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Sex Differences in Virtual Network Characteristics and Sexual Risk Behavior among Emerging Adults

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Abstract

Emerging adults (EAs) ages 18 to 24 account for a large proportion of all sexually transmitted infections (STIs), HIV infections, and unintended pregnancies in the United States. Given the increased influence of online media on decision-making, we examined how EA online networks were associated with sexual risk behaviors. We used egocentric network data collected from EAs aged 18 to 24 years old across the United States (N=1,687) to examine how online norms (e.g., acceptance of HIV infections, other STIs, and pregnancy) and network characteristics (i.e., network size and density; ties' closeness, race, age, and sex similarities) were associated with participants' unprotected vaginal intercourse (UVI) in the last 30 days. Findings suggested that in male EAs, there was a strong association between sexual norms, structural characteristics, and sexual risk behavior compared to females. Researchers and practitioners may wish to address online peer norms and EAs' online network composition when developing online sexual risk prevention tools.

Keywords

Online social networks; HIV; sex; emerging adulthood

Emerging adults (i.e. 18-29) account for a large proportion of all sexually transmitted infections (STIs), HIV infections, and unintended pregnancies in the United States (Zolna & Lindberg, 2012). Youth represent only 25% of the sexually active population, yet they account for over half of all new STI infections (Weinstock, Berman, & Cates, 2004). Researchers have found that offline peers play a particularly important role in influencing a myriad of behaviors during emerging adulthood (Nelson & Barry, 2005). Emerging adults who have peers in their network who use substances (Cook, Bauermeister, Zimmerman, & Gordon-Messer, 2012) or participate in risky sexual behaviors (Allison et al., 2012) are generally more likely to participate in these behaviors themselves. Further, given the increased availability and usage of online social networking sites (e.g., Facebook and Twitter), researchers have acknowledged the importance of examining how features of online peer networks are associated with sexual risk practices (Cook et al., 2012). Yet many

studies of online social networks on risk behaviors use college student samples and do not explore how sex differences in features of online social networks are associated with sexual risk behaviors. Utilizing a diverse sample of emerging adults (e.g., those in and out of college) could improve the generalizability of study findings and broaden our understanding of the ways in which social networks influence risk behaviors among emerging adults. Further, the social networks of males and females may differentially influence their sexual risk behaviors. For instance, emotional closeness to online network members may differentially influence sexual risk behaviors between male and female emerging adults. To our knowledge, this and similar inquiries have not been adequately explored in online social networks of emerging adults. Therefore, utilizing a national online sample of emerging adults, we sought to examine (1) how emerging adults' online social networks were associated with their recent sexual risk behavior (e.g., number of partners with whom participants had unprotected vaginal intercourse), and (2) if these potential associations differed by sex. These data are critical to better understanding how online networks may inform sexual health-related prevention and intervention activities aimed at decreasing the high incidence of STI/HIV transmission and unintended pregnancy among emerging adult males and females.

Online Social Networks and Sexual Risk Behavior

Young adults are increasingly using social network sites to interact with peers. The proliferation of Internet usage has led to the formation of online social networks—online forums through which peers can communicate with one another (Lenhart, Purcell, Smith, & Zickuhr, 2010). Further, online social networks may provide a forum for emerging adults to discuss potentially sensitive issues such as substance use and sexual behavior. Recent evidence suggests that risk behaviors promoted within online networks of peers may be related to an increase in individual risk behavior among emerging adults (Cook et al., 2012; Stoddard, Bauermeister, Gordon-Messer, Johns, & Zimmerman, 2012). Stoddard et al. (2012), for example, found that discussions about substance use via postings within online social networks of peers were associated with greater substance use frequency among emerging adults. In addition, Young and Jordan (2013) found that peers who viewed sexually suggestive content on a social networking site were more prone to think their peers were participating in unprotected sexual risk behavior and reported that they would be more prone to participate in unprotected risk behavior as compared to individuals who viewed non-sexually suggestive content on the site. Taken together, these findings underscore how online interactions play a key role in understanding peer influences on emerging adult risk behaviors. Yet it remains unclear the extent to which the characteristics of online social networks of peers influence the sexual risk behaviors of emerging adults. Moreover, it is unclear whether the influence of these online relationships is sustained after accounting for the possibility that emerging adults also interact with these social ties offline. Therefore, we sought to examine whether the characteristics of, and interactions with, online social network peers were associated with having a recent unprotected vaginal intercourse partner after acknowledging that young adults also interacted with peers in offline settings.

Peer Influences, Social Networks Analysis, and Emerging Adult Sexual Risk Behaviors

Peer influences during young adulthood are important as youth explore sexual relationships and look to peers for information about sexual identity and sexual relationships (Arnett, 2004; Black, 2013). During this transition, emerging adults are developing new, and editing old, ways of being and interacting with peers and romantic partners (Schwartz, Côté, & Arnett, 2005). Researchers have found that during this period, emerging adults become more accepting of casual sexual relationships and appraise sexual relationships more positively (Lefkowitz, Gillen, Shearer, & Boone, 2004). Researchers have used social network analysis to understand the context of peer offline and, to a smaller extent, online relationships and emerging adult risk behaviors (Valente, 2010). A social network refers to the way in which individuals are linked and the similarities between those who are linked (Israel, 1982; Smith & Christakis, 2008). Further, a key assumption of social network theory is that different features of the social network (e.g., how many individuals there are in a social network) will affect individual decision-making and behaviors (Berkman & Glass, 2000). Social network theory and analysis allows for the examination of the structure and quality of individual linkages within a network, as well as the structure and quality of the overall network. Social network *ties* refer to the linkages between the individual and the people they are linked to in their individual social network. Researchers have identified two general types of social networks: (1) an egocentric network where the focus is the individual and how features of their network influence the individual, and (2) a sociocentric network where the focus is on the behaviors and patterns of behavior between these individuals in a network. In terms of peer networks and sexual risk behaviors, this technique allows for the examination of characteristics related to interpersonal relationships, peer norms, and the determination of how these factors are associated with health and health behaviors (Israel, 1982). Israel (1982) discusses three distinct social network characteristics: functional, structural, and interactional.

