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Social Network Factors and Addictive Behaviors among College Students

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Abstract

Purpose of the review—To provide an overview of studies within the past five years examining the impact of social network factors on addictive behaviors among college students, to discuss gaps, limitations, and controversies in the field, and to summarize with a discussion of future directions and implications for interventions.

Recent findings—A review of 13 studies indicated that greater network exposure, centrality, reciprocated ties, and more tightly interconnected networks were associated with greater alcohol use and other addictive behaviors among college students.

Summary—Greater research is needed that expands beyond alcohol use to other addictive behaviors among college students. Additionally, more studies are needed that longitudinally study the impact of changes in social networks on addictive behaviors and vice versa, as well as studies examining sociocentric (whole) networks. Social network approaches offer innovative perspectives in understanding social influences on addictive behaviors and novel intervention strategies for potentially reducing addictive behaviors among college students.

Keywords

college students; addictive behaviors; substance use; social networks

Introduction

Over 30 years of research has examined the association between perceived norms of substance use and addictive behaviors among college students [1, 2, 3, 4, 5, 6]. The Social Norms Approach [7, 8] provides the theoretical framework by which to understand the association between norms and behaviors, with consistent empirical evidence to indicate that college students overestimate the amount and approval of peers' drinking [1, 5, 9], and that this overestimation is associated with risky drinking behaviors. Perceptions of peers' behaviors have consistently been found to be one of the strongest predictors of personal behavior among college students, controlling for other known predictors, such as demographics, motives, and expectancies [2, 8, 10]. Furthermore, the association between

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perceived descriptive norms, or the perception of how others' behave [11], of more specific referent groups, (e.g. based on gender, being a student at that particular university, ethnicity, fraternity/sorority status) and personal behaviors has been found to be stronger than the association between the perceived norms of the "typical college student" and subsequent behaviors [9, 12, 13, 14, 15, 16].

Social norms for addictive behavior among college students and those transitioning to college are thought to be established and/or maintained by selection and socialization processes. "Selection" refers to the influence of individual characteristics in leading an individual toward certain experiences, organizations or environments, and "socialization" refers to the influence of experiences, organizations or environments on the individual [17]. Often the two concepts work concurrently, with evidence suggesting that college students who live in college residence halls tend to drink more [18] and that students who select into heavy-drinking environments, such as fraternities and sororities, tend to drink more heavily than those who do not select into these environments [19]. Conversely, students who select into more academically-focused groups, such as residential learning communities, drink less [20]. Additionally, there is evidence to suggest that there are reciprocal selection and socialization processes that influence both alcohol use and the choice to join heavy-drinking social groups in the transition from high school to college [21, 22, **23, 24].

The body of work to-date strongly and consistently suggests that perceived drinking norms and reciprocal selection and socialization processes impact college student drinking. However, a major limitation of this work is that peer groups are still broadly conceptualized at varying levels of abstraction (e.g. "typical female college student), and are rarely focused on the individual's personal peer affiliations. Moreover, this work still relies on the individual's reported perceptions of college students' drinking, and do not consider the quality of the connections of the individual to each peer within the group. This work also does not consider connections between group members, or the impact of certain group members who may be more influential than others with regard to alcohol or substance use. To address these limitations, recent research has begun to expand beyond the static conceptualization of social influences to focus more broadly on network factors associated with substance use and addictive behaviors among college students.

Social networks are defined as the connections, or relationships, among people, organizations, or any such units [**25]. "Connections" may be characterized in a wide variety of ways, based on geography, communications, friendships, family, etc. Social network analysis allows one to characterize the network and individuals within the network by measuring the impact of these relationships on thoughts, attitudes, and behaviors. Research related to social network theory and analysis suggests that an individual's behavior is influenced by more than just their perceptions of group norms, and is more directly influenced by specific individuals within a social network [**25]. The individual's position within a network, along with characteristics of that network, are what most directly impact the individual's behavior. Therefore, social network theory and its associated metrics (examples and definitions provided in Table 2) more specifically account for both peer selection and socialization effects, as well as the social norms of the individual's network.

The purpose of this review was to provide an overview of studies within the past five years examining the impact of social network factors on addictive behaviors among college students, to discuss gaps, limitations, and controversies in the field, and to summarize with a discussion of future directions.

Methods

To select relevant studies for this review, we conducted database searches of PsycINFO, PsycARTICLES, PubMed, and Google Scholar. We used a Boolean search strategy with the following key words: social networks, addictive behaviors, addiction, substance use, college, university, college students, university students, undergraduates, alcohol, cigarettes, tobacco, e-cigarettes, hookah, smoking, marijuana, cannabis, drugs, and gambling. All articles had to be in English and published between January 1, 2011 and June 1, 2016. Articles were not limited to only those published in peer-reviewed journals and dissertations were included in the search. This search strategy identified a number of studies focused on the use of social media (i.e. “social networking sites”) in relation to addictive behaviors. These studies were excluded unless there was a component that examined social network factors via online social media sites that were related to addictive behaviors among college students. Additionally, studies were excluded if they were not exclusively focused on an addictive behavior as an outcome. Using these criteria, 13 studies were included in the review (Table 1).

Results

The majority of studies have focused on alcohol use, with a few focused on combined alcohol and marijuana, tobacco, and gambling behaviors [26, 27, 28, 29] , and one study focused on non-medical use of prescription drugs [30]. Five studies focused on the general college population, with two studies focused on college students in residence halls [26, 31]), two studies focused on mandated college students [32, 33], one study comparing students in a psychology and engineering program [34], two studies focused specifically on fraternities and sororities [29, 35] and one study focused only on female college students [36].

