



Original Contribution

Social Network Clustering of Sexual Violence Experienced by Adolescent Girls

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We used data on 3,139 female social network friendship dyads from 3 waves of the National Longitudinal Study of Adolescent to Adult Health (wave I: 1994–1995; wave II: 1996; and wave IV: 2007–2008) to assess whether friends' reports of experiencing sexual violence (SV) and friends' substance use risk scores predicted whether adolescents and young adults would experience SV themselves. We also used longitudinal analyses to test the associations of combined wave-I and -II risk factors with wave-IV reports of SV and of combined wave-I and -II SV with network connectivity at wave II. After adjustment for a participant's substance use risk score, each 1-point increase in a friend's substance use risk score increased a respondent's odds of experiencing SV by 1.19 (95% confidence interval: 1.03, 1.36). Having a friend who reported SV increased a respondent's odds of reporting SV by 1.95 (95% confidence interval: 1.25, 3.07), although not after we included school-level fixed effects. Having a friend who experienced SV in adolescence did however increase the respondent's odds of reporting SV as a young adult by 1.54 (95% confidence interval: 1.00, 2.37). Respondents who reported SV by wave II had less network connectedness at wave II. Experiences of SV and substance use within adolescent girls' friendship networks are linked to risk for SV into young adulthood, which suggests that network-focused SV prevention and intervention approaches may be warranted.

adolescent health; sexual violence; social networks; social norms; substance use

Abbreviation: SV, sexual violence.

Adolescent girls are at high risk of experiencing sexual violence (SV). More than 1 in 10 high school girls in the United States reports a history of forced sex. Among women with a history of SV, 30% were first assaulted between the ages of 11 and 17 years, and 37% were first assaulted between the ages of 18 and 24 years (1, 2). SV is a pervasive and difficult-to-monitor human rights violation; it threatens the health and well-being of girls through well-documented physical, sexual, behavioral, and mental health consequences (3), including substance use, injury, unintended pregnancy, poor birth outcomes, human immunodeficiency virus infection, and sexually transmitted infections (4–7). Furthermore, girls who experience SV may engage in maladaptive coping by withdrawing socially (8), with the potential consequence of limiting their sources of social support. Emphasis on young populations is of particular importance because they have higher rates of victimization but also because such experiences have been found to have long-lasting effects on girls' trajectories into adulthood (3, 9). Prevention and intervention are

needed; however, despite increased funding and focus on this issue over the past 20 years, there has been no reduction in the rate of SV among adolescents or any other population in the United States over this time. Innovations in prevention are essential (10).

National efforts to prevent sexual assault emphasize the importance of using an ecological approach that is inclusive of peers, schools, and communities; recent efforts have focused on the prevention of perpetration. Historically, prevention efforts were directed at females (e.g., self-defense training), but these approaches directed responsibility at potential victims rather than perpetrators (11). Research was primarily limited to analysis of individual risk behaviors that place girls at risk for victimization and identified substance use as a major risk factor, both in the United States and cross-nationally (5). It is important to consider, however, that although consumption of an intoxicating substance may hinder a girl's ability to defend herself against a perpetrator, perpetration of SV is likely

greater within social contexts in which drinking and other risk behaviors occur (12, 13). Because adolescent friendship networks are significant determinants of girls' substance use (14, 15), they may offer important context to help understand other related risks, such as SV. In prior research among adolescent males, researchers documented that boys with social networks characterized by violence perpetration were more likely to perpetrate violence (16), which suggests that there may be some social contexts in which girls are at higher risk of experiencing SV, including social contexts in which substance use is occurring. These contexts may include neighborhood or schools (17) or more proximal social networks of peers and family. School-level factors, including norms of acceptability of violence, interpersonal climate, and school responsiveness to violence, have been demonstrated as predictors of students' physical aggression, with school effects being stronger for female students than for male students (18).

Social network studies offer important insights into social contexts by demonstrating how risks and exposures, including those specific to sexual behavior, substance use, and perpetration of violence (14, 15, 19–22), cluster between socially connected individuals (23–25). By identifying associations between clusters of socially connected people, network analyses can help identify descriptive norms, or behaviors that are regularly practiced by people within a specific group (26). Network studies also provide insight into how to engage in innovative normatively focused interventions for groups of people rather than individuals. Finally, network studies can help identify the relationships between social structural characteristics and risk factors. For instance, in some previous research it has been shown that girls with lower social status are more likely to experience sexual harassment (27), although the relationship between sexual victimization and social status may be dependent upon the context of the girl's social network (28). Experience of sexual violence can cause girls to socially withdraw, resulting in a change in network after the experience of trauma (8). Despite evidence of these dynamics, there have been few studies in which the associations between networks and experiences of SV have been investigated.

