4-2018

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HHS Public Access

Author manuscript

Addict Behav. Author manuscript; available in PMC 2019 April 01.

Published in final edited form as:

Addict Behav. 2018 April ; 79: 189–194. doi:10.1016/j.addbeh.2017.12.030.

An Event- and Network-Level Analysis of College Students' Maximum Drinking Day

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Abstract

Background—Heavy episodic drinking is common among college students and remains a serious public health issue. Previous event-level research among college students has examined behaviors and individual-level characteristics that drive consumption and related consequences but often ignores the social network of people with whom these heavy drinking episodes occur. The main aim of the current study was to investigate the network of social connections between drinkers on their heaviest drinking occasions.

Methods—Sociocentric network methods were used to collect information from individuals in the first-year class (N=1342) at one university. Past-month drinkers (N=972) reported on the characteristics of their heaviest drinking occasion in the past month and indicated who else among their network ties was present during this occasion.

Results—Average max drinking day indegree, or the total number of times a participant was nominated as being present on another students' heaviest drinking occasion, was 2.50 (*SD* = 2.05). Network autocorrelation models indicated that max drinking day indegree (e.g., popularity on heaviest drinking occassions) and peers' number of drinks on their own maximum drinking occasions were significantly associated with participant maximum number of drinks, after controlling for demographic variables, pregaming, and global network indegree (e.g., popularity in the entire first-year class).

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Contributors: MKM analyzed the results of the study, and was the primary contributor to the composition of the manuscript. AMB, SGB, MQO, GTD, MAC, and NPB were the secondary contributors to the composition of the manuscript. NPB, MAC, and MQO contributed to the primary design of the parent study.

Conflict of Interest: No conflict declared.

Conclusion—Being present at other peers' heaviest drinking occasions is associated with greater drinking quantities on one's own heaviest drinking occasion. These findings suggest the potential for interventions that target peer influences within close social networks of drinkers.

Keywords

event-level; social network analysis; college students; alcohol; maximum drinks

1. Introduction

College student drinking tends to be highly variable over the course of the school year, as a function of day of the week, academic requirements, holidays, and school-based events (Del Boca, Darkes, Greenbaum, & Goldman, 2004; Greenbaum, Del Boca, Darkes, Wang, & Goldman, 2005; Hoeppner et al., 2012). Although there are known periods of risk that promote heavy drinking, such as Spring Break, sporting events, and 21st birthday celebrations (Brister, Sher, & Fromme, 2011; Glassman, Werch, Jobli, & Bian, 2007; Neighbors et al., 2011), college students also frequently drink heavily outside of these specific events (Johnston, O'Malley, Bachman, & Schulenberg, 2013). Identifying influences associated with maximum drinking occasions is important. Volume of alcohol consumption is positively associated with various negative consequences such as hangovers, harming oneself or others, and blacking out (Hingson, Heeren, Winter, & Wechsler, 2005; Hingson, Zha, & Weitzman, 2009; White & Hingson, 2014). Similarly, at the event-level, peak alcohol consumption is associated with greater risk, relative to average alcohol consumption (Neal & Carey, 2007; Neal & Fromme, 2007).

Previous event-level research among college students has examined behaviors and individual- level characteristics that drive consumption and related consequences, but has often ignored the characteristics of individuals with whom these heavy drinking episodes occur (Grant, LaBrie, Hummer, & Lac, 2012; Mallett et al., 2017; Merrill, Vermont, Bachrach, & Read, 2013; Montes, LaBrie, & Froidevaux, 2016). For example, among males, drinking with other males is related to greater consumption compared to drinking with a mixed-sex group (Miller, Borsari, Fernandez, Yurasek, & Hustad, 2016). However, the paucity of literature in this area does not consider the characteristics of the social network members with whom the individual is drinking. For example, some network members with specific characteristics, such as those who are more popular, may exert a stronger influence on others' drinking behavior than other network members. Identifying the characteristics of network members who are present at risky drinking events may provide information about the optimal ways to intervene to prevent negative outcomes.

Broadly speaking, social networks are defined as the connections among units or entities (Wasserman & Faust, 1994). Social network theory posits that the pattern of relationships an individual has to other members of the network has implications for behavioral influence. In sociocentric network research, every member of a network is observed, and social connections (also referred to as ties) between individuals in the network are recorded; this allows for the examination of important associations, and ultimately influence, in the

network. Using these social network connections, researchers can better understand how behavior is transmitted across a network (Valente, 2010).

