Substance use and HIV risk behavior among
black South African men who have sex with men

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ABSTRACT

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Black South African men who have sex with men (MSM) face a set of adverse circumstances, including economic hardship and stigmatization, that combine to put them at an elevated risk for hazardous substance use and HIV infection. This creates a context where substance use is normative and high-risk sexual behavior is often engaged in covertly and under the influence of intoxicating substances. The overarching objective of this dissertation was to explore determinants of hazardous drinking and HIV risk behavior among black South African MSM with a particular focus on the role of social networks. In order to achieve this, I used data drawn from the study, “HIV and Sexual Risk in African MSM in South African Townships” (R01-MH083557; PI: Sandfort, PhD). First, I conducted a systematic literature review to identify studies that used social network analysis to evaluate alcohol use among adults in order to answer the question: how have social network characteristics been shown to influence adults’ drinking behaviors, both in terms of characteristics of their network structures and characteristics of their network ties? Results of the review demonstrated that characteristics of one’s peers as well as social network structure influenced egos’ alcohol consumption in a variety of ways and across settings. Second, I described drug and alcohol use among black South African MSM and identified determinants of hazardous drinking, a highly prevalent form of alcohol use identified in the sample. The results showed that hazardous drinking was highly prevalent and multiple indicators of social vulnerability were identified as independent determinants of hazardous drinking. Third, I assessed the relationship between substance use and sexual risk behavior and explored the moderating effects of psychosocial factors. The results showed that there was not a
main effect between substance use and sexual risk behavior; however, among men with high intentions to engage in safer sex, substance use was associated with increased risky sexual behavior. Overall, this dissertation increased our understanding of social networks, substance use and HIV risk behavior among black South African MSM. Our results suggest the importance of using pre-existing social networks to deliver potential interventions. The results also suggest that the most vulnerable members of this community are at increased risk of hazardous drinking. Lastly, efforts to reduce HIV risk behavior should focus on both increasing safer sex intentions and negating the impact of substance use on sexual risk behavior. Taken together, these studies provide insight for developing potential interventions, including intervention that use social network data to facilitate behavioral change, as well as undertaking further research among a critical population.
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Chapter 1 Introduction

Background

Black South African men who have sex with men (MSM) face a set of circumstances that put them at an elevated risk for hazardous drinking and HIV infection. The majority of black South Africans reside in townships, peri-urban areas previously segregated under Apartheid that are characterized by limited resources, low levels of education, and high rates of unemployment (1). Black South African MSM suffer further deprivation because of the discrimination and stigma they face due to their sexual preferences (2, 3). Institutional channels, (e.g., civic or commercial institutions, such as Lesbian-Gay-Bisexual-Transgender (LGBT) community organizations) through which these men can interact are relatively scarce. There is no commercial gay subculture, save a few exceptions (i.e., in major metropolitan areas like Cape Town and Johannesburg). Therefore, black South African MSM are forced to meet other men through social networks, by traveling to gay clubs outside of the townships where many of them live, or going to informal drinking establishments (shebeens). These circumstances combine to create a context where substance use, particularly hazardous drinking, is normative and high-risk sexual behavior is often engaged in covertly and under the influence of intoxicating substances.

Accordingly, black South African MSM suffer from a disproportionate burden of hazardous drinking and HIV infection (4-13).

