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The Effects of Peer Networks on the Status of Gonorrhea and Chlamydia Infections among High School Adolescents in the United States

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Biostatistics

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Abstract

The Effects of Peer Networks on the Status of Gonorrhea and Chlamydia Infections

among High School Adolescents in the United States

By Tiffany S. Williams

Sexually transmitted diseases are the most common reportable infectious disease in the United States. The two most common STDs are chlamydia and gonorrhea. Adolescents ages 15-19 are the most affected by these STDs and have rates higher than the total population. Females and African Americans of this subset also have disproportionate rates.

During adolescence, people engage in their most risky behaviors. Peers become an important source of reinforcement and modeling concerning the individual's attitude and belief system. Since most of their time is spent with their peers, this network provides more influence on their behaviors compared to their family. Thus, examination of an individual's social network may provide increased insight into the individual's behavior.

The goal of this thesis is to evaluate the effects of peer networks on the status of gonorrhea and chlamydia infections among high school adolescence in the U.S. using the National Longitudinal Survey of Adolescent Health.

Due to the design of the study, generalized estimating equations (GEE) methods were conducted under the assumption of an exchangeable intra-cluster correlation structure. Models identifying risk factors for positive status infections of gonorrhea and chlamydia were produced. 1985 students were used in the analysis.

Sixty one (2.96%) students were classified as having had gonorrhea or chlamydia. Individual attributes, race and gender, in combination with the peer network levels of drinking, smoking, skipping school, and fighting, are significant in helping predict the status of gonorrhea and chlamydia infections. The odds for getting these STDs, adjusting for gender, drinking, smoking and fighting, is approximately 4 times higher for blacks. Furthermore, females have odds approximately 3 times higher than males when adjusting for all other predictors in the model. The GEE analysis concluded that none of the ego network measures have an individual effect on the acquisition of gonorrhea and chlamydia. However, in the prediction model individuals' gender, race, centrality, and density of their send/receive network are significant. Adjusting for gender, centrality, and send/received density, blacks are 2.54 times higher than non-blacks for a positive STD status.

Public health implications and future directions of research are also discussed.

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1. Introduction

Adolescence is one of the most important times for development in a person's life. It is the transition from the naivety of childhood to the responsibility of adulthood. Youth are required to make informed decisions, manage risk, and weigh options and they are faced with making smart choices regarding their health and well-being (Flicker et al., 2007). During adolescence, people engage in their most risky behaviors. The greatest threats to their well-being are from preventable often self-inflicted actions such as violence and drugs. Many forms of risk taking behavior initiated during adolescence puts the individual at higher risk for continuing the behavior into adulthood (Steinberg, 2007). Several studies find that there are few differences among late adolescence and adulthood, in the ability to perceive risk, their vulnerability to it, and their consequences. Knowing that there a few differences in perception raised the question: given that adolescents are knowledgeable, why do they participate at higher rates in risky behavior? (Steinberg, 2007).

Steinberg argues that "factors that lead adolescence to engage in risky activity are social and emotional" (Steinberg, 2007). This introduces the social network theory. This theory explores the social relationships and the attitude and behaviors of the individual. Social influence is exerted over adolescence. Among the social networks, family and friends are the most proximal. Important information regarding appropriate behavior and attitude is learned through these networks. Adolescents spend most of their time with their peers suggesting this network provides more influence on their behaviors than their family (Aalsma et al., 2004).

"In the midst of developing their own identities and establishing more complex social networks, the point of reference by which they guide their behavior shifts from family to the social environment" (Kotchick et al., 2001). Peers become an important source of reinforcement and

modeling concerning the individual's attitudes and belief system. Risk taking increases around the time of puberty and leads to increased reward seeking especially in the presence of their peers. Social acceptance among their peers is viewed as a reward which helps to explain why the majority of risky behavior is done in the context of their peer group. Again, it is not the lack of knowledge of risk but the social benefits outweighing the possible consequences that lead adolescents to participate in risky behavior. They are more likely to engage in negative activity if their friends are or if they believe that their friends are (Steinberg, 2007) (Aalsma et al., 2004). "Each person is an element in the environment of the others and can influence, and be influenced by, others' health-affecting behaviors" (Bearman, 1997). Thus, examination of an individual's social network may provide increased insight into the individual's behavior.

1.1. Problem Statement

Sexually transmitted diseases (STDs) are the most common reportable infectious disease in the United States. The CDC (2010) estimates that there are approximately 19 million new cases of infection every year. This costs the healthcare system about 16.4 billion dollars per year. STDs have both acute and long term health effects. If left untreated, women can develop cancers, become infertile, or pass their infections on to their children during birth. Many studies have also shown that having an STD facilitates and increases the risk for acquiring human immunodeficiency virus (HIV) (Youm & Laumann, 2002). The two most common STDs are chlamydia and gonorrhea respectively.

1.1.1. Problem Statistics

Reported gonorrhea cases have declined steadily over the years. There was a decrease of 17% between 2006-2009, reaching its lowest levels since the CDC began tracking in 1941 with a rate of 99.1 per 100,000. However, in 2010 there was a 2.8% increase (CDC, 2011). New resistant strains of gonorrhea are being found which can pose a new problem for this disease. In addition, case reporting of chlamydia is on the rise at a rate of 426 per 100,000. There was a 19% increase from 2006 to 2009 and a 5% increase between 2009 to 2010. Most of this increase is likely due to the improved screening rates which doubled for women over the years 2000 to 2009 from 25% to 47% (CDC, 2011). Although this is a significant growth, the CDC estimates that the low screening rates suggest there are twice as many cases than actually reported.

1.1.2. Problem among Adolescents

Adolescents ages 15-19 are the most affected by these STDs. They have the highest rates of chlamydia at 2049.1 per 100,000. That is 4.8 times higher than the total population. Their gonorrhea rates are 409.7 per 100,000 (CDC, 2011).

1.1.3. Problem by Gender

STDs also affect the population by gender. Females are 2.7 times more infected with chlamydia with rates of 610.6 per 100,000 versus their male counters with 233.7 per 100,000. Men and women both experienced an increase since 2006 of 36.4% and 19.5% respectively. Gonorrhea rates are fairly similar across gender groups with women at rates of 106.5 per 100,000 and men with 94.1 per 100,000. However, in 2010, the highest rates were observed among women aged 15–19 years (570.9 per 100,000)(CDC, 2011).

1.1.4. Problem by Race/Ethnicity

African Americans have highly disproportionate rates for all STDs. They continue to have the highest rates of gonorrhea and chlamydia than any other population group in the U.S. (Barrow et al., 2008). According to the CDC as of 2010, the rates of gonorrhea for African Americans were 432.5 cases per 100,000. This rate was 18.7 times the rate of their white counterparts (23.1 per 100,000). In cases of chlamydia, African Americans, during 2006–2010, increased 26.9% (from 919.8 to 1,167.5 cases per 100,000). Their rates are 8 times that of their white counterparts (138.7 cases per 100,000) (CDC, 2011). Young African American women, 15-19 years old, hold the highest rates and they are 2 times greater than their male counterparts (CDC, 2011).

1.2. Purpose Statement

The goal of this thesis is to evaluate the effects of peer networks on the status of gonorrhea and chlamydia infections among high school adolescence in the U.S. using the National Longitudinal Survey of Adolescent Health (ADD health) data.

1.3. Objectives

1. Analyze known antecedents and risk behaviors of STD positive networks
2. Analyze social network factors such as degree, size, and centrality of STD positive networks
3. Construct models to assist in the prediction of gonorrhea and chlamydia infection status

2. Background/Literature Review

2.1. Theory

2.1.1. Social ecological framework

The social ecological framework developed by Schulz and Northridge was created specifically to outline various pathways and their interaction with social, political, and economic conditions and its influence on individual and population health and well-being (Schulz & Northridge, 2004). Schulz and Northridge were interested in examining and decreasing the health disparities across population groups. The model consisted of four different levels. The individual level contains health outcomes such as infectious diseases, obesity, cancers and the well-being of individuals which includes life satisfaction and psychosocial distress. The next level is the micro/interpersonal level. It contains stressors, health behaviors, and social integration/support. Family, friend, church, and school social networks are found on this level. Third, is the meso/community level which consists of the built environment and social context. It evaluates things such as transportation systems and quality of education. The final level is the macro which contains the institutional, environmental, and distribution of goods and services (Schulz & Northridge, 2004).

