CONTEXTUAL FACTORS INFLUENCING SEXUAL ACTIVITY AMONG ADOLESCENTS WITHIN SOCIAL NETWORKS IN A MICROPOLITAN/RURAL AREA

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ABSTRACT

This paper examines factors influencing sexual activity among 15-19 year-olds from a micropolitan/rural area, recruited by peers through Participant-Driven Recruitment, a methodology that combines participatory research with Respondent-Driven Sampling. Using the social network derived from recruiting as the unit of analysis, findings indicate that adolescents who: engaged in alcohol, drug and tobacco use; and who were older were more likely to engage in sexual activity. Social network characteristics generated using RDS analysis software show moderate to substantial homophily (tendency of similar persons to form social ties) among the adolescents. Graphics of the social network are also included, providing greater insight into the contextual and reciprocal nature of social ties. Social structures beyond dyadic relationships are explored, illuminating distinctive influences not likely to be captured by conventional statistical methods alone, offering complementary data seldom found in studies regarding non-metropolitan adolescents.

Introduction

This paper seeks to examine the influences of social, cultural and demographic factors on sexual behavior among 15-19 year olds from a micropolitan area and surrounding rural areas in upstate New York. It is based on a study in which respondents were invited to participate in an HIV/AIDS/STD-related research intervention through Participant-Driven Recruitment, a participatory and socially embedded methodology. The unit of analysis is the social network formed by the adolescents through the recruitment process.

Although the study sought to better understand the levels of HIV-related knowledge and worry, intergenerational health communication and youth behaviors, this paper has a narrower scope. It focuses on four risk behaviors: alcohol, drug and tobacco use as well as sexual activity, at least once and during the past thirty days, where the probability of engaging in sexual activity is the outcome of interest. Protective behaviors are characterized as not engaging in any of these behaviors. Socio-cultural and demographic variables (participant's age, sex, race/ethnicity, residence, religiosity, and HIV/AIDS/STD-related knowledge) are also included as controls.

This paper also analyzes social network characteristics including recruitment patterns, sample and population proportions, homophily and heterophily. Homophily here is defined as the tendency of similar persons to form social ties, whereas heterophily is defined as the formation of social ties based on differences.[1]

Ecological-transactional theory conceptualizes adolescent behavioral risk and protective factors both through ecological effects, namely the social contexts in which the risk or protection occurs as well as transactional effects, including the reciprocal nature of the relationship between adolescents' behavior and their social contexts.[2] The theory also stresses that the most proximal influences, including friends and family, may have the greatest effects on developmental outcomes.[2] Regardless of whether the youth grow up in rural or

2

urban communities, their behaviors are embedded in norms and patterns established by their interactions with their communities, families, peers, as well as broader social structures, including social standing, gender and geography.[3, 4] These contextual influences are critical in adopting and modifying behaviors, sometimes putting youth at increased risk of experiencing harmful behaviors[3] and possibly increasing HIV risk.[4, 5]

The interactive relationship between social context and everyday life, however, has not fully been integrated in sexual health promotion intervention.[3] Most of these interventions rely instead on individual risk factor approaches.[3] This misplaced reliance emphasizes the need for a practical move towards an ecological approach that favors studying the interactions between social context and youth sexual behavior, as first argued by Bronfenbrenner.[3]

Adolescents/Youth

This paper focuses on late adolescents (15 to 19 years) and the terms "adolescents," "youth," and "teenagers" are used interchangeably to define this group. In the United States, adolescent health is said to have shown little improvement over the last thirty years.[6] Research not only indicates that the leading causes of death among adolescents have shifted from natural causes to injury and violence,[7] but also that the major causes of mortality and morbidity among adolescents have shifted from infectious to behavioral causes, reflecting lifestyle choices such as tobacco, alcohol and drug use as well as early sexual activity and teenage pregnancy.[7, 8] Half of all adolescents participate in one or more high-risk behaviors[9] and empirical studies show associations between sexual activity and other risk behaviors.[10-12] Alcohol, drug and tobacco use are therefore regarded in this paper, as complementary risk behaviors to sexual activity.

Youth who use alcohol have been found to be seven times more likely than youth who do not drink alcohol to be sexually active, significant even after adjusting for age, race,

gender and parental educational level.[13] A study found that students who reported alcohol use were more likely to report having had sexual intercourse, having engaged in unprotected sex, or having had four or more sexual partners.[14] The Centers for Disease Control and Prevention (CDC) also found that by the age of fourteen years, over 50% of secondary school students drink at least occasionally and that drinking patterns established in high school often persist during college.[15] Additionally, boys are generally more likely to engage in significant use of alcohol.[16-18] Drug use among adolescents also remains a problem in the United States.[7] Data indicate that almost half of all high school seniors have used marijuana at some point in their lives, with male high school seniors much more likely than females to report annual usage of marijuana.[6] As might be expected, tobacco use among adolescents has also received much attention due to a rising number of adolescents who engage in this health risk behavior per day and an even earlier age of initiation.[19, 20]

Approximately 50% of all adolescents in the United States are sexually experienced, with 17% reporting having had four or more sexual partners.[21] Nationally representative data suggest that patterns of sexual intercourse differ according to gender, age, ethnicity/race and socioeconomic status.[22] Overall, males are more likely than females to report having had sexual intercourse, and older students are more likely than younger students to report having had sexual intercourse.[9] The possible adverse impact of early sexual intercourse are staggering: contracting sexually transmitted diseases including HIV/AIDS, increased risk of cervical cancer, pelvic inflammatory disease, compromised future fertility, unwanted pregnancy, low educational attainment, greater social isolation and compromised economic future.[23-25]

Researchers, however, have interpreted trends in adolescent sexual activity in various ways. On one hand, Irwin highlights a trend in the postponement of sexual intercourse initiation and in the increased use of contraception among adolescents.[26] On the other hand, data from the 2003 YRBS reveals that the proportion of students reporting having had sexual

intercourse increases as they move into higher grades[9] and advance in age.[27] Another study found that among those who are sexually active, many fail to consistently protect themselves from pregnancy, fewer protect themselves from disease[28, 29] and many have multiple and potentially riskier partners.[28] In 2003, of sexually active high school students nationwide, 37% reported that neither they nor their partner had used a condom during last sexual intercourse and 25% reported using alcohol or drugs before their last sexual encounter.[9]

Among the U.S.' 15 to 19 year old females, about 9% become pregnant each year.[30] The risk of acquiring sexually transmitted diseases/infections (STDs/STIs) is also very real. Approximately twelve million of new cases of STDs are reported annually, with about a quarter of the cases found among those under the age of 25 years.[28, 31] All in all, while some statistics related to risky sexual behaviors among youth suggest that they have improved/declined,[26] other prevalence and incidence statistics suggest that adolescents continue to engage in risky sexual behaviors.[32, 33]

Although the Human Immunodeficiency Virus (HIV) is a sexually transmitted disease, the magnitude of the epidemic warrants a separate discussion (following section). With rates of STDs remaining higher among teenagers than any other age group, HIV continues to represent a salient health risk among teenagers.[34]

HIV/AIDS

Engaging in risky sexual behavior is directly related to the extremely high rates of youth HIV infection.[35] Indeed, about 20,000 people between the ages of 13 and 25 years are infected with HIV annually, representing about half of the infections in the United States.[36] Women make up an increasing proportion of those infected with HIV, with about 75% of the estimated 12,000 U.S. women infected with HIV annually having been exposed to the virus

through heterosexual contact.[37] Women under the age of 25 years make up slightly over half of HIV infections among youth.[38]

It is important to realize that the transmission of HIV and other STDs do not depend on just one person's behavior, but also on how those behaviors are linked to one another (see Bell et al. (2002) for extensive review on HIV transmission modes).[39] Transmission through sex, for instance, involves intimate personal contact and transmission through intravenous drug use involves the shared use of possibly contaminated equipment.[39] These risk behaviors are therefore embedded in relationships whose interconnections essentially influence the potential for the transmission of HIV and other STDs (also see Bell et al. (2002) for extensive review of HIV embeddedness).[39]

Focus: Adolescents in Non-Metropolitan/Rural Areas

Roughly three-fourths of U.S. counties and landmass are considered rural, where an estimated 20% of the population resides.[40] Rural populations generally fare worse along several health-related dimensions, compared with other populations, especially suburban ones.[41, 42] In 1997 and 1998, the prevalence of cigarette smoking among U.S. adolescents and adults who lived in the most rural counties was 19% and 32% higher, respectively, than among their suburban counterparts.[42] Furthermore, the spread of HIV to rural areas also continues to be an important issue.[43-49] Studies suggest that rural HIV epidemics may be distinct from nonrural epidemics because rural communities may be less prepared to meet the prevention and treatment challenges.[50-52] This calls for an increased understanding of rural HIV epidemics in the United States.[49] Lastly, demographic and socioeconomic factors, including race/ethnicity, education and income compound the health differences among rural and nonrural residents.[42, 53, 54] It is necessary to indicate, however, that rural residence itself must not always connote a health disparity. Certain urban areas do, in fact, fare worse than

other areas based on health indicators such as homicide.[54] Some urban and rural areas even share common disparities such as lack of health insurance and socioeconomic status.[54]

There is a lack of research on either the likely predictors of the onset of sexual intercourse among rural youth[55] or the obstacles faced by rural adolescents in creating social opportunities and the strategies they face in overcoming such obstacles.[56] Studies that have included rural adolescents as a subpopulation have been primarily descriptive and exploratory.[55] While research conducted with urban and suburban teenagers provides insights on some aspects of life common to all teenagers, it cannot fully represent adolescent experiences in rural areas.[56, 57] To critically understand and respect the reality in which these adolescents live and function, research sensitive to rural specificity is imperative.[7, 16, 19]

The relatively few studies focusing specifically on rural adolescents indicate greater ratios for a number of behavioral risks among rural adolescents, as compared to urban and suburban adolescents.[19] Many rural adolescents, for instance, have experimented with tobacco, alcohol and other drugs[16, 19] and are at a higher risk of accessing alcohol.[58] The use of increasing numbers of substances has been positively associated with increasing likelihood of sexual activity.[55] Even among rural adolescent virgins, rates and patterns of substance use are similar between males and females, although older youth have substantially higher rates for use of alcohol, tobacco, marijuana or their combinations.[55] Indeed, alcohol remains the substance of choice for rural high school students[19] and its use is considered one of the most popular activities when teenagers meet.[56] Rural adolescents also often participate in large outdoor drinking parties in secluded areas unmonitored by adults.[19] As a result, older adolescents often initiate younger adolescents to these parties by purchasing alcohol for them or providing them with mood-altering substances.[19, 58]

Regarding drug use, rural adolescents are likely to start using other drugs as they progress from middle to high school.[19] Although cocaine is not commonly used among rural adolescents, marijuana use has close to doubled since the 1990s.[19] Adolescent use of

marijuana increased by 105% between 1992 and 1994, and increased by another 37% between 1994 and 1995.[19] By the time rural adolescents reach age 17, 68% can buy marijuana within a day, 62% have friends who use marijuana, and 58% have been solicited to buy marijuana.[59]

Certain studies, however, have found no significant differences between urban, suburban and rural youth with regard to substance use or sexual risk behaviors even when accounting for race/ethnicity.[60] As such, some scholars advocate instead for a shift in focus to adolescents' environments and other demographic factors such as race/ethnicity, access to health, educational resources and socioeconomic status when predicting adolescent involvement in risk behaviors.[60]

Social Networks & Homophily

Social networks are made up of multiple personal networks[4] and represent the connection of individuals to a central individual based on a particular behavior or interaction.[61] Focusing on social networks is critical because such a perspective considers the influence of relationships within a group and how the totality of these relationships can influence a person's likelihood of engaging in risk-taking behaviors.[62, 63] The network contagion theory asserts that the resulting networks and self-organizing systems, should be the units of analysis, rather than the individuals and their isolated cognitive structures and processes.[64]

Another dimension of social network theory that is central to this paper is the theory of homophily, based on the notion that contact between people who share similar characteristics occurs at a higher rate than among those who are dissimilar in characteristics.[65, 66] Ties that are based on differences in affiliation are known as heterophily.[1]

