Alcohol and sex: friendship networks and co-occurring risky health behaviours of US adolescents

Kwon Chan Jeon and Patricia Goodson

Department of Health and Human Performance, Northwestern State University, Natchitoches, LA, USA; Department of Health and Kinesiology, Texas A&M University, College Station, TX, USA

ABSTRACT
This study examined how the structure of friendship networks influences two risk behaviours in tandem (drinking and sexual intercourse) among a sample of US adolescents (7th–12th grades, \( n = 901 \); 2 schools) from Wave I of the Add Health data. For one school, adolescents in denser and smaller networks were at higher risk for engaging in sexual intercourse and drinking alcohol simultaneously. In that school, network attributes (out-degree and betweenness) and adolescents’ age were associated with an increased risk. In the other school, more diffused friendship networks posed less risk of engaging in these two behaviours in tandem. Moreover, engagement in risky behaviours was significantly predicted by teens’ age and gender. We conclude that friendships’ influence on adolescents’ risk behaviours varies, depending on size and composition of the networks and adolescents’ characteristics. Moreover, understanding adolescents’ social ties can be useful for health promoters, thus research on adolescent networks remains warranted.

ARTICLE HISTORY
Received 24 June 2015
Accepted 17 October 2015

KEYWORDS
friendship; social networks; adolescents; sexual behaviour; alcohol use; peer influence

Introduction
In the USA, the national Youth Risk Behavior Survey (YRBS) has documented that 9th–12th grade students in high school have engaged in many risky health behaviours. According to the YRBS data from 2011, 70.8% of teenagers reported having consumed at least one alcoholic drink (Centers for Disease Control and Prevention, 2012a). Moreover, 47.4% of adolescents had engaged in sexual intercourse (Centers for Disease Control and Prevention, 2012c). These two behaviours (i.e. alcohol use and sexual intercourse) occur more frequently among adolescents than other risky behaviours, such as tobacco use (44.7%) (Centers for Disease Control and Prevention, 2012d) or marijuana use (39.9%) (Centers for Disease Control and Prevention, 2012b). In addition, in the same year, 22.1% answered positively to the item: ‘Did you drink alcohol or use drugs before you had sexual intercourse the last time?’ — indicating that nearly half of the adolescents who engaged in sexual intercourse, did so under the influence of drugs or alcohol (Centers for Disease Control and Prevention, 2012c).

Risky behaviours among adolescents pose a significant threat to their health during the adolescence years, and engaging in risky behaviours can lead to non-trivial health problems, even as adults (DiClemente, Hansen, & Ponton, 1996). Certain levels of alcohol consumption during adolescence can negatively affect physiological development (by affecting the brain and hormones,
for instance), and can lead to other risky behaviours, including unprotected sexual activity and tobacco use (Guo et al., 2002; Santelli, Robin, Brenner, & Lowry, 2001). Although engaging in sexual activity during adolescence is normative within many social groups in the USA (Brendgen, Wanner, & Vitaro, 2007), beginning sexual intercourse at an early age leads to an increased risk for sexually transmitted infections, or for becoming pregnant (Tapert, Aarons, Sedlar, & Brown, 2001). These risks may increase when sexual activity is coupled with significant amounts of alcohol consumption (Bailey, Pollock, Martin, & Lynch, 1999), because high blood alcohol levels can impair judgement and lead to unprotected intercourse.

The literature on adolescents' health addresses the notion that when adolescents engage in a risky behaviour, they are more likely to engage in other risky behaviours. For instance, in a study conducted by MacArthur et al. (2012), the authors documented that alcohol use among adolescents (aged 15 and 16) was positively associated with other risky behaviours (i.e. substance use and sexual activity). Additionally, the study by Patrick and Schulenberg (2010) presented adolescents' substance use (i.e. smoking and marijuana use) as leading to greater intentions to drink alcohol.

For these phenomena, earlier literature demonstrate that, in particular, friends and/or friendship networks during adolescence play a key role in influencing adolescents' risky behaviours (Alexander, Piazza, Mekos, & Valente, 2001; Pollard, Tucker, Green, Kennedy, & Go, 2010; Sieving, Eisenberg, Pettingell, & Skay, 2006; Valente, Unger, & Johnson, 2005), because friends and friendships underlie person-to-person and/or group-to-group interactions. For instance, the study conducted by Schwinn and Schinke (2014) found that drinking and offering alcohol increasingly affected other teens’ intentions toward drinking. In addition, Fujimoto and Valente (2012a) addressed a key finding that various types of friendships among adolescents (i.e. mutual, reciprocal and directional friendships) strongly influenced friends’ substance use (e.g. drinking and smoking).

