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Binge Drinking Trajectories from Adolescence to Young Adulthood: The Effects of Peer Social Network

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Abstract

This study investigates an association between social network characteristics and binge drinking from adolescence to young adulthood, utilizing National Longitudinal Study of Adolescent Health (n = 7,966) and employing social network and longitudinal analysis. Lower integration and socialization with alcohol-using peers had immediate risks of binge drinking during adolescence; however, over time, the effects of socialization with alcohol-using peers had the most dramatic reduction. The most prestigious adolescents had the highest longitudinal risks of binge drinking, although they had no immediate risk. Alcohol consumption-related interventions overlooking longitudinal dynamics of social networks may not effectively prevent adolescents from binge drinking in young adulthood.

Keywords

National Longitudinal Study of Adolescent Health; Add Health; social network; social network analysis; binge drinking; longitudinal data analysis; adolescent drinking; centrality; young adulthood; popularity; generalized estimating equation (GEE)

INTRODUCTION

Binge drinking results[1] in serious health problems, premature deaths, and economic losses (CDC, 2010). Early drinkers have a higher likelihood of developing alcohol dependence at a younger age and exhibiting multiple and longer episodes of alcohol dependence with more symptoms (Li, Hewitt, & Grant, 2004). Thus, identification of risk factors[2] for binge drinking among adolescents is crucial. Social network structures are argued to shape the

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Declaration of Interest
The authors report no conflicts of interest.

[1]The reader is referred to Hills's criteria for which were developed in order to help assist researchers and clinicians determine if posited *risk factors* were causes of a particular disease or outcomes or merely associated (Hill, 1965). Editor's note.

developmental trajectories of binge drinking among adolescents; however, few investigations have examined the nature of this relationship longitudinally. Thus, this current study aims to address the following research question: Are social network characteristics during adolescence associated with binge drinking patterns in adolescence and young adulthood (7-year developmental trajectories of adolescence)? This study will determine whether the various structures of peer social network during adolescence are associated with binge drinking during adolescence as well as young adulthood using both social network analysis and longitudinal data analytic methods.

Social Network Structures and Definitions

The period between adolescence and young adulthood is a crucial time for the development of substance use (Wiersma, Fischer, Harrington Cleveland, Reifman, & Harris, 2011). According to the social ecological perspective, peer relationships predominate over the development and functioning of adolescence compared with other life stages (Bronfenbrenner, 1998). A wide range of risk factors have been identified for substance use; however, the influence of a substance-using peer has been consistently found as a prominent factor for drinking opportunities among adolescents (Kobus & Henry, 2010). A substance-using peer influences[3] adolescents through modeling the use and shaping attitudes and norms about substance use during adolescence (Borsari & Carey, 2000; Hu, Flay, Hedeker, Siddiqui, & Day, 1995).

However, one must recognize that an adolescent's peer relationship is complex; thus, the influence of a substance-using peer may represent only a one-dimensional aspect of multidimensional peer relationships. In general, adolescents are less likely to be fixated with a single proverbial “clique” of “friends”; rather, they have flexible and dynamically bounded friendship groups exhibiting various structural network properties (Haynie, 2001). In this article, we focus on three such properties. First, we look at *group integration* by considering how well an ego, the adolescent respondent of the survey, is integrated in the same school and in the same grade (Moody, 2001). This is done by using the social network measure *heterogeneity*, which measures the proportion of friends who were not in the same school or grade as the ego. If a nominated friend did not attend the ego's school, he or she was counted as an outside school friend. For instance, an adolescent reporting few friends in the same grade or same school may have more friends outside of the school or in other grades. These friendship ties outside of the student's network may influence the adolescent's substance use (Valente, Gallaher, & Mouttapa, 2004). Second, we consider *centrality*, how prestigious of a position an adolescent occupies within the network. This is done using the Bonacich centrality score, which measures centrality or popularity of an ego in one's network. If an ego has friends who are nominated as friends by many actors in his network and also their friends are recognized by many other actors as friends, an ego is considered to have a high centrality. This phenomenon, an ego with high centrality, seeks to capture what is commonly known as a *popular kid* in his school or group as the concept of popularity has shown high association with network centrality (Gest, Graham-Bermann, & Hartup, 2001). Finally, we consider the *density* of the network through examining how densely nominated school friends of the ego, so-called alters, are connected to each other (Valente et al., 2004).

[2]The reader is asked to consider that concepts and processes such as “risk” and “protective” factors are often noted in the literature, without adequately delineating their dimensions (linear, nonlinear, rates of development, sustainability and cessation, etc.), their “demands,” the critical necessary conditions (endogenously as well as exogenously; micro to macro levels) that are necessary for them to operate (begin, continue, become anchored and integrate, change as de facto realities change, cease, etc.) or not to operate, and whether their underpinnings are theory-driven, empirically based, individual and/or systemic stakeholder-bound, historically bound, based upon “principles of faith” or what. This is necessary to clarify, if possible, if these terms are not to remain as yet additional shibboleths in a field of many stereotypes. Editor's note.