In the present study, we used girls' friendship networks to assess experiences of SV and substance use reported by their friends and their associations with the respondent's likelihood of experiencing SV in adolescence and (via longitudinal examination) into young adulthood. Secondly, to further understand the social structural context of SV, we considered whether an adolescent girl's experience of SV influenced her connectedness within friendship networks. Findings from this work can guide innovative network-level SV prevention efforts for girls.

METHODS

Data

To assess the associations of friendship networks with the incidence of SV against adolescent girls and young adult women, we used data from the National Longitudinal Study of Adolescent Health, which is a nationally representative study in which investigators explored adolescent well-being (29). Four waves of the study have been completed (29). Wave I was conducted in 1994–1995 and included adolescents in grades 7 through

12; wave II was conducted in 1996, wave III was conducted in 2001–2002, and wave IV was conducted in 2007–2008. In wave I, researchers collected an “in-school” sample of 90,118 adolescents chosen from a nationally representative sample of 142 schools. A subset of adolescents was sampled for follow-up interviews. In all 4 waves of data collection, this nationally representative “in-home” sample completed longer questionnaires about their social networks, health behaviors, family dynamics, and emotional/developmental outcomes (see Web Appendix 1, available at <https://academic.oup.com/aje>). Students named up to 5 male and 5 female friends who were later identified from school-wide rosters to generate information about each school's complete social network. We drew our information about social networks, experiences of SV, and correlated risk behaviors from questions available in the wave I, wave II, and wave IV in-home data sets.

Social networks

To identify the friendship networks, we treated each friendship nomination as a “directed tie” from the respondent to the named friend. Dyadic observations were created based on these nominations and included data from both the respondent and a friend at waves I and II for each respondent–friend pair; the dyadic data structure meant that respondents could appear in multiple observations (i.e., friendship dyads)—as both the nominating respondent and as the friend—and that the same friend pairing can appear in 2 observations if each respondent in the pairing is listed as the respondent in one and the friend in the other. Sibling dyads and dyads with missing data were removed from the data set. We further restricted the data set to female–female relationships because our primary outcome and primary predictor was a measure of SV that was only asked of female respondents, leaving a sample of 3,139 girl dyads based on 1,658 individual interviews (see Web Appendix 2).

Measures

Experience of SV. Respondents in wave I and wave II who reported having sexual intercourse were asked to report SV with the question, “Were you ever physically forced to have sexual intercourse against your will?” Sexual intercourse was defined as follows: “When we say sexual intercourse, we mean when a male inserts his penis into a female's vagina.” In wave IV, they were asked 2 questions. 1) “Have you ever been forced, in a nonphysical way, to have any type of sexual activity against your will? For example, through verbal pressure, threats of harm, or by being given alcohol or drugs? Do not include any experiences with a parent or adult caregiver.” 2) “Have you ever been physically forced to have any type of sexual activity against your will? Do not include any experiences with a parent or adult caregiver.”

Because there were relatively few changes in responses between wave I and II, we collapsed responses to create a binary measure of whether or not a respondent experienced SV by wave II (“adolescent SV”). We considered a respondent to be a victim of young-adult SV in wave IV if they responded yes to either of the 2 questions regarding verbal or physical coercion. Although respondent's reports of SV in adolescence and adulthood were our primary dependent variables, a friend's report of SV in adolescence was our primary independent variable (see Web Appendix 3).

Substance use risk score. In a comprehensive section on substance use in wave I and II, adolescents were asked a variety of detailed questions about prior and current substance use related to alcohol use, cigarette smoking, marijuana use, and binge drinking (see Web Appendix 3 for exact questions). Wave-IV respondents were asked similar questions.

We coded 6 separate dichotomous substance use outcomes from questions asked in waves I and II to represent either having engaged in the behavior or not. Cronbach's α on these measures as a scale was 0.80. We then used an item response theory model to create a combined risk score for each girl using these questions (see Web Appendix 4).

Many of the substance use questions were changed in wave IV, and the questions that were available did not cluster into a reasonable index. We therefore used 2 dichotomous yes or no questions on problem drinking and marijuana use. Smoking in wave IV was assessed using the same question that was asked in waves I and II. Substance use by friends was a primary independent variable for the dependent variables of SV in adolescence and young adulthood.

Network connectedness. Using the *igraph* library in R (R Foundation for Statistical Computing, Vienna, Austria), we calculated 2 individual-level network centrality measures for each respondent in each school. Degree (30) is the total number of unique social contacts that nominate or are nominated by the respondent. The second measure, eigenvector centrality (31), is a measure of popularity that assumes the centrality of a given individual is an increasing function of the centralities of all the individuals that support her (see Web Appendix 4). Network connectedness was our secondary dependent variable, with experience of SV as its primary independent variable.

We included respondent age and race/ethnicity (white, Hispanic, black, or Asian), as well as mothers' self-reported education and household income as covariates in the analyses.

