Measuring impaired control over cannabis use:

Initial evaluation of the Impaired Control Scale-Cannabis (ICS-C)

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Abstract

Background: Impaired control is a central concept in addiction. Impaired control over alcohol has been associated with heavy drinking and alcohol-related problems in young adults, but there is less research on impaired control over cannabis. Currently, there is no validated self-report instrument that comprehensively assesses impaired control over cannabis use. This study examined the factor structure, reliability, and validity of a new measure, the Impaired Control Scale-Cannabis (ICS-C), which was adapted from the Impaired Control Scale (ICS) for alcohol (Heather et. al, 1993). *Method:* The sample consisted of students at two Canadian universities who reported past-month cannabis use (N=362; 63% women; 66% White, mean age=19.91). Participants completed an online survey including the ICS-C and ICS, along with measures of cannabis use, cannabis problems, alcohol use, impulsivity, and self-regulation. *Results:* After trimming problematic and redundant items, the final exploratory factor analysis of the ICS-C items yielded two factors: Attempted Control (attempts to control cannabis use) and Failed Control (unsuccessful attempts to limit cannabis use). High correlations between the ICS-C subscales and the Impaired Control subscale of the Marijuana Consequences Questionnaire provided evidence for convergent validity. Support for concurrent and discriminant validity was observed in the associations of the ICS-C subscales with cannabis use, cannabis problems, impulsivity, self-regulation, alcohol use, and the alcohol ICS. *Conclusions:* The ICS-C is a promising tool for assessing impaired control over cannabis in young adults. Future research should further validate the ICS-C and examine its potential clinical utility for identifying individuals at risk for cannabis use disorder.

Keywords: cannabis, marijuana, impaired control, addiction, young adults, college students, cannabis problems, measurement, factor analysis

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Cannabis is widely used among young adults in North America. In the U.S., past-year cannabis use among individuals aged 18-25 years increased from 29.8% in 2002 to 35.4% in 2019 (Substance Abuse and Mental Health Services Administration, 2020). In Canada, where recreational cannabis was legalized in October 2018, the prevalence of past-year cannabis use in young adults increased from 33% in 2017 to 45% in 2019 (Government of Canada, 2021a). Among Canadian college and university students specifically, 48% reported past-year cannabis use in the 2019/2020 academic year (Government of Canada, 2021b). Although cannabis use does not inevitably lead to detrimental cannabis-related outcomes, frequent cannabis use among youth is associated with increased risk of developing cannabis use disorder (CUD; Leung et al., 2020). Thus, it is important to understand factors that may play a role in the transition from non-problematic use to CUD among young adults.

Impaired control over cannabis use may be an important factor in the development of CUD. Impaired control can be defined as difficulty limiting or abstaining from substance use (Heather et al., 1993; Leeman et al., 2007). Symptoms related to impaired control (i.e., using more of a substance than intended and difficulty cutting down on substance use) are central to diagnoses of substance use disorders (American Psychiatric Association, 2013). However, impaired control over cannabis use is relatively understudied. This may partly be attributed to the lack of a comprehensive and valid scale to assess impaired control over cannabis. The goal of this study was to provide a preliminary evaluation of a questionnaire designed to assess impaired control over cannabis use among young adults. We first review research on the measurement of impaired control over alcohol and associations between impaired control over alcohol and

alcohol-related outcomes. We then discuss the limited research on impaired control over cannabis use and introduce the Impaired Control Scale – Cannabis (ICS-C), an adaptation of the Impaired Control Scale (ICS) used in the alcohol literature.

Research on Impaired Control over Alcohol

Previous studies have highlighted the significance of impaired control over alcohol in undergraduate students' heavy and problematic drinking, suggesting that symptoms related to impaired control are among the earliest to emerge in the development of alcohol use disorder (Langenbucher & Chung, 1995; Leeman et al., 2007; Leeman et al., 2012). Prospective analyses have shown that impaired control over alcohol predicts subsequent alcohol-related problems (e.g., Leeman et al., 2009) and that impaired control mediates the association between distal risk factors and later alcohol problems in undergraduate students (Martinez-Loredo et al., 2020). Studies have also examined the role of impaired control over alcohol as a potential mechanism that links related constructs such as impulsivity and self-regulation to heavy drinking (see Leeman et al., 2014; Patock-Peckham et al., 2001; Patock-Peckham et al., 2018). Further, impaired control over alcohol is most strongly associated with impulsive traits that reflect behavioral disinhibition such as response impulsivity and positive and negative urgency (Martinez-Loredo et al., 2020; Vaughan et al., 2019; Wardell et al., 2016).

In addition, self-regulation, or the generalized ability to manage thoughts, emotions, and actions to achieve goals, has been associated with alcohol-related consequences in young adults (Quinn & Fromme, 2010). Low levels of self-regulation have been associated with heavy drinking and alcohol-related problems among college students (Quinn & Fromme, 2010). Self-regulation has also been shown to serve as a protective factor against incidents of alcohol-related consequences for undergraduate students (Neal & Carey, 2007). Conceptually, impaired control

over alcohol may be a mechanism that links poor self-regulation with alcohol-related problems, given that both impulsivity and self-regulation are related with negative alcohol outcomes and both constructs involve difficulties with self-control (Leeman et al., 2014).

