

TYPES AND GENDER COMPOSITION OF SOCIAL NETWORKS: THEIR
INFLUENCE ON ADOLESCENT SUBSTANCE USE

A Dissertation

by

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ABSTRACT

This dissertation presents three separate studies designed to examine how the different factors and determinants known to influence adolescent alcohol and tobacco use and the gender compositions of different adolescent network types are associated with alcohol and tobacco use among adolescents. Additionally, the similarities and/or differences in networks of adolescent substance users and non-users are also examined.

First, a systematic review of empirical studies (n=48) employing social network analysis to examine adolescents' alcohol, tobacco, and other drugs (ATOD) use behavior will be presented discussing: (a) how this body of literature examined gender differences in ATOD use, (b) whether these network studies examine the gender composition of these adolescents' networks, and (c) what network affiliation types are used to characterize adolescent networks.

Secondly, descriptive characteristics and network analysis of the social networks of 10th grade substance using and non-using adolescents will be presented. Employing a bounded whole network approach, data was collected from 1,707 10th graders in a school district in Los Angeles, California. The students were asked different network questions in order to generate different network types. The network types elicited from these network questions are: *Friendship, Admiration, Succeed, Popularity, and Romantic* networks. Attributes and network characteristics of users and non-users across these five different networks are presented and the commonalities and/or differences are described also.

Lastly, using data from the same students, a quantitative analysis of the associations between interpersonal (e.g. age, gender) and interpersonal (e.g. parent and sibling substance use) factors, network measures, and gender composition of the networks and their alcohol and tobacco use will be discussed. These associations are then further examined across the five different types of networks mentioned above.

Prior to this study, research studies employing social network analysis did not attempt to examine the gender composition of the networks in which adolescents are embedded; and only a few other studies used networks other than friendship networks to characterize adolescent social networks. Thus, this study represents the first step towards addressing these limitations associated with examining how adolescents' social networks facilitate or constrain their substance use behavior and filling these apparent conceptual gaps.

DEDICATION

To the author and the finisher of my faith whose grace and strength sustains me.

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CHAPTER I

INTRODUCTION

Although not all substance use is abuse, when considered within the context of the other risk behaviors that develop during adolescence, it becomes imperative to identify strategies that help inhibit/delay early initiation of substance use. Also, there is evidence that initiation of substance use during adolescence is associated with other risky behaviors such as delinquency, crime, sexually risky practices, and suicide attempts (Jackson & Geddes, 2012). Hence, the prevalence of adolescent substance use has been, and remains, a public health concern.

Monitoring the Future, a study funded by the National Institute on Drug Abuse (NIDA) examining adolescents' behaviors, attitudes, and values in the US documented that by 2009 nearly half (44%) of adolescents have tried cigarettes by the 12th grade, and one out of every five 12th grader (20%) is a current smoker. The study also found that alcohol use among adolescents is widespread with 57% of 12th grade students reporting having being drunk at least once in their life and almost three quarters (72%) of the students reporting having consumed alcohol (more than just a few sips) by the end of high school (Johnston, O'Malley, Bachman, & Schulenberg, 2010).

According to the 2011 national Youth Risk Behavior Surveillance (YRBS), many adolescents are still engaging in health-risk behaviors implicated as being the leading cause of morbidity and mortality among youth and adults (Eaton et al., 2012). These behaviors, such as smoking, drinking, and drug use, when established during

adolescence, are shown to extend into adulthood leading to a myriad of health and economic problems (Eaton et al., 2012).

In the past, substance use has been considered primarily a male problem (Brady & Randall, 1999a). However, with studies identifying gender differences in the biology of substance (ab)use, epidemiology of substance use disorders, and in its etiological factors, there has been an increased focus on determinants of substance use for males and females (Brady & Randall, 1999a). For example, studies have shown that girls are more receptive to social pressures and are more likely to use substances if they have weak family bonds; boys, in contrast, are more likely to use substances if they are aggressive or shy (Brook, Brook, Gordon, Whiteman, & Cohen, 1990; Ensminger & Others, 1982; Lifrak, McKay, Rostain, Alterman, & OBrien, 1997).

Adolescence is a period of self-awareness and identity formation. This period is also marked with a move from predominant attachment to family to a heightened interest in social relationships and peer approval (Simons-Morton & Farhat, 2010). In fact, several researchers have established that peer associations are very important to adolescents and thus a stronger proximal predictor of adolescent substance use while controlling for other background characteristics (Bearman, Moody, & Stovel, 2004; T. W. Valente, Fujimoto, Unger, Soto, & Meeker, 2013).

Studies have shown that the mechanisms through which peer associations influence adolescent substance use depend upon the gender of the adolescent and the gender composition of the peer group/network to which he/she belongs (Mason et al., 2010; Mercken, Snijders, Steglich, Vartiainen, & de Vries, 2010). Adolescents belong

to/are embedded in different kinds of networks and for different purposes. Some of these networks are friendship networks or networks based on attributes such as popularity or academic achievement (Bearman, Moody, & Stovel, 2004; Valente, Fujimoto, Unger, Soto, & Meeker, 2013). These different networks may provide access to substances, as well as constrain or reinforce substance use behavior. Thus, there is a need to explore these different adolescent network types and how they might influence behavior transmission among adolescents (Coleman, Katz, & Menzel, 1966; Cruz, Emery, & Turkheimer, 2012; Hoffman, Monge, Chou, & Valente, 2007; Trucco, Colder, & Wieczorek, 2011; Valente, Fujimoto, Soto, Ritt-Olson, & Unger, 2013).

In order to capture the influence of adolescents' peer interactions (or social relationships broadly) and how they might facilitate or constrain substance use behavior, researchers have turned to social network analysis (SNA). This research methodology uses relational data, besides individual attributes, to understand how social structural attributes emerging from relationships influence individual behavior (Carrasco, Hogan, Wellman, & Miller, 2008).

However, despite the gendered differences in the determinants and in the patterns of adolescent substance use, as well as in the different kinds of networks adolescents have and rely on, there is little known regarding the relationship between the gender structure of adolescent networks and their alcohol and tobacco use behavior. Additionally, very few social network studies have examined network types (other than friendship networks) in which adolescents are embedded, to assess how different types

of networks might factor into the dynamic of how social influence is transmitted within social groups.

The overarching purpose of this dissertation is to employ social network analytic methodology to provide evidence-based insight into how the different determinants known to influence adolescent alcohol/tobacco use and the gender composition of different types of adolescent networks are associated with alcohol and tobacco use among adolescents. More specifically, this dissertation will accomplish the following:

(1) Appraise the body of literature reporting the use of social network analysis for examining adolescent alcohol, tobacco, and drug use (ATOD) with particular focus on assessing: a) how this body of literature examines gender differences in ATOD use; b) whether the gender composition of adolescent networks are examined in these studies; and c) what network affiliation types are being used to characterize adolescent networks. (2) Examine the commonalities and/or differences in the attributes and network characteristics of adolescent substance users and non-users. (3) Examine whether determinants, network measures, and gender composition of the networks of adolescents are associated with their alcohol and tobacco use, and whether these factors vary across different types of networks.

The current document is structured as five distinct sections/chapters. It should be noted that Chapters II-IV were written as manuscripts that will serve as independent pieces to be submitted for publication in peer-reviewed journals. Below is a description of each of the chapters herein:

- Chapter I presents a succinct overview of the topic to be examined in greater detail throughout the document. In addition, the purpose of, and rationale for the topic are outlined.
- Chapter II appraises the extant body of literature using social network analysis for examining the influences of individual gender differences and of gender composition of networks upon adolescent ATOD use. In addition, the network types used to characterize adolescent networks in this literatures are presented. The chapter will represent the first journal article.
- Chapter III provides descriptive characteristics and network analysis of networks of adolescent substance users and non-users. Analyses examine the similarities and/or differences between networks of users and non-users among a sample of 10th grade adolescents in four high schools in Los Angeles, California, across 5 different network types. This chapter will represent the second journal article.
- Chapter IV reports on a quantitative analysis of the associations between intrapersonal (e.g. age, gender) and interpersonal (e.g. parent and sibling substance use) factors, network measures, and gender composition of the networks of a sample of 10th grade adolescents in four high schools in Los Angeles, California, as regards their alcohol and tobacco use. These associations are further examined across 5 different types of networks. This chapter will represent the third and final journal article.
- Chapter V presents general conclusions regarding the project as a whole (i.e., the lessons gleaned from Chapters 2, 3 and 4, in tandem). In addition, implications

for the fields of health education and alcohol and tobacco prevention/education are identified and discussed. Further directions for future research are also offered. Appendices, including supporting documentation follow this chapter.

CHAPTER II

THE ROLE OF GENDER IN ADOLESCENTS' SOCIAL NETWORKS AND ALCOHOL, TOBACCO, AND DRUG USE: A SYSTEMATIC REVIEW

Introduction

The period of adolescence is marked by heightened interest in peer interactions, withdrawal from parental influence, increased self-awareness, and increased tendencies to experiment with substances such as alcohol, tobacco, and other drugs (ATOD) (Mason et al., 2010; Poulin, Denault, & Pedersen, 2011; Richards, Crowe, Larson, & Swarr, 1998; Simons-Morton, 2007). According to *Monitoring the Future* (MTF), a nationally representative study of US adolescents, by 10th grade, 54% of the students report having initiated alcohol use, while 25.7% and 36.8% had initiated alcohol and any illicit drug use respectively. Although, not all adolescent substance use is considered misuse, early initiation and sustained substance use can increase the risk for a variety of health issues in adulthood.

As shown by several researchers, peer associations — either through selection or socialization — are one of the most important determinants of substance use by adolescents alongside other individual and contextual factors (Burk, Van der Vorst, Kerr, & Stattin, 2012; R. Engels, Bot, Scholte, & Granic, 2007; Falci, Whitbeck, Hoyt, & Rose, 2011; Gaughan, 2006; Simons-Morton, 2007). To better capture individual, peer, social, and contextual determinants of adolescent ATOD use, many researchers are now employing social network analytic methods to understand the mechanisms through

which adolescent networks influence their use of alcohol, tobacco, and other drugs (Hsieh & Hollister, 2004; Leaper, Tenenbaum, & Shaffer, 1999; A. J. Rose & Rudolph, 2006). Social network analysis is a research paradigm (Wasserman, 1994) that focuses on assessing relationships between and among people and how these relationships affect behavior while also taking into consideration the different socio-cultural environments in which an individual and his/her network are embedded (Smith & Christakis, 2008; Valente, 2010; Valente, Gallaher, & Mouttapa, 2004).

Adolescents' Gender and Gender Composition of Networks: Effects on ATOD Use

Studies have shown that the mechanisms through which peer interactions influence adolescent substance use depend upon the gender of the adolescent and the gender composition of the network to which he/she belongs (Mason et al., 2010; Mercken, Snijders, Steglich, Vartiainen, & de Vries, 2010). Even though the role of gender and of networks are well documented, researchers still struggle to understand how the adolescent's gender, the gender composition of their networks, and the different types of networks adolescents belong to, shape teens' ATOD use. There is a lack of consensus regarding the significance of these factors and how they might influence the dynamics of substance use.

Gender extends beyond one's identity as a male or a female. Gender is a social construction that attributes different expectations and advantages for each category according to specific cultural and historic contexts (Gaughan, 2006; Ridgeway, 1991; Kimmel & Aronson, 2010). According to Ridgeway (1991), gender identity is a crucial source of differentiation in beliefs, attitudes, and behaviors among humans.

Gender differences begin at birth, but acquire special significance in adolescence, and many studies have demonstrated gendered patterns in susceptibility to, degree, and rate of substance use, as well as relationship forming patterns (Flannery, Vazsonyi, Torquati, & Fridrich, 1994; Leaper, Tenenbaum, & Shaffer, 1999; A. J. Rose & Rudolph, 2006; Wallace et al., 2003). The period of adolescence is particularly interesting because gender roles, beliefs, and patterns of interactions formed during this period are usually carried on to young adulthood and beyond (Gaughan, 2006; A. J. Rose & Rudolph, 2006). Studying adolescent relationships patterns and types provides a unique opportunity to examine the basic dynamics of how gender shapes social interactions among peers (Gaughan, 2006; Knecht, Burk, Weesie, & Steglich, 2011; Rose & Rudolph, 2006).

Over time, scholars have proposed various explanations for the mechanisms through which gender shapes interactions among teens and, in turn, influence behavior. One explanation is proposed by Gaughan (2006) who hypothesized that adolescent in male-male/female-female (hereafter referred to as same sex) relationships/friendships or networks exert *mutual* influence on one another. Moreover, this notion is consistent with Status Characteristics Theory which posits that compared to mixed sex groups where, depending on behavioral or status expectancy one gender might be more dominant/influential in the group, adolescents in same-sex networks experience a balance in influence and behavioral expectancy (Gaughan, 2006a; Huselid & Cooper, 1992).

In contrast to same sex relationships/friendships or networks, adolescents in male-female (hereafter referred to as mixed-sex) friendships/relationships or networks may influence each other in different ways, with male friends hypothesized to have a stronger influence on their female friends' behavior (Deutsch, Steinley, & Slutske, 2013; Waldron, 1998). Using drinking as an example: because heavy drinking is considered a male characteristic, in a same sex male friendship/relationship, males will equally and mutually influence one another's drinking habit. In mixed-sex friendships, however, the male friend may exert a stronger influence on the female friend's drinking pattern with the female having little impact on the male friend's behavior¹ (Deutsch, Steinley, & Slutske, 2013; Gaughan, 2006; Waldron, 1998).

Another theoretical perspective proposes that female adolescents will tend to adopt the drinking habits of their friends because females place more importance on *conforming* in order to maintain close ties, than males do (Burke & Weir, 1978; Mrug, Borch, & Cillessen, 2011; Schulenberg et al., 1999; Simons-Morton, Haynie, Crump, Eitel, & Saylor, 2001; Urberg, Luo, Pilgrim, & Degirmencioglu, 2003). Conversely, some studies on adolescent drinking posit that males, more than females, feel more pressure to conform to the drinking patterns of their friends, as males in those studies perceived drinking to have little to no consequences to them (Schulte, Ramo, & Brown,

¹ This proposition does not ignore the possibility of some males significantly altering their behaviors (for instance, quitting smoking), to impress or please a female friend or romantic partner. Nonetheless, in most cultures experiencing male-dominance — and consistent with status characteristic theory — adolescent friendships constitute a minimally structured male-female interaction (unlike adult friendships) and thus adolescent boys might tend to have a stronger influence on their female friend's substance use patterns (Ridgeway & Smith-Lovin, 1999).

2009; Suls & Green, 2003; Windle, 2000). Still, other studies conclude boys and girls are not different in how they are influenced by their networks to use substances such as alcohol (Jaccard, Blanton, & Dodge, 2005; Poelen, Engels, Van Der Vorst, Scholte, & Vermulst, 2007; Urberg, Degirmencioglu, & Pilgrim, 1997) or tobacco (Ennett et al., 2008; Huisman, van de Werfhorst, & Monshouwer, 2012).

Perhaps the lack of consensus regarding the mechanisms through which gender differences influence adolescent ATOD use can be partially explained by the variability in the types of adolescent networks assessed. Many of the studies base their conclusions on networks of *friends*, ignoring the possibility that observed influence patterns might be different for other types of networks such as those based on romantic, kinship, or admiration relationships (Gaughan, 2006; Valente, Fujimoto, Unger, Soto, & Meeker, 2013). In fact, the majority of social network studies on adolescent ATOD use focus on friendship networks as the main network affiliation type.

Although friendships are an important social structure and a potent source of peer influence, an adolescent's peer relationships are complex. Adolescence is marked with increased sexual attraction and/or interest in romantic relationships, and exertion of independence (Mason et al., 2010; Simons-Morton, 2007; Simons-Morton, Haynie, Crump, Eitel, & Saylor, 2001). During this period, adolescents might rely on many other types of relationships/networks (e.g. religious networks, romantic networks, social club networks); friendship might be only one aspect of this multidimensional relationship dynamic that embodies various kinds of structural network properties and influences (Haynie, 2003; Valente, Fujimoto, Unger, Soto, & Meeker, 2013). Interactions and

communication among, within, and between these multidimensional relationships may have different associations with risk behaviors, albeit via complex mechanisms.

Not accounting for gender differences and/or gender structures of the different types of adolescent networks begs the conclusion that both boys and girls are equally at risk or protected and their associations/relationships are also equally risky or protective (Gaughan, 2006). This assumption can be misleading, at best, and damaging, at worst, especially when designing substance use prevention programs.

With the growing number of interventions focusing on adolescents' networks, it is imperative to understand the influences of individual gender differences and of gender composition of networks upon adolescent ATOD use. To this end, this review proposes to systematically appraise the body of literature reporting the use of social network analysis for examining adolescent alcohol, tobacco, and drug use with particular focus on three research questions:

- 1) How has this body of literature examined gender differences in ATOD use?
- 2) Are gender compositions of adolescent networks examined in these studies?
- 3) What network affiliation types are being used to characterize adolescent networks? In other words, what types of networks are being studied?

There are several advantages to systematically synthesizing the literature on a topic. One such advantage is the ability to organize and integrate existing literature and provide context which otherwise might not be evident in a single study. Such integration can be useful for informing program or policy development, and for grounding interventions in current evidence (Mulrow, 1994). In addition, we will assess the

methodological quality of the studies we synthesize in order to capture the strengths and weaknesses of this body of literature and to determine how much confidence we can have in these studies' findings (Schulz, Chalmers, Hayes, & Altman, 1995).

Methods

Retrieval

Using procedures outlined by Garrard (2013) and consultations with a medical librarian, we searched three electronic databases (PsycINFO, EBSCO, Communication Abstract) using variations and Boolean connections of social network terms (e.g., network analysis, peer interaction, peer association), substance use terms (e.g. alcohol, drinking, tobacco, smoking, drugs), and adolescent-related terms (e.g. teen, high school, middle school, junior high school). We also searched the reviewed studies' reference lists using SCOPUS to identify additional publications. The search was not restricted in terms of when studies were published. All studies published at the time of the search were included.

Inclusion and Exclusion Criteria

To be included in this review, the studies had to: 1) report empirical research in a peer-reviewed English language journal; 2) focus primarily on adolescents between 12 – 18 years of age or 7 – 12th graders; 3) empirically examine the influence of network factors on substance use (alcohol, tobacco, drugs or combinations of these); and 4) use social network measures and analytic methods. Studies were excluded if they were not primary reports of research findings (e.g. editorial, theoretical pieces, or reviews);

employed qualitative methods, or were not truly network studies (a study was considered a network study if its design included a network measure and considered the different levels, e.g. node, dyad, of network analysis). A total of 48 reports met the inclusion criteria and constituted the final sample. Figure 1 shows the selection process for the included studies.