Social network theory and research extends traditional studies on individual drinking by: 1) obtaining actual self-report data from an individual's peers instead of relying on participant perceptions of peers' drinking (i.e., social norms approach), 2) using network ties to investigate the importance of the quality of relationships (e.g., best friend versus peer), 3) considering the connections between other peers in one's own network (i.e., friends of friends), and 4) allowing for the examination of individual-level characteristics (i.e., network position) that are based on connections to other network members. Characteristics derived from the nominations to and from members in a network (by asking for example, "who are your friends?") include indegree, outdegree, betweenness centrality, mutuality, and ego density.

Indegree, a measure of popularity, is defined as the number of times an individual is nominated by other network members, while outdegree, a measure of expansiveness, is defined as the number of network members the individual nominates. Betweenness centrality, a measure of bridging, is defined as the number of times an individual falls on the shortest path between two other people in the network. Individuals who are high in betweenness centrality connect others who are not connected; these individuals are considered important because by linking parts of a network they may transmit or prevent transmission of information or influence. Mutuality is the extent to which a person's ties are reciprocated by others so could be considered a measure of relationship stability, in that both members agree that they share the relationship. Lastly, ego density, defined as the extent to which a person's ties are connected to each other as well, is considered a measure of personal network cohesion. Most of these network measures have been investigated as to their relationship with specific behaviors, for example among adolescents the measures of centrality (i.e., degree centrality and betweenness centrality) are positively related to alcohol use, with the most consistent relationship found with indegree (Ennett et al., 2006; Fujimoto & Valente, 2012; Moody, Brynildsen, Osgood, Feinberg, & Gest, 2011; Mundt, 2011; Pearson et al., 2006). Despite the potential for using social network methods to understand behaviors that have a strong peer influence component such as alcohol use, very few sociocentric network studies have been conducted with college students (see Rinker, Krieger, & Neighbors, 2016 for a review).

The main aim of the current study was to utilize social network theory and methods to investigate the social connections between drinkers on their heaviest drinking occasion. We sought to: 1) describe the network of members who are present in the drinking occasions of their peers, and 2) examine the relationship between participants' position in the network of heavy drinking day ties and the total number of drinks consumed on their maximum drinking day. Describing the network ties that link together high-risk drinking occasions can help inform interventions that account for the social influence of peers.

Method

2.1 Participants

Incoming first-year students at a private university in the northeast were invited to participate in a longitudinal social network study. Eligibility criteria for the study were: residing on-campus, and full-time enrollment status. All first-year students are required to live on campus at the university. A small number of returning undergraduates who were participating in a program for nontraditional age students (ages 23 to 43) and who did not live in first-year residences were excluded. Using these criteria, 1,660 students were eligible and 33 were ineligible. Of the 1,660, 1,342 participants completed the baseline survey (80.8% completion rate). Of the 1,342, 972 participants (55.0% female based on sex assigned at birth) consumed at least one drink of alcohol in the past month and were included in the present analysis. Gender identity was as follows: 44.8% male, 54.3% female, 0.9% different gender identity. This subsample of participants was on average 18.7 years old (SD = 0.53). Hispanic ethnicity was reported by 15.0%, and self-reported racial identification was as follows: 62.0% White, 20.0% Asian, 10.1% Multi-racial, 6.1% Black, 1.8% other or did not answer. 5.8% lived in a substance-free dorm.

2.2 Procedure

During the summer prior to the beginning of the students' first-year at college, mailer postcards were sent to the home addresses of incoming students explaining the nature of the study and emails were sent to the students' university e-mail address, which included a web link to participate in the study. In the invitation email, students were informed that in the survey they would be asked to review a list of all of the names of first-year students to designate who in the first year class was important to them (i.e., a member of their social network). Students who did not want to have their names on the list were able to "opt out" of the study (n = 42). All other student names were shown on the list, regardless of their participation status. This "opt out" method is a recommended strategy for protecting nonparticipants in sociocentric network studies (Borgatti & Molina, 2005) and has been used in other work with underage participants (Laurens et al., 2017) and college students (Barnett et al., 2014). Students under the age of 18 provided their assent as well as contact information (postal mail or e-mail) for a guardian who could provide consent.