Social networks, sets of individuals linked together by one or more specific types of relations (14, 15), are of great importance to their members (16). Members of a shared social network influence each other by sharing information, expressing support, and creating social norms (17-20). In South Africa, where there is no commercial gay subculture (e.g. gay friendly bars and clubs) except for in a few major metropolitan areas (i.e. Cape Town and Johannesburg), social
networks are the primary context in which MSM learn how to express their sexuality, deal with stigma, and manage the risks of unprotected sex (21). Black South African MSM communities, particularly those in townships, mainly consist of geographically dispersed and often hidden social networks. Because they lack the identifiable civic and business institutions that characterize better-resourced MSM communities of urban North America, Western Europe, Australia, or even those of South Africa’s urban centers, these men are less effectively targeted through community venues and organization-based approaches to health promotion that have been institutionalized elsewhere. Due to the limited education and resources, and stigmatization of homosexuality, MSM often seek members of their personal network for trusted information and advice. Social networks can also play a major role in persistence of unhealthy behaviors (22-29). Research has documented associations between social norms and behaviors such as drug use (30), alcohol use (31, 32), smoking (33), and needle-sharing (17). The composition and characteristics of networks have also been linked to sexual risk behaviors (number of sexual partners, incidences of unprotected sex) (34), and networks have been shown to facilitate the spread of sexually transmitted infections (STI’s) (35-39). Given the potential importance of social networks in this setting, a comprehensive, systematic review of the literature that describes the application of social network analysis to the evaluation of alcohol use among adults (a salient health issue among this population) in previous scientific investigations is needed. Despite the known burden of substance use, particularly hazardous drinking, and its association with health risks, no study to date has identified risk factors for hazardous drinking among black South African MSM, nor any other African MSM population (40). Researchers have observed elevated rates of concurrent psychosocial problems, including heavy alcohol use, among non-African LGBT populations (41-46), noting that they work synergistically to increase risk of HIV
infection (46, 47). For example, mental health problems, including anxiety (48), and depression (49), often co-occur with substance use disorders, particularly alcohol dependence (43). Sexual minority stressors, such as internalized homophobia and external homophobia (i.e. experiences with sexual orientation-related discrimination), are associated with increased alcohol-related problems (43, 44), and are likely of heightened importance among black South African MSM where same-sex sexuality is highly stigmatized (50-55). All of these factors need to be explored as potential determinants of hazardous drinking among black South African MSM. Social network characteristics are also potential determinants of hazardous drinking as social networks are known to play a major role in many health-related behaviors (18, 24, 28, 34, 37, 39, 56). For example, the drinking behavior of an individual’s social network members often provides a crucial context for individual decisions on how much and how often to drink (57). One’s degree of connectedness to a specific social network has been found to be positively associated with one’s likelihood of reflecting the normative behavior of that group regarding substance use (58). Peers’ alcohol use has been found to be a primary influence on an individual’s alcohol use (59, 60). There is a potential heightened importance of social networks among stigmatized populations, such as black South African MSM (61). Therefore, a comprehensive understanding of hazardous drinking among black South African MSM should include an assessment of how they are influenced by psychosocial factors and social networks characteristics. The public health implications of potential findings could be particularly significant given the lack of other outlets through which to target them.

One potentially detrimental effect of drug and alcohol use is sexual risk behavior. Sexual risk behavior is especially important to investigate among populations with high rates of HIV (62), such as black South African MSM (9). HIV prevalence among the sample used for the empirical
analyses in this dissertation is 30% (63). While alcohol use has often been observed to be associated with sexual risk behavior, these findings have not always been consistent (64-66). Such inconsistencies have been observed among black South African MSM, in whom an initial study found that sexual risk behavior and alcohol use are common and that the two are associated (8), a finding, however, not replicated in a subsequent study (9). Findings regarding drug use and sexual risk behavior were also inconsistent.

One possible explanation for these inconsistencies is the unmeasured moderating effects of other psychosocial factors (67-79). Such factors impact the magnitude or even the direction of the effect of an exposure on an outcome. In a recent study conducted among black South African men who have sex with men (MSM), we found that reasons for drinking and intentions to engage in safer sex modified the relationship between substance use and HIV risk behavior, but that alcohol expectancies did not (77). Specifically, drinking led to sexual risk behavior among men who endorsed drinking to enhance social interaction but not among men who did not, while drug use led to increased sexual risk behavior among men who intended to engage in safer sex but not among men who did not (77). Indeed, the effects of substance use on sexual behavior are not necessarily homogeneous; they may be contingent on other factors. Thus, there is a need for research that assesses the relationship between substance use and sexual risk behavior among black South African MSM and explores the possibility of effect modification.

**Dissertation Overview**

The overarching objective of this dissertation is to assess determinants of hazardous drinking and explore the relationship between substance use and HIV risk behavior among black South African MSM with a particular focus on the role of social networks. This will be achieved through: 1) a comprehensive, systematic review of the literature that describes the application of
social network analysis to the evaluation of alcohol use among adults (Aim 1); 2) an empirical assessment of determinants of hazardous drinking, including individual risk factors and social network characteristics (Aim 2); 3) an empirical assessment of whether substance use predicts HIV risk behavior during a defined sexual encounter, including whether the relationship between substance use and HIV risk behavior is modified by reasons for substance use, expectations about their effect on sexual behavior, and safe sex intentions (Aim 3). Alcohol use, particularly hazardous drinking, will be the focus of the analyses for this dissertation because of its high prevalence in the sample (62%) and its potentially deleterious consequences in this context of high HIV prevalence. However, other drug use will be described among the sample. Furthermore, the item used to assess alcohol use prior to the defined sexual encounter that is the focus of the analyses in Aim 3 did not distinguish between alcohol or drug use; therefore, this dissertation will, at times, discuss substance use more generally, particularly in the context of that analysis and when reviewing literature that address both alcohol and drug use. Whenever possible, the terminology I use will reflect whether I am discussing alcohol use, drug use, or substance use (drug and alcohol use are not distinguished) This dissertation will use data drawn from the study, “HIV and Sexual Risk in African MSM in South African Townships” (R01-MH083557; PI: Sandfort, PhD) to achieve the empirical aims. This study used respondent-driven sampling (RDS) to recruit 480 black MSM in Tshwane, South Africa, thus providing information on these men’s ties to other MSM. A survey using previously validated measures to assess drug use, alcohol use, and sexual risk behavior was administered among these men. This dissertation is comprised of five chapters. Following this introductory chapter, Chapter 2 presents a systematic review of existing literature relevant to Aim 1. This review aims to answer the following question: how have social network characteristics been shown to influence adults’
drinking behaviors, both in terms of characteristics of their network structures and characteristics of their network ties.