The majority of studies were based on a personal network design, with three studies requiring students to nominate important people within a whole network [26, 29, 31]. The studies that focused on students in the psychology and engineering programs and fraternities and sororities were naturally whole network designs [34, 35]. Network sizes in personal networks varied between three and 30 individuals in the network, and the type of alters in each network differed among groups. For instance, some studies asked students to name friends that they had regular face-to-face contact with [32, 33], while others asked students to name friends, family members, romantic partners, or co-workers [28, 37]. All but three studies [29, 32, 33] measured social network factors and alcohol use at one time point.

Social network influence was measured in different ways in each study. The majority of studies measured network influence on ego's behavior as the proportion of individuals within ego's network who engaged in each behavior (i.e. network exposure) [27, 30, 32, 33, 37, 38]. The authors of all of these studies concluded that greater network exposure was positively

associated with the individual's own use of alcohol, cigarettes, marijuana, and non-medical prescription drugs, as well as gambling behaviors. Studies that examined other metrics of social network influence found that being more central, having more reciprocated ties, and being in more tightly interconnected networks were associated with increased alcohol use in particular [29, 31, 34, 35, 36]. Moreover, two studies found that even within networks, clusters of individuals can be identified and vary in type of behavior and level of use or involvement [26, 28].

The dissertation by Rodrigues [35] was the only article that examined the effect of social network concepts on willingness to intervene among fraternity and sorority members who appeared to be drinking in a problematic way. Although the author did not find that friendship or other types of peer-group nominations were significantly associated with willingness to intervene, being a leader in the group, which could be a proxy for centrality, was associated with increased willingness to intervene. Additionally, the author concluded that drinking excessively and experiencing alcohol-related problems was associated with greater social costs and the individual being viewed less favorably.

Gaps, Limitations, and Controversies

The use of social network methodology, assessing beyond the “average” group behavior (e.g. average number of drinks consumed by friends), is becoming more prevalent in examining addictive behaviors among college students. However, a number of limitations, gaps, and potential controversies exist in this growing field and bear further scrutiny.

In general, there is a paucity of work assessing college student social networks as they relate to addictive behaviors. Much of the work on social networks and addictive behaviors has been conducted with adolescent samples [39, 40, 41, 42, 43]. College students' social networks likely differ greatly from those of adolescents, where membership in and movement between groups is more prevalent and parental monitoring is reduced [44, 45].

Studies related to social networks and addictive behaviors among college students have thus far been disproportionately focused on alcohol consumption, with very little work having been done on other addictive behaviors. Additionally, only a quarter of these studies focused on sociocentric networks, with the majority of studies having assessed self-reported behaviors of egocentric network members. The overwhelming focus on egocentric data limits the conclusions that can be drawn regarding the social influence of networks, as well as selection and socialization effects. The reliance on egocentric networks is likely due to the difficulty in identifying meaningful network boundaries in college samples where individuals continue to develop their identities and transition into and between groups [46].

A third major limitation to consider in social network research is the varied and inconsistent use of measures across studies. For instance, studies asked participants to report on networks of various sizes ranging from three close peers [27] to entire Facebook networks [36]. In addition, studies that assessed egocentric networks asked participants to think of and define their social networks in a variety of ways, including listing important people [26, 31, 32, 33], close friends [27, 30, 38], close friends on campus [33], individuals that have had the most

impact [28], and best friends, family members, co-workers, etc. [28, 37]. Several studies went beyond asking participants to think about important people and further defining network members by asking participants to think of time spent together [27, 32, 37], closeness [30, 33], and those who they trusted and turned to for social support [29]. Some variation in measurement is expected to answer specific study questions. However, researchers should employ greater precision when discussing study findings by referencing what peers were identified and included in the network. For example, researchers should specify that the average drinking of ‘students they see weekly’ predicts individual drinking rather than ‘average network drinking’ predicts individual drinking. Identifying who the network is made up of will be integral to assessing the impact of network members across studies. Network size is also a factor, with network statistics calculated from networks of less than five members providing little information not accounted for by the transitivity property [25]. Therefore, studies designed to assess the impact of social networks on individuals should focus on networks of at least five individuals.

Variations in size and the way network information is defined and collected may impact the associations that are being tested and the conclusions can be drawn from the study. Network size impacts the social network variables that can be used in analyses, with smaller networks providing much less structurally meaningful information than larger networks. Additionally, in studies assessing networks comprised of important people, one student may only list friends, while another may list both friends and family. While both participants have listed who is important to them, we would expect that there would be different effects of selection and social influence in these networks, particularly as it related to addictive behaviors. This limitation also applies to the instructions used for indicating connections between group members. Network members can “know”, “like”, “interact”, or feel “close” to other network members. Classifying social networks in such a wide variety of ways limits the level of precision with which conclusions can be drawn regarding the impact of social networks on addictive behaviors. The use of detailed prompts for collecting network member information is needed to help reduce potential variability in participant responses. All variability cannot be removed but some of the remaining variability may be accounted for by assessing the relationship or role that network members have in the participant's life (e.g. friend, family member, coworker, etc.). Furthermore, specificity when reporting results is important for clear interpretation of research findings. Researchers should also avoid using generic terms to describe these relationships (e.g. using the term “popular” to describe someone who has been nominated as being liked by many network members).

