The Interaction of Cannabis Consumption with Heavy Episodic Drinking and Alcohol-induced Blackouts in Relation to Cannabis Use Consequences Among Recent Undergraduate College Cannabis Users

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ABSTRACT

Introduction: Risky alcohol use patterns, characterized by heavy episodic drinking (HED) and alcohol-induced blackout, are prevalent in college students. However, it is not clear if experiencing HED and blackout among college-attending cannabis users heightens risk for adverse cannabis use consequences. The purpose of this study was to examine whether heavy episodic drinking and blackout episodes moderate the relationship between cannabis consumption and cannabis use consequences among college students. **Methods**: Undergraduate college students (n = 4331) were recruited from a Midwest University in 2021. This analysis used a subset of data from past 6-month cannabis users (n= 772; 17.8% of the full sample). Among cannabis users, 64.5% identified as female and 87.8% were White with an average age of 19.99 (SD=2.88). A linear regression was conducted with two two-way interactions of cannabis consumption and HED frequency as well as cannabis consumption and alcohol-induced blackout episodes. **Results**: Results showed a statistically significant positive association between cannabis consumption and cannabis use consequences (B=0.73, p<.001), adjusting for the other variables in the model. Blackout, but not HED, was a significant moderator (B=0.19, p=.003). **Discussion**: The findings of this study indicate that blackout experiences amplify the relationship between cannabis use and cannabis-related consequences among college students. This underscores that blackouts not only signal a risk of problematic drinking but also exacerbate the association between cannabis use and its negative consequences. **Conclusion**: Findings may inform college campus interventions targeting cannabis and alcohol concurrent-users who experience alcohol-induced blackouts to reduce their additional risk for cannabis-related consequences.

Key words: cannabis consumption; cannabis use consequences; heavy episodic drinking (HED); alcohol-induced blackout; college undergraduate students

Cannabis use is prevalent among college students (Patrick et al., 2022). According to a national report, 24% of young adults aged 18 to 25 years consumed cannabis in the past month, which is the highest prevalence compared to other age groups (SAMHSA, 2022). Of concern, cannabis use is associated with a range of adverse consequences including cannabis-related motor vehicle accidents (Hammond et al., 2020), mental illness (Hosseini & Oremus, 2019), physical health and sleep problems (Tuvel et al., 2023), and cannabis use disorder (Connor et al., 2021).

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However, a significant portion of the variance in cannabis use negative consequences is unexplained by cannabis consumption alone (Pearson, 2019), which underscores the need for a broader array of risk factors to comprehensively understand the etiology of such consequences among cannabis users.

One pivotal aspect to consider is the use of other substances, particularly alcohol. Alarming rates of alcohol use, including heavy episodic drinking and alcohol-induced blackouts, persist among college students throughout the United States (Mundt & Zakletskaia, 2012; Siqueira & Smith, 2015). Based on the 2021 National Survey on Drug Use and Health (NSDUH), nearly half (49.3%) of full-time college students (18 to 22 years old) reported alcohol consumption within the past month, with approximately 27.4% engaging in heavy episodic drinking (NIAAA, 2023). Notably, approximately 50% of college students who consume alcohol report experiencing one or more episodes of alcohol-induced blackout during their lifetime (Mundt & Zakletskaia, 2012). Heavy episodic drinking (4/5 drinks for women/men) (White & Hingson, 2013) is associated with significantly graver outcomes in contrast to moderate or light alcohol consumption (Hingson & White, 2012), including incidents as severe as sexual assaults and fatalities (Siqueira & Smith, 2015). Alcohol-induced blackouts (Davis et al., 2021) serve as a significant marker of problematic drinking behavior (Hingson et al., 2016), denoting episodes of anterograde amnesia induced by alcohol consumption (White, 2003). During a blackout, individuals remain conscious but lack memory retention of their actions (Lee et al., 2009), potentially engaging in activities without recollection. This phenomenon has adverse impacts on cognitive and behavioral functioning, ranging from suicide ideation to increased risk of injury and alcohol dependence (Bae et al., 2015; Hingson et al., 2016; Studer et al., 2019).