2.1.2. Bronfenbrenner's ecological systems theory

The Bronfenbrenner's ecological systems theory provided in the article from Kotchick, Schaffer, and Foreman in 2001, evaluates the influence family and extra familial systems have on a person's behavior. Several studies evaluated in Aalsma and Fortenberry, 2004, show that the family and friend social networks are the primary contributors to adolescent sexual behaviors since they are the most proximal. Family and friends are the main source of information regarding

appropriateness and values. Most sexual information is received through these networks either explicitly or in more subtle ways (Kotchick et al., 2001). Social network theory is a promising way to explore the function of adolescent relationships on their behavior (Aalsma et al., 2004).

2.2. Previous Research

Most interventions, until recently, for STDs have been done at the individual level. They are designed to promote healthier individual behavior such as consistent use of condoms, self-efficacy, and risky behavior modification of alcohol and drugs (DiClemente, Salazar & Crosby, 2007). Follow up studies examined in articles by Adimora & Schoenbach (2005) and Choi & Gregorich (2009) show that individual based interventions lack sustainability and are limited in insight to this complex issue. These studies suggest focusing on multiple levels of intervention. The social context is defined as an important factor suggesting targeting social networks directly in prevention efforts. In the article written by Barrow et al. (2008), they also concluded that these types of intervention programs are less effective and unsustainable mostly in the African American community. Many researchers agree that focus needs to be placed at the micro level.

2.3. Antecedents

During adolescent development, there is a shift from the point of reference by which guides their behavior from family to their peers. Peers become the important source for modeling, support, and reinforcements. Perceptions of sexual norms and behaviors among friends also strongly help predict adolescent behaviors (Kotchick et al., 2001). Many studies have assessed the influence peers have on sexual behavior. They have shown that perceptions of peer sex norms and

behaviors clearly predict an adolescent's sexual behavior. (Aalsma et al., 2004). During these studies, researchers have discovered many antecedents involving peer influence on sexual behavior. Those identified as factors are:

- Substance use
- Permissive attitudes towards risky behavior
- Sexual activity of the peer group.
- Age of peer group
- Grades/ academic achievement
- Perceived susceptibility to STDs

3. Methods

3.1. Study Description

The National Longitudinal Survey of Adolescent Health was conducted to measure the influence of the social environment on the health of adolescents. It examines both helpful and harmful behaviors and its effect on the well-being and health of adolescents in the United States. This is a nationally representative sample of adolescents in school, grades 7 to 12 in the United States and an over-sample of high-education black students which is a representation of African American students living with at least one parent or guardian who completed college.

3.2. Wave I

Data for Wave I was collected between September 1994 and December 1995. Participants were students in grades 7 through 12.

3.3. In-school Survey

3.3.1. Recruitment

The initial sampling frame came from the Quality Education Data, Inc database. In order for a high school to be selected, it must have contained an 11^{th} grade and had more than 30 students enrolled. 80 high schools were selected and more than 70% of them were recruited. The sample was stratified by urban city, school type, ethnic mix, and size. Participating high schools were asked to identify its feeder schools (a school that includes the 7^{th} grade and sends its students to that high school upon graduation) for possible recruitment. The final results were 134 discrete schools in 80 communities.

3.3.2. Questionnaire

The in-school questionnaire was given to the students during one class period. There was no make-up sessions allowed for students not present that day. Students were given a student roster, provided by the school and assigned identification numbers by the study staff, and asked to identify their friend during the course of the questionnaire. More than 90,000 students completed the questionnaire.

3.4. In-home Survey

3.4.1. Recruitment

All students listed on the school roster, even if they did not complete the in-school questionnaire, were eligible for selection. Students were stratified by grade and sex. Approximately 17 students were chosen from each strata. The total sample consisted of 12,105 students.

3.4.2. Special Samples

Four ethnic groups were over-sampled based on the self-reported data on the in-school questionnaire: blacks from families that had a parent with a college degree, Chinese, Cubans, and Puerto Ricans.

3.4.3. Saturation

In the interest of social networks, 16 schools were chosen to have all their students interviewed for the in-school questionnaire.

3.4.4. Questionnaire

The in-home interviews were conducted between April and December of 1995. The interviews took between one to two hours. They were administered by interviewers and for more sensitive material through an audio-CASI. Students were also given the ADD Health Picture Vocabulary Test.

3.4.5. Weights

The public-use sample includes data from 6,504 respondents, who were originally selected from the core sample, the high education black supplement sample, or both. For the purpose of weighting the public-use data, respondents were divided into two groups: those who were eligible only for the core sample and those who were eligible for selection into both. For the respondents eligible only for the core sample, the calculations of the initial public-use weights were twice their final core weights which already incorporated adjustments for in-home questionnaire nonresponse. For the respondents eligible for selection into both samples, however, a more elaborate weighting procedure was needed. First, a base weight was calculated that reflected the student's probability of selection into either sample. Then, we used the inverse of the final school weight that took into account school-level nonresponse and school-level post-stratification adjustments. Next, we multiplied the base probability by one-half since the public-use file included data for only half of the eligible respondents. Finally, we put the two groups of respondents back together again and adjusted the sum of the weights for the entire sample to agree with estimates from the Census Bureau of the size of each population.

3.5. Wave II In-home Survey

3.5.1. Recruitment

The sample for Wave II were students that completed Wave I in-home questionnaire, except for those who were in the 12th grade during Wave I.

3.5.2. Questionnaire

The interviews took place between April and August of 1996. Wave II questionnaire was generally similar to Wave I.

3.5.3. Weights

4,834 completed the Wave II questionnaire. Since there was no subsampling, the weight for Wave II is the final Wave I public-use weight adjusted for additional nonresponse during the second wave of data collection.

3.6. Network Measures and Analysis

3.6.1. Data Collection

The ADD Health study has a cluster design to facilitate the collection of social network data. Students were asked to nominate up to five female and five male friends and given a school roster to enter their identification number. Responses to friendship nomination section of the in-school questionnaire were used to construct multiple network variables. Only schools with more than 50% completion rate of the in-school questionnaire were used in the calculation of network variables considering only those who completed the questionnaire. Friendship nominations to individuals that did not attend their high school or sister school or those that did not appear on the roster were not included in the construction of the friendship networks.

3.7. Independent Variables

3.7.1. Individual Level Network variable

In-degree
The number of times ego is nominated by other students in the school.

$$= \sum X_{ji}$$

Where:

$\sum_j X_{ji}$ = the sum of the *i*th column of **X** the adjacency matrix of the total friendship network

Out-degree
The number of people respondent nominates in the school.

$$= \sum X_{ii}$$

Where:

$\sum X_{ij}$ = the sum of the *i*th row of **X** the adjacency matrix of the total friendship network

Students were allowed to nominate up to 10 people. If a student skipped this entire section, degree is 0.

Bonacich centrality, b= 0.1

Ego's centrality, weighted by the centrality of those to whom he/she sends ties.

$$= a (I - b \mathbf{X})^{-1} \mathbf{X}1$$

Where:

a = a scaling vector

b = power weight (here = 0.1)

I = identity matrix

X = adjacency matrix of the total friendship network

1 = column of 1s

Reach

Maximum number of alters ego can reach in the total friendship network.

$$R_i = \sum_j B_{ij}$$

Where:

B is the reachability matrix of **X**

D = geodesic distance matrix of **X** the adjacency matrix of the total friendship network

and $B_{ij} = 1$ if $D_{ij} > 0$

Reach in three steps

A step refers to the length of a path from i to j. If i nominates j and j nominates k and k nominates l, then i and l are three steps apart. The value is the total number of alters ego can reach in three steps.

$$R_{i3} = \sum_j B_{ij}$$

Where:

B is a variant of the reachability matrix of **X**

such that:

D = geodesic distance matrix of **X** the adjacency matrix of the total friendship network

and $B_{ij} = 1$ if $0 < D_{ij} < 4$

Proximity prestige

Measures the prestige of ego relative to the number of people who can reach ego

$$P_i = [I_i/(g-1)] / \sum_j d(n_j,n_i)/I_i$$

Where:

Ii = influence domain of i, which is equal to the number of alters who can reach i

g = number of nodes in **X**

d (nj,ni) =length of the geodesic distance between actor j to actor i

if in-degree is 0, then the prestige is missing.