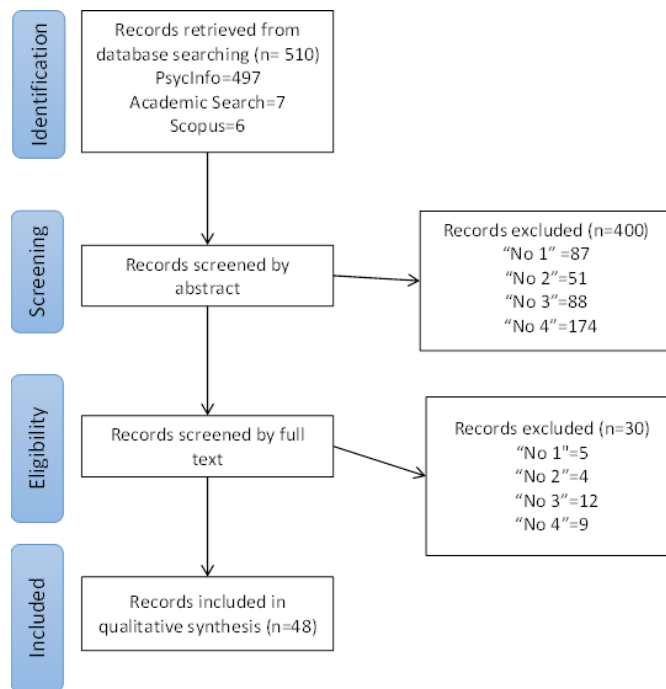


Figure 1. Literature search process for retrieving articles employing social network analysis methodologies to examine adolescent alcohol, tobacco, and drug use. “No 1” indicates studies excluded because they were not empirical studies; “No 2”—studies excluded because they were not about adolescents; “No 3”—studies excluded because substance use was not outcome of interest; and “No 4”—studies excluded because they did not employ SNA.

Data Abstraction and Synthesis

Each study was assessed using a coding scheme and a methodological quality score (MQS). The coding scheme included study description, sample characteristics, dependent variable(s), independent variables, network affiliation types, analytic methods, as well as findings related to gender differences in ATOD use, and gender composition of the networks studied.

We assessed each study's methodological quality with a checklist developed by Kmet, Lee, & Cook (2004), designed to assess adequacy of quantitative studies.

Appraising the quality of research reports is important particularly for evaluating the extent to which the studies' design minimizes biases and errors. On a scale varying between 0 and 4, studies were scored according to several criteria for quality such as study design, clear objectives, analytic methods, sample, and results description, each criterion allowing the study to receive a MQS between 0 and 4 points. Table 1 shows the details of the scoring rubric, which allowed for a maximum MQS of 22 points.

Table 1. Summary of the criteria used for assessing each study's methodological quality

Methodological criterion	Description	Score
MQ1: Did the study address a clearly focused question / objective?	Yes	2
	Partial	1
	No	0
MQ2: Study design evident and appropriate	Yes	2
	Partial	1
	No	0
MQ3: Method of subject selection clearly described	Yes	2
	Partial	1
	No	0
MQ4: Subject characteristics sufficiently described	Yes	2
	Partial	1
	No	0
MQ5: Outcome measures well defined and means of assessment reported?	Yes	2
	Partial	1
	No	0
MQ6: Analytic methods described/justified and appropriate?	Yes	2
	Partial	1
	No	0
MQ7: Results reported in sufficient detail?	Yes	2
	Partial	1
	No	0
MQ8: Conclusions supported by the results?	Yes	2
	Partial	1
	No	0
MQ9: Study design	Longitudinal	2
	Cross-sectional	1
MQ10: Data Analysis (highest level)	ERGM, ABM, QAP, MR-QAP	4
	Multivariate statistics (SEM, HLM, Path analysis, MANOVA, MANCOVA)	3
	Regression analyses, Ordinary least squares, ANOVA, ANCOVA	2
	Bivariate statistics (t-tests, Pearson r)	1
	Univariate statistics (descriptive)	1

Results

Results are presented below in four sections: 1) studies' characteristics, 2) gender differences in adolescent ATOD use, 3) network gender composition and adolescent ATOD use, 4) network affiliation types studied, and 4) methodological quality of reviewed studies.

Studies' Characteristics

As depicted in Figure 1, the initial search yielded 510 publications. After the first round of abstract screening, 400 articles were excluded from the review because they did not meet the inclusion criteria. In the second round of screening, full texts of the remaining studies were skimmed for eligibility, resulting in the exclusion of 30 additional studies. We then conducted a supplemental search of the reference lists in the studies that met the inclusion criteria. This search yielded one additional report, bringing the final number eligible for review to 48.

Reviewed studies were published in 30 different journals with 16 (33%) representing journals with emphasis on adolescence and adolescent health. Almost half of the studies had common authors (47%), and one author coauthored nine of the reviewed studies.

Gender Differences in ATOD Use

Among the 48 studies reviewed, half (n=25, 52%) did not address how peer influence on susceptibility to substance use may vary by gender. The remainder (n=23, 48%) did mention how rates of use and/or peer influence susceptibility varied by gender,

but lacked consensus in their conclusions, depending on the substance studied. Table 2 provides a summary of the studies that examined gender differences in ATOD use.

Among the studies testing differences in peer influence across genders, there were contrasting findings on how adolescent networks influenced boys' and girls' susceptibility to substance use. For studies in which alcohol use/drinking was the outcome of interest (n=17), 59% (n=10) found that there *were* gender differences in rates of use and in the influence networks exert on both boys and girls. In some studies, boys were found to be more susceptible to peer influence, while other studies found that girls were more susceptible to peer influences from their networks (see Table 3). Forty-one percent (41%; n= 7) of studies examining alcohol use did not find gender differences in adolescent susceptibility to or use of alcohol despite testing for them.

Only four of the reviewed studies examined drugs (mostly marijuana) as the/one of the outcomes of interest. All four studies found differences between the genders with two of the studies concluding that males were more likely to use and to be influenced to use drugs than females. Reviewed studies and their findings are listed in Table 2.

Table 2. Summary of findings from the reviewed studies that reported examining gender differences in ATOD use

Outcome of interest	Gender diffs observed	n	Studies (Author, Year)
Alcohol/Drinking			
	Yes	10	(Burk,2012); (Poulin,2011); (Mason,2010); (Pearson,2006); (Giletta,2012); (Kreager,2011); (Balsa,2011); (Bot,2005); (Ragan,2014); (Gaughan,2006)
	No	7	(Deutsch,2013); (Light,2013); (Mrug,2011); (Killeya-Jones,2007); (Osgood,2014); (Kiuru,2010); (Aloise-Young,2005)
Tobacco/Smoking			
	Yes	8	(Fang,2003); (Kiuru,2010); (Fujimoto,2012); (Osgood,2014); (Giletta,2012); (Mason,2010); (Mercken,2010); (Mrug,2011)
	No	3	(Huisman,2012); (Ennett,2008); (Aloise-Young,2005)
Drugs			
	Yes	4	(Mason,2010); (Henry,2007); (Osgood,2014); (Giletta,2012)

Table 3. A list of the 48 reviewed studies and their categorizations based on different descriptors

Description	n (%)	Studies (First Author, Year)
Research Design		
Longitudinal	32(67)	(Arielle,2013); (Light,2013); (Burk,2012); (Poulin,2011); (Knecht,2011); (Mercken,2010); (Henry,2007); (Killeya-Jones,2007); (Osgood,2014); (Tucker,2014); (Corten,2013); (Giletta,2012); (Cruz,2012); (Huisman,2012); (Go,2012); (Schaefer,2012); (Hahm,2012); (Fujimoto,2012); (Kreager,2011); (Kiuru,2010); (Pollard,2010); (Mercken,2010); (Mercken,2009); (Ali,2009); (Popp,2008); (Ennett,2008); (Hall,2007); (Ennett,2006); (Bot,2005); (Aloise-Young,2005); (Ennett, 1994); (Ragan,2014)
Cross-sectional	16(33)	(Mrug,2011); (Mason,2010); (Pearson,2006); (Valente,2013); (Fujimoto,2012); (Lakon,2012); (Balsa,2011); (Kramer,2011); (Ali,2010); (Kobus,2010); (Kirke,2004); (Fang,2003); (Ennett, 1994); (Ennett,1993), (Fujimoto,2012); (Gaughan,2006)
Network affiliation types		
“Friends”	20 (41.7)	(Deutsch,2013); (Light,2013); (Poulin,2011); (Knecht,2011); (Pearson,2006); (Valente,2013); (Cruz,2012); (Huisman,2012); (Go,2012); (Hahm,2012); (Fujimoto,2012); (Fujimoto,2012); (Schaefer,2012); (Kreager,2011); (Balsa,2011); (Kramer,2011); (Pollard, 2010); (Kobus,2010); (Ragan,2014); (Gaughan,2006)
“Best Friends”	16 (33.3)	(Mrug,2011); (Mercken,2010); (Osgood,2014); (Corten,2013); (Tucker,2014); (Giletta,2012); (Fujimoto,2012); (Lakon,2012); (Mercken,2010); (Mercken,2009); (Ennett,2008); (Ha;l,2007); (Bot,2005); (Ennett,1994a); (Ennett,1994); (Ennett,1993)
Other (peer, most important peers, school mate, “hang out with”	12 (25)	(Burk, 2012); (Mason,2010); (Henry,2007); (Fujimoto,2012); (Kiuru,2010); (Kobus,2010); (Ali,2009); (Popp,2008); (Ennett,2006); (Aloise-Young,2005); (kirke,2004); (Fang,2003)
Gender treated as a focal variable		
No	30 (62.5)	(Light,2013); (Killeya-Jones,2007); (Osgood,2014); (Tucker,2014); (Valente,2013); (Corten,2013); (Cruz,2012)), (Go,2012); (Fujimoto,2012); (Schaefer,2012); (Fujimoto,2012); (Lakon,2012); (Hahm,2012); (Balsa,2011); (Kramer,2011); (Pollard,2010); (Ali,2010); (Kobus,2010); (Mercken,2010); (Mercken,2009); (Ali,2009); (Popp,2008); (Ennett,2008); (Hall,2007); (Ennett,2006); (Kirke,2014); (Ennett,1994); (Ennett,1994); (Ennett,1993); (Ragan,2014)
Yes	18 (37.5)	(Deutsch,2013); (Burk,2012); (Poulin,2011); (Mrug,2011); (Knecht,2011); (Mercken,2010); (Mason,2010); (Henry,2007); (Pearson, 2006); (Giletta,2012); (Huisman,2012); (Fujimoto,2012); (Kreager,2011); (Kiuru,2010); (Bot,2005); (Aloise-Young,2005); (Fang,2003); (Gaughan,2006)

Table 3 Continued

Description	n (%)	Studies (First Author, Year)
ATOD use gender differences		
Addressed	23 (47.9)	(Deutsch,2013); (Light,2013); (Burk,2012); (Poulin,2011); (Mrug,2011); (Knecht,2011); (Mercken,2010); (Mason,2010); (Henry,2007); (Killeya-Jones,2007); (Pearson,2006); (Osgood,2014); (Giletta,2012); (Huisman,2012); (Fujimoto,2012); (Kreager,2011);(Balsa,2011); (Kiuru,2010); (Ennett,2008); (Bot,2005); (Fang,2003); (Ragan,2014); (Gaughan,2006)
Not addressed	25 (52.1)	(Tucker,2014); (Valente,2013); (Corten,2013); (Cruz,2012); (Go,2012); (Fujimoto,2012); (Schaefer,2012); (Fujimoto,2012); (Lakon,2012); (Hahm,2012); (Kramer,2011); (Pollard,2010); (Ali,2010); (Kobus,2010); (Mercken,2010); (Mercken,2009); (Ali,2009); (Popp,2008); (Hall,2007); (Ennett,2006); (Aloise-Young,2005); (Kirke,2004); (Ennett,1994a); (Ennett,1994); (Ennett,1993)
Network gender composition		
Addressed	10 (21)	(Deutsch,2013); (Poulin,2011); (Mrug,2011); (Knecht,2011); (Mercken,2010); (Mason,2010); (Giletta,2012); (Fujimoto,2012); (Ennett,1994); (Gaughan,2006)
Not-addressed	38 (79)	(Light,2013); (Burk,2012); (Henry,2007); (Killeya-Jones,2007); (Pearson,2006); (Osgood,2014); (Tucker,2014); (Valente,2013); (Corten,2013); (Cruz,2012); (Huisman,2012); (Go,2012); (Fujimoto,2012); (Schaefer,2012); (Fujimoto,2012); (Lakon,2012); (Hahm,2012); (Kreager,2011); (Balsa,2011); (Kramer,2011); (Kiuru,2010); (Pollard,2010); (Ali,2010); (Kobus,2010); (Mercken,2010); (Mercken,2009); (Ali,2009); (Popp,2008); (Ennett,2008); (Hall,2007); (Ennett,2006); (Bot,2005); (Aloise-Young,2005); (Kirke,2004); (Fang,2003); (Ennett,1994); (Ennett,1993); (Ragan,2014)
Network Approach		
Egocentric	42(87.5)	(Deutsch,2013); (Light,2013); (Burk,2012); (Poulin,2011);(Knecht,2011); (Mercken,2010); (Mason,2010); (Pearson,2006); (Osgood,2014); (Tucker,2014); (Corten,2013); (Cruz,2012); (Huisman,2012); (Go,2012); (Fujimoto,2012); (Schaefer,2012); (Fujimoto,2012); (Lakon,2012); (Hahm,2012); (Fujimoto,2012); (Kreager,2011); (Balsa,2011); (Kramer,2011); (Kiuru,2010); (Pollard,2010); (Ali,2010); (Kobus,2010); (Mercken,2010); (Mercken,2009); (Ali,2009); (Popp,2008); (Ennett,2008); (Hall,2007); (Ennett,2006); (Bot,2005); (Aloise-Young,2005); (Fang,2003); (Ennett,1994); (Ennett,1994); (Ennett,1993); (Ragan,2014); (Gaughan,2006)
Sociometric	6 (12.5)	(Mrug,2011); (Henry,2007); (Killeya-Jones,2007); (Valente,2013); (Giletta,2012); (Kirke,2004)
Data Analysis		
ERG, ABM, QAP	14 (29.2)	(Light,2013); (Burk,2012); (Knecht,2011); (Mercken,2010); (Tucker,2014); (Giletta,2012); (Huisman,2012); (Schaefer,2012); (Kiuru,2010); (Mercken,2010); (Mercken,2009); (Ragan,2014); (Popp,2008); (Valente,2013)
Multivariate Statistics (SEM, HLM, Path analysis)	12(25)	(Kreager,2011); (Ennett,2008); (Bot,2005); (Lakon,2012); (Ennett,2006); (Deutsch,2013); (Pollard,2010); (Fang,2003); (Poulin,2011); (Ali,2009); (Hall,2007); (Gaughan,2006)
Regression analyses, OLS, ANOVA, ANCOVA	17 (35.4)	(Hahm,2012); (Mrug,2011); (Mason,2010); (Henry,2007); (Pearson,2006); (Osgood,2014); (Corten,2013); (Cruz,2012); (Go,2012); (Fujimoto,2012a); (Fujimoto,2012b); (Fujimoto,2012c); (Balsa,2011); (Kramer,2011); (Ali,2009); (Kobus,2010); (Bot,2005)
Bivariate statistics	4 (8.3)	(Ennett,1994); (Ennett,1994); (Ennett,1993); (Killeya-Jones,2007)
Univariate statistics	1 (2.1)	(Kirke,2004)

Eleven studies examined smoking as the outcome variable and similar to findings for alcohol use, researchers documented absence or presence of gender difference in smoking initiation patterns, rates of smoking, and peer influence on smoking. Eight of these studies observed a gender difference with two of them finding that girls were more susceptible to peer influence to smoke than boys. Three studies (27%) however, did not find a gender difference in boys' and girls' smoking initiation patterns or propensity to be influenced by peers (see Table 2).

Network Gender Composition and Adolescent Alcohol, Tobacco and Drug Use

Among reviewed studies, the majority, or 79% (n=38), did not assess or consider the gender composition of the networks. Eight 8 (n=17%) studies did examine the gender structure/composition of the networks or of the dyadic relationship in which the adolescents were embedded. The remaining studies (n=2) did examine the cliques² in which the individuals were embedded but this network composition/variation was then controlled for during the analysis. See Table 3 for a list of the reviewed studies and their categorizations based on descriptors such as study design, gender and network gender composition examined or not, substance studied, network affiliation type measured, and network approach.

Similar to findings from studies examining gender differences at the individual adolescent level, studies that examined the gender composition/structure of the networks drew contrasting conclusions regarding how network gender composition influenced

² A clique is a group of individuals who interact/communicate more with one another than with other members of the community (Valente, 2010).

behavior. Some studies found that friendship with other-sex peers predicted initiation of smoking while another found that girls, not boys, were more likely to be influenced by their peers but this effect was stronger in girls-only networks. Another study also found that among girls in the 10th grade, friendships with boys were associated with smoking, while for boys, friendship with girls in the 11th grade lowered their subsequent alcohol consumption (see Table 3).

Network Affiliation Types

The majority of the reviewed studies ($n = 36$; 75%) assessed *friendship* networks. Of these 36, 16 asked adolescents to list their “best friends” while 20 studies asked respondents to list people whom they regarded as “friends”. The remaining 12 studies (25%), used various typologies to characterize adolescent networks such as “peer,” “closest friends,” “school mates,” “important peers,” and “people you hang out with.” Only one of the reviewed studies asked adolescents to include individuals with whom they had had a romantic relationship/friendship in addition to listing other friends.

Methodological Quality

Table 4 provides a distribution of MQS points awarded to each reviewed study. The maximum possible MQS score was 22, and 10 studies (20.8%) achieved this score. No study scored below 11 (the theoretical mid-point of the scale); actual scores ranged from 17 – 22 with a mean of 19.96 (SD = 1.46). Overall, studies exhibited good quality with all of them clearly stating their research question(s)/objective, using appropriate study design, and employing adequate analyses.

Regarding design, the majority of studies (n=32, 67%) employed a longitudinal design while the remainder (n=16, 33%) employed a cross-sectional design. The majority (n = 42; 87.5%) employed an egocentric approach (a local or personal network environment from the ego's [respondent's] perspective, while the others (n=6, 12.5%) used a sociometric/whole network (network data collected from all members of the network/community) approach for their study.

The studies examined various network measures such as degree, transitivity, reciprocity, connectedness, constraint, and structural measures such as network density, and group/clique membership (See glossary for definition of these and other network-related terms). Fourteen studies (29%) employed more recent statistical techniques (exponential random graph model - ERGM, stochastic actor-based models -ABM, and quadratic assignment procedures – QAP) designed specifically for network data. Eleven studies (23%) employed multivariate methods (e.g. structural equation modeling - SEM, hierarchical linear modelling -HLM, path/growth analysis), 18 (38%) employed regression analyses and ANOVA, and 10% (n=5) reported only bivariate or univariate statistics (see Table 4 for a complete matrix of reviewed studies, their characteristics, and gender-related findings).

Discussion

This systematic review aimed to identify studies employing SNA to examine adolescent alcohol, tobacco, and drug use and to assess their consideration of gender differences, network gender composition, and network affiliation types. Additionally, this review also critically evaluated the methodological quality of the identified studies. We reviewed 48 reports and found the majority of the studies did not take the gender composition of the network into consideration. Most studies examined friendship networks, exclusively, did not test for gender differences in ATOD use, and did not assess the varying network influences for girls and boys.

Findings from the methodological assessment indicated the reviewed studies' quality was high, as all scored above the theoretical average of our methodological quality scale. This finding is especially informative when compared to a review by Seo & Huang (2012) — assessing adolescent social networks with regards to their smoking behavior — which also indicated the included studies had a high quality score. Taken together, their review findings and ours reinforce the notion that irrespective of the substance (alcohol, tobacco, or other drugs) studies employing SNA methodology exhibit adequate rigor and high methodological quality. This review showed that statistical techniques employed in analyzing social network data are evolving, with more recent studies employing statistical techniques designed specifically for network data such as and exponential random graph models (ERGM).