Approximately six weeks into the fall semester, participants were emailed a web link containing a battery of assessments about their social networks and health behaviors, including alcohol use. We expected that at about six weeks, peer friendships would be relatively established. Specifically, participants were asked whether they consumed any alcohol in the past month; those who reported any past-month drinking completed the measures that are used in the current analysis (N = 972). Participants were compensated $50. The study was approved by the University Institutional Review Board and a Certificate of Confidentiality was obtained from the National Institute of Alcohol Abuse and Alcoholism.

2.3 Measures

2.3.1 Demographics—Participants indicated their sex assigned at birth, gender identity, age, race, ethnicity, athletic team membership, whether they received financial aid, and

whether they were a first-generation student. Substance-free dorm residence was obtained from the university registrar.

2.3.2 Sociocentric Network Questionnaire—The parent study utilized a sociocentric network methodology, in which all individuals in a bounded network (i.e., the first-year class at the university) were invited to participate. To identify social ties or connections within the network, participants were given the instruction: “The next question is about first-year students at [University name withheld] who have been important to you in the past month, regardless of whether or not you liked them. These might be people you socialized with, studied with, or regularly had fun with.” Participants were asked to select up to 10 names on a pre-populated list containing the names of first-year students who had not opted out. These names were saved as unique identification numbers in the dataset, allowing for the observations of ties between and among network members without retaining identifiers. Using this measure, we calculated a variable that measured the overall network popularity of all students in the first-year class. Global network indegree, or overall network popularity, was defined as the number of times a participant was identified as a social network member (i.e., an important person).

2.3.3 Maximum Number of Drinks in Past Month—Participants were presented with the definition of a standard drink as 12 oz. beer, 5 oz. wine, or 1.5 oz. of 80 proof liquor. Participants were asked, “In the past 30 days, what was the most you had to drink on any one day?” Responses could range from “1 drink” to “more than 30 drinks” (coded as 31).

2.3.4 Maximum Drinking Episode—Participants who self-reported drinking in the past 30 days were reminded of the number of drinks they consumed on the day they drank the most and were presented with the instructions, “On the day that you drank the most, indicate which of the people you named in the sociocentric network questionnaire were there.” They were shown the names of their nominated network members in a “check all that apply” fashion. There was no limit on the number of individuals they could select as present during their maximum drinking episode. Participants were also asked “On the day that you drank the most, did you pregame? We define pregaming as drinking before going out.”

Using the social network of connections between participants on each of their own maximum drinking episodes, network characteristics were calculated and assigned to each participant. Indegree (i.e., popularity on the max drinking day) was the number of times a participant was nominated as being present at other network member’s maximum drinking episode. Outdegree was the number of network members nominated by the participant as being present during the participant’s maximum drinking episode. Mutuality, the extent to which each pair was at each other’s maximum drinking day, was calculated by dividing the number of reciprocated ties by the total number of unreciprocated ties plus the total number of reciprocated ties. To calculate ego density of the maximum drinking episode, the total number of ties between a participant’s own nominations was divided by the total number of possible ties between the nominations (e.g., if a participant nominated three people, there are three possible ties between the three [A<->B, B<->C, and C<->A]. If only one of these three ties was made in the network, ego density would be .33).

2.4 Data Analysis

Only the network members enumerated who completed the survey and consumed alcohol in the past month were included in these analyses (N = 972). Correlations were calculated to examine the relationship between social network indices and alcohol use. Network autocorrelation models, which are similar to regression analyses but take into account the nonindependence of the data due to the social network structure, were conducted to examine if the network indices were associated with the participant's maximum number of drinks. In the network autocorrelation model, we controlled for demographic variables, pregaming, and global network indegree in the first-year class (e.g., popularity among the entire first-year class). Due to the nature of the design, in some analyses we had to remove participants who did not nominate at least one drinker in the first-year class (n = 190), and in other analyses we had to remove participants who did not nominate at least one individual in the first-year class (n = 154). All analyses were conducted in SPSS and the sna package in R (Butts, 2008).