Influence domain

Number of alters who can reach ego.

$$I_i = \sum_j B_{ji}$$

Where:

B is the reachability matrix of **X**

such that:

D = geodesic distance matrix of **X** the adjacency matrix of the total friendship network

And $B_{ij} = 1$ if $D_{ij} > 0$

3.7.2. Ego Network Variables

Ego send-network density

Density of the network composed of ego and the set of alters nominated by ego

$$D_i = \frac{\sum S}{s*(s-1)}$$

Where:

S = total ego send-network

s = number of nodes in S

Size of ego send-network

Number of alters nominated by ego, plus ego.

$$A_s = s$$

Where:

s = the number of nodes in S

Ego send- and receive-network density

Density of the network composed of ego, the set of alters nominated by ego, and the set of alters who nominate ego.

$$D_{ii} = \frac{\sum SR}{sr*(sr-1)}$$

Where:

SR = total ego send- and receive-network

sr = number of nodes in SR

Size of ego send- and receive-network

Number of alters who are nominated by ego or who nominate ego, plus ego.

$$A_{sr} = sr$$

Where:

sr = the number of nodes in SR

3.7.3. Ego-network Behavior/Attribute Means

For most of the behavior and attribute variables, means from the in-school questionnaire items are

provided for the ego networks. Mean values exclude ego and any alters with missing values on the attribute or behavior variable.

Mean Values on Behavior and Attribute Measures.

The mean value of ego's peers (defined by a particular ego network) on behavior and attribute measures from the in-school questionnaire.

$$\overline{X} = \sum x_j / n_j$$

Where:

x = the in-school behavior or attribute variable

x_j = the value of x for the jth member of the ego network

n_j = the number of nodes in the ego network with valid data on x (excluding ego)

3.8. Outcome Variables

The outcome variable is the STD status of the student. Students were asked during the in-home questionnaire if they have ever been told by a doctor that they had gonorrhea or chlamydia separately. This was asked in both waves of the questionnaire. A student in this model is said to be STD positive if he or she answered 'yes' to having had chlamydia or gonorrhea in either wave. An STD negative student answered 'no' to all questions.

3.8.1. Question Scales

The scale for questions that asked 'What do you think are your chances…'

0 = No chance

1 = 1

2 = some chance

3 = 3

4 = about 50-50

5 = 5

6 = pretty likely

7 = 7

8 = it will happen

Questions that began with ‘How often do you…’

0 = never

1 = once or twice

2 = once or twice

3 = 2 or 3 days a month

4 = once or twice a week

5 = 3 or 5 days a week

6 = nearly everyday

Question ‘In the past year, how often have you gotten into a physical fight?’

0 = never

1 = 1 or 2 times

2 = 3 to 5 times

3 = 6 or 7 times

4 = more than 7 times

3.9. Statistical Analysis

All analyses were conducted using SAS and SAS-Callable Sudaan (version 9.3, SAS Institute Inc.). The ADD Health study was a cluster sample with unequal probability of selection. Therefore, design-based analysis is necessary to achieve results that are nationally representative. Correcting for the design effects and the unequal probability for selection provides unbiased parameter and correct variance estimates. The students were clustered by schools that had unequal probability of selection and this was the primary sampling unit. Several articles produced specifically to assist with the analyses of the ADD Health data suggest using the assumption that the schools were selected with replacement (Chantala et al., 2010). Data used in this analysis included variables in the In-school, Wave I, and Wave II questionnaires. Therefore, the grand sample weights of Wave II were used. Adolescents with missing values of weight were eliminated from the analysis. Furthermore, to achieve the desired population of interest, a subset was created to include only high school students with network measures. The variable 'Race' was created for comparison analysis. If the participant identified themselves as black on the in-school questionnaire, the variable race was given the value '1', for all else, race equaled zero which was considered the reference group. Descriptive statistics and comparisons among STD status groups were done using t-test for continuous variables and Chi-squared tests for categorical variables. Given the clustered sample design, the response variables are exposed to intra-cluster correlations. The generalized estimating equations (GEE) method was conducted under the assumption of an exchangeable intra-cluster correlation structure. Models of individual and combined predictor effects were produced to identifying risk factors for a positive STD status using the p-value approach. All analyses were performed on the alpha level of .05.

4. Results

The original dataset contained 6504 observations. After filtering for high school students only with network analysis variables, the final dataset contained 1985 observations. Fifty two percent of the observed population was female. Sixty one (2.96%) students were classified as STD positive. Among the two waves of the study, there were 53 cases of chlamydia and 18 cases of gonorrhea (**Table 1**). 10 students had both a case of chlamydia and gonorrhea during the two waves.

Table 1. Distribution of Sexually Transmitted Diseases

STD	# of Cases
Chlamydia	53
Gonorrhea	18
Both	10

The average age of the positive group is 15.67 years compared to the STD negative group with a mean age of 15.35. Approximately, 74% of the STD positive population is female and 47.54% of the population is black **Table 2**. The grade levels are fairly evenly distributed in each stratum. The mean grade level for the positive group is 10.29 and for the negative it is 10.01 which is early sophomore year for both.

Table 2. Descriptive Statistics Stratified by STD Status

Variables	STD negative (n=1924)	STD positive (n=61)
Age (SE)	15.35 (0.04)	15.67 (0.22)
Sex = female (%)	1020 (53.29)	45 (73.77)
Race = black (%)	469 (24.38)	29 (47.54)
Grade (SE)	10.01 (0.03)	10.29(0.14)

Behaviors and Attributes Variables

The comparison analysis of the mean values of the individual behaviors and attributes of each group yielded several statistically significant predictors. Individuals in the positive group feel their chances to live to age 35 are between 50/50 and pretty likely. In contrast, the STD negative group feels much stronger in their chances with a mean level of 6.71. The difference between the two means is significant with a p-value of 0.0016. Both groups believe their chances of getting HIV and being killed by 21 are slight to almost no chance of them happening **Table 3.** Individuals in the STD positive group on average smoke about 3 times a month and drink at least once a month. When compared with those in the negative group, levels are much higher and the differences are significant, 0.0012 and 0.0045, respectively. Due to their higher level of drinking, the positive group also has a higher level of being drunk. They report having been drunk at least twice in the last twelve months. The difference between the two status groups is significant, having a p-value of 0.0110. Lying to their parents and skipping school also showed to be statistically significant with higher levels in the STD positive group as well.

Table 3.
Comparison of Mean Values of Behaviors and Attributes of the Ego Stratified by STD Status

Variables	STD Negative	STD Positive	p-value
Chances to live to 35*	6.71(0.05)	5.73(0.30)	0.0016
Chances of being killed by 21	1.47(0.04)	1.81(0.36)	0.3515
Chances of getting HIV	1.03(0.05)	1.36(0.31)	0.3105
How often did you smoke*	1.33(0.07)	2.60(0.39)	0.0012
How often did you drink*	1.32(0.05)	1.98(0.22)	0.0045

How often did you get drunk*	0.76(0.05)	1.37(0.24)	0.0110
How often did you do something dangerous because you were dared	0.87(0.04)	1.12(0.24)	0.3135
How often did you lie to your parents*	2.21(0.05)	2.82(0.29)	0.0377
How often did you skip school*	0.58(0.05)	1.43(0.21)	0.0001
How often did you get into physical fights	0.70(0.03)	0.91(0.14)	0.1461

*indicates statistical significance in the difference of the means between stratum

The mean values of the previous behaviors listed in Table 3 were also analyzed and compared for the peer networks of each STD group. Similarly, smoking and drinking were higher among the positive group's peer networks and statistically significantly different from the networks of the negative group (p=0.0147, p=0.0185) respectively. The peers of the positive group also lie to their parents, skip school, and get into physical fights more often. These behaviors have statistically significant differences with p-values equal to 0.0187, 0.0006, and 0.0228, respectively. Comparison of all variables and statistics are found in **Table 4**.

Table 4.
Comparison of the Mean Values of Behaviors and Attributes of the Peer Networks Stratified by STD Status

Variables	STD Negative Mean (Standard error)	STD Positive Mean (Standard error)	P-value
Chances to live to 35	6.66 (0.04)	6.51 (0.07)	0.0671
Chances of being killed by 21	1.50 (0.03)	1.75 (0.13)	0.0603

Chances of getting HIV	1.03 (0.03)	0.88 (0.10)	0.1148
How often did you smoke*	1.35 (0.06)	1.89 (0.23)	0.0147
How often did you drink*	1.36 (0.04)	1.63 (0.12)	0.0185
How often did you get drunk	0.81 (0.04)	0.94 (0.12)	0.2597
How often did you do something dangerous because you were dared	0.90 (0.03)	0.98 (0.16)	0.5761
How often did you lie to your parents*	2.22 (0.03)	2.44 (0.09)	0.0187
How often did you skip school*	0.56 (0.04)	0.87 (0.10)	0.0006
How often did you get into physical fights*	0.68 (0.02)	0.93 (0.11)	0.0228

*indicates statistical significance in the difference of the means between stratum

Individual evaluations of the effects of each behavior and attribute of the peer networks were conducted. Peers drinking increased the individuals' odds of having a positive STD status by 39% and peers smoking increases it by 34%. Those individuals' whose peer networks skip school and physically fight also increase the odds, OR=1.57 and 1.95, respectively. In addition, having friends that lie to their parents and have higher beliefs in their chances of being killed by 21 also are significant and increase the odds 30% and 45% respectively. The effects of each predictor are listed in **Table 5**.