Statistical analyses

We conducted a series of logistic regression analyses using friendship dyads as the unit of analysis. We first tested the association between respondent and friend risk scores for adolescent substance use. We then tested whether a friend reporting SV in waves I/II was a predictor of a respondent's report of SV, first in waves I/II ($n = 3,139$) then in wave IV ($n = 2,732$). It should be noted that the measure used in waves I/II was limited to forced physical sex, whereas that used in wave IV included coercion. We used generalized estimating equation procedures, clustering on individual respondents, to account for multiple observations of the same respondent across respondent-friend pairings and assumed an independent working correlation structure for the clusters. The generalized estimating equation regression models in the tables presented in the main text and Web Tables 2–5 provide parameter estimates in the form of β coefficients. Because associations between friends' behaviors could be the result of neighborhood, school, or other contextual factors related to geographic proximity, we also conducted all analyses with and without school fixed effects. Inclusion of fixed effects effectively eliminates any spurious correlations that may arise because of between-school variation in the incidence of the dependent variables. However, this inclusion could mask friendship network associations, so we also included analyses without the school-level fixed effects (32).

For the analysis of wave IV data, we only included respondents who did not report a history of SV in waves I or II; because the wave-IV questions did not specify when in a respondent's life the violence occurred, reports of SV at wave IV could reflect SV that occurred at either wave I or II or sometime after. This sample of dyads allowed us to look for a relationship between new reports of SV from individuals who did not report SV in the earlier wave I and wave II surveys and the SV status of those individuals' friends. The wave-IV analysis therefore allowed us to

Table 1. Summary Statistics for Individual Adolescent Girls in Wave I (1994–1995), Wave II (1996–1997), and Wave IV (2008) of the National Longitudinal Study of Adolescent Health

Variable	Wave I ($n = 1,658$)		Wave II ($n = 1,658$),	Wave IV ($n = 1,426$)	
	Mean (SD)	%	%	Mean (SD)	%
Self-reported SV		5	3		20
Age, years	15.6 (1.5)			28.4 (1.51)	
Mother's education score ^a	5.6 (2.3)				
Respondent's education score ^a				6.05 (2.13)	
Income, US\$	47,000 (47,000)				
Race					
Asian		8			7
Black		19			19
Hispanic		14			13

Abbreviations: SD, standard deviation; SV, sexual violence.

^a Education was scored as follows: 0 = never went to school; 1 = completed eighth grade or less; 2 = completed more than eighth grade but did not graduate from high school; 3 = went to a business, trade, or vocational school instead of high school; 4 = graduated from high school; 5 = completed a General Education Development program; 6 = went to a business, trade, or vocational school after high school; 7 = went to college but did not graduate; 8 = graduated from a college or university; and 9 = had professional training beyond a 4-year college or university.

Table 2. Associations Between Respondent's and Friend's Risk Scores Using Data From Wave I (1994–1995) and Wave II (1996–1997) of the National Longitudinal Study of Youth^a

Variable	Participant's Risk Score in Wave II			With School-Level Fixed Effects		
	β	SE	P Value	β	SE	P Value
Friend's risk score in wave II	0.34	0.02	0.00	0.24	0.02	0.00
Education	-0.02	0.01	0.16	-0.01	0.02	0.38
Income	0.00	0.00	0.17	0.00	0.00	0.22
Age	0.12	0.02	0.00	0.09	0.03	0.00
Hispanic race	-0.10	0.10	0.32	0.21	0.13	0.11
Black race	-0.32	0.07	0.00	-0.13	0.10	0.19
Asian race	-0.34	0.11	0.00	-0.10	0.14	0.47

Abbreviation: SE, standard error.

^a We used dyadic-level multivariate linear regression analyses and controlled for multiple observations per individual using general estimating equations.

examine whether there was evidence that SV travels through the friendship network observed earlier.

We then ran a separate set of individual level logistic regression models (nondyadic $n = 1,459$) in which we considered the network position of a respondent in wave II as a function of her experience of SV in wave I, controlling for her network position in wave I. Because the network centrality measures were heavily skewed, we dichotomized the measures to categorize respondents as above or below the mean of each measure.

RESULTS

A total of 8% of respondents reported having experienced SV in adolescence: 5% in wave I and an additional 3% in wave

II. By wave IV, that proportion had increased to 20%. Table 1 shows the summary statistics for our sample, and Web Table 1 shows a summary of our item response theory model, including the prevalence of risk behaviors in our sample. In waves I and II, 45% of respondents reported the use of alcohol, 29% reported the use of tobacco, 15% reported the use of marijuana, 27% reported binge drinking, 12% reported regret because of drinking, and 8% reported regret because of sexual behavior while drinking. The latent variable from the item response theory model allowed us to discriminate between respondents who engaged in various combinations of risk-taking behaviors by using all of the information from these 6 indicators and then comparing those behaviors systematically between friends.