Unlike data obtained through traditional research methods, social network data are interdependent. As a result of this unique attribute, traditional analytical approaches,

mostly parametric statistics, have been shown to be inadequate and sometimes inappropriate for proper analysis (Krackhardt, 1988). The finding that more studies are now employing statistical techniques designed for network data is an indication of improvement given the limitations of traditional parametric statistics (Borgatti, 2013; Krackhardt, 1988; Wasserman, 1994).

Regarding the studies' assessments of the gender composition of the network, only a few reviewed studies examined network gender composition as a contextual factor that might influence adolescents' substance use behavior. Several researchers have highlighted the differences in adolescent male and female social relations, network structure, and extent to which they take on attributes of other adolescents within their networks (Deutsch, Steinley, & Slutske, 2013; Giletta et al., 2012; Poulin, Denault, & Pedersen, 2011; A. J. Rose & Rudolph, 2006). Despite the fact that social processes are quite dissimilar for an adolescent male and female (regardless of cultural contexts), findings from this review demonstrated a paucity of studies examining the relationship between gender structure of peer interactions and substance use behavior.

However, the few studies that considered the gender composition of the adolescents' network did find varying effects in susceptibility to smoking, alcohol, and drug use when adolescents were in male-/female-only or mixed-sex friendships. For example, Mrug (2011) found that girls with a greater proportion of male friends were more likely to initiate smoking. Another study, by Giletta (2012), also revealed that male and female peers and friendship relations are very different in structure and content, thereby exerting varying proportions of influence in using or abstaining from substances.

Similar to findings on gender composition of the network, many of the reviewed studies did not examine gender patterns or differences in adolescents' use or susceptibility to, degree, and rate of alcohol, tobacco, and other drugs use. Only 14 of the reviewed studies examined gender differences in the research questions they were addressing. Some of them only alluded to a possible difference, but then controlled for gender in their subsequent analyses, using males —rarely females — as the reference gender/group. For social network studies, social constructs such as gender, are crucial to understanding the underlying socio-cultural determinants of certain behaviors, especially substance use (Haynie, 2003; Mrug, Borch, & Cillessen, 2011a). Some researchers might claim that not all studies are suitable for gender considerations, but we would argue that for studies assessing the determinants of social behaviors such as substance use, it is imperative to assess the interactions and influences in their differential effects on each gender.

Although many studies have shown that adolescent *friendships* are the most proximal determinants of adolescent ATOD use, increasingly, research is identifying the import of other types of networks in influencing adolescent substance use (Ennett & Bauman, 2000; Farrell & White, 1998; Knecht, Burk, Weesie, & Steglich, 2011). Studies have shown that the period of adolescence is marked with self-awareness and self-evolvement which usually includes interest in the opposite sex, admiration of (developing a crush), or aspiration to become like certain peers (Burke & Weir, 1978; Knecht, Burk, Weesie, & Steglich, 2011). In a network study conducted by Valente et al (2013), adolescents were asked to name friends, peers they admired, aspired to be like,

or with whom they would like to have a romantic relationship. The resulting networks for these different nominations yielded distinct types of network affiliations showing that adolescents rely on and might be influenced by networks other than friendship networks.

Neglecting to capture the influence of other affiliation types on adolescent behavior might mean missing a facet of this complex dynamic mechanism through which social-cultural interactions influence behavior. Examining the findings from this review, we learn that research in this field, albeit of high quality, could benefit from including other affiliation types in examining the influence of adolescent networks on behavior. Almost all the studies reviewed, except for two (Popp, Laursen, Kerr, Stattin, & Burk, 2008; Valente, Fujimoto, Unger, Soto, & Meeker, 2013) examined friendship networks exclusively.

Findings from our review highlight the state of the current body of scientific literature employing social network analysis for examining adolescent ATOD use; particularly relevant are the lapses and the strength of this body of knowledge. However, this review is not without its own shortcomings. First, even though we searched all the electronic databases in which studies on the topic could be indexed, using several key terms, it is possible some studies were overlooked. Second, our methodological quality assessment criteria were not tested for their reliability and may, therefore, not have captured specific nuances of quality characterizing this particular body of literature.

This review also shows that although these studies exhibit high methodological rigor, future research would do well to examine the gender composition of adolescent networks as a determinant of how substance use behavior might influence adolescents

within a network or as factor that determines adolescents' selection into a substance-using group. This review highlights the need for studies that do not assume all adolescents have the same susceptibility to or risk for substance use within different network types and different gender compositions. Similarly, for interventions geared towards prevention, clarifying the risk factors for substance use across genders, network gender compositions, and affiliation types is critical particularly for developing effective gender-appropriate interventions.

CHAPTER III
EXAMINING ATTRIBUTES AND NETWORK CHARACTERISTICS OF 10TH
GRADE SUBSTANCE USERS AND NON-USERS

Introduction

For many people, experimenting with substance use begins during adolescence. Regardless of whether the experiments lead to habituation, several risks have been associated with early initiation of substance use (Grant et al., 2004; Schulenberg, Patrick, Maslowsky, & Maggs, 2014a). These risks, such as dropping out of school, delinquency, getting injured, involvement in motor accidents, homicides, suicides, and other preventable deaths, pose significant acute and/or long term health, social, and economic problems for individuals, families, and society at large (Hingson, Heeren, Winter, & Wechsler, 2005; Osilla et al., 2014; Sitnick, Shaw, & Hyde, 2014). Early initiation is also implicated in increased likelihood for substance use disorders in adulthood (Newcomb & Bentler, 1988). Despite current efforts at preventing or delaying substance use initiation, almost a quarter (22%) of American adolescents are current smokers; and about 73% have used alcohol (more than a few sips) by the 8th grade (Johnston, O'Malley, Bachman, & Schulenberg, 2013).

Researchers have identified social factors such as modeling of substance use behaviors by parents, siblings, and friends/peers to be a consistent predictor of adolescent substance. This association between parent, sibling, and friend/peer substance use behavior and that of the adolescent has been well documented in the literature

(Ennett et al., 2010; Kothari, Sorenson, Bank, & Snyder, 2014; Van Der Vorst, Engels, Meeus, Deković, & Van Leeuwe, 2005). However, more than other forms of social influences, friend/peer influences are particularly important for adolescents (especially between 10th and 12th grades) because, at that stage, they are undergoing the process of differentiating themselves from their parents and turning to friends/peers to establish their social identity (Eisenberg, Toumbourou, Catalano, & Hemphill, 2014; Gifford-Smith, Dodge, Dishion, & McCord, 2005).

Adolescents rarely belong to a single group of peers, or a single social network. Usually, they are members of different networks with different characteristics depending upon the context of the ties (relationship/connection) that exist between or among the members of the group/network (Bearman et al., 2004). However, most network studies of adolescents have typically focused on *friendship networks* (Freeman, 2004; Valente et al., 2013).

Although friendship networks are a potent source of influence on adolescent substance use behavior, there is research evidence also suggesting that adolescent friendship networks are only one aspect of a multidimensional relationship dynamic upon which adolescents rely (Haynie, 2003). Other possible networks in which adolescents might be embedded include religious networks, romantic networks, and social clubs' networks. Thus, to better understand why certain peer contexts facilitate or enhance risk for substance use while others serve as protection, there is a need to explore various types of adolescents' social networks including friendship networks, aspiration networks (e.g. romantic aspirations), and admiration networks (e.g. who you admire).

Exploring adolescents' social networks and how these networks influence behavior is the purview of Social Network Analysis — a distinct approach that uses relational data to understand how social structures and relationships facilitate or constrain behavior (Carrington, Scott, & Wasserman, 2005; Scott & Carrington, 2011; B. Simons-Morton, McLeroy, & Wendel, 2011; Valente, Gallaher, & Mouttapa, 2004). Based on the assumption that relationships among different interacting units are important, a social network approach highlights the importance of structure and content of social relationships as having key behavioral implications (Knoke & Yang, 2008) . For instance, Haynie ((L. Haynie, 2001) documented in a study on adolescent friendship networks and delinquency that beyond individual attributes, the structure of an adolescent's network was a stronger influencer of his/her behavior.

Measuring and Describing Adolescents' Networks

The power of networks resides in the patterns of relationships/ties among members: these ties structure the flow of information and social norms and provide linkages for behavior transmission (Ennett, Bailey, & Federman, 1999; L. Haynie, 2001). Several network measures have been used to describe adolescent networks. *Homophily*, the tendency for people to associate with others like themselves, is considered one of the most salient network measures (Borgatti, Everett, & Johnson, 2013; Valente, 2010). The principle of homophily implies that people tend to associate/form ties with others with whom they share commonalities such as behavioral, sociodemographic (e.g. gender, ethnicity), or attitudinal characteristics (McPherson, Smith-Lovin, & Cook, 2001). In essence, examining the extent to which networks of

adolescent substance users and non-users are homophilous is important information especially for the purposes of determining how likely it is for new or existing behavior to spread through such networks (Valente, 2010).

However, it should also be noted that forming ties with another person could be a result of two often intertwined factors: *preference* and *opportunity* (Borgatti et al., 2013). One explanation for preference-based tie formation mechanisms is Festinger's (1962) cognitive dissonance theory. This theory posits that a person tries to be congruent with those he/she likes. In other words, if Jack likes Joe, and Joe likes John, it would be cognitive dissonance for Jack not to like John. So, based on this theory, Jack will either choose to like John or dislike Joe. An opportunity-based factor, on the other hand, refers to the idea that the presence of certain kinds of ties provides opportunity for the development of other kinds. In the example of Jack, Joe, and John (provided Jack does not exhibit cognitive dissonance), one could say the tie between Jack and Joe provides the opportunity for the development of a tie between Jack and John.

Another measure often used to describe networks is *density*—a measure of how connected a network is (Otte & Rousseau, 2002). Valente (2010) describes density of adolescent networks as the number of connections in the network as a proportion of the total possible connections in the network. Dense networks have been shown to possibly accelerate behavioral diffusion since there might be more peer modeling and peer influence in such networks (Valente et al., 2004). For example, Haynie (2001)—in his adolescent delinquency study—showed that network density is an important structural component that influences how behavior is transmitted within peer networks. Other

studies also have examined the import of density as a network characteristic that predicts individual behavior. An example is Ennett & Bauman (2000) who, in their study on peer context of adolescent substance use, demonstrated that adolescents in dense networks were less likely to smoke or use marijuana compared to those who were in sparse networks.

Centralization is another network measure often used to describe adolescent networks and their influence on substance use. Defined as the degree to which network ties are concentrated on one or a few people (Valente et al., 2004), centralization indicates whether a node (ego) occupies a position of power and control in the network (Valente, 2010). This network measure is important in its ability to identify the network influencers who can possibly be targeted for intervention purposes. Closely related to centralization is the notion of *centrality*. While centralization focuses on the extent to which ties are focused on one or few people, centrality is a measure that indicates how many links are required for an ego to link other alters in their network (L. Haynie, 2001). This can be interpreted as: the smallest number of links required to connect an adolescent to others in his/her network, the more central the adolescent is.

There are numerous other measures used to describe networks; to attempt to discuss or examine all these measures is beyond the scope of this study. Thus, here, we will attempt to describe some of the network characteristics of adolescent substance users and non-users and in addition, also examine other salient attributes of adolescents in these two groups. Hence, the purpose of this study is to:

1. Examine the commonalties and/or differences in the attributes of 10th grade substance users and non-users in four high schools in Los Angeles, California, across different network types—*friendship, popularity, romantic, succeed, and admiration* networks, and
2. Describe the network characteristics of substance users and non-users across these different network types (*friendship, popularity, romantic, succeed, and admiration* networks).

Methods

Data for this study were collected from 1,701 10th graders enrolled in four high schools from a single school district in Los Angeles, California. Approval to conduct the survey was obtained from University of Southern California's institutional review board and the school district's superintendent, principals, and teachers. Cross-sectional samples of 2,290 adolescents from the four participating high schools were asked to fill a paper and pencil survey in May 2010. Out of the 2,290 students asked to participate in the study, 2,016 students returned their parental consent forms and 1,823 agreed to participate in the study. Of these students, 1,707 completed the surveys. Overall participation rate was 74.5%. Students completed the survey during regular class periods: one school used the History class period, while the other three schools completed the survey during the English class.

Outcome Variables

Tobacco and alcohol use were measured with two questions that each assessed whether the student smoked or drank in the past 30 days. Responses to the survey

questions ranged from 1 (never smoked/ used alcohol in the past 30 days) to 7 (drank/smoked all 30 days). Students who responded as having smoked or drunk in the past 30 days were coded as “substance users” while those who indicated never having engaged in those behaviors were coded as “non-users.” While we acknowledge that alcohol and tobacco use represent two different substance use trajectories and arguments can be made for why they should not be combined in a single measure, both alcohol and tobacco use indicate an adolescent’s risk-taking tendency. Since the focus of the study is not the type of behavior but the engagement in risky behaviors, itself — as exemplified by alcohol or tobacco use — grouping the adolescents into users and non-users was deemed appropriate for our purposes.

Sample Attributes

Students’ attributes examined in the study include demographic characteristics such as age, gender, and ethnicity. Other attribute information asked were:

- i. *Academic achievement*: They were also asked to indicate what grades they mostly got in the last school year. This was measured on a scale of “mostly A’s to mostly F’s and students were also given the option to indicate if they weren’t in school the past year.
- ii. *Qualifying for reduced lunch*: The students were asked to indicate (Yes/No) if they received free or reduced lunch in school.

- iii. *Number of rooms in the household:* Students were asked to indicate how many rooms, excluding the kitchen and bathrooms, their house/apartment had. The options ranged from 1 room to 7 or more rooms.
- iv. *Number of people in the household:* Students were asked to indicate how many people, including them, lived in the home where they spend most of their time. The options ranged from 2 people to 7 or more people.

Number of rooms per people in household was calculated by dividing response to the question on number of rooms by the response to the question on number of people.

- v. *Parental substance use:* The students were asked to indicate whether one or both of the adult they spend most of their time with smoked or drank. Response ranged from “None or 0” to “2 of them.”
- vi. *Sibling substance use:* Students were asked to indicate if any of their sibling smoked. Responses to question ranged from “No I don’t have any sibling” to “Yes both older and younger siblings.”

Social Networks

To measure students’ networks, a roster of all 10th graders with a photo of all students in the grade and an ID number (generated by the research team) printed at the bottom of the picture was provided to each student. Students were asked to name 1) their best friends regardless of where they lived and went to school; 2) closest friends in their classroom; and 3) closest friends in their grade. In order to generate other (non-

friendship) types of networks, the students also were provided the classroom roster and asked to write the IDs of five students in the class whom they thought: a) were the most admired; b) were the most likely to succeed; c) with whom they would like to have a romantic relationship; and d) who were the most popular. These questions were asked again, focusing on naming five students in their grade level.

For this study, the boundary of the network was set to the grade level. This was done for two reasons: 1) Valente (2013), using data similar to the one used in this study, showed that there was no difference in the magnitude of associations when the boundary was set as either the classroom or the grade); 2) setting the boundary to the grade provides the opportunity to capture a wider range of interactions that extend beyond the classroom level. The networks generated from these questions were: *Friendship, Admire, Succeed, Romantic, and Popularity* networks.

Network Characteristics

Because this study focuses on the structure and properties of the various networks in which substance users and non-users are embedded, rather than focusing on the individual nodes (ego), the network measures examined are ones that provide a “macro” perspective of the networks. The following network characteristics were estimated:

- i. *Average geodesic distance*: As the data for this study are binary (Student A has a tie to Student B, or not), the average geodesic distance is the sum of the shortest paths between node pairs in the network divided by the number of possible node pairs (Hanneman & Riddle, 2005).

- ii. *Reciprocity*: A measure of the extent to which nominations are reciprocated. The hybrid/dyad estimation method was used (Borgatti et al., 2013). This approach estimates the proportion of node pairs that have a reciprocated tie between them. The data was partitioned by substance use to estimate the degree of reciprocity within and between users and non-users.
- iii. *Transitivity*: The proportion of transitive triads in a network. Transitivity of a relation means that when there's a tie from i to j, and also from j to h, then there's also a tie from i to h (in other words, friends of my friends are my friends) (Hanneman & Riddle, 2005).
- iv. *Clustering*: This measure further explains the effect of geodesic distance by estimating the extent to which nodes in the networks cluster (Hanneman & Riddle, 2005). The weighted overall clustering coefficient is estimated (Borgatti et al., 2013). This measure estimates the mean of the clustering coefficient of all the actors, each one weighted by its degree.
- v. *E-I Index*: Developed by Krackhardt and Stren (1988), the E-I (external-internal) index estimates the difference in the number of ties within a group and outside the group as a proportion of the total number of ties. The resulting index ranges from -1 (all ties internal to the group) to +1 (all ties external to the group) (Hanneman & Riddle). This is a form of homophily measure.
- vi. *Degree centrality*: This refers to the number of ties a node has to other nodes. This indicator is calculated using indegree centrality (the number of directional links to an ego (student) from other actors (other students) (Valente, 2010).

- vii. *Indegree centralization*: This is the degree to which a network's ties are focused on one or a few people. This indicator is calculated using a formula proposed by (Valente, 2010). Indegree centralization is measured by calculating the standard deviation of the centrality score (Hanneman & Riddle, 2005).
- viii. *Density*: Number of direct ties among other students to whom a student is connected, as a proportion of the possible connections among these other students (Valente, 2010).
- ix. *Integration and radiality*: Proposed by Valente & Foreman (1998), integration and radiality is a measure of closeness or the extent to which nodes are connected and reachable within a network. Integration measures the degree to which an adolescent's incoming nominations integrate him/her into the network, while radiality measures the degree to which an adolescent's outgoing nominations reach out into the network.
- x. *Diameter*: This is a measure of the largest geodesic distance in the (connected) network (Hanneman & Riddle, 2005; Valente, 2010). The diameter of a network tells us how "big" it is. In essence, the measure answers the question, "How many steps are necessary to get from one side of the network to the other?"

Data Analysis

We conducted a descriptive/frequency analysis of students' demographic characteristics for all four schools using SPSS 22. Given the school variances and the contextual and endogenous structural properties inherent to the networks in the different

schools, the overall network characteristics were calculated separately for users and non-users in each of the four schools.

For ease of presentation and discussion of results, we focus on one school (School 4) in order to paint a more complete picture of the characteristics of adolescent users' and non-users' networks across the different network types³. Since all schools were homogenous in terms of ethnic diversity and geographic location, School 4 was chosen primarily because it had the highest overall substance use rate compared to the other three schools. All network analyses were conducted using UCINET 6.5 (Borgatti, Everett, & Freeman, 2002a) and NetDraw (Borgatti et al., 2013).

Results

Overall descriptive characteristics of adolescents in the four schools sampled are reported in Table 4. Slightly more than half of the students in the four schools were females (percent of females ranging from 51-55%). Most (ranging from ~80% to 95% across the four schools) of the students sampled reported qualifying for reduced lunch and identified as Hispanic/Latino (ranging from 46% -59%). Schools 3 and 4 had the highest (38.7% and 38.8% respectively) alcohol use rate while School 1 had the lowest (24.3%) alcohol use rate among the students sampled. For smoking, School 2 had the

³ Although only results for the analyses of the networks of students in School 4 are presented here, network analyses for students in the other three schools were also conducted. The choice of presenting the results for only one school was guided by the desire to help readers grasp the findings, conceptually. Given the variability in findings across schools, readers would run the risk of becoming lost among the 'trees', while losing site of the 'forest'. Results of these analyses are included in the appendix, for reference.

highest (11.9%) smoking rate while School 1 had the lowest (7.1%) smoking rate.

Overall, School 4 had the highest (41.6%) substance use rate while School 1 had the lowest (25.4%) overall substance use rate.