Functional characteristics

Functional characteristics refer to the social influence of ties within a social network. Peer norms are forms of functional characteristics. In the context of emerging adult risk behaviors, many researchers have utilized *social norms theory* to understand how individual behaviors are influenced by peer behaviors or perceptions about peer behaviors (Perkins & Berkowitz, 1986). Among emerging adults, researchers have found that the perceived risk behaviors of peers (injunctive norms) and the actual risk behaviors of peers (descriptive norms) are associated with the increased likelihood of young adults participating in risky behaviors (Black, Schmiede, & Bull, 2013). For example, Martens et al. (2006) found in a sample of college students that frequency of actual sexual behavior (i.e., oral sex, vaginal sex, anal sex, and number of sex partners) was associated with a greater perceived frequency of sexual behaviors by peers. Similarly, Frost, Lindberg, and Finer (2012) found that emerging adults who had more friends that thought using birth control was important were more likely to use birth control. Thus, peer influences on sexual behaviors during emerging adulthood are key to understanding actual individual behavior. Although research on peer norms and sexual behavior during emerging adulthood is growing, many of these studies

focus only on college students and their offline social networks. We sought to better understand the association between online social network functional characteristics (i.e., peer norms concerning pregnancy and HIV/STI) and on emerging adult sexual risk behaviors in a national sample of emerging adults.

Structural network characteristics

Structural network characteristics refer to the way in which individuals in a network are directly tied, or linked, to one another (Wasserman, 1994). These characteristics include factors such as size (i.e., the number of direct ties an individual has to other network members) and density (i.e., the proportion of ties between people within a network) of a network. The size of a social network is important because it demonstrates the number of available ties to which an individual has access. The density of a social network is important because it can demonstrate how quickly or slowly behaviors may diffuse within a network. Much of the research in this area has focused on high risk populations (e.g., men who have sex with men and substance users). Researchers have found that having a greater number of ties and/or a denser social network is associated with greater sexual risk behavior (Smith, Grierson, Wain, Pitts, & Pattison, 2004). Smith et al. (2004) found in a study of 206 men who have sex with men that men with less dense offline networks may report fewer sexual risk behaviors than those with denser networks. They also found that injecting drug users with more network ties and denser networks were more likely to participate in sexual risk behaviors than those injecting drug users with fewer network ties and less dense networks. These findings suggest that the diffusion of behaviors or norms may be easier when more individuals are connected in a social network. In terms of structural characteristics in online social networks among emerging adult, the ways in which norms and communication about sexual behaviors diffuse through these networks may be consistent with offline networks. Thus, it may be the case that emerging adults who have more online social network ties and/or denser online social networks are more influenced by risky sexual norms. We sought to better understand how the connectedness of emerging adults in online social networks may influence sexual risk behavior.

Interactional network characteristics

Interactional network characteristics describe the nature and quality of ties in a network (Israel, 1982). *Content* (e.g., average age of network members) refers to the characteristics of ties in a network, and *intensity* describes emotional closeness between network members. Researchers have found that close peers exert more of an influence on individual risk behavior than peers who are not as close (Valente, Fujimoto, Chou, & Spruijt-Metz, 2009). Several researchers have found that individuals who report being in love are more likely to have condomless sex (Fincham & Cui, 2010). In the context of substance use, emerging adults are more likely to consume alcohol if they perceive that a close friend is consuming alcohol (Cox & Bates, 2011). To our knowledge, no researchers have examined how emotionally close online social network members (vs. less emotionally close online network members) influence individual sexual risk behaviors.

Homophily is another interactional network characteristic that focuses on similarity of network members in attributes such as sex and race. Individuals tend to interact with others

who are most like themselves (McPherson, Smith-Lovin, & Cook, 2001) and engage in similar behaviors. Researchers have found that emerging adult males with a high proportion of other males in their network were more likely to use substances than emerging adult females with a high proportion of other females in their network (Andrews, Tildesley, Hops, & Li, 2002). Researchers have found in a sample of college students that males and females perceived their same-sex peers to have more sexual partners, greater frequency of casual sexual intercourse, and more alcohol-related risky sexual behavior than their opposite-sex peers (M. A. Lewis, Lee, Patrick, & Fossos, 2007). Unfortunately, we have little information regarding the association between homophily in online social networks and sexual risk behavior. The limited available research highlights some notable findings. For instance, Thelwall (2009), found a large amount of race homophily but not sex homophily in a set of about 26,000 MySpace users. In addition, Mazur and Richards (2011) found that emerging adult online social network members were more similar to themselves in terms of age, race, and geographic location compared to adolescents. Cook et al. (2012) also found that having a more racially diverse online social network was associated with greater substance use. We sought to better understand the associations between online social network homophily and sexual risk behavior among emerging adults.

