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The Impact of Peer Social Networks on Adolescent Alcohol Use Initiation

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Abstract

Context—Early adolescent alcohol use is a major public health problem. Drinking before the 14th birthday is associated with a fourfold increase in risk of alcohol dependence in adulthood. The objective of this study is to evaluate the association between adolescent social network characteristics and alcohol initiation prospectively over time.

Design—The study analyzes data from Add Health, a nationally representative survey of seventh through eleventh grade students enrolled between 1995 and 1996. Generalized estimating equations are used to model the risk of alcohol use initiation at one-year follow-up among non-drinkers at Wave 1 of the study.

Results—Both an adolescent's friends' alcohol use and the adolescent's social network characteristics displayed an independent main effect on alcohol initiation. In comparison to abstainers, alcohol initiators had more popular friends, as measured by more peer nominations as friends (*in-degree*) and having more friends up to three steps removed (*three-step reach*), and more friends who drank. An adolescent's risk of alcohol use onset increased 13% (95% CI: 4%–22%) for every additional friend with high *in-degree*, 3% (95% CI: 0.3%–6%) for every additional 10 friends within *three-step reach*, and 34% (95% CI: 14%–58%) for each additional friend who drank alcohol, and after controlling for confounders.

Conclusion—The findings suggest that, in addition to well established demographic risk factors, adolescents are at heightened risk of alcohol use onset because of their position in the social network in relation to their friends and the friends of their friends.

What's New—Peer social networks impact adolescent alcohol use onset. Alcohol initiators have more friends and friends of friends who drink, are in closer proximity to more popular individuals, and interact with more friends and more friends of friends than abstainers.

Introduction

Adolescent alcohol initiation is a major public health problem. One quarter of all adolescents begin drinking alcohol by the age of 13 years old.[1] Drinking before the 14th birthday is associated with a fourfold increase in risk of becoming alcohol dependent in adulthood.[2] Early alcohol initiation leads to a variety of risky adolescent behaviors,

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including marijuana and cocaine use, having sex with multiple partners, and academic underperformance.[3]

Peer influence has been shown to play a large role in adolescent alcohol initiation. Peer alcohol use and a best friend's alcohol drinking behavior predict alcohol initiation among middle and high school students.[4–5] Middle schoolers are more likely to begin using alcohol if they perceive a higher prevalence of alcohol use among the other students in their grade.[6–7]

Social network analysis is the optimal research tool for studying the peer dynamics of adolescent alcohol use,[8–10] because it maps out peer dyadic interdependencies in a larger social group (i.e. network) context. In the social network analysis framework, adolescents and their friends indicate their friendships by naming a list of friends. The friendships are then are represented by social tie connections on a graph. As a result, the individuals (i.e. egos) are directly linked to their friends (i.e. alters) and indirectly to the friends of their friends. Thus, they form a large social network of relationships. The unique feature of social network analysis is that it relies on friendship ties reported by each adolescent and not on perceived, reputational or idealized social connections from one person's point of view.[11–12] Adolescent social networks are ideally suited for social network analysis as they have naturally occurring friendship boundaries (i.e. schools).

There is no clear agreement on how social network effects influence alcohol drinking among adolescents.[8, 13–17] Some studies have found that isolates, teenagers who have relatively few or no friends, are more likely to consume alcohol.[14–15, 17] Other investigations indicate higher drinking prevalence among liaisons, school age students who have friends, but are not connected primarily to a single group of friends.[13] Popular adolescents, those who receive more friendship nominations from other students (i.e. high *in-degree*) appear to enjoy greater social status if they drink.[18] Individuals who are more centrally located in the social network (i.e. higher *centrality*), by virtue of having more social ties and more thoroughly interconnected friends, are more likely to use alcohol if their friends drink.[8,19] Social proximity (i.e. *three stepreach*) via friends of friends' ties to other alcohol users is also linked to adolescent alcohol use.[8] Dense social networks with more interconnected individuals are associated with alcohol use.[8]