Attributes of Substance Users and Non-Users

Attributes of users and non-users in the schools are listed in Tables 5-8. In all four schools, adolescents who identified as never having smoked or drank alcohol (non-users) had higher academic performance compared to those who reported ever smoking or drinking (users). With the exception of School 4, non-users had a higher proportion of number of rooms per people in the household compared to users. In School 4, both users and non-users reported the same proportion of number of rooms per people in the household (0.87, SD=0.49 and 0.87, SD=0.48 respectively).

Table 4. Sample characteristics of adolescents from the four schools sampled in the study

	School 1 (%) n=376	School 2 (%) n=277	School 3 (%) n=204	School 4 (%) n=254
Age (Mean, SD)	15.6	15.6	15.5	15.6
Gender				
Female	51.1	55.1	51	52
Ethnicity				
Hispanic/Latino	45.5	53.1	57.4	59.4
Academic Achievement				
Mostly A's	12.3	17.0	5.1	7.1
Mostly A's and B's	24.6	23.6	21.5	25.0
Mostly B's	3.0	5.8	4.1	5.8
Mostly B's and C's	25.5	23.2	30.3	29.6
Mostly C's	8.7	6.2	10.8	5.8
Mostly C's and D's	15.0	13.9	17.9	15.4
Mostly D's	1.2	.4	1.5	.4
Mostly D's and F's	6.6	6.2	7.7	9.2
Mostly F's	2.4	3.9	1.0	1.7
Socioeconomic status				
Qualify for reduced lunch	79.7	93.4	95.4	88.0
No of rooms /people in the household	1.1	.82	.83	.85
Have parents who smoke				
Yes	24.9	28.8	35.4	26.1
No	75.1	71.2	64.6	73.9
Have parents who drink alcohol				
Yes	45.9	49	59.5	57.1
No	54.1	51	40.5	42.9
Have siblings who smoke				
Yes	15.1	14.5	19.6	18.3
No	84.9	85.5	80.4	81.7
Have siblings who drink alcohol				
Yes	67.1	36	36.4	36.2
No	32.9	64	63.6	63.8
Substance use (Users/Non-users)				
Overall substance users*	25.4	37.1	39.7	41.6
Smoking	7.1	11.9	8.3	9
Alcohol	24.3	35.6	38.7	38.8

*Values for smoking and alcohol don't add up to the overall substance users.

When asked with which groups of students users and non-users identified, both groups across all schools consistently identified themselves mostly as “regular kids. In School 1 next to identifying as being regular kids, a larger percent (36.2%) of users in the school identified as being athletes and then as popular kids (25.5%) and “stoners/druggies” (24.5). In this school, the group users least identified with was “smart kids.” In school 2, a larger percent (31.3%) of the users in our sample identified as being athletes as 26.3% identified as being popular kids and 23.2% identified as being “stoners/druggies.” In school 3 the trends observed were similar to those among users in School 1. Next to identifying as regular kids, the largest group users identified with were athletes (30.9%), and then as stoners/druggies (22.2%). In school 4, next to identifying as regular kids, a large percent of users identified as being “stoners/druggies (32.1%), and 27.4% identified as being athletes.

In all four schools, non-users identified more as being athletes and smart kids. In School 3 and 4 non-users identified more as being athletes than as smart kids, while in School 1 and 2, more non-users identified as being smart kids than athletes. With the exception of School 3, the group non-users least identified with was “stoners/druggies.” In School 3, the group non-users least identified with was “gangsters/cholos” (7.5%). “Stoners/druggies” was the second least group non-users identified with (9.2%).

Familial characteristics of users and non-users were also very different for both groups. In all four schools, parent and sibling substance use reports were higher for substance using adolescents than their non-using counterparts (Table 5-8).

Table 5. Descriptive characteristics of substance-using and non-substance using adolescents in School 1

	Users % (n=92)	Non-Users % (n=284)
Gender		
Male	42	50.7
Age (Mean, SD)		
	15.7 (0.75)	15.6 (0.57)
Ethnicity		
Hispanic/Latino	39.6	47.2
Qualifying for Free/Reduced Lunch		
Yes	79.2	71.9
No	13.5	23.4
No of rooms/people in the household (Mean, SD)		
	0.962 (0.587)	1.17 (0.807)
Academic Performance		
Mostly A's and B's	17.7	44.3
Mostly B's and C's	27.1	28.1
Mostly C's and D's	33.3	18.3
Mostly D's and F's	16.7	7.2
Wasn't in school last year	1	-
Group(s) identified with*		
Regular kids	59.6	63.2
Athletes	36.2	34.1
Popular kids	25.5	18.4
Stoners/Druggies	24.5	8.5
Gangsters/Cholos†	22.3	9.4
Smart Kids	13.8	34.5
Familial characteristics		
Either/both parents smoke	34	19.2
Sibling smokes	20.2	11.6
Either/both parents drink	65.9	37.3
Sibling drinks	49	25.1

*Students were allowed to select more than one group. Report shows the groups with the highest frequencies among substance using and non-substance using adolescents in this school

† Cholo is a term for Mexican/Latino gangster

Table 6. Descriptive characteristics of substance-using and non-substance using adolescents in School 2

	Users (n=99)	Non-Users (n=166)
Gender (%)		
Male	45.5	44
Age (Mean, SD)		
	15.6 (0.618)	15.5 (0.554)
Ethnicity (%)		
Hispanic/Latino	52	60.8
Qualifying for Free/Reduced Lunch (%)		
Yes	85.7	91.6
No	8.2	4.8
No of rooms per people in the household (Mean, SD)		
	0.77 (0.45)	0.87 (0.59)
Academic Performance		
Mostly A's and B's	21.4	50.6
Mostly B's and C's	32.7	22.9
Mostly C's and D's	25.5	15.7
Mostly D's and F's	16.3	6
Group(s) identified with (%)*		
Regular kids	51.5	66.9
Athletes	31.3	28.3
Popular kids	26.3	13.3
Stoners/Druggies	23.2	3.0
Smart Kids	20.2	36.1
Gangsters/Cholos [†]	16.2	4.8
Skaters/Bladers	15.2	8.4
Gamers	13.1	19.3
Familial Characteristics		
Either/both parents smoke	34.4	24.7
Sibling smokes	25.2	7.2
Either/both parents drink	55.6	40.9
Sibling drinks	51.5	23.5

*Students were allowed to select more than one group. Report shows the groups with the highest frequencies among substance using and non-substance using adolescents in this school

[†] Cholo is a term for Mexican/Latino gangster

Table 7. Descriptive characteristics of substance-using and non-substance using adolescents in School 3

	Users (n=81)	Non-Users (n=120)
Gender (%)		
Male	46.9	49.2
Age (Mean, SD)		
	15.6 (0.544)	15.5 (0.58)
Ethnicity (%)		
Hispanic/Latino	58	58.3
Qualifying for Free/Reduced Lunch (%)		
Yes	91.4	90.8
No	4.9	4.2
No of rooms per people in the household (Mean, SD)		
	0.746 (0.37)	0.837 (0.52)
Academic Performance		
Mostly A's and B's	13.6	32.5
Mostly B's and C's	32.1	34.2
Mostly C's and D's	37	21.7
Mostly D's and F's	13.6	7.5
Group(s) identified with (%)*		
Regular kids	54.3	50
Athletes	30.9	39.2
Stoners/Druggies	22.2	9.2
Popular kids	21	12.5
Smart Kids	21	25.8
Skaters/Bladers	14.8	10
Gamers	12.3	17.5
Gangsters/Cholos [†]	11.1	7.5
Familial Characteristics		
Either/both parents smoke	40.7	31.6
Sibling smokes	25.9	15
Either/both parents drink	74.1	49.2
Sibling drinks	44.5	30

*Students were allowed to select more than one group. Report shows the groups with the highest frequencies among substance using and non-substance using adolescent groups in this school

† Cholo is a term for Mexican/Latino gangster

Table 8. Descriptive characteristics of substance-using and non-substance using adolescents in School 4

	Users (n=106)	Non-Users (n=120)
Gender (%)		
Male	46.2	48.6
Age (Mean, SD)		
	15.58 (0.552)	15.64 (0.525)
Ethnicity (%)		
Hispanic/Latino	73.6	69
Qualifying for Free/Reduced Lunch (%)		
Yes	77.4	85.2
No	16	7.7
No of rooms per people in the household (Mean, SD)		
	0.87 (0.49)	0.87 (0.48)
Academic Performance		
Mostly A's and B's	23.6	36.6
Mostly B's and C's	28.3	39.4
Mostly C's and D's	26.4	16.1
Mostly D's and F's	17	6.6
Group(s) identified with (%)*		
Regular kids	59.4	60.6
Stoners/Druggies	32.1	5.6
Athletes	27.4	31
Popular kids	24.5	17.6
Gangsters/Cholos [†]	17.9	8.5
Smart Kids	17	20.4
Skaters/Bladers	14.2	7.0
Gamers	5.7	11.3
Familial Characteristics		
Either/both parents smoke	29.2	22.5
Sibling smokes	22.6	14.1
Either/both parents drink	69.8	45.8
Sibling drinks	43.4	29.6

*Students were allowed to select more than one group. Report shows the groups with the highest frequencies among substance using and non-substance using adolescent groups in this school

[†] Cholo is a term for Mexican/Latino gangster

Network Characteristics

Tables 9-12 display the results from the network measures estimated for users, non-users, and the school overall, for each network type examined in School 4.

Average geodesic distance (shortest path between nodes in the network)

As shown in Table 3, with the exception of Romantic network, substance users had the lowest geodesic distance (or shortest path between nodes) for all network types. In the Friendship network users had a geodesic distance of 6.72 (SD=3.8) compared to non-users 7.9 (SD=4.6); in the Admiration network, users had a geodesic of 1.42 (SD=0.67), non-users had a geodesic of 2.37 (SD=1.1); in the Succeed network users had a geodesic distance of 1.5 (SD=0.64), non-users had a geodesic distance of 3.823 (SD=1.87); and in the Popularity network, users had a geodesic distance of 1.47 (0.769), and non-users had a geodesic distance of 2.29 (1.261)). In the Romantic network, users had the highest geodesic distance 1.517 (SD=0.764) compared to non-users 1.382 (SD=0.571).

Reciprocity (reciprocated nominations)

The proportion of reciprocity among users and non-users varied across the different network types. Compared to other network types, more friendship ties were reciprocated than ties in the other networks, with users having the highest proportion (36%) of ties reciprocated. Non-users had 28% of their ties reciprocated while the overall reciprocation rate in the school Friendship network was 30%. In the Admiration and Succeed networks, users had a higher proportion of reciprocated ties (6% and 8% respectively) compared to non-users (4% and 3% respectively). In the Romantic

network, there was a higher reciprocity among non-users (7%) than users (3%). In the Popularity network, there were no reciprocated ties among users but 3% of ties among non-users were reciprocated; overall reciprocity rate for the popularity network type was 2%.

Transitivity (friends of my friends are my friends)

Substance users' Friendship networks had higher levels of transitivity or transitive triads (0.25) compared to non-users' Friendship networks (0.124). There were no transitive ties among users and non-users in the romantic network. In the Admiration and Popularity networks, non-users had higher levels of transitivity (0.098 and 0.117 respectively) compared to users with a transitivity index of 0.063 both in the Admiration and Popularity networks (same value for both network types).

Clustering coefficient (extent to which network is clustered)

In the Friendship network, there were more clusters among substance users (clustering coefficient=0.17) than non-users (clustering coefficient=0.079). There were no clusters in the Romantic network while the network of "students likely to succeed" had a similar amount of clustering among users (0.053) and non-users (0.056). In the Popularity network, there were more clusters among non-users (clustering coefficient=0.05) than among users (clustering coefficient=0.024).

E-I Index (measure of proportion of ties internal and external to the network)

Table 12 shows results of the E-I Index analysis. In the Friendship network, both substance users and non-users showed a tendency towards developing ties internal to their group (i.e. users nominate other users as friends [E-I Index=-0.367, $p < 0.05$] and

non-users nominating other non-users as friends [E-I Index=-0.139, $p<0.05$]). However, in the other network types, users demonstrated a tendency towards forming ties with non-users as they had a positive E-I score (indicating their ties are external to the group).

Degree centrality and indegree centralization

In the Friendship network, non-users had a higher indegree centrality—higher number of incoming nominations from other actors—score 1.253 (SD=1.201) while users had a score of 1.174 (SD=0.991). Non-users also had higher centralization (3.954%) compared to users (2.64%) indicating that the network of non-users was more centralized around one or a few adolescents. This same trend, non-users having a higher centrality and a more centralized network, was observed in the Admiration, Succeed, and Popularity networks in our sample. However, in the Romantic network, users had a higher centrality and centralization score (0.303, and 3.364% respectively) compared to non-users (centrality=0.187, centralization=1.516).

Density

Overall, all five network types at the grade level were very sparse in this School. The users' and non-users' friendship network densities were 0.012 and 0.013 respectively. In the Admiration, "Likely to Succeed," and Popularity networks, networks of non-users were slightly denser than the networks of users. In the Romantic network, however, network of users and non-users had similar densities (0.003 and 0.002 respectively).

Integration and radiality (measure of connectedness and reachability)

Integration and radiality scores across the different network types were the same for both users and non-users (but with differing deviations) in this school. With the exception of the Romantic network, non-users had a higher average integration and radiality scores across the different network types indicating that non-using adolescents in our sample were more connected to others in their (non-using) network. In the Romantic network, users had a higher integration (0.428, SD=1.089) and radiality (0.428, SD=0.958) compared to non-users with an integration score of 0.247 (SD=0.525) and a radiality score of 0.247 (SD=0.599).

Diameter

Across the different networks, but again with the exception of the Romantic network, non-users' networks had a larger number of steps required to get from one side of the network to another—in other words, a wider diameter. For the Romantic network, the users' network had a slightly larger diameter (4) which was only one unit more than that of the Romantic network of non-users (3). For non-users, their Friendship network had the overall highest diameter (25) while their Romantic network had the lowest diameter. For users, their Friendship network also had the highest diameter (21) while the lowest was for their Succeed network (3). See Table 3 for details.

Table 9. Results of network analysis of users and non-users in School 4 Friendship and Admiration networks

	Friendship Network			Admiration Network		
	Users	Non-Users	Overall	Users	Non-Users	Overall
Indegree Centrality (Mean, SD)	1.174 (0.991)*	1.253 (1.201)*	0.943 (0.687)*	0.4 (0.685)*	1.246 (1.422)*	0.213 (0.297)*
Centralization (Indegree) (%)	2.64	3.954	2.703	2.721	6.289	1.976
Density	0.012	0.013	0.009	0.004	0.012	0.004
Average degree	1.855	1.453	2.594	0.388	1.333	1.159
Integration (Mean, SD)	3.628 (4.005)*	4.095 (4.681)*	9.387 (4.461)*	0.537 (0.982)*	3.682 (6.618)*	3.232 (6.61)*
Radiality (Mean, SD)	3.628 (2.988)*	4.095 (3.583)*	9.387 (3.598)*	0.537 (1.076)*	3.682 (4.125)*	3.232 (4.793)*
Connectedness	0.237	0.226	0.731	0.006	0.048	0.043
Diameter	21	25	20	4	6	18
No. of components	77	68	67	96	99	250
Geodesic distance (Mean, SD)	6.72 (3.8)	7.9 (4.6)	8.16 (3.3)	1.421 (0.674)	2.375 (1.101)	5.56 (3.29)
Weighted overall clustering coefficient	0.17	0.079	0.127	0.038	0.066	0.059
Reciprocity	0.3594	0.2782	0.2995	0.056	0.0435	0.0458
Transitivity	0.25	0.124	0.193	0.063	0.098	0.092

* Indicates measures for which normalized results were available and are reported

Table 10. Results of network analysis of users and non-users in School 4 Succeed and Romantic networks

	Succeed Network			Romantic Network		
	Users	Non-Users	Overall	Users	Non-Users	Overall
Indegree Centrality (Mean, SD)	0.344 (0.646)*	0.828 (1.213)	0.555 (0.788)*	0.303 (0.661)*	0.187 (0.387)*	0.104 (0.182)*
Centralization (Indegree) (%)	2.405	6.553	4.553	3.364	1.516	0.99
Density	0.003	0.008	0.006	0.003	0.002	0.002
Average degree	0.378	1.466	1.525	0.333	0.331	0.569
Integration (Mean, SD)	0.497 (0.940)*	6.808 (13.846)*	5.065 (10.608)*	0.428 (1.089)*	0.247 (0.525)*	0.388 (0.971)*
Radiality (Mean, SD)	0.497 (1.147)*	6.808 (6.347)*	5.065 (5.470)	0.428 (0.958)*	0.247 (0.599)*	0.388 (0.875)*
Connectedness	0.006	0.087	0.069	0.005	0.003	0.005
Diameter	3	13	11	4	3	7
No. of components	108	158	246	110	174	271
Geodesic distance (Mean, SD)	1.507 (0.644)	3.823 (1.878)	3.953 (1.837)	1.517 (0.764)	1.382 (0.571)	2.02 (1.24)
Weighted overall clustering coefficient	0.053	0.056	0.054	0	0	0
Reciprocity	0.076	0.0316	0.0369	0.0278	0.0727	0.0327
Transitivity	0.107	0.078	0.079	0	0	0

* Indicates measures for which normalized results are reported

Table 11. Results of network analysis of users and non-users in School 4 Popularity networks

*Indicates measures for which normalized scores were reported

	Popularity Network		
	Users	Non-Users	Overall
Indegree Centrality (Mean, SD)	0.385 (0.748)*	0.495 (0.967)	0.378 (0.669)
Centralization (Indegree) (%)	4.198	6.32	4.365
Density	0.004	0.005	0.004
Average degree	0.423	0.876	1.04
Integration (Mean, SD)	0.506 (1.083)*	1.196 (2.903)*	1.5 (3.827)*
Radiality (Mean, SD)	0.506 (1.042)*	1.196 (1.97)*	1.5 (2.378)*
Connectedness	0.006	0.015	0.02
Diameter	4	7	10
No. of components	111	174	270
Geodesic distance (Mean, SD)	1.471 (0.769)	2.29 (1.261)	3.439 (1.976)
Weighted overall clustering coefficient	0.024	0.05	0.048
Reciprocity	0	0.0263	0.0214
Transitivity	0.063	0.117	0.104

Table 12. E-I Index estimates showing number of ties within and between networks of users and non-users in School 4 across the different network types examined

	Friendship Network		Admiration Network		Succeed Network		Romantic Network		Popularity Network	
	Non-Users (ties)	Users (ties)	Non-Users (ties)	Users (ties)	Non-Users (ties)	Users (ties)	Non-Users (ties)	Users (ties)	Non-Users (ties)	Users (ties)
E-I Index	-0.139	0.367	-0.483	0.213	-0.614	0.308	-0.25	0.031	-0.543	0.071
Non-Users (ties)	266	201	318	111	506	121	110	66	304	90
Users (ties)	201	434	111	72	121	64	66	62	90	78

Discussion

In this study, we set out to examine the attributes and network characteristics of a sample of 10th grade substance users and non-users. Very few studies have examined descriptively the attributes of adolescents in these two groups alongside the characteristics of their networks. This study examined the macro properties of the adolescent networks in one of the four schools sampled in order to identify the differences and commonalities among a sample of 10th grade users and non-users.