Given the significance of impaired control in alcohol-related problems, the Impaired Control Scale (ICS) was developed to assess impaired control over alcohol use (Heather et al., 1993). The ICS is the most widely used self-report measure of impaired control over alcohol and consists of three subscales: Attempted Control (Part 1) was designed to measure the frequency of intentions to control drinking in the past six months. Failed Control (Part 2) was designed to measure the frequency of unsuccessful or failed attempts to limit drinking in the past six months. Perceived Control (Part 3) was designed to measure the beliefs about the inability to control drinking if one decides to limit their alcohol use in the future. Parts 2 and 3 are nearly identical, except Part 2 measures past behaviors whereas Part 3 measures beliefs about future behaviors. Part 3 was added to distinguish people who successfully controlled their drinking from people who did not feel the need to control their alcohol consumption (Heather et al., 1993).

Previous studies on the factor structure of the ICS have tended to examine each subscale separately and essentially found that each subscale is unidimensional, with Parts 2 and 3 consistently found to be highly correlated with one another (Heather et al., 1993; Heather et al., 1998; Marsh et al., 2002). Most studies using the ICS with undergraduate samples have focused primarily on the Perceived Control scale, although some have instead used the Failed Control scale (Leeman et al., 2012); few studies incorporate the Attempted Control scale into analyses. However, a laboratory study by Vaughan et al. (2019) found that Attempted Control was a stronger predictor of greater alcohol self-administration than Failed Control in a sample of

nondependent drinkers. This finding highlights the importance of failed control as a distinct component of impaired control over alcohol that may have a unique role in alcohol use behavior.

Impaired Control over Cannabis Use

A few studies suggest that impaired control over cannabis use is a risk factor for frequent and problematic cannabis use. Previous work on the prevalence rates of CUD in young adults found that more than half of the students who met the criteria for a CUD diagnosis endorsed symptoms related to impaired control over cannabis (Pellegrino et al., 2020). A prospective study found that among young adults who did not meet full criteria for DSM-IV cannabis dependence, endorsing symptoms related to impaired control over cannabis was found to be among the strongest predictors of subsequent development of cannabis dependence (van der Pol et al., 2013). However, impaired control over cannabis remains underexamined in the literature on young adult cannabis use, especially when considering the number of studies examining impaired control over alcohol in young adults.

This paucity of research may be partly attributable to the lack of a comprehensive self-report measure of impaired control over cannabis. The Marijuana Consequences Questionnaire (MACQ) contains a subscale measuring impaired control over cannabis use (Simons et al., 2011); however, this subscale is typically combined with other subscales of the MACQ to form a total cannabis consequences score, and the MACQ impaired control (MACQ-IC) subscale is rarely used as a standalone measure of impaired control. Further, compared with the ICS for alcohol, the MACQ-IC contains an imbalance of items that pertain to attempted vs. failed control over cannabis use, and none of the items pertain to the perceived control of cannabis use. Thus, the MACQ-IC is not as comprehensive as the ICS. A more comprehensive instrument similar to the ICS may help to improve our understanding of impaired control over cannabis use. Given

that the ICS has been widely used and validated as a measure of impaired control over alcohol, and given that impaired control is a general construct that is common to all substance use disorders, the ICS may serve as a good starting point from which to develop a new measure of impaired control over cannabis.

The Present Study

The present study aimed to provide an initial evaluation of the Impaired Control Scale-Cannabis (ICS-C), a newly developed instrument to assess impaired control over cannabis that was directly adapted from the ICS. Given the limited prior research on the measurement and factor structure of impaired control over cannabis, exploratory factor analysis was conducted in this preliminary study. Specifically, this study examined the factor structure, internal consistency, and validity of ICS-C. We anticipated that 3 factors would emerge from the ICS-C consistent with the structure of the alcohol ICS, although we expected that there may be a high degree of overlap between the Failed and Perceived control factors consistent with past research on the ICS (Heather et al., 1998; Marsh et al., 2002). We hypothesized that the ICS-C scales would show high correlations with the MACQ-IC, supporting convergent validity. We also expected the ICS-C to have weaker correlations with both the alcohol ICS scales and measures of alcohol consumption, indicative of discriminant validity. Also, concurrent validity was explored by examining correlations between the ICS-C scales and measures of cannabis use and cannabis problems, as well as related constructs including impulsivity and self-regulation. We expected moderate positive correlations between ICS-C scales and measures of cannabis use, cannabis problems, and impulsivity, as well as a moderate negative correlation between ICS-C scales and a measure of self-regulation.

Method

Participants and Procedures

The sample consisted of undergraduate students from two major universities in central Canada who participated in an online survey assessing alcohol and substance use for course credit. A total of *N*=1,655 students completed the survey; the present analyses focused on the subset of *n*=382 participants who reported using cannabis at least once in the past month. Eighteen (4.7%) were excluded from the analyses because they did not have complete data on all items of the ICS-C, resulting in a final sample of *n*=362 (63% female) for the current study. Participants in the analytic sample had a mean age of 19.91 (*SD* = 3.43), and 66% identified as White. See Table 1 for detailed sample characteristics. Participants in the sample used cannabis on an average of 8.21 days in the past month (*SD* = 9.56; *Median* = 3; *Range* = 1-30) and reported using an average of 4.15 grams per week (*SD* = 8.42; *Median* = 1.60; *Range* = 0.05-77). The majority of participants (92%; n=333) reported that they had also consumed alcohol in the past month (see Table 4 for alcohol use descriptives).