Moreover, other studies have identified friendships as probably the most significant factor in the spreading of risky behaviour among groups of teens (Ali & Dwyer, 2011; Fujimoto & Valente, 2012b; Jaccard, Blanton, & Dodge, 2005), because of adolescents’ development and most of them needing to belong to their friends’ or other social groups outside their own family. For instance, a study carried out by Mercken, Snijders, Steglich, and de Vries (2009) identified that adolescents were more likely to select their friends based on similar smoking behaviour. Additionally, the study conducted by Fujimoto and Valente (2013) found that adolescents affiliated with organised school sports and clubs (e.g. basketball and playing chess) affected non-affiliated adolescents’ drinking behaviour. Therefore, examining friendship networks may provide better information on adolescents’ behaviours and their interpersonal mechanisms, than the study of individual intra-personal factors alone.

One way to capture the influence of friendships among adolescents is Social Network Analysis (SNA). Studies have highlighted that SNA can be applied to understanding the scope of changes in risky health behaviours and friendship ties among adolescents (Christakis & Fowler, 2007; Jeon & Goodson, 2015; Luke & Harris, 2007; Smith & Christakis, 2008), because the interplay of dynamic friendships and behaviours occur inside inter-personal systems (Steglich, Snijders, & Pearson, 2010). Specifically, utilising SNA can provide visuals (in graph form) that are useful to describe and analyse the patterns of a network’s structure, as well as verify statistical measures (Crnovrsanin, Muelder, Faris, Felmlee, & Ma, 2014).

The theoretical perspective of network theory focuses on structural and/or relational approaches to the research of social (network) influence (Cook & Whitmeyer, 1992), compared with learning and/or observing approaches in traditional theories. In other words, network theory is based on the notion of network influence: adolescents are affected by interacting directly and indirectly with their friends or with their friends’ friends (Ennett & Bauman, 1996). The result is that they can share similar behaviours (i.e. influenced by friends or exert influence on friends) or stand in similar positions inside their networks (i.e. individuals connecting to all other friends in the network measured by network centralities such as degree [the number of links to and from a person], density [the ratio of the number of actual connections divided by the total possible connections in the network] (Valente, 2010) and betweenness [the number of times an adolescent lies on the shortest paths linking other adolescents
in the network]) (Borgatti, Everett, & Johnson, 2013). Therefore, utilising network analysis, researchers can examine the composition or the set-up of the network and its influence upon adolescents’ risky behaviours.

Traditionally, risky behaviour dissemination relies on individual-level information on how adolescents adopt a behaviour through learning and/or observing others perform the behaviour. Researchers have used traditional theories such as the Theory of Planned Behavior or Social Cognitive Theory in studies of health and risky behaviours among adolescents. These classical theories have emphasised the individual-level inter-personal process of learning risky behaviour by directly observing how others behave, or by adopting a group’s social norms and framing attitudes according to these norms in order to be accepted into those groups (National Institutes of Health, 2005).

Regarding our topic of interest, here, in addition to social network theory, Jessor’s Problem Behavior Theory (PBT) (1987) can also help explore the mechanism of influence of friendship network structure upon adolescents’ risky behaviours. PBT is based on a social-psychological framework that attempts to explain risk factors related to adolescent involvement in various problem behaviours such as sexual intercourse, tobacco, alcohol and drug use (Jessor, 1987). PBT includes three major systems of socio-psychological variables: the personality system (i.e. individual values, beliefs and attitudes), the perceived environment system (i.e. family and friend influences) and the behaviour system (i.e. drinking, deviant behaviour, marijuana, cigarettes and drug use behaviours). According to Jessor (1987), adolescents’ problem behaviours are associated with the perceived environment system (e.g. peer relations) and personality system (e.g. attitudes), because, within peer relations, friends’ behaviours can directly influence various risky behaviours among adolescents.