[3]The reader is reminded to consider that the posited influence of substance-using peers on the nonuser is not unidirectional. The nonuser can influence the user(s) as well. Internal and external conditions need to be considered. Editor's note.

Density is the number of ties, or links created between two people when one nominates another in a network, as a proportion of all possible ties. Dense networks have many ties while sparse networks have few. Group integration, centrality, and density are conceptually distinct dimensions of friendship networks based on their intimacy (Ennett & Bauman, 1994). These social network concepts will help determine the association between adolescents' binge drinking and the accurate structural patterns of their friendship network (Bauman, Faris, Ennett, Hussong, & Foshee, 2007).

The Role of Social Network Structures in Predicting Binge Drinking During Adolescence and Young Adulthood

An accumulated body of evidence indicates that adolescents' substance use and misuse are strongly linked to their social network structures (Ennett et al., 2006). For example, Ennett et al. (2006) demonstrated that adolescents who were less integrated in their peer network, those who had lower density, those who held greater prestige/status, and those who had closer social proximity to peer substance users exhibited a higher use of substances. Unlike the majority of the social network literature that used cross-sectional research designs (Alexander, Piazza, Mekos, & Valente, 2001; Bauman & Ennett, 1996; Kobus & Henry, 2010; Mason et al., 2010), Ennett et al. (2006) used a prospective longitudinal design to investigate the associations between different types of social networks and substance uses by using five time points. However, the observed time was only focused on during adolescence.

Identifying the mechanism of binge drinking during the period between adolescence and young adulthood is critical for two reasons. First, the onset of alcohol dependence peaks by the age of 18 and rapidly declines after 25 years (Li et al., 2004). It is critical to study the period of 18–25 years of age because the greatest risk of alcohol dependence for the highest-level binge drinkers occurs at the end of adolescence and into young adulthood (Hill, White, Chung, Hawkins, & Catalano, 2000). Thus, examining the patterns of binge drinking during this developmental period will provide a broad picture of binge drinking behaviors and give us insights into prevention measures of binge drinking later on. Second, the associations between social network characteristics during adolescence and substance use patterns may change over time. For instance, recent studies found that adolescents with a higher degree of popularity were associated with increased substance use among adolescents one year later (Allen, Porter, McFarland, Marsh, & McElhaney, 2005; Fallu, Brière, Vitaro, Cantin, & Borge, 2011). However, whether the effects of popularity on binge drinking continuously increase as adolescents emerge into young adulthood is unknown. It is possible that high centrality has an impact on binge drinking during adolescence; however, its impact may become more significant on binge drinking throughout emerging adulthood.

Social learning theory (Bandura & Walters, 1963) and problem behavior theory (Jessor, 1987) postulate that young people's substance use should be understood in their developmental context. In this perspective, actions are usually taken to meet the individuals' goals, and their goals are strongly shaped by their immediate social norms and social contexts of everyday life. Thus, if an individual is surrounded by the norms and contexts that value substance use, he or she will be more likely to use substances in order to enhance and strengthen social approvals and friendships. In the US school setting, young adults' (e.g., college students) binge drinking is perceived as a more normative behavior than adolescents' binge drinking (Neighbors, Lee, Lewis, Fossos, & Larimer, 2007). The importance of the role of alcohol in the social dynamics among young adults is a generally accepted perception; however, among the adolescents, alcohol may serve as a more useful role for those who have lower integration, lower density, and those who have best friends who are already using alcohol (Ennett et al., 2006).

Guided by these theories, first, we hypothesize that having lower social integration, lower density, and associating with peers who use substances have an influence on binge drinking during adolescence rather than young adulthood. Second, we hypothesize that the relative impact of centrality on binge drinking will be less during adolescence, but it will become greater during young adulthood. In other words, adolescents who were central in their social networks will be less likely to use substances; however, over time, they will be at a higher risk of binge drinking in young adulthood.

OBJECTIVES OF THE STUDY

The objectives of our studies are as follows. First, we describe the proportion of binge drinking in Waves 1, 2, and 3 based on four distinctive social network characteristics (group integration, prestige, density, and proximity to the best friend's substance use). The second objective is to analyze short-term and long-term changes of binge drinking status by social network structures measured in adolescence. Short-term binge drinking changes indicate the differences of the social network effects on binge drinking between 1994 and 1995 (during adolescence), and the long-term changes indicate the differences of the social network effects between 1994 and 2001 (from adolescence to young adulthood). We investigate whether the effects of the four distinct measures of social network structures on binge drinking outcomes will change systematically from adolescence to young adulthood. Unlike most studies that only focused on popularity or network centrality (Alexander et al., 2001; Allen et al., 2005; Fallu et al., 2011; Gest et al., 2001) during the period of adolescence, we will extend our testing by examining the role of three other social network characteristics (group integration, density, and proximity to the best friend's substance use) in predicting binge drinking between adolescence and young adulthood using the longitudinal analytic model. We also document how the magnitudes of the effects of social network characteristics on binge drinking differ at three time points (1995, 1996, and 2001) over a period of 7 years. This “snapshot” taken at three time points will provide information about the relative contribution of each social network structure on binge drinking through a 7-year period. Identification of posited potentially risky or protective social network characteristics for both short-term and long-term changes will allow clinicians or school administrators to intervene earlier in order to prevent binge drinking behaviors or alcohol dependence that may possibly develop during adulthood.