The data were collected between October 2019 to March 2020, the year after cannabis was legalized for recreational use in Canada. All participants completed an online consent form, demographics questionnaire, and measures of relevant constructs through a Qualtrics survey. The measures related to cannabis and alcohol were administered to all participants, along with a random subset of the additional measures (including the impulsivity and self-regulation measures) to reduce participant burden. The median completion time for the survey was 78 minutes. The study was approved by the Research Ethics Boards at [institution names removed for blind review].

Measures

Impaired Control Scale-Cannabis (ICS-C). The preliminary version of ICS-C contained 25 items that were directly adapted from the alcohol ICS items by changing the reference substance from alcohol to cannabis. The wording of some items was slightly modified to make the content more relevant to cannabis (items 8, 11, 12, 13, 18, 21, 22, and 23; see Table 2 for item wording). Five items assessed attempts to control cannabis use in the past 30 days (i.e., Attempted Control), 10 items assessed failed attempts to control cannabis use in the past 30 days (i.e., Failed Control), and another 10 items assessed beliefs about the inability to limit cannabis use in the future (i.e., Perceived Control). Consistent with the alcohol ICS, response options for the Attempted and Failed Control items were 1 = *Never*, 2 = *Rarely*, 3 = *Sometimes*, 4 = *Often*, 5 = *Always,* and response options for the Perceived Control items were 1 = *Strongly Disagree*, 2 = *Disagree*, 3 = *Neither Agree nor Disagree*, 4 = *Agree*, 5 = *Strongly Agree*. The Failed control items included the response option *N/A-No Attempt,* which was recoded to 1 = *Never* to reflect a lack of impaired control for the item (Heather et al., 1993; Heather et al., 1998). Eight reverse-keyed items, where higher scores reflect *lower* impaired control (e.g., "I have been able to stop using cannabis before becoming extremely high/stoned"), were reverse coded prior to analyses.

Impaired Control Scale (ICS). The Impaired Control Scale (ICS; Heather et al., 1993) was used to measure impaired control over alcohol consumption among participants reporting past 30-day alcohol use. Part 1 (Attempted Control) consisted of five items and assessed the frequency of attempts to limit alcohol use (e.g., "During the past 30 days, I have tried to limit the amount I drank"). Part 2 (Failed Control) consisted of 10 items which measured the frequency of failed attempts to control drinking (e.g., "During the past 30 days, I have found it difficult to limit the amount I drank"). Part 3 (Perceived Control) consisted of 10 items which assessed the

participant's beliefs regarding their present inability to control their drinking (e.g., "I would have difficulty limiting the amount I drink"). Response options and coding of the items were identical to the ICS-C described above. The ICS scales showed good internal consistency in this sample (see Table 4). Previous work provided evidence for high test-retest reliability, as well as concurrent and discriminant validity of the ICS (Heather et al., 1993; Marsh et al., 2002).

Marijuana Consequences Questionnaire (MACQ). The MACQ is a 50-item scale that assessed cannabis use consequences including social-interpersonal, self-perception, self-care, academic/occupational, physical dependence, and cognitive consequences (Simons et al., 2011). The MACQ Impaired Control (MACQ-IC) subscale consisted of six items that were used to assess impaired control over cannabis (e.g., "I often used more marijuana than I originally had planned"). The responses were recorded on a dichotomous scale (1 = *Yes* and 0 = *No*). The total score from the six items in the Impaired Control subscale and the total score from the rest of the items in other subscales (reflecting total cannabis problems excluding impaired control) were used in the validity analyses for this study. The MACQ-IC and the total cannabis problems scale both had good internal consistency in this sample (see Table 4).

Cannabis Use and Alcohol Use Measures. Participants completed items related to the frequency and quantity of cannabis consumption in the past 30 days. The frequency item read, "On how many days during the last 30 days did you use marijuana?" Participants responded on a scale that ranged from 0 to 30. Typical cannabis use quantity was assessed using the Marijuana Use Grid (MUG; Pearson & Marijuana Outcomes Study Team, 2021). The quantity item read, "During a week of typical marijuana use in the past 30 days, please indicate times, days, and approximate number of grams of marijuana that you used." To improve accuracy, participants were presented with a visual guide showing different amounts of cannabis in grams. Participants

recorded their typical cannabis use in grams for each 4 hour time period (12am – 4am, 4am – 8am, 8am – 12pm, 12pm – 4pm, 4pm – 8pm, and 8pm – 12 am) on each day of the week. We summed the reported number of grams across all time periods and days to obtain an estimate of the total number of grams consumed in typical week.

Alcohol use was assessed with a similar approach. Participants were presented with visual guide orienting them to standard drink units. Participants responded to an item assessing the frequency of past 30-day alcohol use with response options ranging from 0 to 30 days. They then used a grid to report the typical number of standard drinks they consumed during each 4 hour time period on each day of the week for a "typical week" in the past 30 days. We summed the reported number of drinks across all time periods and days to obtain an estimate of the total standard drinks consumed in a typical week.