Given that the population of students sampled was homogenous in terms of its ethnicity (predominantly Hispanic/Latino), most of the results discussed here should be viewed with this in mind. Research evidence suggests that adolescents from different ethnic backgrounds are differentially vulnerable for use, intensity, and abuse of substances based upon varying exposures to risk factors (Griesler & Kandel, 1998; Maddahian, Newcomb, & Bentler, 1988). For example, Chen & Jacobson (2012) in their longitudinal study on developmental trajectories of substance use among US adolescents found that Hispanic adolescents had the highest levels of substance use during early adolescence compared to non-Hispanic Caucasians and African American adolescents.

Although all the students in our sample were 10th graders and within the same age range, the study showed that across three of the four schools sampled substance users had a slightly higher mean age compared to non-users. This finding further supports literature which links older age with stronger tendency to engage in risky behaviors (Jenkins et al., 2011).

Findings from this study showed that the family unit, namely parents and siblings, plays an important role in adolescents' substance use patterns. Substance-using adolescents in all four schools reported having parents and siblings who use alcohol and tobacco, more often than their non-using counterparts. This result is consistent with studies (Duncan, Duncan, & Hops, 1996a; Kothari et al., 2014) indicating that, when viewed in the context of child development, familial characteristics are an important source of influence especially during adolescence.

Bandura's (1986) Social Cognitive Theory (SCT) also provides an explanation for how adolescents' parents and siblings could serve as substance-use role models, affecting adolescents' substance use behaviors. SCT asserts that exposure to role models (such as parents and siblings) will shape adolescents' outcome expectations—their beliefs about the social, physical, or psychological consequences of substance use. For example, adolescents who observe their parents use alcohol to relax or siblings using smoking to facilitate social interactions, might also develop positive attitudes towards these substances and, hence, are more likely to engage in substance use themselves (Petraitis, Flay, & Miller, 1995).

Additionally, from a child development perspective, the influence of parents and siblings is shown to vary in strength depending upon a child's life-course stage (Duncan and Hops, 1996). Duncan and Hops (1996) posited that although peer influence is important, equally important is the influence of parental use of substances as parental substance use has been found to encourage initiation while sibling substance use might reinforce or amplify the behavior (Kothari et al., 2014; Van Der Vorst et al., 2005). In

essence, even though the period of adolescence is marked with increased susceptibility to peer influence, parental and sibling behaviors are also important at this stage and should not be underestimated as they (parents and siblings) can also be targeted for intervention purposes.

Regarding the group(s) with whom users and non-users identified, contrary to expectations, both users and non-users in our sample identified themselves as “regular kids” more often than any other identity group (some of the other groups they could have identified with are Artistic kids (artists, actors), Athletes, Ballers, Gamers, Gangsters/Cholos, Geeks, Goths, Hipsters, Jocks, LGBT (Lesbian/gay/bisexual/transgender) students, Musicians, Nerds, Paisas, Popular kids, Punks, Regular kids, Rockers, Skaters, Bladders, Smart kids, Stoners/ Druggies). Alongside identifying themselves as “regular kids”, many users also identified themselves as being athletes and/or “stoners/druggies.” Non-users, on the other hand, identified themselves as “smart kids”, but more so as athletes than as smart kids (i.e., the number of students that identified as athletes was larger than those that identified as smart kids).

How these students (users and non-users) identify themselves has several implications. First, as documented in the literature, sports are one of the extracurricular activities in which adolescents spend most of their time (Hansen, Larson, & Dworkin, 2003). Eder & Kinney (1995) found that for adolescents in their study, participating in athletic activities was deemed more important than academics, because sport participation provided an opportunity to gain access to the “elite” (the leading

crowd/well-known) peers. In essence, for both users and non-users, activities such as sports are considered an important social status determinant.

Consequently, athletic activities could be a meeting and mixing avenue for substance users and non-users and this might be a possible avenue where non-users might have the opportunity to be influenced by their peers to initiate substance use in order to “belong.” This hypothesis is supported by studies which have shown that sports participation, particularly in-school sports participation, increases the risk of substance use among adolescents (Moore, & Werch, 2005). This finding has important implications for health promotion practice: programs looking for possible intervention strategies might consider using sports clubs/groups as an avenue for intervention programs targeting both current substance users and non-users who might be on the verge of being initiated into substance use by peers.

Comparing the different types of networks in which users and non-users are embedded revealed a number of interesting findings. One of the most salient is that while Friendship networks are a good indicator of adolescents’ social network and a potent source of influence, Romantic networks (aspired romantic interests in the case of this study) is also a critical network in terms of influencing how peer interactions facilitate or constrain behavior. While for Friendship, Admiration, “Likely to Succeed,” and Popularity networks similar trends were observed for most of the network indicators for users and non-users, the trends were not the same for the groups in the Romantic network.

In the romantic network, for example, there were no transitive ties in the network. This lack of transitive ties is somewhat expected as transitivity in a Romantic network could be equated to a “lovers’ triangle.” Also, unlike in the other network types where non-users were more integrated, in the Romantic network, it was the users who were more integrated. A possible explanation for this high integration observed for users and lower integration observed for non-users might be that some non-using adolescents aspire to be romantically involved with users, while users only aspired to be romantically involved with other users. The implication this explanation has for further research is that romantic aspirations/relations could serve as bridge between users and non-users, hence, researchers need to pay attention to how romantic associations (and not just friendship associations) might be a conduit for influence transmission.

Another reason why researchers need to pay attention to romantic ties is that even though other network types may impact substance use initiation, romantic relations/aspirations are different and might have a stronger impact on adolescents’ substance use initiation due to the intensity of the relationship and the desire to please or be acceptable to the other person (Booth, Booth, Marsiglia, & Nuno-Gutiérrez, 2014; Collins, 2003).

Another salient finding from this study regards network homophily. Most of the indicators estimating similarities of members of a network showed that across all five network types, the networks of users and non-users are very homophilous with regards to behaviors, i.e. there is a preponderance of ties within members of the same group (users or non-users) than there are ties to others outside the group. The implication of

this finding is that in a homophilous user network there is increased accessibility to substances such as alcohol or tobacco, as well as increased opportunities for reinforcement of the usage behaviors.

While there was a large difference between the number of ties within the group and the number ties sent outside the group for all the other network types, romantic networks had a smaller ratio of -ties-within-the-group to ties-outside-the-group. And this, again, reinforces the importance of romantic relationships for adolescent substance use as these romantic relationships or aspirations for romantic connections can serve as a link between users and non-users.

This finding regarding the number of ties internal and external to the network of users and non-users might indicate that for adolescents in this study's sample, using substances or not was a characteristic that might have influenced who an adolescent associated with. This explanation is supported by researchers who have shown social *selection* process (i.e. adolescents selecting to associate with others with similar substance use behaviors) to be a key contributor to peer group homogeneity (Engels, Knibbe, Drop, & de Haan, 1997; Ennett & Bauman, 1994).

Findings from this study suggest a couple of specific recommendations for future research. First, research endeavors employing social network analysis need examine network types *other than* friendship networks as these different network types are possible conduits through which adolescents could be influenced by peers. Particularly, there is a need for studies exploring the dynamic of romantic associations, as findings from this study showed the romantic network to be a possible bridge between substance

users and non-users. Second, future research on adolescent substance use should examine the determinants underlying homophily within the two groups (users and non-users), qualitatively. Employing a qualitative approach to explore how and why substance using and non-using adolescents choose whom they relate with will enhance the understanding of the basic processes involved in *selection* and homophily.

While this study's findings contribute to a better understanding of how different types of networks entail (and consist of) different salient determinants of substance use/non-use, they carry their own limitations. The most important limitation is that this study employed a bounded ego network approach (i.e. there was a limit on the number of nominations each ego was allowed to make). This approach prevents seeing the complete structure of the complete networks of substance users and non-users. Hence, the results presented in this study might not be a complete representation of the networks of adolescent substance users and non-users in this school.

Additionally, other than the friendship networks, all other networks (admiration, succeed, romantic, and popularity) are networks based on aspirations (perceived), so results reported should be tempered by the notion that no actual exchanges are occurring in these networks; they merely reflect study participants' desires and aspirations (even though research suggests that admiration can be a mechanism for imitation or modeling, especially by adolescents (Bahr, Hoffmann, & Yang, 2005)).

Yet despite its limitations, this study further reinforces the notion that adolescents have, and rely on, different types of associations/relationships and the contexts of these are important determinants of the mechanisms through which

adolescent networks influence behavior. Furthermore, this study also shows that a potential intervention target for substance use prevention programs is adolescent sports clubs as both users and non-users in the school we sampled, actively identify as being athletes. Another contribution this study makes to the prevailing body of literature is reinforcing the notion that, alongside peer influences, those of parents and siblings do matter. While several studies have established that peers are the most important influencers of adolescent ATOD use, the importance of parents' and siblings' behaviors should not be easily dismissed.

CHAPTER IV
EXAMINING THE INFLUENCE OF DIFFERENT NETWORK TYPES AND
GENDER COMPOSITION ON ADOLESCENT ATOD USE

Introduction

Adolescent boys and girls differ in many ways such as in their relationship forming patterns or the extent to which they are influenced by peer interactions (Flannery, Vazsonyi, Torquati, & Fridrich, 1994; Leaper, Tenenbaum, & Shaffer, 1999; Rose & Rudolph, 2006). Research scholars have documented how these differences influence susceptibility to, degree, and rate of substance use. For example, in a study by Flannery, Vazsonyi, Torquati, & Fridrich, (1994), more boys than girls reported heavy drinking and drug use while more girls than boys reported smoking; but boys were more likely to report heavy smoking (Flannery et al., 1994; Rose & Rudolph, 2006; Wallace et al., 2003).

Adolescence, Adolescent Networks, and Substance Use

Described as a time of self-development, self-awareness, and increased interest in exploring new behaviors, adolescence is a complex and crucial developmental period (Labouvie & White, 2002; Osilla et al., 2014). During this stage, adolescents attempt to develop new identities and parental influence gradually diminishes (B. G. Simons-Morton & Farhat, 2010). Alongside parental influence, peer associations are considered very important and thus a stronger proximal predictor of adolescent substance use, according to the extant literature (Bauman & Ennett, 1996; Bettes, Dusenbury, Kerner, James-Ortiz, & Botvin, 1990; Ennett & Bauman, 2000).

Adolescents are embedded in different networks of peers, and for different purposes. Some of these networks are friendship networks, others are networks based on attributes such as popularity, academic achievement, aspirations to be like others, or admiration for certain peers (Bearman et al., 2004; Valente et al., 2013).

These different types of networks may provide access to modeled behaviors and substances, as well as constrain, or reinforce substance use behavior. For example, Poelen, Engels, Van Der Vorst, Scholte, & Vermulst, (2007) found that while friends are influential, their influence may not be as strong as that of a romantic partner. Urberg et al. (2003) also showed in their study on individual and relationship-specific differences in peer influence that the dynamic and quality of a peer relationship (e.g. an admired friend vs a casual friend) is of particular importance when assessing how adolescent networks influence individual behavior. Thus, there is a need to explore these different adolescent network types and how they might influence behavior transmission among adolescents (Coleman et al., 1966; Cruz et al., 2012; Hoffman et al., 2007; Trucco et al., 2011; Valente et al., 2013).

It has been well established in the literature that an adolescent's behavior is associated with the behavior of others within his/her network (Balsa, Homer, French, & Norton, 2011; Bauman, Faris, Ennett, Hussong, & Foshee, 2007). This idea that an adolescent's behavior is associated with that of his/her peers is grounded in different theoretical principles. One of these is the principle of *homophily* (McPherson, Smith-Lovin, Cook, 2001). The homophily principle posits that people with similar characteristics such as age, gender, race, attitudes or behaviors will interact with those

similar to themselves more often than with those who are dissimilar (McPherson et al., 2001).

However, there are also two main schools of thought explaining how homophily manifests itself among people, or among adolescents, in our case. One school of thought proposes that homophily in substance use behavior is due to *socialization* while another claims it (homophily in substance use behavior) is due to *selection* (Fisher & Bauman, 1998). Selection refers to the process by which adolescents seek out friends based on their similarity on substance use, while socialization occurs when adolescents modify their behavior to conform to that of their existing friends (B. Simons-Morton, 2007). Whether the process of homophily in substance use behavior among adolescents is a product of adolescents choosing friends with similar substance use behavior or adjusting their behavior to match that of their friends, studies have shown both processes contribute to homophily in substance use behavior among adolescents (Mercken, Steglich, Sinclair, Holliday, & Moore, 2012; Hall & Valente, 2007).

Gendered Patterns in Network Influence

Although adolescents are influenced by the attitudes, beliefs, and behaviors of other adolescents in their network, there is evidence that this influence and the strength of its effect might vary with the gender of the adolescent and gender composition of his/her networks (Hsieh & Hollister, 2004; Leaper et al., 1999; Rose & Rudolph, 2006). Evidence supports the notion that there are gendered patterns in how influence is transmitted in a same-sex network/friendship versus in a mixed-sex network /friendship. Gaughan (2006) showed that adolescents within a same-sex friendship/network will

experience a mutual influence pattern, whereas those in mixed-sex friendships/networks will experience a disproportionate amount of influence depending upon several factors such as friendship context and the predominant gender in the friendship/network.

Substance Use Among Adolescents

The National Institute on Drug Abuse (NIDA) conducts a yearly survey of adolescents in 8th, 10th, and 12th grades – the *Monitoring the Future* (MTF) study. Findings from the survey reveal that by 10th grade, 54% reported having initiated alcohol and 34% reported initiating marijuana use (Johnston et al., 2013; Johnston, O'malley, Bachman, & Schulenberg, 2014). Strikingly, the survey also showed an increase in the number of adolescents who do not perceive regular use of marijuana to be harmful (Johnston et al., 2014).

Not all adolescent substance use is considered misuse (Newcomb & Bentler, 1989). Nevertheless, studies have shown that early initiation of substance use can lead to habituation of the behavior which, in turn, can cause negative substance-related health issues and social effects in adulthood (Schulenberg, Patrick, Maslowsky, & Maggs, 2014b; B. G. Simons-Morton & Farhat, 2010). Some of these negative health issues and social effects associated with substance use include injuries, homicides, suicides, and substance use disorders in adulthood (Newcomb & Bentler, 1988; Sitnick et al., 2014). According to the *Monitoring the Future Study*, about 73% of adolescents have used alcohol (more than a few sips) by the 8th grade and almost a quarter of American adolescents currently smoke (Johnston et al., 2014). Additionally, a 2012 report from the office of the Surgeon General showed that about 5,000 people under age 21 die from

alcohol-related injuries. Thirty-eight percent of these 5,000 deaths involve motor vehicle crashes, 32% result from homicides, and 6% from suicides ((Centers for Disease Control and Prevention (CDC) National Center for Injury Prevention and Control (NCIPC), 2012; Hingson & Kenkel, 2004). With increased access to marijuana via its legalization in different states in the US, the early initiation of alcohol and tobacco use among adolescents poses a significant concern for public health (Joffe & Yancy, 2004; Johnston et al., 2014).

In sum, although shown to be important, it remains unclear how the gender of the person and the gender characteristics of his/her network interact to facilitate or constrain adolescent alcohol and tobacco use (Brady & Randall, 1999b; Gaughan, 2006).

Additionally, only a few studies have examined network types (other than friendship networks) in which adolescents are embedded and how these different network types might possibly factor into the dynamic of how social influence is transmitted within social networks (Freeman, 2004; Wasserman, 1994).

To this end, the objective of the present study is to:

1. Examine whether intrapersonal (e.g. age, gender) and interpersonal (e.g. parent and sibling substance use) factors, network measures, and gender composition of the networks of 1,707 tenth grade adolescents in four high schools in Los Angeles, California, are associated with their alcohol and tobacco use, and
2. Assess whether these factors vary across 5 types of networks—*friendship, popularity, romantic, succeed, and admiration* networks.

Methods

Data for this study were collected as part of a pilot for The University of Southern California Social Networks Study. Permission to conduct the study was provided by the district superintendent, principal, and teachers in the schools. Approval to conduct the survey was also obtained from the University of Southern California's Institutional Review Board. Cross-sectional samples of 2,290 tenth grade adolescents from four high schools in a school district in Los Angeles were asked to fill a paper and pencil survey in May 2010: 2,016 students returned their parental consent forms and 1,823 of them agreed to participate in the study. Of these students, 1,707 completed the surveys during a regular school day, an overall participation rate of 74.5%. . One of the schools completed the survey during the History class and the remaining three schools during the English class.

Outcome Variables

Tobacco use was measured with a question that assessed whether the student had ever smoked in the past 30 days. To measure alcohol use, students were asked whether they had ever had at least one drink of alcohol during the past 30 days. Responses to these survey questions measuring alcohol and tobacco use ranged from 1 (never smoked/used alcohol in the past 30 days) to 7 (drank/smoked all 30 days). Responses to these questions were initially coded into seven categories. The distribution was highly skewed with 90.5% and 64.5% reporting never having smoked, or used alcohol, respectively. Therefore, to simplify the variation in responses, responses to the smoking and alcohol use questions were dichotomized into two variables with students

categorized as ever smokers/drinkers or never smokers/drinkers based on their response to the survey questions.

Network Types

Students' social networks were assessed by providing a roster of all 10th graders with a photo of all students and an ID number (created for each student by the researchers) printed on the bottom of the pictures. Students were asked to name 1) their best friends, regardless of where they lived and went to school; 2) the closest friends in their classroom; and 3) the closest friends in their grade. In order to generate network types other than friendship networks, the students were also provided the classroom roster and asked to write the IDs of five students in the class whom they thought: a) were the most admired; b) were the most likely to succeed; c) with whom they would like to have a romantic relationship; and d) whom they thought were the most popular. These questions were asked again, focusing on naming five students in their grade level. The networks elicited by this question will be subsequently referred to — in this text — as “admire/admiration network/network of students who admire one another,” “likely to succeed network,” “romantic network,” and “popularity network.”

For the purpose of this study, the network boundary was set to the grade level for two reasons: 1) a study published from similar data showed there was no difference in the magnitude of associations when the boundary was set as either the classroom or the grade (Valente et al., 2013); and 2) extending the boundary beyond the classroom provides the opportunity to capture a wider range of interactions.

Network Gender Composition

We created a variable labeled network gender composition, by counting the frequency of males and females in a student's outgoing ties (outdegree) for each of the different network types. A computer algorithm implemented in C++ was used in this analysis. If a student nominated more males than females for their admiration network, for example, that student was coded as having a predominantly male admiration network. If the student nominated equal numbers of males and females, the predominant gender for that student's network was coded as "equal/balanced."

Network Measures

For each network type, four network measures were calculated:

- indegree — number of directional links to an ego (student) from other actors (other students, also known as incoming nominations)
- outdegree — number of directional links from an actor to other actors (outgoing nominations)
- density — number of direct ties among other students to whom a student is connected as a proportion of the possible connections among all students.

Density is also considered a measure of connectedness.

These measures were calculated for each node/ego (students) as the study employed an egocentric analytic approach (i.e. ego network measures were calculated). All network analyses were conducted using UCINET 6.5 (Borgatti, Everett, & Freeman, 2002b).

Data Analysis

We ran descriptive/frequency analyses for the demographic variables, and quadratic assignment procedure (QAP) to estimate the overlap among the five different network types (i.e. if the same sets of people were nominated for all the different network types). We also ran several ordered logistic regression models to test the effects of gender composition of the network on “ever smoke” and “ever drink” outcomes, while controlling for covariates.