Sex Differences in the Sexual Risk Behaviors and the Composition of Social Networks

Many researchers have outlined the differences in peer influences on risk behavior between males and females (Cubbins & Tanfer, 2000). Researchers examining risk behaviors more generally have found that male emerging adults are more likely to participate in risky behaviors than female emerging adults (Byrnes, Miller, & Schafer, 1999). Further, researchers have found that sex differences may account for differences in social network composition and that these differences may be related to risk behavior (Cook et al., 2012; Cubbins & Tanfer, 2000; Lewis, Kaufman, Gonzalez, Wimmer, & Christakis, 2008; Lewis & Neighbors, 2004; Mazur & Richards, 2011). These differences in social network influences on risk behavior have been largely attributed to differences in the socialization of males and females (Byrnes et al., 1999; Potard, Courtois, & Rusch, 2008). Compared to females, for instance, young adult males are less likely to self-disclose (Henrich, Kuperminc, Sack, Blatt, & Leadbeater, 2000), openly express feelings, confide in friends within their social network (Banks, Pandiani, Schacht, & Gauvin, 2000;) and place demands on their peer network members (Felmlee, 1999) than females. In contrast, females are more likely to self-disclose to close friends in their social network and have more intimate social networks where they can openly share private information than males (Shklovski, Kiesler, & Kraut, 2006).

Several researchers have documented sex differences in online activities. Females tend to utilize online forums to maintain existing interpersonal relationships with offline and online social network members more than males. However, males are more likely than females to participate in task-oriented activities (e.g., reading news articles) and other gender role-specific activities (e.g., playing online video games) (Guadagno, Muscanell, Okdie, Burk, & Ward, 2011; Williams, Consalvo, Caplan, & Yee, 2009). Researchers examining differences in social network site utilization have also found that females were more likely to utilize

social networking sites than males overall (Hargittai, 2007) and that males are more likely to utilize social networking sites for relationship formation while females were more likely to use social networking sites for relationship maintenance (Muscanell & Guadagno, 2012).

Few online social network studies have focused on understanding how the features of online social networks influence sexual risk behavior differently for male and female emerging adults. Researchers examining risk behaviors in offline social networks have found that males are more likely to develop networks of other males who bond through drinking alcohol (Nezlek & Pilkington, 1994). In contrast, females are less likely to develop networks of friends who drink alcohol compared to males (Hartzler & Fromme, 2003). Taken together, the limited available research highlight the importance of understanding sex differences in online social networks. We sought to better understand the ways in which online social network characteristics influence sexual risk behaviors between male and female emerging adults in an attempt to clarify how social network features may differentially operate to increase or decrease sexual risk behaviors. Understanding sex differences could also aid in the creation of tailored online prevention programming.

The Current Study

Our goal in this study is to understand the association between online social network characteristics and sexual risk behavior in a national sample of emerging adults, and to further explore whether sex moderates this association. First, we examined how online peer norms (e.g., acceptance of HIV/STI infections and pregnancy permissiveness) were associated with participants' sexual risk behaviors. We hypothesized that positive norms concerning pregnancy and HIV/STI in online networks would be associated with more sexual risk behavior. We then sought to examine whether structural characteristics (i.e., network density and total number of network ties) and descriptive characteristics (i.e., emotional closeness to network members, race and sex similarities, and age of network members) of these online networks were associated with sexual risk behaviors. We hypothesized that the structural and descriptive characteristics of participants' online networks would be associated with participants' sexual risk behavior. Finally, we examined whether sex moderated the association between all of the online social network characteristics listed above and individual sexual risk behavior among a nationwide sample of emerging adults. Based on gender role theory (Courtenay, 2000) and the available empirical evidence related to sex differences in online social networks, we hypothesized that the association between online social network characteristics and sexual risk behavior would be stronger for males than females.

Method

Virtual Networks Study

Data for the current study was collected as part of the *Virtual Networks Study* (VNS), a cross-sectional observational study examining emerging adults' interpersonal relationships online. To be eligible for participation, youth had to be between the ages of 18 and 24, live in the United States, and have access to the Internet. We used an adapted web-version of

Respondent-Driven Sampling (webRDS) to recruit participants (Bauermeister et al., 2012). The first wave of participants, or seeds, were recruited through an online Facebook advertisement and selected based on race/ethnicity and region of the United States to ensure that initial network seeds were diverse and that we would not concentrate recruitment in a single region in the United States. We recruited 22 racially diverse seeds from across the United States. The remainder of the sample (N = 3,426) were recruited through referral chains from the original 22 seeds.

Procedure

Each prospective participant logged into the survey portal using a unique identifying number (UID) and completed a short eligibility screener. Eligible participants consented to the study and completed the survey. On average, the questionnaire took 37 minutes to complete. Emerging adults received \$20 for their participation and were offered an additional \$10 each for up to 5 additional participants who were referred and completed the questionnaire. Incentives were paid with a VISA e-gift card. Study data were protected with a 128-bit SSL encryption and kept on a secure firewalled server at the [BLINDED]. Data quality checks were conducted to circumvent duplicate and fraudulent entries (Bauermeister et al., 2012). The [BLINDED] Institutional Review Board approved the study procedures.

Measures

Demographic information—Participants reported their age, sex, race/ethnicity, and highest education level completed. We calculated participants' ages by subtracting their month and year of birth from the date of study participation. We identified two racial/ethnic categories: Racial/ethnic minority and White/European. Education was collapsed into two categories: completed high school (1) or did not complete high school (0).

Total number of UVI partners—Participants were asked to report how many sexual partners they had in the last 30 days. Participants were then asked to report on the number of sexual partners in the past 30 days with whom they did not use a condom. Participants who did not have sexual partners in the past 30 days were assigned a value of zero. Five participants reported a high number of UVI partners (i.e., > 30). We trimmed these outliers and assigned them a value of 30 (Rivest, 1994). Male-to-male sexual intercourse was excluded from these analyses.

Pregnancy—Female participants were asked if they had ever been pregnant, and male participants were asked if they had ever impregnated a female. The resulting variable was dichotomous with 0 = No (never) and 1 = Yes.