The Short UPPS-P Impulsive Behavior Scale. This 20-item scale was used to measure different facets of impulsivity including sensation seeking (e.g., "I quite enjoy taking risks"), lack of premeditation (e.g., "My thinking is usually careful and purposeful (reverse keyed)"), lack of perseverance (e.g., "I generally like to see things through to the end (reverse keyed)"), negative urgency (e.g., "When I feel bad, I will often do things I later regret in order to make myself feel better now"), and positive urgency (e.g., "When I am in great mood, I tend to get into situations that could cause me problems") (Cyders et al., 2014). Each facet of impulsivity had four items, and each was rated on a 4-point scale that ranged from *agree strongly* to *disagree strongly*. This short version of the UPPS-P Impulsive Behavior Scale is considered valid with a comparable inter-relation to UPPS-P (Cyders et al., 2014).

Short Self-Regulation Questionnaire. The Short Self-Regulation Questionnaire (SSRQ) is a 31-item measure that assessed self-regulation or the generalized ability to regulate behavior to

achieve future goals and desired outcomes (e.g., “I have a lot of willpower”). The participants answered the items using a response scale that ranged from *strongly disagree* to *strongly agree*, where higher scores reflect better self-regulation. This measure had good internal consistency in this sample (see Table 4).

Data Analyses

We conducted an exploratory factor analysis (EFA) to examine the factor structure of the ICS-C. Prior to analysis, the distributions of the individual items were examined. Since many of the items were positively skewed and responses were reported on a 5-point categorical scale, we treated the items as ordinal categorical variables for the analysis, which does not involve the same assumptions of normality. Thus, the EFA was conducted on the polychoric correlation matrix of the categorical items, which has been shown to perform as well as the Pearson’s correlation matrix in parallel analysis for data that are moderately skewed (Garrido et al., 2013).

We conducted the EFA in R (version 4.0.4) using the *psych* and *GPArotation* packages. Maximum likelihood estimation with oblimin rotation was used because we expected the factors to be intercorrelated. We used multiple approaches including parallel analysis (which involves comparing the eigenvalues generated by the EFA to eigenvalues derived from randomly generated data; Cokluk & Kocak, 2016), scree plot (visual inspection of the eigenvalue plot), and Kaiser criterion (i.e., eigenvalues > 1) to determine the range of factors to extract. The final number of factors to retain was decided according to the interpretability of the factor loadings and achieving simple structure as indicated by each item loading only onto a single factor (with a loading threshold of .30; Costello & Osborne, 2005). Coefficient alpha was used to estimate the internal consistency of the final factors.

To ensure that multivariate outliers in our data did not substantially affect the number of factors that we retained, we ran our analysis twice (both including and excluding the outliers) to compare the results. To do so, we calculated Mahalanobis distance values for each participant, and considered values that exceeded the critical value for the chi-square test with an alpha level of .001 (i.e., $X^2(25) = 52.62$) to indicate a multivariate outlier (Hadi et al., 2009).

After finalizing the factor analysis, we proceeded to examine the validity of the scales. First, the total score for each factor was calculated by summing the items in each factor and then examining their correlations with the other measures of interest. Due to skewed distributions and outliers in our data, we used the Spearman rank correlation coefficient for correlational analyses because it has been shown to be less biased when dealing with skewed distributions and is less influenced by outliers compared with the Pearson correlation coefficient (Bishara & Hittner, 2015; Holgado-Tello et al., 2010).

Results

Factor Structure and Internal Consistency of ICS-C

The results of the EFA suggested a range of possible factor solutions: the parallel analysis suggested a 7-factor solution, whereas the scree plot and Kaiser criterion suggested only 3 factors. Thus, we examined all possible factor solutions ranging from 3- to 7-factor models. The factor loadings for the 3-factor model are shown in Table 2. The first five items loaded onto the first factor, most of the remaining items loaded onto the second factor, and all the reverse-keyed items (which were reverse coded prior to analysis) loaded onto the third factor, with some cross-loading onto factor 2. Similarly, the 4- to 7-factor models resulted in the reverse keyed items loading onto the additional factors, with several cross-loadings present in most of the solutions,

making these additional factors difficult to interpret. Therefore, the 3-factor model was chosen as the best model because it was the most interpretable among the other factor solutions. When we reran the EFA excluding the participants identified as outliers (n = 23), the same pattern of factor loadings emerged, where the reverse-keyed items loaded onto separate factors and cross-loadings were present, and the 3-factor solution was still the preferred solution. Thus, we report only results with outlier participants included in order to be more inclusive.

In the 3-factor model, the third factor was comprised of all the reverse keyed items, which might have reflected a methodological issue related to the reversal in the item wording (i.e., items that reflect good control rather than impaired control; see Dalal & Carter, 2015). Therefore, all the reverse keyed items were excluded from further analyses. We conducted a second round of EFA without the reverse coded items, which resulted in a two-factor model that achieved simple structure as indicated by each item loading onto only one factor. The results of this model are shown in Table 3. The first factor, labelled Attempted Control, was comprised of the same five items in the Attempted Control subscale in ICS. The second factor, labelled Failed/Perceived Control, was comprised of a mixture of the items that comprise the Failed and Perceived Control subscales in the ICS.

