



Internet use and adolescent binge drinking: Findings from the Monitoring the Future study[☆]



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ABSTRACT

Objective: To investigate the relation between Internet use and binge drinking during early and middle adolescence.

Methods: This is a cross-sectional study of a sub-sample of 8th and 10th graders from the Monitoring the Future (MtF) study, which annually surveys a nationally representative sample of U.S. youth on their attitudes, behaviors, and values. This study includes data from 21,170 8th and 24,362 10th graders who participated between 2007 and 2012 and were asked questions about Internet use and binge drinking.

Results: In fully adjusted models, we found a dose response relation between hours of recreational Internet use (i.e. outside work or school) and binge drinking which was stronger for 8th than 10th graders. Compared to <1 h of Internet use per week, odds ratios estimates for 1–5 h/week, 6–19 h/week, and 20 or more h/week were 1.24 (99% CI: 0.85, 1.82), 1.83 (1.28, 2.61), and 2.78 (1.99, 3.87) for 8th graders, respectively. For 10th graders, this same association was attenuated [estimated OR = 1.06 (99% CI: 0.96, 1.16); 1.20 (1.03, 1.40); and 1.30 (1.07, 1.58), respectively].

Conclusions: Drawing on a nationally representative sample of U.S. youth, we find a significant, dose–response relation between Internet use and binge drinking. This relation was stronger in 8th graders versus 10th graders. Given that alcohol is the most abused substance among adolescents and binge drinking confers many health risks, longitudinal studies designed to examine the mediators of this relation are necessary to inform binge drinking prevention strategies, which may have greater impact if targeted at younger adolescents.

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1. Introduction

Internet access has become a ubiquitous and critical aspect of life as an adolescent. Today, 95% of adolescents are online and 93% have their own computer, suggesting that adolescents in the United States have more access to the Internet than ever before (Madden, Lenhart, Duggan, Cortesi, & Gasser, 2013; Rideout, Foehr, & Roberts, 2010). Internet use among teens is diverse and extensive. On average, adolescents engage in 10 h and 45 min of media use (i.e. surfing the Internet, social networking, playing video games, watching TV, listening to music) each day, with the majority of their recreational internet use being spent on social networking sites (SNS) (Lenhart, 2012; Rideout et al., 2010). However, despite this dramatic change in how adolescents maintain social relationships and connect over

the Internet, there are relatively few studies examining how Internet use may impact risk behaviors such as the development of substance abuse.

Binge drinking among teenagers, defined as the consumption of at least five drinks on one occasion, accounts for more than 90% of alcohol consumed by 12 to 17 year-olds (Pacific Institute for Research and Evaluation, 2005). Approximately 16.5% of males and 14% of females ages 12–20 are binge drinkers, and many adolescents start to binge drink at very young ages (Substance Abuse and Mental Health Services Administration, 2014). Underage alcohol use in general contributes to the top three causes of mortality in this age group – injury, homicide, and suicide (U.S. Department of Health and Human Services, 2007) – and is associated with other high risk behaviors including suicide attempts, illicit drug use, sexual activity, increased number of sex partners, riding with a driver who has been drinking, and dating violence victimization (Miller, Naimi, Brewer, & Jones, 2007; Patrick, Ph, & Schulenberg, 2012). In addition, very early drinking, prior to age fourteen, confers additional health risks including a potential four-fold increase in the likelihood of developing alcohol dependence (Hingson, Heeren, & Winter, 2006).

Much has been made in the news about the facilitation of large binge drinking events through social networking sites. The Australian

Abbreviations: MtF, Monitoring the Future; SNS, social networking sites.

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“Neknominate” online drinking craze that spread virally worldwide in early 2014 involved adolescents and young adults imbibing large quantities of alcohol on film and nominating their friends to do the same, leading to at least five deaths (Wilkinson & Soares, 2014 February 18). It is well-known that perceived social norms of alcohol consumption in adolescence are related to alcohol use, and this extreme “Neknominate” example may illustrate how the medium of the Internet or social media may amplify or distort this effect (Keyes et al., 2012; King, Delfabbro, Zwaans, & Kaptsis, 2013). For example, Ridout et al. observed that self-curation of an “alcohol identity” on Facebook was socially desirable and may result in further promotion of binge drinking (Ridout, Campbell, & Ellis, 2012).