METHOD

Data

We used the National Longitudinal Study of Adolescent Health (Add Health), which provides a comprehensive summary of social network data (Harris et al., 2011). Add Health consists of in-school questionnaires in 1994, Wave 1 in 1994–1995, Wave 2 in 1996, and Wave 3 in 2001–2002. There are 132 schools in the core study and 90,118 nationally representative sampled individuals from these schools participated in in-school questionnaires. Among the individuals who are on the 132 school rosters, 20,745 students were first interviewed in 1994–1995 (Wave 1); 14,738 of the first home-interview participants were interviewed in 1996 (Wave 2) and 15,197 participated in the third home interview in 2001–2002 (Wave 3). Original core samples in 1994 ranged from grade 6 to grade 12 and at Wave 3, the respondent's age ranged from 18 to 27.

As part of the in-school questionnaires, students were asked to nominate five male and five female friends. As Add Health assigned a unique identification number to each person on school rosters, in-school questionnaire participants were able to enter each friend's identification number. Anyone who was on the respondent's school roster or the sister school roster was used to construct the friendship social network. This friendship matrix was

created to provide various social network characteristics during adolescence. In addition, binge drinking behavior was collected during Waves 1, 2, and 3. For this study, 7,966 individuals who participated in all of the first three interviews (Waves 1, 2, and 3) and in-school questionnaires were selected for the analysis. Participants who changed schools or moved subsequent to their first interviews were excluded from the final sample of 7,966. The analysis by Udry and Chantala (2003) revealed that the estimates for those who enrolled and estimates for those who included those who had dropped out or graduated between the time rosters were identical, thus, had negligible bias in health risk behaviors including alcohol use. The institutional review board of Boston University and University of North Carolina approved this study.

Measurements

Outcome Variable—*Binge drinking* was obtained by asking the participants: "Over the past twelve months, on how many days did you drink five or more drinks in a row?" If they reported having had five drinks or more in a row over the past 12 months at the time of first home interview, they were considered as binge drinkers at Wave 1. If they reported having had five drinks or more in a row over the past 12 months at the time of second and third home interviews, they were treated as binge drinkers at Wave 2, and similarly at Wave 3.

Predictor Variables—All predictor variables were from in-school survey and Wave 1, which were collected during 1994–1995.

Demographics: *Demographics* included *gender* (female and male), *ethnicity*, *and grade*. *Ethnicity* was categorized as White, Black, Hispanic, Asian, Native American, and Other. *Grade* was obtained by asking the participants what grade they were in during in-school questionnaires. *School size* indicated the number of students.

Social Network Measures

Group Integration: It refers to the extent to which adolescent's friendship choices are in the same school and in the same grades. Conceptually, the more outside school friends and different-grade friends that adolescents choose, the less group integration one has. *Number of friends outside school* was obtained by asking the participants to nominate five male and five female friends through in-school questionnaires (possible ranges from 0 to 10). If a nominated friend did not attend ego's school, then he or she was counted as a friend outside school. Since most participants reported having either 0 or 1 friend outside school, and only a comparatively small number had more than 1 friend outside school, *number of friends outside school* was divided into two groups: no friends outside school (no), and one or more friends outside school (yes). *Grade heterogeneity* measured the proportion of friends who were not in ego's grade. The value ranged from 0 to 1. These measures were used in another study as a measure for the integration (Ueno, 2005).

Prestige: *Bonacich centrality* is a measure of prestige, which implicitly captures the effects of not only how many connections a participant had, but also how many connections the friends of the participant had, and so on. Observed values ranged from 0 to 4, and greater values of the Bonacich centrality reflect greater centrality. Ennett et al. (2006) used the Bonacich centrality measurement as well to examine the centrality of the ego based on how many ties between ego's friends and their friends were present.

Density: *Egocentric density* measured how tightly friends of the ego were linked to each other. If an ego nominated or was nominated by five friends and they were all friends with each other, then the ego's egocentric density was 1. If none of the ego's friends were friends

with each other, then the ego's egocentric density was 0. This measure was used in previous studies to measure the cohesion among alters in ego's local network (Haynie, 2001).

The grade heterogeneity, Bonacich centrality, and egocentric density were recoded into categorical variables (low, medium, and high). Values less than one standard deviation below the average were coded as *low*, greater than or equal to one standard deviation below the average and less than one standard deviation above the average as *medium*, and more than one standard deviation above the average as *high*.

Alcohol-Using Peers: This was measured by asking the participants that "of your three best friends, how many drink alcohol at least once a month?" at Wave 1. If they reported having one or more friends who drank at Wave 1, they were considered to have an *alcohol-using friend*. In Kobus and Henry (2010), perceived friend's substance use was used as a measurement of alcohol-using peers and participants were asked how many friends used substances (Hahm, Lahiff, & Guterman, 2004; Kobus & Henry, 2010).