Total number of lifetime STIs—Participants were asked if a doctor had ever diagnosed them with an STI. Participants then selected from the following list of 7 STIs: 1 = Chlamydia, 2 = Gonorrhea, 3 = Syphilis, 4 = Herpes/HSV, 5 = Human Papilloma Virus/HPV/Genital Warts, 6 = Crabs/Pubic Lice, 7 = Other. An index was created for each participant by adding the number of STIs each participant reported having had. The resultant variable was on a scale from 0 (No STI in lifetime) to 6 (6 or more STIs). Only 2

participants reported being diagnosed as HIV positive. Thus we did not control for HIV status.

Total number of lifetime contraceptive methods used—Participants selected from a list of 10 different contraceptives methods: 1 = the rhythm method or natural family planning; 2 = withdrawal or pulling out; 3 = a condom; 4 = hormonal birth control; 5 = foam, cream, jelly, or suppository; 6 = a diaphragm or sponge; 7 = NuvaRing; 8 = intrauterine device; 9 = Plan B, 10 = Other method not listed). If a participants had never used a contraceptive method, they could select the following option: “We didn't use any protection or birth control.”. We created an index by adding together the number of contraceptives selected for each participant, ranging from 0 (No contraceptives used) to 10 (Ten different types of contraceptive methods used).

STI/HIV norms—Participants were asked to indicate how accepting each tie would be if the participant had HIV or an STI. Response options ranged from 1 = completely accepting to 5 = not accepting at all. We recoded these responses into a dichotomous variable (0 = Not accepting, Not accepting at all; 1 = Very accepting, accepting and neutral), and created an STI/HIV acceptance norm index by calculating the proportion of accepting ties.

Pregnancy norms—Participants were also asked to indicate how accepting their ties would be if they got themselves or someone else pregnant. Response options ranged from 1 (Completely accepting) to 5(Not accepting at all). We computed a dichotomous a variable (0 = Not accepting, Not accepting at all; 1 = Very accepting, accepting and neutral), and created a pregnancy acceptance norm index by estimating the proportion of accepting ties.

Total online peer ties—We employed egocentric network techniques (Borgatti, Mehra, Brass, & Labianca, 2009). The participants (i.e., the ego) were asked to list the 5 people (i.e., the alters) whom they interacted with most frequently online (e.g., on Facebook or Instant Messenger). The link between the *ego* and the *alter* is called the *tie* in social network terminology. For each of the 5 people listed, data were collected from the participant on demographic characteristics of each of the ties, the participants' relationship with each of the ties, the ties' relationship to one another, and information concerning the ties' norms surrounding sexual health. Furthermore, only participants who listed one or more peer ties were included in the analysis. We summed each participant's peer ties to create a measure of their total number of ties.

Proportion of offline peer ties—Participants were asked to list all of the people they interacted with online and of those people, how many they also interacted with offline. We calculated a proportion of offline ties by dividing the number of offline peer ties by the total number of online peer ties.

Density—We asked participants to indicate if the people they listed knew each other: 1 = know each other well, 2 = acquaintances, 3 = no relationship, 4 = I don't know. Relationships where ties knew each other well or were acquaintances were coded as *connections*; “no relationship” or “I don't know” responses were coded as *no connection*. We calculated

density by taking the proportion of connections in the network divided by all possible connections.

Emotional closeness—Participants were asked how close they felt to each of their ties. Possible response options were 1 = very close, 2 = somewhat close, and 3 = not close. We reverse-coded these items and calculated the mean closeness score for each participant's network.

Sex and race homophily—We calculated sex and race homophily indices, respectively, using the Krackhardt & Stern homophily index computation (1988). We subtracted the ties of similar sexes and the ties of different sexes and then divided this number by the total number of network ties. We then repeated this approach for race. The scores are on a scale from -1 (indicating network ties are similar) to +1 (indicating network ties are not similar).

Age of network ties—Participants were asked the age of each tie. Using these entries, we calculated the mean age of the ties in each participant's network.

Data Analytic Strategy

We conducted descriptive statistics with the full sample as well as with the sample stratified by sex in order to understand the relationship among sociodemographic variables and virtual network variables. The average age of network members was skewed and therefore was log-10 transformed to meet the assumption of normality for linear regression modeling. The final sample consisted only of participants with information for all study variables.

Model selection procedure—We initially used generalized linear models with a Poisson distribution because our count outcome variable was heavily skewed to the right. We used the Poisson model to examine the relationship between egocentric network characteristics and number of UVI partners in the past 30 days. To avoid artificially inflating the Type-I error rate, we examined the omnibus test for each model and the Wald χ^2 statistic for each predictor. To minimize the likelihood of wrongly specifying our model by including both lifetime non-sexually and sexually active participants in our analyses, we conducted analyses only among individuals that reported at least one instance of sex in their lifetime (even if no sexual activity in the last 30 days was reported). Thus, the resulting dependent variable was total number of UVI partners in the last 30 days among sexually active participants. In sensitivity analyses we observed no differences when we included the non-sexually active individuals in our multivariate models. A major assumption of the Poisson model, however, is that the variance is equal to the mean. In this case, this assumption was violated for both the main effect and moderation models because we had excessive zero values in the data (> 57%). We used the Vuong test to determine whether the Poisson models or the zero-inflated (ZIP) models were a better fit for the data (Long & Freese, 2006). The Vuong test compares the zero-inflated Poisson model to the standard Poisson model by testing the null hypothesis that both models are equally associated with the observed distribution. The z-value was positive and statistically significant for the main effect models ($z = 4.21, p < .001$) as well as the moderation models ($z = 4.39, p < .001$), indicating that the ZIP models more accurately aligned with the observed data than the standard Poisson

model. The exponentials of the coefficients are reported in-text for ease of interpretation, while raw unstandardized coefficients and standard errors are reported in tables 2 and 3. All analyses were completed in Stata v12. To better visualize the moderation effects, the predicted margins were plotted and are presented in figures 1–3.