Chapter 3, which addresses Aim 2, is motivated by the fact that no study to date has identified risk factors for hazardous drinking among an African MSM population (40), including black South African MSM, despite the known burden of hazardous drinking among these men and its associated health risks. This chapter aims to describe alcohol use among black South African MSM and identify determinants that put them at risk for hazardous drinking. Psychosocial factors and social network characteristics will both be considered as potential determinants.

Chapter 4, which addresses Aim 3, is motivated by the fact that while alcohol use has often been observed to be associated with sexual risk behavior, these findings have not always been consistent (64-66). These inconsistencies have been observed among black South African MSM where an initial study found that men who regularly consumed alcohol were more than four times as likely to engage in unprotected anal intercourse as those who did not (8). However, a subsequent study among another sample of black South African MSM found no relation between alcohol use and sexual risk behavior (9). Information regarding the relationship between drug use and sexual risk behavior among black South African MSM has also not been consistent. This first study measured drug use but found no association with sexual risk behavior (8). In the second study, recent marijuana use was protective against HIV infection, although buying drugs or alcohol for a partner was a predictor of HIV infection (9). These discrepancies have not been explored. Possible explanations for these inconsistencies include the unmeasured moderating effects of other psychosocial factors (67-79). In a recent study conducted among black South African MSM, we found that reasons for drinking and intentions to engage in safer sex modified the relationship between substance use and HIV risk behavior, but that alcohol expectancies did
not (77). One limitation to our study, and others that have examined effect modification when looking at the relationship between substance use and sexual risk behavior (72, 74), is that they relied on general measures of substance use and sexual risk behavior over a specific time frame but without regard to their temporal overlap. For this chapter, I use data from a specific sexual event, where I can discern whether substances were used in close enough temporal proximity that they could influence sexual activity, in order to assess the direct effect between substance use and sexual risk behavior and then to assess effect modification of this relationship by alcohol expectancies, reasons for drinking and safer sex intentions.

Chapter 5 presents a summary of the findings of this dissertation along with a discussion of implications and future directions.
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Chapter 2  Social Network Analysis to Examine Alcohol Use among Adults: A Systematic Review

Introduction

Social networks, sets of individuals linked together by one or more types of relations. Social networks can be formed around shared activities (e.g. sports teammates) or shared environments (e.g. schoolmates or neighbors). The study of social networks presumes that actors (or nodes) and actions are interdependent and that information and influence flows along the ties formed between people (1). Social networks and our increasing capacities to analyze them have made them of growing interest to researchers in disciplines ranging from anthropology to economics (2).

Social network analysis, a growing and heterogeneous field (3), is the term applied to the set of theories, methods and techniques used to investigate how social interactions between individuals influence certain outcomes (2). A fundamental concept in social network analysis is that it incorporates information about relationships between pairs of individuals (i.e., network members) (2). Data on social networks can be collected using two primary approaches (2). The first approach, egocentric networks, collect information about a person’s (i.e. an ego) social network (their alters) only from the ego’s perspective (2). Egocentric network data are limited to perceptions of those surveyed (i.e. the ego’s perceptions of alters’ behaviors or of ties between alters). The second approach, sociometric networks, provide a more comprehensive assessment of a social network by interviewing multiple members of the network (2). Sociometric techniques are most often used when studying discrete social networks whose boundaries can be easily defined, such as schools or office groups. While sociometric data are more laborious and challenging to collect, they have greater analytic possibilities because they allow one to measure
the actual behavior of alters, rather than just the ego’s perception of their behavior. Further, sociometric data provide a global view of a social network and its structure, including multiple members’ perspectives. Table 2.1 provides a list of many of the terms used in social network analyses and their definitions.