While adolescent social network characteristics are shown to play a role in adolescent alcohol consumption, little is known on how these factors lead to the onset of adolescent alcohol use. To fill this gap in the literature, the present study will investigate the association between adolescent social network characteristics identified in the previous studies, such as social status, social embeddedness, social proximity to alcohol users, and overall network interconnectedness, to adolescent alcohol initiation prospectively over time. The present study will explore the following research questions:

1. Is social status, as measured by *in-degree*, associated with adolescent alcohol initiation?
2. Is social embeddedness in the social network, as measured by *centrality*, linked to adolescent alcohol onset?
3. Is proximity to alcohol users, as measured by *three-step reach*, correlated with adolescent alcohol inception?
4. Is overall network connectedness, as measured by network density, related to the start of adolescent alcohol drinking?

Methods

Data Source

The data source for this study is the National Longitudinal Study of Adolescent Health (Add Health). Add Health is a longitudinal, school-based study of adolescents in grades 7 to 12. Sample schools were selected through stratified sampling to be representative of high schools nationwide based on region of the country, urbanicity, school funding, and racial composition. Middle school or junior high feeder schools for the participating high schools were also recruited. The Add Health study was approved by the by the Institutional Review Board of the University of North Carolina-Chapel Hill and the current analysis was approved by the Institutional Review Board at the University of Wisconsin-Madison.

An In-School Survey was given to all 7th through 12th graders at the 132 participating schools. Students who responded to the In-School Survey (n=90,118), were eligible to be randomly selected for an in-home interview and parent survey (Wave 1, n=20,745). Wave 1 was conducted from April 1995 to December 1995. In-home interview respondents participated in Wave 2 (n=14,738) of the study one year later, from April 1996 to August 1996.

A novel aspect of Add Health is the collection of peer social network data as a means of understanding adolescent health. Respondents named up to five male and five female friends from their school roster. To construct social network variables,[20] Add Health excluded nominations of students who did not complete the survey or whose name did not appear on the school roster. The Add Health publicly available social network data set provides individual and school-level network data on 75,781 adolescents.

Sample

Wave 1 of Add Health surveyed 20,745 individuals. Of the Wave 1 sample, 4,039 (19%) were in 12th grade and excluded from the Wave 2 sample. Of the remaining 16,706 students eligible for Wave 2, 1,968 students (11.8%) were lost to follow-up or refused participation, for a total Wave 2 sample size of 14,738 students.

The total sample size for the analysis was 2,610 students. The sample includes Add Health subjects who (1) completed in-home interviews at both Wave 1 and Wave 2; (2) had never drunk alcohol outside of the presence of a parent or adult family member prior to the Wave 1 in-home survey; (3) named at least one friend who also completed an in-home interview at Wave 1. A total of 1,592 students (11%) were excluded from the analysis sample because they had already initiated alcohol use at Wave 1 and 10,536 students (71%) were excluded because they did not name as a friend any student who completed a Wave 1 survey.

Measures

Alcohol Use Initiation

At both Wave 1 and Wave 2, adolescents were asked if they had ever drunk beer, wine, or liquor when they were not with their parents or other adult family member. Alcohol use initiators were defined as adolescents who had not consumed alcohol outside their family group at Wave 1, but who at Wave 2 had drunk alcohol without the presence of their relatives.

Social Networks

Social network variables were based on friendship nominations from the initial In-School Survey and were provided in the Add Health dataset. The Add Health social network

measures were calculated using social network analysis methodology.[20] *In -degree* is the number of friendship nominations received by the respondent from the other study participants. *Centrality (Bonacich β)* is the relative number of connections that an individual's friends have within the adolescent social network. *Three-step reach* is the degree to which a member of the peer social network can make contact with other members of the network through 3 steps of friendship connections. A school-level measure, *density*, is the number of ties in the total school peer social network divided by the number of possible network ties.