Given the potential school variances, schools were compared to see if they were statistically similar based on the outcome of interest, “ever drink” or “ever smoke”. Given the significant differences found, schools that were similar (no significant differences in substance use) were grouped into a single category. For alcohol use, this classification resulted in three categories: Category 1 (School 1), Category 2 (Schools 3 and 4), and Category 3 (School 2). For tobacco use, based on their similarity on the “ever smoked” variable, the schools were grouped into two categories: Category 1 (Schools 1, 3, and 4) and Category 2 (School 2). All logistic regression analyses were conducted in SPSS 20.

Results

Table 13 details the demographic characteristics of study participants across the four schools in our sample.

Table 13. Characteristics of students in four schools in the Los Angeles area, participating in the Social Networks Study

	School 1 (%) n=376	School 2 (%) n=276	School 3 (%) n=204	School 4 (%) n=254
Age (Mean, SD)	15.6 (.63)	15.6 (.59)	15.5 (.56)	15.6 (.53)
Gender				
Female	51.1	55.1	51	52
Ethnicity				
Hispanic/Latino	54	53.1	67.2	59.4
Academic Achievement				
Mostly A's	12.3	17.0	5.1	7.1
Mostly A's and B's	24.6	23.6	21.5	25.0
Mostly B's	3.0	5.8	4.1	5.8
Mostly B's and C's	25.5	23.2	30.3	29.6
Mostly C's	8.7	6.2	10.8	5.8
Mostly C's and D's	15.0	13.9	17.9	15.4
Mostly D's	1.2	.4	1.5	.4
Mostly D's and F's	6.6	6.2	7.7	9.2
Mostly F's	2.4	3.9	1.0	1.7
Socioeconomic status				
Qualify for reduced lunch	79.7	93.4	95.4	88.0
# of rooms /people in the household (Mean, SD)	1.1(.74)	.82 (.54)	.83 (.63)	.85 (.47)

Table 13 Continued

	School 1 (%) n=376	School 2 (%) n=276	School 3 (%) n=204	School 4 (%) n=254
Have parents who smoke				
Yes	24.9	28.8	35.4	26.1
No	75.1	71.2	64.6	73.9
Have parents who drink alcohol				
Yes	45.9	49	59.5	57.1
No	54.1	51	40.5	42.9
Have siblings who smoke				
Yes	15.1	14.5	19.6	18.3
No	84.9	85.5	80.4	81.7
Substance use (10 th Grade)				
Smoking	8.1	11.9	8.6	9.4
Alcohol	28.9	35.6	39.5	40.6
Outdegree (Mean, SD)				
Friend	2.42 (1.4)	2.94 (1.42)	2.8 (1.38)	2.65 (1.40)
Admire	1.17 (1.4)	1.38 (1.6)	1.22 (1.48)	1.16 (1.38)
Succeed	1.58 (1.5)	1.75 (1.61)	1.7 (1.63)	1.54 (1.69)
Romantic	0.65 (1.1)	.82 (1.38)	.44 (.90)	.61 (1.11)
Popular	1.02 (1.4)	1.36 (1.63)	1.01 (1.42)	1.09 (1.43)
Indegree (Mean, SD)				
Friend	2.47 (1.9)	2.93 (2.0)	2.73 (2.08)	2.65 (1.97)
Admire	1.34 (2.4)	1.21 (1.68)	1.17 (2.19)	1.13 (1.43)
Succeed	1.83 (3.5)	1.34 (2.24)	1.76 (3.27)	1.57 (1.20)
Romantic	.7 (1.1)	.74 (1.24)	.45 (.98)	.60 (1.02)
Popular	1.2 (2.3)	1.18 (2.25)	.93 (2.71)	1.305 (1.59)
Density (Mean, SD)				
Friend	12.19 (18.9)	16.9 (20.51)	17.66 (21.32)	14.36 (20.23)
Admire	3.18 (9.6)	3.01 (12.9)	4.55 (10.18)	2.77 (6.22)
Succeed	5.3 (13.64)	.5.25 (12.9)	4.15 (9.38)	3.16 (6.86)
Romantic	0.866 (1.082)	0	0	0
Popular	1.8 (6.36)	3.34 (8.31)	1.83 (6.42)	3.88 (11.28)

Study respondents were evenly distributed across gender and were on average 15.6 (SD=0.584) years old. Consistent with the ethnic distribution in the area in which the data were collected, the students in the study were predominantly Hispanic/Latino. Socioeconomic status was represented by whether students qualified for reduced lunch and number of rooms per people in their household. Participants reported on average, 3.9 (SD=1.37) people in the household and 3.1 (SD=1.31) rooms in the home indicating a case of slight overcrowding (Myers, Baer, & Choi, 1996). The schools varied on alcohol use rates in the 10th grade, but overall, 35.5% of the adolescents surveyed reported ever drinking, not including those who drank for religious purposes. Most students (90.5%) reported not having ever smoked. More than a third of the students (35.1%) reported having a sibling who consumed alcohol and 16.6% had siblings who smoked. Parental alcohol and tobacco use varied across the schools (from 45 to 57% and from 24 to 35% respectively), but overall, more than half (52.1%) reported having a parent who drank alcohol and 28.2% reported having a parent who smoked.

Regarding network characteristics, mean outdegree, indegree, and density scores across the different networks are shown in Table 13. There were variations in these scores across the different networks and schools. Overall, the romantic network had the lowest mean outdegree (nominations made) scores, 0.64 (SD=1.16) across all four schools, while the friendship network had the highest mean outdegree score in all four schools, 2.67(SD=1.41). For indegree scores (nominations received), again, the romantic network had the lowest mean indegree scores, 0.64 (SD=1.17) while friendship networks had the highest, 2.67 (SD=2.02). Average density scores also varied across the schools

and the different network types. Following patterns similar to the previously discussed network measures, the romantic network had the lowest density, 0.033 (SD=0.67) while the friendship network had the highest density score, 14.87 (SD=20.17).

Gender composition of the networks is shown in Table 14. With the exception of one school (School 4), students in networks of predominantly female students were more commonplace compared to students in networks of predominantly male or balanced/equal (same number of female and male nominations) networks among the surveyed adolescents. However, in the romantic network of one school (School 4) 68.9% of the students' aspired romantic relations was in balanced/equal networks.

Quadratic assignment procedure correlations were conducted to determine the extent of similarity in nomination patterns (for example, whether a student nominates the same set of people as friends and/or as popular and/or as admired) across the networks. As shown in Tables 15-18, there were some significant associations between some of the networks across the four schools indicating that there was some overlap across the different network types.

Table 14. Network gender characteristics of students in the four schools sampled in the Social network Study

	School 1 (%) n=376	School 2 (%) n=276	School 3 (%) n=204	School 4 (%) n=254
Friendship network				
Predominantly male	34.1	36.5	39.2	33.1
Predominantly female	45.5	49.5	49.0	53.4
Equal	11.4	8.3	7.8	7.2
Admiration network				
Predominantly male	16.4	15.9	17.6	18.3
Predominantly female	31.0	31.8	28.4	27.1
Equal	4.8	5.8	4.4	6.8
Likely to succeed network				
Predominantly male	20.9	20.6	15.7	20.3
Predominantly female	32.3	36.8	33.3	34.7
Equal	8.7	9.7	14.2	5.2
Romantic network				
Predominantly male	13.8	14.1	8.3	13.9
Predominantly female	17.5	19.9	15.2	17.1
Equal	1.3	1.1	.5	68.9
Popularity network				
Predominantly male	16.4	16.2	16.2	18.3
Predominantly female	22.8	27.1	14.7	22.7
Equal	6.6	6.9	9.3	5.6

In all four schools, the strongest QAP correlations (highest overlap) were between admire and succeed networks. In essence, many of the students nominated as being admired were also nominated as being likely to succeed. In school 1, the lowest amount of overlap was observed between the romantic and popular network (Table 15). In school 2, the lowest overlap (weakest correlations) was between friendship and romantic network and friend and succeed network (Table 16). In schools 3 and 4, the weakest correlation was between friendship and romantic network (Tables 17-18).

Table 15. Quadratic assignment procedure correlations between the different network types examined in the Social Network Study for School 1

	Friend	Popular	Romantic	Succeed
Popular	0.228*			
Romantic	-0.001	-0.003		
Succeed	0.002	0.001	0.105	
Admire	0.002	-0.002	0.137*	0.388*

Significant at $p < 0.01$

Table 16. Quadratic assignment procedure correlations between the different network types examined in the Social Network Study for School 2

	Friend	Popular	Romantic	Succeed
Popular	0.002			
Romantic	-0.002	0.135*		
Succeed	-0.002	0.301*	0.12*	
Admire	0.002	0.416*	0.134*	0.404*

Significant at $p < 0.01$

Table 17. Quadratic assignment procedure correlations between the different network types examined in the Social Network Study for School 3

	Friend	Popular	Romantic	Succeed
Popular	0.002			
Romantic	-0.005	0.115*		
Succeed	-0.002	0.182*	0.109*	
Admire	-0.003	0.294*	0.115*	0.368*

Significant at $p < 0.01$

Table 18. Quadratic assignment procedure correlations between the different network types examined in the Social Network Study for School 4

	Friend	Popular	Romantic	Succeed
Popular	0.159*			
Romantic	0.062*	0.086*		
Succeed	0.222*	0.164*	0.086*	
Admire	0.226*	0.288*	0.067*	0.355*

Significant at $p < 0.01$

To examine whether intra- and interpersonal factors and network determinants implicated in alcohol and tobacco use vary by type of network and gender composition

of the network, ordered logistic regression models were run. The results of these analyses are described below, sectioned into the two outcomes of interest (alcohol use and tobacco use). Under each section, we then describe the results based on 1) network type and 2) gender composition of the networks.

Alcohol Use

For the models with drinking as the outcome of interest, covariates typically associated with drinking—demographic characteristics, intrapersonal (e.g. age, gender), and interpersonal factors (e.g. parent and sibling alcohol and tobacco use)—were included, alongside network measures such as indegree, outdegree, density, and network gender composition. Table 4 lists all the variables included in the models.

School category 1 (School 1)

Network type and network measures: Depending upon the network type, network characteristics and covariates included in the model behaved differently (Tables 19-23). None of the network characteristics (indegree, outdegree and density) in the Friendship, Romantic, Succeed, or Popular networks were significantly associated with alcohol use for students in School Category 1. The only significant association we encountered related to indegree in the Admire Network. For every additional admiration nomination received, the odds of reporting alcohol use was reduced by 0.723 (CI=0.524-0.998, $p < .05$), holding all other factors constant.

Network gender composition: In the friendship network in School Category 1, there was a significant association between students in predominantly male and female networks and alcohol use. Students in predominantly male networks were 0.32

(CI=0.109 -0.915, $p<.05$) times less likely than students in a balanced network to report ever drinking, holding all other factors constant. Similarly, students in predominantly female networks were also 0.37 (CI= 0.140-0.980, $p<.05$) times less likely than students in a balanced network to report ever drinking, holding all other factors constant.

In the romantic network in School Category 1, students who nominated mostly males (predominantly male network) were 0.062 (CI=0.006 – 0.621, $p<.05$) times less likely to report ever drinking compared to students in networks composed of the same/equal number of males and females holding all other factors constant.

School category 2 (School 3 and 4)

Network type and network measures: In this School Category, none of the different types of networks assessed was associated with drinking.

Network gender composition: Network gender composition was not associated with alcohol use in this school category.

School category 3 (School 4)

Network type and network measures: Similar to School Category 1, depending upon the network type, network characteristics and covariates included in the model behaved differently (Tables 19-23). With the exception of indegree, none of the other network characteristics (outdegree and density) in the Friendship, Romantic, Succeed, or Popular networks were significantly associated with alcohol use for students in School Category 3. The only significant association we encountered related to indegree in the Romantic Network. For every additional romantic nomination received, the odds of

reporting ever drinking was reduced by 0.68 (CI= 0.471 - 0.995, $p < .05$) holding all other factors constant.

Network gender composition: Gender compositions of the different networks were not significantly associated with reporting ever drinking in this school category.

Covariates

The covariates included in the models were intrapersonal factors (age, gender, ethnicity, and grades) and interpersonal factors (qualifying for reduced lunch, parent and sibling alcohol use). These covariates also behaved differently across the different network types and school categories.

Among the intrapersonal factors included in the models, only grades, (academic achievement) were found to be consistently predictive of individual drinking across friendship, succeed and popular networks for all three school categories (Tables 19-23). In the Romantic network, grades were predictive of drinking in only School Category 2. In the Admire network, grades were predictive of individual drinking behavior in School Categories 2 and 3, but not in School Category 1.

Ethnicity was found to be predictive of individual drinking in the Admire and Popularity networks in School Category 3 only. In the Admire network, compared to non-Hispanic adolescents nominated as being admired, admired Hispanic adolescents were 0.157 (CI=0.037-0.679, $p < 0.05$) times less likely to report ever drinking holding all other factors constant. Similar to results obtained for the admire network, Hispanic students nominated as being popular were 0.241 (CI=0.074-0.789, 0.05) times less likely to report ever drinking holding all other factors constant.

Qualifying for reduced lunch was also found to be predictive of individual drinking in School Category 2 Friendship and Popularity networks and School Category 3 Admire networks. In all three instances, adolescents who qualified for reduced lunch were less likely to report ever drinking compared to students who did not qualify for reduced lunch, holding all other factors constant. This association however was not statistically significant for the other network types in School Categories 2 and 3 and all network types in School Category 1.

Regarding interpersonal factors, for many of the School Categories, sibling *and* parental alcohol use were consistently predictive of individual drinking. Parental alcohol use was predictive of individual drinking more times than sibling alcohol use (10 vs 8 times respectively) across all three School Categories and network types.

Table 19. Logistic regression results of the effects of intrapersonal, interpersonal, and network characteristics on adolescents' alcohol use in a friendship network

	School Category 1		School Category 2		School Category 3		
	OR	95%CI	OR	95%CI	OR	95%CI	
Friendship Network	Age	1.164	.734-1.848	.922	.589-1.445	.854	.479-1.521
	Gender	1.264	.555-2.88	1.526	.931-2.501	1.094	.562-2.130
	Ethnicity	1.348	.709-2.562	.712	.427-1.188	.598	.304-1.177
	Grades	1.345**	1.154-1.567	1.316**	1.158-1.494	1.373**	1.185-1.591
	Reduced Lunch	2.424	.988-5.949	.328*	.130-.828	.314	.087-1.131
	Parent Alcohol	2.987**	1.558-5.728	3.079**	1.822-5.204	1.536**	.786-3.001
	Sibling Alcohol	2.384**	1.254-4.531	1.575	.951-2.609	3.596**	1.807-7.158
	Indegree	.894	.752-1.064	1.062	.934-1.208	1.034	.888-1.207
	Outdegree	1.131	.880-1.454	1.074	.975-1.298	.960	.741-1.245
	Density	1.008	.989-1.027	.989	.888-1.002	1.011	.993-1.030
	NetPredomGender (Male)	.315*	.109-.915	1.218	.475-3.124	.641	.188-2.187
	NetPredomGender (Female)	.371*	.140-.980	1.125	.445-2.845	.922	.289-2.947

*p<.05 **p<.01

Table 20. Logistic regression results of the effects of intrapersonal, interpersonal, and network characteristics on adolescents' alcohol use in a network of adolescents with romantic aspirations for one another

	School Category 1		School Category 2		School Category 3		
	OR	95%CI	OR	95%CI	OR	95%CI	
Romantic Network	Age	.993	.398-2.481	1.066	.467-2.433	1.198	.765-1.878
	Gender	5.803*	1.028-32.745	2.089	.867-5.032	1.526	.889-2.62
	Ethnicity	1.533	.455-5.171	.785	.320-1.926	.769	.451-1.31
	Grades	1.113	.849-1.461	1.471**	1.167-1.853	1.338	1.181-1.516
	Reduced Lunch	2.458	.411-14.685	.269	.055-1.328	2.932	1.153-7.453
	Parent Alcohol	4.594*	1.326-15.914	2.780*	1.095-7.055	2.158	1.273-3.659
	Sibling Alcohol	3.551*	1.090-11.573	1.549	.648-3.705	3.363	1.965-5.756
	Indegree	.636	.315-1.282	1.078	.749-1.551	.779*	.618-.982
	Outdegree	1.085	.687-1.713	.920	.604-1.399	1.008	.840-1.211
	Density†					.000	.000
	NetPredomGender (Male)	.062*	.006-.621	1.359	.148-12.433	.712	.345-1.469
	NetPredomGender (Female)	.434	.055-3.395	1.709	.192-15.192	.782	.413-1.477

*p<.05 **p<.01

†Density scores was mostly zeros for School Category 1 and 2

Table 21. Logistic regression results of the effects of intrapersonal, interpersonal, and network characteristics on adolescents' alcohol use in a network of “likely to succeed” adolescents

	School Category 1		School Category 2		School Category 3	
	OR	95%CI	OR	95%CI	OR	95%CI
Age	.846	.441-1.623	.915	.505-1.66	1.008	.462-2.198
Gender	1.193	.469-3.035	1.472	.764-2.834	1.211	.455-3.222
Ethnicity	1.706	.736-3.957	.785	.403-1.53	.390	.138-1.104
Grades	1.380*	1.112-1.712	1.445*	1.223-1.708	1.595**	1.257-2.026
Reduced Lunch	1.829	.580-5.769	.318	.091-1.113	.142	.018-1.108
Parent Alcohol	3.063*	1.359-6.904	2.790*	1.391-5.597	1.494	.57-3.913
Sibling Alcohol	2.777*	1.198-6.439	1.088	.548-2.16	3.696*	1.354-10.089
Indegree	.981	.860-1.118	1.029	.931-1.137	.960	.793-1.162
Outdegree	.941	.732-1.208	1.048	.859-1.28	.866	.641-1.172
Density	1.019	.991-1.047	.994	.957-1.032	1.005	.966-1.046
NetPredomGender (Male)	.462	.105-2.202	1.003	.383-2.631	103652270	7.812
NetPredomGender (Female)	1.525	.428-5.433	.960	.399-2.309	786255699.	241

*p<.05 **p<.01

Table 22. Logistic regression results of the effects of intrapersonal, interpersonal, and network characteristics on adolescents' alcohol use in a network of students who admire one another

	School Category 1		School Category 2		School Category 3	
	OR	95%CI	β	95%CI	β	95%CI
Age	1.061	.478-2.357	.738	.355-1.534	.702	.246-2.005
Gender	1.409	.48-4.14	1.798	.833-3.879	2.740	.716-10.489
Ethnicity	2.618	.955-7.177	.656	.29-1.488	.157	.037-.679
Grades	1.238	.969-1.581	1.609**	1.3-1.991	2.022**	1.428-2.864
Reduced Lunch	4.177	18.688	.137	.017-1.106	.029**	.002-.396
Parent Alcohol	4.647*	1.708-12.644	3.364**	1.433-7.897	1.096	.295-4.074
Sibling Alcohol	6.429*	2.203-18.760	1.492	.667-3.339	7.710**	1.765-33.668
Indegree	.723*	.524-.998	1.035	.851-1.257	.956	.705-1.298
Outdegree	.904	.637-1.284	1.106	.818-1.496	1.171	.97-1.736
Density	1.027	.987-1.069	1.022	.947-1.102	.858	.71-1.037
NetPredomGender (Male)	5.326	.253-112.086	.743	.196-2.281	.333	.047-2.351
NetPredomGender (Female)	15.714	.834-295.980	.544	.146-2.034	.599	.096-3.727

*p<.05 **p<.01

Table 23. Logistic regression results of the effects of intrapersonal, interpersonal, and network characteristics on adolescents’ alcohol use in a network of students thought to be popular students

	School Category 1		School Category 2		School Category 3	
	OR	95%CI	OR	95%CI	OR	95%CI
Age	.717	.306-1.684	.844	.36-1.975	.849	.354-2.034
Gender	1.062	.334-3.377	1.866	.772-4.51	1.318	.48-3.617
Ethnicity	1.640	.551-4.884	.713	.29-1.756	.241*	.074-.789
Grades	1.282	1.003-1.64	1.454	1.158-1.826	1.326*	1.057-1.663
Reduced Lunch	5.424*	1.061-27.16	.029**	.002-.337	.239	.017-3.446
Parent Alcohol	3.991*	1.216-13.097	6.072*	2.173-16.965	2.236	.765-6.535
Sibling Alcohol	2.799	.966-8.105	.972	.392-2.409	2.448	.789-7.592
Indegree	.837	.610-1.149	.972	.773-1.221	.920	.696-1.216
Outdegree	1.150	.789-1.676	1.120	.846-1.484	1.364	.998-1.865
Density	.930	.8-1.081	.968	.922-1.017	.981	.915-1.051
NetPredomGender (Male)	.424	.064-2.28	1.185	.351-4.003	1.289	.264-6.29
NetPredomGender (Female)	.920	.208-4.075	1.351	.402-4.539	3.087	.637-14.965

*p<.05 **p<.01

Smoking

For the models with smoking as outcome of interest, covariates typically associated with smoking—demographic characteristics, intrapersonal (e.g. age, gender), and interpersonal factors (e.g. parent and sibling alcohol and tobacco use)—were included, alongside the network measures indegree, outdegree, density, and gender composition. Tables 24-28 lists all the variables included in the models.