As with other phenomena, social networks matter to health (1). Social networks provide a structure through which communicable diseases can be transmitted. Social networks also allow for people to influence each other by sharing information, expressing support, and creating social norms (i.e. they are the context in which people display normative behavior amongst each other).

Social networks have been shown to play a major role in influencing many health-related behaviors, both healthy behaviors, such as smoking cessation or HIV prevention (1, 4-7) and unhealthy behaviors, such as drug use and HIV risk (8-10). Specific interventions have also been developed that utilize social networks to promote behavior change (11).

Social networks analysis has shown that social networks affect the health of their members in two main ways. One way is that characteristics of the social network structure influence health outcomes. Using this approach, the presence of social network ties in themselves (e.g. being connected versus isolated) are considered as determinants of health (12-14). Also using this approach, social network ties provide conduits along which a virus or information can spread (15-21). Analysis of the linkages among members of a social network often involves visualizing social structures (i.e. generating maps of persons and how they are connected), which allows for the identification of individuals that are critical for transmission based on their position within a network. A second way that social networks have been shown to influence the health of their members is that the characteristics of alters in one’s social network provide a context for the ego’s behavior and norms (22-25). Using this method, the characteristics of nodes themselves are
explored to assess their relationships to the characteristics of other nodes (e.g., do the substance use patterns of one’s close friends influence an individual’s substance use). While we distinguish between these two approaches, they are often inter-related; as for example, one’s degree of connectedness to a specific social network has been found to be positively associated with one’s likelihood of reflecting the normative behavior of that group (12). While it may seem obvious that understanding the structure and characteristics of social networks is relevant to communicable diseases, such as the spread of viruses and bacteria, social networks structure and characteristics have also been linked to non-communicable diseases (26, 27), even implausible ones, such as acne, height and headaches (28), and health behaviors, such as alcohol use (29-36). Alcohol use and heavy drinking constitute a major public health problem (37), contributing to morbidity (38) and mortality (39) worldwide. Alcohol consumption both shapes (i.e. people often form friendships while drinking) and is shaped by the presence of personal social network ties (i.e. one’s connectedness to specific social networks may be expressed through shared activities like drinking). Social networks may have grown or been maintained at drinking venues or events that involved drinking, and in such networks drinking behavior may be subject to social influence. Thus, an individual’s social network members’ drinking behaviors may provide a crucial context for individual decisions on how much and how often to drink (40).

Much of the empirical research that has used social network analysis to examine alcohol use has been conducted among adolescent populations (29-36, 41, 42). As evidence, a recent systematic review on the use of social network analyses to understand risky behaviors focused solely on empirical research conducted among adolescents, using the many papers that used data from the National Longitudinal Study of Adolescent to Adult Health (Add Health) (43). Taken together, these studies have shown that social network characteristics are important determinants of
adolescent drinking behaviors, both in terms of characteristics of their network structures and characteristics of their network ties. A similar review has not been conducted among adult populations, despite numerous empirical social network studies examining alcohol use among adults, especially young adults. This is a gap in our understanding as social network dynamics are different among adults than adolescents (44). Furthermore, alcohol consumption is a different phenomenon among adults as it can be consumed legally, thus the influence of social network dynamics might also be different.

The current paper aims to address this gap by answering the following question: how have social network characteristics been shown to influence adults’ drinking behaviors, both in terms of characteristics of their network structures and characteristics of their network ties? In order to answer this question, I systematically identified and described empirical studies that used social network analysis to evaluate alcohol use among adults (persons who are 18 years and older). This review will not be restricted to studies conducted among samples of MSM because there would be too few. This review is limited to studies that collected sociometric network data in order to focus on robust applications of social network analysis. I then synthesized the findings of identified studies that statistically measured the influences of social networks on alcohol use among adults. Because the methodologies used in social network analysis studies are heterogeneous, they do not lend themselves to meta-analysis. Therefore, a narrative synthesis of the studies was conducted. Understanding the contribution of social interactions to alcohol use will help to inform public health professionals on determinants of risk, as well as appropriate prevention and treatment strategies.
Methods

This review was informed by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement and the PRISMA checklist (45, 46) is shown in Table A1.1.

Data Sources and Literature Search

A literature search of 4 databases (PubMed/MEDLINE, EMBASE, PsycINFO and Web of Science, Sociological) was conducted in June 2017 to identify studies that used sociocentric social network analysis to evaluate the effects of social network characteristics on alcohol use. Keyword search strategies and terms varied based on the database (to account for distinct indexing criteria) and are described in detail in Table A1.2. To identify additional studies not found in the literature search, the reference lists of relevant reviews and included articles were reviewed. The literature search was conducted with guidance from an Education and Curriculum Librarian who serves as the Coordinator for Systematic Review Services at the New York University School of Medicine.