We first considered whether a respondent's substance use risk score was predicted by her friends' substance use risk

Table 3. Associations^a of Social Network–Level Risk Factors With a Girl's Probability of Experiencing Sexual Violence Using Data From Wave I (1994–1995), Wave II (1996–1997), and Wave IV (2008) of the National Longitudinal Study of Adolescent Health

Variable	Model 1 ^b			Model 2 ^c			Model 3 ^d			Model 4 ^e		
	β	SE	P Value	β	SE	P Value	β	SE	P Value	β	SE	P Value
Friend's experience of SV	N/A	N/A	N/A	0.67	0.23	0.00	0.31	0.24	0.19	-0.05	0.27	0.87
Respondent risk score	0.54	0.10	0.00	N/A	N/A	N/A	0.53	0.10	0.00	0.51	0.11	0.00
Friend's risk score	0.17	0.07	0.01	N/A	N/A	N/A	0.16	0.07	0.02	0.15	0.07	0.04
Education	0.01	0.07	0.93	0.00	0.07	0.99	0.01	0.07	0.93	0.04	0.07	0.55
Income	0.00	0.00	0.38	0.00	0.01	0.44	0.00	0.00	0.40	0.00	0.00	0.56
Age	0.08	0.09	0.37	0.18	0.09	0.04	0.08	0.09	0.39	0.07	0.12	0.59
Hispanic race	0.34	0.42	0.42	0.17	0.43	0.70	0.36	0.42	0.40	0.08	0.62	0.90
Black race	1.00	0.31	0.00	0.49	0.30	0.10	0.99	0.31	0.00	0.40	0.53	0.45
Asian race	-0.90	0.53	0.09	-1.34	0.54	0.01	-0.90	0.53	0.09	-1.70	0.67	0.01

Abbreviations: N/A, not applicable; SE, standard error, SV, sexual violence.

^a We used dyadic-level multivariate analyses using logistic regression.

^b Participant's and friend's risk factors are their computed risk scores.

^c Nominated friend experienced SV in wave I or II.

^d Includes nominated friend's experience of SV in wave I or II and participant's and friend's risk scores.

^e Includes variables in model 3 and school-level fixed effects.

scores. Table 2 shows that a friend's overall risk score significantly predicted the respondent's risk score, even with all demographic and fixed effect controls included (for bivariate results see Web Table 2). The risk score is a normally distributed latent variable with mean of 0 and standard deviation of 1. Each 1-point increase in a friend's risk score is equivalent to a 1-standard-deviation change in this variable. For such a change, the respondent's risk score increases by 0.24 standard deviations, showing that, on average, only 76% of the respondent's risk score is explained by her own characteristics, whereas 24% is explained by her friend's risk score.

We next considered the outcome of SV in adolescence by wave II. Model 1 in Table 3 shows that each 1-point increase in the friend's risk score increased a respondent's odds of SV by 1.19 (95% confidence interval: 1.03, 1.36) even after adjustment for her own risk score (see Web Table 3 for bivariate results). Each one-point increase in the respondent's risk score increased her odds of reporting SV by 1.72 (95% confidence interval: 1.41, 2.09). In model 2, a friend's report of SV increased the respondent's odds of experiencing SV by 1.95 (95% confidence interval: 1.25, 3.07). Figure 1 depicts the social network of girls in 1 school, with clustering of SV and risk scores between socially connected girls. In model 3, the association between a friend's report of SV and a respondent's odds of

experiencing SV decreased in magnitude and significance with the inclusion of respondent's and friend's risk factors, although the direction of association was the same. When we added in the school-level fixed effects, we found that the association with a friend having experienced SV became insignificant, potentially because of significant school-level determinants on SV. Fixed effects removed between-school variation, which was substantially important in explaining the patterns we observe. The fixed-effects estimator should be considered a conservative result. A multilevel model log likelihood test showed a significant school-level association, which supported this possibility.

We next considered the outcome of experiencing SV in young adulthood in wave IV. In Table 4, we show that if a friend reported SV in adolescence by wave II, a respondent had 1.54 times the odds of reporting SV by wave IV (95% confidence interval: 1.00, 2.37) (see Web Table 4 for bivariate results). Adolescent substance use risk scores for respondents or friends were not associated with this outcome, but adult substance use was. These results were robust to the inclusion of demographic control variables.