Demographics

Student gender, age, and race were collected in the in-home interview. Age was calculated to the nearest month. As a proxy for cognitive skills, participants completed a 5-minute Picture Vocabulary Test. Respondents were also asked how often in the past week they participated in team sports.

Family Characteristics

Adolescents naming only one parent in their current household roster were defined as living in a single parent household. Study participants indicated how much fun they have with their family and whether they had gone shopping or to a movie or event with a parent in the past 4 weeks. In the in-home interview at Wave 1, parents offered information on how often they drink alcohol and how many times they had five or more drinks on a single occasion in the past month.

Census Block Characteristics

The Add Health study used geocoding of addresses to link subject data to U.S. census block data. Census block data included the percentage of families in the block who were at or below the poverty level, the percentage over age 25 who had completed a college degree, and the percentage in the block who reported themselves to be religious adherents.

School Characteristics

Schools were characterized as urban, suburban, or rural and from the northeast, midwest, south, or east portion of the United States. Schools were listed as public or private, and either small (400 or less students), medium (401–1000 students), or large (1001 or more students). School administrators indicated if school staff had training in alcohol/drug prevention.

Friend Characteristics

Add Health adolescents' friends' alcohol use, grade point average, delinquency scale score, and parent alcohol use were derived directly from the friends' answers to the Add Health in-home interviews. The delinquency scale was constructed in a manner similar to prior research using the Add Health data.[21] Add Health respondents were provided with a 15 item delinquency scale and were asked to indicate how often they had engaged in each behavior in the past year. Items included vandalism, physical fighting, stealing, lying, joyriding, breaking and entering, and drug use, among others. Responses to individual questions were coded as 0 = never, 1 = 1 or 2 times, 2 = 3 or 4 times, and 3 = 5 or more times. The delinquency scale score was created by summing together responses to each of the 15 items.

Statistical Analysis

Each observation in the data set represented a single adolescent-friend pair. A dichotomous variable indicated whether the adolescent initiated alcohol use in Wave 2 of the study.

Multilevel modeling using generalized estimating equations (GEE) adjusted for a friend having multiple nominations. An independent working correlation structure was applied for the clusters.

First, the analysis estimated a reduced-form GEE model of adolescent characteristics associated with alcohol use initiation. The model included demographics, parent and family characteristics, census block characteristics, area of the country, school size and funding, school staff training in alcohol prevention, and school-wide social network density.

Second, the study estimated the impact of friend characteristics on alcohol use initiation while including all of the reduced-form variables as control variables. Friend characteristics included grade point average, delinquency scale score, parent drinking, and friend drinking at Wave 1.

Third, a GEE model was constructed to test the influence of friends' social network characteristics on the adolescent's alcohol initiation status, while excluding friend drinking from consideration. The model included social network parameters of *in-degree, centrality* and *three-step reach*. These social network measures were chosen a priori based on research findings regarding friend influence.[8]

A fourth GEE model analyzed both friend drinking characteristics and friend social network characteristics while controlling for confounders. This model sought to determine the independent main effect of social network characteristics on an adolescent's alcohol use initiation after controlling for the friend's drinking status. Increased likelihood of alcohol initiation was calculated by exponentiating the beta coefficients in the model. Additional analyses tested various model interaction terms.

Next, alcohol initiator social network characteristics (*in-degree*, *centrality*, and *three step reach*) were compared to abstainer social network characteristics. T-tests and chi square tests contrasted the social network characteristics and the prevalence of alcohol use for the friends of initiators and abstainers. Friends were classified as being one, two, or three steps away from the initiator or abstainer based on the minimum number of friendship steps it took to reach the friend from the study participant. For example, a directly named friend is one step away from an individual. A friend of a friend who is not directly named by the individual is two steps away. A friend of a friend of a friend who cannot be reached in the one step or two step manner described above is defined as being three steps away. All analyses were carried out with SAS statistical software.[22]

Finally, the friendship networks for a sample initiator and abstainer from the same grade were plotted using NetDraw software.[23] The diagram provides an indication of the three-step reach of both adolescents and the degree of alcohol use within their networks.