Concurrent use of both cannabis and alcohol refers to using both substances within a specified time frame (though not necessarily simultaneously). Such use is common among college students (Gonçalves et al., 2022; Gunn et al., 2022; Hai et al., 2022; Jackson et al., 2020; Lee et al., 2022) and the bulk of studies have shown that the concurrent use of cannabis and alcohol among college students increases risk for *alcohol*-related negative outcomes (Davis et al., 2021; Stevens et al., 2022). Concurrent use also may be associated with heightened risk for negative *cannabis*-related consequences (Hammond et al., 2020). A study conducted by Barnwell and colleagues (2005) found a stronger positive association between cannabis consumption and cannabis dependence among undergraduate college students who also engaged in more frequent or high quantity alcohol use. This finding suggests that higher risk patterns of alcohol use might operate as a moderator of the link between cannabis use and cannabis-related outcomes among college students.

While research on the concurrent use of cannabis and alcohol among college students is growing (e.g., Linden-Carmichael & Wardell, 2021), the extent to which multiple manifestations of alcohol use, especially those involving higher risk drinking behaviors like heavy episodic drinking and blackouts, heighten the risk for adverse cannabis-related consequences among cannabis users remains a critical gap. Understanding which types of alcohol use pose the greatest risk for cannabis users can inform screening and referral efforts aimed at preventing cannabis-related harms among those most susceptible. Thus, the purpose of this study is to examine whether past 30-day heavy episodic drinking and past 30-day blackout episodes moderate the relationship between cannabis consumption and cannabis use consequences among college students. It is expected that both greater heavy episodic drinking and greater blackout episodes will exacerbate the relationship between cannabis consumption and cannabis use consequences.

METHODS

Participants and Procedures

The researchers recruited undergraduate college students (n=4331; 20.3% response rate) from a Midwest university in 2021. Participants were predominantly female (65.7%) and White (82.2%) with an average age of 20.3 (SD=4.35). This study used a subset of data from all past 6-month cannabis users (n=772; 17.8% of the full sample). Among cannabis users, 64.5% (n=492) identified as female, 32.9% (n=251) as male, and 2.6% (n=20) as other genders including 0.3% (n=2)

transwoman, 2.3% (n=18) as genderqueer/gender non-conforming. Overall, 87.8% were White (n=675), 3.3% (n=25) were Black, 2.6% (n=20) were Asian, and 1.2% (n=9) were other race; 5.2% (n=40) were multi-race. Average age of the subsample was 19.99 (SD=2.88). The survey included a selection of measures of alcohol use, cannabis use, other substance use, sexual assault experiences, and mental health issues. To minimize response burden, only a random sample of the participants received all of the measures in this study (i.e., planned missingness). Upon completion of the survey, students received a $3 coupon for a local coffee shop. This study was approved by the university's Internal Review Board.

Measures

Demographics. Age, gender, and race were included in the analysis as covariates. Age was measured by asking "What is your age?" Gender was measure by asking "What is your current gender identity?" with response options (0=woman/female, 1=man/male, 2=transwoman, 3=transman, 4=genderqueer/gender non-conforming, 5=a gender not listed here, 7= prefer not to answer, 8=intersex). Gender was recoded into 3 categories with 0=female, 1=male, and 2=other, 5 and 7 were coded as missingness, and then two dummy variables were created with female as the reference group. Race was measured by asking each respondent to "Describe your race/ethnicity. Please check all that apply." Response options included Black/African American, American White/Caucasian, Asian or Asian American, Hawaiian or Pacific Islander, Native American or Alaskan Native, and other. To capture race, analyses included 6 dummy-coded variables with White as the reference group. Furthermore, since some students selected more than one race, a count variable was created by adding all the categories to identify students with multiple racial identities and then dichotomized to reflect multi-race (coded 1) or not (coded 0) for use as an additional covariate.

Cannabis Use. Cannabis use was measured by one question "Have you used any cannabis (i.e., marijuana) over the past SIX months?" with responses options (1=yes, and 0=no). The final sample only included individuals who indicated "yes." The online Qualtrics survey was designed

with a skip function such that only those who responded yes to this question were directed to the additional cannabis questions; those who selected no skipped to a different set of questions.