Despite the prevalence of binge drinking and the ubiquity of adolescent Internet usage, only a few scientific studies have examined the relation between Internet use and binge drinking in early and middle adolescence (Lenhart, 2012; Rideout et al., 2010). Some studies have found an added risk of problematic alcohol use among Internet addicted adolescents and young adults, but very few have addressed risks associated with internet use outside of this subgroup (Ko et al., 2008; Yen, Ko, Yen, Chen, & Chen, 2009). There are no studies to our knowledge that draw on a representative sample of adolescents to test this association or that specifically focus on adolescent binge drinking. Although we are unable to deduce a causal relationship between Internet use and binge drinking due to the data's cross-sectional nature, we contribute to the current literature by drawing on a large nationally representative sample to test the hypothesis that there is a positive association between recreational Internet use and binge drinking among 8th and 10th graders.

2. Methods

2.1. Sample

The Monitoring the Future (MtF) study began in 1975 and includes a yearly cross-sectional survey of a nationally representative sample of high school students across the United States (Johnston, Bachman, O'Malley & Schulenberg, 2007). It is funded by the National Institute on Drug Abuse and conducted by the Survey Research Center, Institute for Social Research at the University of Michigan.

Approximately 130 US high schools (both public and private) participate each year and are selected using a multistage sampling design. Youth were selected via a three-stage sampling procedure: classrooms and students within schools within geographic areas, which were the primary sampling units. Sampling weights are provided to correct for selection bias occurring in any of the three stages listed above. School participation rates range between 66 and 80% over all years of the MtF study. If a school declines to participate, that school is replaced with one with similar geographic and demographic characteristics. The MtF study began in 1975 by surveying 15,000 12th grade students annually. Eighth and 10th grade students were added in 1991, including 17,000 students in 8th grade and 15,000 students in 10th grade. All questionnaires were self-administered, and typically conducted during class time with a teacher present. All data used in the present study was self-reported by the participant. The University of Michigan Behavioral Sciences Institutional Review Board approved the study and each student consented to participation.

The primary purpose of the MtF study is to estimate the prevalence of drug and alcohol use in high school aged youth. Additional questions were added to understand contextual and etiological factors associated with substance use and these questions have evolved over the years. We used 8th- and 10th-grade Surveys from the years 2007–2012 in analyses presented here because our primary predictor variable (Internet use) was added to the MtF questionnaires in 2006. We further restrict our sample to those surveyed after 2006 because, after this time point, at least 70% of children had access to a computer within their home according to the U.S. Census (U.S. Census, 2013). Eighth and 10th grade

average student response rates over these years were 90 and 88%, respectively, with less than 1% refusing to participate. Most non-response is due to absenteeism.

Our analytic sample is limited to those who were asked about Internet use, which was included on Form 1 only. This Form was given to approximately one third of participants, which were randomly selected from the larger sample (Johnston, Bachman, O'Malley & Schulenberg, 2011). Additionally, our sample was limited to those with complete data on covariates of interest as well as on our primary outcome - binge drinking.

2.2. Measures

2.2.1. Outcome: binge drinking

To measure heavy alcohol use (binge drinking), respondents were asked the number of occasions on which they consumed five or more drinks in the past two weeks, which is consistent with prior literature on binge drinking in this age group (U.S. Department of Health and Human Services National Institutes of Health, 2004). We examined this outcome dichotomously (once or more versus none).

2.2.2. Primary predictor: internet use

Recreational Internet use was assessed in the following way: “Not counting work for school or a job, about how many hours a week do you spend on the Internet e-mailing, instant messaging, gaming, shopping, searching, downloading music, etc.?” Due to the fact that response options were expanded in later years to account for higher levels of internet use, we condensed response options to less than one hour [includes none], one to five hours, six to nineteen hours, or twenty or more hours per week so that categories were consistent across years of analysis.