Peer groups, such as adolescents, are a significant source of influence on behavior.[65] Consequently, risk behaviors including sexual activity, alcohol and tobacco use are influenced by peer social networks.[67] Homophily studies have shown that adolescents exhibit the

8

tendency to associate with others who share their behavior patterns, whether positive (e.g., academic achievement) or negative (e.g., smoking marijuana).[65] In this paper, the friendships among the adolescents are considered voluntary associations and as McPherson et al. emphasize, these associations represent an excellent opportunity to examine the characteristics of homophily.[65]

Certain caveats on social networks, however, must be noted. First, while social networks may integrate individuals into a community, they can equally place stringent isolating regulations on behavior.[68] Second, the influence of social network ties may not be always positive, since having too many ties may be as damaging as having too few.[68] Third, networks are situation, issue and context-driven and are governed by other social boundaries and hierarchies.[69] Lastly, even though social networks may facilitate the flow of information and convey this information differently, they can also misreport and misinterpret information.[69]

The rationale for employing social network analysis to understand the HIV/AIDS epidemic is strong, particularly because social networks can assume a dual role in these epidemics. Not only do social networks serve both as the path of transmission for the virus and other diseases, but also as the potential path of transmission for HIV/STD prevention information and services.[70] Health interventions can, therefore, be improved by understanding how social structure influences sexual behavior and using that understanding to develop strategies for positive change.[63] Doing so requires interventions with high external validity as well as representative data that is generalizable to the population under surveillance.[71] Yet, several important populations (such as injection drug users, men who have sex with men, commercial sex workers), continue to be systematically excluded from these efforts and interventions, creating critical gaps in understanding HIV/AIDS epidemics

Evidently, these "hidden populations[a]" are important, but the generalizability of study results to diverse populations and settings hinges on developing sampling methods from which valid estimates of infection rates or behaviors among its members can be derived.[71]

To conduct scientifically rigorous studies, social scientists and researchers have historically been required to start out with a list of all the members of the population, but in many of these hidden populations, such a sampling frame simply does not exist.[72] As an alternative, street and network sampling strategies have been used, namely (i) targeted, (ii) stratified, (iii) time-space, and (iv) respondent-driven sampling.[73] Admittedly less than optimal from a theoretical perspective – due to inherent limitations described in Semaan et al. (2002)[73] – these street and network sampling strategies offer pragmatic options both for obtaining probability or representative samples when data are collected and analyzed, and for maintaining a high degree of external validity in situations where traditional sampling methods will most likely not produce successful results.[73] This paper focuses on Respondent-Driven Sampling (RDS).

Respondent-Driven Sampling

RDS was developed by Douglas Heckathorn, Robert Broadhead and other colleagues at the University of Connecticut during the 1990s[72, 74-76] as a way to improve sampling methods for hard-to-reach populations.[72] Unlike other chain-referral methods previously used,[76] RDS attempts to overcome the biases such as masking, volunteerism and the oversampling of groups with large networks [72, 76, 77] to provide more representative samples. RDS has now been touted for using the least amount of formative research and resources

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[a] Although adolescents/youth are generally not regarded as a hidden population, addressing sensitive issues regarding HIV/AIDS/STDs-related knowledge and risk/protective behaviors may inadvertently stigmatize some members of this population.

(including funding, participant involvement and time,[72] when compared to other methods used to sample hidden populations).[73]

RDS sampling and estimation methods are predicated on the understanding that unlike outreach workers, peers are better able to locate and recruit other members of a hidden population.[73, 76] Relying on social networks affords RDS greater population coverage and the potential to reach those who would not participate in a study conducted only in common venues.[76]

RDS has superior external validity because it is not limited to the sample hidden population.[71] Since participants are accessed through the social networks of the recruits, RDS extends the sample to all potential members of the group.[71] Further unique features include the fact that the relationship between recruiters and recruits is documented as a way to assess and adjust recruitment biases during analysis.[71] Similarly, personal network size information for each respondent is gathered to facilitate weighted analysis and to make up for the oversampling of respondents with larger social networks and to weight analyses.[71] It is this information on personal network sizes that allows for the calculation of selection probabilities. According to the authors of RDS, the aggregate recruitment patterns tend to reflect personal network composition such that participants recruit as though they were selecting randomly from their personal networks, thus generating a sample based on probability sampling. [72, 76]

The RDS sampling process starts with a set of original participants selected by the researcher who serve as "seeds." Seeds are given a detailed explanation of the study's purpose as well as a limited number of coupons (containing unique serial numbers) to recruit eligible peers into a given study.[71, 77] The first wave of recruitments is made up of participants recruited by the seeds and Wave 2 is made up of participants recruited by those in Wave 1.[76] Recruitment cycles then proceed until the sample reaches "equilibrium."[71] Over the course of more than a dozen recruitment waves, for example, a seed may yield hundreds

of additional participants.[77] With RDS, the effects of the choice of seeds become progressively weaker as the sample increases, enabling the sample composition to eventually attain an equilibrium that is independent of the starting point.[74, 77] To achieve this, RDS borrows from the Markov chain argument and incorporates a method for eliminating sampling bias introduced by the arbitrary selection of seeds.[75] In other words, whether all seeds emerge from one group or from a variety of groups, the final composition of the sample will arrive at an equilibrium that is independent of the characteristics of seeds, provided the number of waves is satisfactorily large.[74, 76] Studies have confirmed that RDS estimates are asymptotically unbiased, regardless of how the seeds are selected.[72, 74] Still, the initial diversity of seeds is important because it reduces the number of waves needed to reach equilibrium.[76] Paradoxically, the appropriate choice of seeds can accelerate the process by which the influence of seeds is minimized in the final composition.[76]

Another major contribution to the study of hidden populations is that RDS does not require an extensive mapping process to construct sampling frames since these are devised *during* the sampling process when members of the hidden population recruit their peers and these recruitment patters are documented.[71] This recruitment process integrates the direct and voluntary recruitment of peers by their own peers, even though the process begins with a small number of non-randomly chosen seeds.[71] The RDS sampling methodology also encourages long recruitment chains and increases the "reach" of the sample into more hidden pockets of the population.[71] The essence of long referral waves is that they ensure that the sample will have considerable socio-demographic depth so that seeds will comprise only a small portion of the entire sample.[77] Other distinguishing factors of RDS are its recruitment quotas and dual system for incentives.[71, 73] Recruitment quotas are usually no more than three recruits and the incentive system remunerates the peer *both* for participating and for recruiting. RDS makes use of recruitment incentives to construct a very robust system of chain referrals.[77] Additionally, the RDS sampling methodology is supplemented by the

Respondent-Driven Sampling Analysis Tool (RDSAT), a software extension capable of analyzing network data and making statistical inferences from hidden populations.[78]

RDS & Homophily

The originality of RDS also offers an opportunity to gather and study information on both affiliation patterns and group size.[74, 75, 77] As a result, RDS population samples provide information not only regarding the larger population, but also about the social structure connecting them.[72] If ties are formed within the group one-third of the time and without regards to group membership two-thirds of the time, homophily is said to be 0.30.[1] A positive value also shows that the group is cohesive. Conversely, if ties are formed outside the group one third of the time and are formed two thirds of the time without regard to group membership, homophily is said to be -0.30. All ties formed within the group represent complete homophily, with a value of +1. If all ties are formed outside the group, however, a value of -1 is assigned to this occurrence known as heterophily.[1] The homophily is zero for categories that are deemed socially irrelevant, like whether one was born in an odd or even month.[1] A homophily index of 0.32 among 15-year olds, for instance, means that they recruited as though 32% of the time, they recruited another 15-year old and the remainder of the time, they recruited randomly. This paper seeks to determine the extent to which homophily applies to a network of 15-19 year olds living in a micropolitan area and surrounding rural areas, based on variables of interest.

As with all existing sampling methods, RDS has its limitations. A review of four street and network sampling strategies cautions that although RDS has shown potential in generating representative samples, existing results must be replicated to be widely accepted by researchers.[73] Another limitation has been the difficulty in readily assessing the fit between RDS theory and RDS data[79].

Participant-Driven Recruitment

Participant-Driven Recruitment (PDR) is a participatory, community-based and socially embedded methodology that assimilates the core analytical principles of RDS (quantitative) and Participatory Research (qualitative) to effectively derive research-based prevention education and services.[80] The continuous and dynamic nature of PDR uses its research findings to tailor the research process to the needs of the population of study. As such, data generated throughout the PDR interventions are reinvested into the target population during scheduled meetings, allowing those who have participated in the intervention to own the information and discuss what it might represent to themselves and the community at large. As with Participatory Research, the target population is central in formulating the research project/intervention as they contribute to the applicability of survey contents and educational activities. Otherwise said, PDR places great importance on the role of the participants in research design as well as data interpretation. By doing so, PDR tunes into the community's social processes and engages its members in effectively addressing issues that, on the surface, may not seem to affect them as a whole.

Like RDS, PDR reaches people who might otherwise be overlooked by programs and research studies.[81] A principal advantage of PDR is that it endeavors to overcome a situation known as the "peer education dilemma," where peer education programs are perceived to primarily benefit the youth who serve as peer educators.[81] The latter may result from the peer educators' active involvement and refined understanding of the information being related to their peers.[81]

The PDR process also involves the selection of seeds. In this case, seeds engage in the research project/intervention by co-designing a survey and contributing to the development of educational and interactive activities. As with RDS, seeds recruit their peers and the latter recruit other peers into the research project/intervention. Each participant takes the same survey and engages in the same educational and interactive activities. Thus, while in the

process of recruiting their peers, participants are very likely to relay the educational information they have acquired.[80, 81] This double role might not only allow more participants to experience the effect of peer education, but also develop a new relationship to the information being acquired and shared – possibly leading to healthier behaviors.[81] PDR has been proven successful among groups that have strong social ties, befitting it as socially embedded methodology.[81-85]

Having recognized the dearth of research focusing on rural communities, researchers from Cornell University (Allen et al.) implemented *Project Rural R.O.A.D: Reach Out AIDS/HIV/STD Discussions* between 1999 and 2002, using PDR both as part of the intervention as well as the recruitment strategy in a micropolitan area and surrounding rural areas in upstate New York. The purpose of *Project Rural R.O.A.D* was to further understand how 15 to 19 year olds youth learn about and discuss health-related issues – alcohol, drugs, sex and preventing HIV/AIDS/STDs – with adults such as parents/guardians, relatives and service providers. The silence and stigma around the HIV/AIDS epidemic has resulted in a failure to fully acknowledge not only the risks facing young people, but also their strengths and capabilities in curtailing the epidemic.[81] A participatory and community-based approach such as PDR was sensitive to the nature of these issues and built on its strength as a socially embedded process that engages participants and eventually, the community-at-large. Allen et al. engaged the support of rural community members[81] in a collaborative and empowering partnership to develop protocols and implement *Project Rural R.O.A.D*. Engaging adolescents, parents and youth service providers highlighted the strength and diversity of the social ties among the community's youth. It also affirmed the effectiveness of PDR as methodology that stimulates adolescents' discussions of HIV/AIDS/STD-related issues as well as intergenerational communication.[81]

The youth who participated in *Project Rural R.O.A.D.* hail from an area in upstate New York that includes a micropolitan area with close to 20,000 people, bordered by several rural communities. The term "micropolitan" – coined by the U.S. Office of Management and Budget (OMB) and adopted by the U.S. Census Bureau – designates areas containing at least one urban cluster of between 10,000 and 49,999 people.[86]

General demographic characteristics based on U.S. Census statistics in 2000 indicate that in this county of about 50,000 people, white non-Hispanics comprise 96.6% of the population, followed by Blacks (0.9%), Asians (0.4%), American Indian and Alaska Native persons (0.3%), and Other (0.3%). Females and males made up 51.7% and 48.3% of the entire population, respectively. Additionally, those living in the micropolitan area made up close to 39% of the county's population.[87] Statistics also show that in 2000, the median family income in 2000 was roughly $42,000. Finally, youth between the ages of 15 and 19 years made up about 13% of the micropolitan area and 9.6% of the county. Approximately 3% of the adolescents in the county participated in *Project Rural R.O.A.D.*

Hypotheses

This paper is premised on two basic hypotheses. First, youth who: engage in other risky behaviors such as alcohol, drug and tobacco use; are male; are older; are non-white; are from rural areas will be *more* likely to have had sex at least once and/or have had sex during the past thirty days. Second, depending on whether they abstain or whether they are sexually active, youth belonging to each subgroup will exhibit considerable homophily based on each defining risk/protective behaviors, as well as socio-cultural and demographic factors including participant's age, sex, race/ethnicity, residence, religiosity, and HIV/AIDS/STD-related knowledge.