Results

The study sample consisted of 2,610 seventh through eleventh grade students (Table 1). Subjects ranged from 12 to 19 years of age, with a mean age of 15. Forty five percent of participants were minorities. Over a quarter of respondents lived in single parent households. More than forty percent had parents who consumed alcohol and 9% had a parent who consumed 5 or more drinks in a single sitting in the past month. A greater part of the respondents lived in a suburban area, were from the south, and attended a large public school (>1000 students). Over three quarters of the participants' schools provided training for staff in alcohol and drug prevention.

Table 2 presents the results from the four multivariate GEE models for alcohol initiation. Twenty percent (n=523) of the 2610 adolescents who were nondrinkers in Wave 1 initiated alcohol use by Wave 2 of the study. The analysis data set comprised 5,096 friendship pairs, for an average of 1.95 nominated friends for each individual in the sample. In the reduced form Model 1, significant predictors of alcohol use initiation were older age, white race, participating in team sports, heavy drinking by a parent, and higher social network density in the school. Variables which were associated with a reduced likelihood of alcohol use initiation were having family fun together and being in a private school.

Model 2 added friend characteristics to the model of alcohol use initiation. Friend drinking at Wave 1 increased the risk of alcohol use initiation. Having a friend with a higher delinquency score also increased likelihood of alcohol use initiation. Model 3 included the social network characteristics of the nominated friend, while removing friend drinking from consideration. Having more popular friends, as measured by peer nominations (*in-degree*) and being able to reach a greater number of friends *(three-step reach)*, was highly predictive of alcohol use initiation.

Model 4 presents the full model results which include both the friend's network characteristics and the friend's alcohol use. Two of the three friend social network characteristics (i.e., *in-degree*, *three-step reach*) increased the risk for the student to initiate alcohol use. For every additional friend with high *in-degree*, the likelihood that an adolescent initiated alcohol use increased by 13% (95% CI: 4%–22%). For every additional 10 friends within *three-step reach* of a nominated friend, risk of alcohol initiation by a nondrinker increased by 3% (95% CI: 0.3%–6%). Risk of alcohol use onset increased 34% (95% CI: 14%–58%) for each additional friend who drank alcohol. Additional analyses revealed that neither the interaction term between friend *three-step reach* and drinking status nor the interaction between friend *in-degree* and drinking behavior added significantly to the explanatory power of the model. Of note, friend *centrality* was not significant in the model. More network ties, as opposed to being highly embedded in a tight network, appeared to be the factor that had the strongest impact on alcohol initiation.

Table 3 presents the social network characteristics of the alcohol initiators' friends up to three steps removed compared to the abstainers' friends at three degrees of separation. These analyses were performed post-hoc based on the significant social network variables found in the GEE models. The results indicate that drinking initiators have more friends within three steps of them (*three-step reach*) prior to starting drinking. The drinking initiator's extended circle of friends also has more popular (*in-degree*), more connected (*three-step reach*), and more alcohol drinking friends within three steps.

Figure 1 provides a visual representation at Wave 1 of the three-step networks of two adolescents at Wave 1 from the same grade: one who initiates alcohol use by Wave 2, and the other who remains an abstainer. The initiator has access to more social ties three steps removed from him/her and more alcohol drinking friends. The abstainer has fewer friends within three step reach.

Discussion

The objective of this study is to evaluate the association between adolescent social network characteristics and alcohol initiation prospectively over time. The study results demonstrate that both the friend's alcohol use and the adolescent's social network characteristics display an independent main effect on alcohol initiation. In line with previous research,[8,24] a best friends' drinking at Wave 1 was a significant predictor of alcohol initiation at Wave 2. Similar to other investigations, the study findings demonstrate that, in addition to well

established demographic risk factors (e.g. age, race, team sports), peers' immediate drinking friends are risk factors for alcohol use inception.