Table 5. Individual GEE Analysis of Each Behavior and Attribute of the Peer Networks

Variables	Coefficient (Standard Error)	P-Value	Odds Ratio (95% CI)
Chances to live to 35	-0.14 (0.07)	0.0638	0.87 (0.75, 1.01)
Chances of being killed by 21	0.37 (0.17)	0.0316	1.45 (1.03, 2.05)
Chances of getting HIV	-0.26 (0.20)	0.1829	0.77 (0.52, 1.13)
How often did you smoke	0.29 (0.09)	0.0014	1.34 (1.12, 1.60)
How often did you drink	0.33 (0.12)	0.0091	1.39 (1.09, 1.77)
How often did you get drunk	0.21 (0.16)	0.1935	1.23 (0.90, 1.67)
How often did you do something dangerous because you were dared	0.16 (0.22)	0.4803	1.17 (0.75, 1.83)
How often did you lie to your parents	0.26 (0.11)	0.0153	1.30 (1.05, 1.61)
How often did you skip school	0.45 (0.10)	<.0001	1.57 (1.29, 1.91)
How often did you get into physical fights	0.67 (0.21)	0.0021	1.95 (1.28, 2.98)

The GEE method for modeling was used to identify the risk behaviors related to the status of gonorrhea and chlamydia infections (**Table 6)**. Individual attributes, race and gender, in combination with the peer network levels of drinking, smoking, skipping school, and fighting, are significant in predicting the status of gonorrhea and chlamydia. We can conclude that odds for having a positive STD status, adjusting for gender, drinking, smoking and fighting, is approximately 4 times higher for blacks than non-blacks. Furthermore, females have odds approximately 3 times higher than males when adjusting for all other predictors in the model.

Table 6. GEE Analysis Model for Behaviors and Attributes of the Peer Networks Effects on the Ego's STD Status

Parameter	Estimate	Standand Error	95% Confidence Limits		T statistic	P value	Odds Ratio	95%CI for OR
Intercept	-5.80	0.47	-6.73	-4.87	-12.31	<.0001		
Gender	1.10	0.32	0.45	1.74	3.38	0.0010	2.99	1.57, 5.67
Race	1.39	0.26	0.88	1.91	5.34	<.0001	4.02	2.40, 6.74
Smoking	0.34	0.13	0.09	0.59	2.69	0.0081	1.40	1.09, 1.80
Drinking	0.30	0.21	-0.11	0.71	1.44	0.1526	1.35	0.89, 2.03
Skipping School	1.04	0.27	0.50	1.57	3.83	0.0002	2.83	1.65, 4.83
Drinking and Skipping School	-0.36	0.12	-0.60	-0.12	-2.94	0.0039	0.70	0.55, 0.89

Since gender and race had such significance, further comparison of the behaviors and attributes were conducted stratified by these factors (**Table 7** and **Table 8**). Notable differences are in the peer levels of drinking, getting drunk, skipping school, and physically fighting for the STD positive group among males and females that are not in the negative group. There are also differences between peer networks of blacks and non-blacks in their beliefs in chances of getting killed by 21 and getting HIV among both groups. There also is a sizable difference in the levels of peer smoking, getting drunk, and doing something dangerous because of a dare between genders among both status groups. Black's peer networks participate in these activities at lower levels.

Table 7.
Comparison of Peer Behaviors and Attributes Stratified by STD Status and Race

Variable	Gender	STD Negative	STD Positive
Chances to live to 35	Non-Black	6.69	6.49
	Black	6.51	6.54
Chances of being killed by 21	Non-Black	1.54	1.97
	Black	1.31	1.35
Chances of getting HIV	Non-Black	1.06	0.96
	Black	0.87	0.75
How often did you smoke	Non-Black	1.46	2.44
	Black	0.75	0.91
How often did you drink	Non-Black	1.38	1.72
	Black	1.23	1.46
How often did you get drunk	Non-Black	0.85	1.09
	Black	0.58	0.66
How often did you do something dangerous because you were dared	Non-Black	0.96	1.22
	Black	0.55	0.54
How often did you lie to your parents	Non-Black	2.20	2.47
	Black	2.36	2.40
How often did you skip school	Non-Black	0.58	0.86
	Black	0.48	0.88
How often did you get into physical fights	Non-Black	0.67	1.02
	Black	0.70	0.78

Table 8. Comparison of Peer Behaviors and Attributes Stratified by STD Status and Gender

Variable	Gender	STD Negative	STD Positive
Chances to live to 35	Male	6.66	6.19
	Female	6.66	6.60
Chances of being killed by 21	Male	1.51	1.82
	Female	1.49	1.72
Chances of getting HIV	Male	1.07	0.96
	Female	1.01	0.86
How often did you smoke	Male	1.35	1.83
	Female	1.34	1.91
How often did you drink	Male	1.37	1.85
	Female	1.34	1.57

How often did you get drunk	Male	0.85	1.18
	Female	0.76	0.87
How often did you do something dangerous because you were dared	Male	1.01	1.02
	Female	0.78	0.97
How often did you lie to your parents	Male	2.25	2.62
	Female	2.20	2.39
How often did you skip school	Male	0.56	0.66
	Female	0.57	0.93
How often did you get into physical fights	Male	0.69	1.30
	Female	0.66	0.82

Previous studies suggest that individual antecedents, age, gender, and race, should be accounted for in order to obtain an accurate understanding of the nature of STD infections among high school adolescents. Therefore, age, gender, and race were evaluated to determine their effects on the status of gonorrhea and chlamydia infections. The odds for females are 3.16 times higher than males and blacks are 3.01 times greater than non-blacks (**Table 9**). Both have statistical significance with p-values equal to 0.0003 and <.0001 respectively. Age in this study was not statistically significant.

Table 9. Individual GEE Analysis on STD Status of Individual Descriptive Measures

Variables	**Coefficient (Standard Error)**	**P-Value**	**Odds Ratio (95% CI)**
Age	0.27 (0.16)	0.1051	1.31 (0.95, 1.80)
Gender (Male=Reference)	1.15 (0.31)	0.0003	3.16 (1.71, 5.86)
Race (Non-black=Reference)	1.10 (0.24)	<.0001	3.01 (1.87, 4.85)

Gender and race are known confounders. Therefore statistical test was conducted to determine if confounding existed (Table 10).

Table 10.
The Effects of Race and Gender: Check For Confounding

Variable	Beta (SE)	Race Beta (SE)	Gender Beta (SE)
Chances to live to 35	-0.14 (0.07)	-0.12 (0.08)	-0.16 (0.08)
Chances of being killed by 21	0.37 (0.17)	0.42 (0.16)	0.40 (0.19)
Chances of getting HIV	-0.26 (0.20)	-0.20 (0.19)	-0.26 (0.21)
How often did you smoke	0.29 (0.09)	0.40 (0.09)	0.29 (0.09)
How often did you drink	0.33 (0.12)	0.37 (0.12)	0.35 (0.13)
How often did you get drunk	0.21 (0.16)	0.29 (0.16)	0.25 (0.16)
How often did you do something dangerous because you were dared	0.16 (0.22)	0.29 (0.19)	0.27 (0.24)
How often did you lie to your parents	0.26 (0.11)	0.22 (0.11)	0.30 (0.12)
How often did you skip school	0.45 (0.10)	0.50 (0.10)	0.46 (0.11)
How often did you get into physical fights	0.67 (0.21)	0.68 (0.22)	0.74 (0.23)

Race and gender were related to both STD status and most variables. Therefore, race stratified analyses of each variable while adjusting for gender was conducted. **Table 11** shows the effect of each behavior and attribute of the peer networks on STD status by race. For non-blacks, except for chances of getting HIV, all variables were statistically significant. Increased belief of their peers in their chances to live to age 35, decreased the odds of the ego having a positive STD status by 18%. However, an increase in the peers' belief of being killed by 21, increases the odds of having a positive status nearly two-fold (OR=1.9). Similarly to the previous analyses, drinking, smoking, fighting, and skipping school are all risk factors for having a positive STD status. Not previously identified was the effect of doing something dangerous because of a dare among the non-black group. The odds of having a positive STD status given that their peers often do something because of a dare is 1.62 times greater than those whose friends do not. Contrarily, the only statistically significant peer behavior that is associated with STD status for blacks is skipping school. The odds of having a positive STD status among blacks given that their friends often skip school is 2.53 times more likely than those who have friends that do not skip as often.