Methods

Participants completed a twenty-three-page self-administered baseline survey. Of the 128 total participants, nine were seeds who actively participated in the pilot phase of the research project.[81] Participants were asked to invite three to five friends between the ages of 15 and 19 years to participate in the research project/intervention. Participation meant that those recruited would meet at a designated community location to complete a survey and to engage in two educational and interactive activities. The total sample yielded was diverse and represented youth from somewhat isolated areas, farming communities and small villages as well as youth from public schools, vocational schools and those out-of-school.[81] Close to 60% of the youth in the sample lived at home with two parents/guardians and approximately 50% of them indicated having a job or occupation. As compensation for participating in the research project/intervention, participants received $15 for completing the baseline survey and $20 for completing a follow-up survey (this paper concentrates on the baseline survey). Participants also received $10 for each recruited friend who participated in the project.

After completing the survey, the adolescents participated in two educational and interactive activities. The first activity addressed common misconceptions about HIV/AIDS/STDs-related risk and prevention and morbidity. This activity encouraged and very often generated group interaction and conversation regarding a statement, all the while reinforcing correct knowledge. The second activity consisted of role-plays and more often than not, participants expressed a newfound appreciation for adults and the difficulties in responding to questions posed by children and teenagers. Following the two activities, each participant was given an answer key to the fifty-four knowledge questions on the survey. Each survey session included a feedback segment during which the participants candidly provided their opinions on the positive and negative aspects of the survey session and suggestions for future sessions.

Measures

Socio-demographic measures were dichotomized as follows: **age** (15 years vs. 16-19 year olds)[b]; **race/ethnicity** (white non-Hispanic vs. non-whites and white Hispanics); **residence** (micropolitan area vs. surrounding rural areas); **religiosity** (attending "some" church, religious services or activities vs. rarely or never attending); and **sex of participant** (males vs. females).

As with the YRBS questionnaire, the survey's behavior differentiated between those who "ever" engaged in a certain behavior and those who "currently or recently" engage(d) in that behavior. In these analyses, both measures were used for selected behaviors and characteristics. **Using alcohol at least once** (do not use = 0 vs. used alcohol = 1)**; alcohol use during the past thirty days** (have used alcohol within the last month = 1 vs. not = 0). This dichotomy was also used for the variables measuring **drug and tobacco use at least once and during the past thirty days. Engaging in multiple risks at least once and Engaging in multiple risks during the past thirty days**[c] were measured by combining alcohol use, drug use and tobacco use to determine the proportion of participants simultaneously engaging in two or more behaviors. Unlike other dichotomous variables, these variables were coded into four categories ("0 risks", "1 risk", "2 risks", or "3 risks"). **Having had sex at least once** was based on two survey items: "I have always abstained from sex" = 0 vs. "I have had sex [oral, vaginal, or anal intercourse] = 1. **Sexual activity during the past thirty days** was measured by the item "I have had sex [oral, vaginal, or anal intercourse] within the last month." This group was recoded as "1," further distinguishing them from those who had abstained as well as those who had had sex, but not during the past thirty days. The latter combined group was recoded as "0."

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[b] Analyses showed no significant associations between sexual activity and age as a continuous variable (15, 16, 17, 18, 19 years); age categorized as 15-17 year olds and 18-19 year olds; or age categorized as 15-16 year olds and 17-19 year olds.

[c] Both variables were constructed for analyses in this paper and are not found in the original survey.

Knowledge measures focused on HIV/AIDS/STDs transmission as well as risk and protective behaviors, recoded as "0" to measure questions that were not correctly answered and as "1" for those that were.

Analyses

Analyses were conducted in three parts using STATA 9.0, RDS Analysis Tool (RDSAT) and NetDraw. First, bivariate associations and odds ratios were assessed using a Chi-square test. Multivariate logistic regressions were then performed, controlling for the socio-cultural and demographic variables. Second, RDSAT (v.5.4) was used to analyze social network data, including recruitment patterns, sample and population proportions, confidence intervals, network size, equilibrium, homophily and population weights. Third, NetDraw (v2.86) was used to derive graphics of the entire social network generated through the recruitment process, according to the variables in examined in this paper. The networks resulting from the sample population of this study were conducted using 1-mode social network data and therefore have no spatial relevance.

Findings

Table 1 describes the socio-demographic characteristics of the sample (N=126), by participants' sex. The mean age was 16.5 years (± 1.3 years), with relatively equal percentages of males (50.8%; n=64) and females (49.2%; n=62). Over 75% of the sample resided in a micropolitan area with the remaining residing in rural and small farming communities.[d] All race/ethnicities (except white non-Hispanics) were overrepresented in this study. More females attended some church or religious activity, although overall, more adolescents did not attend any church or religious activities. Besides age, there was very little socio-demographic variation between males and females.

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[d] Frequencies of zip code distributions are available upon request

19

Tables 2-4 contain the frequencies, percentages, odds ratios, and significance levels of independent variables associated with the outcome variable. Table 2 suggests that, compared to youth who never engaged in each behavior, youth who used drugs were over eight times more likely to have had sex at least once. This was followed by those who used alcohol and smoked tobacco at least once, who were over seven and four times, respectively, more likely to have had sex at least once. Those who simultaneously engaged in all three risk behaviors were almost nine times more likely to have had sex at least once. All these variables were significant at the 0.001 level.

Figure 1 shows that on the whole, alcohol use was the highest (65%), followed by having had sex at least once (61%), tobacco use (50%) and lastly, drug use (46%). Females were ahead of males by twelve percentage points regarding alcohol use at least once (71% and 59%, respectively). Also, 64% of females indicated having had sex at least once as compared to 58% of males. Regarding multiple risk behaviors, Figure 2 suggests that although a higher percentage (38%) engaged in all three risk behaviors [alcohol, drug and tobacco use], about a similar proportion engaged in one and two risk behaviors at least once (18% and 15%, respectively). It seems likely that the six percentage difference between females and males regarding engagement in one risk behavior reflects the higher proportion of females engaging in alcohol use as seen in Figure 1. Slightly below a third of the participants (29%) did not engage in any risky behaviors at all.

For recent engagement in risk behaviors described in Figure 3, drug use was highest with approximately 70% of the youth recently engaging in this behavior: 77% males and 63% females. Equal proportions of the sample reported recently using alcohol and tobacco (42%), even though more females indicated using alcohol (45%) as compared to males (39%) and more males indicated smoking tobacco (49%) as compared to females (34%). For sexual experience, a total of 37% indicated having recently had sex (roughly 40% of males and 33% of females).

Similar to engaging in multiple risks at least once, **Figure 4** indicates that an equal proportion of participants engaged in one or two other risk behaviors (20% each). In contrast, 16% recently engaged in all three other risk behaviors. Again, a higher proportion of participants (44%) did not engage in any risk behaviors during the past thirty days.

In **Table 3**, compared to youth who never engaged in any behaviors plus those who engaged in them at least once, youth who recently used alcohol and smoked tobacco were over four times more likely to have recently had sex (OR = 4.33, in both instances). Interestingly, those who recently engaged in all three complementary behaviors were close to three times more likely to have recently had sex (OR=2.67). **Table 4** describes knowledge as well as socio-demographic variables among those who had sex at least once as well as those who had sex during the past thirty days: participant's age was the only significant variable among the socio-demographic variables, where older youth (those between 16-19 years) were over twice as likely to have had sex at least once (OR=2.08) as well as during the past 30 days (OR = 2.27). Although there are no significant differences based on the associations, the considerable percentage point differences regarding knowledge, participants' sex, race/ethnicity, residence and religious activities are suggestive of a real effect.

Table 1 – Socio-demographic Characteristics by Participants' Sex

Characteristics	Males % (n)	Females % (n)	Total % (n)
Age			
Mean: 16.5 years			
15 years	21.9 (14)	40.3 (25)	31.0 (39)
16 years	28.1 (18)	19.4 (12)	23.8 (30)
17 years	21.9 (14)	17.7 (11)	19.8 (25)
18 years	20.3 (13)	19.4 (12)	19.8 (25)
19 years	7.8 (5)	3.2 (2)	5.6 (7)
Race/Ethnicity			
White non-Hispanic	85.9 (55)	87.1 (54)	86.5 (109)
Non-white	14.1 (9)	12.9 (8)	13.5 (17)
African-American	*3.2 (2)*	*1.6 (1)*	*2.4 (3)*
Asian	*3.2 (2)*	*0.0 (0)*	*1.6 (2)*
Hispanic/Latino	*1.6 (1)*	*6.5 (4)*	*4.0 (5)*
Other	*6.3 (4)*	*4.8 (3)*	*5.5 (7)*
Residence			
Micropolitan Area	81.2 (52)	72.6 (45)	77.0 (97)
Rural Area	18.8 (12)	27.4 (17)	23.0 (29)
Attend Religious Activities			
No/Never	63.5 (40)	53.2 (33)	58.4 (73)
Yes	36.5 (23)	46.8 (29)	41.6 (52)
Two or more times a week	*7.9 (5)*	*12.9 (8)*	*10.4 (13)*
Once a week	*17.5 (11)*	*16.1 (10)*	*16.8 (21)*
Once or twice a month	*3.2 (2)*	*11.3 (7)*	*7.2 (9)*
Once or twice a year	*7.9 (5)*	*6.5 (4)*	*7.2 (9)*

Table 2 – Percentage Distributions and Odds Ratios of Independent Variables and Outcome Variable (Sex at Least Once and (Sex during the Past 30 Days)

	Sex at Least Once[a]		
	n[c]	%	Odds Ratios
Alcohol Use – At Least Once			
- **No**	41	31.7	
- **Yes**	76	77.6	**7.47*****
Drug Use – At Least Once			
- **No**	63	41.3	
- **Yes**	54	85.2	**8.18*****
Tobacco Use – At Least Once			
- **No**	58	44.8	
- **Yes**	59	78.0	**4.35*****
Multiple Risks – At Least Once			
- **0 risks**	34	26.5	
- **1 risk**	21	57.1	
- **2 risks**	18	77.8	
- **3 risks**	44	84.1	**8.75*****

[a] *Reference group*: those who reported always abstaining; [b] *Reference group*: those who reported always abstaining and those who ever had sex, but not within the past 30 days;
[c] Sample size for each subgroup; OR = Odds Ratios; Statistical significance: *p<0.05; ** p<0.01; ***p<0.001; †p<0.10