Statistical Analysis

We used SAS 9.1.3 (SAS Institute, Inc., 2000) for the statistical analyses and R 2.13.0 for creating the plots (Hornik, 2011) for the statistical analyses. We also used Pajek software (de Nooy, Batagelj, & Mrvar, 2005) for visualizing social networks during the exploratory analysis. Appropriate multivariate analyses were used to account for the clustered sampling design and weights (Chantala & Tabor, 1999). When analyzing the longitudinal effect of social networks on changes in binge drinking over time, one needs to account for within-subject correlations because the repeated measures of an individual at different time points are hardly independent from each other (Singer & Willett, 2003). For instance, those who drank in Wave 1 are more likely to drink in Wave 2, and Wave 3 as well. Therefore, ignoring these correlations within the individuals assumes that binge drinking behaviors in each wave are independent and treating these repeated measures as independent will negatively impact the estimation of standard errors and, therefore, the assessment of significance. Due to correlation between repeated measures of binge drinking behaviors at three time points, a generalized estimating equation (GEE) was applied by using the SAS Genmod Procedure. This framework and software allowed for estimation of the longitudinal effects of our social network variables in adolescence on binge drinking, in terms of both early onset and later use over time, thus controlling for demographic variables. The quasi-likelihood under the independence model criterion (QIC) was used to select a first-order autoregressive [i.e., AR(1)] within-subject correlation structure in the GEE model.

RESULTS

Table 1 displays the frequency of the sample characteristics. Among the 7,966 total samples, approximately 54% were females, and 48% were White followed by 18% Hispanic, 18% Black, 7% Asian, 1% Native American, and 9% Other. Approximately 44% of the total sample indicated having one or more friends outside of their schools and more than half of the students belonged to the medium Bonacich centrality and egocentric density groups. Approximately 40% of adolescents reported having one or more best friends who smoked cigarettes and 52% of adolescents reported having one or more best friends who drank alcohol.

This figure provides information on the proportion of binge drinking in Waves 1, 2, and 3 by social network characteristics. Additionally, we indicated the average proportions of binge drinking at three time points in order to compare each social network group with the overall average. Overall, a substantial proportion of adolescents was engaged in binge drinking, and the proportion of binge drinking increased over time: 22.3% (Wave 1), 26.3% (Wave 2), and

47.7% (Wave 3). However, the proportion of binge drinking among those with low group integration and alcohol-using friends was greater than the average proportion of binge drinking in Wave 1. Approximately, 31% of those who had a high level of grade heterogeneity reported binge drinking in Wave 1. This indicates a 50% greater proportion of binge drinking compared with the average proportion of binge drinking in Wave 1. Approximately 38% of those who had alcohol-using friends reported binge drinking, which is 70% greater than the average proportion among the samples in Wave 1.

In Wave 3, the groups that had the highest proportion of binge drinking were those that had the highest Bonacich centrality (53.7%) and those that had alcohol-using friends (53.7%). These indicate approximately a 13% greater proportion of binge drinking, compared with the average proportion of binge drinking in Wave 3.

The interaction terms between each level of each social network variable and three time points have been used to show the change in association with binge drinking over time. The effects of three social network characteristics out of four on binge drinking changed over time. Specifically, lower group integration (measured by *outside school friends*, a higher level of *grade heterogeneity*) and socialization with alcohol-using friends were associated with increased odds of binge drinking at Wave 1. However, the impact of outside school friends decreased by 10% in Wave 2 and by 20% in Wave 3. A higher level of grade heterogeneity also showed a similar pattern in that its impact decreased by 20% in Wave 2 and by 60% in Wave 3. Similarly, the effect of having alcohol-using friends has decreased by 50% in Wave 2 and by 90% in Wave 3 [odds ratio (OR): 0.5 (Wave 2), OR: 0.1 (Wave 3); Table 2].

High prestige (measured by high level of *Bonacich centralities*) showed the opposite patterns. A high level of prestige, in fact, showed decreased odds of binge drinking in Wave 1 (not statistically significant). However, it had a significant impact on the growing use of binge drinking over time. The effect of high level of prestige has increased by 60% in Wave 2 and by 140% in Wave 3 [OR: 1.6 (Wave 2), OR: 2.4 (Wave 3)], compared with a low level of prestige. High density had no association with binge drinking during adolescence, and this pattern continued during young adulthood.

Table 3 illustrates how the magnitudes of social network characteristics on binge drinking differ at three time points (1995, 1996, and 2001) over a period of 7 years. This quantifies the relative contribution of each social network structure on binge drinking at each time point.

We calculated the ORs and confidence intervals of each social network group on binge drinking at Waves 1, 2 and 3, controlling for gender, grade, ethnicity, and school size. At Wave 1, adolescents with friends outside school were 1.3 times more likely to engage in binge drinking and those with high *grade heterogeneities* were 1.5 times more likely to participate in binge drinking. Similarly, *socialization with substance-using peers* increased the risk of binge drinking by almost 10 times, demonstrating the greatest impact on early onset of binge drinking. However, having high Bonacich centralities was associated with slightly decreased odds of binge drinking at Wave 1 (OR: 0.8).