Informed by these theoretical perspectives, the purpose of this study, therefore, is twofold: using data from a large, national sample of adolescents in the US, to (1) describe the structure of friendship networks for adolescents who engage in, and for adolescents who do not engage in sexual intercourse and alcohol consumption simultaneously; and (2) assess the influence of friendship network structure upon adolescents’ risky health behaviours (specifically the behaviours of sexual intercourse and alcohol consumption in tandem). To achieve this purpose, we employ SNA techniques utilised by authors in the research of social networks (Ennett et al., 2006; Mercken et al., 2009; Valente, Gallaher, & Mouttapa, 2004).

This study is important because it examines two risky behaviours simultaneously, while most previous studies examine risky behaviours individually and in isolation. We believe that research examining multiple simultaneous risk behaviours can significantly help with the design of more effective prevention programmes to promote adolescents’ healthy development.

**Methods**

**Data source**

This study utilised the longitudinal data generated by the National Longitudinal Study of Adolescent Health to Adult Health (Add Health) in the USA. The Add Health study gathers information (e.g. health-related behaviours of adolescents, demographics and family socio-economic status) for students in grades 7–12 nationwide, thus yielding representative data stored in the Caroline Population Center at The University of North Carolina at Chapel Hill. To date, Waves I, II, III and IV of the data collection conducted in 1994–1995, 1996, 2001–2002 and 2007–2008, respectively, have followed youth from adolescence to young adulthood. The Add Health data-set comprises completed in-school questionnaires and in-home interviews. The Wave I in-school questionnaire (n = 90,118) from 145 schools includes topics such as demographic characteristics (e.g. age, gender and ethnicity), health-risk behaviours, extracurricular activities in the school year, and friendship nominations for the five best male and five best female friends from school rosters (Harris et al., 2009).
Sample

From the pool of adolescents completing the in-school questionnaire, the Wave I in-home interview sample \( (n = 20,745) \) in grades 7–12 is drawn. The in-home interview includes sensitive questions including those about alcohol use and sexual behaviour. Additionally, the in-home interview sample contains a subsample, called the saturated school sample \( (n = 3702) \) from 16 schools where all enrolled students in the schools participated in in-home interviews. Therefore, in order to achieve our purpose, this study used the saturated sample from the two schools providing the largest samples out of the original 16, for analysis. The remaining 14 schools are excluded due to relatively small sample sizes and substantially larger amounts of missing data. Moreover, friendship nominations in these saturated schools allow us to construct complete friendship networks, indicating these networks can provide inter-relationships such as adolescent’s relations and network positions among individual adolescents.

We limited our analysis to adolescents who answered ‘yes’ or ‘no’ to the question, ‘The most recent time you had sexual intercourse, had you been drinking alcohol?’ in the in-home interview, from the two schools with the largest saturated samples. This resulted in a total sample of 901 (School 1: \( n = 324 \) and School 2: \( n = 577 \)).

Measures

Friendship nominations were obtained by asking students to name up to five best male and five best female friends. The friendship nominations from the same school rosters to which the respondent belonged received unique identification codes (e.g. 12345678), whereas friends from different schools were duly identified by specific codes (e.g. 77777777). We excluded friendship nominations from different schools in subsequent analyses because these friends did not connect with each other within the same friendship networks. Using nominations from the same school rosters, we can create complete networks within a given school. These complete networks allow us to measure adolescent’s relations and network positions.

We computed the following measures of friendship networks via a social network analysis computer program.

1. Degree is ‘the number of links to and from a person’ (Valente, 2010). Out-degree is the number of friendship ties that the ego (person responding to the survey) nominates; in-degree is the number of friendship nominations the ego receives (Valente, 2010).
2. Density is the ratio of the number of actual connections divided by the total possible connections in the network (Valente, 2010).
3. Betweenness is the number of times an adolescent lies on the shortest paths linking other adolescents in the network (Borgatti et al., 2013).
4. Bonacich centrality is ‘… not only a function of how many friends an individual has but also the number of friends one’s friends have’ (Ali, Amialchuk, & Rizzo, 2012).