Finally, we considered the outcome of adolescent network connectedness at wave II for those who reported prior SV at wave I. In Table 5, we show the results of a set of individual (nondyadic) logistic regressions in which we used SV experience as a predictor of network centrality (see Web Table 5

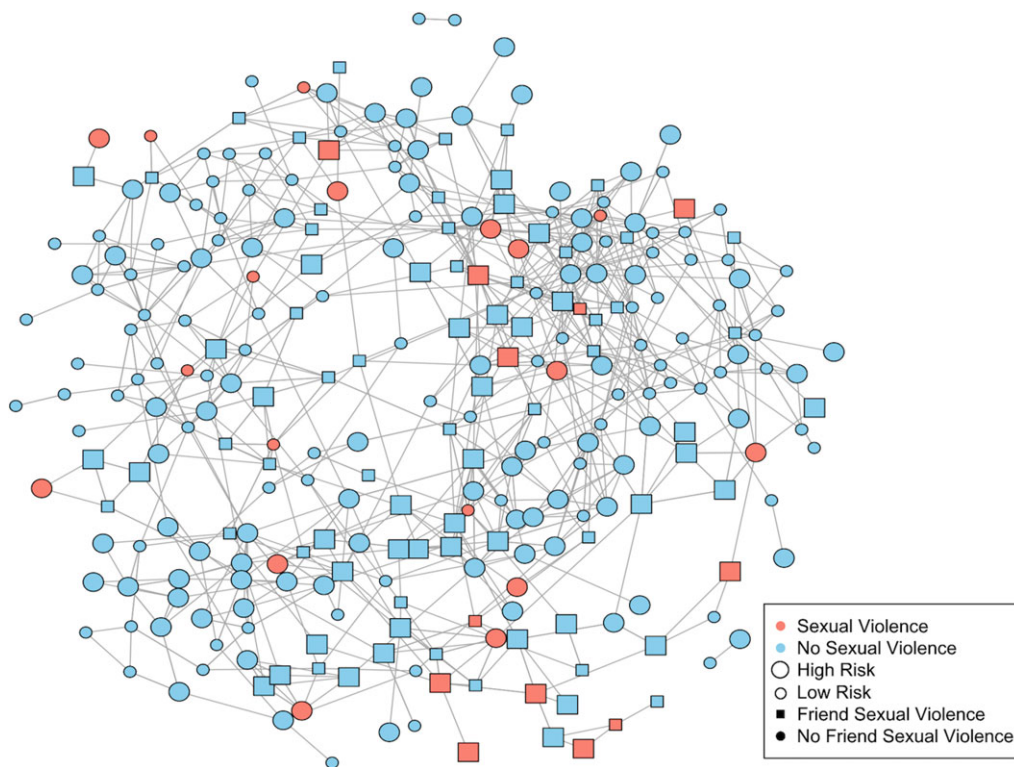


Figure 1. The network of 1 school within the data set, National Longitudinal Study of Adolescent Health. Girls who had experienced sexual violence are indicated in pink, and those who had not are indicated in blue. The large-sized nodes represent girls who had above average risk scores, and the smaller sized nodes represent girls with below average scores. Square nodes represent girls who had a friend who experienced sexual violence. Note that the pink nodes are likely to be large and square. Also note the clustering of large square nodes, which represent high-risk girls who had not experienced sexual violence themselves but who had friends who did.

Table 4. Associations of Social Network–Level Risk Factors With a Girl’s Probability of Experiencing Sexual Violence by Wave IV^a Using Data From Wave I (1994–1995), Wave II (1996–1997), and Wave IV (2008) of the National Longitudinal Study of Adolescent Health

Variable	Model 1 ^b			Model 2 ^c		
	β	SE	P Value	β	SE	P Value
Friend’s experience of SV by wave II	0.53	0.22	0.02	0.43	0.22	0.05
Participant’s risk score in wave II	N/A	N/A	N/A	0.08	0.10	0.43
Problem marijuana use in wave IV	N/A	N/A	N/A	0.58	0.42	0.17
Problem drinking in wave IV	N/A	N/A	N/A	0.62	0.35	0.08
Smoking in wave IV	N/A	N/A	N/A	0.30	0.21	0.15
Education	0.06	0.04	0.15	0.07	0.04	0.10
Income	0.00	0.00	0.16	0.00	0.00	0.11
Age	–0.18	0.06	0.00	–0.19	0.06	0.00
Hispanic race	–0.75	0.35	0.03	–0.64	0.35	0.07
Black race	–0.68	0.23	0.00	0.42	0.22	0.05
Asian race	–2.44	0.56	0.00	0.08	0.10	0.43

Abbreviations: SE, standard error, SV, sexual violence.

^a We used dyadic-level multivariate analyses with logistic regression and excluded girls who reported experiencing sexual violence in waves I and II.

^b Nominated friend experienced SV in wave I or II.

^c Includes nominated friend’s experience of SV in wave I or II and participant’s wave-II risk score, wave-IV marijuana use, wave-IV problem drinking, or wave-IV smoking.

for bivariate results). After we controlled for whether or not a respondent was above or below the mean centrality in wave I, demographic characteristics, risk score, and school-level fixed effects, we found that experiencing SV by wave II was associated with a greater likelihood of being below the mean degree (i.e., fewer friends) and below the mean eigenvector centrality (i.e., lower overall popularity) in wave II. Figure 2 is a loess plot showing that the probability of experiencing SV increased with lower eigenvector centrality.