Finally, there are several evolving discussions within social network research on the definitions and calculation of the social network constructs and the direction of the relationships tested. There is a wide range of social network variables that can often be calculated using different formulas. For example, a network member can be identified as central to the network if they nominate a lot of other members, are nominated by a lot of other members, or reside in a position that connects different clusters. Additionally, constructs like “average” group behaviors or similarity between behaviors can be calculated using exposure or homophily. Exposure is used most often, but more consistency between constructs and statistical terminology will help researchers better understand social network findings. Confidence in conclusions regarding general effects of social network

characteristics on addictive behaviors is contingent on the degree of similarity of findings reported across diverse samples, methods, and definitions. As the body of research continues to grow, there will be opportunities to draw conclusions specific to methodological strategies employed.

Another discussion within social network research relates to unidentified directional relationships due to the lack of longitudinal studies. Of the studies which assessed networks longitudinally, which accounted for only a quarter of the studies reviewed, analyses examined the effect of the network on the individual's behavior. Current research has not assessed the impact of an individual's combined characteristics and network position on the network's behavior, or the strength of the interaction between the network and the individual network position on addictive behaviors.

Finally, a small but growing subfield of social network research on addictive behaviors has focused on two-mode network analysis, or the “affiliation exposure model.” Using this method, social influence is conceptualized as influence from co-membership with activities/ events (i.e. affiliation-based social influence). Work by Fujimoto and colleagues has examined the overlapping co-influence of friendship networks and participation in school-sponsored sports and club activities on alcohol use [40], the combined influence of friendship networks and school-sponsored sports on smoking behaviors [47], and the overlapping influence of “crowd identification” (i.e. self-identifying as a jock, popular kid, etc.) and participation in school-sponsored sports activities on alcohol use among adolescents [48]. Results indicate that the overlapping influence of co-participation in organized activities (sports or clubs) and “crowd” identification with friendship networks significantly impacts drinking and smoking behaviors among adolescents. To date, no studies of the affiliation exposure model have been conducted in college samples, presumably because such affiliation-based networks are less easily defined and are far more varied and numerous in college than in middle school or high school.

Future Directions for Social Network Interventions

Interventions utilizing social norms and personalized norms feedback have improved over the years and are perhaps reaching the asymptote of what can be expected with regard to their ability to change behavior. Attempts to refine reference groups to be more and more specific have demonstrated limited improvement [49]. Social network approaches have much to offer in our understanding of how specific individuals' behavior affects and is affected by other people. While social norms approaches have emphasized how others' drinking compares to one's own drinking, the “others” are usually not identifiable specific individuals, but rather hypothetical others who are presumably similar. Group-based interventions where norms are assessed and reported during live interactive polling are a creative exception [50, 51].

It is clear that the individuals who have the greatest influence on us are those whom we know, care about, spend time with, etc. They are the people with whom we have some degree of relationship with. Perceived norms have their place, but friends, intimate partners, and family members are likely to have much greater influence on behavior relative to any

abstract estimate of a hypothetical group. Studies of natural drinking groups have identified consistent roles individuals tend to fill within drinking groups, such as organizer/planner; initiator of drinking activities (e.g., drinking games); social regulator/leader; and person who watches out for others (e.g., caregiver/designated driver) [52]. Surveys of natural drinking groups before and after visiting drinking establishments have shown that higher status members drink the most in heavy drinking groups, and encourage the most consumption by other members [53]. In high risk alcohol-related contexts (i.e., 21st birthday celebrations), where excessive drinking is heavily encouraged by most of the people present, romantic partners stand out as a unique protective influence [54]. These findings suggest multiple potentially fruitful avenues to pursue with respect to innovative intervention strategies by considering the roles and dynamics of individuals in personal drinking networks.

In addition to smaller personal networks, sociocentric networks have considerable potential to provide novel intervention approaches. The primary difficulty is the identification of meaningful and salient boundaries. In many university settings there are at least three natural candidates for sociocentric examinations (residence halls, fraternity/sorority groups, and athletes). Barnett and colleagues have initiated promising work in the context of residence halls [31]. Providing a targeted intervention to influential individuals within a network that may be diffused to other network member may prove to be a profitable avenue for social network interventions. Feedback that highlights specific individuals' positions within the network in the context of addictive behaviors might also prove to be a useful intervention strategy. Finally, providing targeted interventions to influential individuals within a network to increase the use of protective behavioral strategies and intervene on others within in the network who may be drinking problematically may also be an opportunity to further explore, particularly in a social network with a large number of "extreme" binge drinkers.

Conclusions

The purpose of this review was to provide an overview of recent studies examining social network factors and addictive behaviors among college students. A significant body of research has been established with regard to social norms and addictive behaviors among college students, namely alcohol use. Despite the significant increase in the number of publications examining social networks and addictive behaviors in college students within the past five years, a number of gaps remain and further work is needed in the field. Specifically, the vast majority of studies are focused on alcohol use, are cross-sectional and do not examine changes in network composition and structure over time, and are focused on egocentric data. Moreover, studies vary with regard to the number and type of network members named (e.g. important people, friends, campus friends that participants are in regular contact with). Further work is needed that examines a wider variety of addictive and risky behaviors in this group, as well as examines the reciprocal effects of both the network on the individual and the individual on the network. In summary, with further research, social network approaches may offer novel perspectives in understanding social influences on addictive behaviors, as well as innovative intervention strategies for reducing addictive behaviors among college students.

Acknowledgments

Conflict of Interest

Ms. Heather Krieger reports grants from the National Institute on Alcohol Abuse and Alcoholism (# F31AA024377) during the conduct of the study. Dr. Dipali Venkataraman Rinker and Dr. Clayton Neighbors report grants from the National Institute on Alcohol Abuse and Alcoholism (# R01AA014576) during the conduct of the study.