Cannabis Consumption. Cannabis consumption was the sum of 2 items drawn from the Cannabis Use Disorder Test-Revised (CUDIT-R; Adamson et al., 2010). As indicated in the CUDIT-R documentation, cannabis consumption is covered by 2 of the measure's 8 items, including cannabis use frequency and cannabis use quantity over the past six months. Cannabis use frequency was measured by asking "How often do you use cannabis?" with response options (0=never, 1=monthly or less, 2=2-4 times a month, 3=2-3 times a week, 4=4 or more times a week). Cannabis use quantity was measured by "How many hours were you 'stoned' on a typical day when you had been using cannabis?" with response options (0=less than 1, 1=1 or 2, 2=3 or 4, 3=5 or 6, and 4=7 or more). Because the response options were different between two items, the items were standardized as Z scores before creating a composite variable of cannabis consumption. Internal consistency (Cronbach's alpha) is .46 based on the subsample (n=772). Note that this measure is similar to the two-item cannabis use quantity-frequency measure used in the Barnwell et al. study (2005).

Cannabis Use Consequences. The outcome variable was the sum of 3 items drawn from the Cannabis Use Disorder Test-Short Form (CUDIT-SF; Bonn-Miller et al., 2016). Items included "How often in the past 6 months did you find that you were not able to stop using cannabis once you had started?/have you devoted a great deal of your time to getting, using, or recovering from cannabis?/have you had a problem with your memory or concentration after using cannabis?" with response options (1=never, 2=less than monthly, 3=monthly, 4=weekly, 5=daily or almost daily). The responses were recoded as 0 for never and 1-4 for the rest of the response options. Internal consistency (Cronbach's alpha) is .82 based on the subsample (n=772).

Alcohol Use

Heavy Episodic Drinking (HED). HED frequency was included in the analysis as one moderator that was measured by asking "Think back over the last month. How many times have

you consumed 5 or more drinks in one day?" with responses (1=never, 2=once, 3=2 to 3 times, 4=4-6 times, 5=7 or more times). The responses were recoded as 0 for never, and 1-4 for responses options 2-5.

Alcohol-Induced Blackout. The second moderator was measured by one question "In the past 30 days, have you had a blackout as a result of your alcohol consumption?" with responses (1=don't drink, 2= didn't drink in the past 30 days, 3=no blackouts, 4=yes, during one drinking episode, 5=yes, during a few drinking episodes, 6=yes, during most of my drinking episodes, 7=yes, during all of my drinking episodes) (Ward & Guo, 2020). The responses were recoded as 0 for response options 1, 2, and 3 and 1-4 for responses options 4-7. The survey also provided the definition of an alcohol-related blackout which "is defined as a period of time during a drinking event in which you cannot recall all or parts of the event."

Analysis Plan

Product-term linear regression modeling was conducted in two steps to examine the association between cannabis consumption and cannabis use consequences and moderation by HED and blackout. Models were conducted using the maximum likelihood-robust (MLR) estimator in Mplus version 8.5 (Muthén & Muthén, 1998–2017). In the first step, the measure of cannabis use consequences was regressed on demographic variables (age, gender, race), cannabis consumption, HED frequency, alcohol-induced blackout episodes, and two two-way interactions: one between cannabis consumption and heavy episodic drinking frequency and one between cannabis consumption and blackout episodes. The predictor (cannabis consumption) and the two moderators (HED and alcohol-induced blackout) were mean centered prior to analysis. If there was no evidence of statistically significant moderation, then the subsequent step was to drop the interaction term and re-run the model with only the main effect. If there was evidence of statistically significant moderation, then the subsequent step was to probe the interaction at one standard deviation below the mean, at the mean, and one standard deviation above the mean per standard procedures (Aiken & West, 1991).

RESULTS

Among the cannabis users, 72.7% had at least one day of heavy episodic drinking in the past month, and 28% experienced at least one blackout episode in the past month. Table 1 provides correlations, means, and standard deviations for all variables. Heavy episodic drinking frequency, alcohol-induced blackout episodes, and cannabis consumption had expected positive associations with cannabis use consequences. Male gender was positively associated with cannabis use consequences but race and age had no relationship with cannabis use consequences.