School category 1(Schools 1, 3, and 4)

Network type and network measures: Depending upon the network type, network characteristics and covariates included in the model behaved differently (Tables 24-28). With the exception of density, none of the other network characteristics (outdegree and

indegree) in the Friendship, Romantic, Succeed, or Popular networks were significantly associated with alcohol use for students in School Category 1. The significant association we encountered related to density in the Admire network. In the Admire network, density (or level of connectedness) was positively associated with reporting ever smoking. Hence, when the density of the network increases by one unit, the odds of reporting ever smoking increases by 1.05 (CI=1.009-1.084, $p<.05$), holding all other factors constant.

Network gender composition: In the Friendship, Succeed, Admire and Popular networks, there was no association between the network gender composition and smoking. However, in the romantic network, there was a significant association between students in predominantly male and female networks and smoking. Students in predominantly male networks were 0.10 (CI=0.011 - 0.864, $p<.05$) times less likely than students in a balanced network to report ever smoking, holding all other factors constant. Similarly, students in predominantly female networks were 0.08 (CI= 0.009-0.648, $p<.05$) times less likely than students in a balanced network composition to report ever smoking, holding all other factors constant.

School category 2 (School 2)

Network type and network measures: Similar to School Category 1 results, network characteristics and covariates included in the model behaved differently depending upon the network type (Tables 24-28). We encountered a significant association between two network measures (outdegree and density) and smoking in School Category 2. In the Admire network, for every additional nomination made

(outdegree), the odds of smoking reduced by 0.379 (CI=0.158-0.907, $p<.05$) holding all other factors constant. In the Popularity network, density was positively associated ($p<.05$) with reporting ever smoked. In other words, for every increase in density, there was a 1.05 (CI=1.005-1.106, $p<.05$) increase in the likelihood of smoking for students in this school category.

Network gender composition: In School Category 2, network gender composition was not associated with smoking.

Covariates

For the model with smoking as the outcome variable, covariates included were intrapersonal factors (age, gender, ethnicity, and grades) and interpersonal factors (qualifying for reduced lunch, parent and sibling alcohol use). Similar to results obtained for the models on alcohol use, the covariates also behaved differently across the different network types and school categories.

Among the intrapersonal factors in these models, only age, gender and grades were associated with individual adolescent smoking and these behaved differently depending upon the type of network. In the Friendship network, only grades were associated with individual smoking in both school categories (School Category 1: OR=1.319, CI=1.138-1.529, $p<0.01$; School Category 2: OR=1.419, CI=1.121-1.796, $p<0.01$).

In the Romantic network in School Category 1, age was associated with smoking. With every 1 year increase in age, adolescents in this network were 4.367 (CI=0.963-2.644, $p<0.05$) times more likely to report smoking. In School Category 2's

Romantic network, however, grades were the factor associated with smoking (OR=2.527, CI=1.196-5.337, $p<0.05$). No other covariate was associated with smoking in the romantic network.

In the Succeed network, grades were the only covariate associated with smoking in both school categories. For School Category 1, higher grades increased the likelihood of smoking by 1.346 (CI=1.107-1.637, $p<0.01$) times, while in School Category 2, higher grades increased the likelihood of smoking by 2.013 (CI=1.297-3.124, $p<0.01$) times.

Gender was the only intrapersonal factor associated with smoking in the admire network in School Category 2. Girls in this network were about 5.795 (CI=1.051-31.955, $p<0.05$) times more likely to report ever smoking compared to boys, holding all other factors constant.

Similar to the Admire network, in the Popular network for School Category 2, girls were 7.495 (CI=1.376-40.824, $p<0.05$) times more likely to report smoking compared to boys, holding all other factors constant. However, given the very wide confidence intervals, there is need for further inquiry in order to determine the precise effect of individual gender on smoking behavior of students in the Popular and Admire networks.

For interpersonal factors, sibling smoking was consistently associated with smoking in several of the school categories and across all the network types with the exception of the Admire network (Table 26). In contrast, parent smoking was only associated with adolescent smoking in School Category 1's Popularity network (students

with parents who smoked were twice as likely to smoke themselves; OR=2.048, CI=0.668-6.278). Qualifying for reduced lunch was also associated with adolescent smoking, but only in School Category 2's succeed network. Students in that network, who qualified for reduced lunch, were less likely (OR=0.057, CI=0.004-0.838) to report ever smoking.

Table 24. Logistic regression results of the effects of intrapersonal, interpersonal, and network characteristics on adolescents' smoking in adolescents' friendship network

	School Category 1		School Category 2	
	OR	95%CI	OR	95%CI
Age	1.596	.963-2.644	1.339	.524-3.422
Gender	1.385	.695-2.756	.373	.123-1.135
Ethnicity	1.574	.831-2.984	1.421	.481-4.198
Grades	1.319**	1.138-1.529	1.419**	1.121-1.796
Reduced Lunch	1.627	.545-4.856	.545	.093-3.195
Parent Smoke	1.690	.868-3.291	.382	.101-1.441
Sibling Smoke	2.547**	1.282-5.057	19.907**	5.817-68.126
Indegree	.881	.739-1.050	1.064	.827-1.369
Outdegree	1.028	.807-1.310	.966	.634-1.472
Density	1.000	.985-1.016	1.003	.978-1.028
NetPredomGender (Male)	3.276	.709-15.139	.529	.089-3.139
NetPredomGender (Female)	1.799	.397-8.148	.824	.156-4.341

* $p < .05$ ** $p < .01$

Table 25. Logistic regression results of the effects of intrapersonal, interpersonal, and network characteristics on adolescents’ smoking in a network of adolescents with romantic aspirations for one another

	School Category 1		School Category 2		
	OR	OR(95%CI)	OR	OR(95%CI)	
Romantic Network	Age	4.367*	1.393-13.61	7.090	.653-76.947
	Gender	.977	.278-3.437	.081	.003-1.933
	Ethnicity	2.788	.82-9.395	.170	.008-3.504
	Grades	1.384*	1.054-1.818	2.527*	1.196-5.337
	Reduced Lunch	.342	.054-2.190	.453	.007-30.367
	Parent Smoke	1.331	.383-4.629	.035	.000-2.886
	Sibling Smoke	2.106	.546-8.127	764.467**	5.325-109743.726
	Indegree	.314	.097-1.019	3.709	.735-18.725
	Outdegree	.955	.577-1.578	1.621	.604-4.35
	Density†				
	NetPredomGender (Male)	.099*	.011-.864	52600156.700	0
	NetPredomGender (Female)	.077*	.009-.648	10116576.896	0

* $p < .05$ ** $p < .01$ †Density score was mostly zeros for schools in both categories

Table 26. Logistic regression results of the effects of intrapersonal, interpersonal, and network characteristics on adolescents’ smoking in a network of “likely to succeed” adolescents

	School Category 1		School Category 2		
	OR	95%CI	OR	95%CI	
Succeed Network	Age	1.215	(.592-2.493)	2.026	.528-7.773
	Gender	1.062	(.441-2.554)	1.380	.252-7.548
	Ethnicity	1.998	(.861-4.633)	.785	.137-4.491
	Grades	1.346**	(1.107-1.637)	2.013**	1.297-3.124
	Reduced Lunch	1.677	(.360-7.808)	.057*	.004-.838
	Parent Smoke	1.249	(.506-3.081)	.173	.017-1.754
	Sibling Smoke	3.036*	(1.243-7.416)	21.741**	2.555-184.981
	Indegree	1.024	(.920-1.140)	1.260	.936-1.696
	Outdegree	.918	(.709-1.187)	.623	.347-1.118
	Density	1.013	(.985-1.042)	.951	.842-1.075
	NetPredomGender (Male)	.918	(.272-3.098)	.776	.043-14.001
	NetPredomGender (Female)	.656	(.2-2.148)	1.019	.056-18.577

* $p < .05$ ** $p < .01$

Table 27. Logistic regression results of the effects of intrapersonal, interpersonal, and network characteristics on adolescents' smoking in a network of students who admire one another

	School Category 1		School Category 2		
	OR	OR(95%CI)	OR	OR(95%CI)	
Admire Network	Age	1.731	.721-4.157	1.224	.305-4.915
	Gender	1.482	.536-4.101	5.795*	1.051-31.955
	Ethnicity	1.942	.716-5.265	.371	.085-1.622
	Grades	1.244	.988-1.566	1.070	.772-1.484
	Reduced Lunch	.993	.186-5.297	2.024	.14-29.248
	Parent Smoke	1.197	.41-3.489	.508	.118-2.182
	Sibling Smoke	2.774	.9298.281	1.545	.687-3.477
	Indegree	.954	.743-1.224	1.110	.69-1.784
	Outdegree	.927	.650-1.322	.379*	.158-.907
	Density	1.046*	1.009-1.084	.973	.85-1.114
	NetPredomGender (Male)	3.226	.508-20.493	.534	.061-4.649
	NetPredomGender (Female)	.916	.144-5.804	.622	.061-6.337

* $p < .05$ ** $p < .01$

Table 28. Logistic regression results of the effects of intrapersonal, interpersonal, and network characteristics on adolescents' smoking in a network of popular students

	School Category 1		School Category 2		
	OR	95%CI	OR	95%CI	
Popular Network	Age	1.407	.556-3.559	.718	.165-3.128
	Gender	.751	.264-2.137	7.495*	1.376-40.128
	Ethnicity	1.537	.516-4.575	.696	.171-2.831
	Grades	1.469	1.127-1.914	.933	.641-1.359
	Reduced Lunch	1.891	.202-17.688	8.333	.445-156.209
	Parent Smoke	2.048*	.668-6.278	.337	.085-1.333
	Sibling Smoke	4.481*	1.492-13.456	1.187	.535-2.635
	Indegree	1.055	.808-1.377	1.065	.764-1.484
	Outdegree	1.046	.724-1.511	.658	.3491.24
	Density	.674	.376-1.206	1.055*	1.005-1.106
	NetPredomGender (Male)	.562	.126-2.511	1.246	.159-9.775
	NetPredomGender (Female)	.436	.103-1.846	.922	.106-8.028

* $p < .05$ ** $p < .01$

Discussion

Given the substantial variability in the findings described above, the question that arises is, “What does this variability point to, or what do we make of these results?” As we sift through the variations from model to model, two common threads stand out and, in effect, represent the take-home messages from this study: 1) different intrapersonal and interpersonal factors and network measures identified as determinants of substance use among adolescents vary depending on the type of network examined; and 2) the gender composition of the networks can be an important factor associated with alcohol and tobacco use.

Due to these two major findings, we believe this study makes an important contribution to the research utilizing social network analyses of adolescents’ risky behaviors. This study employed an egocentric analytic approach to examine whether factors implicated in alcohol and tobacco use among adolescents vary by type of network and gender composition of those networks. The findings do support the notion that these two factors — type of network and the network’s gender composition — are important factors to consider in network studies of adolescents. In fact, to the best of our knowledge, this is one of the few studies examining gender composition of adolescent networks as a factor that might influence adolescents’ smoking and alcohol use. Another similar study is the one conducted by Gaughan, 2006, who examined gender in the context of dyadic friendship relations and found that peer influence processes differed by the gender structure of the friendships.

Similar to Gaughan's (2006) findings, we uncovered a negative association between gender composition of both the friendship as well as romantic networks and smoking/alcohol use. Although some of our associations exhibited moderate-sized odds ratios, they indicate that adolescents in our sample, in both predominantly male or female friendship and romantic networks, were less likely to report having ever smoked or consumed alcohol compared to those in balanced gender networks (same number of female and male nominations).

This finding regarding gender composition of the networks and substance use can be interpreted in terms of status characteristic theory, which posits that if a male is in a predominantly male network, or a female in a predominantly female network, there is a balance in influence and behavioral expectancy compared to mixed sex groups where, depending on behavioral or status expectancy, one gender might be more dominant/influential in the group (Lockheed & Hall, 1976). When adolescents are in mixed/balanced networks, usually there is a disproportionate amount of influence exerted depending upon the context of the associations and upon other characteristics of the network (Gaughan, 2006).

Our study's findings regarding how intrapersonal and interpersonal factors and network measures known to influence adolescent substance use vary across the different networks examined are counter to those documented in Valente's (2013) study. In that study, Valente concluded that only friendship networks were associated with alcohol and tobacco use among adolescents, whereas in our study we found associations between

other network types examined and the different intrapersonal and interpersonal factors and network measures known to influence adolescent alcohol and tobacco use.

Regarding alcohol use, students' indegree was the only other network measure consistently negatively associated with alcohol use in some of the network types (romantic and admire). With an increase in indegree, participants were less likely to report using alcohol. Aside from indegree, none of the other network characteristics were associated with alcohol use. This finding can be understood from the perspective of adolescents' social integration and how integration influences their risk for alcohol use. Indegree is a measure of social integration (Valente, 2010), and as such, students who are more socially integrated (in other words, not isolates) are less likely to use alcohol – at least in this study's samples. This perspective supports the existing literature indicating that isolates in a network are more likely to engage in substance use behaviors compared to those who are socially embedded in a network (Ennett & Bauman, 1993; Fujimoto & Valente, 2012).

For smoking, however, density of the admiration and popularity networks was positively associated with smoking. An ego's network density is an indicator of the extent to which their nominees know and nominate one another. Hence, adolescents in our samples who are admired, associate with other students who are admired, and who also admire each other, are more likely to smoke than others who are not as well or densely connected.

There are different explanations for this finding. One explanation is the admired students also are the popular ones (as is the case in some of the schools, see Table 3b, c,

and d) and studies have shown that popularity is an attribute that increases adolescents' susceptibility to smoking, especially in schools with high substance use rates

(Alexander, Piazza, Mekos, & Valente, 2001; Valente, Unger, & Johnson, 2005).

Another possible explanation is that since the network is composed of adolescents who admire one another, having more connections/friends who are also well connected themselves increases the possibility of having more access to (admired) peers who smoke which, in turn, increases the likelihood of adopting the behavior of the admired peer.

Regarding adolescent's individual gender and how this is associated with smoking risk, in one of the school categories (School Category 1) we found that girls in the admiration and popularity networks (but not in the other network types) were more likely to report smoking than boys in these networks. This is, potentially, an intriguing finding, given that participants' gender is a fixed attribute and does not change depending on the network examined. One possible explanation is that although the adolescent girls are the same across the different networks, changing the ties that connect them to their peers (e.g. friendship vs admire vs popular networks) places girls at varying levels of risk for engaging in risky behaviors, particularly smoking in the case of our study. In this sense, individual attributes appear to gain different relevance, depending on the type of network the adolescents are embedded. The mechanisms explaining how the different contexts influence or shape gender susceptibility, however, remain unexamined and not clearly understood.

Our study controlled for familial sources of influence on adolescents' substance use, and found these sources to play a role in adolescents' substance use behaviors. Consistent with other studies, we found that sibling smoking was, in most cases, associated with adolescent smoking (Avenevoli & Merikangas, 2003; Vink, Willemsen, & Boomsma, 2003). This finding supports existing literature reporting that siblings do matter, especially regarding transmission of influence among adolescents within a family unit (Kothari et al., 2014).

In our study, parental smoking behavior was not associated with adolescents' report of smoking and this is contrary to studies that have shown that parental smoking is an important source of vulnerability to smoking among adolescents (Gilman et. al., (2009; Engels, Vitaro, Blokland, de Kemp, & Scholte, 2004). However, there is mixed evidence about the role (direct or indirect) of parental influence on adolescent smoking (Hoffman, Sussman, Unger, & Valente, 2006). Some studies have shown there is an indirect relationship between parent smoking and adolescent smoking and that the relationship is mediated by peers— i.e., parental smoking influenced associations with smoking peers (Fergusson, Lynskey, & Horwood, 1995); O'Loughlin, Paradis, Renaud, & Gomez, 1998). On the other hand, studies also have shown that parents' smoking behavior directly influences adolescents' smoking (Harakeh, Scholte, Vermulst, de Vries, & Engels, 2004). Hence, the lack of association, in our samples, between parental smoking behavior and adolescents' report of smoking could be a result of this indirect effect of parental smoking behavior on adolescents' smoking.

Differing from the results obtained for smoking, parental drinking but not sibling drinking was more often associated with adolescent drinking within our sample. This finding also corroborates existing studies showing there is a strong association between parents' drinking patterns and the drinking patterns of their adolescent and young adult offspring (Cohen & Rice, 1997). One of the mechanisms proposed to explain this association is that parents who consume alcohol model this behavior directly to their children and are thus the influential precursors of adolescent alcohol use within a family system (Kothari et al., 2014; Van Der Vorst et al., 2005).

While these results on familial determinants of adolescent drinking may differ from studies which have indicated that sibling substance use is the most influential predictor of adolescent substance use, irrespective of the substance, (McGue, 1996; Windle 2000), these differing findings for alcohol and tobacco should be viewed in context. The sample in our study is 10th graders that are predominantly Hispanic/Latino and the results should be assessed with this in mind as studies have shown that there are ethnic differences in correlates of adolescent smoking behavior (Griesler, & Kandel, 1998). Additionally, our results, when viewed from a child development perspective, are in line with studies supporting the notion that effects of familial influences (parents and siblings) vary through the life course with parental influence stronger early on (during initiation) and sibling influence stronger later on (as behavior reinforcement or amplifier) (Duncan, Duncan, & Hops, 1996b).

Overall, findings from this study have shown significant variability in how the different intra- and inter-personal factors, as well as adolescent network characteristics

implicated in alcohol and tobacco use among adolescents behave in different network and school contexts. This variability points to one overarching conclusion: different contexts and network gender compositions result in different risks.

The implications of this conclusion for health promotion practice are not trivial: program planners must bear in mind that mere knowledge of adolescents' gender may not be enough to fully understand the kinds of risks girls and boys might be exposed to. While it is important to account for differences in patterns of alcohol and tobacco use for males and females, it is perhaps equally (or even more) important to consider the gender composition of the various types of networks in which they are embedded. Program developers would do well to assess the gender composition and the types of networks to which program participants belong, in order to develop more appropriately-targeted messages. For example, program developers can develop advertisements that depict the different possible gender compositions of adolescent friendships and teach adolescents how to resist pressures from within these networks.