Inclusion and Exclusion Criteria

Duplicates were removed and screening of retrieved articles by title and abstract was conducted by two independent reviewers using Covidence systematic review software (Veritas Health Innovation, Melbourne, Australia. Available at www.covidence.org). Final inclusion was determined by two independent reviewers screening the full-text of potentially eligible articles using the following criteria. Studies were eligible to be included in the review if they were (1) published in a peer-reviewed journal, (2) written in English, (3) conducted in human populations, (4) utilized a social network analysis design for which sociometric data were collected (i.e., data linking participants were measured or inferred (e.g., known roommates were considered ties) and
data were collected among alters) and network visualizations were generated or network measures were calculated based on this data, (5) evaluated alcohol use as an outcome, and (6) included a majority of participants that were adults (18 years or older). There were no date restrictions in the inclusion criteria; studies from any year were potentially eligible to enter the review if they met the other inclusion criteria. In addition to the inclusion criteria, studies were excluded if (1) transmission was assessed using simulated networks, (2) social contact pattern data were collected but were not used in the context of a social network analysis, (3) the study described qualitative research or was a case study.

Quality Assessment

A 12-item quality assessment tool was used for the purposes of this review (Table A1.3) to evaluate study relevance and methodology. The tool was developed using modified sets of criteria from other quality assessment tools for assessing observational studies (47), network studies (48), and qualitative research studies (49). Articles with a quality score of less than 70% were excluded from the review because they did not have appropriate or sufficient data or reporting quality; although all articles identified met the criteria for inclusion.

Data Extraction and Synthesis

A data extraction form was developed to extract information on study objectives, study design and sampling approach, data collection method, setting and target population, participants, relational data collection (used to link study participants for the social network analysis), outcome measurement, social network analysis methods used to analyze the data and calculated measures, statistical analyses used (as relevant to social network analysis), and key findings.
Results

Identifying empirical studies

The database search yielded 5,155 records for screening (4,748 after removing duplicates) and an additional 35 were included for screening based on reference list review. The full text of 139 articles was reviewed to determine eligibility and 18 articles were judged potentially eligible and further assessed for quality and relevance (Table A1.4); ultimately, all 18 articles were included in the review (Figure 2.1) (50-67).

Describing included studies

Among the included studies, 15 were conducted in the United States (50-54, 56-61, 63, 65-67) and 3 were conducted in different European countries (55, 62, 64). The majority of studies (13) were conducted among university students (51-57, 59, 61-65), with 5 studies conducted in community settings (50, 58, 60, 66, 67). Half (9) of the studies were cross-sectional (51-53, 58, 59, 62-64, 67) and half (9) were longitudinal (50, 54-57, 60, 61, 65, 66). Characteristics of the included studies are summarized in Table 2.2. Sample selection procedures included the use of respondent-driven sampling (67), recruitment of entire peer groups (64), and the collection of complete sociometric social networks (56, 62, 65). Sample sizes ranged from 34 (65) to 15,197 (56). Mean age ranged from 18 years to 51 years. Proportion of male participants ranged from 25% (65) to 100% (55). Details of the studies, including objective, study period and design, setting, participant characteristics, data sources, social network measures, analytic methods, and major findings are presented in Table 2.3.

The objectives of the included studies were heterogeneous. Eight of the studies assessed the influence of characteristics of network structure (e.g., network density [the total number of
observed ties divided by the maximum number of possible ties] or betweenness centrality [the number of pairs of nodes a given node connects that would otherwise not be connected]) as exposures (51, 52, 55, 56, 58, 62, 65, 66). Twelve of the studies assessed characteristics of network ties (e.g. ties’ weekly alcohol consumption or ties’ beliefs about alcohol) as exposures (50, 52-54, 57, 59-61, 63, 64, 66, 67) (with 2 studies assessing both) (52, 66). Specific social network measures discussed in this review are listed and defined in Table 2.1.

