using cannabis?
   Never (0) Less than monthly (1) Monthly (2) Weekly (3) Daily or almost daily (4)

5. How often in the past 6 months have you devoted a great deal of your time to getting, using, or recovering from cannabis?
   Never (0) Less than monthly (1) Monthly (2) Weekly (3) Daily/almost daily (4)

6. How often in the past 6 months have you had a problem with your memory or concentration after using cannabis?
   Never (0) Less than monthly (1) Monthly (2) Weekly (3) Daily or almost daily (4)

7. How often do you use cannabis in situations that could be physically hazardous, such as driving, operating machinery, or caring for children?
   Never (0) Less than monthly (1) Monthly (2) Weekly (3) Daily/almost daily (4)

8. Have you ever thought about cutting down, or stopping, your use of cannabis?
   Never (0) Yes, but not in the past 6 months (2) Yes, during the past 6 months (4)

Adamson SJ, Kay-Lambkin FJ, Baker AL, Lewin TJ, Thornton L, Kelly BJ, and Sellman JD. (2010). An Improved Brief Measure of Cannabis Misuse: The Cannabis Use Disorders Identification Test – Revised (CUDIT-R). Drug and Alcohol Dependence 110:137-143.

Appendix B: The Brief Marijuana Consequences Questionnaire (BMAC-Q)

The following is a list of things that sometimes happen to people either during, or after they have been using cannabis. Select either YES or NO to indicate whether that item describes something that has happened to you IN THE PAST 6 MONTHS.

1. The quality of my work or schoolwork has suffered because of my marijuana use.
2. I have driven a car when I was high.
3. I have felt in a fog, sluggish, tired, or dazed the morning after using marijuana.
4. I have been unhappy because of my marijuana use.
5. I have spent too much time using marijuana.
6. I have felt like I needed a hit of marijuana after I'd gotten up (that is, before breakfast).
7. I have become very rude, obnoxious, or insulting after using marijuana.
8. I have been less physically active because of my marijuana use.
9. I have had trouble sleeping after stopping or cutting down on marijuana use.
10. I have neglected obligations to family, work, or school because of my marijuana use.
11. When using marijuana I have done impulsive things that I regretted later.
12. I have awakened the day after using marijuana and found I could not remember a part of the evening before.
13. I have been overweight because of my marijuana use.
14. I haven't been as sharp mentally because of my marijuana use.
15. I have received a lower grade on an exam or paper than I ordinarily would have because of marijuana use.
16. I have tried to quit using marijuana because I thought I was using too much.
17. I have felt anxious, irritable, lost my appetite or had stomach pains after stopping or cutting down on marijuana use.
18. I often have thought about needing to cut down or to stop using marijuana.
19. I have had less energy or felt tired because of my marijuana use.
20. I have lost motivation to do things because of my marijuana use.

Bravo, A. J., Pearson, M. R., Pilatti, A., Mezquita, L., & Cross-Cultural Addictions Study Team (2019). Negative marijuana-related consequences among college students in five countries: measurement invariance of the Brief Marijuana Consequences Questionnaire. Addiction (Abingdon, England), 114(10), 1854–1865. https://doi.org/10.1111/add.14646

Appendix C: The Eating Disorders Examination Questionnaire

Please select the appropriate number on the right. Remember that the questions only refer to the past four weeks (28 days) only.

On how many of the past 28 days…

No 1-5 6-12 13-15 16-22 23-27 Every day

1. Have you been deliberately trying to limit the amount of food you eat to influence your shape or weight (whether or not you have succeeded)?
2. Have you gone for long periods of time (8 waking hours or more) without eating anything at all in order to influence your shape or weight?
3. Have you tried to exclude from your diet any foods that you like in order to influence your shape or weight (whether or not you have succeeded)?
4. Have you tried to follow definite rules regarding your eating (for example, a calorie limit) in order to influence your shape or weight (whether or not you have succeeded)?
5. Have you had a definite desire to have an empty stomach with the aim of influencing your shape or weight?
6. Have you had a definite desire to have a totally flat stomach?
7. Has thinking about food, eating or calories made it very difficult to concentrate on things you are interested in (for example, working, following a conversation, or reading)?
8. Has thinking about shape or weight made it very difficult to concentrate on things you are interested in (for example, working, following a conversation, or reading)?
9. Have you had a definite fear of losing control over eating?
10. Have you had a definite fear that you might gain weight?
11. Have you felt fat?
12. Have you had a strong desire to lose weight?

