

Prospective Relationships Between Objectively Assessed Social Media Use, Drinking Norms, and Alcohol Consumption Among First-Year Students

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ABSTRACT. Objective: Previous research has linked social media involvement and alcohol use among college students. However, this literature has been limited by self-report measures of social media use, cross-sectional data, inadequate attention to potential moderators and mediators, and unclear implications for interventions. To improve and extend this work, students' ($N = 297$) daily time on Facebook, Twitter, Instagram, and Snapchat during the transition into college were assessed objectively and examined as predictors of later drinking. **Method:** Time spent on social media overall and on each individual platform between August and September were examined as predictors of alcohol consumption in March. Perceptions of peer drinking norms in October were examined as a potential mediator of these relationships, and sex as a potential moderator. **Results:** Students spent the most daily time on Snapchat, followed by Instagram. The results indicated that among

men, but not women, daily social media time during the transition into college predicted second semester drinking. This relationship was mediated by perceptions of same-sex student drinking norms. Analysis of individual platforms revealed that daily time on Snapchat drove the relationships among men. **Conclusions:** Greater time on social media during the transition to college, and on Snapchat in particular, predicted increases in perceptions of peer drinking norms and, in turn, greater alcohol consumption among men only. These findings carry precise implications for interventions seeking to reduce alcohol-related risks among first-year men and underscore the need for additional research examining developmental factors and social media user experiences that may explain the sex-specific patterns of relationships observed. (*J. Stud. Alcohol Drugs*, 82, 339–350, 2021)

HEAVY DRINKING AND alcohol-related consequences on college campuses remain a significant public health issue (Croteau & Morrell, 2019; Hingson et al., 2017; White & Hingson, 2013). In recent years, the widespread and frequent use of social media by college students has gained attention as one factor that may both contribute to heavy drinking and undermine existing campus prevention and intervention efforts (Griffiths & Casswell, 2010; Hebden et al., 2015; Ridout et al., 2012). Cross-sectional studies that used self-report measures have revealed a positive correlation between social media involvement and alcohol use (e.g., Ilakkuvan et al., 2019; Ohannessian et al., 2017), although the directionality of this relationship remains unclear. Other published research has highlighted the first year of college, and in particular students' first 6 weeks on campus, as a period in which alcohol-related risks peak (Fromme et al., 2008) and consumption levels determine drinking trajectories through and beyond the college years (National Institute on Alcohol Abuse and Alcoholism, 2002; Riordan & Carey, 2019). The current study uses improved methods to evaluate the directionality of the social media–alcohol use relationship over this key developmental period. We

objectively assess matriculating college students' time on four popular social media platforms across their electronic devices (smartphones, laptops, tablets) to rigorously examine if, how, and among whom social media use during the transition to college longitudinally predicts alcohol consumption over the first year.

Social media involvement and alcohol use

Recent reports indicate that 98% of 18- to 24-year-olds use social media regularly (Villanti et al., 2017), and most college students report logging into multiple social media platforms daily (Knight-McCord et al., 2016; Smith & Anderson, 2018). As social media has become an increasingly integral aspect of both the high school and college experience, researchers have rushed to investigate the potential impacts of social media on the brain during adolescence and emerging adulthood and examine whether heavy, “addiction-like” patterns of use may be related to other addictive behaviors (for a recent review, see Vannucci et al., 2020). One of the most reliable findings to emerge from this literature is the positive correlation between social media involvement and alcohol consumption. Findings suggest that using a greater number of social media platforms (e.g., Ceballos et al., 2018; Vannucci et al., 2019), more frequently checking one's social media accounts (e.g., Brunborg et al., 2017; Ohannessian et al., 2017), and spending more time on social media (e.g., across multiple platforms, Ilakkuvan et al., 2019; Instagram in particular, Bergman et al., 2018) are

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associated with greater alcohol consumption in samples of high school and college students.

Despite enthusiasm for this emerging body of research, there is much room for increased methodological rigor regarding study design and assessment. For instance, these studies have relied on retrospective, self-report measures of social media involvement. However, the degree to which students are able and motivated to accurately report their social media experiences is unknown. Further, the reliance on cross-sectional data has prevented a deeper understanding of temporal relationships, explanatory mechanisms, and moderating variables needed to inform alcohol prevention and intervention efforts.

A potential mediator: Perceptions of peer drinking norms

Perceptions of peer drinking norms are among the strongest and most reliable predictors of college students' future drinking (Jun et al., 2016; Neighbors et al., 2007). As matriculating college students enter campus uncertain about their new social environments, it has been proposed that they may be especially inclined to turn to social media during their initial weeks on campus to glean normative information about peer attitudes and appropriate behavior (Adams et al., 2017; Boyle et al., 2018). Both "super-peer" theory (Elmore et al., 2017; Moreno, 2010) and the Facebook influence model (Moreno et al., 2013) suggest that the peer observations that occur on social media are likely to exert a strong and lasting influence on young adults' perceptions of normative behavior.