Table 1. *Correlation Matrix and Descriptive Statistics for Cannabis Users (n=772)*

	1	2	3	4	5	6	7	8	9	10	11
1.Age	1.00										
2.Gender_M	-.01	1.00									
3.Gender_O	.05	-.12	1.00								
4.Race_B	.09	.01	-.03	1.00							
5.Race_A	.01	-.05	-.03	-.03	1.00						
6.Race_O	.00	.001	-.02	-.02	-.02	1.00					
7.Race_M	-.03	-.01	.07	-.04	-.04	-.03	1.00				
8.HED	-.09	.23	-.18	-.11	-.05	-.06	-.04	1.00			
9.Blackout	-.08	.05	-.09	-.09	-.02	-.05	-.02	.46	1.00		
10.CC	.06	.16	-.03	.05	-.01	.06	.02	.12	.08	1.00	
11.CUC	.01	.12	-.002	.01	-.03	.06	-.04	.11	.15	.53	1.00
M	19.99	.33	.03	.03	.03	.01	.05	1.74	.42	.03	1.14
SD	2.88	.47	.16	.18	.16	.11	.22	1.42	.75	1.60	2.33

Note. Bold=p<.05; Gender_M=gender dummy variable for male; Gender_Other=gender dummy variable for other; Race_B=race dummy variable for Black; Race_A=race dummy variable for Asian; Race_O=race dummy variable for other; Race_M=race dummy variable for multi-race; HED=heavy episodic drinking; CC=cannabis consumption; CUC=cannabis use consequences.

The linear regression model (see Table 2) showed a statistically significant positive association between cannabis consumption and cannabis use consequences (B=0.72, p<.001) adjusting for the other variables in the model. Multi-race status was negatively associated with cannabis use consequences (B=-0.51, p=.01). The cannabis consumption X blackout interaction effect was statistically significant (B=0.18, p=.01). However, the cannabis consumption X HED interaction effect was not statistically significant (B=0.01, p=.89). Since no statistically significant moderation was observed between cannabis consumption and HED, the interaction term was removed. The final model was then re-run with only the interaction term of cannabis consumption and blackout, along with the main effects. In the final model (See Table 3), the cannabis consumption X blackout interaction effect remained statistically significant (B=0.19, p=.003). Multi-race status remained significant in the final model.

Table 2. *Regression Model of Cannabis Consumption, Heavy Episodic Drinking, Blackout, and Cannabis Use Consequences with Two Two-Way Interactions*

Model	Predictors	B	SE	p
	Age	0.01	0.02	.76
	Gender_Male	0.17	0.17	.32
	Gender_Other	0.41	0.45	.36
	Race_Black	-0.10	0.38	.79
	Race_Asian	-0.30	0.33	.36
	Race_Other	0.76	1.14	.51
	Race_Multi-Race	**-0.51**	0.21	.01
	HED	-0.02	0.06	.78
	Blackout	**0.27**	0.11	.01
	CC	**0.72**	0.06	.00
	HED × CC	0.01	0.05	.89
	Blackout × CC	**0.18**	0.07	.01

Note. Bold=p<.05; Gender_M=gender dummy variable for male; Gender_Other=gender dummy variable for other; Race_B=race dummy variable for Black; Race_A=race dummy variable for Asian; Race_O=race dummy variable for other; Race_M=race dummy variable for multi-race; HED=heavy episodic drinking; CC=cannabis consumption.

Table 3. *Final Regression Model of Cannabis Consumption, Heavy Episodic Drinking, Blackout, and Cannabis Use Consequences with One Two-Way Interaction*

Model	Predictors	B	SE	p
	Age	0.01	0.02	.76
	Gender_Male	0.16	0.17	.33
	Gender_Other	0.41	0.45	.36
	Race_Black	-0.10	0.38	.79
	Race_Asian	-0.30	0.33	.36
	Race_Other	0.77	1.13	.50
	Race_Multi-Race	**-0.51**	0.21	.01
	HED	-0.02	0.06	.80
	Blackout	**0.27**	0.11	.02
	CC	**0.73**	0.06	.00
	Blackout × CC	**0.19**	0.06	.003

Note. Bold=p<.05; Gender_M=gender dummy variable for male; Gender_Other=gender dummy variable for other; Race_B=race dummy variable for Black; Race_A=race dummy variable for Asian; Race_O=race dummy variable for other; Race_M=race dummy variable for multi-race; HED=heavy episodic drinking; CC=cannabis consumption.