The effects of outside school friends, high grade heterogeneity, and socialization with alcohol-using peers on binge drinking decreased in Wave 2, and again in Wave 3, compared with Wave 1. However, the effect of high Bonacich centrality increased in Wave 2, and again in Wave 3 (Table 3). Specifically, having outside school friends was no longer associated with later onset of binge drinking (OR: 1.0), and having high grade heterogeneities was less likely to engage in later onset of binge drinking (OR: 0.6), compared with low grade heterogeneities. Although socialization with alcohol-using peers

was associated with increased odds of later onset of binge drinking (OR: 1.4), its impact at Wave 3 was only 1.4. Finally, having high Bonacich centralities showed the greatest risk in binge drinking during the young adulthood (OR: 1.8).

DISCUSSION

Binge drinking among young people has one of the most serious health and economic consequences in US society (CDC, 2010). Accurate prediction of binge drinking is pivotal in designing interventions to prevent binge drinking. The substance abuse field identifies the important role of substance-using peers as well as the social network characteristics in binge drinking among young people. Nevertheless, whether the influence of substance-using peers and the social network characteristics measured in adolescence have short-term (during adolescence) and long-term (between adolescence and young adulthood) impacts on binge drinking has been unclear. Our findings address this gap by analyzing the longitudinal data of adolescents who are transitioning to young adulthood. We expand on prior reports by using a nationally representative sample to ascertain the generalizability of the findings. We also evaluated multiple social network variables (social integration, centrality, density), while many previous studies tended to focus solely on the role of substance-using friends or one or limited network variables.

We discuss two key findings. First, we found that group integration and socialization with substance-using peers during adolescence had an immediate impact on binge drinking during adolescence. Similar to the findings of other studies (Crosnoe & Needham, 2004; Ennett & Bauman, 1994; Hingson, Heeren, & Winter, 2006; Hu et al., 1995), the prevalence of binge drinking gradually increased from adolescence to young adulthood and the patterns of binge drinking emerged in association with social network characteristics. The effects of four types of social network characteristics had different magnitudes of impact on binge drinking in each developmental time point. In fact, the multivariate analysis indicates that adolescents who were on the periphery of the network were 30%–50% more likely to have the *early* onset of binge drinking. This finding is similar to Ennett et al.'s (2006) study, which suggests that adolescents who nominated friends who were not enrolled in their schools had greater odds of substance use. We also found that those who had an alcohol-using peer had a 10 times higher odds of having an *early* onset of binge drinking. This finding is similar to other studies showing that friends' substance use has been one of the most consistent and influential predictors of adolescent substance use (Engels, Knibbe, Vries, Drop, & Breukelen, 1999). This robust magnitude on early onset of binge drinking may be explained by the social learning theory, which argues that adolescents are more likely to respond immediately when they are stimulated by an active pressure to drink (e.g., explicit offers and encouragement by peers; Bandura & Walters, 1963).

Second, the strength of association with binge drinking systematically differed by the social network characteristics over time. With the exception of the density, the association with binge drinking for all other network characteristics showed dynamic patterns of change over time. The impact of adolescents with low social integration on binge drinking reduced by 10%–20% in Wave 2 and 20%–60% during young adulthood (Wave 3). The impact of having alcohol-using friends had more dramatic changes over time in that it decreased by 50% in Wave 2 and by 90% in Wave 3. The longitudinal pattern we observed was that the risk factors for binge drinking during adolescence do not necessarily carry over through young adulthood, regardless of how robust the impact was during adolescence. The reduced effects of best friends' substance use over time were also observed by another study. Engels et al. (1999), in their longitudinal study, found that best friends' cigarette use was significantly associated with adolescents' cigarette use in Time 1, but the effect became

nonsignificant in Time 2 and 3 (during adolescence), suggesting that this observation may be due to the peer group changes as time goes by.

Another explanation can be that there are other predictors for binge drinking in later stages of life. For instance, prestige during adolescence was found as the strongest predictor during young adulthood. The longitudinal impact of prestige also shows the reverse pattern from social integration and proximity to alcohol-using friends of binge drinking. Initially, adolescents who had high prestige were not associated with binge drinking in the short term (from 1995 to 1996). However, in the long term, those who had high prestige showed the greatest increase in binge drinking, compared with the rest of the network characteristics. The effect of a high level of prestige was dramatic and significant, marked by an increase of 70% in a subsequent year and by 140% in 6 years. Overall, the proportion of binge drinking for those who had a high level of prestige in 6 years became identical (53.7%) to those who had alcohol-using best friends (indicated in Figure 1). Our study supports the socialization-population model, which postulates the reason why popular adolescents are at higher risks of substance use: they are more socially involved and sensitive to social norms regarding substance use (Allen et al., 2005). It seems that those who were involved in binge drinking early on were depicted as a more or less “socially marginalized group,” who tended to be unpopular, out-of-network, noncentral, and those who hang out with friends who use substances. In contrast, binge drinking was not associated with those who were most prominent in the network, appear to be popular, socially dominant, and accepted by peers during adolescence. This means that those who are peripheral in the network are at a higher risk of early onset of binge drinking (Aloise-Young, Graham, & Hansen, 1994). Although the mechanisms are not clear, it is plausible that adolescents are watching each other to see who follows the “norms” and who does not follow the “norms” that are generally accepted among peers in an adolescent developmental stage. Studies show that binge drinking is not an acceptable norm for young adolescents in general (Office of Judicial Justice and Delinquency, 2005). However, for those who have lower integration and alcohol-using best friends, the desire to keep up or adhere to the generally accepted norms may be outweighed by their desire to enter or maintain reciprocal friendships. Thus, they may be less sensitive to respond to social sanctions or the consequences of drinking. This may explain the immediate risk (short-term risk) of binge drinking.