The methods used in the included studies were also heterogeneous. All of the studies measured some form of alcohol consumption over a specific time period as the outcome, with some using as few as a single item and others measuring multiple forms of consumption using previously validated scales. Outcome measures included frequency of alcohol consumption, quantity of alcohol consumption, and frequency of binge drinking. One naturalistic observational study relied on observed counts of alcoholic drinks consumed (64) while the other 17 studies relied on self-reported data (50-63, 65-67), including one that compared perceived levels of alcohol consumption by peers to self-reported alcohol consumption by participants (63). There was also heterogeneity in the statistical analyses used to assess social network characteristics, although the majority used some form of regression modeling. Many of the longitudinal studies used Generalized Estimating Equations (GEE) to account for repeated measures. Overall, the methodologies described by the included studies were rigorous in terms of the data collected and the methods used to analyze it, as evidenced by all of the full-text studies that were identified exceeding the quality assessment threshold for inclusion in the review.
Synthesis of the findings

Despite the heterogeneity in social network measures and analyses, all of the included studies observed an association of a social network characteristic with an alcohol-related outcome. Studies that considered characteristics of network ties (e.g. ties’ weekly alcohol consumption or ties’ beliefs about alcohol) as exposures (50, 52-54, 57, 59-61, 63, 64, 66, 67) all found that the alcohol consumption of a participant’s peers was associated with the participant’s alcohol consumption. In a naturalistic observational study, peer group alcohol consumption was the strongest predictor of participants’ alcohol consumption (64). The studies that used longitudinal data to explore peer effects attempted to assess whether the observed association between peers’ and participants’ alcohol consumption (i.e. homophily, the tendency for nodes with similar characteristics to be connected) was a result of selection (i.e. individuals choose to befriend others who are like them), confounding (peers are similar because of a shared environment) or induction (friends influence each other to become more similar). Andrews et al. found support for selection for binge drinking and induction for quantity of alcohol consumption (50). Rosenquist et al. used data from the Framingham Heart Study to show how peer effects diminished across degrees of separation (66). The authors felt their findings provided more support for induction because the directionality of friendship nominations mattered and they controlled for participants’ previous alcohol consumption. Ott et al. showed how a novel Bayesian comparative calibration model could be used to improve estimates of self-reported consumption despite the peer-reports that it relied on being overestimates of individuals’ alcohol consumption (63).

Studies that assessed the influence of characteristics of network structure as exposures (51, 52, 55, 56, 58, 62, 65, 66) also all observed an association of a social network characteristic with an
alcohol-related outcome. Among young men who have sex with men in a community setting, Janulis et al. observed that transitivity (the extent to which the relation between two nodes in a network that are connected by an edge is transitive, or put more plainly, that friends of my friends are my friends) positively influenced an ego’s frequency of alcohol use (58). Among university students in Belgium, Lorant et al. found that centrality was positively associated with binge drinking (62). Barnett achieved the same finding among university students in the US (51). Among university students in Germany, Giese et al. observed that reciprocation of friendship only mattered with regards to participants’ frequency of drinking but not the quantity of alcohol they consumed (55). Using data from the young adults who participated in Wave 3 of the Add Health study, Hahm et al. observed that centrality was associated with binge drinking, although, in general, the strength of social network effects had diminished from adolescence into adulthood regardless of how robust the impact was during adolescence (56). This is not to say that social network effects do not matter during adulthood as multiple studies observed clustering of alcohol use and alcohol-related problems (52, 66). Studies that used longitudinal data also observed that social networks became more homophilous over time (65, 66).

**Discussion**

In this review, 18 studies were identified and evaluated to answer the following question: how have social network characteristics been shown to influence adults’ drinking behaviors, both in terms of characteristics of their network structures and characteristics of their network ties? Overall, these studies found that characteristics of one’s peers as well as social network structure influenced egos’ alcohol consumption in a variety of ways and across settings. Studies that explored the homophily of social networks observed that members of a shared social network became more alike over time in terms of drinking (65, 66) and that selection and induction were
both likely contributing factors (50, 66). These results suggest that social network effects, including both peer characteristics and social structure, influence alcohol consumption among adults.

There was a remarkable amount of heterogeneity in the ways that the included studies approached this topic, in terms of how social network characteristics were measured, visualized, and analyzed. There was also considerable heterogeneity in the studies in regards not related to social networks; for example, in the various ways alcohol use was measured. One outstanding fact is that a high proportion (72%) of studies were conducted in university settings. This is likely because it is easier to collect sociometric network data in institutionalized settings. Further, young adult populations might be more frequently studied because peer dynamics are expected to be stronger in young adulthood (i.e. an extension of adolescence) than in later adulthood (56). This points to the need to collect sociometric social network data among older adults where far less is understood about social network effects. In general, though, the use of social network analysis helped to capture, describe, and account for the complex flow of behaviors, information, attitudes and norms among individuals and the relationships that they form. Additionally, the application of network visualization and advanced statistical tests strengthened the inferences drawn.