2. Results

On the sociocentric network questionnaire (prior to the maximum drinking network questions), the 972 participants nominated an average of 5.6 (SD= 3.0) other first-year participants[1], including drinkers and nondrinkers. On their heaviest drinking day in the past month, participants consumed an average of 6.3 drinks (SD = 4.0), and a large proportion (65.4%) reported pregaming on that day. Participants indicated that 3.1 (SD= 2.4) of their nominated peers were present on the participant's maximum drinking day, representing approximately half (55.4%) of their overall nominations on the sociocentric network questionnaire. Of the peers who participants indicated were present, an average of 2.5 (SD= 2.1) reported drinking in the past month.[2] Thus, on average, 81% of the peers who were present on the participant's maximum drinking day reported past month alcohol use as well. Put another way, on average, 19% of peers who were present on the participant's maximum drinking day reported no past month alcohol use. The proportion of peers who were present who were also past month drinkers was significantly associated with the participants' maximum number of drinks ($t(818) = .08$, $p = .032$).[3]

3.1 Social network characteristics and drinking

From this point forward, we present and analyze data on the network of maximum drinking days, including analyzing statistics about network position. Figure 1 shows a sociogram of the network of presence on others' maximum drinking days. Participants' maximum number of drinks in the past month was significantly associated with their nominated peers' maximum number of drinks in the past month ($t(782) = 0.32$, $p < .001$)[4], even though these

[1]Nonparticipants in the parent study who were nominated by participants were not included here. On average, participants nominated 1.3 (SD = 1.8) students who did not themselves participate.

[2]Indegree (i.e., the number of times an individual is nomianted by other network members) and outdegree (i.e., the number of network member the individual nominates) have identical means because only nominations to participants who also completed the survey were counted.

[3]Not all participants are included in this analysis because 15.8% (n = 154) of the sample indicated that none of their nominated peers in the sociocentric network were present on their maximum drinking day.

[4]Not all drinkers were included in this analysis because 19.5% (n = 190) of the 972 drinkers indicated that no other drinkers in their sociocentric network were present on their maximum drinking day.

events may not have occurred on the same day. Bivariate correlations indicated that maximum number of drinks was significantly and positively associated with max drinking day network indegree ($r(972)= 0.33$, $p< .001$), outdegree ($r(972)= 0.20$, $p< .001$), betweenness centrality ($r(972)= 0.17$, $p< .001$), and ego density ($r(972)= 0.07$, $p= .04$). Maximum number of drinks was not related to mutuality ($r(900)= 0.06$, $p= .09$). In a multivariable analysis using a network autocorrelation model in which demographics, pregaming, and global network popularity (i.e., the number of times a participant was nominated as important by all students [$N = 1342$] in the first-year class) were controlled, max drinking day network indegree ($d = .20$) and friends' maximum number of drinks ($d = .15$) were significantly associated with participant maximum number of drinks, with athlete status and pregaming in the event also positively associated, and global network popularity ($d = .09$) negatively associated with maximum number of drinks (Table 1). To better understand the relationship between network drinking and max drinking day indegree, we correlated these variables. Max drinking day network indegree was positively related to nominated friends' maximum number of drinks ($r(782) = .17$, $p < .001$).

3.2 Demographic variables and maximum drinking day indegree

Because maximum drinking day indegree was the only social network index associated with maximum number of drinks in the multivariable analysis, we investigated which demographic variables were associated with indegree using ANOVAs. All ANOVAS controlled for participant frequency of drinking. Students receiving financial aid had significant lower maximum drinking day indegree than students not receiving financial aid ($M = 2.2$, $SD = 1.9$ and $M = 2.8$, $SD = 2.1$; $F(1,969) = 7.53$, $p < .01$). Students residing in substance-free dorms ($M = 1.2$, $SD = 1.4$ and $M = 2.6$, $SD = 2.1$; $F(1,969) = 5.03$, $p = .03$) also had significantly lower maximum drinking day indegree. There was no difference between men and women on maximum drinking day indegree ($M = 2.7$, $SD = 2.1$ and $M = 2.4$, $SD = 2.0$; $F(1,969) = 0.36$, $p = .55$). There was no difference in maximum drinking day indegree based on race (white vs nonwhite; $M = 2.6$, $SD = 2.0$ and $M = 2.4$, $SD = 2.1$; $F(1,960) = 0.02$, p = .90), first-generation student status ($M = 2.1$, $SD = 1.9$ and $M = 2.6$, $SD = 2.1$; $F(1,969) = 2.86$, $p = .09$) or athlete status ($M = 2.6$, $SD = 1.8$ and $M = 2.5$, $SD = 2.1$; $F(1,969) = 2.17$, $p = .14$).