Since we found that the items that were originally designed to assess Perceived Control and Failed Control loaded on the same factor in our sample, and thus did not appear to measure distinct constructs, we decided to remove the Perceived Control items and use only the Failed Control items for subsequent analyses. This was done for several reasons. First, each item in the Perceived Control scale is a duplicate of the item in the Failed Control scale that is modified to focus on beliefs about future impaired control rather than past impaired control. Thus, including both Failed Control and Perceived Control items in the same factor would be inefficient and

redundant. Second, there are also issues with the interpretation of a factor comprised of both Failed Control and Perceived Control items as they measure different timeframes and have different response scales. Third, the Failed Control items are most central to the assessment of impaired control as they measure actual impaired control experiences that have recently occurred, rather than beliefs about future experiences. Therefore, we removed all of the Perceived Control items and conducted a final EFA. Our final solution consisted of two factors: Attempted Control and Failed Control (see Table 3), which accounted for 52% and 48% of the total variance, respectively. Both Attempted Control ($\alpha = 0.96$) and Failed Control ($\alpha = 0.88$) had excellent internal consistency.

Convergent, Discriminant, and Concurrent Validity

The means, internal consistency, and correlation coefficients for the scores on Attempted Control and Failed Control scales of the ICS-C and the other variables of interest are shown in Table 4. The sample size for the SSRQ and Short UPPS-P were smaller compared to the rest of the variables because only a subset of participants completed these additional measures to minimize participant burden (see method section). As shown in Table 4, we found a strong correlation ($r > .50$; Cohen, 1988), between the Failed Control subscale of the ICS-C and MACQ-IC scores, providing evidence for convergent validity. There was a sizable but somewhat smaller correlation between the Attempted Control subscale of the ICS-C and MACQ-IC, suggesting greater convergence for the Failed Control subscale. With respect to discriminant validity, we found weaker correlations between the ICS-C subscales and the corresponding subscales in alcohol ICS, suggesting the ICS-C and ICS measure different, albeit related, constructs. Moreover, the ICS-C subscales were much more strongly correlated with the

cannabis use variables (quantity and frequency of use) than with the alcohol use variables (see Table 4), providing further evidence for discriminant validity.

Evidence for concurrent validity was shown by the significant correlations between the ICS-C scales and related constructs including frequency and amount of cannabis use, self-regulation, and impulsivity. As shown in Table 4, there were weak to moderate correlations between the subscale scores in ICS-C and the frequency and quantity of cannabis use, with stronger correlations observed for the Failed Control subscale. Additional support for concurrent validity was also shown by the negative and significant correlations between the Attempted Control and SSRQ scores, as well as between Failed Control and SSRQ scores. There were also positive and significant correlations between Failed Control and the Negative Urgency, Positive Urgency, and Lack of Premeditation subscales in the Short UPPS-P.

Discussion

Given the high rates of cannabis use and problems among young adults and the significance of impaired control in substance use disorders, a comprehensive and valid self-report measure is needed to help improve our understanding of the role of impaired control in the development of cannabis-related problems. This study provided an initial examination of the psychometric properties of the ICS-C, a new measure of impaired control over cannabis, in a sample of Canadian undergraduates. Results from the final EFA yielded 2 factors, Attempted Control and Failed Control, both with excellent internal consistency. Evidence for the convergent, discriminant, and concurrent validity of the ICS-C also was observed.

Results of the initial factor analysis indicated that the reverse-keyed items did not load onto the main factors and instead loaded together on separate factor. We suspect that this method

effect for the reverse-keyed items may reflect a lack of attention to the reverse keying of the items on the part of participants (see Weijters et al., 2013). Additionally, there may be greater ambiguity for these items with respect to the best response option when there is an absence of impaired control. For example, when responding to the item "I have been able to stop using cannabis easily after using a small amount (in a given day)," a participant who has never attempted to control their cannabis use may have difficulty deciding between "N/A", "Never" and "Always". Previous studies examining the alcohol ICS have found similar results where the reverse-keyed items loaded onto separate factors (Heather et al., 1998; Marsh et al., 2002). Future studies could attempt to revise the reverse-keyed items so that they are keyed in the same direction as the other items in order to further examine their relevance for the construct of impaired control over cannabis.

After removing the reverse keyed items, we found one factor that consisted of the same five items that comprise the Attempted Control subscale of ICS. Contrary to expectations, items assessing Failed Control and Perceived Control loaded onto a single factor, indicating that they were not measuring distinct constructs. Past research with the alcohol ICS shows high correlations between the Failed Control and Perceived Control subscales in both social and treatment-seeking drinkers (Marsh et al., 2002). Further, Marsh et al. (2002) also found that Failed Control and Perceived Control are indicators of a single construct based on higher-order confirmatory factor analysis. Since the Failed Control items measure past behaviors, which are more specific and less subjective than the assessment of one's perception of their inability to control their substance use (i.e., the Perceived Control items), we decided to retain only the Failed Control items in the final measure. This allowed us to cut down the length of the scale

without losing any breadth in our assessment of the impaired control construct. We also found high levels of internal consistency for both Attempted Control and Failed Control factors.