In contrast, those who are well accepted among peers do not want to deviate from the generally accepted “norms” because this deviation may damage the stability of their own status and they may be more responsive to the loss of reputation than those with lower integration. However, as adolescents emerge into young adulthood, binge drinking is viewed as a generally accepted norm among college students (Ahern, Galea, Hubbard, Midanik, & Syme, 2008). Thus, it is possible that those with high prestige feel pressure to drink and to entertain others in order to secure their popularity because the loss and dislocation of social status might come as more painful than the consequences of health risk behaviors. Therefore, prestigious adolescents are associated with latent risks of binge drinking. This implies that when the norm is both valued by others and functional in itself, individuals gravitate toward it. This interpretation is also supported by a study that found that popular students were at a greater risk of smoking when they attended schools with a higher prevalence of smoking, whereas popular students had a lower smoking prevalence in the schools that have lower prevalence (Alexander et al., 2001). The effects of a lower level of density did not have any immediate or long-term effect on binge drinking. This is not immediately clear; however, one possible explanation can be drawn. This null finding on density may be due to the unidentified norms surrounding three levels of the density. Types of norms supported by each level of density and degree in which actors with different levels of density are supporting the specific norms are unknown. For instance, participants with low density may not regard norms in their networks as important as those with high density

because the norms of low-density networks might not have a big impact on the actors. Therefore, in order to have a better understanding of the relationship between density and binge drinking, future studies should not only examine density to predict binge drinking but also examine the norms of the networks and how significant the norms in each network are to the actors.

Study's Limitations

There are several limitations in the Add Health data. First, the social network variables were only measured between 1994 and 1995; thus, there is no information on the changes in an individual's social network. As a result, what we are able to assess is the impact of a single "snapshot" of the study participants' social network during adolescence on binge drinking at various time points, from adolescence to young adulthood. Because adolescents' social positions are dynamic and affected by time and environmental contexts, it would be desirable to observe the changes in our social network variables over time and their possibly varying effects on the longitudinal trends of binge drinking. However, the costs of taking additional measurements over multiple waves would be prohibitively high. Capturing true networks of changing and evolving relationships between people (e.g., from high school to college) may be highly challenging (Scott, 1991).

Second, although we controlled for the size of the school, we did not control for the degree of substance use prevalence in each school. As indicated earlier, Alexander et al. (2001) found that being popular provides a different risk for substance use, which depends on the rates of substance use of the other students in their school. Future studies should document the extent to which the high school or college environments with regard to alcohol or drug use prevalence affect the highly central adolescents and young adults. This will provide insight into the role of norms perceived by young people and how these norms affect substance-using behaviors.

Third, binge-drinking episodes were measured via self-report. Self-reported data are commonly acknowledged as being credible (Akers, Massey, Clarke, & Lauer, 1983; Del Boca & Noll, 2000), yet there are doubts about the credibility of such results when considering alcohol and drug use. Another study found that one fourth of the adolescents who self-reported never consuming alcohol reported on a different occasion that they had, thus suggesting that self-reports from adolescents who say they never consumed alcohol are questionable (Brown & Zimmerman, 2004). To address the problems with underreporting sensitive health risk behaviors associated with self-reported data, Add Health utilizes computer-assisted self-interviewing (CASI) and audio-CASI systems to administer these sensitive questionnaires. CASI and audio-CASI are proven to be highly effective in drawing out disclosures of illegal or unacceptable behaviors such as substance abuse (Lessler & O'Reilly, 1997). For example, Waterton and Duffy (1984) found that reported alcohol consumption was 30% greater with CASI than with Self-Assessment Questionnaires (SAQs).

Despite the data limitations, our findings demonstrate a new avenue in this field that peer social networks place immediate and latent risks in the developmental progression of binge drinking. This study also provides the insights that an alcohol consumption-related intervention, which neglects the longitudinal impacts of social network, may fail to "protect" the seemingly most accepted and prestigious adolescents from being binge drinkers, as they become adults. Future research should place heightened consideration on identifying the mechanism of social network characteristics on binge drinking and pay increased attention to social network assessment and intervention efforts.