References

Papers of particular interest, published recently, have been highlighted as:

•• Of major importance

1. Borsari B, Carey KB. Descriptive and injunctive norms in college drinking: a meta-analytic integration. *J Stud Alcohol*. 2003; 64(3):331–341. [PubMed: 12817821]
2. Neighbors C, Lee CM, Lewis MA, Fossos N, Larimer ME. Are social norms the best predictor of outcomes among heavy-drinking college students? *J Stud Alcohol Drugs*. 2007; 68(4):556–565. [PubMed: 17568961]
3. Perkins HW, Berkowitz AD. Perceiving the community norms of alcohol use among students: some research implications for campus alcohol education programming. *Int J Addict*. 1986; 21(9-10): 961–976. Doi:10.3109/10826088609077249. [PubMed: 3793315]
4. Kilmer JR, Walker DD, Lee CM, Palmer RS, Mallett KA, Fabiano P, Larimer ME. Misperceptions of college student marijuana use: implications for prevention. *J Stud Alcohol*. 2006; 67(2):277–281. Doi: <http://dx.doi.org/10.15288/jsa.2006.67.277>. [PubMed: 16562410]
5. Perkins HW, Meilman PW, Leichliter JS, Cashin JR, Presley CA. Misperceptions of the norms for the frequency of alcohol and other drug use on college campuses. *J Am Coll Health*. 1999; 47(6): 253–8. Doi: 10.1080/07448489909595656. [PubMed: 10368559]
6. Larimer ME, Neighbors C. Normative misperception and the impact of descriptive and injunctive norms on college student gambling. *Psychol Addict Behav*. 2003; 17(3):235–243. Doi: 10.1037/0893-164X.17.3.235. [PubMed: 14498818]
7. Berkowitz AD. The social norms approach: Theory, research, and annotated bibliography. 2004
8. Perkins HW. Surveying the damage: A review of research on consequences of alcohol misuse in college populations. *J Stud Alcohol Suppl*. 2002; 14:91–100. Doi: 10.15288/jsas.2002.s14.91.
9. Lewis MA, Neighbors C. Gender-specific misperceptions of college student drinking norms. *Psychol Addict Behav*. 2004; 18(4):334–339. doi: 10.1037/0893-164X.18.4.334. [PubMed: 15631605]
10. Pedersen ER, LaBrie JW, Hummer JF. Perceived behavioral alcohol norms predict drinking for college students while studying abroad. *J Stud Alcohol and Drugs*. 2009; 70(6):924–8. Doi: 10.15288/jsad.2009.70.924. [PubMed: 19895769]
11. Cialdini RB, Reno RR, Kallgren CA. A focus theory of normative conduct: recycling the concept of norms to reduce littering in public places. *J Pers Soc Psychol*. 1990; 58(6):1015–1026. Doi: 10.1037/0022-3514.58.6.1015.
12. Larimer ME, Kaysen DL, Lee CM, Kilmer JR, Lewis MA, Dillworth T, et al. Evaluating level of specificity of normative referents in relation to personal drinking behavior. *J Stud Alcohol Drugs*. 2009; (Suppl 16):115–121. Doi: 10.15288/jsads.2009.s16.115.
13. Larimer ME, Neighbors C, LaBrie JW, Atkins DC, Lewis MA, Lee CM, et al. Descriptive drinking norms: for whom does reference group matter?. *J Stud Alcohol Drugs*. 2011; 72(5):833–43. Doi: 10.15288/jsad.2011.72.833. [PubMed: 21906510]
14. Lewis MA, Neighbors C. Optimizing personalized normative feedback: the use of gender-specific referents. *J Stud Alcohol Drugs*. 2007; 68(2):228–37. Doi. [PubMed: 17286341]
15. Lewis MA, Neighbors C, Oster-Aaland L, Kirkeby BS, Larimer ME. Indicated prevention for incoming freshmen: personalized normative feedback and high-risk drinking. *Addict Behav*. 2007; 32(11):2495–2508. doi: 10.1016/j.addbeh.2007.06.019. [PubMed: 17658695]