For new college students, this influence is particularly concerning as studies have documented a high prevalence of alcohol-related social media posts among college students (Egan & Moreno, 2011; Moreno et al., 2015), as well as the tendency for these posts to be both positively framed and further reinforced by peers through likes and positive comments (Beullens & Schepers, 2013). As research using self-report assessments suggests that greater time on social media is correlated with greater exposure to substance-related content (Clendennen et al., 2020) and that greater exposure to alcohol-related content predicts elevated perceptions of peer drinking norms (Boyle et al., 2016; Davis et al., 2019; Fournier et al., 2013; Litt & Stock, 2011), it seems likely that a prospective relationship between time on social media and alcohol use may be explained by perceptions of peer drinking norms.

A potential moderator: Student sex

Several recent articles have called for increased attention to potential sex differences in young adults' social media experiences and behaviors (e.g., Reed & Saunders, 2020). To date, previous studies using self-report measures have found that although women spend more time on social me-

dia than men (Kimbrough et al., 2013; Knight-McCord et al., 2016), men are more likely than women to post photos depicting drinking and other risky behaviors on their social media accounts (Peluchette & Karl, 2008; Tifferet & Vilnai-Yavetz, 2014). Thus, to the extent that men follow other men on social media, they may be more likely than women to have exposure to self-relevant peers engaging in alcohol use and other risky behaviors. Other findings suggest that men and women have different motivations for their social media use. Among women, use tends to be motivated by desires to maintain and grow relationships that already exist offline, whereas men are more likely to use social media for information seeking and forming new relationships (Barker, 2009; Hargittai & Hsieh, 2010; Muscanell & Guadagno, 2012). Most germane to the current study, sex was also found to moderate relationships between self-reported exposure to alcohol-related social media posts, descriptive drinking norms, and alcohol use in a study of college students (Boyle et al., 2016). Specifically, that study revealed that more frequent viewing of alcohol-related content on social media predicted higher descriptive drinking norms and heavier alcohol use among men, but not women.

Taken together, these findings suggest that men's perceptions of drinking norms and alcohol consumption may be more likely than women's to be affected by their time on social media because of their greater social information seeking motivations, use of social media to form new friendships with same-sex peers, and those peers' (i.e., men) tendencies to post alcohol-related content. However, because all of this research has used self-report measures of social media variables (e.g., use duration, posting behavior, motivations, alcohol exposure), it is also possible that the differences observed are attributable to sex-specific reporting biases in the social media domain. The current study aims to bring clarity to this issue by exploring participant sex as a potential moderator of relationships between objectively assessed daily duration of social media use, descriptive drinking norms, and alcohol use.

Current study

A novel objective assessment protocol was used to assess students' time using four popular social media platforms (see Table 1 for descriptions) across their electronic devices during the transition to college. First, we examined whether total time spent on social media during the transition to college (Time 2 [T2], August–September) predicted alcohol use near the end of the students' first year (T4, March), after controlling for pre-transition drinking (T1, July). Then, we examined whether sex-specific predictive relationships were similarly explained by perceptions of peer drinking norms assessed during students' first semester on campus (T3, October). We hypothesized that time spent on social media at T2 would predict perceived typical student drinking norms

TABLE 1. Characteristics of social media platforms assessed in the current study

Platform	Popularity ^a	Privacy	Key features and characteristics
Facebook	Low	Low: User profiles are searchable by first and last name, although profile content can be set to private.	Post types include text-based status updates, photos, videos, and web/news links. Users can like, comment, or share friends' posts. In recent years, this platform has become increasing popular among adults (including parents, family, employers) and less popular among college students.
Twitter	Low	High: Profile can be tied to any username/handle rather than real name; accounts can easily be set to private.	Tweets are character text-based status updates; web links, memes, short videos, and gifs often accompany text. Observers can favorite, retweet, or comment on peers' tweets.
Instagram	High	High: Profile can be tied to any username/handle rather than real name; accounts can easily be set to private.	Image and video-based posts; rich set of photo editing and beautification filters; permanent images and videos posted by users appear in followers' newsfeeds as determined by algorithm; more recently, ephemeral stories that disappear after 24 hours viewable by all followers or select followers ("close friends").
Snapchat	High	High: Profile tied to any username/handle rather than real name; accounts can easily be set to private.	Direct user-to-user ephemeral image/video-based snaps disappear after a single view; ephemeral multi-snap stories viewable by followers and other users for 24 hours before disappearing; fun augmented reality filters can be added to snaps; university-geolocation filters allow college students to view a campus story comprising snaps taken by fellow students.

^aPopularity designations based on Perrin and Anderson (2019).

at T3 and drinking at T4, and these relationships would be stronger among men than women. We further hypothesized that the T2 social media use and T4 drinking relationship would be mediated by perceptions of drinking norms at T3, with the mediated effect stronger among men than women. Last, parallel predictions specific to time on each social media platform were examined through exploratory analyses.