Interestingly, having friends with more friends, regardless of their drinking status, impacts the likelihood of alcohol initiation. For every additional 10 friends within *three-step reach* of an adolescent, risk of alcohol initiation increases by 3%. The findings are in concordance with the results of the Framingham Heart Study, where adults up to three degrees removed from the individual influence weight gain, cigarette cessation, and alcohol use.[25–27] Similar clustering effects are demonstrated in studies of health behavior such as vaccination decisions among college students who coordinate their flu shots with their friends.[28]

The findings suggest that potentially limiting the size of adolescent groupings may have a positive effect on delaying alcohol initiation. In this case, the study results argue for smaller schools as they provide a smaller number of peers an adolescent can reach on their own or through their friends. This reasoning may also explain why private schools show protective effects against alcohol initiation in the model. Interestingly, a new generation of on-line social networks (Path, GroupMe, Rally Up, Shizzlr) focuses on limiting the size of the friendship group.[29]

In this study, adolescents in higher density school networks were more likely to initiate alcohol use. More dense networks exhibit more interconnected clusters which magnify the spread of influence. Notably, the results come to light in view of computer simulations showing that more dense networks amplify the dynamics of influence cascades.[30–31] Future research may want to explore how the density of virtual social communities (e.g. Facebook), which connect a great number of adolescents on-line, influence alcohol drinking among adolescents.

It should be noted that in the current sample alcohol initiators are closer through their friendship connections to more popular adolescents, defined here as individuals with more peer nominations (*in-degree*), than abstainers. For every additional friend with high popularity status (*in-degree)*, the likelihood that an adolescent initiates alcohol use increases by 13%. Our findings are in line with research showing popularity status and conforming to peer alcohol use are linked.[18] More desirable students with more social connections may serve as positive or negative opinion leaders who could influence the behavior of others. They may be critical in efforts to delay alcohol initiation. Studies on the immunization of complex networks (e.g. sexual partnership web, the Internet) confirm that immunization/ intervention efforts targeting highly connected nodes (e.g. most promiscuous individuals or high-traffic routers) will greatly reduce a networks' vulnerability to virus outbreaks.[32–34]

These data demonstrate that parental modeling of responsible alcohol use and having fun together as a family offer protective benefit against adolescent alcohol initiation. The results are similar to previous research showing that low family bonding and parental drinking are linked to the onset of alcohol consumption.[35–36] Health care professionals may wish to establish community partnerships for building stronger families that encompass spending quality time together. More research on fostering conditions for families to have fun together is warranted.

Future studies may wish to explore how cascades of influence to initiate drinking are driven, whether temporal patterns of the social network matter for alcohol initiation, and how adolescent social networks can be exploited to promote healthy choices with regard to alcohol.

This study has several limitations. First, it relies on participant self-report of alcohol initiation, although self-reported substance consumption is generally perceived as a valid

measure.[37–38] Second, although the study design takes advantage of longitudinal data, it is not possible to distinguish between two potential causes of behavioral clustering: induction, or the direct influence of one individual on another, and homophily, the tendency of persons to choose to associate with similar individuals. This is left for future investigation. Third, this study is limited to individuals who provided school peer group data. For many adolescents, the peer network includes students outside of their particular school, which were not available for the analysis. Finally, the study results are susceptible to potential selection and sample biases. Subjects were excluded from the analysis if they had no friends who completed the Add Health Wave 1 survey. This study does not attempt to draw conclusions about students who are isolated from their school peer group. Subjects were also excluded if they did not complete the Wave 2 survey. Over 88% of eligible participants completed Wave 2 in-home interviews, making it unlikely that the results suffer from significant response bias. Non-response has been investigated by the Survey Research Unit at the University of North Carolina and findings showed that bias for measures of health and risk behaviors rarely exceeded 1% in either Wave 1 or Wave 2.[39]

Conclusions

Social network analysis proves to be a useful tool for the study of the dynamics of adolescent friendships and alcohol use. Adolescents whose best friends drink, who have friends with more friends, and who are in closer proximity to more popular individuals in the peer network are at greater risk to initiate alcohol use. Family bonding and attending private school, which may limit the size of adolescent groupings, serve as protective factors against alcohol onset.