Results

Study Sample Characteristics

Table 1 provides information on the sample characteristics. The majority of participants identified racially/ethnically as White/European and ranged in age from 18 to 24. Fifty-two percent of the sample was female. Ninety-seven percent of males and 98% of females reported completing high school. Females were more likely to report being pregnant than males were to report impregnating a female ($\chi^2 = 6.36$, $df = 1$, $p < .05$). Females had a slightly higher mean number of contraceptive methods used than males ($t(1685) = -2.01$, $p < .05$). The effect size estimator (Cohen's d) indicates that the average number of contraceptive methods used differed between males and female by approximately -.10 standard deviations with 95% confidence intervals of -.19, -.002. STI rates were generally low in the sample, with female participants reporting a slightly higher mean number of STI's than males ($t(1685) = -2.24$, $p < .05$). The effect size estimator (Cohen's d) indicates that the average number of sexually transmitted infections differed between males and females by approximately -.11 standard deviations with 95% confidence intervals of -.21, -.01.

Men had slightly denser networks ($t(1685) = 2.77$, $p < .01$) and a higher proportion of total online peer ties ($t(1685) = 2.06$, $p < .05$) than female participants. In addition, males interacted with a higher proportion of the peers both online and offline compared to female participants ($t(1685) = 5.10$, $p < .001$). Females had a slightly higher average age of peer ties than male participants ($t(1685) = -3.30$, $p < .01$). The proportion of pregnancy-accepting peer ties differed by sex with males having a higher proportion of network ties than females ($t(1636) = 10.18$, $p < .001$). Forty-two percent of participants reported at least one UVI episode in the last 30 days. Males had a higher average number of UVI partners than females ($t(1003) = 3.66$, $p < .001$).

Main Effects of Online Social Network Characteristics on Sexual Risk Behavior

Table 2 displays the results for the ZIP model predicting UVI. The likelihood ratio chi-square omnibus test for UVI partners was significant (χ^2 ($N(\text{nonzero's}) = 716$, $N(\text{zero's}) = 971$, $df = 16$) = 426.39, $p < .001$). Females were less likely than males to have had UVI partners in the last 30 days ($e^b = .48$, $p < .05$). Racial/ethnic minority participants were less likely to have had UVI partners in the last 30 days in comparison to White/European participants ($e^b = .60$, $p < .05$). Individuals who graduated from high school were less likely to have had a UVI partner in the last 30 days compared to those who did not graduate from high school ($e^b = .40$, $p < .05$). Individuals who had more lifetime STIs were more likely to have had a UVI partner than individuals who reported fewer STIs ($e^b = 1.11$, $p < .05$). Individuals with more HIV/STI-accepting network ties were 1.46 times more likely to have had a UVI partner than individuals with fewer HIV/STI-accepting network ties. Individuals with more network ties accepting of pregnancy were less likely to have had a UVI partner

than individuals with fewer network ties accepting of pregnancy ($e^b = .58, p < .05$). Individuals who reported denser online social networks were more likely to have had a UVI partner in comparison to individuals with less dense networks ($e^b = 2.63, p < .05$). Individuals with more network members of the same sex were less likely to have had a UVI partner than individuals with fewer network members of the same sex ($e^b = .80, p < .05$). Lastly, participants with a greater proportion of ties who were older were more likely to have had a UVI partner in the last 30 days compared to participants who had a lower proportion of older ties ($e^b = 13.1, p < .05$). In the dichotomous part of the model, an individual's chance for membership in the "always zero" group (UVI partner) increased if the individual had ever been pregnant or impregnated another individual, holding all other variables constant ($e^b = 1.50, p < .05$). In addition, an individual's chance for membership in the always zero group (UVI partner) decreased the more contraceptive methods he or she used ($e^b = .40, p < .05$).

Sex as a Moderator of Online Social Network Characteristics and Sexual Risk Behavior

Table 3 displays the results for the moderation analyses: ($\chi^2 (N(\text{nonzero's}) = 716, N(\text{zero's}) = 971, df = 25) = 539.01, p < .001$). Figures 1–3 display the simple slopes for the significant interaction terms, by social network category (i.e., functional, structural, and interactional) from Table 3. None of the simple slopes for females were statistically significant in any of the figures. Males had a stronger negative association between pregnancy norms and UVI partners ($e^b = 1.44, p < .05$) in comparison to females. Further, males had a stronger positive association between the proportion of online peers they also interacted with offline and UVI partners in the last 30 days ($e^b = 0.39, p < .05$) as well as a positive association between density ($e^b = 0.11, p < .05$) and UVI partners in comparison to females. For the interactional characteristics, the association between sex homophily and UVI partners ($e^b = 1.44, p < .05$), average age of ties and UVI partners ($e^b = 0.05, p < .05$), and emotional closeness and UVI partners ($e^b = 0.79, p < .05$) was greater for males than females. The association between race homophily and UVI partners in the last 30 days ($e^b = 0.70, p < .05$) was also greater for males than females. In the dichotomous part of the model, an individual's chance for membership in the always zero group (UVI partner) decreased if the participant was male ($e^b = .46, p < .05$) or used more contraceptive methods ($e^b = .40, p < .05$), holding all other variables constant. In addition, an individual's chance for membership in the always zero group (UVI partner) increased if the participant reported ever being pregnant or impregnating another person ($e^b = 1.76, p < .05$).