Probing the interaction (see Figure 1) showed that blackout was statistically significant at one standard deviation below the mean (B=0.54, p<.001), one standard deviation at the mean (B=0.73, p<.001), and one standard deviation above the mean (B=0.91, p<.001), with an increasing magnitude of association at higher levels of cannabis consumption. This indicates that a higher number of blackout episodes exacerbated the relationship between cannabis consumption and cannabis consequences, controlling for heavy episodic drinking frequency and the other covariates.

Figure 1. *Plot of the Interaction of Blackout with Cannabis Consumption in Relation to Cannabis Use Consequences*
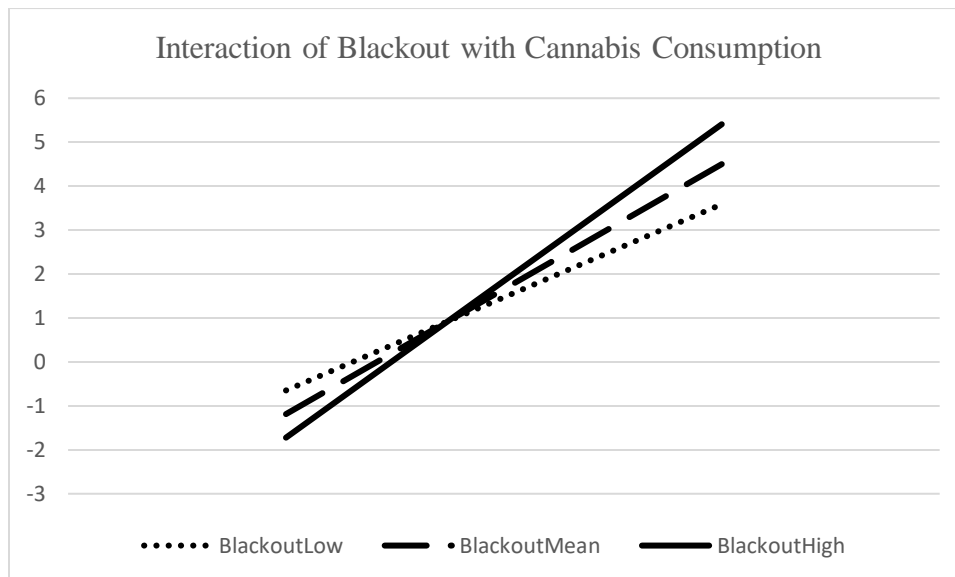
Note. x-axis=cannabis consumption, and y-axis=cannabis use consequences; BlackoutLow= simple slope of cannabis consumption when blackout episodes was 1 SD bellow the mean; BlackoutMean= simple slope of cannabis consumption when blackout episodes was at the mean; BlackoutHigh= simple slope of cannabis consumption when blackout episodes was 1 SD above the mean.

DISCUSSION

Cannabis remains a popular substance among college students, particularly in light of the changing cannabis legalization landscape in the U.S. Thus, studies examining cannabis use behaviors and consequences among college students are warranted. The present findings align with previous research, suggesting that cannabis consumption is a robust predictor of negative cannabis-related outcomes, demonstrating a medium-sized association (Gunn et al., 2020; Pearson, 2019). Furthermore, experiences of alcohol-induced blackout significantly moderated the link between cannabis consumption and cannabis-related consequences such that this association was strengthened with an increasing number of episodes of alcohol-induced blackout. Among students who engaged in frequent and/or high-quantity cannabis use, and who had recently experienced alcohol-induced blackouts, the likelihood of experiencing cannabis-related consequences was higher. This finding underscores that blackouts not only signal a risk of problematic drinking (Hingson et al., 2016; Studer et al., 2019) but also enhance the association between cannabis use and its resulting consequences. Moreover, this finding extends a prior study that found heavy drinking moderated the relationship between cannabis use and cannabis-related consequences (Barnwell et al., 2005), although that study did not simultaneously consider multiple forms of alcohol involvement, including blackouts.