Questions 13-18: Please fill in the appropriate number in the boxes on the right. Remember that the questions only refer to the past four weeks (28 days).

Over the past four weeks (28 days)…….

13. Over the past 28 days, how many times have you eaten what other people would regard as an unusually large amount of food (given the circumstances)?
14. On how many of these times did you have a sense of having lost control over your eating (at the time that you were eating)?
15. Over the past 28 days, on how many DAYS have such episodes of overeating occurred (i.e. you have eaten an unusually large amount of food and have had a sense of loss of control at the time)?
16. Over the past 28 days, how many times have you made yourself sick (vomit) as a means of controlling your shape or weight?
17. Over the past 28 days, how many times have you taken laxatives as a means of controlling your shape or weight?
18. Over the past 28 days, how many times have you exercised in a "driven" or "compulsive" way as a means of controlling your weight, shape or amount of fat or to burn off calories?

Questions 19-21: Please circle the appropriate number. Please note that for these questions the term "binge eating" means eating what others would regard as an unusually large amount of food for the circumstances, accompanied by a sense of having lost control over eating

19. Over the past 28 days, on how many days have you eaten in secret (ie, furtively)?......Do not count episodes of binge eating

No	1-5	6-12	13-15	16-22	23-27	Every day
0	1	2	3	4	5	6

20. On what proportion of the times that you have eaten have you felt guilty (felt that you've done wrong) because of its effect on your shape or weight? Do not count episodes of binge eating.

None of the times	A few of the times	Less than half	Half of the times	More than half	Most of the time	Every time
0	1	2	3	4	5	6

21. Over the past 28 days, how concerned have you been about other people seeing you eat? ......Do not count episodes of binge eating.

Not at all		Slightly		Moderately	Markedly
0	1	2	3	4	5

Questions 22-28: Please circle the appropriate number on the right. Remember that the questions only refer to the past four weeks (28 days)

Not at all		Slightly		Moderately	Markedly
0	1	2	3	4	5

22. Has your weight influenced how you think about (judge) yourself as a person?
23. Has your shape influenced how you think about (judge) yourself as a person?
24. How much would it have upset you if you had been asked to weigh yourself once a week (no more, or less, often) for the next four weeks?
25. How dissatisfied have you been with your weight?
26. How dissatisfied have you been with your shape?
27. How uncomfortable have you felt seeing your body (for example, seeing your shape in the mirror, in a shop window reflection, while undressing or taking a bath or shower)?
28. How uncomfortable have you felt about others seeing your shape or figure (for example, in communal changing rooms, when swimming, or wearing tight clothes)?

Fairburn CG, Beglin S. Eating disorder examination questionnaire. In: Fairburn CG, editor. Cognitive behavior therapy and eating disorders. New York, NY: Guilford Press; 2008. pp. 309–313

Appendix D: Compensatory Eating and other Behaviors in Response to Alcohol Scale (CEBRACS)

BEFORE drinking

1=Never, 2=Rarely (about 25% of the time), 3=Sometimes (about 50% of the time), 4=Often (about 75% of the time), 5= Almost all the time

1. In the past 3 months, I have eaten less than usual during one or more meals before drinking to get DRUNKER.
2. In the past 3 months, I have exercised before drinking to make up for the calories in alcohol that I anticipated consuming.
3. In the past 3 months, I have eaten less than usual during one or more meals before drinking to feel the effects of alcohol FASTER.
4. In the past 3 months, I have skipped one or more meals before drinking to make up for the number of calories in alcohol that I anticipated consuming
5. In the past 3 months, I have taken laxatives before drinking to make up for the calories in alcohol that I anticipated consuming.
6. In the past 3 months, I have skipped one or more meals before drinking to feel the effects of alcohol FASTER.