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GLOSSARY

Alter	The alter is any person to whom the subject is linked. In this case, the alters are students in the same school as the ego who are eligible to be nominated as friends.
Bonacich centrality	Bonacich centrality score measures centrality or popularity in a social network by how many friends an individual (ego) has and also by the number of friends the ego's friends have. The degree to which an ego is centrally located in the network is a function of the centrality of those they are connected to. Therefore, individuals who are connected to more central people would have a higher Bonacich centrality score than those who are not.
Density	The density is the volume of connections in the network. It is the number of ties in a network as a proportion of all possible ties. Dense networks have many ties while sparse networks have few.
Ego	The ego is the respondent of the survey, the main subject.
Grade heterogeneity	Heterogeneity of an ego network is defined in respect to the traits of a categorical attribute; in this case, it is grade level. Grade heterogeneity measured the proportion of friends who were not in ego's grade. The value ranged from 0 to 1, if all members of the network are in the same grade, then grade heterogeneity = 0.
Outside school friends	This social network was defined by the school in which the questionnaire was given and its sister school. If a nominated friend

	did not attend ego's school, then he or she was counted as an outside school friend.
Tie	A tie is a link between two people in a network. There are direct ties and indirect ties. In this case, a tie is created when one person nominates another.
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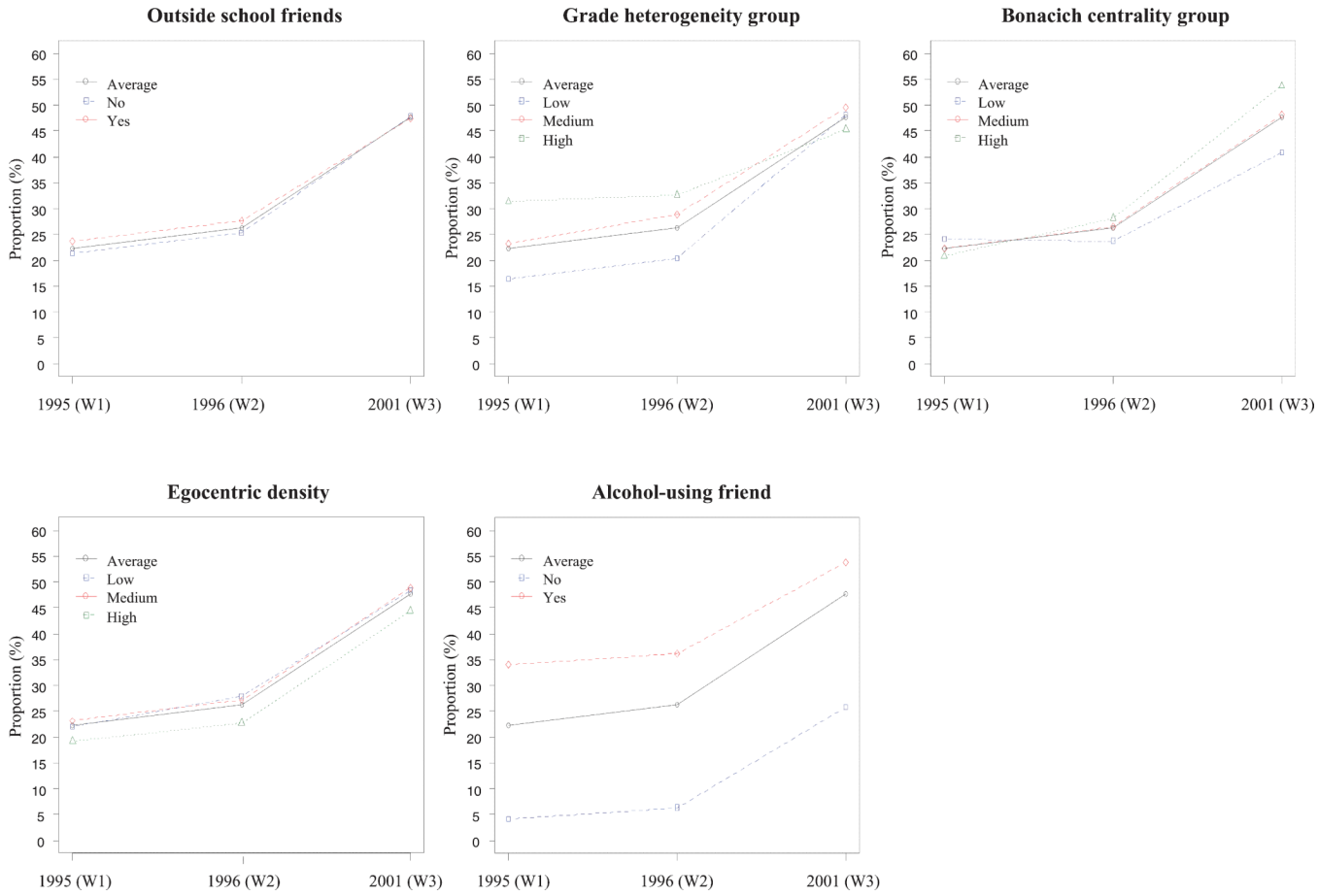

FIGURE 1.