Because of the heterogeneity in assessment strategies, the limitations of self-report, and the lack of generalizability within studies, it is difficult to make generalizations about the effects of social network characteristics on alcohol consumption among adults. Social network characteristics seem to influence alcohol consumption but they seem to work in a variety of ways. There also remains much to be explored about whether the homophily that has been observed among networks of adults is due to the proclivity to befriend people similar to oneself, the effects of
shared environments, or that this truly represents the spread of alcohol consumption. This is a particularly salient issue when researching alcohol consumption (as opposed to other health behaviors) because drinking is often a shared social activity.

This review and the study results have several limitations. First, only 18 studies were identified and deemed eligible to be included based on relevance and quality. This is likely because the use of social network analysis to study alcohol use among adults is much more challenging than studying peer effects among adolescents, where social network data are easier to collect and peer effects seemingly more salient. Articles may have been missed because the use of social network methods was not indicated in the title or abstract and thus they would not have been identified during the literature search. However, for that reason, a broad search was conducted and ultimately 4,780 articles were screened based on title and abstract. Similarly, many studies have used egocentric approaches to conduct social network analysis but these were excluded because they did not utilize sociometric data; such studies would have been identified by my search criteria but were excluded from the review. Second, the results of social network analysis studies are context specific and insights are likely to vary based on setting and the exposures and the outcomes that were measured. Attempts to synthesize across the included studies were difficult given their heterogeneity. Even findings within studies varied by whether the researchers were looking at frequency of alcohol consumption, quantity of alcohol consumption, or outcomes related to binge drinking. Further research is needed to implement some level of standardization across studies and to assess the replicability of findings in different settings. While there was heterogeneity with regards to study methodologies, there was much less with regard to types of study settings. Namely, 15 of the 18 studies were conducted among college students. Results showing the importance of peer effects on alcohol consumption across different college settings
speaks to the importance of peer effects during this developmental period, although they should not be assumed among older adults for whom social network dynamics differ (65). Finally, implementing social network analysis can be resource intensive, requiring extensive data collection and/or data mining. Network methods are still relatively novel in the context of substance use epidemiology, with 72% of the included papers published since 2010, and expertise and training are needed in order to conduct social network studies, analyze social network data, and interpret the results correctly.

Implications for research and intervention

Despite the limitations, this review demonstrated the utility of social network analysis for studying alcohol consumption among adult populations and its adaptability to various settings. To date, relatively few studies have used social network analysis to study alcohol consumption among adult populations, suggesting that these approaches are underutilized. However, social networks appear to matter when alcohol outcomes are considered, and social network analysis remains a powerful tool with the potential to explore their effects. These findings can be used to inform researchers, public health professionals, and policy makers about structures of networks, their role in the spread of alcohol use, and the potential for interventions that utilize these pre-existing networks to help reduce the burden of harmful alcohol consumption.
Figures

Figure 2.1. Flow diagram of search strategy and selection process

5,155 records identified through searches in electronic bibliographic databases, including Medline, PubMed, EMBASE, PsychINFO, and Web of Science

430 duplicate records removed

32 additional records identified through reference searching

4,757 potential titles and abstracts screened for reporting of empirical use of social network analysis to assess alcohol use among adult populations

4,618 of records excluded because deemed irrelevant

139 full-text manuscripts assessed for reporting on use of social network analysis to assess alcohol use among adult populations

121 manuscripts excluded because:
70 not among adult population
31 did not utilize relational data
9 alcohol not used as an outcome
6 qualitative
3 use simulated data
2 not available in English

18 manuscripts reporting on empirical use of social network analysis to assess alcohol use among adult populations selected for systematic review
### Tables

#### Table 2.1. Definitions of social network analysis terms and measures used in the reviewed articles

<table>
<thead>
<tr>
<th>Term/Measure</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure</td>
<td>Networked sets of nodes and the ties that connect them</td>
</tr>
<tr>
<td>Nodes</td>
<td>Represent distinct network members (e.g., study participants, places of social aggregation)</td>
</tr>
<tr>
<td>Ties</td>
<td>Represent relationships that link nodes within a network</td>
</tr>
<tr>
<td>Characteristic</td>
<td>A feature or quality belonging to a node</td>
</tr>
<tr>
<td>Network density</td>
<td>The total number of observed ties divided by the maximum number of possible ties</td>
</tr>
<tr>
<td>Degree centrality</td>
<td>The number of nodes that a given node can encounter within one step (i.e., they are directly connected)</td>
</tr>
<tr>
<td>Normalized group degree centrality</td>
<td>Number of nodes outside a given subgroup that are connected to nodes within the subgroup, normalized by dividing the group degree by the number of nodes outside the group</td>
</tr>
<tr>
<td>Betweenness centrality</td>
<td>The number of pairs of nodes a given node connects that would otherwise not be connected</td>
</tr>
<tr>
<td>Closeness centrality</td>
<td>How close a node is to all other nodes (directly and indirectly) as a function of geodesic distance</td>
</tr>
<tr>
<td>Reach centrality</td>
<td>The number of nodes a given node can encounter within x steps</td>
</tr>
<tr>
<td>Homophily</td>
<td>Tendency for nodes with similar characteristics to be connected</td>
</tr>
<tr>
<td>Transitivity</td>
<td>The extent to which the relation that relates two nodes in a network that are connected by an edge is transitive</td>
</tr>
</tbody>
</table>
Table 2.2.  Summary of characteristics of n=18 articles included in the systematic review