In terms of validity, the ICS-C significantly correlated with MACQ-IC, providing evidence for convergent validity. Although there was a moderate to strong correlation between the ICS-C Attempted Control and MACQ-IC scores, the highest correlation was found between the Failed Control of ICS-C and MACQ-IC. This likely reflects the fact that more of the MACQ-IC items assess failure to control cannabis use rather than mere attempts to control cannabis use. Although we found a strong and significant correlation between the Failed Control scale and MACQ-IC scores, the correlation coefficient (r = .67) was slightly lower than the very strong correlation that we expected to observe. This might have been due to the difference in the response scale used in the two instruments, where the binary response scale (Yes/No) of the MACQ items is less sensitive to individual differences in the severity of impaired control over cannabis, which may have limited variability and attenuated correlations with the ICS-C.

Relative to associations with the MACQ-IC, we found weaker (albeit statistically significant) correlations between ICS-C and the alcohol ICS, which supported discriminant validity. While we expected there to be some relationship between ICS-C and ICS given that impaired control is common to all substances, only 12-13% of the variance in the ICS-C scales overlapped with variance in the ICS scales. Further, we observed very weak (and mostly nonsignificant) correlations between the ICS-C subscales and alcohol use variables (quantity and frequency of use). The weaker associations of ICS-C with both ICS and alcohol use (relative to MACQ-IC and cannabis use, respectively) indicated that we could differentiate the measurement of impaired control over cannabis from impaired control over alcohol and that these are two distinct constructs.

We also observed evidence for the concurrent validity of the ICS-C. We found a weak and significant correlation between the Attempted Control scores and the frequency of cannabis use measured in days as well as the amount of cannabis use in a typical week measured in grams. We also observed moderate to strong correlations between the Failed Control scale and frequency and amount of cannabis use. This indicates that individuals who reported more past attempts to limit their cannabis use (Attempted Control) and more failed attempts to limit their use (Failed control) tended to report greater frequency and quantity of cannabis use. These associations were in the expected direction – because light cannabis users are less likely to perceive a need to limit their use, we expected both greater Attempted Control and greater Failed Control among heavier cannabis users.

We also found positive and statistically significant correlations between Negative and Positive Urgency and ICS-C scores, providing further evidence for concurrent validity. The results indicate that people who reported higher levels of positive and negative urgency also reported higher levels of impaired control, and Failed Control in particular. Although we expected the magnitude of the correlations between these constructs to be higher based on previous work with the alcohol ICS, the associations observed between ICS-C Failed Control and Positive and Negative Urgency are in line with the results from studies in the alcohol literature (Vaughan et al., 2019). We also found a weak and significant correlation between Failed Control and Lack of Premeditation. This result is in line with a previous alcohol study which found an association between lack of premeditation and alcohol-related problems through impaired control (Patock-Peckham et al., 2018). Future studies should further explore the relationships between impulsive traits and impaired control over cannabis, and examine impaired control as a possible mediator between impulsivity and cannabis use behaviors and outcomes.

Additionally, results revealed negative, weak to moderate, and statistically significant associations of the ICS-C scales with a measure of self-regulation, further supporting concurrent validity. Although previous work found that self-regulation negatively and significantly correlated with alcohol-related consequences (D'Lima et al., 2012), the role of impaired control in this association has not been thoroughly explored. Future studies should explore impaired control as a potential mechanism that links self-regulation process with cannabis use outcomes.

Overall, the observed correlations between ICS-C and related variables were generally higher for Failed Control than Attempted Control. This is consistent with the notion that intentions or plans to limit substance use (measured by Attempted Control) is a precursor to the experience of impaired control, but is not sufficient for defining the experience of impaired control. Instead, *difficulty* in controlling one's substance use (measured by Failed Control) is the core aspect of impaired control that is associated with substance use and problems and treatment outcomes (Heather et al., 1998; Heather & Dawe, 2005). Still, the scores on the Attempted Control subscale of ICS-C might be useful to distinguish people who were able to successfully cut down their cannabis use from those who have never felt the need to limit their use, both of whom may have lower scores on Failed Control, which was the intention behind the inclusion of Attempted Control items in the original alcohol ICS (Heather et al., 1993). Given that the results of our study support the reliability and validity of the ICS-C for measuring both Attempted and Failed control over cannabis in young adults, a next step will be to examine the utility of incorporating both scales into future studies examining impaired control over cannabis.

Limitations

Given the modest sample size of cannabis users in this study, we were limited in our ability to split the sample to perform both exploratory and confirmatory analyses. Because we

were able to provide valuable initial evidence of validity by making use of the full sample, we opted to focus on an initial evaluation of the factor structure and validity in this first study. Additional studies will be required to confirm the factor structure of the ICS-C. Future studies should also further examine the reliability and validity of the scale in different populations (e.g., heavy cannabis users and treatment-seeking users) and different age groups (e.g., adolescents and older adults) to examine the scale's utility in clinical practice. The study used a convenience sample of predominantly White and female undergraduate students, the majority of whom reported occasional (non-daily) cannabis use. Therefore, the findings of this study might only be relevant to this population. The cross-sectional nature of this study and the use of retrospective self-report measures, which might have caused recall bias, are also considered as limitations. Moreover, the online format and the length of the survey may have contributed to reduced participant attentiveness, leading some to inadvertently miss the reverse-keying of some of the items in the measure.