Method

Participants

Participants were 297 first-year students at a private, mid-sized university on the West Coast. The students were recruited during the summer before matriculation to take part in a study investigating social media experiences during the transition to college. To be eligible participants had to be at least 18 years of age, in possession of an Apple or Android smartphone, have one or more active social media accounts, and be planning to live on campus during their first year. The sample had a mean age of 18.06 years (*SD* = 0.26); 63%

were female; and 48% were White, 15% Asian, 10% African American, 17% Hispanic, and 9% multiracial or other. Participants' demographics closely mirrored those of the host institution's entire student body (57% female, 44% White, 22% Hispanic, 11% Asian, 6% African American, and 17% multiracial or other).

Procedure

This study was approved by the Institutional Review Board at the host institution. One month before the beginning of the school year (July 2017, T1), incoming first-year students were recruited via email to take part in a study investigating social media experiences during the transition to college. Interested students completed a screening questionnaire (*N* = 658). Those who met eligibility criteria were invited to complete informed consent, take a baseline survey, and download an app to measure social media usage on their electronic devices (*n* = 457, 69.5%). Recruitment ended after 6 days when the 320 available spots in the study were filled. Participants completed a second online assessment

following their first month on campus (October, T3) and a third assessment near the end of their first year (March, T4). Each survey assessment took approximately 20–25 minutes to complete. Nearly all (92.8%) participants completed all three assessments. No differences in baseline measures were observed between the 297 participants who completed all three assessments and the 23 participants (7.2%) who did not. Participants received a \$20 gift card following each survey assessment as well as a \$40 gift card following the social media tracking period (total compensation: \$100).

Measures

Demographics. Participants were asked to report their sex, age, race, and ethnicity.

Objective social media use. Participants installed a custom research version of RescueTime Inc.'s (2018) commercially available time-tracking software on their Android smartphones, computers, and tablets. This software allowed the research team to track participants' use of Facebook, Instagram, Snapchat, and Twitter on these devices during the transition to college (i.e., August and September). Using these data, average platform-specific and total daily durations of active social media use (i.e., minutes in which social media sites and apps were viewable on-screen while devices were being used) were computed. Because RescueTime was incompatible with iPhones, iPhone users were asked to upload screenshots of their phone's battery screen app usage for the past 2 weeks in four online surveys sent 2 weeks apart in August and September. Average daily time spent on each social media platform was calculated by summing iPhone battery screen and RescueTime data collected from the iPhone users' other devices. This procedure ensured that total and platform-specific daily social media use time across devices could be computed consistently for each participant.

Perceived weekly drinking norm. Participants completed the Drinking Norms Rating Form (Baer et al., 1991) at T1 (July) and T3 (October) to assess their perception of normative drinks consumed per week. Participants were prompted to think about a typical week during the past 30 days and estimate the number of drinks consumed on each day of the week by the typical same-sex, first-year student. Daily estimates were summed to create a measure of perceived typical student drinks per week at T1 and T3.

Alcohol use. A modified version of the Daily Drinking Questionnaire (Collins et al., 1985; Dimeff, 1999) was completed by participants to assess weekly drinks consumed over the last month at T1 (July) and T4 (March). Participants were asked to think about a typical week during the last 30 days and estimate the number of drinks they consumed each day. Responses were aggregated across drinking days to reflect the average number of drinks consumed per week over each 30-day period.

Analysis plan

T tests were conducted to examine potential sex differences in total social media time (T2), time on each individual platform (T2), perceived typical student drinking norms (T1 and T3), and alcohol consumption (T4). Sex-specific bivariate correlations were also examined between variables. Next, a hierarchical regression model examined participants' daily social media time at T2, sex, and age (all entered in Step 1), as well as the interaction between daily social media time and participant sex (Step 2) as predictors of alcohol consumption at T4. To improve the interpretability of regression coefficients, raw daily social media use time was divided by 10. Thus, a one-unit increase in daily social media time corresponded to a 10-minute (rather than 1-minute) increase. The 10-minute incremental social media time predictor was used in all subsequent regression-based tests.

Following recommended guidelines (5,000 bootstrap samples and 95% bias-corrected confidence intervals), PROCESS Version 3.4 (Hayes, 2018) Model 8 assessed the indirect effect of social media use during the transition to college on changes in drinking behavior through an interaction between sex and descriptive norms. Participants' age, perceived drinking norms at T1, and drinks per week at T1 were entered as covariates. Parallel exploratory models were then conducted to determine if time spent on specific social media platforms drove the effects observed for total social media time.

Results

Preliminary results

Means and standard deviations for study variables, including raw daily minutes on the four social media platforms, are presented in Table 2. On average, participants spent 3–4 times more minutes on Instagram and Snapchat compared with Facebook and Twitter. Overall, participants averaged 104 minutes per day on social media ($SD = 69.97$) and on average, women spent more time each day on social media than men (approximately 109 minutes vs. 95 minutes, $p < .05$).