Discussion

Emerging adults are increasingly utilizing online venues to maintain existing relationships and foster new relationships with peers. Our results suggest that emerging adults who had more online network members who were not accepting of HIV/STI norms were more likely to report UVI partners. These findings support our hypotheses that functional, interactional, and structural features of online social networks are associated with sexual risk after controlling for the influences of offline peers. In addition, our results indicate that emerging adults with network members who had a higher proportion of individuals in their network with accepting-pregnancy norms were less likely to report UVI partners. These finding are

consistent with other research on peer networks and HIV/STI and pregnancy norms (Bull, Levine, Santelli, Black, & Schmiege, 2012; Cubbins & Tanfer, 2000; Fielder & Carey, 2010; Friedman et al., 1997; Young & Rice, 2011). They are also consistent with findings that females may be more bothered by online sexual content than males (Šev íková, Simon, Daneback, & Kvapilfk, 2015). Our study findings extend existing research by demonstrating that social norms concerning pregnancy and STI/HIV are influential in offline as well as online social networks of emerging adults. Our findings also suggest that researchers may want to consider examining how social norms diffuse through online social networks of emerging adults (e.g., via communication and messaging involving sexual content).

We also found that the influence of online social network members on individual behavior is guided in part by interactional social network characteristics. Results suggest that emerging adults with more dissimilar sex online social network ties and a greater proportion of older social network ties are more likely to participate in sexual risk behavior. These findings suggest that both online and offline social networks may be important for fostering romantic relationships among males and females. Our results also suggest that males and females may be utilizing online social networks for relationship development purposes that may be associated with sexual risk behavior. Thus, future research that examines the role of relationship formation may help us better understand how emerging adults are utilizing their online social networks differently than their offline networks to develop intimate peer relationships.

Although we found an overall association between online social network characteristics and sexual risk behavior, the moderation analysis suggests that there are also important sex differences. First, males who reported having a higher proportion of network members who had positive pregnancy norms reported fewer UVI partners; however, we found no relationship between pregnancy norms and UVI partners among female participants. Researchers have suggested that social norms concerning sexual behavior differ between males and females (Cubbins & Tanfer, 2000). Females tend to have social norm expectations related to having few sexual partners and later sexual debut, while males have the opposite social norm expectations (Baumeister, Catanese, & Vohs, 2001; Jonason & Fisher, 2009). Thus, it is possible that the sex differences in online social norms and sexual risk behavior found in these data are reflective of differences in social norm expectations for male and females (Courtney, 2000). It could also be the case that males with more online network members who are accepting of pregnancy also tend to participate in more family planning activities and are more knowledgeable about the effects of sexual risk behaviors (e.g., pregnancy and STIs). Emerging adults who have online social network members who are able to communicate about safe sex practices could influence the kind of messages about sexual health that young men receive. Positive sexual health messaging could decrease sexual risk-taking behaviors. Yet it remains unclear why this idea is not also true for female participants who, according to gender role expectations, engage in intimate communication with online social network members.

Online structural social network characteristics were also associated with sexual risk behaviors, and these relationships also differed by sex. Emerging adult males who had a higher proportion of ties with whom they communicated offline (in addition to online) were

more likely to participate in sexual risk behavior than males who had a lower proportion of offline ties. In addition, emerging adult males with denser networks were more likely to participate in sexual risk behavior in comparison to males with less dense networks. In female emerging adults, there was no association between structural network characteristics and sexual risk behavior. Males are more likely to spend time online participating in time-oriented activities such as playing online video games—most likely with other males (Williams et al., 2009). Therefore, it could be the case that males are spending more time online communicating with other males and thus do not have the opportunity to participate in sexual behaviors. This, however, is only one plausible explanation. In the future, researchers should further examine how frequency and usage of online social networks by male and female emerging adults are associated with sexual risk behavior.

Sex differences persisted when we examined the association between interactional social network characteristics and sexual risk behavior. Males who were more heterogeneous in terms of race were less likely to have had a UVI partners in the last 30 days. The opposite was the case for sex homophily, such that males who had a higher proportion of males in their online social network had had more UVI partners in the last 30 days. The finding related to sex homophily is surprising because most research indicates that sexual risk behavior is greater in more diverse social networks due to the higher availability of opposite sex partners (Mazur & Richards, 2011). It may be the case, however, that online social networks may be a more likely venue for males than females to share sexually explicitly content that translates into greater individual sexual risk taking. Future research that evaluates online peer network members to better understand the association between homophily in online social networks and sexual risk behavior would be useful.

We also noted that network density was associated with sexual risk behavior for males but not for females. Previous research examining both offline and online networks has generally shown that network density is associated with risk behavior (Valente, 2010). Males tend to have riskier social networks than female emerging adults (Byrnes et al., 1999; Cubbins & Tanfer, 2000). In addition, males tend to have more cross-sex online social network friends and use these forums for dating purposes more than female young adults (Livingstone, 2008). Thus, the possibility of forming potentially risky connections is greater for male young adults who aim to find relationships with females online. Given our focus on ego-based analyses, however, future research is needed to examine these plausible explanations as we cannot ascertain the sexual risk practices of participants' peers.

Limitations

Although our study provides valuable information regarding online network influences on emerging adult sexual risk behavior, several study limitations require attention. First, because the design of the study was cross-sectional, causal inference cannot be established. Nevertheless, this was one of the few respondent driven sampling (RDS) Internet-based studies to examine sex risk and social media networks, which is useful for informing future research. This is a unique contribution because it helps establish a useful methodology for future research. A longitudinal design, however, could help researchers better understand the temporal ordering between social norms and sexual risk behavior in online social networks.