16. Neighbors C, LaBrie JW, Hummer JF, Lewis MA, Lee CM, Desai S, et al. Group identification as a moderator of the relationship between perceived social norms and alcohol consumption. *Psychol Addict Behav.* 2010; 24(3):522–28. doi: 10.1037/a0019944. [PubMed: 20853938]
17. Pascarella, ET., Terenzini, PT. Findings and Insights from Twenty Years of Research. Vol. 1991. Jossey-Bass; San Francisco: How college affects students..
18. Wechsler H, Lee JE, Kuo M, Seibring M, Nelson TF, Lee H. Trends in college binge drinking during a period of increased prevention efforts: Findings from 4 Harvard School of Public Health College Alcohol Study surveys: 1993–2001. *J Amer Coll Health.* 2002; 50(5):203–17. Doi: 10.1080/07448480209595713. [PubMed: 11990979]
19. McCabe SE, Schulenberg JE, Johnston LD, O'Malley PM, Bachman JG, Kloska DD. Selection and socialization effects of fraternities and sororities on US college student substance use: a multi-cohort national longitudinal study. *Addiction.* 2005; 100(4):512–24. Doi: 10.1111/j.1360-0443.2005.01038.x. [PubMed: 15784066]
20. McCabe SE, Boyd CJ, Cranford JA, Slayden J, Lange JE, Reed MB, et al. Alcohol involvement and participation in residential learning communities among first-year college students. *J Stud Alcohol Drugs.* 2007; 68(5):722. [PubMed: 17690806]
21. Capone C, Wood MD, Borsari B, Laird RD. Fraternity and sorority involvement, social influences, and alcohol use among college students: a prospective examination. *Psychol Addict Behav.* 2007; 21(3):316–27. Doi: 10.1037/0893-164X.21.3.316. [PubMed: 17874882]
22. Read JP, Wood MD, Capone C. A prospective investigation of relations between social influences and alcohol involvement during the transition into college. *J Stud Alcohol.* 2005; 66(1):23–34. Doi: 10.15288/jsa.2005.66.23. [PubMed: 15830900]
- 23••. Reifman A, Watson WK, McCourt A. Social networks and college drinking: probing processes of social influence and selection. *Pers Soc Psychol B.* 2006; 32(6):820–32. Doi: 10.1177/0146167206286219. [The authors found evidence for both social and selection processes, that “drinking buddies” were uniquely associated with drinking, and that changes in drinking over times were associated with changes in the network over time (i.e. individuals dropping out or being added to the network)]
24. Stappenbeck CA, Quinn PD, Wetherill RR, Fromme K. Perceived norms for drinking in the transition from high school to college and beyond. *J Stud Alcohol Drugs.* 2010; 71(6):895–903. Doi: 0.15288/jsad.2010.71.895. [PubMed: 20946747]
- 25••. Valente, TW. Social networks and health: Models, methods, and applications. Oxford University Press; Oxford: 2010. [Explores the constructs and concepts associated with social networks and their application to health behaviors.]
26. Barnett NP, Ott MQ, Rogers ML, Loxley M, Linkletter C, Clark MA. Peer associations for substance use and exercise in a college student social network. *Health Psychol.* 2014; 33(10):1134–42. Doi: 10.1037/a0034687. [PubMed: 24364375]
27. Mason MJ, Zaharakis N, Benotsch EG. Social networks, substance use, and mental health in college students. *Journal of Amer Coll Health.* 2014; 62(7):470–7. Doi: 10.1080/07448481.2014.923428. [PubMed: 24848433]
28. Meisel MK, Clifton AD, MacKillop J, Goodie AS. A social network analysis approach to alcohol use and co-occurring addictive behavior in young adults. *Addictive Behav.* 2015; 51:72–9. Doi: 10.1016/j.addbeh.2015.07.009.
29. Phua J. The influence of peer norms and popularity on smoking and drinking behavior among college fraternity members: A social network analysis. *Social influence.* 2011; 6(3):153–68. Doi: 10.1080/15534510.2011.584445.
30. Meisel MK, Goodie AS. Predicting prescription drug misuse in college students' social networks. *Addictive Behav.* 2015; 45:110–2. Doi: 10.1016/j.addbeh.2015.01.025.
31. Barnett NP, Ott MQ, Clark MA. The relevance of network prominence and reciprocity of relationships for alcohol use and alcohol-related problems in a college residence hall network. *Psychol Addict Behav.* 2014; 28(4):980–89. Doi: 10.1037/a0038354. [PubMed: 25528047]
32. DeMartini KS, Prince MA, Carey KB. Identification of trajectories of social network composition change and the relationship to alcohol consumption and norms. *Drug Alcohol Depen.* 2013; 32(1):309–15. Doi: 10.1016/j.drugalcdep.2013.02.020.