In this study, we assessed the influence of friendship network structures upon the behaviours of sexual intercourse and alcohol consumption in tandem, based on a question in the in-home interview at Wave I. Specifically, students were asked if they had been drinking alcohol when they last had sexual intercourse. Originally, while the questionnaire offers the option of answers coded as three categorical variables (e.g. 0 = ‘no’, 1 = ‘yes’, and 3 = ‘refused’), we dichotomised the variable, examining only participants who answered ‘yes’ or ‘no’. We also utilised gender and grade as control variables, coded as dichotomous (1 = male and 2 = female) and categorical variables (e.g. 7 = 7th grade and 8 = 8th grade) from the in-home interview at Wave I.
Statistical analyses

For descriptive analyses we employed Stata 13 (StataCorp LP, College Station, TX). Moreover, to analyse the saturated samples from the in-home interview at Wave I, we utilised the NetDraw feature in UCINET, a dynamic network analysis tool, to describe the structure of the friendship networks for adolescents who engaged in and for those who did not engage in simultaneous sexual intercourse and alcohol use.

To assess the relationship between network structure and adolescents’ risk behaviours, we ran a logistic linear regression using Stata 13 for each school. In a preliminary analysis, we assessed whether students in the two schools were similar enough to agglomerate into a single sample, and found there were statistically significant differences between Schools (1 and 2) on the question regarding alcohol use during sexual intercourse ($p = .03$). We report our analyses, therefore, separately for each school,
as students in the schools differed significantly in their responses on the surveys. Moreover, we also
assessed multicollinearity, reporting variance inflation factors (VIF), among variables in the logistic
regression analysis. The VIF values of all variables were below 4.42 in Schools 1 and 2, indicating mul-
ticollinearity was not a problem (O’Brien, 2007).

Results

Descriptive statistics

As shown in Table 1, we employed descriptive statistics to highlight the characteristic of the samples
from School 1 (n = 324) and School 2 (n = 577), respectively. Because adolescents were allowed to choose
multiple options for the item on race/ethnicity, the percentage totals exceed 100%. In School 1, nearly
half of the students were female (49.48%), 29.1% reported being 18 years old and 99.4% marked their
race/ethnicity as white. In School 2, more than half of the students (54.1%) were male, 35.88% were
18 years old and 29.5% reported their race/ethnicity as African-American.

Table 2 shows descriptive statistics for adolescents from the two schools, who engaged in (‘yes’
and who did not engage in (‘no’) drinking alcohol before having intercourse. Once again, the total
percentages for race/ethnicity exceed 100%, because students could have chosen multiple ethnic-
ities. School 1 had 50 students in the ‘yes’ group, and 274 students in the ‘no’ group. More than half
the students in the ‘yes’ group (62%) were boys and 34% were 17 and 18 years old, respectively. All
students (100%) marked one of their race/ethnicities as white. Among the ‘no’ group at School 1,
more than half (51.5%) of students were girls and 28.1% reported being 18 years old. The majority
(99.3%) marked white as one of their ethnicities. In School 2, 40% were boys in the ‘yes’ group and,
of these, 40.98% were 17 years old; 34.4% reported their race/ethnicity as African-American. In the
‘no’ group, 52.7% were boys, 37% were 18 years old, and 28.9% marked one of their race/ethnicity
choices as African-American.

Networks

Figure 1 depicts the network structures of School 1 and 2, based on friendship nominations, for the
adolescents who engaged in sexual intercourse and drinking alcohol. Adolescents were asked to report
five best male and female friends; however, the total number of friendship nominations varied by stu-
dent. It is important to note we did not include ‘isolates’ or adolescents with no ties in Figure 1. Thus,
the number of students in the graph depicted in Figure 1 differs from the total sample. Each square
(adolescents engaged in risky behaviours) or circle (their friends) represents a student in the network.
Squares and circles are sized based on degree. In School 1, there are 137 adolescents with 147 ties. The
graph for School 2 displays 92 students with 41 ties.

Figure 2 shows students (circle) who did not engage in the two behaviours we assessed within each
school, based on friendship nominations. We also did not include ‘isolates’ in Figure 2. Thus, as for Figure
1, the number of students in the graphs differ from the number of students in the analytical sample.
Each circle represents a student in the network. Circles are sized based on degree. School 1 portrays
468 adolescents with 524 ties in the network. School 2 shows 701 students with 448 ties.