Binge drinking proportion by social network characteristics. Average proportions of binge drinking are 22.32% in Wave 1, 26.32% in Wave 2, and 47.71% in Wave 3 and they are marked with black dots. (W1), (W2), and (W3) indicate Waves 1, 2, and 3.

TABLE 1

Frequency and prevalence distribution of study samples by explanatory variables in 1994–1995

Explanatory variables (*n* = 7,966)	***n***	**Prevalence (%)**
Gender		
Males	3,679	46.2
Females	4,287	53.8
Grade		
Grade 6	10	0.1
Grade 7	1,229	15.4
Grade 8	1,192	14.0
Grade 9	1,620	20.3
Grade 10	1,812	22.7
Grade 11	1,674	21.0
Grade 12	380	4.8
Race		
White	3,822	48.0
Hispanic	1,399	17.6
Black	1,421	17.8
Asian	533	6.7
Native American	79	1.0
Other	712	8.9
	Mean	Range
School size (number of students/100)	8.9	Min.: 0.3, Max.: 25.6
Social network variables	*n*	Prevalence (%)
Group integration		
Outside school friends		
No	4,440	55.7
Yes	3,526	44.3
Grade heterogeneity group		
Low	2,737	34.4
Medium	3,392	42.6
High	1,594	20.0
Prestige		
Bonacich centrality		
Low	1,503	18.9
Medium	5,072	63.7
High	1,391	17.5
Density		
Egocentric density		
Low	708	8.9
Medium	5,870	73.7
High	1,145	14.4

Explanatory variables (*n* = 7,966)	***n***	**Prevalence (%)**
Socialization with substance-using peers		
Alcohol-using friend		
No	3,730	46.8
Yes	4,108	51.6

TABLE 2

Longitudinal analyses of social network structures on binge drinking: Changes of binge drinking rate over time (n = 7,966)

	Binge drinking
Wave (Ref.) = Wave 1	
Wave 2	2.5***
Wave 3	22.4***
Gender (Ref.) = Male	
Female	0.6***
Grade (Ref.) = Grade10	
Grade 6	1.6
Grade 7	0.6***
Grade 8	0.8*
Grade 9	0.9
Grade 11	1.3**
Grade 12	1.3*
Race (Ref.) = White	
Hispanic	0.8**
Black	0.3***
Asian	0.4***
Native American	0.8
Other	0.8**
School size (number of students/100)	1.0
Social network variables	
Group integration	
Outside school friends	
No (Ref.)	1.0
Yes	1.3**
Grade heterogeneity group	
Low (Ref.)	
Medium	1.2*
High	1.5**
Prestige	
Bonacich centrality	
Low (Ref.)	
Medium	0.8*
High	0.8
Density	

	Binge drinking
Egocentric density	
Low (Ref.)	
Medium	1.2
High	1.0
Socialization with substance-using peers	
Alcohol-using friend	
No (Ref.)	
Yes	9.6***
*Interaction terms (social network groups * wave)*	
Outside school friends	
Yes × Wave 2	0.9
Yes × Wave 3	0.8*
Grade heterogeneity group	
Medium × Wave 2	1.0
High × Wave 2	0.8
Medium × Wave 3	0.6***
High × Wave 3	0.4***
Bonacich centrality	
Medium × Wave 2	1.3
High × Wave 2	1.6**
Medium × Wave 3	1.7***
High × Wave 3	2.4***
Medium × Wave 2	0.8
High × Wave 2	0.9
Medium × Wave 3	0.7*
High × Wave 3	0.8
Alcohol-using friend	
Yes × Wave 2	0.5***
Yes × Wave 3	0.1***

Note: (Ref.) denotes a reference group. Reference groups for interaction terms are consistent with main effects. The reference groups are as follows: no outside school friends, low grade heterogeneity, low Bonacich centrality, low egocentric density, and no cigarette smoking friend/alcohol-using friend and Wave 1.

* $p < .05$

** $p < .01$

*** $p < .001$.

TABLE 3

Longitudinal analyses of social network structures on binge drinking: ORs of binge drinking at Waves 1, 2, and 3 (n = 7,966)

	Binge drinking		
	Wave 1	**Wave 2**	**Wave 3**
Group integration			
Outside school friends			
No (Ref.)	1.0	1.0	1.0
Yes	1.3	1.2	1.0
Grade heterogeneity group			
Low (Ref.)	1.0	1.0	1.0
Medium	1.2	1.3	0.8
High	1.5	1.1	0.6
Prestige			
Bonacich centrality			
Low (Ref.)	1.0	1.0	1.0
Medium	0.8	1.0	1.3
High	0.8	1.3	1.8
Density			
Egocentric density			
Low (Ref.)	1.0	1.0	1.0
Medium	1.2	1.0	0.9
High	1.0	0.9	0.8
Socialization with substance-using peers			
Alcohol-using friend			
No (Ref.)	1.0	1.0	1.0
Yes	9.6	4.6	1.4

Note: (Ref.) denotes a reference group.