Engaging in Individual Risk Behaviors at Least Once

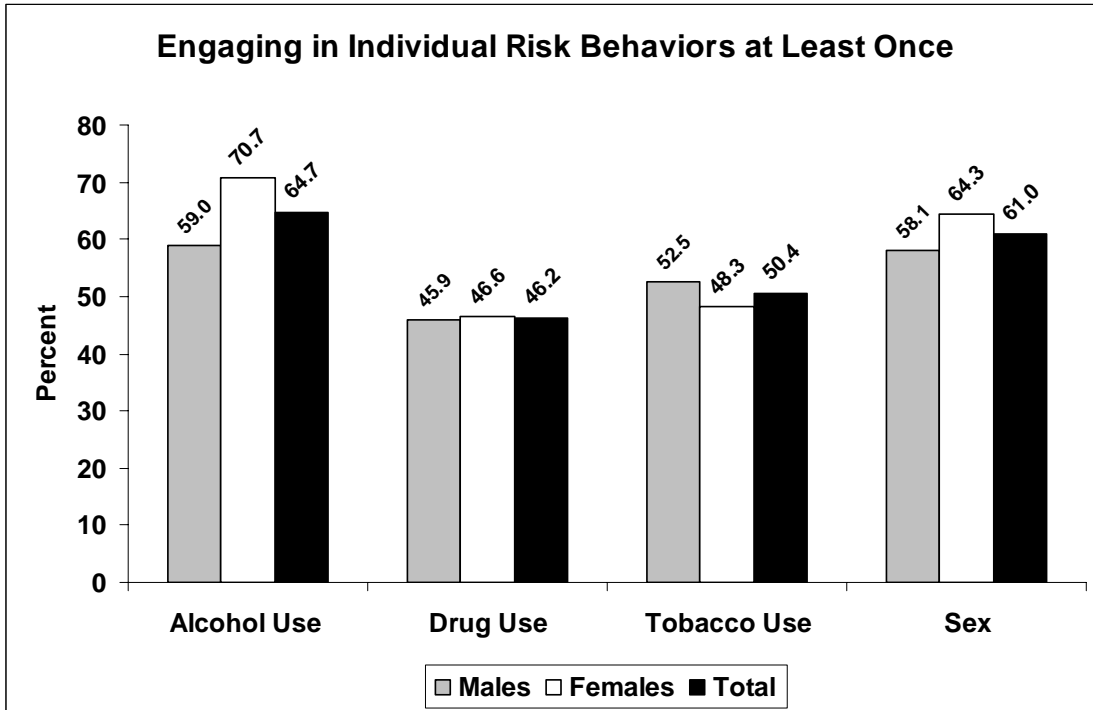**Figure 1 – Percent Distribution of Adolescents who Engaged in Individual Risk Behaviors at Least Once, by Participants' Sex**
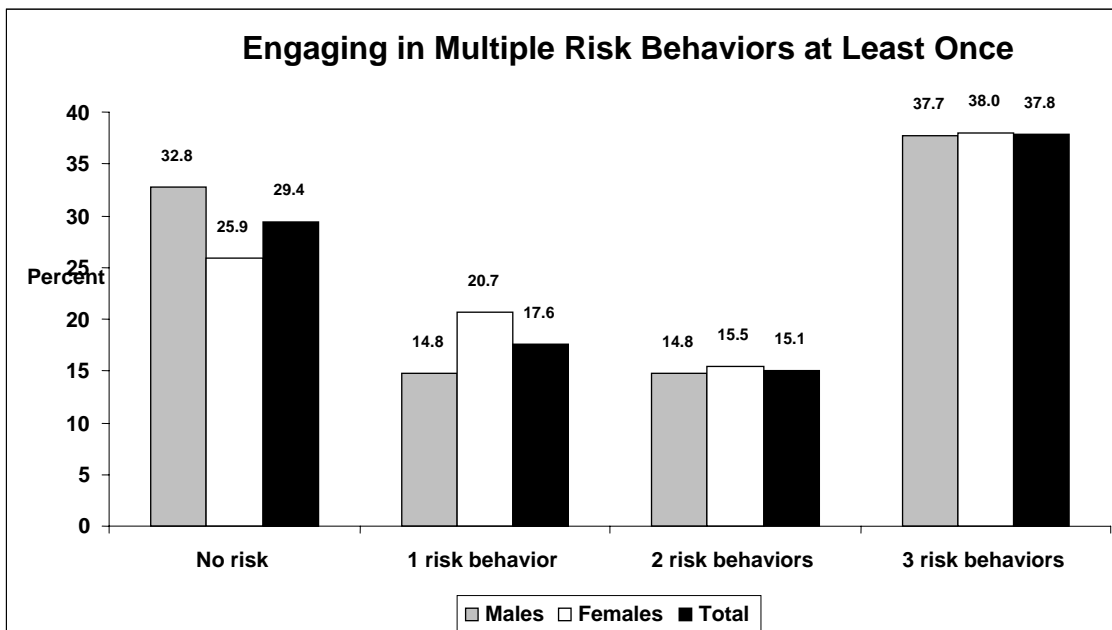
Engaging in Multiple Risk Behaviors at Least Once

Figure 2 – Percent Distribution of Adolescents who Engaged in Multiple Risk Behaviors at Least Once, by Participants' Sex

Engaging in Individual Risk Behaviors during Past Thirty Days

Percent

	Alcohol Use	Drug Use	Tobacco Use	Sex
Males	39.0	76.9	49.1	40.3
Females	44.8	63.0	34.5	32.8
Total	41.9	69.8	41.9	36.7

☐ Males ☐ Females ■ Total

Figure 3 – Percent Distribution of Adolescents who Engaged in Individual Risk Behaviors during the Past Thirty Days, by Participants' Sex

Engaging in Multiple Risk Behaviors during the Past Thirty Days

Percent

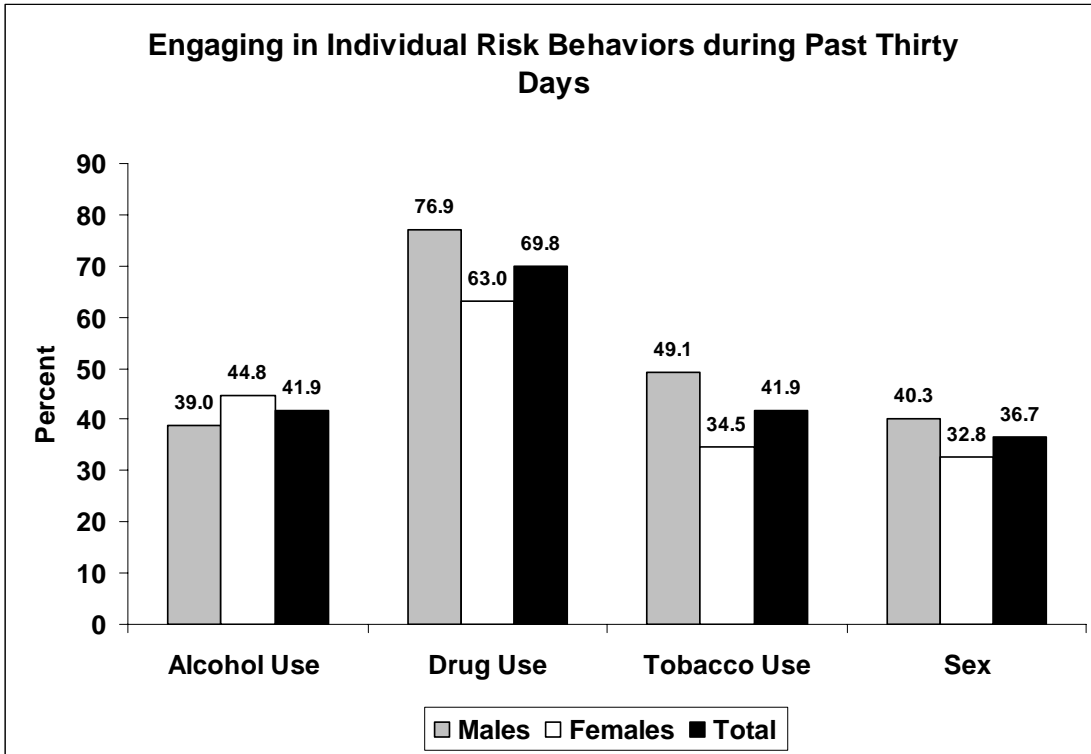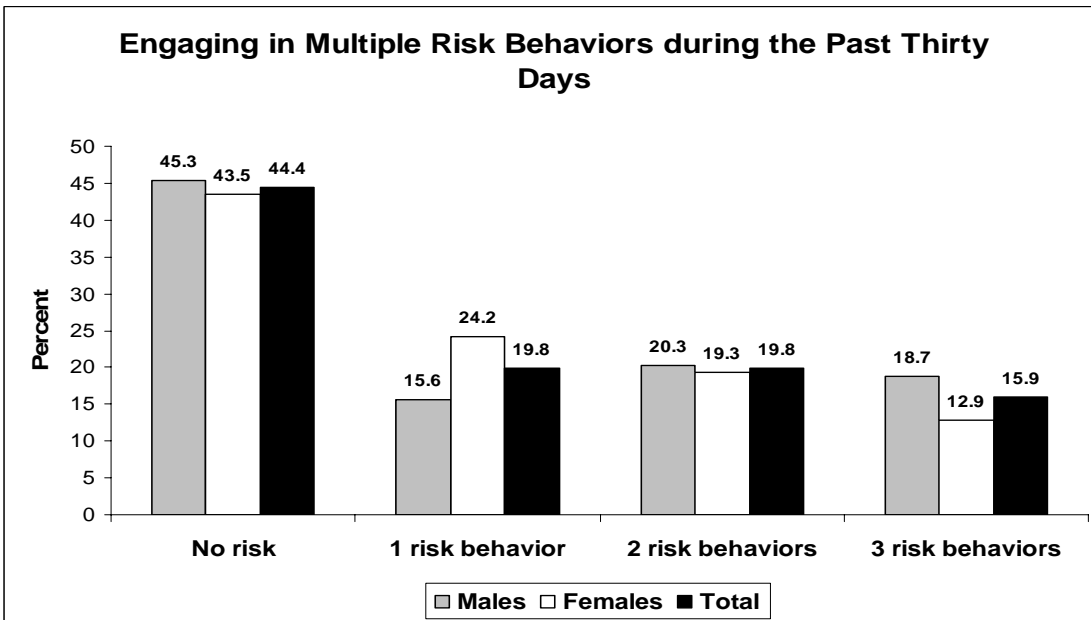|	No risk	1 risk behavior	2 risk behaviors	3 risk behaviors
Males	45.3	15.6	20.3	18.7
Females	43.5	24.2	19.3	12.9
Total	44.4	19.8	19.8	15.9

☐ Males ☐ Females ■ Total

Figure 4 – Percent Distribution of Adolescents who Engaged in Multiple Risk Behaviors during the Past Thirty Days, by Participants' Sex

Table 3 – Percentage Distributions and Odds Ratios of Independent Variables and Outcome Variable

	Sex During Past 30 Days[b]		
	n[c]	%	Odds Ratios
Alcohol Use – 30 Days			
- No	68	23.5	
- Yes	49	57.1	**4.33***
Drug Use – 30 Days			
- No	16	43.7	
- Yes	37	67.6	2.68
Tobacco Use – 30 Days			
- No	68	23.5	
- Yes	49	57.1	**4.33***
Multiple Risks – 30 Days			
- 0 risks	50	12.0	
- 1 risk	25	28.0	
- 2 risks	25	76.0	
- 3 risks	20	60.0	**2.67***

[a] *Reference group*: those who reported always abstaining; [b] *Reference group*: those who reported always abstaining and those who ever had sex, but not within the past 30 days; [c] Sample size for each subgroup; OR = Odds Ratios;
Statistical significance: *p<0.05; ** p<0.01; ***p<0.001; †p<0.10

Table 4 – Percentage Distributions and Odds Ratio of Independent Variables and Outcome Variable (Sex at Least Once and Sex During the Past 30 Days)

	Sex at Least Once[a]			Sex During Past 30 Days[b]		
	n[c]	%	Odds Ratios	n[c]	%	Odds Ratios
Knowledge						
- Below Mean	57	54.4		58	29.3	
- Above Mean	61	67.2	1.72	62	43.6	1.86
Age						
- 15	35	48.6		37	24.3	
- 16-19	83	66.3	**2.08†**	83	42.2	**2.27†**
Participants' Sex						
- Male	62	58.1		62	40.3	
- Female	56	64.3	1.30	58	32.8	0.72
Race/Ethnicity						
- White non-Hispanic	102	58.8		103	34.9	
- Non-white	16	75.0	2.10	17	47.1	1.65
Residence						
- Micropolitan	91	64.8	1.98	93	37.6	1.21
- Rural	27	48.1		27	33.3	
Religious Activities						
- No	42	66.7		43	30.2	
- Yes	76	57.9	0.69	76	40.8	1.59

[a] *Reference group*: those who reported always abstaining; [b] *Reference group*: those who reported always abstaining and those who ever had sex, but not within the past 30 days; [c] Sample size for each subgroup; OR = Odds Ratios; Statistical significance: *p<0.05; ** p<0.01; ***p<0.001; †p<0.10

Multivariate Analyses

       Table 5 contains the results of the regressions models assessing the probability of having had sex at least once. In Model 2, alcohol and drug use remain significant predictors, but after controlling for socio-demographic variables, Model 3 reveals drug use as the only significant predictor among the risk behaviors after controlling for socio-demographic variables. Model 4, however, shows an additive and significant effect of simultaneously engaging in sex and other risk behaviors. Indeed, those who simultaneously engaged in all three complementary risk behaviors (alcohol, drugs and tobacco use) at least once were almost fifteen times more likely to have had sex at least once. Even after controlling for socio-demographic variables, this additive effect persists as a strong predictor in Model 5. Both age (being between 16-19 years) and race/ethnicity (being non-white) remained significant predictors in all three models in which the socio-demographic variables were controlled for. Residing in the micropolitan area was only a significant predictor in Model 1.