DISCUSSION

Overall, our findings suggest that the risk of SV among adolescent girls is socially clustered and that the occurrence of SV is also associated with behavioral risks such as substance use that occur within social networks. Our findings suggest that if a respondent has a friend who has experienced SV, she is also more likely to have experienced SV. However, this association is dampened when school-level fixed effects are included, which suggests that

Table 5. Association Between Sexual Violence at Wave I and Degree Centrality Above the Mean at Wave II Using Data From Wave I (1994–1995), Wave II (1996–1997), and Wave IV (2008) of the National Longitudinal Study of Adolescent Health

Variable	Total Degree			Eigenvector Centrality ^a (Also Includes Control for Total Degree)		
	β	SE	P Value	β	SE	P Value
Respondent SV by wave II	–0.69	0.33	0	–0.70	0.34	0.04
Risk score	0.1	0.08	0.24	0.10	0.08	0.24
Education	0.01	0.05	0.83	0.01	0.05	0.83
Income	0.00	0.00	0.26	0.00	0.00	0.26
Age	–0.38	0.09	0.00	–0.38	0.09	0.00
Hispanic race	0.10	0.36	0.79	0.10	0.36	0.79
Black race	–0.49	0.37	0.19	–0.49	0.37	0.19
Asian race	0.11	0.39	0.77	0.11	0.39	0.77

Abbreviations: SE, standard error, SV, sexual violence.

^a We used multivariate individual logistic regression models that included wave I centrality and school-level fixed effects.

^b $n = 1,459$.

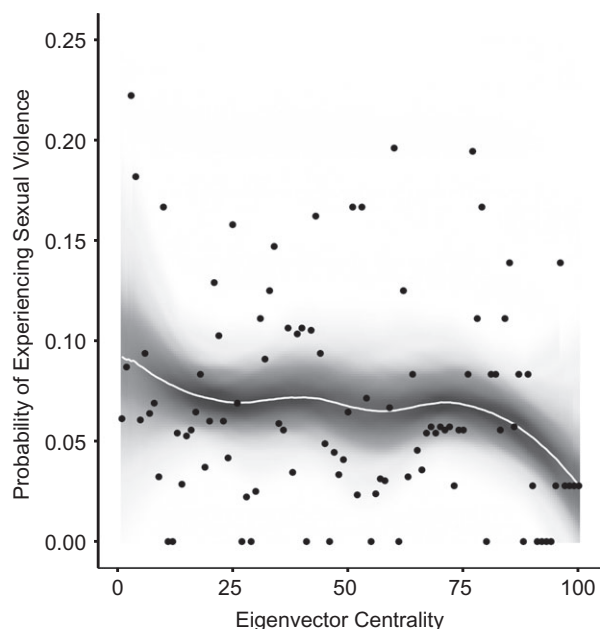


Figure 2. Loess plot showing the probability that girls had experienced sexual violence by wave II conditional on wave II eigenvector centrality, National Longitudinal Study of Adolescent Health. Girls were binned into 1% blocks across the range of eigenvector centrality. Each point represents the probability of having experienced sexual violence for any given individual within that block. The white line is the median fit of 1,000 Markov chain Monte Carlo loess smoother fits across these points. Darker gray regions are regions of higher confidence.

the significant association of SV experience between socially connected girls might be explained by school-level factors, including school- or community-level descriptive norms (32). Thus, school-wide social norms related to SV may play a significant role in determining respondents' risks of experiencing SV. In addition, adolescents who reported substance use were more likely to associate with others who did, and both a respondent's substance use as well as her friends' substance use was predictive of the respondent's risk for SV. Substance use may therefore be indicative of a social risk environment in which perpetration of SV is more likely to occur. These results hold with school-level fixed effects, providing clues toward friendship clustering of behavior.

Although our discussion is focused on the nexus of risk factors that includes SV, we are not making claims about the causality of the relationship; rather, we are observing the clustering of certain risk factors associated with SV and the continuation of risks in time periods after adolescence. These findings suggest that sharing a social context or network in which SV occurs is associated with an increase in a girl's risk of experiencing SV. The social clustering may be indicative of risk environments in which SV perpetration is more likely to occur, as well as a normalization of SV within that social context. That there seems to be significant variation in the proportion of respondents who experience SV across schools supports such a possibility. Although neighborhood effects could also cause school-level associations, not all adolescents attend schools within their neighborhoods. The persistent association between a friend's risk behavior and a girl's experience of SV supports the likelihood that school-level

social norms are at play and that school-level efforts may address norms permissive of SV.