33. Reid AE, Carey KB, Merrill JE, Carey MP. Social network influences on initiation and maintenance of reduced drinking among college students. *J Consult Clinical Psych.* 2015; 83(1): 36–44. Doi: 10.1037/a0037634.
34. Lorant V, Nicaise P. Binge drinking at University: a social network study in Belgium. *Health Promot Int.* 2014; 31(2) Doi: 10.1093/heapro/dau007.
35. Rodrigues, J. Exploring relationships among friendships, social status, and problem drinking in college students: a social network analysis 2014: (Doctoral dissertation, The Pennsylvania State University).
36. Oshri A, Himelboim I, Kwon JA, Sutton TE, Mackillop J. Childhood physical and sexual abuse and social network patterns on social media: associations with alcohol use and problems among young adult women. *J Stud Alcohol Drugs.* 2015; 76(6):845–51. Doi: 10.15288/jsad.2015.76.845. [PubMed: 26562592]
37. Lau-Barraco C, Linden AN. Drinking buddies: Who are they and when do they matter?. *Addiction Res Theory.* 2014; 22(1):57–67. Doi: 10.3109/16066359.2013.772585.
38. MacKillop J, Acker JD, Bollinger J, Clifton A, Miller JD, Campbell WK, Goodie AS. Brief report: The brief alcohol social density assessment (BASDA): Convergent, criterion-related, and incremental validity. *J Stud Alcohol Drugs.* 2013; 74(5):810–15. [PubMed: 23948542]
39. Ennett ST, Bauman KE, Hussong A, Faris R, Foshee VA, Cai L, DuRant RH. The peer context of adolescent substance use: Findings from social network analysis. *J Res Adolescence.* 2006; 16(2): 159–86. Doi: 10.1111/j.1532-7795.2006.00127.x.
40. Fujimoto K, Valente TW. Alcohol peer influence of participating in organized school activities: a network approach. *Health Psychol.* 2013; 32(10):1084–92. Doi: 10.1037/a0029466. [PubMed: 22924449]
41. Hahn HC, Kolaczyk E, Jang J, Swenson T, Bhindarwala AM. Binge drinking trajectories from adolescence to young adulthood: the effects of peer social network. *Subst Use Misuse.* 2012; 47(6):745–56. Doi: 10.3109/10826084.2012.666313. [PubMed: 22452735]
42. Kobus K, Henry DB. Interplay of network position and peer substance use in early adolescent cigarette, alcohol, and marijuana use. *The J Early Adolescence.* 2009; 30(2):225–45. Doi: 10.1177/0272431609333300.
43. Pearson M, Sweeting H, West P, Young R, Gordon J, Turner K. Adolescent substance use in different social and peer contexts: A social network analysis. *Drug-Educ Prev Polic.* 2006; 13(6): 519–36. Doi: 10.1080/09687630600828912.
44. Brechwald WA, Prinstein MJ. Beyond homophily: A decade of advances in understanding peer influence processes. *J Res Adolescence.* 2011; 21(1):166–179. Doi: 10.1111/j.1532-7795.2010.00721.x.
45. Zarrett N, Eccles J. The passage to adulthood: Challenges of late adolescence. *New directions for youth development.* 2006; 111:13–28. Doi: 10.1111/j.1532-7795.2010.00721.x.
46. Schulenberg JE, Maggs JL. A developmental perspective on alcohol use and heavy drinking during adolescence and the transition to young adulthood. *J Stud Alcohol Suppl.* 2002; 14:54–70. Doi: <http://dx.doi.org/10.15288/jsas.2002.s14.54>.
47. Fujimoto K, Unger JB, Valente TW. A network method of measuring affiliation-based peer influence: Assessing the influences of teammates' smoking on adolescent smoking. *Child Dev.* 2012; 83(2):442–51. Doi: 10.1111/j.1467-8624.2011.01729.x. [PubMed: 22313152]
48. Fujimoto K, Wang P, Valente TW. The decomposed affiliation exposure model: A network approach to segregating peer influences from crowds and organized sports. *Network Science.* 2013; 1(02):154–69. Doi: 10.1017/nws.2013.7.
49. LaBrie JW, Lewis MA, Atkins DC, Neighbors C, Zheng C, Kenney SR, et al. RCT of web-based personalized normative feedback for college drinking prevention: Are typical student norms good enough? *J Consult Clin Psychol.* 2013; 81(6):1074–1086. doi:10.1037/a0034087. [PubMed: 23937346]
50. LaBrie JW, Hummer JF, Huchting KK, Neighbors C. A brief live interactive normative group intervention using wireless keypads to reduce drinking and alcohol consequences in college student athletes. *Drug Alcohol Rev.* 2009; 28(1):40–47. doi:10.1111/j.1465-3362.2008.00012.x. [PubMed: 19320674]

51. LaBrie JW, Hummer JF, Neighbors C, Pedersen ER. Live interactive group-specific normative feedback reduces misperceptions and drinking in college students: a randomized cluster trial. *Psychol Addict Behav*. 2008; 22(1):141–48. Doi: 10.1037/0893-164X.22.1.141. [PubMed: 18298241]
52. Lange JE, Devos-Comby L, Moore RS, Daniel J, Homer K. Collegiate natural drinking groups: Characteristics, structure, and processes. *Addict Res Theory*. 2011; 19(4):312–322. Doi: 10.3109/16066359.2010.507895.
53. Dumas TM, Wells S, Flynn A, Lange JE, Graham K. The influence of status on group drinking by young adults: A survey of natural drinking groups on their way to and from bars. *Alcoholism Clin Exp Res*. 2014; 38(4):1100–1107. Doi: 10.3109/16066359.2010.507895.
54. Rodriguez LM, Young CM, Tomkins MM, DiBello AM, Krieger H, Neighbors C. Friends in low places: The impact of locations and companions on 21st birthday drinking. *Addict Behav*. 2016; 52:52–57. Doi:10.1016/j.addbeh.2015.08.009. [PubMed: 26363304]
- 55•. Hawe P, Webster C, Shiell A. A glossary of terms for navigating the field of social network analysis. *J Epidemiol Commun H*. 2004; 58(12):971–5. Doi: 10.1136/jech.2003.014530. [Provides definitions and examples of social network constructs.]

Overview of Studies on Social Network Factors and Addictive Behaviors among College Students, January 1, 2011-June 1, 2016

Table 1

Author(s) and Year	Relevant Outcome(s)	Demographics	Study Description	Whole or Personal Networks?	Networks	Cross-sectional or Longitudinal	Results
[31] Barnett, Ott, & Clark, 2014	Alcohol	Undergraduate students in a residence hall (N=129; 51.9% female; 48.1% non-Hispanic White; 84.5% first-year)	Reported on alcohol use and alcohol-related problems in the past semester, and nominated up to ten residence hall peers who were important to them.	Nominated important people within a whole network	Up to ten important residence hall peers	Cross-sectional	Being more "in the middle" of a network, measured by betweenness-centrality, and popular (in-degree centrality) was associated with problem drinking for women. Nominating more people as important (out-degree centrality) was associated with more drinking.
[26] Barnett, Ott, Rogers, Loxley, Linkletter, & Clark, 2014	Alcohol, marijuana	Undergraduate students in a residence hall (N=129; 51.9% female; 48.1% non-Hispanic White; 84.5% first-year)	Completed a survey of substance use and exercise and identified up to 10 students in the residence hall who were important to them. Community detection cluster analysis and network autocorrelation modeling were used to identify peer groupings and examine the associations between peer and participant behaviors.	Nominated important people within a whole network	Up to ten important residence hall peers	Cross-sectional	Edge betweenness using the Girvan-Newman method was used to create clusters. There were differences in alcohol and marijuana use between these clusters. Nominated peer alcohol and marijuana use was associated with participant's own use.
[32] DeMartini, Prince, & Carey, 2013	Alcohol	503 students (64% male, 85% White, 64% freshman) mandated to participate in an alcohol prevention	At baseline, 6-month, and 12-month follow-ups, students provided data about alcohol consumption, perceived peer drinking norms, and	Personal networks	10 of the most important friends on campus that they had regular face-to-face contact with, nominated by participants using	Longitudinal	Growth-mixture models identified four groups of individuals with similar proportions of heavy drinkers