Table 3 contains the correlation matrix by sex for all study variables. Among men, total time on social media during the transition to college was significantly associated with perceived drinking norms at T1 and T3, and with drinks per week at T4. Among women, daily social media time was significantly correlated with perceived drinking norms at T1, but not with perceived norms at T3 or drinks per week at T4. Additional sex differences emerged when examining correlates of time on individual social media platforms. Among women, the only significant correlations detected were between daily Facebook time at T2 and perceived drinking norms at T1, and between daily Snapchat time at T2

TABLE 2. Descriptive statistics overall and by participant sex

Variable	Overall (<i>N</i> = 297) <i>n</i> (%)	Men (<i>n</i> = 110) <i>n</i> (%)	Women (<i>n</i> = 187) <i>n</i> (%)
Race/ethnicity			
White	152 (47.5)	58 (47.9)	94 (47.2)
Hispanic	54 (16.9)	22 (18.2)	32 (16.1)
Asian	49 (15.3)	19 (15.7)	30 (15.1)
African American	31 (9.7)	10 (8.3)	21 (10.6)
Native Hawaiian	2 (0.6)	2 (1.7)	0 (0.0)
Multiethnic	25 (7.8)	9 (7.4)	16 (8.0)
Other	4 (1.3)	1 (0.8)	3 (1.5)
	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)
T1 Perceived drinking norms	10.80 (6.57)	10.40 (6.72)	11.05 (6.48)
T1 Drinks per week	3.14 (5.34)*	4.14 (6.38)	2.53 (4.50)
T2 Daily Facebook minutes	12.51 (18.82)	12.17 (19.36)	12.72 (18.53)
T2 Daily Instagram minutes	34.81 (30.92)*	29.91 (29.70)	37.79 (31.34)
T2 Daily Snapchat minutes	42.20 (33.89)	38.71 (35.25)	44.32 (32.94)
T2 Daily Twitter minutes	14.12 (27.96)	14.49 (23.76)	13.90 (30.28)
T2 Total daily social media minutes	103.64 (69.97)*	95.28 (74.06)	108.72 (67.04)
T3 Perceived drinking norms	11.67 (5.60)*	12.74 (6.63)	11.03 (5.50)
T4 Drinks per week	9.00 (10.07)***	11.76 (12.95)	7.36 (7.46)

Notes: Sex differences are flagged in overall column. Timing of measures: Time 1 (T1): July, summer before matriculation; T2: during the transition to college (August–September); T3: October (2nd month on campus); T4 March (end of first year). **p* < .05; ****p* < .001.

and drinks per week at T1. Among men, daily time on Instagram and Snapchat at T2 were both significantly associated with drinks per week at T4 but not at T1. Further, daily time on Snapchat at T2 was associated with perceived drinking norms assessed at T1 and T3 among men.

Prospective relationship between social media time and drinking

Hierarchical regression model results are presented in Table 4. As shown in the initial model step, when participant sex, age, and weekly drinks at T1 were controlled for, total daily social media time during the transition to college was not a significant predictor of weekly drinks at T4. However, the significant Social Media Minutes × Sex interaction in the second model step indicated that the relationship between social media time and later weekly drinks was moderated by sex. Probing the interaction revealed that greater daily social media time at T2 was significantly associated with greater drinking at T4 among men, *B* = 0.27, *SE* = 0.11, *t*(291) = 2.33, *p* = .02, but not women, *B* = -0.03, *SE* = 0.06, *t*(291) = -0.47, *p* = .63 (Figure 1).

Moderated mediation model

Controlling for age, T1 drinks per week, and T1 drinking norms, in the first stage of the model (i.e., a path; Figure 2), there was a significant interaction between daily social media time and sex on perceived drinking norms at T3, *t*(291) = -2.25, *p* = .025. Probing the interaction revealed that male

participants who spent more daily time on social media at T2 perceived the typical male student to consume significantly more drinks per week at T3 than did male participants who spent less time on social media, *t*(291) = 2.42, *p* = .015. Among women, there was no significant effect for time spent on social media at T2 on the perception of typical female weekly drinking norm at T3, *t*(291) = -0.311, *p* = .76.

Further, there was a significant effect of perceived drinking norms at T3 on weekly drinks at T4 over and above the effects of social media time, sex, and T1 covariates, *t*(290) = 2.496, *p* = .013. Table 5 presents total, direct, and indirect conditional effects. Accounting for the perceived weekly drinking norms at T3, there was no significant direct effect of social media use on drinking for either men or women. However, the indirect effect of social media use on drinking through the perceived drinking norm was statistically significant for men only.

The exploratory, parallel, platform-specific moderated mediation models revealed that the model results for total social media time were primarily driven by time on Snapchat (see bottom half of Figure 2). None of the theorized paths were significant for time on Facebook, Instagram, or Twitter. Null model results are available on request to the corresponding author.