3. Discussion

The main aim of the current study was to examine network connections (e.g., ties) associated with a recent maximum drinking episode of first-year college students. We found that the total number of times a participant was nominated as being present on another students' heaviest drinking occasion (i.e., maximum drinking day indegree) and the number of drinks consumed by the participant's nominated ties on *the ties'* maximum drinking days both independently were associated with a participant's maximum number of drinks. In other words, higher indegree on others' maximum drinking days (i.e., being present on others' heavy drinking days) and higher maximum drinking among ties were associated with greater maximum consumption of participants. Furthermore, we found that several characteristics were associated with maximum drinking day indegree. Specifically, not receiving financial aid and not residing in a substance free dorm were associated with a

higher number of times that participants were present on their friends' maximum drinking day.

This study is the first, to our knowledge, to examine the social network characteristics of a maximum drinking episode. The finding that approximately four-fifths of the peers who were present on a participants' maximum drinking day also self-reported drinking in the past month, and the finding that having a higher proportion of friends present who were drinkers was associated with a higher number of drinks suggests that drinking with close peers may encourage riskier drinking. Although the effect size was small, this finding is consistent with the literature on "drinking buddies" (Lau-Barraco, Braitman, Leonard, & Padilla, 2012; Leonard, Kearns, & Mudar, 2000; Reifman, Watson, & McCourt, 2006), which has found that the presence of drinking buddies in one's social network uniquely predicts drinking even after controlling for the overall drinking of the social network. In our study, however, we cannot be certain if the network members the participant consumed alcohol with would be considered a "drinking buddy" by the participant.

Our finding that the more often an individual was identified by another participant as being present on the individual's maximum drinking day (i.e., maximum drinking day indegree) was associated with consuming more drinks is consistent with previous studies with adolescents and young adults on the association between network indegree and higher levels of substance use (Ennett et al., 2006; Hahm, Kolaczyk, Jang, Swenson, & Bhindarwala, 2012; Moody et al., 2011; Phua, 2011; Valente, Unger, & Johnson, 2005). In our case, we first identified social network ties, but then defined indegree more narrowly as the number of times a participant was present at another participant's maximum drinking occasion. Taken together, the finding suggests that popularity in drinking events specifically is associated with an individual's own risk, even after controlling for global network popularity. That is, the popularity seen in the maximum drinking day network is not solely a function of overall popularity. In fact, global network popularity was inversely related to maximum number of drinks, suggesting that the most popular network members of the entire first-year class were not the most extreme drinkers.

Furthermore, although outdegree, betweeness centrality, and ego density were related to participant maximum number of drinks in bivariate correlations, they were not significant in the network autocorrelation model. Although these variables may be important predictors with other outcomes and in other types of designs, these variables are not relevant when examining the social connections between drinkers on their maximum drinking day. Future research should examine the differential impact of network indices on different alcohol outcomes.

4.1 Limitations

Although the current study has many advantages including the large sample size, the high proportion (81%) of the network that was observed, and the ability to link the self-reported drinking of the participant with the self-reported drinking of his or her peers, like all studies it also has limitations. Some limitations of this study had to do with our methodology. We are unable to link participants' maximum drinking day with the maximum drinking day of their ties – that is, we do not know whether ties were reporting the same or different days of

drinking. In the maximum drinking day network analyses, nondrinkers by definition were excluded, and their influence on drinking days could be relevant, given our finding that the more drinkers a person nominated as being present, the higher the number of drinks that person consumed. Given the cross-sectional nature of our data we also cannot infer causation, and therefore cannot interpret the findings as indicating the direction of influence between ties. Lastly, our sample consisted of students at one university who lived on campus and were underage, so results may not generalize to other universities and other undergraduates. However, a sizable number of college and universities require that full-time first-year college students reside on campus, thus increasing the external validity of the current study.