2.3. Covariates

Final models also included individual level sociodemographic characteristics that are associated with alcohol use in prior research (Keyes et al., 2012; Patrick et al., 2012). Covariates included sex, age (younger than 16, for grade 10 only),¹ race/ethnicity (categorized as African American, Caucasian, or other), highest level of student-reported parental education (“some college or less” or “completed college or grad school”), average grades (A- or higher, B+ to B, or C+ or lower), and whether the mother or father, both, or neither lived at home (Bachman, O'Malley, Johnston, Schulenberg, & Wallace, 2011; Keyes et al., 2012; Patrick & Schulenberg, 2014; Ruutel et al., 2014; Wallace et al., 2003). We also included working for pay (0 h/week, 1–20 h/week, more than 20 h/week) as prior research in the MtF study has demonstrated an association between binge drinking and hours worked (Safron, Schulenberg, & Bachman, 2001).

2.4. Statistical analysis

All statistical analyses were completed using StataSE 13 (StataCorp., 2013). We estimated descriptive statistics on our sample using within-year sampling weights paired with Stata's svy commands. We implemented a two-level random intercept logistic regression model clustered by study years (2007–2012) to estimate the association between Internet use and binge drinking. This regression model was fit using the user-written Stata add-on gllamm where the marginal log-likelihood was maximized using numerical integration and carried out via adaptive quadrature (Rabe-Hesketh & Skrondal, 2012; Rabe-Hesketh, Skrondal, & Pickles, 2002). Fifteen quadrature points were used to improve the precision of our estimates. We calculated robust standard errors using the Huber-White “sandwich” estimator

¹ To protect the identity of the participants, specific ages were not available in this dataset.

of the covariance matrix of the parameter estimates. From this, we estimated 99% confidence intervals, which provide a conservative inference estimate relative to the customary reported level of 95%. We estimated regression models both unadjusted and adjusted for covariates listed above. Ordinal variables were first transformed into indicator variables before they were entered into regression equations, resulting in separate regression parameter estimates for each non-baseline level of these variables. All descriptive and regression analyses were conducted separately in 8th and 10th graders. Figures were produced in R 3.1.0 with package ggplot2 (R Core Team, 2014).

3. Results

3.1. Descriptive statistics

Of the 32,131 8th graders who received Form 1, 9363 were missing a response on at least one covariate of interest. The majority of excluded participants were missing our predictor of interest, Internet use (5157 of 9363). An additional 1598 8th graders were excluded due to missing data on alcohol use. Of the 31,679 10th graders who received Form 1, 5828 were missing a response on at least one covariate of interest. Again, the majority of these were due to missing Internet use data (2845 of 5828). An additional 1489 10th graders were excluded due to missing data on alcohol use. Therefore, our analytic sample included 21,170 8th and 24,362 10th graders (Table 1). Approximately 7% of 8th and 17% of 10th graders reported binge drinking in the last two weeks. Within grade levels, our sample was approximately 53% female, 10% were African American and 78% lived with both their mother and father. Compared to 10th graders in our sample, more of the 8th graders

Table 1
Sample description.

	% grade 8 (N = 21,170)	% grade 10 (N = 24,362)
Binge drinking in last 2 weeks		
No	93.5	83.4
Yes	6.5	16.6
Age		
<16 years	–	42.3
≥16 years	–	57.7
Sex		
Female	53.3	52.7
Male	46.7	47.3
Race		
African American	10.0	9.4
Caucasian	59.5	63.7
Hispanic, other, or not specified	30.5	26.9
Household		
Mother and father	78.0	78.1
Mother only	17.2	16.9
Father only	3.9	4.0
Neither	0.9	1.0
Parent education		
College degree or higher	59.8	57.2
HS diploma or some college	33.1	36.2
Some HS or less	7.1	6.7
Average grades in current school year		
A– or higher	42.8	33.4
B+ to B–	39.7	43.3
C+ or lower	17.5	23.4
Average time working for pay during school year		
0 h/wk	74.8	71.3
1 to 20 h/wk	23.6	24.4
>20 h/wk	1.6	4.3
Approx. time on internet excl. School/job		
<1 h/wk	19.9	16.8
1 to 5 h/wk	44.7	43.3
6 to 19 h/wk	25.2	28.0
≥20 h/wk	10.3	11.9

Monitoring the Future 2007–2012, stratified by grade with years combined. Survey-weighted percentages and raw sample sizes are displayed. –, not applicable.

were Hispanic (30% versus 27%), had parents with a college degree (60% versus 57%), and had higher grades on average (43% versus 33% were A- or higher). As expected, more 10th graders were working for pay (4% of 10th graders versus 2% of 8th graders worked more than 20 h per week).