WHILE under the effects of alcohol

Instructions: For each of the following statements, think about behaviors you have engaged in WHILE you were drinking or under the effects of alcohol (e.g. while you were drinking during a wedding reception, party, bar, club, football game). This also includes situations where you may have been done drinking, but the effects of alcohol had not completely worn off. As an example, imagine arriving home from a party where you had been drinking and you could still feel the effects of alcohol even though you had stopped drinking earlier in the night.

7. In the past 3 months, I have eaten less than usual while I was drinking because I wanted to feel the effects of the alcohol FASTER.
8. In the past 3 months, I have taken diuretics while I was drinking to make up for the calories in alcohol that I was consuming.
9. In the past 3 months, I have not eaten at all while I was drinking because I wanted to feel the effects of the alcohol FASTER
10. In the past 3 months, I have eaten low-calorie or low-fat foods while I was drinking to make up for the calories in alcohol that I was consuming.
11. In the past 3 months, I drank low-calorie beer or alcoholic drinks to get fewer of the calories that are in alcohol.
12. In the past 3 months, I have eaten less than usual while I was drinking because I wanted to get DRUNKER.

13. In the past 3 months, I have taken laxatives while I was drinking to make up for the calories in alcohol that I was consuming.
14. In the past 3 months, I have not eaten at all while I was drinking because I wanted to get DRUNKER.

AFTER effects from alcohol have worn off

15. In the past 3 months, I have taken diuretics to make up for the calories in alcohol that I had consumed previously while I was under the effects of alcohol.
16. In the past 3 months, I have eaten low-calorie or low-fat foods during one or more meals to make up for the calories in alcohol that I had consumed previously while I was under the effects of alcohol.
17. In the past 3 months, I have taken laxatives to make up for the calories in alcohol that I had consumed previously while I was under the effects of alcohol.
18. In the past 3 months, I have exercised to make up for the calories in alcohol that I had consumed previously while I was under the effects of alcohol.
19. In the past 3 months, I have made myself vomit to make up for the calories in alcohol that I had consumed previously while I was under the effects of alcohol.
20. In the past 3 months, I have eaten less than usual during one or more meals to make up for the calories in alcohol that I had consumed previously while I was under the effects of alcohol.
21. In the past 3 months, I have skipped an entire day or more of eating to make up for the calories in alcohol that I had consumed previously while I was under the effects of alcohol.

Rahal CJ, Bryant JB, Darkes J, Menzel JE, Thompson JK.2012. Development and validation of the Compensatory Eating and Behaviors in Response to Alcohol Consumption Scale (CEBRACS). Eat Behav. 2012 Apr;13(2):83-7.

Appendix E: Compensatory Eating and other Behaviors in Response to Cannabis Scale (CECBS)

What types of cannabis products have you used in the past 3 months?

Flower, Edibles, Concentrates (e.g., dabs, wax)

"The munchies" refer to feelings of hunger and craving for food experienced under the influence of cannabis. How often do you experience the munchies when using cannabis?

1 = Never, 2 = Rarely (about 25% of the time), 3 = Sometimes (about 50% of the time), 4 = Often (about 75% of the time), 5 = Almost all the time

Please indicate how frequently you engaged in any of the following BEFORE using cannabis in the past 3 months. Answer for any type of cannabis product that applies (flower, concentrates, or edibles), you may later be asked to specify.