Discussion

The current study is the first to objectively assess matriculating college students’ time spent on four popular social media platforms to rigorously investigate if, how, and among

TABLE 3. Bivariate correlations between variables by participant sex

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. T1 Perceived weekly drinking norm	–	.28***	.11	.19**	.07	.11	-.05	.53***	.17*
2. T1 Drinks per week	.30***	–	.16*	-.06	.10	.23***	.04	.12	.22**
3. T2 Total daily social media minute	.29***	.17	–	.31***	.66***	.73***	.55***	.06	.03
4. T2 Facebook daily minutes	-.02	.1	.46***	–	.08	-.01	.01	.08	.01
5. T2 Instagram daily minutes	.21*	.05	.79***	.29***	–	.36***	.02	.03	-.02
6. T2 Snapchat daily minutes	.22*	.16	.79***	.17	.50***	–	.16*	.01	.13
7. T2 Twitter daily minutes	.18	-.06	.49***	.02	.16	.15	–	.04	-.07
8. T3 Perceived weekly drinking norm	.40***	.14	.26**	.09	.09	.29**	.16	–	.21*
9. T4 Drinks per week	.40***	.48***	.19*	-.08	.19*	.21*	.05	.35***	–

Notes: Correlations are below the diagonal for male participants and above the diagonal for female participants. T = time. * $p < .05$; ** $p < .01$; *** $p < .001$.

whom social media use during the transition to college longitudinally predicts alcohol consumption. After we controlled for drinking and perceptions of peer drinking norms pre-matriculation, total daily time spent on social media during the college transition was a significant predictor of drinking at the end of the first year among male students only.

The relationship between time on social media and later drinking for men was also explained by their perceptions of peer drinking norms assessed during the first semester in college. Exploratory analyses revealed that, for men, the effects of daily time spent across all four platforms were driven by their time spent using Snapchat, the platform on which they

logged the most daily time ($M = 38.71, SD = 35.25$). In fact, regression coefficients indicated that a 30-minute increase in Snapchat use by a man during the transition to college (T2) corresponded to roughly a 1.5 drink increase in perceived typical student drinks per week at T3, in turn leading to a 1 drink increase in weekly drinks by the male participant at T4. These results highlight the utility of conceptualizing Snapchat as a norm-influencing “super peer” (Elmore et al., 2017; Moreno, 2010) perhaps more than other social media platforms currently popular among youth. In addition, the findings among men are consistent with previous research finding that the ephemeral nature of snaps and user stories

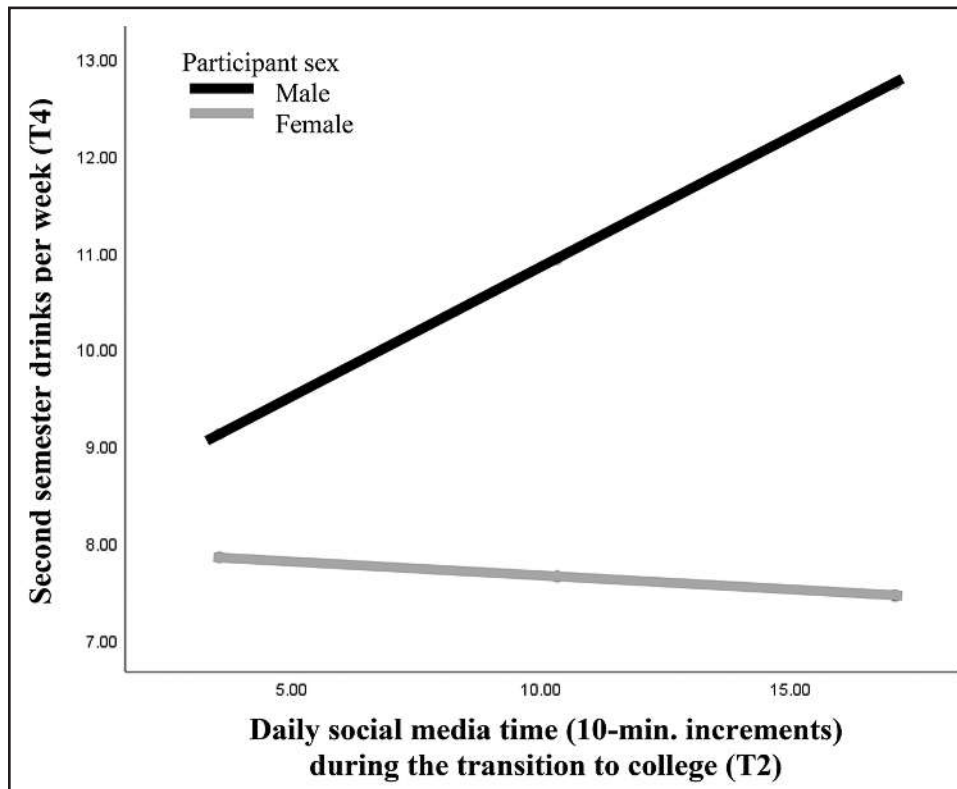


FIGURE 1. The relationship between daily social media time during the transition to college and second semester drinks per week as a function of participant sex. T = time; min. = minute.