We also show that there is a directional relationship between experience of SV and network connectivity: Respondents who reported SV by wave II also became less central by wave II, even after adjustment for their social position in wave I. This result suggests a downward social trajectory for girls who are already victims of a traumatic act of violence.

It is possible that this finding does not suggest a negative outcome (girls may have fewer but closer friendships). However, a number of studies have highlighted the psychosocial and mental health consequences (e.g., depression, anxiety, posttraumatic stress disorder) of SV and how these may affect girls' attachment and trust in relationships including the possibility of social withdrawal as a maladaptive coping strategy (33–35). Our study is among the first to demonstrate that SV specifically affects girls' social connectivity.

Limitations and strengths

Our analyses have several limitations. First, we do not know the personal or social networks characteristics of the perpetrators who committed the violence against these girls. Although in some cases it may be friends, in others it may be adults outside of or within the school environment. Second, any measure of a sensitive nature will be understandably susceptible to response bias; therefore, we potentially underestimated the actual extent of SV within this population. Relatedly, the act of reporting abuse may be a behavior that clusters in the social networks of these individuals, which might influence our results. Third, the wave-I and wave-II data are relatively old (collected in the 1990s); however, the use of this data set allowed us to follow individuals into adulthood. Although there has been increasing attention to SV among adolescents and college students across the United States, there is no reason to believe that this phenomenon or its risk factors have changed significantly since that time. Fourth, although school-level fixed effects may to some degree adjust for neighborhood influences, they are an imperfect proxy given the likelihood of attending a school out of neighborhood.

Despite these limitations, the present study provides a unique and important lens through which to view a serious problem that has gained increasing attention over the past several years. Although intuitively we expect that cultures of SV grow and are maintained within socially connected groups of people, we have little quantitative evidence to support this inference. This analysis provides important evidence of the need to address SV within social contexts while addressing the social clustering of associated risk factors as well. Not only did we see a significant association within friend relationships, but we also found that these associations varied across schools, which suggests that schools may have a role in maintaining norms, either negative or positive. Network-based interventions within schools may be a powerful strategy for reduction of SV against adolescent girls.