Table 11.
Effects of Peer Network Behaviors and Attributes on STD Status Stratified by Race while Adjusting for Gender

	Non Black (n=1476)	**Black** (n=499)
	Odds Ratio	**Odds Ratio**
Chances to live to 35	0.82*	1.05
Chances of being killed by 21	1.9**	1.04

Chances of getting HIV	0.83	0.84
How often did you smoke	1.52***	1.25
How often did you drink	1.53**	1.33
How often did you get drunk	1.48*	1.17
How often did you do something dangerous because you were dared	1.62*	1.09
How often did you lie to your parents	1.46*	1.06
How often did you skip school	1.48**	2.53**
How often did you get into physical fights	2.41**	1.3

*Indicates an association between behavior and STD status
* p-value<.05 **p-value<.005 ***p-value<.0001

Further subgroups were created by race and gender to evaluate the effect modification and the association with STD status of each behavior and attribute. Several odds ratios for black males could not be calculated because there was instability in the model that lead the parameter to approach infinity. **Table 12** shows that smoking, drinking, being drunk, and getting into fights are affected by race and gender. In addition, peers' belief in their chances to live to 35, be killed by 21, and getting HIV are also affected. For non-black males, peers' chances to live to 35, smoking, and fighting are associated to one's STD status. Non-black females, whose friends smoke, drink, skip school, and fight, in addition to having higher beliefs of being killed by 21 and doing dangerous things because of a dare, have increased odds of having an STD positive status. Significant association between STD status and peers getting drunk, fighting, and living to 35 were found for black males. Black females only showed skipping school as having an association with

STD status. Each subgroup's predictor model can be found in **Table 13**.

Table 12.
Effects of Peer Network Behaviors and Attributes on STD Status Stratified by Gender and Race

	Non- Black Male (n=706)	**Non-Black Female** (n=770)	**Black Male** (n=204)	**Black Female** (n=295)
	Odds Ratio	**Odds Ratio**	**Odds Ratio**	**Odds Ratio**
Chances to live to 35	0.74**	0.87	na[a]	1.22
Chances of being killed by 21	1.73	2.00**	na[a]	0.98
Chances of getting HIV	1.17	0.72	na[a]	1.02
How often did you smoke	1.48*	1.55***	na[a]	1.25
How often did you drink	1.55	1.52*	1.48	0.99
How often did you get drunk	1.53	1.45	na[a]	0.83
How often did you do something dangerous because you were dared	1.2	1.86*	na[a]	1.2
How often did you lie to your parents	1.58	1.39	na[a]	1.03
How often did you skip school	1.2	1.62**	1.2	3.02**
How often did you get into physical fights	2.55*	2.33*	4.51**	0.6

*Indicates a significant association between behavior and STD status
* p-value<.05 **p-value<.005 ***p-value<.0001
na[a] implies the parameter is approaching infinity and there is instability in the model

Table 13. Predictor Models Associated with Each Subgroup

Non-black Males

	Coefficient	Standard Error	P-value	Odds Ratio
Intercept	-2.58	0.7	0.0003	
Chances to live to 35	-0.3	0.1	0.0022	0.74 (0.62, 0.90)

Non-black Females

	Coefficient	Standard Error	P-value	Odds Ratio
Intercept	-4.72	0.52	<.0001	
Smoking	0.4	0.11	0.0003	1.50 (1.21, 1.85)
Chances of being killed by 21	0.75	0.28	0.0080	2.11 (1.22, 3.66)
Chances of getting HIV	-0.69	0.28	0.0171	0.50 (0.29, 0.88)

Black Males

	Coefficient	Standard Error	P-value	Odds Ratio
Intercept	-4.31	0.47	0.0001	
Fighting	1.51	0.40	0.0003	4.51 (2.04, 10.00)

Black Females

	Coefficient	Standard Error	P-value	Odds Ratio
Intercept	-3.14	0.34		
Skipping	1.1	0.34	0.0013	3.02 (1.55, 5.86)

Social Network Measures

Ego network measures were analyzed for each group. Bonacich centrality was the only measure that had a statistically significant difference (p=0.0307) between status groups. Overall, the network measures of the STD positive group's egos are lower compared to the negatives. Complete comparison statistics on each network measures can be found in **Table 14**.

Table 14. Comparison of Ego Network Variables Stratified by STD Status

Variable	STD Negative (Standard Error)	STD Positive (Standard Error)	P-value
Bonacich Centrality*	0.86 (0.02)	0.68 (0.08)	0.0307
Proximity Prestige	0.16 (0.01)	0.14 (0.01)	0.1553
Influence Domain	605.04 (48.62)	581.17 (75.57)	0.6502
Reachable Alters	615.78 (52.63)	612.89 (97.71)	0.9684
Reachable Alters in 3 Steps	68.31 (3.38)	60.50 (6.21)	0.2209
Send Network Density	0.39 (0.01)	0.35 (0.03)	0.2063
Send and Receive Network Density	0.29 (0.01)	0.26 (0.02)	0.1295
Send Network Size	5.80 (0.12)	5.35 (0.42)	0.3042
Send and Receive Network Size	8.66 (0.19)	7.94 (0.52)	0.2035
In-degree	4.84 (0.14)	4.27 (0.43)	0.1838

Out-degree	4.80 (0.12)	4.35 (0.42)	0.3042

*indicates statistical significance in the difference of the means between stratum

The GEE analysis concluded that none of the ego network measures have a statistically significant individual effect on the status of gonorrhea and chlamydia infections (**Table 15**).

Table 15. Individual GEE Analysis of Ego's STD Status of Each Ego Network Variable

Variable	Coefficient	Standard Error	P-Value	Odds Ratio (95% CI)
Bonacich Centrality	-0.47	0.24	0.0503	0.62 (0.39, 1.00)
Proximity Prestige	-4.00	2.71	0.1422	0.02 (0, 3.89)
Influence Domain	-0.00	0.00	0.6610	1.00 (1.00, 1.00)
Reachable Alters	-0.00	0.00	0.9685	1.00 (1.00, 1.00)
Reachable Alters in 3 Steps	-0.00	0.003	0.2109	1.00 (0.99, 1.00)
Send Network Density	-1.19	1.12	0.2906	0.30 (0.03, 2.80)
Send and Receive Network Density	-1.48	1.15	0.2003	0.23 (0.02, 2.22)
Send Network Size	-0.05	0.05	0.3029	0.95 (0.87, 1.05)
Send and Receive Network Size	-0.04	0.03	0.2211	0.96 (0.90, 1.03)
In-degree	-0.05	0.04	0.2261	0.95 (0.88, 1.03)
Out-degree	-0.05	0.05	0.3029	0.95 (0.87, 1.05)

The GEE analysis concluded that an individuals' gender, race, centrality, and density of their send/receive network are all significant in predicting gonorrhea and chlamydia infection status **(Table 16).** Having a central position decreases the odds of having a positive STD status (OR=0.49). Adjusting for gender, centrality, and send/received density, blacks are 2.54 times higher than non-blacks for having a positive status.

Table 16. GEE Analysis of Ego's STD Status by Ego Network Variables

Variables	Coefficients	Standard Error	P-Value	Odds Ratio
Intercept	-1.78	0.74	0.0186	
Gender	-0.69	0.81	0.3905	
Race	0.93	0.28	0.0012	2.54
Bonacich Centrality	-0.70	0.31	0.0237	0.49
Density of Send and Received Network	-8.47	2.72	0.0023	
Gender and Density of Send/Receive Network	7.32	3.07	0.0185	

Further comparison of the network measures means were conducted stratified by gender and race (**Table 17** and **Table 18**). Notable differences are in the density of the send network and in-degree of the ego for the STD positive group among males and females that are not in the negative group.

Table 17 .
Comparison of Ego Network Measures Stratified by STD Status and Gender

Variable	Gender	STD Negative	STD Positive
Bonacich Centrality	Male	0.84	0.69
	Female	0.88	0.68
Proximity Prestige	Male	0.15	0.13
	Female	0.16	0.14
Influence Domain	Male	581.58	588.28
	Female	624.41	579.03
Reachable Alters	Male	584.72	402.06
	Female	643.00	676.56
Reachable Alters in 3 Steps	Male	65.88	47.62
	Female	70.51	64.39
Send Network Density	Male	0.39	0.26
	Female	0.40	0.38
Send and Receive Network Density	Male	0.29	0.21
	Female	0.29	0.28
Send Network Size	Male	5.57	5.28
	Female	6.01	5.37
Send and Receive Network Size	Male	8.35	8.26
	Female	8.94	7.85
In-degree	Male	4.49	3.75
	Female	5.16	4.42
Out-degree	Male	4.57	4.28
	Female	5.01	4.37

There are noticeable differences between blacks and non-blacks in centrality, influence domain, and reach in both STD status groups.