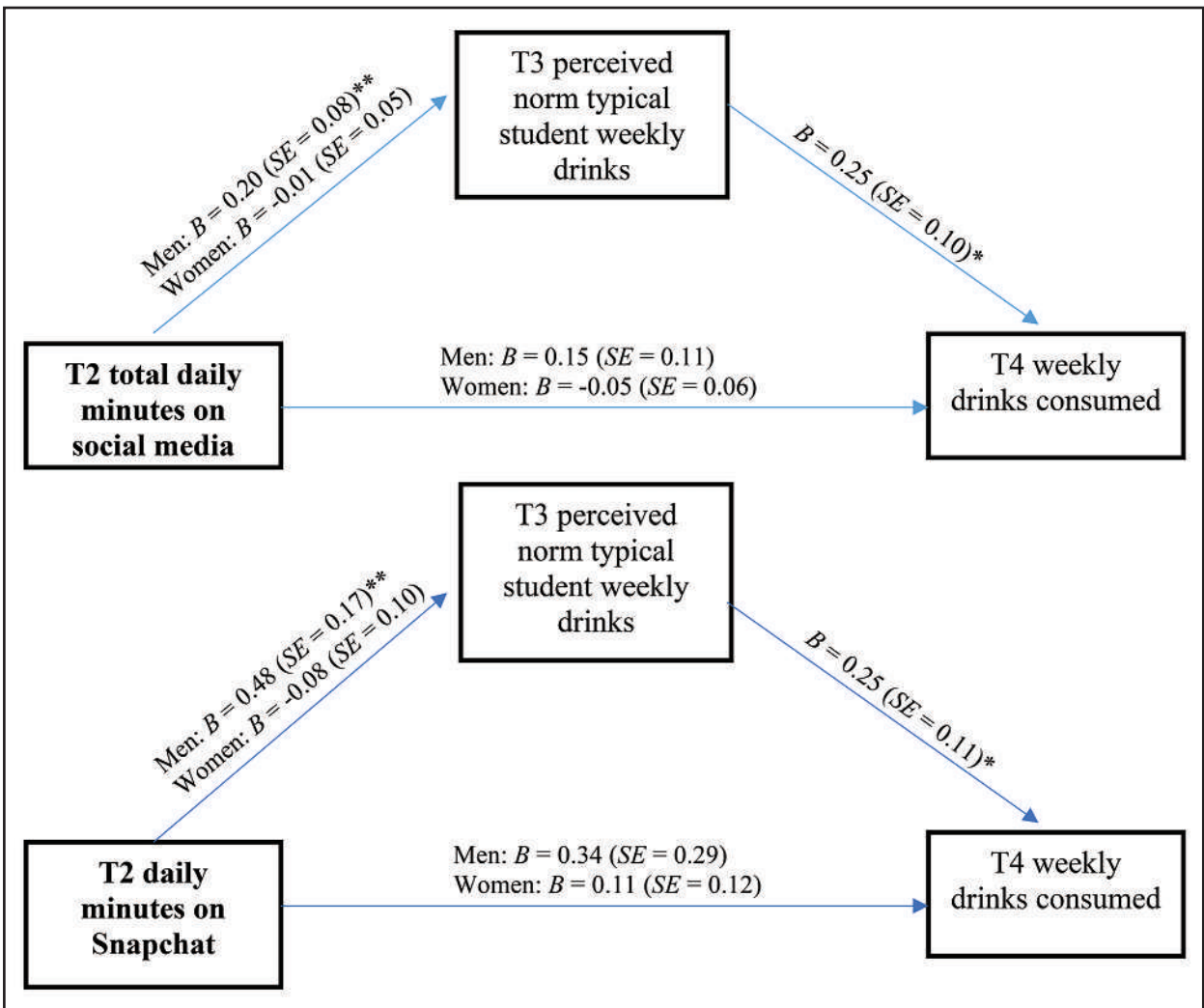


FIGURE 2. Moderated mediation models wherein time on social media (Upper: Total social media time; Lower: Snapchat time) during the transition to college predicts second semester drinking via perceived drinking norms among men but not women. T = time. * $p < .05$; ** $p < .01$.

on Snapchat, coupled with enhanced account privacy and lack of adult users, may make this platform an especially attractive destination for college students to showcase their heavy drinking and negative alcohol-related consequences (Boyle et al., 2017).

To our knowledge, no previously published studies have examined sex differences in the associations between time spent on social media, descriptive drinking norms, and alcohol use. Interestingly, the sex-specific patterns of relationships observed paralleled those found in a previous study that examined self-reported exposure to peers' alcohol-related social media content in relation to later drinking in an independent sample of first-year college students (Boyle et al., 2016). Although that study examined a different social media construct (i.e., self-reported frequency of seeing alcohol-related posts on social media) than was objectively

assessed in the current study (i.e., daily duration of use), the similar pattern of findings suggests a plausible link between these two constructs, wherein greater time on social media increases exposure to substance-related content (e.g., Clendennen et al., 2020).