Assessing the influence of network structure on individual behaviour

Table 3 shows the results of the probabilities (or odds ratios) of engaging in sexual intercourse and
drinking alcohol associated with individual-level and network-level variables for adolescents in Schools
1 (n = 324) and 2 (n = 577). The probabilities were estimated separately for each school.

In School 1, in terms of demographic predictors, age was significantly associated with simultaneous
engagement in sexual intercourse and alcohol consumption (OR = .66, p < .05), indicating adolescents
who were younger were more likely to participate in these two behaviours.
We also tested network centrality measures such as degree, density and Bonacich power, and found out-degree and betweenness to be associated with engaging in these behaviours (sex and drinking alcohol) in School 1. Engaging in sex and drinking alcohol simultaneously was significantly predicted by out-degree (students named others as a friend: OR = 1.39, $p < .05$) in this friendship network, indicating adolescents who named more friends were more likely to have an increased engagement in these behaviors.

**Figure 1.** Network of adolescents who engaged in sexual intercourse and alcohol drinking, simultaneously, within Schools 1 and 2 from the Add Health data-set.
behaviours. Additionally, betweenness (the fraction of the shortest path between students: OR = 1.01; p < .05) was significantly related with engagement in risky behaviours (sexual intercourse and drinking alcohol in tandem), indicating students who were connected through a short path with others exhibiting risky behaviours were more likely to engage in these risky behaviours, themselves.

In School 2, engagement in risky behaviours (sex and alcohol consumption simultaneously) was significantly predicted by gender (OR = .46, p < .05), indicating male students were more likely to have

---

**Figure 2.** Network of adolescents who did not engage in sexual intercourse and alcohol drinking in tandem, within Schools 1 and 2 from the Add Health data-set.
increased involvement in risky behaviours. Moreover, age (OR = 1.43, \( p < .05 \)) was another significant predictor, indicating students who were older were more likely to engage in sexual intercourse and drinking alcohol at the same time. In contrast with the results from School 1, none of the network centrality measures for the School 2 sample had a statistically significant relationship with adolescents’ sexual intercourse and drinking in tandem.

**Discussion**

In this study, we were interested in the influence of friendship network structures upon adolescents’ risky health behaviours, specifically the simultaneous behaviours of sexual intercourse and alcohol consumption. Utilizing SNA, we identified three predictors (i.e. age, out-degree and betweenness) in School 1 and 2 predictors (i.e. gender and age) in School 2. These factors were significantly associated with risky behaviours (sexual intercourse and drinking alcohol in tandem) among adolescents in our sample. Our results indicated that (a) the structure of friendship relationships (i.e. out-degree and betweenness) among students was related to an increased risk for engaging in these behaviours in one school, but not in the other; and (b) demographic attributes (i.e. age and gender) also varied by school.

In School 1 – as shown in Table 1 describing the characteristic of the sample – the sample size is relatively smaller (\( n = 324 \)) than School 2 (\( n = 577 \)), but, the friendship network in School 1 shows a larger number of connections (denser network) among adolescents sampled than School 2 (as depicted in Figure 1, School 1 had 147 ties in the ‘yes’ group). School 2 displays a friendship network with sparser connections (also in Figure 1: School 2 had 41 ties in the ‘yes’ group). This suggests that in this study, at least, tightly bound friendship networks in smaller schools with single race/ethnicity (School 1) may carry higher risk of engagement in sexual intercourse and alcohol consumption in tandem. On the other hand, more diffused (spread out) networks in larger schools with more diverse race/ethnicity (School 2) seem to pose less risk of engaging in these two risk behaviours simultaneously. This finding suggests that, counterintuitively, larger networks may pose less risk, depending on how densely connected its members are.

With respect to network attributes (i.e. out-degree and betweenness), out-degree refers to the number of friendship nominations teens made (Valente, 2010). In this study, the out-degree attribute in School 1 was correlated with an increased risk of engaging in sexual intercourse and alcohol consumption simultaneously. As defined earlier, out-degree refers to the nominations made by a study participant (or the number of ties that stem from a node in the directed network; in the case of friendship networks: a measure of gregariousness); in-degree refers to the nominations received by a study participant (in the case of friendship networks, a measure of popularity) (Valente, 2010). In our sample, students who nominate others rather than receive nominations from others appear to influence their peers’ behaviours within their friendship network. This may indicate that, potentially, these students
actively seek contact with other students in order to embed into friendship networks. Similar to our finding, the study conducted by Fujimoto and Valente (2012a) identified that students who nominated others were more likely to influence their friends’ smoking and drinking behaviours, than adolescents who were nominated by others.