Further, our measure of cannabis use in this study used the term "marijuana" which may be more narrowly interpreted by some participants as referring only to the dried cannabis plant material. Future studies should look at the association of impaired control over cannabis use involving a more comprehensive assessment of cannabis products including concentrates, edibles, and beverages. This study also adapted the items for the ICS-C directly from the alcohol ICS with only slight modifications to the items to make them more relevant to cannabis use. This approach assumes a high level of overlap between the constructs of impaired control over alcohol and impaired control over cannabis. While this is a plausible assumption given that impaired control is a cross-cutting construct that is central to all substance use disorders, it is possible that there are aspects of impaired control that are unique to cannabis that would not have

been captured on the ICS-C. Thus, future validation studies should focus on further exploring and verifying the construct validity of the ICS-C.

Conclusions

This study provided preliminary evidence for the reliability and validity of ICS-C as an instrument to assess impaired control over cannabis in young adults. The significant associations between impaired control over cannabis and related constructs including cannabis use, cannabis problems, impulsivity, and self-regulation highlight the importance of this construct in cannabis-related outcomes. Therefore, future studies should further explore the relationships among these variables and examine the role of impaired control in pathways that lead to the development of CUD. Future studies should also examine the feasibility of the ICS-C as a tool to screen young adults who may be at high risk for CUD.

Disclosure of Interest

The authors report no conflicts of interest.

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Table 1. Demographic characteristics of participants (N=362)

	n	%
Gender		
Male	127	35
Female	227	63
Transgender	4	1
Other	3	1
Level of Study		
First year	238	66
Second year	80	22
Third year	28	8
Fourth year	8	2
Fifth year	5	1
Postgraduate	3	1
Race/Ethnicity[a]		
White	239	66
Indigenous/Native North American	32	9
East Asian	24	7
Black or African American	29	8
South Asian	30	8
Native Hawaiian or Pacific Islander	5	1
Hispanic, Latino, or of Spanish origin	14	4
Other	43	12
	M	***SD***
Age	19.91	3.43
Past month cannabis use frequency (days)	8.21	9.56
Past month weekly cannabis quantity (grams)	4.15	8.42

Notes. [a]Participants could select multiple categories and were counted in each category

Table 2. Factor loadings for three-factor model

	Factor		
Item	1	2	3
1. I have tried to limit the amount of cannabis I used.	**0.91**	0.01	0.02
2. I have tried to resist the opportunity to start using cannabis.	**0.95**	-0.02	-0.03
3. I have tried to slow down my cannabis use.	**0.95**	0.05	0.03
4. I have tried to cut down on my cannabis use (i.e., use less).	**0.95**	0.06	0.04
5. I have tried to stop using cannabis for a period of time.	**0.93**	-0.03	-0.05
6. I have found it difficult to limit the amount of cannabis I used.	0.30	**0.65**	0.17
7. I have started using cannabis even after deciding not to.	0.23	**0.64**	-0.02
8. Even when I intended to use only a small amount of cannabis in a given day, I ended up using much more.	0.11	**0.77**	0.01
9. I have been able to cut down my cannabis use (i.e., use less) when I wanted to. (R)	0.03	-0.15	**0.82**
10. I have used cannabis at times when I knew it would cause me problems (e.g., problems at work/school, with family/friends, or with the police, etc.).	0.11	**0.73**	0.06
11. I have been able to stop using cannabis easily after using a small amount (in a given day). (R)	0.01	0.08	**0.85**
12. I have been able to stop using cannabis before becoming extremely high/stoned. (R)	0.04	-0.04	**0.80**
13. I have had an irresistible urge to continue using cannabis once I started (i.e., after a small amount, I want more).	0.05	**0.76**	-0.02
14. I have found it difficult to resist using cannabis, even for a single day.	0.00	**0.83**	0.08
15. I have been able to slow down my cannabis use when I wanted to. (R)	0.04	-0.07	**0.89**
16. I would find it difficult to limit the amount of cannabis I used.	0.05	**0.81**	0.05
17. I would start using cannabis even after deciding not to.	0.06	**0.85**	-0.09
18. Even when I intended to use only a small amount of cannabis in a given day, I would end up using much more.	-0.06	**0.92**	-0.07
19. I could cut down on my cannabis use (i.e., use less) if I wanted to. (R)	-0.07	0.13	**0.66**
20. I would still use cannabis at times when I knew it would cause me problems (e.g., problems at work/school, with family/friends, or with the police, etc.).	0.01	**0.84**	-0.07
21. I would be able to stop using cannabis easily after using a small amount (in a given day). (R)	-0.06	**0.41**	**0.49**
22. I would be able to stop using cannabis before becoming extremely high/stoned. (R)	-0.08	**0.33**	**0.51**
23. I would have an irresistible urge to continue using cannabis once I started (i.e., after a small amount, I want more).	-0.02	**0.77**	0.03
24. I would find it difficult to resist using cannabis, even for a single day.	-0.14	**0.92**	0.02
25. I would be able to slow down my cannabis use when I wanted to. (R)	-0.13	**0.42**	**0.45**

Note: Factor loadings above .30 have been bolded. Factor 1 = Attempted Control; Factor 2 = Failed/Perceived Control; Factor 3 = Reverse-keyed items; (R) = denotes an item that is reverse keyed and thus was reverse scored prior to analyses.