However, if this explanation were sufficient to account for this study's findings, we would have expected men to have spent more time on social media than women, which they did not. It may be that men and women differ not in their frequency of alcohol exposure but, rather, in the characteristics of the alcohol-related content they encounter as a function of their social media involvement. For instance, relative to heavy social media-using women, men engaging in heavy use may see more overt and extreme depictions of drinking, encounter alcohol-related content posted by a wider network of loose ties, or observe greater peer reinforcement

TABLE 4. Hierarchical regression model testing the prospective relationship between total daily social media time at T2 and alcohol consumption at T4 (Step 1) and potential moderation by sex (Step 2)

Step	Predictor	<i>B</i>	<i>SE</i>
1	Age	-3.39***	0.90
	Sex	-3.14**	1.05
	T1 weekly drinks	0.68***	0.12
	T2 daily social media minutes (10-min. increments)	0.08	0.06
2	Age	-3.58***	0.97
	Sex	-0.22	1.63
	T1 weekly drinks	0.69***	0.12
	T2 daily social media minutes (10-min. increments)	0.27*	0.11
	T2 Social Media Min. × Sex	-0.30*	0.13

Notes: T = time; min. = minute.

* $p < .05$; ** $p < .01$; *** $p < .001$.

TABLE 5. Sex-specific conditional effects of daily social media time at Time 2 (T2) on alcohol consumption at T4

Conditional effect	Women Estimate [95% CI]	Men Estimate [95% CI]
Total	-.03 [-.15, .09]	.27* [.04, .49]
Direct	-.05 [-.17, .08]	.15 [-.07, .37]
Indirect (perceived drinking norms)	-.004 [-.04, .02]	.05* [.002, .111]

Note: CI = confidence interval.

* $p < .05$.

for alcohol-related posts from same-sex peers (i.e., likes, comments, views), leading to elevated perceptions of peers' drinking and subsequent increases in their alcohol use.

The sex-specific patterns of bivariate correlations observed also suggest that developmental factors may play a role in our findings. Specifically, among women, daily social media time during the transition to college was significantly correlated with self-reported drinking before the transition into college, but not later in the year. Meanwhile, among men, significant prospective relationships were observed with social media time predicting perceived drinking norms and alcohol consumption later in the school year, suggesting that men may be more susceptible to social media-based alcohol influences during the transition to college. This idea is consistent with previous findings suggesting that men are more susceptible to offline peer alcohol influences than women during this developmental period (Borsari & Carey, 2001). Women's susceptibility to online and offline peer influences may peak before men's because of their earlier maturation. For instance, research investigating sex differences in personality development has suggested that women enter a stage of conformity earlier in adolescence than do men (e.g., Cohn, 1991), making it reasonable to assume that social media may be more likely to influence a girl's alcohol use during the mid-to-late high school years. Taken together, there may be different developmental windows in which social media influences peak among men and women, and the timing of the current study's assessments only captured this window among men.

Given the unclear explanations for the sex differences observed, additional longitudinal research is needed to more thoroughly examine perceived drinking norms and alcohol use in relation to sex-specific trajectories of social media use and potential user experiences (e.g., when different platforms are adopted, time spent on different platforms, composition of peers followed, characteristics of alcohol-related content encountered, peer reinforcement garnered by posts) between early adolescence and emerging adulthood. In addition, because the first year of college is known to confer significant alcohol-related risks for both sexes, and previous research has highlighted women's relationship-oriented approach to social media and greater tendency for seeking support online (Barker, 2009; Hargittai & Hsieh, 2010; Muscanell & Guadagno, 2012), future research should also investigate whether women's more relational social media profile serves as a protective buffer against the negative alcohol-related impacts observed among men.

Implications

This research demonstrates how emerging software applications like RescueTime and smartphone battery screens can be used together to make objective assessments of time on social media, both across multiple platforms and electronic devices, possible. Although self-report methods have been widely used in previous studies, they are usually cited as a major limitation (Phua et al., 2017; Roberson et al., 2018; Villanti et al., 2017), as recall errors and bias can

affect self-report estimates (Junco, 2013; Prior, 2009; Staddon et al., 2013). Importantly, this study's improved design also answered crucial questions of where (i.e., Snapchat), who (i.e., incoming male college students), and why (i.e., normative alcohol influence), all of which are required to inform alcohol intervention development. For instance, whereas health behavior intervention efforts for young adults have long focused on Facebook (i.e., Ridout & Campbell, 2014), our results point to Snapchat and Instagram as better virtual arenas for alcohol interventionists seeking to find present-day college students where they spend the most time. Consistent with Hassanpour et al.'s (2019) call for research using social media data to identify at-risk drinkers, findings from this study suggest that targeting heavy Snapchat-using men with alcohol risk-related messaging campaigns and other Snapchat-based interventions at the start of college may prove fruitful.

Our findings among men also cast renewed light on perceptions of peer drinking norms as crucial psychological mediators to be targeted in interventions. Currently, personalized normative feedback (PNF) interventions represent a popular means of reducing alcohol-related risks among first-year college students, despite modest effect sizes commonly attributed to inattention (Lewis & Neighbors, 2015), norm credibility concerns (Hummer & Davison, 2016; LaBrie et al., 2010), and defensiveness among drinkers (Granfield, 2005; Steers et al., 2016).