Betweenness is another attribute of a network, referring to the number of times an adolescent lies on the shortest paths linking other adolescents in the network (Borgatti et al., 2013). We included betweenness centrality because it can be an indirect measure of network flow or influence spread among adolescents. Betweenness also allows us to identify individuals who would possibly exert control over others, within the network.

In this study, the betweenness attribute was significantly related with engagement in sexual intercourse and drinking alcohol in School 1. This relationship potentially indicates that individuals in the network are likely to be influenced by the risky behaviours of friends or exert influence toward risky behaviours on others, because they are connected by a greater number of geodesic paths. Additionally, it may be possible that there are individual adolescents with higher betweenness in the network, so they control or influence behaviour or information flow serving as gatekeepers among the other adolescents (Ennett et al., 2006). Supporting this finding, a study conducted by Ennett et al. (2008) assessed the relationship between peer attributes and adolescents’ smoking utilising SNA. Authors found there was a significant correlation between friend’s cigarette use and betweenness centrality: higher betweenness centrality was related to an increased risk for engaging in smoking behaviour.

While these two network attributes (out-degree and betweenness centrality) were associated with risky behaviours (sex and drinking alcohol simultaneously) in School 1, no effects for network structure were found in School 2.

Consistent with previous research on adolescents’ risky health behaviours and peer influence, we did find that adolescents’ age was associated with an increased risk for involvement in sexual intercourse and simultaneous alcohol consumption. In School 1, adolescents who were younger were more likely to have engaged in these risky behaviours; conversely, in School 2, teens who were older were more likely to participate in those behaviours. In other words, being young, within certain structures, may entail protection. On the other hand, being young, within different structures, may lead to risk. A study by Ali and Dwyer (2011) assessed the association between peer friendship networks and adolescent’s sexual behaviour. The authors documented that older adolescents enrolled in higher grades were more likely to have had sexual intercourse and multiple sexual partners.

Regarding gender, surprisingly, we did not find any effect in School 1. Even when we calculated a logistic regression model including only demographic variables and no network attributes, the results did not show gender as having a positive relationship with the risky behaviours in that school (OR = .642, p = .166). However, in School 2, male teens were more likely to have engaged in the two risky behaviours we assessed, compared with female teens. It is possible that male adolescents within this present friendship network may show particularly high susceptibility toward risky behaviours. It may also indicate that male teens may get an earlier start to engage in risky behaviours than females in this study. Reasons explaining why gender was a significant predictor in School 2, but not in School 1, are not clear. Findings indicated that, for School 1 study participants, knowledge about the structure of their networks supersedes knowledge about individual students’ gender. In other words, for School 1, if attempting to predict engagement in sexual intercourse and alcohol consumption (in tandem), having information about the network would be more valuable than information on gender. For School 2, because the network structure had no association with the behaviours, knowing the students’ gender becomes more valuable predictive information than their network structures.

We did find in one school that adolescents’ friendship network characteristics can influence theirs and their friends’ risky behaviours, within certain contexts. These findings are in line with network theory because the theory proposes that network properties (such as network centralities, such as degree or density) represent mechanisms that can affect outcomes of interest (Fredericks & Durland, 2005). Moreover, our findings suggest the underlying causes of tie formation (i.e. out-degree and betweenness) among adolescents can influence the risky behaviours of other adolescents in the network. Therefore,
these findings can provide an additional layer of understanding and greater insight into the overall influence of friendship networks on adolescents’ risky behaviours.

When examining risky behaviours of adolescents (e.g. smoking or drinking alcohol), previous studies have found evidence that intra-personal factors (e.g. attitudes or beliefs) and the relationships among adolescents (inter-personal factors) are significantly correlated with teens’ risky behaviours. Such findings indicate that adolescents’ risky behaviours can be influenced by friendships or by observation of other teens’ behaviours. Jessor’s PBT helps explain this phenomenon as it proposes that problem behaviours can be explained from the perspective of three major systems acting upon each other: socio-psychological variables, such as families (i.e. parents or siblings) or friends’ behaviours (perceived environment system) may affect the adolescents’ beliefs or attitudes (personality system) that may predispose individual adolescents toward risky behaviours (behaviour system) (Donovan, Jessor, & Costa, 1991; Jessor, 1987). Therefore, PBT as a conceptual framework can help clarify the mechanisms through which adolescent ties can influence their behaviour.