Table 18.
Comparison of Ego Network Measures Stratified by STD Status and Race

Variable	Gender	STD Negative	STD Positive
Bonacich Centrality	Non-Black	0.88	0.70
	Black	0.75	0.66
Proximity Prestige	Non-Black	0.16	0.15
	Black	0.14	0.13
Influence Domain	Non-Black	613.84	627.78
	Black	556.78	496.47
Reachable Alters	Non-Black	621.41	678.17
	Black	584.95	494.25
Reachable Alters in 3 Steps	Non-Black	69.99	69.53
	Black	59.08	44.09
Send Network Density	Non-Black	0.40	0.37
	Black	0.38	0.32
Send and Receive Network Density	Non-Black	0.29	0.27
	Black	0.27	0.25
Send Network Size	Non-Black	5.91	5.48
	Black	5.22	5.10
Send and Receive Network Size	Non-Black	8.78	8.02
	Black	7.96	7.80
In-degree	Non-Black	4.96	4.44
	Black	4.21	3.96
Out-degree	Non-Black	4.91	4.48
	Black	4.22	4.10

To determine if race and gender were confounders on network measures, race stratified analyses of network measures while adjusting for gender was conducted (**Table 19**). The GEE analysis showed no association between network measures and STD status when stratified by race. However, there were notable difference between races for centrality and density.

Table 19.
Effects of Network Measures on STD Status Stratified by Race while Adjusting for Gender

	Non Black	Black
	Odds Ratio	**Odds Ratio**
Bonacich Centrality	0.59	0.73
Proximity Prestige	0.02	0.23
Influence Domain	1.00	1.00
Reachable Alters	1.00	1.00
Reachable Alters in 3 Steps	1.00	0.99
Send Network Density	0.46	0.10
Send and Receive Network Density	0.31	0.17
Send Network Size	0.94	0.98
Send and Receive Network Size	0.95	0.99
In-degree	0.94	0.97
Out-degree	0.94	0.98

*Indicate a significant association between network measure and STD status
* p-value<.05 **p-value<.005 ***p-value<.0001

To tease out the effects, further stratification was made on gender and GEE analyses conducted.

Several odds ratios for black males could not be calculated because there was instability in the

model that lead the parameter to approach infinity. The send and receive network density of non-black males are associated with STD status and for non-black females the send and receive network size was significant (**Table 20**). No associations were found for black males and black females between network measures and STD status.

Table 20. Effects of Network Measures on STD Status Stratified by Gender and Race

	Non- Black Male	Non-Black Female	Black Male	Black Female
	Odds Ratio	**Odds Ratio**	**Odds Ratio**	**Odds Ratio**
Bonacich Centrality	0.80	0.52	na[a]	0.79
Proximity Prestige	0.003	0.01	0	0.50
Influence Domain	1.00	1.00	1.04	1.00
Reachable Alters	1.00	1.00	0.82	1.00
Reachable Alters in 3 Steps	0	1.00	0.89	0.99
Send Network Density	0	1.08	na[a]	0.14
Send and Receive Network Density	0*	1.75	0	0.16
Send Network Size	1.00	0.92	1.00	0.99
Send and Receive Network Size	1.04	0.91*	na[a]	1.02
In-degree	1.00	0.92	0.01	1.02
Out-degree	1.00	0.92	1.00	0.99

*Indicates a significant association between network measure and STD status
* p-value<.05 **p-value<.005 ***p-value<.0001
na[a] implies the parameter is approaching infinity and there is instability in the model

GEE analysis was conducted on both behavior and network measures to produce a predictor model **(Table 21).** Individuals' gender, race, and density of the send/receive network along with their peers levels of drinking, smoking, and skipping school are significant in assisting with prediction of high school adolescents' status of gonorrhea and chlamydia infection.

Table 21.
GEE Analysis of the Combination of Behaviors, Attributes, and Ego Network Variables

Parameter	Parameter Estimate	Standard Error	95% Confidence Limits		t statistic	P value
Intercept	-3.38	1.34	-6.03	-0.72	-2.52	0.0130
Gender	-0.74	0.79	-2.30	0.83	-0.93	0.3537
Race	1.36	0.29	0.79	1.94	4.72	<.0001
Smoking	0.29	0.14	0.02	0.56	2.14	0.0340
Drinking	0.38	0.24	-0.09	0.85	1.60	0.1120
Skipping School	1.22	0.34	0.54	1.91	3.56	0.0005
Drinking and Skipping	-0.42	0.15	-0.72	-0.12	-2.75	0.0067
Density of Send/Receive Network	-14.35	5.49	-25.23	-3.48	-2.61	0.0100
Gender and Density of Send/Receive Network	7.22	3.00	1.30	13.15	2.41	0.0173

5. Discussion

5.1. Discussion

The analysis conducted in this paper provides further insight to the effects of peer networks on the status of gonorrhea and chlamydia infections. Approximately 3 % of the high school students in the ADD Health study had either one of the sexually transmitted diseases which is slightly higher compared to the current rate of adolescents in 2010 (2.46%). This is expected since there has been a reported decrease of the diseases since 1996. The analysis also supports the previous research that the gender and race of an individual has a significant impact on the status of gonorrhea and chlamydia infections. Blacks and females have higher odds and higher rates than their counterparts. Individuals' that have friends participating in delinquent behavior such as drinking, smoking, skipping school and getting into fights, increases the odds of having a positive STD status. As well, individuals are also likely to participate in these behaviors which are well documented antecedents. It is unclear as to whether it is the "birds of a feather" effect or peer influence. The network measures suggest that the more connected you are, the more friends you have, and the more friends your friends have is a protective factor against gonorrhea and chlamydia. Therefore, individuals that have smaller and less dense networks are more likely to have a positive STD status. The subgroups created by gender and race showed that different behaviors and network measures are associated with STD status in each group. For non-black males, peers' chances of living to 35 are significant in predicting STD status. Non-black females' status can be predicted by their peers' belief in being killed by 21, probability of getting HIV, and smoking. Peer fighting for black males and peers skipping school for black females were associated with STD status.

5.2. Implications

The results suggest that efforts to decrease rates of gonorrhea and chlamydia among high school adolescents in the U.S. should target peer networks. Individuals are more likely to change their behaviors and attitudes if their friends also change their behaviors. Prevention and intervention programs should target peer networks not just individuals and tailor to specific demographic subgroups particularly black and female networks.

5.3. Limitations and Future Research

Due to the restricted use of the public data set, identification numbers of the friendship nominations were not available and network structures could not be produced. Therefore, we were limited to ego-centric networks and their provided network measures. This inhibited us from evaluating the connections of individuals especially the STD positive individuals. The ADD Health study has such an extensive in-home questionnaire that deeply investigated the attitudes, behaviors, and motives of individuals that would have allowed for a more in-depth analysis of the effects on infection status of gonorrhea and chlamydia. For future analysis, evaluation of the network effects should be conducted with the global network information. Having the friendship nomination ids, one should construct the global network and analyze new network measures. Connections of STD positive individuals should be made. In addition, new mean attributes and behaviors can be created and analyzed for a more comprehensive study.

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Appendix A: All Tables

Table 1. Distribution of Sexually Transmitted Diseases

STD	# of Cases
Chlamydia	53
Gonorrhea	18
Both	10

Table 2. Descriptive Statistics Stratified by STD Status

Variables	STD negative (n=1924)	STD positive (n=61)
Age (SE)	15.35 (0.04)	15.67 (0.22)
Sex = female (%)	1020 (53.29)	45 (73.77)
Race = black (%)	469 (24.38)	29 (47.54)
Grade (SE)	10.01 (0.03)	10.29(0.14)

Table 3.
Comparison of Mean Values of Behaviors and Attributes Stratified by STD Status

Variables	STD Negative	STD Positive	p-value
Chances to live to 35*	6.71(0.05)	5.73(0.30)	0.0016
Chances of being killed by 21	1.47(0.04)	1.81(0.36)	0.3515
Chances of getting HIV	1.03(0.05)	1.36(0.31)	0.3105
How often did you smoke*	1.33(0.07)	2.60(0.39)	0.0012
How often did you drink*	1.32(0.05)	1.98(0.22)	0.0045
How often did you get drunk*	0.76(0.05)	1.37(0.24)	0.0110
How often did you do something dangerous because you were dared	0.87(0.04)	1.12(0.24)	0.3135

How often did you lie to your parents*	2.21(0.05)	2.82(0.29)	0.0377
How often did you skip school*	0.58(0.05)	1.43(0.21)	0.0001
How often did you get into physical fights	0.70(0.03)	0.91(0.14)	0.1461

*indicates statistical significance in the difference of the means between stratum