1 = Never, 2 = Rarely (about 25% of the time), 3 = Sometimes (about 50% of the time), 4 = Often (about 75% of the time), 5 = Almost all the time

1. I have eaten less than usual during one or more meals to get higher
2. I have eaten less than usual during one or more meals to get high faster
3. I have skipped one or more meals to get higher
4. I have skipped one or more meals to get high faster
5. I have eaten less than usual during one or more meals to make up for calories I anticipate consuming when I have the munchies
6. I have skipped one or more meals to make up for calories I anticipate consuming when I have the munchies
7. I have exercised to make up for calories I anticipate when I have the munchies
8. I have eaten low-calorie foods and/or drank low calorie beverages to make up for calories I anticipate consuming when I have munchies
9. I have made sure that calorically dense foods that I could eat when I get the munchies are not readily available to me
10. I have planned to smoke or vape cannabis instead of taking an edible to avoid the extra calories in edibles
11. I have made myself throw up to make up for calories I anticipate consuming when I have the munchies
12. I have used laxatives to make up for calories I anticipate consuming when I have the munchies
13. I have used diuretics to make up for calories I anticipate consuming when I have the munchies

For which types of cannabis products do your answers to the previous questions apply? Select all that apply. Flower, Concentrates (e.g. dabs, wax), Edibles

Please indicate how frequently you engaged in any of the following WHILE using or being under the influence of cannabis in the past 3 months. Answer for any type of cannabis product that applies (flower, concentrates, or edibles), you may later be asked to specify.

1 = Never, 2 = Rarely (about 25% of the time), 3 = Sometimes (about 50% of the time), 4 = Often (about 75% of the time), 5 = Almost all the time

14. I have eaten less than usual to get high faster
15. I have not eaten at all to get high faster
16. I have eaten less than usual to get higher
17. I have not eaten at all to get higher
18. I have eaten less than usual to prolong a high
19. I have not eaten at all to prolong a high
20. I have eaten low-calorie foods and/or drank low calorie beverages to make up for calorie I consume while I have the munchies
21. I have made myself vomit to make up for calories I consume while I have the munchies
22. I have used laxatives to make up for calories I consume while I have the munchies
23. I have used diuretics to make up for calories I consume while I have the munchies

For which types of cannabis products do your answers to the previous questions apply? Select all that apply. Flower, Concentrates (e.g. dabs, wax), Edibles

Please indicate how frequently you engaged in any of the following AFTER using cannabis (i.e. the effects have worn off or the following day) to compensate for calories consumed during the munchies in the past 3 months. Answer for any type of cannabis product that applies (flower, concentrates, or edibles), you may later be asked to specify.

1 = Never, 2 = Rarely (about 25% of the time), 3 = Sometimes (about 50% of the time), 4 = Often (about 75% of the time), 5 = Almost all the time

24. I have eaten less than usual during one or more meals to make up for calories I consumed when I had the munchies
25. I have exercised to make up for calories I consumed when I had the munchies
26. I have eaten low-calorie foods and/or drank low calorie beverages to make up for calories I consumed when I had the munchies
27. I have skipped one or more meals to make up for calories I consumed when I had the munchies
28. I have made myself vomit to make up for calories I consumed when I had the munchies
29. I have used laxatives to make up for calories to make up for calories I consumed when I had the munchies
30. I have used diuretics to make up for calories I consumed when I had the munchies

For which types of cannabis products do your answers to the previous questions apply? Select all that apply. Flower, Concentrates (e.g. dabs, wax), Edibles

Adapted EDEQ Binge-Eating Questions

Please indicate how frequently you have experienced any of the following while eating under the influence of cannabis in the past 3 months

1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5= Almost all the time

1. I have eaten what other people would regard as an unusually large amount of food
2. I have felt a sense of having lost control over my eating (at the time that I was eating)?

3. I have felt sick after eating
4. I have felt guilty (felt that I've done wrong) afterwards because of its effect on my shape or weight.

Appendix F: Compensatory Eating and other Behaviors in Response to Cannabis Scale (CECBS)

What types of cannabis products have you used in the past 3 months?

Flower, Edibles, Concentrates (e.g., dabs, wax)

"The munchies" refer to feelings of hunger and craving for food experienced under the influence of cannabis. How often do you experience the munchies when using cannabis?