Table 3. Factor loadings for two-factor solution excluding the reverse keyed items

	Initial (with Perceived Control items)		Final (without Perceived Control items)	
Item	AC	FC/PC	AC	FC
1. I have tried to limit the amount of cannabis I used.	**0.91**	0.01	**0.90**	0.02
2. I have tried to resist the opportunity to start using cannabis.	**0.95**	-0.05	**0.95**	-0.04
3. I have tried to slow down my cannabis use.	**0.95**	0.06	**0.95**	0.05
4. I have tried to cut down on my cannabis use (i.e., use less).	**0.95**	0.07	**0.95**	0.07
5. I have tried to stop using cannabis for a period of time.	**0.94**	-0.06	**0.95**	-0.07
6. I have found it difficult to limit the amount of cannabis I used.	0.27	**0.74**	0.19	**0.79**
7. I have started using cannabis even after deciding not to.	0.21	**0.64**	0.11	**0.75**
8. Even when I intended to use only a small amount of cannabis in a given day, I ended up using much more.	0.08	**0.78**	0.00	**0.85**
10. I have used cannabis at times when I knew it would cause me problems (e.g., problems at work/school, with family/friends, or with the police, etc.).	0.09	**0.76**	0.01	**0.82**
13. I have had an irresistible urge to continue using cannabis once I started (i.e., after a small amount, I want more).	0.03	**0.76**	-0.05	**0.81**
14. I have found it difficult to resist using cannabis, even for a single day.	-0.04	**0.89**	-0.11	**0.93**
16. I would find it difficult to limit the amount of cannabis I used.	0.03	**0.84**	-	-
17. I would start using cannabis even after deciding not to.	0.05	**0.81**	-	-
18. Even when I intended to use only a small amount of cannabis in a given day, I would end up using much more.	-0.07	**0.90**	-	-
20. I would still use cannabis at times when I knew it would cause me problems (e.g., problems at work/school, with family/friends, or with the police, etc.).	0.00	**0.81**	-	-
23. I would have an irresistible urge to continue using cannabis once I started (i.e., after a small amount, I want more).	-0.04	**0.79**	-	-
24. I would find it difficult to resist using cannabis, even for a single day.	-0.17	**0.95**	-	-

Note: Factor loadings above .30 have been bolded. All of the reverse keyed items were removed prior to analysis. AC = Attempted Control; FC = Failed Control; PC = Perceived Control. All of the items measuring perceived and failed control loaded onto a single factor in the initial 2-factor solution. Because of the high correlation between perceived and failed control items, only the failed control items were retained in the final solution to avoid redundancy. The final solution consisted of two factors: Attempted Control (which measured the frequency of attempts to control cannabis use) and Failed Control (which measured the frequency of unsuccessful attempts to control cannabis consumption).

Table 4. Means, Internal Consistency, and Correlation Coefficients of ICS-C Attempted Control and Failed Control with measures of related constructs

Variable	α	n	Mean(SD)	Range	ICS-C Attempted Control (rho)	ICS-C Failed Control (rho)
MACQ-IC	0.81	333	1.48(1.83)	0-6	0.42***	0.67***
Full MACQ	0.92	333	5.65(6.68)	0-39	0.43***	0.65***
ICS (alcohol)						
AC	0.92	322	11.10(5.67)	5-25	0.36***	
FC	0.81	322	18.50(6.73)	10-37		0.34***
SSRQ	0.90	233	104.99(15.16)	58-145	-0.19**	-0.27***
SUPPS-P						
NU	0.85	234	8.89(3.00)	4-16	0.10	0.25***
PS	0.76	234	7.89(2.38)	4-15	0.13	0.10
PM	0.82	234	7.60(2.11)	4-15	0.03	0.16*
SS	0.70	234	10.71(2.65)	4-16	-0.08	-0.08
PU	0.89	234	8.00(3.14)	4-16	0.11	0.16*
Frequency of cannabis use (days)		362	8.21(9.56)	1-30	0.18***	0.47***
Weekly quantity of cannabis used (grams)		321	4.15(8.42)	0.05-77	0.21***	0.44***
Frequency of alcohol use (days)		362	5.14(4.75)	0-30	-0.10	-0.02
Weekly alcohol quantity (standard drinks)		361	10.79(10.65)	0-57	-0.12*	-0.02
ICS-C						
AC	0.96	362	10.52(6.40)	5-25		
FC	0.88	362	10.06(5.21)	6-30		

Note: All correlations are Spearman's rank-order correlation coefficient (rho). Sample sizes vary across correlation analyses due to some measures being administered to only a subsample of participants and due to some participants having missing data on some measures. MACQ-IC = Marijuana Consequences Questionnaire-Impaired Control subscale; Full MACQ = Total Marijuana Consequences Questionnaire score (exluding the Impaired Control subscale); ICS = Impaired Control Scale (alcohol version); ICS-C = Impaired Control Scale – Cannabis; AC = Attempted Control subscale; FC = Failed Control subscale; SSRQ = Short Self-Regulation Questionnaire; SUPPS-P = Short UPPS-P Impulsive Behaviour Scale; NU = Negative Urgency, PS = (lack of) Perseverance, PM = (lack of) Premeditation, SS = Sensation Seeking, PU = Positive Urgency; ICS-C = Impaired Control Scale-Cannabis; *p < .05, **p < .01, ***p < .001