Table 4.
Comparison of Mean Values of Behaviors and Attributes of the Peer Networks Stratified by STD Status

Variables	STD Negative Mean (Standard error)	STD Positive Mean (Standard error)	P-value
Chances to live to 35	6.66 (0.04)	6.51 (0.07)	0.0671
Chances of being killed by 21	1.50 (0.03)	1.75 (0.13)	0.0603
Chances of getting HIV	1.03 (0.03)	0.88 (0.10)	0.1148
How often did you smoke*	1.35 (0.06)	1.89 (0.23)	0.0147
How often did you drink*	1.36 (0.04)	1.63 (0.12)	0.0185
How often did you get drunk	0.81 (0.04)	0.94 (0.12)	0.2597
How often did you do something dangerous because you were dared	0.90 (0.03)	0.98 (0.16)	0.5761
How often did you lie to your parents*	2.22 (0.03)	2.44 (0.09)	0.0187
How often did you skip school*	0.56 (0.04)	0.87 (0.10)	0.0006

How often did you get into physical fights*	0.68 (0.02)	0.93 (0.11)	0.0228

*indicates statistical significance in the difference of the means between stratum

Table 5. Individual GEE Analysis of Each Behavior and Attribute of the Peer Networks

Variables	Coefficient (Standard Error)	P-Value	Odds Ratio (95% CI)
Chances to live to 35	-0.14 (0.07)	0.0638	0.87 (0.75, 1.01)
Chances of being killed by 21	0.37 (0.17)	0.0316	1.45 (1.03, 2.05)
Chances of getting HIV	-0.26 (0.20)	0.1829	0.77 (0.52, 1.13)
How often did you smoke	0.29 (0.09)	0.0014	1.34 (1.12, 1.60)
How often did you drink	0.33 (0.12)	0.0091	1.39 (1.09, 1.77)
How often did you get drunk	0.21 (0.16)	0.1935	1.23 (0.90, 1.67)
How often did you do something dangerous because you were dared	0.16 (0.22)	0.4803	1.17 (0.75, 1.83)
How often did you lie to your parents	0.26 (0.11)	0.0153	1.30 (1.05, 1.61)
How often did you skip school	0.45 (0.10)	<.0001	1.57 (1.29, 1.91)
How often did you get into physical fights	0.67 (0.21)	0.0021	1.95 (1.28, 2.98)

Table 6. GEE Analysis Model for Behaviors and Attributes of the Peer Networks Effects on the Ego's STD Status

Parameter	Estimate	Standard Error	95% Confidence Limits		T statistic	P value	Odds Ratio
Intercept	-5.80	0.47	-6.73	-4.87	-12.31	<.0001	
Gender	1.10	0.32	0.45	1.74	3.38	0.0010	2.99
Race	1.39	0.26	0.88	1.91	5.34	<.0001	4.02
Smoking	0.34	0.13	0.09	0.59	2.69	0.0081	1.40
Drinking	0.30	0.21	-0.11	0.71	1.44	0.1526	
Skipping School	1.04	0.27	0.50	1.57	3.83	0.0002	
Drinking and Skipping School	-0.36	0.12	-0.60	-0.12	-2.94	0.0039	

Table 7.
Comparison of Peer Behaviors and Attributes Stratified by STD Status and Race

Variable	Gender	STD Negative	STD Positive
Chances to live to 35	Non-Black	6.69	6.49
	Black	6.51	6.54
Chances of being killed by 21	Non-Black	1.54	1.97
	Black	1.31	1.35
Chances of getting HIV	Non-Black	1.06	0.96
	Black	0.87	0.75
How often did you smoke	Non-Black	1.46	2.44
	Black	0.75	0.91
How often did you drink	Non-Black	1.38	1.72
	Black	1.23	1.46
How often did you get drunk	Non-Black	0.85	1.09
	Black	0.58	0.66
How often did you do something dangerous because you were dared	Non-Black	0.96	1.22
	Black	0.55	0.54
How often did you lie to your parents	Non-Black	2.20	2.47
	Black	2.36	2.40
How often did you skip school	Non-Black	0.58	0.86
	Black	0.48	0.88
How often did you get into physical fights	Non-Black	0.67	1.02
	Black	0.70	0.78

Table 8.
Comparison of Peer Behaviors and Attributes Stratified by STD Status and Gender

Variable	Gender	STD Negative	STD Positive
Chances to live to 35	Male	6.66	6.19
	Female	6.66	6.60
Chances of being killed by 21	Male	1.51	1.82
	Female	1.49	1.72
Chances of getting HIV	Male	1.07	0.96
	Female	1.01	0.86
How often did you smoke	Male	1.35	1.83
	Female	1.34	1.91
How often did you drink	Male	1.37	1.85
	Female	1.34	1.57
How often did you get drunk	Male	0.85	1.18
	Female	0.76	0.87
How often did you do something dangerous because you were dared	Male	1.01	1.02
	Female	0.78	0.97
How often did you lie to your parents	Male	2.25	2.62
	Female	2.20	2.39
How often did you skip school	Male	0.56	0.66
	Female	0.57	0.93
How often did you get into physical fights	Male	0.69	1.30
	Female	0.66	0.82

Table 9. Individual GEE Analysis on STD Status of Individual Descriptive Measures

Variables	Coefficient (Standard Error)	P-Value	Odds Ratio (95% CI)
Age	0.27 (0.16)	0.1051	1.31 (0.95, 1.80)
Gender (Male=Reference)	1.15 (0.31)	0.0003	3.16 (1.71, 5.86)
Race (Non-black=Reference)	1.10 (0.24)	<.0001	3.01 (1.87, 4.85)

Table 10.
The Effects of Race and Gender: Check For Confounding

Variable	Beta (SE)	Race Beta (SE)	Gender Beta (SE)
Chances to live to 35	-0.14 (0.07)	-0.12 (0.08)	-0.16 (0.08)
Chances of being killed by 21	0.37 (0.17)	0.42 (0.16)	0.40 (0.19)
Chances of getting HIV	-0.26 (0.20)	-0.20 (0.19)	-0.26 (0.21)
How often did you smoke	0.29 (0.09)	0.40 (0.09)	0.29 (0.09)
How often did you drink	0.33 (0.12)	0.37 (0.12)	0.35 (0.13)
How often did you get drunk	0.21 (0.16)	0.29 (0.16)	0.25 (0.16)
How often did you do something dangerous because you were dared	0.16 (0.22)	0.29 (0.19)	0.27 (0.24)
How often did you lie to your parents	0.26 (0.11)	0.22 (0.11)	0.30 (0.12)
How often did you skip school	0.45 (0.10)	0.50 (0.10)	0.46 (0.11)
How often did you get into physical fights	0.67 (0.21)	0.68 (0.22)	0.74 (0.23)

Table 11.
Effects of Peer Network Behaviors and Attributes on STD Status Stratified by Race while Adjusting for Gender

	Non Black (n=1476)	**Black** (n=499)
	Odds Ratio	**Odds Ratio**
Chances to live to 35	0.82*	1.05
Chances of being killed by 21	1.9**	1.04

Chances of getting HIV	0.83	0.84
How often did you smoke	1.52***	1.25
How often did you drink	1.53**	1.33
How often did you get drunk	1.48*	1.17
How often did you do something dangerous because you were dared	1.62*	1.09
How often did you lie to your parents	1.46*	1.06
How often did you skip school	1.48**	2.53**
How often did you get into physical fights	2.41**	1.3

*Indicates an association between behavior and STD status
* p-value<.05 **p-value<.005 ***p-value<.0001

Table 12.
Effects of Peer Network Behaviors and Attributes on STD Status Stratified by Gender and Race

	Non- Black Male (n=706)	**Non-Black Female** (n=770)	**Black Male** (n=204)	**Black Female** (n=295)
	Odds Ratio	**Odds Ratio**	**Odds Ratio**	**Odds Ratio**
Chances to live to 35	0.74**	0.87	na***	1.22
Chances of being killed by 21	1.73	2.00**	na	0.98
Chances of getting HIV	1.17	0.72	na	1.02
How often did you smoke	1.48*	1.55***	na	1.25
How often did you drink	1.55	1.52*	1.48	0.99
How often did you get drunk	1.53	1.45	na***	0.83

How often did you do something dangerous because you were dared	1.2	1.86*	na	1.2
How often did you lie to your parents	1.58	1.39	na	1.03
How often did you skip school	1.2	1.62**	1.2	3.02**
How often did you get into physical fights	2.55*	2.33*	4.51**	0.6

*Indicates a significant association between behavior and STD status
* p-value<.05 **p-value<.005 ***p-value<.0001