Additionally, for interventions employing social network analysis to identify peer opinion leaders, care must be taken to ensure consideration is given to the network types and the gender composition of these networks from which the peers are drawn. For example, opinion leaders (individuals who are at the center of a network) are usually chosen because of their position in the network and their potential ability to convey healthful behavior change messages/innovations. Therefore, in order to identify effective adolescent opinion leaders, program developers need to ensure they are not merely selecting individuals with the highest friendship nominations (which could be a function

of that adolescent being popular) but they must identify the students whom their peers look to, the most (such as in our study, those who were most likely to succeed or most admired). Choosing opinion leaders from across these different network types, with considerations for gender representativeness, will most likely elicit a group of effective opinion leaders.

This study's findings also have important implications for future research. One implication is the need for studies that do not gloss over the gendered patterns in which influence is assimilated or transmitted within a network. There is need for further research studies designed specifically to explore the extent to which adolescents in networks with different gender compositions and in different network types (or contexts) are influenced by their peers. More often than not, studies tend to control for gender, or to assume that being a girl or a boy places an adolescent at a fixed level of risk — based on their gender — without consideration of potential gender-by-context (or type of network) interactions.

As with every research endeavor, however, this study's findings are tempered by its own limitations. First, some of the statistically significant results had only small or moderate odds ratios and may not exhibit practical significance. Another limitation relates to the data set and its measures: the data used for the analyses were not designed to tease out gender differences in adolescent networks or how these differences might influence their alcohol and tobacco use behavior. In other words, the data collection was not originally designed to answer questions regarding gender composition mechanisms

and, therefore, the measures may have lacked sensitivity and, thus, resulted in the small associations found.

Additionally, employing a bounded whole network dataset for this analysis does not allow us to obtain a true/complete picture of the adolescents' networks. Given the lack of information on contextual and endogenous structural properties of the networks in the different schools it is also unclear what might be the underlying factors driving the variable findings across the schools. Lastly, as (Steckler, McLeroy, Goodman, Bird, & McCormick, 1992) pointed out, quantitative methodologies are only able to provide numerical estimates of a social phenomenon but are lacking in their capability to elucidate the context and culture surrounding the social phenomena.

Thus, to adequately capture the gender composition differences and how the different composition mixes might facilitate or constrain behaviors such as alcohol or tobacco use among adolescents, there is a need to integrate a qualitative approach into studying these adolescent social networks.

Despite these limitations, however, this study contributes to the body of knowledge regarding social network analysis of adolescents' substance use behaviors by providing support for the notion that intrapersonal and interpersonal factors and network vary considerably (in our sample) depending upon the context/type of the network and its gender composition. Furthermore, findings from this study have shown that we cannot assume gender (of the individual or of the network) to have a fixed association with risk. Rather, the effects of gender are complex and dependent upon context. The gender composition of the network should not be glossed over or ignored as it plays a

significant role in how peer interactions might facilitate or constrain alcohol and tobacco use among adolescents.

CHAPTER V

CONCLUSION

The overarching purpose of this dissertation was to employ social network analytic methodology to provide evidence-based insight into how the different factors, determinants, and gender composition of different types of adolescent networks are associated with alcohol and tobacco use among adolescents. More specifically, this report sought to address the following gaps present in the body of knowledge regarding how adolescent social networks and their gender compositions influence alcohol and tobacco use: How are adolescent boys and girls different in terms of adolescent ATOD use? How similar and/or different are the attributes and network characteristics of substance using and non-using adolescents? Is gender composition of adolescent networks associated with factors and determinants shown to influence their ATOD use? Do types of network affiliations being used to characterize adolescent networks matter in terms of how influence is transmitted within networks?

To examine these gaps in the professional literature, first we systematically reviewed literature reporting use of social network analysis to examine determinants of substance use by adolescents. Despite the studies' high methodological rigor, gender compositions of the adolescents' network were usually not considered. The majority of reviewed studies used friendship networks to characterize adolescent peer groups; gender differences in the determinants implicated in adolescent substance use were only reported in a few studies.

Next, we used a social network analytic approach to descriptively examine the attributes and network characteristics of a sample of adolescent substance users and non-users (10th graders) from four high schools in Los Angeles, California. The majority of both substance using and non-using adolescents in the sample identified themselves as being “regular kids” and “athletes.” However, more substance-using adolescents identified themselves as “stoners/druggies.” Non-users identified themselves as being smart kids. Findings from the study also showed that the Romantic network of adolescents might be a possible bridge between users and non-users, as patterns observed for the Romantic network differed from those obtained for other networks such as the Friendship network. This finding further highlights the need for studies to explore other possible network affiliation types as different networks might confer different opportunities for, or constraints upon, individual behaviors such as substance use. The findings also showed that the family unit, particularly parents and siblings in our sample, are an important factor that might influence adolescents’ substance use behavior alongside peers. Following this descriptive analysis of adolescent networks, we also conducted quadratic assignment procedure (QAP) correlations to estimate the overlap among five different network types (see Chapter 4). Then, several binary logistic regression models were subsequently fit to examine how the different intrapersonal and interpersonal determinants and network measures known to be associated with substance use among adolescents behaved across the different networks examined.

The results obtained from the QAP correlation and logistic regression analyses indicated that adolescents have and rely on different networks for different purposes.

Depending upon the network examined, the different substance use determinants and network indicators measured varied in their association with individual substance use behavior, and this difference also varied with the type of behavior studied (drinking vs. smoking). More importantly, the gender composition of the different networks in which adolescents in our sample were embedded was found to be associated with their alcohol and tobacco use.

These three studies, in tandem, contribute importantly to the literature because they represent the first effort to examine the gender composition of adolescent networks as a factor that might influence adolescent substance use behavior (not merely as a dyadic friendship relationship, as Gaughan, 2006, did). In addition, this study is also one of a few to examine networks other than friendship networks as a potential source of influence.

The findings from this study suggest a few implications for research endeavors employing social network analytic methodology. The first is the need for future research to clarify the risk factors for substance use across genders, network gender compositions, and affiliation/network types. Researchers should not assume adolescent boys and girls are equally at risk for substance use across the different networks they are embedded in. Secondly, findings from this study revealed we cannot assume gender (of the individual or of the network) to have a fixed association with risk. Rather, the effects of gender are multifaceted and dependent upon context. Thus, researchers need to address the gender composition of adolescent networks and should not dismiss or ignore it. Considerations of the gender composition of adolescent networks is particularly essential for developing

effective gender-appropriate interventions aimed at delaying or stopping substance use among adolescents. Taking into account gender composition of adolescent networks may also facilitate the implementation of specific prevention programs designed to reach entire networks of adolescents at risk.

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APPENDIX A

Glossary

Network Terms	Definition
Ego	The respondent (person providing the information) or focal node.
Alter	This is the person named by the ego.
Node	The entities that make up the network. In social network analysis, the nodes are most often individual actors (a person, a dolphin), but can also be collectivities (teams, firms, cities, countries, tribes, species, etc.). Nodes are sometimes called actors, or vertices
Tie	The relation that constitutes the network. E.g., friendship ties, advice giving ties. Ties can be directed or undirected. Ties can be valued. Ties are sometimes called edges, links, arcs.
Density	Ratio of the number of actual links to the number of possible links in the network.
Indegree	Number of directional links to the actor from other actors (in-coming links)
Outdegree	Number of directional links from the actor to other actors (out-going links)
Reciprocity/ Symmetry	Extent to which relationship is bidirectional. E.g. A nominates B as a friend and B nominates A as a friend.
Transitivity	Three actors (A, B, C) are transitive if whenever A is linked to B and B is linked to C, then C is linked to A. Transitivity is the number of transitive triples divided by the number of potential transitive triples (number of paths of length 2). Also known as the weighted clustering coefficient.
Connectivity/Reachability	Minimum number of actors or ties that must be removed to disconnect the network. Reachability is 1 if two actors can reach each other, otherwise 0. Average reachability equals connectedness
Eigenvector centrality	In the simplest terms, a node that is high on eigenvector centrality has many ties to nodes who have many ties to nodes, who have ...
Closeness (Farness centrality)	Extent to which an actor is close to, or can easily reach all the other actors in the network. Usually measured by averaging the path distances (direct and indirect links) to all others. A direct link is counted as 1, indirect links receive proportionately less weight.

Definitions obtained from Brass and Halgin, LIKNS Center and Valente (2010).

APPENDIX B

Table B-1. Distribution of MQS characteristics across 48 reviewed studies

Methodological criterion	Description	n studies	Percentage (%)
MQ1: Did the study address a clearly focused question / objective?	Yes	48	100
MQ2: Study design evident and appropriate	Yes	48	100
MQ3: Method of subject selection clearly described	Yes	48	100
	Yes	40	83.3
MQ4: Subject characteristics sufficiently described	Partial	7	14.6
	No	1	2.1
MQ5: Outcome measures well defined and means of assessment reported?	Yes	48	
	No	0	100
	Yes	39	
MQ6: Analytic methods described/justified and appropriate?	Partial	9	81.2
	No	0	18.8
	Yes	47	
MQ7: Results reported in sufficient detail?	Partial	1	97.9
	No	0	2.1
MQ8: Conclusions supported by the results?	Yes	48	
	No	0	100
MQ9: Study design	Longitudinal	31	64.6
	Cross-sectional	17	35.4
	ERGM, ABM, QAP, MR-QAP	14	29.2
	Multivariate statistics (SEM, HLM, Path analysis, MANOVA, MANCOVA)	11	22.9
	Regression analyses, Ordinary least squares, ANOVA, ANCOVA	18	37.5
MQ10: Data Analysis (highest level)	Bivariate statistics (t-tests, Pearson r)	4	8.3
	Univariate statistics (descriptive)	1	2.1

Table B-2. Results of network analysis of users and non-users in the Friendship networks in School 1 and 2

	School 1			School 2		
	User	Non-Users	Overall	User	Non-Users	Overall
Indegree Centrality (Mean, SD)	1.043 (1.031)	2.454 (1.905)	3.016 (2.112)	1.204 (1.206)	1.73 (1.368)	1.753 (1.973)
Centralization (Indegree) %	3.285	2.676	2.67	4.321	3.071	1.575
Density	0.011	0.009	0.008	0.011	0.012	0.004
Average degree	1.043	2.454	3.016	1.204	1.73	1.753
Integration	0.126 (0.157)	12.223 (8.694)	8.793 (4.194)	0.322 (0.397)	1.213 (1.552)	3.76 (3.529)
Radiality	0.126 (0.681)	12.223 (4.969)	8.793 (2.936)	0.322 (0.363)	1.213 (1.181)	3.76 (4.039)
Connectedness	0.025	0.575	0.751	0.047	0.123	0.248
Diameter	6	29	18	9	14	21
No. of components	67	92	73	82	75	275
Geodesic distance (Mean, SD)	2.0 (1.2)	8.8 (4.1)	7.3 (2.8)	3.2 (1.9)	5.1 (2.8)	6.9 (2.7)
Weighted overall coefficient	0.275	0.13	0.13	0.1	0.182	0.14
Reciprocity	0.4118	0.3226	0.3232	0.2593	0.3631	0.25
Transitivity	0.4	0.201	0.196	0.143	0.257	1

Table B-3. Results of network analysis of users and non-users in the Friendship networks in School 3

	School 3		
	User	Non-Users	Overall
Indegree Centrality (Mean, SD)	1.024 (0.975)	1.273 (1.379)	2.084 (1.772)
Centralization (Indegree) %	3.719	4.813	3.441
Density	0.018	0.016	0.016
Average degree	1.439	1.967	3.172
Integration	0.208 (0.223)	0.603 (0.897)	7.329 (4.929)
Radiality	0.208 (0.244)	0.603 (0.691)	7.329 (5.451)
Connectedness	0.174	0.277	0.769
Diameter	15	16	12
No. of components	56	83	76
Geodesic distance (Mean, SD)	2.4 (1.4)	4.1 (2.0)	7.5 (3.6)
Weighted overall coefficient	0.124	0.124	0.108
Reciprocity	0.4237	0.2941	0.3137
Transitivity	0.068	0.196	0.152

Table B-4. Matrix of the 48 reviewed studies, and their design, network affiliation type measured, gender-related findings, and their MQS scores

Lead author	Pub year	Sample characteristics	Study design	Network affiliation types	Gender-related findings			Highest data analysis	MQS score
					Alcohol	Smoking	Drugs		
Deutsch	2013	2350 7 -11th graders in the US	Longitudinal	Friend nomination	Gender composition of friendship has no effect on alcohol use			Latent factor analysis	20
Light	2013	6609, 12 - 18year olds, US	Longitudinal	Friend nomination	Rate of onset of use does not vary by gender			Agent Based Modeling (ABM)	22
Poulin	2011	309, 12 - 18 year old Canadians	Longitudinal	Friend nomination	The higher the use of alcohol the more the higher the no. Of other sex friends			Path analysis	20

Mrug	2011	320, 16-18year olds, US	Cross sectional (prospective)	Best friend nominations		Friendship with other-sex peers predicted girls' initiation of smoking		Regression	19
Knecht	2011	3017, 10-15 year old Dutch	Longitudinal	Friend nomination	No difference between genders			ABM	22
Mercken	2010	1163 Finnish adolescents with mean age 13	Longitudinal	Best friend nominations		Females more influenced by peer group		ABM	22
Mason	2010	301, 13-20 year olds, US	Cross sectional	Meaningful relationships	Gender differences observed			Regression	18
Henry	2007	1119, 6th graders in the US	Longitudinal	Peer nomination			Female students had half the risk for marijuana	Regression	19

							compared to males		
Killeya- Jones	2007	156, 12 -15 year olds, NC, US	Longitudinal	Friend nomination	No gender difference observed			Correlation s	18
Pearson	2006	3146, Scottish 13 - 15 year olds	Cross sectional	Friend nomination	Gender influences present with females more likely			Regression	19
Osgood	2014	9500. 6th and 9th graders	Longitudinal	Best friends and additional friends	No gender differences for alcohol	Females were more likely to smoke	Males more likely to have tried drugs	Regression	20
Tucker	2014	1612, 10 - 11th graders, US	Longitudinal	Best friend nominations	Nothing on gender			ABM	22

Valente	2013	1707, adol. with av. age of 15.1, CA, US	Cross sectional	Friend nomination	Nothing on gender		ERGGM	21
Corten	2013	12th graders, The Netherlands	Longitudinal	Best friends and classmates	Nothing on gender		Regression	19
Giletta	2012	704, 14- 18 year old, Italy	Longitudinal	Best friend nominations	Suggests that peer influence susceptibility may vary across different forms of influence and across genders		ABM	22
Cruz	2012	Total/final sample not mentioned (ADD Health), US	Longitudinal	Friend nomination	Nothing on gender		Regression	19
Huisman	2012	961, 13 - 14 year old, Dutch	Longitudinal	Friend nomination		No difference in smoking behavior between boys and girls	ABM	22

Go	2012	2065, 7 - 12th graders, US	Longitudinal	Friend nomination	Nothing on gender differences			Regression	20
Fujimoto	2012	2533, 7 - 12th graders, US	Cross sectional	Friend nomination	Nothing on gender differences, although authors mentioned that as a result of the characteristics of the data employed (Add Health), detecting gender differences might be less likely			Regression	19
Schaefer	2012	509, 7- 12 graders, US	Longitudinal	Friend nomination		Nothing on effects of gender differences		ABM	20
Fujimoto	2012	13187, 7 - 12th graders, US	Cross sectional	Best friend nominations		Nothing on effects of gender differences		Regression	19
Lakon	2012	851, 12 - 18 year olds, CA, US	Cross sectional	Best friend nominations		Nothing on effects of gender differences		HLM	20
Hahm	2012	7966, 6- 12th graders, US	Longitudinal	Friend nomination	Nothing on effects of gender differences			CI and Odds ratio	19

Fujimoto	2012	1260, 12-13 year olds, US	Longitudinal	Closest friend		Girls were more likely to be influenced by their team mates' smoking behavior than boys. These effects were stronger for girls-only boundary specification		Regression	20
Kreager	2011	449, 7-12 graders, US	Longitudinal	Friend nomination	Males more likely than females to report binge drinking			H Generalized LM (HGLM)	21
Balsa	2011	12547, 7-12th graders, US	Cross sectional	Friend nomination	Males used more alcohol in a bid to keep up with peer smoking			OLS	18

Kramer	2011	Total/final sample not mentioned (ADD Health), 7-12th graders,	Cross sectional	Friend nomination	Nothing on effects of gender differences	Ordered logistic regression	18
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Kiuru	2010	1419, Finnish 15 - 17 year olds	Longitudinal	School mates	No difference between genders	Males smoked more		ABM	22
Pollard	2010	Total/final sample not mentioned (ADD Health), 7- 12th graders, US	Longitudinal	Friend nomination	Nothing on gender differences			Latent growth analysis	21
Ali	2010	6549, 7 - 12th graders, US	Cross sectional	Closest friends	Nothing on gender differences			OLS	19
Kobus	2010	163, 6- 8th graders, IL, US	Cross sectional	Friend nomination	Nothing on gender differences			OLS	18
Mercken	2010	1326, 13 - 16 year olds, Finnish	Longitudinal	Best friend nominations		Nothing on effects of gender differences		ABM	22

Mercken	2009	7704, European adolescents, mean age 13	Longitudinal	Best friend nominations	Not discussed			ABM	22
Ali	2009	Total/final sample not clearly mentioned (ADD Health), 7- 12th graders, US	Longitudinal	Close friends and classmates	Not discussed			SEM	20
Popp	2008	1090, 12 - 18 year old Swedish	Longitudinal	Important peers (which can include friends, siblings, or romantic partners	Nothing on effects of gender differences			APIM	22
Ennett	2008	not clearly stated	Longitudinal	Best friend nominations		No differences between girls and boys regarding		Hierarchical growth model	20

		(maybe max of 6,891)				smoking involvement over the years			
Hall	2007	880, mean age 12.2, US	Longitudinal	Best friend nominations	Not discussed			SEM	20
Ennett	2006	5104, 12 - 18 year olds, NC, US	Longitudinal	Closest friend	Not discussed			HLM	21
Bot	2005	1276, 12 - 14 year olds, The Netherlands	Longitudinal	Best friend nominations	Males drank more			Hierarchical regression	20
Aloise- Young	2005	1630, 4- 7th graders, US	Longitudinal	People they "usually hang around with"		No difference		Loglinear ANOVA	19
Kirke	2004	267, 14 - 18 year olds, Ireland	Cross sectional	Peers nomination	Not discussed			Descriptives	18

Fang	2003	1040, 6 - 10th graders, China	Cross sectional	Best friend and other close friends		Smoking experimentation higher among boys		MANOVA	20
Ennett	1994	926, 8 - 10th graders, NC, US	Longitudinal	Best friend nominations	Not mentioned			Bivariate (Fisher's/Chi)	18
Ennett	1994	1092, 9th graders, NC, US	Cross sectional	Best friend nominations	Not mentioned but discussed gender composition of cliques which was then controlled			Bivariate	17
Ennett	1993	1092, 9th graders, NC, US	Cross sectional	Best friend nominations	Not mentioned but discussed gender composition of cliques which was then controlled			Chi-square	18

Ragan	2014	>12,000 6-9th graders, US	Longitudinal	Friend nomination	Females used more alcohol			ABM	22
Gaughan	2006	2980, 13- 21 year olds, US	Cross sectional	Friend nomination	Influence process in alcohol use varies with gender structure of networks			SEM	20