Second, we used egocentric social networks, which does not allow for a more ecologically focused (i.e., sociocentric) set of network interrelationships involving an examination of all linkages within a bounded area (e.g., school, neighborhood, and dormitory). It is also important to note that because we used an egocentric network, all of the variables are based on the perception of the participant. Thus, the norm variables were created based on whether the participant believed their network ties were more accepting of pregnancy or STI/HIV. Although an egocentric-focused study can provide vital information regarding social norms and features of subjective network experiences, the use of sociocentric networks could provide information regarding the location of an individual within a social network (e.g., social position, distance, and centrality) and this position is related to sex risk behavior and the influence of social norms. Our findings suggest that future research that acquires data directly from social networking venues (e.g., Facebook) and utilizes a sociometric framework to examine social network features of sexual risk behaviors among emerging adults would be a useful next step. Third, we found some differences between respondents with missing data compared to those included in the study, but many of the key study variables did not differ and our overall attrition was not large. Fourth, we did not control for relationship status (i.e., married, single, or engaged) or pregnancy intention in our analyses. Some emerging adults could be in a life stage where they are starting families intentionally, and thus condomless sex would not be a risk outcome. Fifth, it is possible that participants did not answer honestly due to the sensitive nature of the questions asked (e.g., sexual risk behaviors could have been underreported). Yet our missing data analysis did not suggest any particular bias in the sample based on skipped responses (i.e., data were missing at random). In addition, respondents' reports of sexual risk behaviors were consistent with other studies suggesting either limited bias or similar bias to the extant research. Sixth, though our study was a national sample, the majority of participants identified as White. Limitations notwithstanding, this study provides useful insight into the relationship between online network characteristics and sexual risk behavior that can inform the creation and modification of online risk reduction activities. The completely online format of the study allowed us to utilize a diverse and national sample of emerging adults to better understand of how social media may influence sexual behavior. Due to the increased use of social networking sites among emerging adults, our approach to data collection may be necessary to reach this population in future research.

Implications and Future Directions

Our results suggest that addressing safer sex norms as well as online social network structure could be useful for constructing online prevention tools. Further, our results suggest that online prevention tools may require practitioners to tailor these approaches differently for males and females. Practitioners considering the use of online forums for sexual risk prevention activities may want to consider approaches that incorporate peer norms and online social network characteristics. Recently, online social networking sites in particular have been a growing venue for prevention and intervention programs as a means to promote safer sexual practices for emerging adults (Ybarra & Suman, 2008). Researchers have found that the Internet may be a useful tool to reduce sexual risk behavior (Davis, 2012). Bull et al. (2012) found that a Facebook-delivered sexual health intervention resulted in a reduction in sexual risk behavior up to 5 weeks beyond the intervention. Our results add to the existing

knowledge concerning social networks and risk behavior by suggesting that safer sex prevention activities may need to be implemented differently for emerging adult females and males to account for differences in how male and female emerging adults create and interact with their online social networks.

Creating or modifying online risk reduction activities to account for sex differences, social norms, and network components could be vital for promoting safer sexual practices in the sexually active period of development. Our findings identify some online social network characteristics that may be a focus for prevention, especially among males. One of our results, as mentioned before, suggests that having a higher proportion of older peers in online social networks is associated with more risky sexual behaviors for males. Thus, sexual health interventions that focus on potential age-related power dynamics among males with online social networks might be helpful in reducing the effects of online peer influences on sexual risk behavior.

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Figure 1. Sex as a Moderator of Functional Online Social Network Characteristics

Figure 2. Sex as a Moderator of Structural Online Social Network Characteristics

Figure 3. Sex as a Moderator of Interactional Online Social Network Characteristics

Table 1
Demographic and all study variables for males and females (N = 1687)

	Males (N = 807)	Females (N = 880)	Total (N = 1687)	
Variable	M(SD) / N(%)			t/ χ^2
Age	20.96 (1.75)	21.03 (1.79)	21.99 (1.78)	-0.89
Sex				
Male	-	-	807 (47.8%)	
Female	-	-	880 (52.2%)	
Race/Ethnicity				0.29
White/European	610 (75.6%)	675 (76.7%)	1286 (76.2%)	
Racial/Ethnic Minority	197 (24.4%)	205 (23.3%)	402 (23.8%)	
Completed High School	784 (97.1%)	866 (98.4%)	1650 (97.8%)	3.11
Ever Pregnant (Yes)	39 (4.8%)	69 (7.8%)	108 (6.4%)	6.36 *
# of Contraceptive Methods	2.16 (1.25)	2.28 (1.68)	2.23 (1.21)	-2.01 *
# Lifetime STI/HIV	0.04 (0.34)	0.07 (0.29)	0.06 (0.31)	-2.24 *
Density	0.84 (0.18)	0.82 (0.18)	0.83 (0.18)	2.77 **
Proportion of Offline Peer Ties	0.80 (0.26)	0.74 (0.29)	0.77 (0.28)	5.10 ***
Total Online Peer Ties	3.86 (1.27)	3.74 (1.20)	3.80 (1.23)	2.06 *
Emotional Closeness	2.61 (0.37)	2.64 (0.36)	2.63 (0.37)	-1.59
Race Homophily	-0.53 (0.68)	-0.53 (0.68)	-0.53 (0.68)	0.10
Sex Homophily	-0.26 (0.58)	-0.30 (0.57)	-0.28 (0.57)	1.48
Avg. Age of Ties ^a	20.77 (2.62)	21.20 (2.73)	20.99 (2.69)	-3.30 **
STI/HIV Norms	0.57 (0.43)	0.54 (0.42)	0.55 (0.42)	1.31
Pregnancy Norms	0.53 (0.42)	0.33 (0.38)	0.43 (0.41)	10.18 ***
# UVI Partners	1.23 (3.66)	0.73 (1.34)	0.97 (2.72)	3.66 ***

 $p < .001$,

**
 $p < .01$,

*
 $p < .05$

^a Average age of network ties is presented in years in the above table for descriptive purposes. Due to the skewed distribution of this variable, we used the log10 transformation in the multivariate analyses.