Findings from this study, together with emerging PNF work, suggest two ways in which social media might be leveraged to enhance the effectiveness of this approach. First, recent pilot studies (e.g., LaBrie et al., 2019) have found that incorporating social media-inspired co-presence features (profiles, avatars) to make the group of peers contributing to actual norms "visible" (to the same extent that they are on social media) bolsters PNF's efficacy. Importantly, relative to traditional PNF, this social media-inspired PNF intervention format has been especially effective in reducing alcohol consumption among heavy social media-using drinkers reporting high levels of exposure to alcohol-related content (e.g., Boyle et al., 2018). Thus, these findings suggest that incorporating social media-inspired co-presence features in PNF may help interrupt the links between greater time on social media, higher perceptions of drinking norms, and increased drinking observed among men in this study.

Second, emerging PNF intervention formats have also explored correcting norms for multiple topics of interest to college students to increase appeal and decrease defensiveness (Boyle et al., 2017, 2018; Earle et al., 2018). Of note, one topic consistently found to be both of high interest and overestimated among first-year students participating in pilot studies has been the social media involvement of peers (e.g., Earle et al., 2018). Given the great variability in daily social media time observed in the current study, students' apparent interest in peers' social media involvement, and their ten-

dency to overestimate this, future research should examine whether correcting peer norms for social media involvement (e.g., daily duration of use, frequency of checking accounts, posting behaviors) in addition to alcohol use leads to concomitant reductions in social media involvement and alcohol consumption among heavy social media users.

Limitations and directions for future research

The current study's findings and implications should be considered alongside several limitations. First, the findings are specific to four popular social media platforms used among incoming first-year students from a single West Coast university, limiting generalizability. As the social media landscape is constantly evolving, it will be important for future research to examine the use of additional emerging but understudied social media platforms (e.g., TikTok, Clubhouse). Likewise, future research should also use larger, more diverse cohorts of college students to further examine relationships between social media use, perceived drinking norms, and alcohol use. Generalizability is further limited by this study's focus on social media use during a very specific developmental window (i.e., the transition into college). Thus, the lack of significant predictive relationships observed among women during this window may not speak to other developmental periods. To better understand the sex differences observed in this study, additional longitudinal research spanning early adolescence to young adulthood is needed to examine sex-specific developmental factors and patterns of use in relation to perceptions of drinking norms and alcohol use.

Another major limitation is that this study did not examine all constructs that may be relevant to understanding the relationship between social media and alcohol use. That is, the current study used an objective measure of daily time on social media to clarify relationships between social media involvement and alcohol use suggested by previous self-report studies but did not examine specific user experiences or characteristics of alcohol-related content that may explain the links observed. For instance, social media users' level of exposure to alcohol-related content, characteristics of alcohol posts encountered, and/or the amount of peer reinforcement garnered by alcohol-related posts may explain the links observed among men in this study as well as the lack of significant links observed among women. Thus, the examination of these constructs together in future research is warranted. As both social media user experiences and the characteristics of content encountered may be prone to self-report bias when assessed via survey but are difficult to assess objectively with software currently available (i.e., snaps that disappear after a single view are not easy to capture or code), it will be important for future research to develop novel software and research protocols able to objectively measure students' alcohol exposure and characteristics of alcohol posts viewed.

A final limitation relates to RescueTime software not being supported on iPhones. Whereas the RescueTime application automatically tracked smartphone-based daily social media time among owners of Android phones, owners of iPhones were required to upload screenshots so that daily use data equivalent to that logged by RescueTime could be computed. As RescueTime and iPhone battery screens defined on-screen use of apps and websites consistently and iPhone users uploaded screenshots of their usage data into an online survey rather than self-reporting data from this screen, this approach remained objective and valid. In fact, no differences were detected between iPhone and Android users with regard to daily social media time derived by the two approaches. However, the battery screen uploading procedure resulted in extra burden among iPhone users relative to other participants and required extra data cleaning by the research team. Thus, future research should seek to identify less burdensome methods for objectively tracking social media use that are identical for all participants across smartphone operating systems.

Conclusion

This research suggests a new methodological standard for social media research that alleviates concerns about self-report data and more precisely informs the development of alcohol interventions to combat social media-based alcohol use influences among college students. Moderated mediation results indicated that greater time on social media assessed objectively during the transition to college predicted heavier drinking later in the school year among men, but not women. Further, among men, this predictive relationship was mediated by perceptions of peer drinking norms. Analysis of individual platform use also revealed that Snapchat was the most heavily used platform among both men and women as well as the platform on which daily time was most predictive of perceived drinking norms and future drinking among men. These results underscore the need for additional longitudinal research to investigate sex-specific developmental factors, user experiences, and characteristics of alcohol-related content that may explain the sex differences observed. Although more research is needed, findings suggest that Snapchat-based messaging campaigns and social media-inspired PNF interventions may represent fruitful means of reducing alcohol-related risks among first-year men.

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