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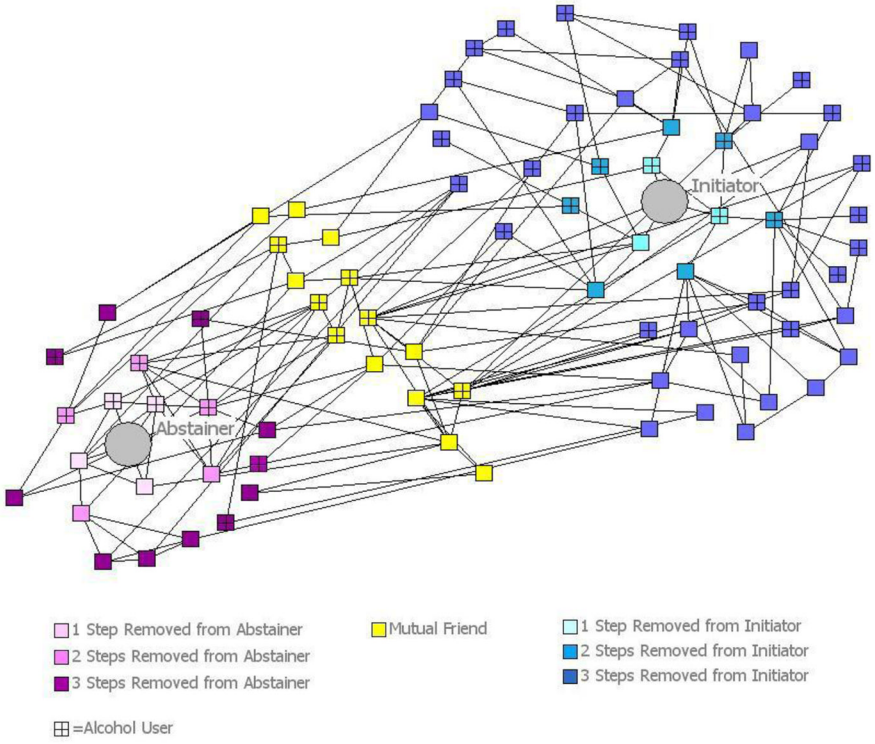

Figure 1.
Three-Step Reach at Wave 1 of an Alcohol Initiator* and an Alcohol Abstainer*
*Both alcohol initiator and alcohol abstainer were non-drinkers at Wave 1. Alcohol initiator began using alcohol by Wave 2.

Table 1

Descriptive Statistics of School-Age Students Who Had Not Initiated Alcohol Drinking in Add Health Study, Wave I, 1995 (n=2,610)

Characteristic	
Demographics	
Male (%)	48.8
Age, mean (se)	15.0 (0.3)
Age, range	12–19
Grade Level (%)	
7th grade	19.9
8th grade	18.7
9th grade	17.2
10th grade	24.1
11th grade	20.1
Race (%)	
Non-Hispanic white	54.6
Black	19.5
Native American	1.6
Asian	10.0
White Hispanic	12.5
Add Health Picture Vocabulary Test, mean (se)	100.9 (0.3)
Participate in team sports (%)	76.7
Family Characteristics	
Parent consumed alcohol, past year (%)	43.9
Parent consumed 5+drinks, past month (%)	9.0
Single parent household (%)	25.4
Family has fun together (quite a bit/very much, %)	70.1
Shopped together, past 4 weeks (%)	75.6
Went to movie/event together, past 4 weeks (%)	29.0
Census Block Characteristics	
Families with Income Below Poverty Level, %	10.7
Population Age 25+ with College Degree, %	22.9
Proportion who are Religious Adherents, %	56.4
School Characteristics	
Urbanicity (%)	
Urban	24.0
Suburban	51.4
Rural	24.6
Region of residence (%)	
Northeast	11.9
Midwest	28.4
South	31.7
West	28.0