HED was weakly correlated with both cannabis use consumption and cannabis use

consequences but both the main effect of HED and the interaction effect of HED with cannabis consumption were found to be non-significant. While simultaneous use of cannabis and alcohol is typical among young adults engaging in HED (Boyle et al., 2023), it did not appear to moderate the relationship between cannabis consumption and its consequences in our adjusted analyses. In contrast, alcohol-induced blackouts enhanced the relationship between cannabis consumption and cannabis use consequences. This may be potentially attributed to the nature of blackouts, representing a more severe pattern of alcohol use typically induced by HED with a rapid increase in blood alcohol concentration over a short period of time (Rose & Grant, 2010; Hermens & Lagopoulos, 2018). Acute alcohol intoxication disrupts cellular communication in the hippocampus and other related brain structures and regions (Siqueira & Smith, 2015; Zeigler et al., 2005). This leads to impairment in memory retrieval and deficits in the encoding process, interfering with the brain's ability to transfer short-term memories into long-term ones, ultimately resulting in partial or complete memory loss (Siqueira & Smith, 2015; White, 2003). Moreover, students who have a history of blackouts tend to endorse positive drinking expectancies (Lee et al. 2009). In the context of college cannabis users with a blackout history, it is conceivable that memory impairment experienced during blackouts might lead them to downplay the negative effects of cannabis use. This could result in a sustained positive perception of cannabis use, potentially elevating their risk for experiencing negative consequences associated with cannabis use.

The findings of this study are concerning given the well-documented harms associated with blackouts (Lorkiewicz et al., 2022; Wetherill & Fromme, 2016). It is crucial to consider the intricate interplay between blackout, cannabis use, and negative cannabis use consequences. Previous studies have indicated that the simultaneous use of alcohol and cannabis amplifies the likelihood of experiencing severe alcohol-related outcomes, such as blackouts (Davis et al., 2021; Jackson et al., 2020). In addition, Deniel et al. (2021) reported that the consumption pattern of cannabis use and binge drinking contributes to memory and executive impairments among college students. It is important to recognize that blackouts can also serve as a moderator in this relationship. Specifically, blackouts may exacerbate the connection between cannabis use and its associated consequences,

highlighting a concerning public health issue. This suggests that the combined effect of alcohol-induced blackout and cannabis use could engender a heightened susceptibility to cannabis-related problems. This is a critical consideration for individuals, healthcare professionals, and policymakers in developing effective harm reduction strategies and public health interventions to consider screening for blackout history among college cannabis users. College campus prevention strategies should also be adapted and tailored to address concurrent use of cannabis and alcohol use. Experiencing blackouts, in particular, may have wide-ranging effects on college students not only as a direct result of alcohol ingestion but also may increase the likelihood that cannabis use leads to significant cannabis-related impairments.

The current study is the first to examine blackouts in the relationships between cannabis use and cannabis-related consequences. However, this study has some limitations. First, this is a cross-sectional study that relied solely on self-report assessments. Drawbacks of this type of study include potential bias related to memory recall and inability to address the direction of causal relationships between predictors and outcomes. Thus, future longitudinal studies will be necessary to confirm the direction of the associations. Second, several measures, including blackout experiences, were based on a single item with unknown reliability and validity. However, a recent study provided evidence for valid measurement of two different types of blackout-induced memory loss: complete blackouts (also known as en bloc), and fragmentary blackouts, as well as for measurement of the frequency of alcohol-related blackouts (Miller et al., 2019). Since we did not intend to study two dimensions of blackout experience, we chose a single-item blackout measure. Still, additional studies with multi-item assessment of key study constructs are needed (e.g., Miller et al., 2019). Third, we did not have measures of simultaneous use of alcohol and cannabis together at the same time. Fourth, the internal consistency of cannabis consumption tends to be low for 2-item scales. But it is not uncommon in this circumstance, especially those two items capturing discrete behavior of cannabis consumption. Fifth, the heavy episodic drinking measure only accounts for 5 or more drinks, which is the standard for males, but it does not include 4 or more drinks for females. Finally, data were collected from students on one college campus, the participation rate was low, and

respondents were predominantly Caucasian and female. Generalization of the results should proceed with caution.

Conclusion

The current study found that higher frequency and quantity of cannabis use increased the likelihood of cannabis-related consequences among college students. Further, among those who also experienced alcohol-induced blackouts, the risk of cannabis use adverse consequences increased. Findings may inform interventions targeting cannabis users who also drink alcohol to the point of blackout. This study suggests that blackout history should be incorporated into cannabis use prevention initiatives for college undergraduate students.

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