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REFERENCES

- Centers for Disease Control and Prevention. High School Youth Risk Behavior Survey data. 2015 results: Forced sexual intercourse. 2016. <https://nccd.cdc.gov/Youthonline/App/Results.aspx?TT=B&OUT=0&SID=HS&QID=H21&LID=LL&YID=RY&LID2=&YID2=&COL=&ROW1=&ROW2=&HT=&LCT=&FS=&FR=&FG=&FI=&FP=&FSL=&FRL=&FGL=&FIL=&FPL=&PV=&TST=&C1=&C2=&QP=G&DP=&VA=CI&CS=Y&SYID=&EYID=&SC=&SO=>. Accessed February 15, 2016.
- Black M, Basile KC, Breiding MJ, et al. *The National Intimate Partner and Sexual Violence Survey (NISVS): 2010 Summary Report*. Atlanta, GA: National Center for Injury Prevention and Control; 2011. https://www.cdc.gov/violenceprevention/pdf/nisvs_report2010-a.pdf. Accessed September 22, 2016.
- Tjaden PG, Thoennes N. *Extent, Nature, and Consequences of Rape Victimization: Findings From the National Violence Against Women Survey*. Washington, DC: US Department of Justice Office of Justice Programs; 2006. <https://www.ncjrs.gov/pdffiles1/nij/210346.pdf>. Accessed September 22, 2016.
- Stockman JK, Lucea MB, Campbell JC. Forced sexual initiation, sexual intimate partner violence and HIV risk in women: a global review of the literature. *AIDS Behav*. 2013; 17(3):832–847.
- Decker MR, Peitzmeier S, Olumide A, et al. Prevalence and health impact of intimate partner violence and non-partner sexual violence among female adolescents aged 15–19 years in vulnerable urban environments: a multi-country study. *J Adolesc Health*. 2014;55(6 suppl):S58–S67.
- Kilpatrick DG, Ruggiero KJ, Acierno R, et al. Violence and risk of PTSD, major depression, substance abuse/dependence, and comorbidity: results from the National Survey of Adolescents. *J Consult Clin Psychol*. 2003;71(4):692–700.
- Silverman JG, Raj A, Mucci LA, et al. Dating violence against adolescent girls and associated substance use, unhealthy weight control, sexual risk behavior, pregnancy, and suicidality. *JAMA*. 2001;286(5):572–579.
- Najdowski CJ, Ullman SE. PTSD symptoms and self-rated recovery among adult sexual assault survivors: the effects of traumatic life events and psychosocial variables. *Psychol Women Q*. 2009;33(1):43–53.
- Dartnall E, Jewkes R. Sexual violence against women: the scope of the problem. *Best Pract Res Clin Obstet Gynaecol*. 2013;27(1):3–13.
- Centers for Disease Control and Prevention. Rape prevention and education: transforming communities to prevent sexual assault. <https://www.cdc.gov/violenceprevention/rpe/>. Accessed February 15, 2016.
- Harner H, Rosenbluth B. Sexual violence and adolescents. In: VAWnet: The National Online Resource Center on Violence Against Women; 2011. http://vawnet.org/sites/default/files/materials/files/2016-09/AR_Adolescent.pdf. Accessed September 22, 2016.
- Lehrer JA, Lehrer VL, Lehrer EL, et al. Prevalence of and risk factors for sexual victimization in college women in Chile. *Int Fam Plan Perspect*. 2007;33(4):168–175.
- Reed E, Amaro H, Matsumoto A, et al. The relation between interpersonal violence and substance use among a sample of university students: examination of the role of victim and perpetrator substance use. *Addict Behav*. 2009;34(3):316–318.
- Mason M, Mennis J, Way T, et al. Young adolescents' perceived activity space risk, peer networks, and substance use. *Health Place*. 2015;34:143–149.
- Mrug S, Borch C, Cillessen AH. Other-sex friendships in late adolescence: risky associations for substance use and sexual debut? *J Youth Adolesc*. 2011;40(7):875–888.
- Ramirez M, Paik A, Sanchagrin K, et al. Violent peers, network centrality, and intimate partner violence perpetration by young men. *J Adolesc Health*. 2012;51(5):503–509.
- Leach FE, Mitchell C. *Combating Gender Violence in and Around Schools*. Stoke on Trent, UK: Trentham Books; 2006.
- Henry DB, Farrell AD, Schoeny ME, et al. Influence of school-level variables on aggression and associated attitudes of middle school students. *J Sch Psychol*. 2011;49(5):481–503.
- Ali MM, Dwyer DS. Estimating peer effects in sexual behavior among adolescents. *J Adolesc*. 2011;34(1):183–190.
- Balbo N, Barban N. Does fertility behavior spread among friends? *Am Sociol Rev*. 2014;79(3):412–431.
- Shakya HB, Hughes DA, Stafford D, et al. Intimate partner violence norms cluster within households: an observational social network study in rural Honduras. *BMC Public Health*. 2016;16:233.
- Ali MM, Amialchuk A, Dwyer DS. Social network effects in contraceptive behavior among adolescents. *J Dev Behav Pediatr*. 2011;32(8):563–571.
- Shakya HB, Christakis NA, Fowler JH. Parental influence on substance use in adolescent social networks. *Arch Pediatr Adolesc Med*. 2012;166(12):1132–1139.
- Cacioppo JT, Fowler JH, Christakis NA. Alone in the crowd: the structure and spread of loneliness in a large social network. *J Pers Soc Psychol*. 2009;97(6):977–991.
- Moody J. Peer influence groups: identifying dense clusters in large networks. *Soc Netw*. 2001;23(4):261–283.
- Cialdini RB, Kallgren CA, Reno RR. A focus theory of normative conduct: a theoretical refinement and reevaluation of the role of norms in human behavior. In: Zanna M, ed. *Advances in Experimental Social Psychology*. San Diego, CA: Academic Press Inc; 1991:201–234.
- Graham K, Bernards S, Abbey A, et al. Young women's risk of sexual aggression in bars: the roles of intoxication and peer social status. *Drug Alcohol Rev*. 2014;33(4):393–400.
- Stogner J, Miller JM, Fisher BS, et al. Peer group delinquency and sexual victimization: does popularity matter? *Women Crim Justice*. 2014;24(1):62–81.
- Harris K. *The Add Health Study: Design and Accomplishments*. Chapel Hill, NC: UNC Chapel Hill; 2009. <http://www.cpc.unc.edu/projects/addhealth/documentation/guides/DesignPaperWIIV.pdf>.
- Proctor C, Loomis C. Analysis of sociometric data. In: Holland P, ed. *Research Methods in Social Relations*. New York, NY: Dryden Press; 1951.

31. Bonacich P. Factoring and weighting approaches to status scores and clique identification. *J Math Sociol.* 1972;2(1):113–120.
32. Hanushek EA, Kain JF, Markman JM, et al. Does peer ability affect student achievement? *J Appl Econom.* 2003;18(5): 527–544.
33. Matheson FI, Daoud N, Hamilton-Wright S, et al. Where did she go? The transformation of self-esteem, self-identity, and mental well-being among women who have experienced intimate partner violence. *Womens Health Issues.* 2015;25(5): 561–569.
34. Lagdon S, Armour C, Stringer M. Adult experience of mental health outcomes as a result of intimate partner violence victimisation: a systematic review. *Eur J Psychotraumatol.* 2014;5:24794.
35. Frazier PA, Burnett JW. Immediate coping strategies among rape victims. *J Couns Dev.* 1994;72(6):633–639.