Table 2
Generalized linear model predicting number of UVI partners in the last 30 days for males and females (N = 1687)

Variable		<i>b</i> (<i>SE</i>)	95% <i>CI</i>	<i>p</i>
Poisson Model				
Demographics	Sex	-0.74 (0.06)	(-0.86, -0.62)	.000***
	Racial/Ethnic Minority	-0.51 (0.08)	(-0.66, -0.35)	.000***
	White/European	<i>ref.</i>		
	Age	-0.03 (0.02)	(-0.07, 0.01)	.171
	Did Not Complete HS	-0.92 (0.12)	(-1.17, -0.68)	.000***
	Completed HS	<i>ref.</i>		
Sexual History	Lifetime STI's	0.11 (0.05)	(0.00, 0.21)	.046*
	Ever Pregnant	0.12 (0.12)	(-0.11, 0.36)	.305
	Never Pregnant	<i>ref.</i>		
	Contraception	-0.04 (0.02)	(-0.09, 0.00)	.069
Functional Social Network Characteristics	HIV/STI Norms	0.38 (0.07)	(0.23, 0.52)	.000***
	Pregnancy Norms	-0.54 (0.08)	(-0.69, -0.39)	.000***
Structural Social Network Characteristics	Density	0.97 (0.20)	(0.57, 1.36)	.000***
	Proportion of Offline Peer Ties	0.53 (0.11)	(0.31, 0.75)	.000***
	Total Peer Ties	-0.01 (0.02)	(-0.05, 0.04)	.761
Interactional Social Network Characteristics	Emotional Closeness	-0.02 (0.08)	(-0.19, 0.14)	.803
	Race Homophily	0.04 (0.05)	(-0.05, 0.14)	.379
	Sex Homophily	-0.22 (0.05)	(-0.32, -0.12)	.000***
	Avg. Age of Ties	2.57 (0.70)	(1.20, 3.95)	.000***
Logit Model (Probability of 0)				
	Contraception	-0.40 (0.06)	(-0.52, -0.28)	.000***
	Lifetime STI's	-0.43 (0.27)	(-0.96, 0.10)	.111
	Ever Pregnant	1.50 (0.47)	(0.59, 2.41)	.001**

NOTE The overdispersion ratio, $\log(\theta)$, was significantly different from 1.00; it is assumed to be 1.00 in a Poisson model.

Table 3
Moderation analyses predicting number of UVI partners in the last 30 days for males and females (N = 1687)

Variable		<i>B</i> (<i>SE</i>)	95% <i>CI</i>	<i>p</i>
Poisson Model				
Demographics	Sex	4.09 (1.73)	(0.71, 7.47)	.018*
	Racial/Ethnic Minority	-0.41 (0.08)	(-0.56, -0.25)	.000***
	White/European	<i>ref.</i>		
	Age	-0.01 (0.02)	(-0.05, 0.03)	.537
	Did Not Complete HS	-0.95 (0.13)	(-1.20, -0.70)	.000***
	Completed HS	<i>ref.</i>		
Sexual History	Lifetime STI's	0.10 (0.05)	(-0.01, 0.21)	.068
	Ever Pregnant	0.11 (0.11)	(-0.11, 0.33)	.332
	Never Pregnant	<i>ref.</i>		
	Contraception	-0.03 (0.02)	(-0.07, 0.02)	.272
Functional Social Network Characteristics	HIV/STI Norms	0.40 (0.09)	(0.22, 0.58)	.000***
	Sex*HIV/STI Norms	-0.15 (0.15)	(-0.45, 0.16)	.341
	Pregnancy Norms	-0.60 (0.09)	(-0.79, -0.42)	.000***
	Sex*Pregnancy Norms	0.37 (1.11)	(-6.11, -1.76)	.020*
Structural Social Network Characteristics	Density	2.03 (0.29)	(1.47, 2.59)	.000***
	Sex*Density	-2.25 (0.41)	(-3.05, -1.45)	.000***
	Proportion of Offline Peer Ties	0.85 (0.15)	(0.55, 1.15)	.000***
	Sex* Proportion of Offline Peer Ties	-0.95 (0.23)	(-1.41, -0.50)	.000***
	Total Peer Ties	0.00 (0.03)	(-0.05, 0.06)	.900
	Sex*Total Peer Ties	0.03 (0.05)	(-0.07, 0.13)	.535
	Interactional Social Network Characteristics			
Interactional Social Network Characteristics	Emotional Closeness	-0.24 (0.10)	(-0.44, -0.04)	.017*
	Sex*Emotional Closeness	0.56 (0.17)	(0.21, 0.90)	.001**
	Race Homophily	0.17 (0.06)	(0.06, 0.28)	.003**
	Sex*Race Homophily	-0.35 (0.08)	(-0.52, -0.19)	.000***
	Sex Homophily	-0.29 (0.07)	(-0.42, -0.15)	.000***
	Sex*Sex Homophily	0.37 (0.11)	(0.16, 0.58)	.001**
	Avg. Age of Ties	3.38 (0.84)	(1.73, 5.03)	.000***
	Sex*Avg. Age of Ties	-2.93 (1.14)	(-5.16, -0.70)	.010*
Logit Model (Probability of 0)				
	Sex	-0.46 (0.15)	(-0.76, -0.16)	.003**
	Contraception	-0.40 (0.06)	(-0.52, -0.28)	.000***
	Lifetime STI's	-0.34 (0.27)	(-0.86, 0.18)	.206
	Ever Pregnant	1.76 (0.56)	(0.67, 2.87)	.002**

NOTE The overdispersion ratio, $\log(\theta)$, was significantly different from 1.00; it is assumed to be 1.00 in a Poisson model.