Among 8th graders, 20%, 45%, 25% and 10% used the Internet outside of school work and work for pay for <1 h/wk., 1–5 h/wk., 6–19 h/wk., and ≥20 h/wk., respectively. In comparison, 10th graders spent more time using the Internet outside of school work and work for pay. An estimated 17%, 43%, 28%, and 12% used the Internet <1 h/wk., 1–5 h/wk., 6–19 h/wk., and ≥20 h/wk., respectively.

3.2. Associations between internet use and binge drinking

Both unadjusted and adjusted results of our logistic regression analyses suggest a dose–response association between Internet use and binge drinking in 8th and 10th grade participants that is much stronger for 8th graders. The addition of covariates did not substantially change the interpretation of our effect estimates for Internet use (Table 2). Compared to <1 h of Internet use per week, odds ratios estimates for 1–5 h/week, 6–19 h/week, and 20 or more hrs/week were 1.24 (99%

Table 2
Unadjusted and adjusted associations between internet use and binge drinking in 8th and 10th graders.

	Unadjusted		Adjusted	
	Grade 8 <i>e</i> ^β (99% CI)	Grade 10 <i>e</i> ^β (99% CI)	Grade 8 <i>e</i> ^β (99% CI)	Grade 10 <i>e</i> ^β (99% CI)
Internet use				
<1 h/wk. (ref.)	1.00	1.00	1.00	1.00
1 to 5 h/wk	1.10 (0.76, 1.58)	0.98 (0.87, 1.11)	1.24 (0.85, 1.82)	1.06 (0.96, 1.16)
6 to 19 h/wk	1.64 (1.18, 2.29)***	1.10 (0.94, 1.29)	1.83 (1.28, 2.61)***	1.20 (1.03, 1.40)**
≥20 h/wk	2.76 (2.02, 3.76)***	1.22 (1.00, 1.49)*	2.78 (1.99, 3.87)***	1.30 (1.07, 1.58)***
Time working				
1 to 20 h/wk	–	–	1.90 (1.69, 2.15)***	1.46 (1.36, 1.56)***
>20 h/wk	–	–	3.08 (1.42, 6.69)***	2.65 (2.00, 3.52)***
Average grades				
B+ to B–	–	–	2.08 (1.90, 2.29)***	1.72 (1.46, 2.01)***
C+ or lower	–	–	4.71 (3.69, 6.00)***	2.87 (2.55, 3.23)***
Parent education				
College degree or higher	–	–	0.67 (0.54, 0.84)***	1.04 (0.97, 1.12)
Household				
Mother only	–	–	1.10 (0.88, 1.36)	1.26 (1.10, 1.44)***
Father only	–	–	1.67 (1.17, 2.40)***	1.54 (1.34, 1.79)***
Neither	–	–	1.61 (0.69, 3.80)	0.86 (0.60, 1.22)
Race				
African American	–	–	0.54 (0.34, 0.86)**	0.33 (0.26, 0.41)***
Hispanic, other, or not specified	–	–	1.12 (0.91, 1.38)	0.81 (0.70, 0.95)**
Sex				
Male	–	–	0.92 (0.77, 1.11)	1.07 (0.95, 1.21)
Age				
≥16 years	–	–	–	1.10 (0.96, 1.25)

Exponentiated coefficient estimates (“odds ratios”) and 99% confidence intervals reported for outcome of binge drinking relative to reference level of internet use. –, not applicable; italics, reference group.

* P < 0.05.