Our study makes an important contribution to the literature on adolescent health promotion because it examines engagement in two risk behaviours, simultaneously (sexual intercourse and drinking alcohol in tandem), and approaches this examination from a friendship network perspective. Nonetheless, despite its contributions, this study contains important limitations: (1) we did not include any intra-personal variables such as attitudes, norms or beliefs, in our analyses; and (2) we only assessed one-time period (Wave I). Further analyses might include intra-personal factors as control variables, to better tease out the potential effects of network structure(s). Also beneficial would be to examine multiple points in time (e.g. Waves I and II) in order to provide a better understanding of the changes in behaviour and in network composition/structure resulting from the influence of friends who engage in risky behaviours. A third limitation regards our findings and their different patterns for School 1 and 2. Given the differences, the findings may not generalise to a more contemporary sample. Lastly, the Add Health data-set is based on self-reported information and carries with it the potential errors in recall and reporting intrinsic to this type of inquiry. Generalisation, again, should be avoided.

Recommendations for researchers and health promoters

Despite these limitations, this study suggests that denser friendship ties, coupled with specific network characteristics (i.e. out-degree and betweenness) among students in a smaller school may be associated with prevalence of engagement in sexual intercourse and alcohol consumption simultaneously, as compared to a larger school. Age and gender were also found to have an association, although gender was not a factor in one of the schools. These findings have implications for future research and for the development of health promotion programs for adolescents.

Regarding research, we believe future studies should employ SNA to examine adolescents’ risky behaviours, but they should also include multi-level data (intrapersonal, interpersonal and school characteristics). Researchers should, whenever feasible, use longitudinal data to understand the mechanisms through which friendship networks lead adolescents to change their behaviours (Kobus, 2003). Also valuable is examining multiple co-occurring behaviours, whenever possible, given that risk behaviours rarely occur in isolation.

Finally, when designing health promotion programs for adolescents, health promoters should consider designing programs directed at networks of adolescents, especially dense friendship networks (Haynie, 2001). Given that most of these networks are school bound, this approach only requires a shift in perspective – from an individual-centred intervention, to a network-centred one. Moreover, when designing programs to target adolescent networks, health promoters should attempt to learn about the composition/characteristics of the networks and identify individual adolescents with high betweenness centrality – these teens may become valuable peer leaders or gatekeepers and influence many others in the network (Ennett et al., 2006). Working with these teens might be an efficient way to promote the health of the entire network.
Acknowledgements

This research uses data from the Add Health, a programme directed by Kathleen Mullan Harris and designed by J. Richard Udry, Peter S. Bearman and Kathleen Mullan Harris at the University of North Carolina, Chapel Hill. Special acknowledgement is due to Ronald R. Rindfuss and Barbara Entwistle for assistance in the original design. Information on how to obtain the Add Health data files is available on the Add Health website (http://www.cpc.unc.edu/addhealth). The authors would like to express special appreciation to Dr Verna M. Keith, who is a professor in the Department of Sociology, for her support and use of the Race & Ethnic Studies Institute (RESI) at Texas A&M University.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was funded by the Eunice Kennedy Shriver National Institute of Child Health and Human Development [grant number P01-HD31921], with cooperative funding from 23 other federal agencies and foundations. No direct support was received from grant P01-HD31921 for this analysis. The open access publishing fees for this article have been covered by the Texas A&M University Online Access to Knowledge (OAK) Fund, supported by the University Libraries and the Office of the Vice President for Research.

Notes on contributors

Kwon Chan Jeon is an assistant professor of Health Promotion in the Department of Health and Human Performance at Northwestern State University. His research interests include perspectives of complex systems, specifically a structural approach utilising network analysis, and peer influence on (co-occurring) risky health behaviours among adolescents. Other research interests include sedentary behaviour and physical activity, HIV in children and adolescents, and abstinence education for youth.