1 = Never, 2 = Rarely (about 25% of the time), 3 = Sometimes (about 50% of the time), 4 = Often (about 75% of the time), 5 = Almost all the time

Please indicate how frequently you engaged in any of the following BEFORE using cannabis in the past 3 months. Answer for any type of cannabis product that applies (flower, concentrates, or edibles), you may later be asked to specify.

1 = Never, 2 = Rarely (about 25% of the time), 3 = Sometimes (about 50% of the time), 4 = Often (about 75% of the time), 5 = Almost all the time

1. I have eaten less than usual during one or more meals to get higher
2. I have eaten less than usual during one or more meals to get high faster
3. I have skipped one or more meals to get higher
4. I have skipped one or more meals to get high faster
5. I have eaten less than usual during one or more meals to make up for calories I anticipate consuming when I have the munchies
6. I have skipped one or more meals to make up for calories I anticipate consuming when I have the munchies
7. I have exercised to make up for calories I anticipate when I have the munchies
8. I have eaten low-calorie foods and/or drank low calorie beverages to make up for calories I anticipate consuming when I have munchies
9. I have made sure that calorically dense foods that I could eat when I get the munchies are not readily available to me
10. I have planned to smoke or vape cannabis instead of taking an edible to avoid the extra calories in edibles
11. I have made myself throw up to make up for calories I anticipate consuming when I have the munchies
12. I have used laxatives to make up for calories I anticipate consuming when I have the munchies
13. I have used diuretics to make up for calories I anticipate consuming when I have the munchies

For which types of cannabis products do your answers to the previous questions apply? Select all that apply. Flower, Concentrates (e.g. dabs, wax), Edibles

Please indicate how frequently you engaged in any of the following WHILE using or being under the influence of cannabis in the past 3 months. Answer for any type of cannabis product that applies (flower, concentrates, or edibles), you may later be asked to specify.
1 = Never, 2 = Rarely (about 25% of the time), 3 = Sometimes (about 50% of the time), 4 = Often (about 75% of the time), 5 = Almost all the time

14. I have eaten less than usual to get high faster
15. I have not eaten at all to get high faster
16. I have eaten less than usual to get higher
17. I have not eaten at all to get higher
18. I have eaten less than usual to prolong a high
19. I have not eaten at all to prolong a high
20. I have eaten low-calorie foods and/or drank low calorie beverages to make up for calorie I consume while I have the munchies
21. I have made myself vomit to make up for calories I consume while I have the munchies
22. I have used laxatives to make up for calories I consume while I have the munchies
23. I have used diuretics to make up for calories I consume while I have the munchies

For which types of cannabis products do your answers to the previous questions apply? Select all that apply. Flower, Concentrates (e.g. dabs, wax), Edibles

Please indicate how frequently you engaged in any of the following AFTER using cannabis (i.e. the effects have worn off or the following day) to compensate for calories consumed during the munchies in the past 3 months. Answer for any type of cannabis product that applies (flower, concentrates, or edibles), you may later be asked to specify.
1 = Never, 2 = Rarely (about 25% of the time), 3 = Sometimes (about 50% of the time), 4 = Often (about 75% of the time), 5 = Almost all the time

24. I have eaten less than usual during one or more meals to make up for calories I consumed when I had the munchies
25. I have exercised to make up for calories I consumed when I had the munchies
26. I have eaten low-calorie foods and/or drank low calorie beverages to make up for calories I consumed when I had the munchies
27. I have skipped one or more meals to make up for calories I consumed when I had the munchies
28. I have made myself vomit to make up for calories I consumed when I had the munchies
29. I have used laxatives to make up for calories to make up for calories I consumed when I had the munchies
30. I have used diuretics to make up for calories I consumed when I had the munchies

For which types of cannabis products do your answers to the previous questions apply? Select all that apply. Flower, Concentrates (e.g. dabs, wax), Edibles