** P < 0.01.

*** P < 0.001.

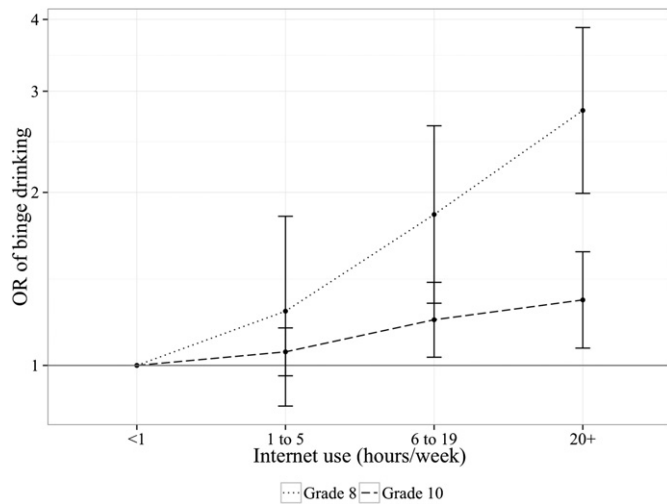


Fig. 1. Associations between internet use and binge drinking

CI: 0.85, 1.82), 1.83 (1.28, 2.61), and 2.78 (1.99, 3.87) for 8th graders, respectively. For 10th graders, this same association was attenuated [estimated OR = 1.06 (99% CI: 0.96, 1.16); 1.20 (1.03, 1.40); and 1.30 (1.07, 1.58), respectively]. Fig. 1 displays these results graphically.

For 8th graders, the estimated regression coefficients associated with Internet use are comparable to or of greater magnitude than several demographic variables that are consistently associated with binge drinking, including race, parental education, family structure, and working for pay.

4. Discussion

To our knowledge, this is the first study to test the hypothesis that Internet use is related to high-risk behaviors such as binge drinking in a randomly selected subsample of a nationally representative study of adolescents. In our fully adjusted models, which included covariates for age, sex, race, parents in the household, parental education, grades, and hours worked, we demonstrated a dose response relation between hours of recreational Internet use and binge drinking in our sample of 8th and 10th graders. We also observed that the association between Internet use and binge drinking was much stronger in 8th graders when compared to their 10th grade counterparts; the coefficients for Internet use among the 8th graders were of similar magnitude to other important demographic predictors such as race, parental education, and family structure. This is of clinical significance given that exposure to alcohol prior to the age of 14, which represents a sensitive and vulnerable period of brain development, may increase the risk of later impulsivity and alcohol dependence (Hingson et al., 2006; Liang & Chikritzhs, 2013; Stautz & Cooper, 2013; Vargas, Bengston, Gilpin, Whitcomb, & Richardson, 2014). These structural brain changes as a consequence of adolescent binge drinking may endure through adulthood, resulting in general cognitive impairment and specific deficits in executive functioning and memory (Hermens et al., 2013; McQueeney et al., 2009). For younger adolescents, peer pressure, which is known to play a role in alcohol use, may be an important mediator of the relation between Internet use and binge drinking (Mercken, Steglich, Knibbe, & De Vries, 2012). Early adolescents are found to be more susceptible than mid-adolescents to peer pressure (Mercken et al., 2012; Steinberg & Monahan, 2007). Given the increased vulnerabilities of early adolescence, more research is needed to understand and design interventions targeting this critical time.

The MtF study did not include sufficient data on potential mediators or mechanisms of the relation between Internet use and binge drinking in this population. However, it has been demonstrated that adolescents with greater exposure to substance use are more prone to use

substances themselves (Hanewinkel et al., 2012; Sargent, Wills, Stoolmiller, Gibson, & Gibbons, 2006; Wills et al., 2007). The hypothesized explanation for this relation is that adolescents exposed to substance use, even by strangers, may come to see this use as more acceptable and/or it may increase the likelihood of socializing with peers who also use substances (Bauman & Ennett, 1996; Wills & Cleary, 1999). This is consistent with studies that demonstrate the powerful effect of population-based social norms on individual alcohol use in this age group (Keyes et al., 2012). These pressures may be further amplified by the added exposures of targeted online alcohol marketing, which is also demonstrated to play a role in increased alcohol use (Anderson, de Bruijn, Angus, Gordon, & Hastings, 2009; Winpenny, Marteau, & Nolte, 2014).