Characteristic	
School funding (%)	
Public	87.1
Private	12.9
School size (%)	
Small (1–400 students)	30.2
Medium (401–1000 students)	28.5
Large (1001 or more students)	41.3
School staff training in alcohol/drug prevention (%)	78.7
Friend Characteristics	
Male (%)	47.3
Age (se)	15.2 (0.3)
Age, range	12–19
Drink alcohol, Wave 1 (%)	35.1
Drink alcohol, Wave 2 (%)	33.9

Table 2

GEE Model for Alcohol Use Initiation among Adolescents in Add Health Study (n=2,610)

	Model 1			Model 2			Model 3			Model 4		
Parameter	**Beta**	**se**	**p-value**	**Beta**	**se**	**p-value**	**Beta**	**se**	**p-value**	**Beta**	**se**	**p-value**
Demographics												
Male	0.142	0.075	0.058	0.077	0.075	0.307	0.108	0.076	0.155	0.080	0.076	0.288
Age	**0.086**	**0.031**	**0.005****	**0.081**	**0.031**	**0.008****	**0.089**	**0.031**	**0.004****	**0.083**	**0.031**	**0.007****
Race, white	**0.278**	**0.112**	**0.013***	**0.297**	**0.112**	**0.008****	**0.255**	**0.113**	**0.024***	**0.257**	**0.112**	**0.022***
AH picture vocabulary	0.001	0.003	0.660	0.002	0.003	0.401	0.002	0.003	0.472	0.002	0.003	0.456
Team sports	**0.084**	**0.033**	**0.011***	**0.091**	**0.033**	**0.006****	**0.084**	**0.033**	**0.012***	**0.085**	**0.034**	**0.011***
Family characteristics												
Parent drinking frequency	0.068	0.036	0.060	0.069	0.036	0.060	0.063	0.037	0.086	−0.005	0.035	0.893
Parent heavy drinking	**0.113**	**0.056**	**0.042***	0.104	0.055	0.060	**0.112**	**0.056**	**0.046***	0.087	0.056	0.122
Single parent household	0.011	0.088	0.902	−0.020	0.089	0.823	−0.010	0.088	0.909	−0.017	0.089	0.845
Family fun together	**−0.146**	**0.038**	**<.001*****	**−0.136**	**0.038**	**<.001*****	**−0.142**	**0.038**	**<.001*****	**−0.138**	**0.038**	**<.001*****
Shopped together	−0.101	0.086	0.241	−0.072	0.088	0.414	−0.090	0.087	0.304	−0.073	0.088	0.406
Movie/event together	−0.012	0.084	0.888	−0.002	0.086	0.986	−0.010	0.086	0..895	−0.012	0.086	0.889
Census block characteristics												
Below poverty percentage	0.421	0.429	0.326	0.514	0.430	0.232	0.548	0.426	0.198	0.572	0.425	0.179
College educated	0.387	0.323	0.230	0.494	0.324	0.127	0.522	0.323	0.107	0.552	0.323	0.087
Religious adherents	0.105	0.382	0.784	0.143	0.380	0.707	0.156	0.384	0.684	0.136	0.381	0.721
Geography												
Urban	0.029	0.145	0.841	0.082	0.147	0.577	0.123	0.149	0.408	0.173	0.150	0.247
Suburban	0.010	0.121	0.938	0.066	0.123	0.593	0.085	0.121	0.484	0.116	0.122	0.344
West	−0.262	0.168	0.119	−0.216	0.169	0.200	−0.143	0.170	0.399	−0.136	0.169	0.423
Midwest	−0.101	0.139	0.468	−0.079	0.140	0.570	−0.119	0.140	0.398	−0.106	0.140	0.450
South	−0.127	0.145	0.383	−0.064	0.146	0.664	−0.127	0.149	0.397	−0.115	0.149	0.441
School characteristics												
Private	**−0.385**	**0.160**	**0.016***	**−0.335**	**0.160**	**0.036***	**−0.374**	**0.161**	**0.020***	**−0.358**	**0.161**	**0.027***
Small	−0.200	0.139	0.151	−0.159	0.139	0.252	−0.105	0.147	0.478	−0.093	0.147	0.530
Medium	−0.127	0.126	0.315	−0.103	0.127	0.417	−0.129	0.126	0.305	−0.111	0.127	0.381