       Table 6 presents the results of the regressions models assessing the probability of having had sex during the past thirty days. Model 3 continues to show drug use as the only significant predictor among the risk behaviors, after controlling for socio-demographic variables. Once more, the significant and additive effect of recently engaging in multiple risks is unambiguous in Model 4 and Model 5; recently engaging in two risks is the strongest predictor, with youth being between 23 and 33 times more likely to have recently had sex. Age (being between 16-19 years) remained the only significant predictor in all three models in which the socio-demographic variables were controlled for.

Table 5 – Probability of Engaging in Sex at Least Once (Odds Ratios)[a]

Model	1	2	3	4	5
Alcohol Use – *At Least Once*	3.10*		2.38		
	(1.08-8.85)		(.78-7.23)		
Drug Use – *At Least Once*	3.46*		4.95*		
	(1.03-11.59)		(1.29-18.94)		
Tobacco Use – *At Least Once*	1.38		1.27		
	(.48-3.96)		(.42-3.82)		
+1 Multiple Risk – *At Least Once*				3.70*	3.27*
				(1.17-11.72)	(.98-10.92)
+2 Multiple Risks – *At Least Once*				9.72***	10.11**
				(2.53-37.40)	(2.39-42.67)
+3 Multiple Risks – *At Least Once*				14.69***	13.92***
				(4.84-44.57)	(4.30-45.05)
Older Adolescents		2.71*	3.65*		3.24*
		(1.11-6.64)	(1.21-10.95)		(1.12-9.37)
Females		1.72	1.52		1.50
		(.77-3.86)	(.59-3.90)		(.60-3.79)
Non-whites		3.63†	4.25†		3.94†
		(.97-13.63)	(.83-21.83)		(.76-20.50)
Micropolitan Area		2.18†	1.57		1.71
		(.87-5.44)	(.55-4.50)		(.59-4.99)
Religious		.69	.90		.82
		(.29-1.52)	(.35-2.35)		(.32-2.14)
Number of Observations	117	118	117	117	117

[a] Reference group: those who reported always abstaining; Statistical significance: *p<0.05; **p<0.01; ***p<0.001; †p<0.10
Number in parentheses indicate 95% Confidence Intervals

Table 6 – Probability of Engaging in Sex During the Past Thirty Days (Odds Ratios)[a]

Model	1	2	3	4	5
Alcohol Use – *Past Thirty Days*	1.49 (.42-5.30)		1.08 (.25-4.70)		
Drug Use – *Past Thirty Days*	2.36 (.67-8.32)		6.31* (1.17-34.06)		
Tobacco Use – *Past Thirty Days*	1.21 (.35-4.20)		1.63 (.38-6.98)		
+1 Multiple Risk – *Past Thirty Days*				2.85† (.84-9.66)	2.65 (.72-9.77)
+2 Multiple Risks – *Past Thirty Days*				23.22*** (6.63-81.29)	32.97*** (8.33-130.52)
+3 Multiple Risks – *Past Thirty Days*				11.00*** (3.19-37.86)	14.33*** (3.68-55.74)
Older Adolescents		2.65* (1.02-6.86)	5.79* (1.30-25.84)		3.86* (1.20-12.40)
Females		.84 (.38-1.85)	.77 (.21-2.80)		0.76 (.29-2.01)
Non-whites		2.47 (.77-7.88)	4.24 (.62-29.20)		2.40 (.58-9.93)
Micropolitan Area		1.21 (.47-3.11)	.30 (.05-1.90)		0.57 (.18-1.74)
Religious		1.67 (.73-3.81)	1.10 (.27-4.55)		2.17 (.79-5.94)
Number of Observations	53	119	53	120	119

[a] Reference group: those who reported always abstaining; Statistical significance: *p<0.05; **p<0.01; ***p<0.001; †p<0.10
Number in parentheses indicate 95% Confidence Intervals

Using the social network as the unit of analysis, the following section describes several possible relationships that exist between the adolescents, differentiating here only between those who reported abstinence and those having had sex at least once. Overall, *Project Rural R.O.A.D.*'s recruitment process was successful. Seven out of twelve seeds initiated recruitment trees, generating a total of 114 ties and nine generational waves. Both these results speak to the minimized influence of seeds on the final sample composition as well as the deep reach into the target population as a result of long recruitment chains. As an RDS/PDR-generated sample based on probability sampling, this adolescent social network depicts a cross-section of the target population and allows for inferences to be made not only regarding its heterogeneity, but also similarities in the characteristics of both the sample population and the larger population. The use of RDSAT captures other socially significant breakpoints of the social network including homophily, recruitment patterns, sample and population proportions, average network sizes, equilibrium sample distributions and population weights (described in **Tables 7 – 18**).

     Table 7 and **Table 17** (which describe the characteristics of two and four sub-groups, respectively) will be explained in detail, while the important characteristics of the remaining tables will be highlighted. Likewise, the main visible trends in the visual representations of the networks will be described. Interpretations of the social network data in this paper are based on previous studies using RDS and RDSAT.[1, 74, 75] **Table 7** on sexual activity indicates that those who reported abstinence (Group 1) recruited about the same number of people from within their group and from the group of adolescents who had sex at least once (Group 2). Those who had sex at least once, however, exhibited a propensity towards in-group recruitment, recruiting about 65% (51/(27+51)*100) from within their group. Additionally, **Table 7** shows that about half of the seeds belonged to each group, that 61% of the adolescents in the sample

engaged in sexual activity at least once and that those in this group had larger networks than those who reported abstinence.

While the sample sizes and sample population proportions are related, the latter is useful in determining whether the sample attained equilibrium. In **Table 7**, the proportion of adolescents who reported abstinence as well as those who reported having had sex at least once both reached equilibrium. Otherwise stated, including another wave of participants belonging to both groups would not have altered the composition of the sample. Homophily for those who reported abstinence was close to zero (-0.08 or 0.08%), suggesting that those in Group 1 formed ties almost completely regardless of group membership. Homophily for Group 2, however, was 0.30. This suggests that those who engaged in sex at least once formed social ties within their group 30% of the time. Finally, the estimated population proportions show that each group made up about 50% of the larger target population. In **Table 17**, the recruitment patterns based on race/ethnicity indicate that white non-Hispanics initiated the bulk of recruitments. In general, it can be said that white non-Hispanics recruited based on their race/ethnicity and not based on sexual activity. Indeed, white non-Hispanics who abstained (Group1) recruited a similar number of participants from within their group as well as from the group of white non-Hispanic who reported having had sex at least once (Group 3). Likewise, those in Group 3 recruited close to 60% from within their group and 30% from Group 1. Most seeds belonged to Groups 1 and 3, which together constituted about 86% of the sample population. Although, on average, those in Group 3 had the largest networks, non-whites who reported abstinence (Group 2) comprised the next largest network. Those in Group 1 had the smallest average network. Equilibrium was attained for those in Groups 1, 2 and 3, but not for those in Group 4. This implies that this sample population would have benefited from having more participants from different racial/ethnic groups.

Interestingly, homophily for Group 4 was most substantial (0.49), suggesting that non-whites who reported having sex formed social ties 49% of the time within their group and 51% of the time without regard to group membership. It is also interesting to note that the largest group (white non-Hispanics who reported having sex) formed social connections within the group only 39% of the time. Group 1's homophily of -0.10 indicates that white non-Hispanics who reported abstinence were slightly heterophilous. The homophily for Group 2 is -1.00, suggesting complete heterophily (that all social ties are formed outside of the group). This complete heterophily, however, may be due to the small number of participants recruited from rural areas such that self-affiliation may not have been accurately determined. Because this unclear pattern of "heterophily" is repeated in several of the tables, those statistics are overlooked. Nevertheless, heterophily was most evident in **Table 14** where males who reported abstinence formed ties outside their group 32% of time.

In-group recruitment

Overall, in-group recruitment (described as percentages) was highest among: (a) those who had sex at least once ***and***: used alcohol (61%), drugs (56%) and smoked tobacco (40%) at least once; had knowledge score above the mean (46%); were non-white (60%) as well as white non-Hispanic (59%); were from the micropolitan area (66%); and attended religious activities (50%); (b) those who abstained ***and***: were female (43%) and were from rural areas (60%). The tendency to recruit within the group was the same between those who simultaneously engaged in the use of alcohol, drugs and tobacco at least once (45%) and those who did not engage in any of these risks (45%). With regards to age, 15-year olds recruited 56% from within, followed by 16-year olds (39%).

When grouping only those adolescents who had sex during the past thirty days[e], results suggest that the highest in-group recruitment was based on: (a) recent use of alcohol (34%); recent use of drugs (58%); and recent use of tobacco (26%). Those who did not engage in any of these behaviors during the past thirty days also exhibited highest in-group recruitment (53%), followed by those who recently engaged in all three of these other risk behaviors (36%).

Homophily

In a study using RDS to explore the social network characteristics of jazz musicians, Heckathorn and Jeffri (2003) describe a homophily level of 0.56 as "substantial homophily."[1] As previously discussed, a homophily of zero implies ties that are formed without regard to group membership.[1] With the midpoint between 0 and 0.60 being ±0.30, this paper considers homophily between 0.30 and 0.50 to be moderate and homophily above 0.50 to be substantial. As such, moderate and substantial social ties from within or outside the group were found among: (a) those who had sex at least once (30%) *and*: used alcohol (38%) and drugs (33%) at least once; were white non-Hispanic (39%) as well as non-whites (49%); were from the micropolitan area (47%); (b) those who had abstained *and*: were males (-32%) and females (32%); and were from rural areas (56%). Again, grouping only those adolescents who had sex during the past thirty days[e] results indicate that moderate and substantial social ties from within or outside the group were found among: (a) those who recently had sex *and*: recently used drugs (30%); those who recently had sex *but*: did not use alcohol(-70%) or drugs (-41%) during the past thirty days.

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[e] Results pertaining to adolescents who had sex during the past 30 days are not shown in these analyses, but are available upon request. This group of adolescents was differentiated from those who abstained and those who had sex, but not during the past thirty days.

Visual Representation of Networks

NetDraw provides color visual representations of the peer/social network(s)[f] according to the selected characteristics examined in this paper. Although each figure on its own illustrates one characteristic (a simplex tie), as a whole, **Figures 5-16** offer further evidence of the multiple ties in social relationships that exist between the adolescents in the sample. Indeed, these figures not only illustrate both the similarities and differences in interaction between each dyad, but also the social network as a whole. As such, it is possible to ascertain which adolescents engaged in each risk/protective behavior and the relationships between them. In this case, it can be said that adolescents who reported having had sex at least once were also the ones who used alcohol, drugs and tobacco at least once. One can also visually describe the relationships between the behaviors and the socio-demographic variables.