Prior studies suggest that adolescents spend a substantial amount of time on the Internet accessing social networking sites (SNS) and video sites (Rideout et al., 2010), and SNS in particular may confer an increased risk of alcohol, marijuana, and tobacco use (The National Center on Addiction and Substance Abuse a Columbia University, 2011). One critical difference between the potential role of SNS versus other types of exposure is that SNS allows for exposure to known peers engaging in substance use as well as direct contact and organization of events involving substance use as in the “Neknominate” phenomenon (Wilkinson & Soares, 2014 February 18). Indeed, exposure to photos of friends’ partying or drinking through social networking sites has been shown to increase alcohol consumption independently of traditional peer influence (Dolcini, 2014; Huang et al., 2014). In addition to being exposed, SNS self-curation of an “alcohol identity” itself was correlated with an increased risk of alcohol-related problems, and was shown to perpetuate peer exposure (Ridout et al., 2012). Thus, one possible mechanism linking Internet use and binge drinking in our study may be the considerable exposure to substance use of both strangers and peers through SNS, advertisements, and videos. Another potential mediator may be decreased parental monitoring, which has been shown to be a risk factor for increased alcohol consumption and may also provide more opportunity for unrestricted Internet usage (Dever et al., 2012). Lastly, the increased problematic alcohol usage observed in those with identified Internet addiction points to a potential shared mechanism rooted in maladaptive self-regulation (Dever et al., 2012; Gamez-Guadix, Calvete, Orue, & Las Hayas, 2015; Ko et al., 2008).

This study has several limitations. Due to the cross-sectional design of the MtF study, we are unable to deduce the temporal relation between Internet use and binge drinking, and are limited in our ability to test the mechanisms by which Internet use may be associated with increased binge drinking. In addition, the MtF study did not include data on how the participants spent their time on the Internet. Given that the risk of substance use is greater for certain uses of the Internet (e.g. SNS) versus others (e.g. email), studies of Internet use and adolescent risk behavior should consider the full spectrum of Internet uses. Furthermore, the MtF study did not include important characteristics that may account for both internet use and binge drinking in adolescents such as parental monitoring (Marchall-Levesque, Castellanos-Ryan, Vitaro, & Seguin, 2014), or underlying problem behaviors (Ko et al., 2008). Therefore, unmeasured confounding may influence our findings.

Despite its limitations, this is the first study to elucidate an important association between adolescent Internet use and binge drinking in a large, representative study of U.S. adolescents. The challenges of ensuring safe Internet exposure for underage and impressionable youth have become more complex as opportunities for youth to interact with the Internet are now ubiquitous. It is important to better understand the particular risks associated with Internet use in order to better protect teens during this uniquely vulnerable time.

In summary, we find a consistent, positive association between adolescent Internet use and binge drinking, which is stronger in younger teens. We hypothesize that the mechanism of this relation may include greater exposure to peer alcohol use through SNS, opportunities for binge drinking, and alcohol related media. Binge drinking is one of the

earliest substance abuse behaviors in adolescents and increases the likelihood of engaging in other high-risk behaviors. Therefore, longitudinal studies designed to assess the effects of Internet use on adolescent risk behaviors are necessary to test these and other potential mechanisms. Given the vast and increasing amount of time youth spend on the Internet, it is essential that we, as clinicians and public health practitioners, understand the health impacts of this large shift in the way adolescents spend their time.

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Contributors

Karen J. Mu: Dr. Mu helped with study design, drafted the initial manuscript, and approved the final manuscript as submitted.

Sara Moore: Ms. Moore helped with study design, carried out the analyses, reviewed and revised the manuscript, and approved the final manuscript as submitted.

Kaja LeWinn: Dr. LeWinn conceptualized and designed the study, provided detailed and substantive changes on all drafts of the manuscript, and approved the final manuscript as submitted.

Conflict of interest

The authors report no conflict of interest.

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