Author(s) and Year	Relevant Outcome(s)	Demographics	Study Description	Whole or Personal Networks?	Networks	Cross-sectional or Longitudinal	Results
		intervention for residence hall alcohol policy violations.	peer alcohol involvement.		the Brief Important People Interview (BIPI)		in their social networks. Two groups reported relatively stable proportions of heavy drinkers from baseline to 6-months and increasing proportions from 6- to 12-months.
[37] Lau-Barraco & Linden, 2014	Alcohol	College students (N = 250; 72.8% women; Caucasian (54.4%) and African American (24.2%); others were Asian (5.6%), Hispanic (3.2%), Native American (2.4%), Alaskan Native (2%) and "other" (8.1%). Participants were 42% freshmen, 31.6% sophomores, 16.8% juniors, and 9.6% seniors; mean age 19.7	Participants completed self-report measures of alcohol use and problems, injunctive norms, descriptive norms, and social network characteristics using a modified version of the Social Network Map.	Personal networks	10 individuals (family, co-workers, boyfriend/girlfriend, teachers, etc.) within their social network with whom they had contact in the past year.	Cross-sectional	Number of "drinking buddies" in a social network was associated with more problem drinking, especially, if the descriptive norms were lower.
[34] Lorant & Nicaise, 2014	Alcohol	Undergraduates (N=487) in two academic departments: Engineering (female n=38) and Psychology (female n=231) at a Belgian university.	Students completed questionnaires regarding drinking behaviors and their social ties (friendship, working with, partying with and room-mate) with each student in each respective department.	Whole network	253 students in Psychology and 234 students in Engineering	Cross-sectional	Reciprocated ties were associated with more binge drinking. Lower gender-homophily was associated with less drinking. Networks with less structural holes (ie. more dense networks) were associated with binge drinking and heavier norms.

Author(s) and Year	Relevant Outcome(s)	Demographics	Study Description	Whole or Personal Networks?	Networks	Cross-sectional or Longitudinal	Results
[38] MacKillop et al., 2013	Alcohol	College undergraduates (N=354; 77.4% female; 84.3% White; mean age=19.8)	Assess the validity of the Brief Alcohol Social Density Assessment (BASDA)	Personal	Four individuals closest to the participant, starting with the closest non-biologically-related social network member.	Cross-sectional	Being more central, but with less social capital was associated with more drinking. More central women in the denser, predominantly male network were binge drinkers. Alcohol social density was associated with alcohol misuse over and above the social and conformity subscales of the Drinking Motives Questionnaire. Individuals with an 8+ on the AUDIT had higher BASDA scores than those with less than an eight on the AUDIT.
[27] Mason, Zaharakis, & Benoit, 2014	Alcohol, marijuana, tobacco	Undergraduate students (N=670; 61% female; 50.4% White, 20.2% Black/AA, 13.5% Asian; mean age=19.6)	To examine associations between the density of network drinkers (i.e. social network risk), perceived peer closeness and use of alcohol, marijuana, and tobacco.	Personal	Three best friends that they spend time with at least monthly.	Cross-sectional	Greater density (proportion) of users in the network was associated with greater odds of use of each substance. Additionally, perceived closeness with other MJ users was associated with greater likelihood of MJ use. No interaction between gender and proportion of users in the

Author(s) and Year	Relevant Outcome(s)	Demographics	Study Description	Whole or Personal Networks?	Networks	Cross-sectional or Longitudinal	Results
[30] Meisel & Goodie, 2015	Non-medical use of prescription drugs (NMUPD)	279 undergraduates (67% female; mean age = 19.4; Caucasian (82.1%), followed by African-American (7.5%), and Asian (6.8%).	Respondents enumerated 10 of their closest friends. For each friend, respondents reported whether the friend misused stimulants, opioid analgesics, anxiolytics, and sedatives in the past 12 months.	Personal	Ten closest friends	Cross-sectional	network on any substance use. Thirty percent of respondents had at least one friend who misused prescription drugs, and the proportion of friends who misused non-prescription drugs was positively associated with respondents' use of prescription drugs.
[28] Meisel, Clifton, MacKillop, & Goodie, 2015	Alcohol, marijuana, tobacco, and gambling	281 undergraduates (67% female; mean age = 19.4; Caucasian (82.1%), followed by African-American (7.5%), and Asian (6.8%).	Examined individuals' perceptions of frequency of network members' co-occurring addictive behavior and investigated whether co-occurring addictive behavior is spread evenly throughout networks or is more localized in clusters. Also examined differences in network composition between individuals with varying levels of alcohol use.	Personal	30 alters who had the most significant impact on the respondent's life in the past year. Each alter was classified as a friend, family member, romantic partner, or co-worker.	Cross-sectional	Large overlap in perceptions of alters' use of multiple substances and gambling. Two clusters of multi-substance users, low and moderate-to-high, suggesting that multiple behaviors don't occur randomly within the group, but occur in specific subgroups. Significant differences were found in the perceptions of alters' use of substances between these two clusters of addictive behaviors.
[36] Oshri, Himelboim, Kwon, Sutton, & MacKillop, 2015	Alcohol	318 undergraduate female college students (mean	Individuals within more embedded networks and/or who were more	Personal (Facebook)	Total size of Facebook networks	Cross-sectional	Childhood sexual abuse was indirectly associated with