Figure 11, for instance, describes recruitment patterns based on HIV/AIDS/STD-related knowledge and confirms that even those adolescents who had knowledge scores above the mean still engaged in all four risk behaviors. With regards to age, **Figure 13** suggests that not only were the seeds of diverse ages, but also that the recruitment trees reflect diversity in age. More so, 15 and 16-year olds recruited heavily from within their age group, confirming the age-homophilous tendencies of adolescents. Youth who recruited outside of their residential area are also evident in **Figure 14**. Three seeds came from rural areas although one seems to have initiated most of the rural recruits. Evidently, among this sample of adolescents, residence was an important factor in recruitment. With 86.5% of the sample identifying as white non-Hispanic, it is expected that most recruitments would occur within that group. **Figure 15**, however, shows which participants initiated recruitments outside their groups based on race/ethnicity. White non-Hispanics recruited eleven participants from other race/ethnicities, and those from the latter group recruited six white non-Hispanic participants. No distinct patterns regarding religious activity were visible.

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[f] These network representations are most useful when viewed in color

Table 7 – Recruitment by Sexual Activity (At Least Once)

Recruiters by Group	Recruits by Group	
	G1	G2
G1[a] = Abstain	11	13
G2[b] = Sex at least once	27	51

Population/Network Estimates by Group		
	G1	G2
Seeds	6	5
Sample Population Sizes	46	72
Adjusted Average Network Sizes	35.52	54.93
Sample Population Proportions	0.39	0.61
Homophily	-0.08	0.30
Equilibrium Sample Distributions	0.39	0.61
Estimated Population Proportions (Confidence Intervals)[c]	0.50 (0.31-0.60)	0.50 (0.40-0.69)
Population Weights	1.28	0.82

[a]G1= Group 1; [b]G2= Group 2; [c]Alpha = 0.05

Table 8 – Recruitment by Sexual Activity (Past Thirty Days)

Recruiters by Group	Recruits by Group	
	G1	G2
G1[a] = Abstain + Sex Ever	35	21
G2[b] = Sex - Past 30 Days	28	20

Population/Network Estimates by Group		
	G1	G2
Seeds	9	2
Sample Population Sizes	76	44
Adjusted Average Network Sizes	39.62	54.71
Sample Population Proportions	0.63	0.37
Homophily	-0.08	0.14
Equilibrium Sample Distributions	0.61	0.39
Estimated Population Proportions (Confidence Intervals)[c]	0.68 (0.50-0.78)	0.32 (0.22-0.49)
Population Weights	1.08	0.87

[a]G1= Group 1; [b]G2= Group 2; [c]Alpha = 0.05

Table 9 – Recruitment by Sexual Activity and Alcohol Use (At Least Once)

Recruiters by Group	Recruits by Group			
	G1	G2	G3	G4
G1[a] = Abstain/ No Alcohol Use	4	1	2	6
G2[b]= Abstain/ Alcohol Use	1	3	0	4
G3[c] = Sex at least once/ No Alcohol Use	6	4	3	8
G4[d] = Sex at least once/ Alcohol Use	9	8	5	35

Population/Network Estimates by Group				
	G1	G2	G3	G4
Seeds	5	0	2	3
Sample Population Sizes	28	17	13	59
Adjusted Average Network Sizes	41.70	29.28	29.53	66.34
Sample Population Proportions	0.24	0.14	0.11	0.50
Homophily	0.12	0.14	0.00	0.38
Equilibrium Sample Distributions	0.19	0.17	0.09	0.54
Estimated Population Proportions (Confidence Intervals)[e]	0.21 (0.11-0.39)	0.27 (0.11-0.41)	0.14 (0.05-0.22)	0.38 (0.25-0.51)
Population Weights	0.88	1.87	1.26	0.74

[a]G1= Group 1; [b]G2= Group 2; [c]G3=Group 3; [d]G4 = Group 4; [e]Alpha = 0.05

Table 10 – Recruitment by Sexual Activity and Drug Use (At Least Once)

Recruiters by Group	Recruits by Group			
	G1	G2	G3	G4
G1[a] = Abstain/ No Drug use	6	0	4	5
G2[b]= Abstain/ Drug use	2	1	0	3
G3[c] = Sex at least once / No Drug use	9	4	10	9
G4[d] = Sex at least once/ Drug use	11	3	6	26

Population/Network Estimates by Group				
	G1	G2	G3	G4
Seeds	5	0	3	2
Sample Population Sizes	37	8	26	46
Adjusted Average Network Sizes	36.15	32.89	50.99	57.30
Sample Population Proportions	0.32	0.07	0.22	0.39
Homophily	0.03	0.08	0.16	0.33
Equilibrium Sample Distributions	0.30	0.06	0.20	0.43
Estimated Population Proportions (Confidence Intervals)[e]	0.38 (0.25-0.53)	0.09 (0.01-0.24)	0.18 (0.09-0.27)	0.35 (0.19-0.45)
Population Weights	1.21	1.30	0.81	0.88

aG1= Group 1; bG2= Group 2; cG3=Group 3; dG4 = Group 4; eAlpha = 0.05

Table 11 – Recruitment by Sexual Activity and Tobacco Use (At Least Once)

Recruiters by Group	Recruits by Group			
	G1	G2	G3	G4
G1[a] = Abstain/ No Tobacco use	5	1	3	6
G2[b]= Abstain/ Tobacco use	1	2	0	3
G3[c] = Sex at least once/ No Tobacco use	8	4	9	15
G4[d] = Sex at least once/ Tobacco use	9	6	10	17
Population/Network Estimates by Group				
	G1	G2	G3	G4
Seeds	5	0	2	3
Sample Population Sizes	32	13	26	46
Adjusted Average Network Sizes	36.01	34.46	55.09	54.84
Sample Population Proportions	0.27	0.11	0.22	0.39
Homophily	0.05	0.17	0.10	0.09
Equilibrium Sample Distributions	0.24	0.15	0.20	0.42
Estimated Population Proportions (Confidence Intervals)[e]	0.30 (0.14-0.40)	0.19 (0.12-0.43)	0.16 (0.09-0.26)	0.35 (0.20-0.42)
Population Weights	1.09	1.73	0.73	0.88

[a]G1= Group 1; [b]G2= Group 2; [c]G3=Group 3; [d]G4 = Group 4; [e]Alpha = 0.05

Table 12 – Recruitment by Multiple Risk Behavior (At Least Once)

Recruiters by Group	Recruits by Group			
	G1	G2	G3	G4
G1[a] = 0 risk	13	5	4	6
G2[b]= 1 risk	4	4	3	9
G3[c] = 2 risks	0	1	2	8
G4[d] = 3 risks	8	7	8	19
Population/Network Estimates by Group				
	G1	G2	G3	G4
Seeds	6	2	0	2
Sample Population Sizes	35	21	18	45
Adjusted Average Network Sizes	33.85	43.22	60.67	49.88
Sample Population Proportions	0.29	0.18	0.15	0.38
Homophily	0.24	0.04	0.06	0.08
Equilibrium Sample Distributions	0.22	0.16	0.17	0.48
Estimated Population Proportions (Confidence Intervals)[e]	0.29 (0.14-0.49)	0.17 (0.06-0.21)	0.13 (0.08-0.26)	0.41 (0.27-0.54)
Population Weights	1.00	0.96	0.85	1.08

[a]G1= Group 1; [b]G2= Group 2; [c]G3=Group 3; [d]G4 = Group 4; [e]Alpha = 0.05

Table 13 – Recruitment by Sexual Activity and HIV/AIDS/STD-related Knowledge

Recruiters by Group	Recruits by Group			
	G1	G2	G3	G4
G1[a] = Abstain/ Knowledge < Mean	3	0	3	2
G2[b] = Abstain/ Knowledge > Mean	6	2	4	4
G3[c] = Sex at least once/ Knowledge < Mean	4	6	11	5
G4[d] = Sex at least once/ Knowledge > Mean	8	9	11	24

Population/Network Estimates by Group				
	G1	G2	G3	G4
Seeds	3	3	0	5
Sample Population Sizes	26	20	31	41
Adjusted Average Network Sizes	33.51	38.50	54.55	55.27
Sample Population Proportions	0.22	0.17	0.26	0.35
Homophily	0.08	-0.26	0.21	0.29
Equilibrium Sample Distributions	0.24	0.14	0.32	0.29
Estimated Population Proportions (Confidence Intervals)[e]	0.32 (0.17-0.42)	0.17 (0.10-0.33)	0.27 (0.18-0.40)	0.24 (0.09-0.37)
Population Weights	1.46	1.00	1.02	0.69

[a]G1= Group 1; [b]G2= Group 2; [c]G3=Group 3; [d]G4 = Group 4; [e]Alpha = 0.05

Table 14 – Recruitment by Sexual Activity and Participants' Sex

Recruiters by Group	Recruits by Group			
	G1	G2	G3	G4
G1[a] = Abstain/ Males	4	3	7	3
G2[b] = Abstain/ Females	1	3	0	3
G3[c] = Sex at least once/ Males	9	4	14	9
G4[d] = Sex at least once/ Females	7	7	12	16

Population/Network Estimates by Group				
	G1	G2	G3	G4
Seeds	3	3	2	3
Sample Population Sizes	26	20	36	36
Adjusted Average Network Sizes	27.02	59.88	43.46	76.32
Sample Population Proportions	0.22	0.17	0.30	0.30
Homophily	-0.32	0.32	0.12	0.23
Equilibrium Sample Distributions	0.20	0.21	0.28	0.31
Estimated Population Proportions (Confidence Intervals)[e]	0.34 (0.16-0.40)	0.16 (0.09-0.35)	0.30 (0.22-0.50)	0.19 (0.08-0.24)
Population Weights	1.56	0.95	0.99	0.63

[a]G1= Group 1; [b]G2= Group 2; [c]G3=Group 3; [d]G4 = Group 4; [e]Alpha = 0.05

Table 15 – Recruitment by Participant's Age

Recruiters by Group	Recruits by Group				
	G1	G2	G3	G4	G5
G1[a] = 15 years old	24	8	8	2	1
G2[b] = 16 years old	4	9	5	5	0
G3[c] = 17 years old	3	5	6	11	3
G4[d] = 18 years old	4	3	2	3	1
G5[e] = 19 years old	0	1	2	2	2

Population/Network Estimates by Group					
	G1	G2	G3	G4	G5
Seeds	4	4	2	2	0
Sample Population Sizes	39	30	25	25	7
Adjusted Average Network Sizes	54.59	50.03	38.73	32.23	94.99
Sample Population Proportions	0.31	0.24	0.20	0.20	0.05
Homophily	0.42	0.22	-0.06	-0.21	0.26
Equilibrium Sample Distributions	0.30	0.24	0.20	0.21	0.06
Estimated Population Proportions	0.24	0.21	0.23	0.29	0.03
(Confidence Intervals)[f]	(0.11-0.33)	(0.14-0.36)	(0.08-0.32)	(0.18-0.46)	(0.01-0.05)
Population Weights	0.76	0.90	1.15	1.46	0.52

[a]G1= Group 1; [b]G2= Group 2; [c]G3=Group 3; [d]G4 = Group 4; [e]G5= Group 5; [f]Alpha = 0.05

Table 16 – Recruitment by Sexual Activity and Residence

Recruiters by Group	Recruits by Group			
	G1	G2	G3	G4
G1[a] = Abstain/ Rural	3	0	1	1
G2[b] = Abstain/ Micropolitan	1	7	2	9
G3[c] = Sex at least once/ Rural	7	2	8	4
G4[d] = Sex at least once/ Micropolitan	1	17	1	38

Population/Network Estimates by Group				
	G1	G2	G3	G4
Seeds	1	5	1	4
Sample Population Sizes	14	32	13	59
Adjusted Average Network Sizes	76.39	28.02	34.58	63.19
Sample Population Proportions	0.12	0.27	0.11	0.50
Homophily	0.56	-0.11	0.28	0.47
Equilibrium Sample Distributions	0.14	0.25	0.10	0.50
Estimated Population Proportions (Confidence Intervals)[e]	0.08 (0.02-0.25)	0.41 (0.21-0.50)	0.14 (0.02-0.32)	0.36 (0.23-0.51)
Population Weights	0.71	1.53	1.24	0.73