Patricia Goodson is a professor of Health Education in the Department of Health & Kinesiology at Texas A&M University. She has won several department, college- and university-level awards for her teaching and research. In 2012, she received the Presidential Professor for Teaching Excellence award (the most prestigious teaching award at TAMU). She has published extensively in high-impact journals, continually reviews for several prestigious publications, and has acted as book review editor for the Journal of Sex Research. She has authored two academic books: Theory in Health Promotion Research and Practice: Thinking Outside the Box (published in 2009 by Jones & Bartlett Learning, and Becoming an Academic Writer: 50 Exercises for Paced, Productive, and Powerful Writing (published in 2012 by SAGE Publications).

References

Alexander, C., Piazza, M., Mekos, D., & Valente, T. W. (2001). Peers, schools, and adolescent cigarette smoking. Journal of Adolescent Health, 29, 22–30. doi:10.1016/S1054-139X(01)00210-5
Ali, M. M., Amialchuk, A., & Rizzo, J. A. (2012). The influence of body weight on social network ties among adolescents. Economics & Human Biology, 10, 20–34. doi:10.1016/j.ehb.2011.10.001
Ali, M. M., & Dwyer, D. S. (2011). Estimating peer effects in sexual behavior among adolescents. Journal of Adolescence, 34, 183–190. doi:10.1016/j.adolescence.2009.12.008
Bailey, S. L., Pollock, N. K., Martin, C. S., & Lynch, K. G. (1999). Risky sexual behaviors among adolescents with alcohol use disorders. Journal of Adolescent Health, 25, 179–181. doi:10.1016/S1054-139X(99)00023-3
Borgatti, S. P., Everett, M. G., & Johnson, J. C. (2013). Analyzing social networks. London: Sage.
Brendgen, M., Wanner, B., & Vitaro, F. (2007). Peer and teacher effects on the early onset of sexual intercourse. American Journal of Public Health, 97, 2070–2075. doi:10.2105/AJPH.2006.101287
Centers for Disease Control and Prevention. (2012a). Trends in the prevalence of alcohol use National YRBS: 1991–2011. Retrieved May 18, 2013, from http://www.cdc.gov/healthyyouth/yrbs/pdf/us_alcohol_trend_yrbs.pdf
Centers for Disease Control and Prevention. (2012b). Trends in the prevalence of marijuana, cocaine, and other illegal drug use National YRBS: 1991–2011. Retrieved May 19, 2013, from http://www.cdc.gov/healthyyouth/yrbs/pdf/us_drug_trend_yrbs.pdf
Centers for Disease Control and Prevention. (2012c). Trends in the prevalence of sexual behaviors and HIV testing, National YRBS: 1991–2011. Retrieved May 28, 2013, from http://www.cdc.gov/healthyyouth/yrbs/pdf/us_sexual_trend_yrbs.pdf
Centers for Disease Control and Prevention. (2012d). Trends in the prevalence of tobacco use National YRBS: 1991–2011. Retrieved May 18, 2013, from http://www.cdc.gov/healthyyouth/yrbs/pdf/us_tobacco_trend_yrbs.pdf
Smith, K. P., & Christakis, N. A. (2008). Social networks and health. *Annual Review of Sociology, 34*, 405–429. doi:10.1146/annurev.soc.34.040507.134601

Steglich, C., Snijders, T. A. B., & Pearson, M. (2010). Dynamic networks and behavior: Separating selection from influence. *Sociological Methodology, 40*, 329–393. doi:10.1111/j.1467-9531.2010.01225.x

Tapert, S. F., Aarons, G. A., Sedlar, G. R., & Brown, S. A. (2001). Adolescent substance use and sexual risk-taking behavior. *Journal of Adolescent Health, 28*, 181–189. doi:10.1016/S1054-139X(00)00169-5

Valente, T. W. (2010). *Social networks and health: Models, methods, and applications*. New York, NY: Oxford University Press.

Valente, T. W., Gallaher, P., & Mouttapa, M. (2004). Using social networks to understand and prevent substance use: A transdisciplinary perspective. *Substance Use & Misuse, 39*, 685–712. doi:10.1081/JA-200033210

Valente, T. W., Unger, J. B., & Johnson, C. A. (2005). Do popular students smoke? The association between popularity and smoking among middle school students. *Journal of Adolescent Health, 37*, 323–329. doi:10.1016/j.jadohealth.2004.10.016