Author(s) and Year	Relevant Outcome(s)	Demographics	Study Description	Whole or Personal Networks?	Networks	Cross-sectional or Longitudinal	Results
		age=20.96; 77% Caucasian) with Facebook accounts	connected to higher drinking individuals drink more, and this association differs by childhood abuse severity				alcohol problems via being in a less interconnected network. Childhood physical abuse was associated with greater alcohol use via increased centrality in a network.
[29] Phua, 2011	Alcohol, cigarettes	Members of a fraternity at a single university (N=34; 76.5% Caucasian; mean age=20.1)	To examine the influence of popularity and conformity to perceived norms on smoking and drinking among college fraternity members between freshman and senior year	Whole	No minimum number. Participants asked to identify fraternity members they turned to for social support, hung out with on a regular basis, and trusted to talk about their problems.	Longitudinal	Popularity predicted both smoking and drinking behaviors. Homophily existed for smoking, but not for drinking. Conforming to peer norms mediated the association between popularity and smoking/drinking behaviors (i.e. greater popularity was associated with greater conformity to norms, which was associated with greater smoking/drinking. Motivation to reduce drinking was lower among those with social networks that were less accepting of substance use in general. Perceived acceptability
[33] Reid, Carey, Merrill, & Carey, 2015	Alcohol	Mandated students (N=316; 63% male; 86% White; 97% freshman/sophomore) who completed either a brief motivational or Alcohol Edu intervention	To determine whether social networks influence the extent to which college students initiate and/or maintain reductions in drinking following an alcohol intervention and whether students with riskier networks respond	Personal	10 of the most important friends on campus that they had regular face-to-face contact with, nominated by participants using the Brief Important People Interview (BIPI)	Longitudinal	

Author(s) and Year	Relevant Outcome(s)	Demographics	Study Description	Whole or Personal Networks?	Networks	Cross-sectional or Longitudinal	Results
			better to a counselor-delivered, vs. a computer-delivered, intervention.				moderated the association between condition and outcomes, such that for those in the control condition, perceived network acceptability more strongly predicted growth in drinking.
[35] Rodrigues, 2014	Alcohol	Fraternity and sorority members (N=200; 62.5% female)	This study sought to examine whether students recognized problem drinkers in their networks, whether different measures of status correlated with drinking behaviors, and whether there was a relationship between status and willingness to intervene or express disapproval for drinking behaviors	Whole	Fraternities and sororities ranging in size from 9 to 41, with a mean of 25.	Cross-sectional	Students can accurately recognize problem drinking in their peers groups. Problem drinking was negatively associated with friendship and status. Students who hold leadership positions and use protective behavioral strategies while drinking are more likely to helpfully intervene with friends.

Table 2

Description of Relevant Social Network Constructs and Measures [**25, **55]

Social Network Construct	Description
Ego	The focal actor in a network
Alter	Others in the network connected to the ego
Tie, Relational tie	Link actors within a network (e.g. ego-alter or alter-alter). Reciprocated ties are when actors are each linked to each other (e.g. Actor 1 feels close to Actor 2, and Actor 2 also feels close to Actor 1)
Whole network (socio-centric network)	Network composed of relational ties among members of a bounded community (e.g. classroom, residence hall, neighborhood, etc.)
Personal network	The ego's network, defined by them
Centrality	Identifies the most prominent members of a network as defined by extensive relational ties with other members of a network. Can be defined and measured in different ways, the following of which is not exhaustive: <i>In-degree centrality</i> is the number of individuals who nominate the actor. Typically a measure of popularity. <i>Out-degree centrality</i> is the number of people that the actor nominates. Can be thought of as “expansiveness”, or social reach. <i>Betweenness centrality</i> is the number of times an actor connects pairs of other actors, who otherwise would be unable to reach one another. Is thought of as a measure of social bridging or gatekeeping. <i>Closeness centrality</i> is a measure of the minimum number of ties needed to reach all the other individuals in the network. If an actor is close to all others in the network, then they are not dependent on as many other actors to reach other actors. This is often considered a measure of network efficiency and independence. <i>Edge betweenness</i> is the link between individuals with the largest betweenness. An edge has high edge betweenness if it is included in the shortest path between multiple actors in the network, connecting “clusters” within the network. <i>Eigenvector centrality</i> is a measure of the ego's association with other central individuals in the network, indicating how central they are relative other central nodes in the network
Network density	Is a measure of cohesion, or interconnectedness, within a network. It is the total number of relational ties that exist within a network divided by all possible ties.
Network exposure (proportion)	Measure the extent to which an ego is exposed to alters who engage in specific behaviors. Exposure is calculated by multiplying the number of direct ties by whether the alter engages in the behavior or not. In personal networks, this would be the proportion of alters in an ego's network who engage in a specific behavior.
Homophily	A measure of similarity between egos and alters in a personal network, which indicates the ego's propensity to have ties with alters in the same group or class as themselves.
Effective Size	Is a measure of brokerage opportunities or social capital. Is a measure of structural holes, which are networks high in disconnectedness between alters. Measured by the number of alters an ego has minus the number of ties that each alter has to other alters. Is positively associated with efficiency, and negatively associated with low density.
Clustering Coefficient	A measure of how tightly connected alters are within a network. High coefficients are indicative of more densely connected networks.