[a]G1= Group 1; [b]G2= Group 2; [c]G3=Group 3; [d]G4 = Group 4; [e]Alpha = 0.05

Table 17 – Recruitment by Sexual Activity and Race/Ethnicity

Recruiters by Group	Recruits by Group			
	G1	G2	G3	G4
G1[a] = Abstain/ white non-Hispanics	8	1	9	3
G2[b]= Abstain/ Non-whites	2	0	0	1
G3[c] = Sex at least once/ white non-Hispanics	24	2	43	4
G4[d] = Sex at least once/ Non-whites	1	0	1	3
Population/Network Estimates by Group				
	G1	G2	G3	G4
Seeds	5	1	5	0
Sample Population Sizes	42	4	60	12
Adjusted Average Network Sizes	34.79	47.37	59.57	40.66
Sample Population Proportions	0.35	0.03	0.51	0.10
Homophily	-0.10	-1.00	0.39	0.49
Equilibrium Sample Distributions	0.33	0.03	0.44	0.20
Estimated Population Proportions (Confidence Intervals)[e]	0.42 (0.28-0.56)	0.03 (0.00-0.10)	0.33 (0.22-0.47)	0.22 (0.06-0.35)
Population Weights	1.19	0.77	0.65	2.17

[a]G1= Group 1; [b]G2= Group 2; [c]G3=Group 3; [d]G4 = Group 4; [e]Alpha = 0.05

Table 18 – Recruitment by Sexual Activity and Religious Activity

Recruiters by Group	Recruits by Group			
	G1	G2	G3	G4
G1[a] = Abstain/ No Religious Activity	1	2	0	4
G2[b]= Abstain/ Some Religious Activity	2	6	4	5
G3[c] = Sex at least once/ No Religious Activity	8	9	9	10
G4[d] = Sex at least once/ Some Religious Activity	2	8	11	21
Population/Network Estimates by Group				
	G1	G2	G3	G4
Seeds	0	6	2	3
Sample Population Sizes	14	32	28	44
Adjusted Average Network Sizes	37.59	34.57	79.73	45.69
Sample Population Proportions	0.12	0.27	0.24	0.37
Homophily	0.00	0.03	0.14	0.16
Equilibrium Sample Distributions	0.11	0.26	0.22	0.41
Estimated Population Proportions (Confidence Intervals)[e]	0.14 (0.07-0.29)	0.33 (0.15-0.38)	0.12 (0.08-0.23)	0.40 (0.27-0.57)
Population Weights	1.17	1.23	0.53	1.07

[a]G1= Group 1; [b]G2= Group 2; [c]G3=Group 3; [d]G4 = Group 4; [e]Alpha = 0.05
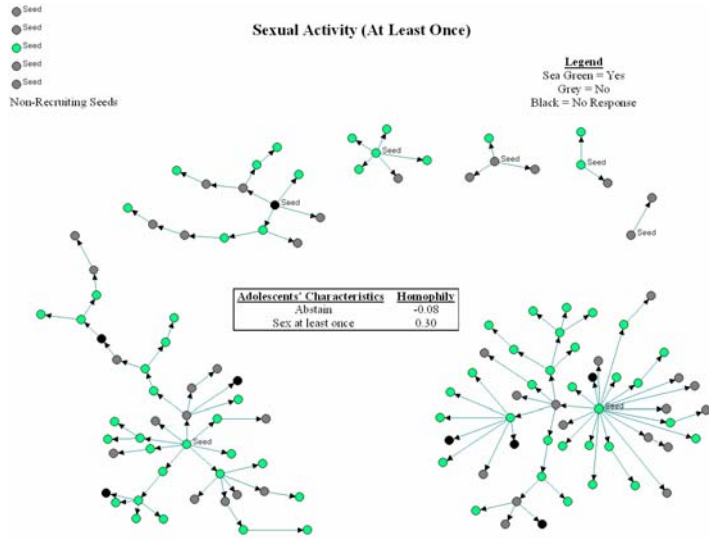
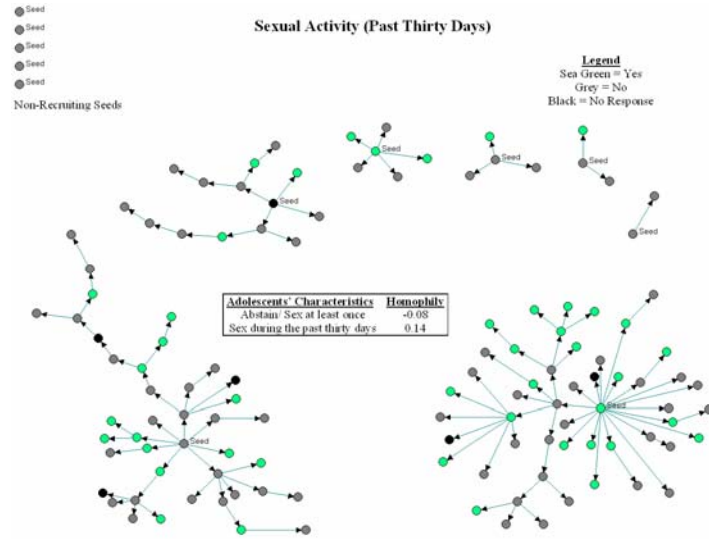**Figure 5 – Sexual Activity (At Least Once)**

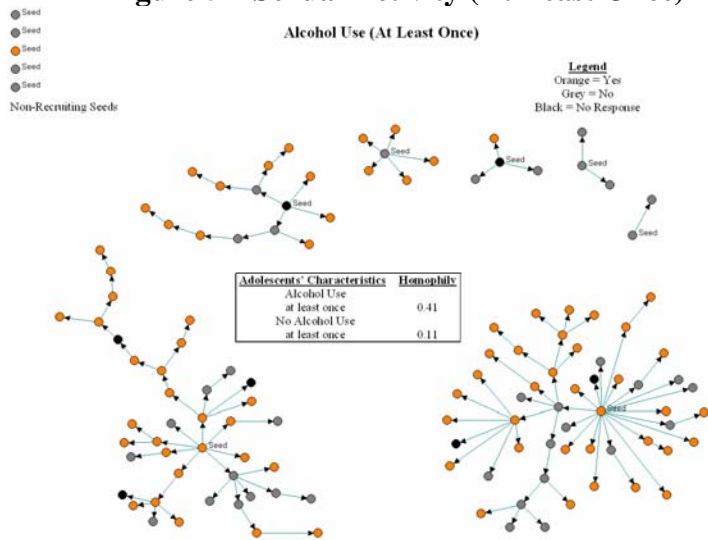**Figure 6 – Sexual Activity during the Past Thirty Days**

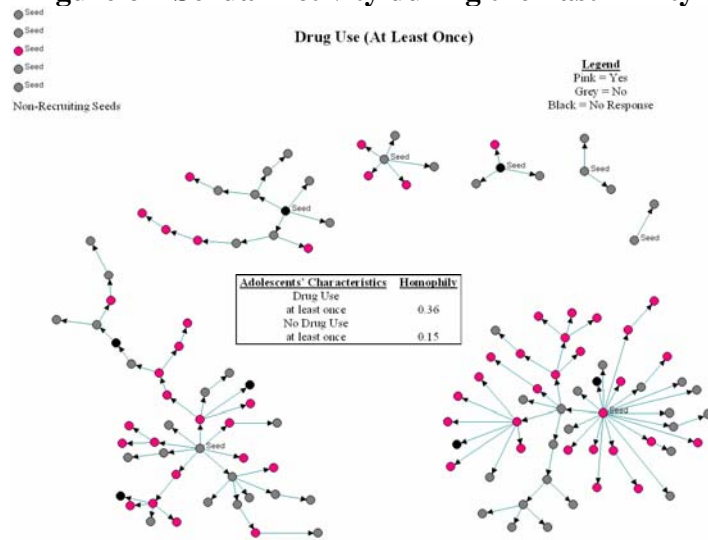**Figure 7 – Alcohol Use (At Least Once)**

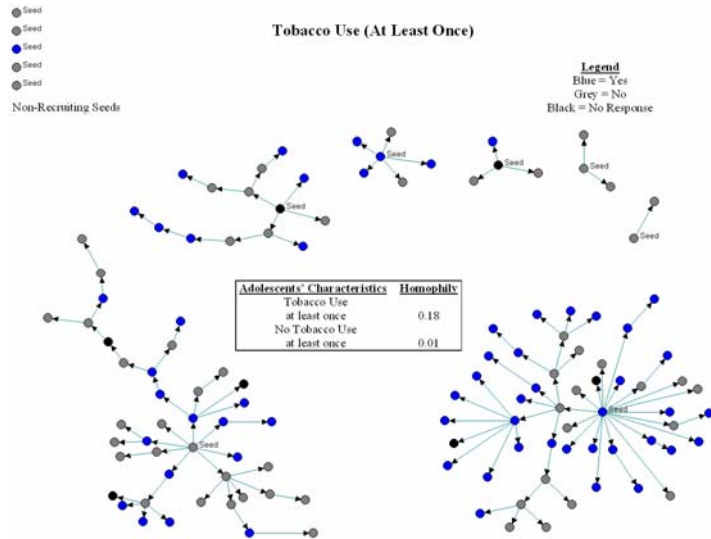**Figure 8 – Drug Use (At Least Once)**

Figure 9 – Tobacco Use (At Least Once)
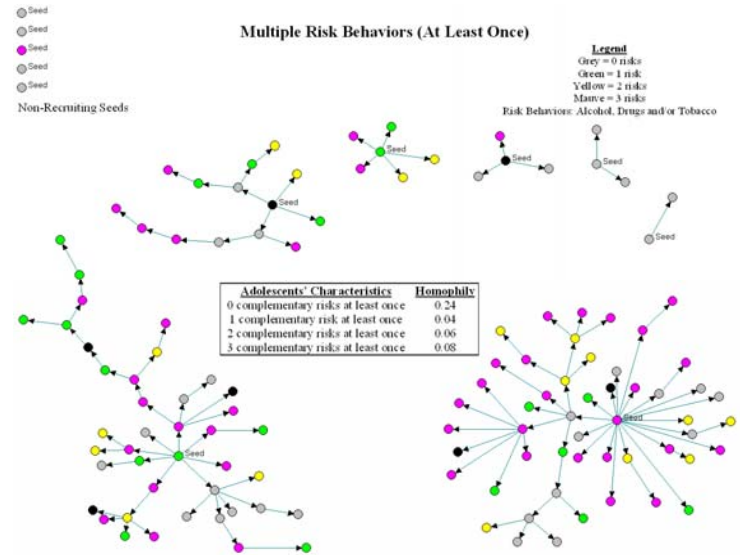

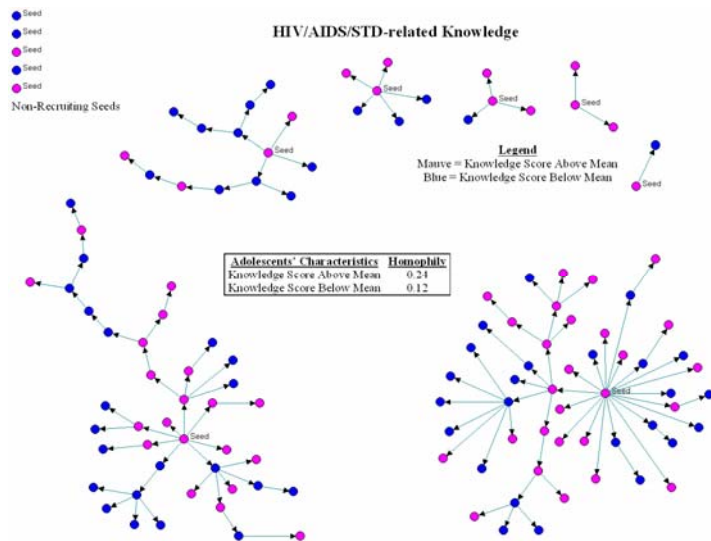**Figure 10 – Engaging in Multiple Risk Behaviors (At Least Once)**
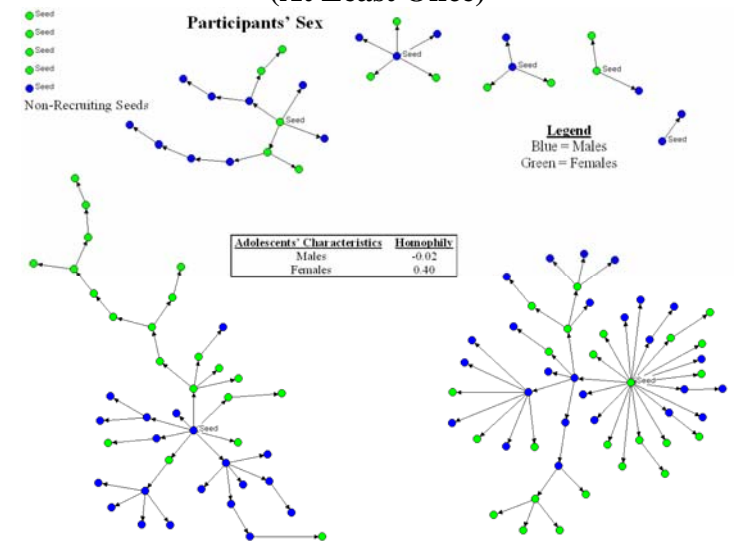