4.2 Future Directions

Our findings extend other work on the homophily of drinking behavior to specific incidents. There are two major implications – first, there is the potential for targeted interventions that take into account the social influence of peers. Individuals who are present at the drinking events of others could facilitate or discourage more drinking, and therefore are a target for intervention addressing the influence they may have on the drinking of others. Second, future research should investigate the processes through which this influence may occur. Social learning theory (Bandura, 1977, 1986) offers a comprehensive framework of the processes by which social influence variables contribute to drinking behavior (Maisto, Carey, & Bradizza, 1999). Namely, social learning theory suggests that drinking behaviors occur through both active (e.g. alcohol offers) and passive (e.g., social modeling, perceived normative behavior) processes within the social environment (Collins, Parks, & Marlatt, 1985; Graham, Marks, & Hansen, 1991; Wood, Read, Palfai, & Stevenson, 2001). Such research would improve our understanding of the influence of close ties during heavy drinking events and inform prevention approaches.

Acknowledgments

This research was supported in part by grant numbers R01AA023522 and T32AA007459-32 from the National Institute on Alcohol Abuse and Alcoholism.

Role of Funding Source: This research was supported in part by grant numbers R01AA023522, K01AA025994, and T32AA007459-32 from the National Institute on Alcohol Abuse and Alcoholism. NIAAA had no role in the study design, collection, analysis or interpretation of the data, writing the manuscript, or the decision to submit the paper for publication.

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Highlights

- 55% of participants' friends were present on their maximum drinking day
- 81% of the peers who were present self-reported drinking in the past month
- The proportion of peers who were drinkers was associated with greater drinking
- Being present at peer heaviest drinking occasions is associated with greater drinking

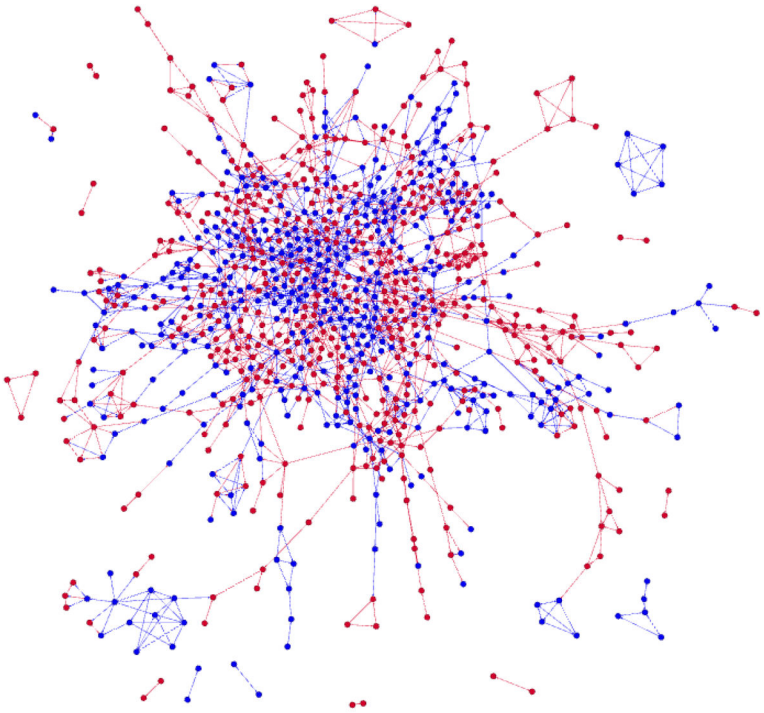

Figure 1.

Sociogram of the connections between individuals on their maximum drinking days. Nodes are coded according to sex: men are blue and women are red. Isolates, those who did not nominate and who were not nominated by anyone are not included in the figure.

Table 1

Network autocorrelation model predicting participant maximum number of drinks.

Variable	*b*	*SE*	*z*
Male	−2.33	0.24	−9.76***
Non-Hispanic white	−0.03	0.25	−0.11
Athlete	1.22	0.33	3.67***
Substance free dorm	−0.53	0.57	−0.93
Financial aid	0.35	0.25	1.42
First-generation student	0.06	0.39	0.16
Pregamed in event	1.91	0.26	7.24***
Global network popularity	−0.40	0.15	−2.58**
Peer maximum number of drinks	0.52	0.13	4.15***
Indegree	0.97	0.17	5.70***
Outdegree	0.26	0.14	1.83
Ego density	−0.14	0.13	−1.08
Mutuality	0.10	0.13	0.78
Betweenness centrality	0.13	0.13	1.03

* $p < 0.05$;

** $p < .01$;

*** $p < .001$.