	Model 1			Model 2			Model 3			Model 4		
Parameter	**Beta**	**se**	**p-value**	**Beta**	**se**	**p-value**	**Beta**	**se**	**p-value**	**Beta**	**se**	**p-value**
Staff training in alcohol prevention	−0.040	0.112	0.724	−0.053	0.111	0.633	−0.091	0.112	0.416	−0.081	0.112	0.466
Social network density	**0.912**	**0.383**	**0.017***	**0.885**	**0.386**	**0.022***	**1.083**	**0.389**	**0.005****	**1.069**	**0.391**	**0.006****
Friend characteristics												
Friend grade point average	·	·	·	−0.082	0.055	0.141	−0.116	0.056	0.037*	−0.105	0.056	0.059
Friend delinquency	·	·	·	**0.020**	**0.007**	**0.004****	**0.027**	**0.007**	**<.001*****	**0.019**	**0.007**	**0.007****
Friend parent drinking	·	·	·	0.000	0.035	0.995	0.006	0.035	0.873	−0.005	0.035	0.893
Friend parent heavy drinking	·	·	·	0.071	0.057	0.208	0.082	0.056	0.142	0.087	0.056	0.122
Friend drinking, wave 1	·	·	·	**0.320**	**0.082**	**<.001*****	·	·	·	**0.295**	**0.082**	**<.001*****
Friend social network characteristics												
Friend in-degree	·	·	·	·	·	·	**0.034**	**0.011**	**0.001****	**0.032**	**0.010**	**0.002****
Friend centrality	·	·	·	·	·	·	−0.098	0.088	0.266	−0.093	0.088	0.288
Friend reach, per 10 friends	·	·	·	·	·	·	**0.031**	**0.013**	**0.014***	**0.030**	**0.013**	**0.020***
Intercept	−2.814	0.712	<.001***	−3.015	0.727	<.001***	−3.252	0.731	<.001***	−2.992	0.725	<.001***
Deviance	4981.6			4943.0			4934.9			4925.7		
df	5071			5066			5064			5063		

* p<.05,

** p<.01,

*** p<.001

Table 3

Social Network Characteristics of Adolescent Drinking Initiators' Friends in Add Health Study (n=2,610)

Social Network Variable, Wave 1	**Drinking Initiator at Wave 2 (n=523)**	**Abstainer at Wave 2 (n=2,087)**
	mean (s.d.)	***mean (s.d.)***
One Step Away Friends[a]		
In-degree	6.28*** (0.12)	5.71*** (0.06)
Centrality (Bonacich β)	0.98 (0.02)	0.96 (0.01)
Reach (3-step)	62.39*** (1.25)	56.01*** (0.60)
Drank alcohol, Wave 1 (%)	44.6***	32.0***
Two Steps Away Friends[b]		
In-degree	6.89*** (0.13)	6.41*** (0.06)
Centrality (Bonacich β)	1.02 (0.02)	1.01 (0.01)
Reach (3-step)	71.57*** (1.39)	62.08*** (0.71)
Drank alcohol, Wave 1 (%)	45.9***	39.6***
Three Steps Away Friends[c]		
In-degree	6.95*** (0.08)	6.54*** (0.05)
Centrality (Bonacich β)	1.04 (0.01)	1.04 (0.01)
Reach (3-step)	78.38*** (0.93)	71.33*** (0.53)
Drank alcohol, Wave 1 (%)	46.3*	43.9*

*p<.05,

**p<.01,

***p<.001

[a]Friend directly named by the individual

[b]Friend of a friend who is not directly named as friend by the individual

[c]Friend of a friend of a friend who is not one or two steps away from the individual