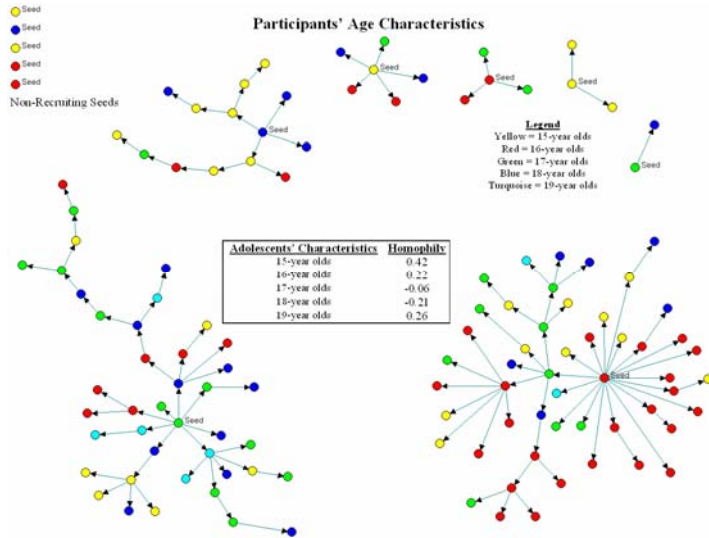**Figure 11 – HIV/AIDS/STD-related Knowledge**

Figure 12 – Participants' Sex

41

Figure 13 – Participant's Age Characteristics

Figure 14 – Participants' Residential Characteristics

Figure 15 – Participants' Race/Ethnicity Characteristics
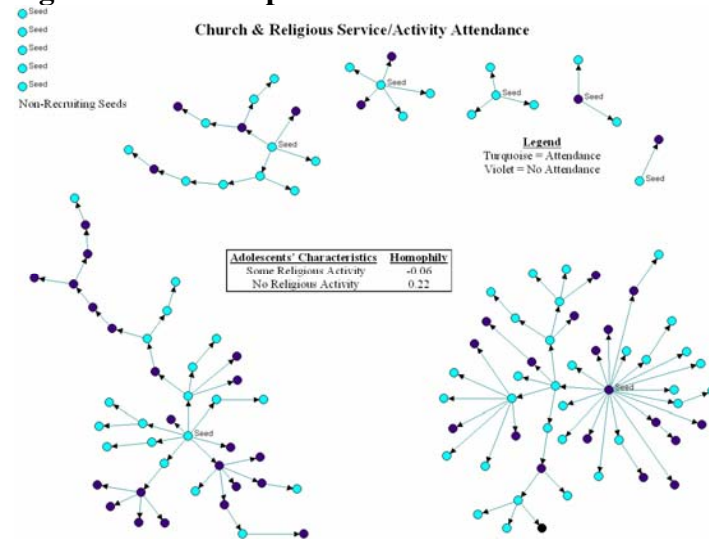
Figure 16 – Church & Religious Service/Activity Attendance Characteristics

Summary of Findings

Similar to previous studies, data from this paper affirm the notion that interrelated factors influence sexual activity among adolescents. Regarding the first hypothesis, findings based on the associations described in **Tables 2-4** suggest that youth who engaged in complementary risk behaviors (alcohol, drugs and tobacco use) at least once and who were older were *more* likely to have engaged in sexual activity at least once. Additionally, the adolescents who recently engaged in these complementary behaviors and were older were also *more* likely to have engaged in sexual activity during the past thirty days. Participants' age remained a strong predictor of sexual activity in the regression models which controlled for risk behaviors as well as other socio-demographic variables.

Findings related to the second hypothesis in this paper indicate that moderate and substantial homophily/heterophily were found according to whether the youth reported abstinence or having had sex at least once. Effectively, those who had sex at least once formed homophilous ties based on sexual activity itself, alcohol and drug use, both being white non-Hispanic and non-white as well as living in a micropolitan area. Those who abstained formed homophilous ties based on living in rural areas and being female. In addition to this, heterophilous ties among those who abstained were formed based on being male. No moderate or substantial heterophilous ties were formed among the group of adolescents who had sex at least once.

The focus of this paper on adolescents living in a micropolitan area and surrounding rural areas reveals several differences and similarities when compared to the adolescent population as a whole. Previous studies, for example, have noted that 46% of all high school students have had sexual intercourse at least once.[9] Data from this paper show that 61% of the youth in this sample (considered to be part of the high-school age group) reported having sex at least once.

Findings from this paper concur with the findings that youth who ever used alcohol were over seven times more likely to be sexually active than youth who did not use alcohol.[13] Differences between males and females regarding alcohol use have been also noted, with males being more likely to engage in alcohol use.[16-18] Findings from this paper suggest the opposite where 59% of males compared to 71% of females engaged in alcohol use at least once and 39% of males compared to 45% of females recently used alcohol.

Adolescents residing in more rural areas have been found to experiment with tobacco, alcohol and other drugs,[16] the latter positively associated with increased likelihood of having sex. In this sample, the adolescents who reported ever using drugs were at the highest odds of having had sex at least once and close to 70% reported using drugs during the past thirty days. Approximately 60% of the sample reported ever using tobacco and 42% reported recently smoking tobacco. Furthermore, engaging in multiple risks shows a staggering additive effect on the likelihood of sexual activity as evidenced in the multiple regression tables. While the multiple risk variables do not provide further information on exactly which risks are combined, the findings from this paper suggest that alcohol use, and more so drug use, greatly influence the likelihood of engaging in sex, both at least once and during the past thirty days. Interestingly, knowledge is also not significantly associated with sexual activity. The latter is consistent with literature which suggests that having high knowledge does not necessarily translate into engaging in healthy or unhealthy behaviors.

Although in other studies males have been found to be more likely than females to report having had sexual intercourse,[9] this sample implies a different pattern. Indeed, 58% of the males reported having had sex at least once compared to 64% of females. Older students have also been reported to be at greater odds of having had sex.[9, 26, 27] In this sample, age seems to have a distinct period effect, with a breakpoint occurring between those who are 15 years and those who are 16-19 years. Adolescents in the older group exhibited a higher likelihood of having had sex at least once.

The data generated by the RDSAT/NetDraw combination put forward two main features: (1) a combination of multiplex ties amounting to the social structure within which adolescents exist, and (2) the homophily/heterophily among these subgroups according to all the characteristics and behaviors of interest in this paper. Indeed, the moderate and substantial homophilies/heterophilies suggest that adolescents may form distinct groups to which health-related information and services as well as social and public policies may be tailored.

Discussion & Conclusions

The fact that these adolescents recruited heavily among peers with whom they share characteristics authenticates PDR as a socially embedded methodology that effectively motivates participants [who might otherwise shy away from the sensitive nature of the issues addressed in the intervention and/or the stigma associated with engaging in risky behaviors] to actively involve themselves both in the purpose of the intervention as well as its recruitment process. The above mentioned essentially substantiates the premise that PDR resolves the peer education dilemma and the dual role of participants.[81] It also confirms the multiplexity of ties found within social networks in that the adolescents recruited their friends based the range of topics addressed and discussed during the interactive portions of the research intervention.

All in all, adolescents living in micropolitan/rural areas continue to engage in risky behaviors, including sexual activity and alcohol, drug, and tobacco use, sometimes simultaneously. This paper posits that those adolescents engaging in sexual activity and complementary risk behaviors have a greater need and/or incentive to be informed about the consequences of unhealthy/risky behaviors. As observed in the literature, knowledge about HIV/AIDS/STDs did not necessarily translate into the adopting healthier behaviors among adolescents in this sample. Indeed, those adolescents who scored above the mean on selected knowledge questions were more likely to engage in sexual activity at least once and during

the past thirty days. Race/ethnicity and participant age were also two contributors to the increased likelihood of sexual activity.

Although this paper is based on exploratory analyses, its unique features using RDS/PDR reinforce the importance of using social network analysis to examine the structural and transactional nature of engaging in risk and/or protective behaviors. Findings from this paper have confirmed that adolescents tend to recruit from a network of friends, with whom they share a multitude of relationships, leading to multiple in-group as well as out-group affiliation patterns. Conducting a study using conventional probability sampling is not likely to capture this multiplexity of relationships, particularly since the traditional sampling frame would have to be defined prior to the research intervention. This is different from RDS/PDR where the sampling frame is constructed *during* the recruiting process. A study by Dolcini et al. (2005) clearly illustrates the limitations of using a traditional probability sampling method to describe how social network characteristics influence health risk behaviors, within a single setting.[67]

By combining standard statistical analyses with innovative ones like RDSAT, this paper has refined the ways in which to better understand the totality of relationships likely to influence sexual activity among adolescents. Evidently, these interactions occur in social, cultural and demographic contexts embedded within peer and social networks.

Policy Recommendations

The limited work in the area of health and behavior among micropolitan/rural adolescents clearly points to the need for more research on this specific subgroup. Policy makers must endeavor to formulate and/or refine policies that: (1) Recognize possible differences in developmental stages even among late adolescents by promoting subgroup-specific interventions/programs on adopting healthy behaviors; (2) Encourage interventions/ programs addressing simultaneous engagement in risky behaviors; (3) Focus on minorities in micropolitan/rural areas; (4) Rely on an ecological approach that shifts the focus from the

level of an individual actor to a collective linked by relationships and that emphasizes social structure as well as the interactions between social contexts and youth risk/protective behaviors; and (5) Integrate social network methodologies such as PDR and statistically sound sampling strategies such as RDS to further understand the relational and transactional nature of both healthy and unhealthy behaviors among adolescents and the mechanisms through which these behaviors become socially acceptable and meaningful.

Limitations

The strengths of this paper notwithstanding, the analyses present some limitations. The results apply to a cross-sectional study of 15 to 19 year olds living in a micropolitan area and surrounding rural areas in the U.S., which may lead to limited generalizability to other settings. Moreover, although the literature points to the validity of self-reported measures, it is possible that socially acceptable answers may have been reported (particularly about abstinence) and that self-reports of behaviors misrepresent actual levels. Having said this, social desirability may have well been minimized throughout this study given the strengths of PDR and its reliance on verified RDS sampling techniques. The RDSAT-based tables also show that some combinations of adolescent subgroups did not reach equilibrium, suggesting that a larger sample size would have yielded even greater homophily and more significant associations. Moreover, some of the population proportion estimates generated through RDSAT are not accurate. The estimates from Table 14, for example, suggest that the population consists of 64% males and 35% females. This discrepancy may be explained by the fact that those in Group 2 (females abstaining) and Group 4 (females having had sex at least once) did not reach equilibrium. Finally, further understanding of population proportion estimates and weights, particularly the fit between RDS theory and RDS data[88] is clearly necessary.

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