Table 13. Predictor Models Associated with Each Subgroup

Non-black Males

	Coefficient	Standard Error	P-value	Odds Ratio
Intercept	-2.58	0.7	0.0003	
Chances to live to 35	-0.3	0.1	0.0022	0.74 (0.62, 0.90)

Non-black Females

	Coefficient	Standard Error	P-value	Odds Ratio
Intercept	-4.72	0.52	<.0001	
Smoking	0.4	0.11	0.0003	1.50 (1.21, 1.85)
Chances of being killed by 21	0.75	0.28	0.0080	2.11 (1.22, 3.66)
Chances of getting HIV	-0.69	0.28	0.0171	0.50 (0.29, 0.88)

Black Males

	Coefficient	Standard Error	P-value	Odds Ratio
Intercept	-4.31	0.47	0.0001	
Fighting	1.51	0.40	0.0003	4.51 (2.04, 10.00)

Black Females

	Coefficient	Standard Error	P-value	Odds Ratio
Intercept	-3.14	0.34		
Skipping	1.1	0.34	0.0013	3.02 (1.55, 5.86)

Table 14. Comparison of Ego Network Variables Stratified by STD Status

Variable	STD Negative (Standard Error)	STD Positive (Standard Error)	P-value
Bonacich Centrality*	0.86 (0.02)	0.68 (0.08)	0.0307
Proximity Prestige	0.16 (0.01)	0.14 (0.01)	0.1553
Influence Domain	605.04 (48.62)	581.17 (75.57)	0.6502
Reachable Alters	615.78 (52.63)	612.89 (97.71)	0.9684
Reachable Alters in 3 Steps	68.31 (3.38)	60.50 (6.21)	0.2209
Send Network Density	0.39 (0.01)	0.35 (0.03)	0.2063
Send and Receive Network Density	0.29 (0.01)	0.26 (0.02)	0.1295
Send Network Size	5.80 (0.12)	5.35 (0.42)	0.3042
Send and Receive Network Size	8.66 (0.19)	7.94 (0.52)	0.2035
In-degree	4.84 (0.14)	4.27 (0.43)	0.1838
Out-degree	4.80 (0.12)	4.35 (0.42)	0.3042

*indicates statistical significance in the difference of the means between stratum

Table 15. Individual GEE Analysis of Ego's STD Status of Each Ego Network Variable

Variable	Coefficient	Standard Error	P-Value	Odds Ratio (95% CI)
Bonacich Centrality	-0.47	0.24	0.0503	0.62 (0.39, 1.00)
Proximity Prestige	-4.00	2.71	0.1422	0.02 (0, 3.89)
Influence Domain	-0.00	0.00	0.6610	1.00 (1.00, 1.00)
Reachable Alters	-0.00	0.00	0.9685	1.00 (1.00, 1.00)
Reachable Alters in 3 Steps	-0.00	0.003	0.2109	1.00 (0.99, 1.00)
Send Network Density	-1.19	1.12	0.2906	0.30 (0.03, 2.80)
Send and Receive Network Density	-1.48	1.15	0.2003	0.23 (0.02, 2.22)
Send Network Size	-0.05	0.05	0.3029	0.95 (0.87, 1.05)
Send and Receive Network Size	-0.04	0.03	0.2211	0.96 (0.90, 1.03)
In-degree	-0.05	0.04	0.2261	0.95 (0.88, 1.03)
Out-degree	-0.05	0.05	0.3029	0.95 (0.87, 1.05)

Table 16. GEE Analysis of Ego's STD Status by Ego Network Variables

Variables	Coefficients	Standard Error	P-Value	Odds Ratio
Intercept	-1.78	0.74	0.0186	
Gender	-0.69	0.81	0.3905	
Race	0.93	0.28	0.0012	2.54
Bonacich Centrality	-0.70	0.31	0.0237	0.49
Density of Send and Received Network	-8.47	2.72	0.0023	

Gender and Density of Send/Receive Network	7.32	3.07	0.0185

Table 17 .
Comparison of Ego Network Measures Stratified by STD Status and Gender

Variable	Gender	STD Negative	STD Positive
Bonacich	Male	0.84	0.69
Centrality	Female	0.88	0.68
Proximity	Male	0.15	0.13
Prestige	Female	0.16	0.14
Influence	Male	581.58	588.28
Domain	Female	624.41	579.03
Reachable	Male	584.72	402.06
Alters	Female	643.00	676.56
Reachable	Male	65.88	47.62
Alters in 3	Female	70.51	64.39
Steps			
Send Network	Male	0.39	0.26
Density	Female	0.40	0.38
Send and	Male	0.29	0.21
Receive	Female	0.29	0.28
Network			
Density			
Send Network	Male	5.57	5.28
Size	Female	6.01	5.37
Send and	Male	8.35	8.26
Receive	Female	8.94	7.85
Network Size			
In-degree	Male	4.49	3.75
	Female	5.16	4.42
Out-degree	Male	4.57	4.28
	Female	5.01	4.37

Table 18.
Comparison of Ego Network Measures Stratified by STD Status and Race

Variable	Gender	STD Negative	STD Positive
Bonacich Centrality	Non-Black	0.88	0.70
	Black	0.75	0.66
Proximity Prestige	Non-Black	0.16	0.15
	Black	0.14	0.13
Influence Domain	Non-Black	613.84	627.78
	Black	556.78	496.47
Reachable Alters	Non-Black	621.41	678.17
	Black	584.95	494.25
Reachable Alters in 3 Steps	Non-Black	69.99	69.53
	Black	59.08	44.09
Send Network Density	Non-Black	0.40	0.37
	Black	0.38	0.32
Send and Receive Network Density	Non-Black	0.29	0.27
	Black	0.27	0.25
Send Network Size	Non-Black	5.91	5.48
	Black	5.22	5.10
Send and Receive Network Size	Non-Black	8.78	8.02
	Black	7.96	7.80
In-degree	Non-Black	4.96	4.44
	Black	4.21	3.96
Out-degree	Non-Black	4.91	4.48
	Black	4.22	4.10

Table 19.
Effects of Network Measures on STD Status Stratified by Race while Adjusting for Gender

	Non Black	Black
	Odds Ratio	**Odds Ratio**
Bonacich Centrality	0.59	0.73
Proximity Prestige	0.02	0.23

Influence Domain	1.00	1.00
Reachable Alters	1.00	1.00
Reachable Alters in 3 Steps	1.00	0.99
Send Network Density	0.46	0.10
Send and Receive Network Density	0.31	0.17
Send Network Size	0.94	0.98
Send and Receive Network Size	0.95	0.99
In-degree	0.94	0.97
Out-degree	0.94	0.98

*Indicate a significant association between network measure and STD status
* p-value<.05 **p-value<.005 ***p-value<.0001

Table 20. Effects of Network Measures on STD Status Stratified by Gender and Race

	Non- Black Male	**Non-Black Female**	**Black Male**	**Black Female**
	Odds Ratio	**Odds Ratio**	**Odds Ratio**	**Odds Ratio**
Bonacich Centrality	0.80	0.52	na	0.79
Proximity Prestige	0.003	0.01	0	0.50
Influence Domain	1.00	1.00	1.04	1.00
Reachable Alters	1.00	1.00	0.82	1.00
Reachable Alters in 3 Steps	0	1.00	0.89	0.99
Send Network Density	0	1.08	na	0.14

Send and Receive Network Density	0*	1.75	0	0.16
Send Network Size	1.00	0.92	1.00	0.99
Send and Receive Network Size	1.04	0.91*	na	1.02
In-degree	1.00	0.92	0.01	1.02
Out-degree	1.00	0.92	1.00	0.99

*Indicates a significant association between network measure and STD status
* p-value<.05 **p-value<.005 ***p-value<.0001

Table 21.
GEE Analysis of the Combination of Behaviors, Attributes, and Ego Network Variables

Parameter	Parameter Estimate	Standard Error	95% Confidence Limits		t statistic	P value
Intercept	-3.38	1.34	-6.03	-0.72	-2.52	0.0130
Gender	-0.74	0.79	-2.30	0.83	-0.93	0.3537
Race	1.36	0.29	0.79	1.94	4.72	<.0001
Smoking	0.29	0.14	0.02	0.56	2.14	0.0340
Drinking	0.38	0.24	-0.09	0.85	1.60	0.1120
Skipping School	1.22	0.34	0.54	1.91	3.56	0.0005
Drinking and Skipping	-0.42	0.15	-0.72	-0.12	-2.75	0.0067
Density of Send/Receive Network	-14.35	5.49	-25.23	-3.48	-2.61	0.0100
Gender and Density of Send/Receive Network	7.22	3.00	1.30	13.15	2.41	0.0173