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Country</strong></td>
<td></td>
</tr>
<tr>
<td>US</td>
<td>15 (83)</td>
</tr>
<tr>
<td>Europe (Germany, Belgium, Netherlands)</td>
<td>3 (17)</td>
</tr>
<tr>
<td><strong>Setting</strong></td>
<td></td>
</tr>
<tr>
<td>College</td>
<td>13 (72)</td>
</tr>
<tr>
<td>Community</td>
<td>5 (28)</td>
</tr>
</tbody>
</table>
## Table 2.3. Summary of social network analysis studies with alcohol as an outcome among adult populations

<table>
<thead>
<tr>
<th>Study</th>
<th>Objective</th>
<th>Study details&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Social network measure(s)</th>
<th>Statistical analyses&lt;sup&gt;2&lt;/sup&gt;</th>
<th>Major findings related to the social network analyses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrews et al. (2002)</td>
<td>Examine if young adult peers are similar to each other in their use of substances and, if so, if the similarity is due in part to the socialization or influence of peers. Examine if similarity and influence vary as a function of the gender of the target participant or their peer.</td>
<td>US 294 young adults and both a same- and an opposite-gender best friend from moderate-sized northwestern urban areas from 1993-1996. 21.8 years = mean age (at baseline) 37% male. Interview with target participant and interview with a same- and an opposite-gender friend from among their 5-closest same- and opposite-gender friends.</td>
<td>Peers’ weekly consumption of alcohol and peers’ frequency of binge drinking’ in the past year.</td>
<td>Linear regression with GEE.</td>
<td>Observed a concurrent and prospective relation in binge drinking between the participant’s male and female friends and the participant, suggesting peer socialization as one process explaining the similarity between peers in binge drinking. Observed a concurrent, but not a prospective, relation between (a) both same- and opposite-gender friend’s alcohol use and the alcohol use of the participant, suggesting selection (influence of peers) as one process explaining the similarity between peers in alcohol use.</td>
</tr>
<tr>
<td>Barnett et al. (2014a)</td>
<td>Investigate five different social network characteristics (indegree centrality, betweenness centrality, outdegree, indegree reciprocity, and outdegree reciprocity) for alcohol use and alcohol-related problems in a college residence network</td>
<td>US 129 students living on a college campus in the NE. 48% male. Interview with SNQ of up to 10 people who lived in the residence hall.</td>
<td>Indegree centrality, betweenness centrality, outdegree, indegree reciprocity, outdegree reciprocity.</td>
<td>Simultaneous autoregressive (SAR) autocorrelation models.</td>
<td>Two network characteristics were significantly associated with alcohol use and a third showed an association for women only. Outdegree was significantly positively related to number of heavy drinking days. Betweenness centrality was significantly positively related to number of alcohol problems. Betweenness centrality and indegree reciprocity were significantly associated with greater alcohol problems for women.</td>
</tr>
<tr>
<td>Study</td>
<td>Objective</td>
<td>Study details</td>
<td>Study design</td>
<td>Data sources</td>
<td>Social network measure(s)</td>
</tr>
<tr>
<td>-----------------------------</td>
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</tr>
<tr>
<td>Barnett et al. (2014b)</td>
<td>Use a college residence hall peer network to examine associations between peer behaviors and alcohol use, marijuana use, and exercise behavior</td>
<td>US 129 students living on a college campus in the NE 48% male</td>
<td>Cross-sectional</td>
<td>Interview with SNQ of up to 10 people who lived in the residence hall</td>
<td>Cluster identification based on betweenness Weekly volume of alcohol consumed by direct ties</td>
</tr>
<tr>
<td>Duncan et al. (2005)</td>
<td>Explore how peers affect drug use and problematic sexual behavior among college students.</td>
<td>US 714 incoming students at a large, academically strong state university in 2002. 39% male</td>
<td>Cross-sectional</td>
<td>Interview (CIRP Entering Student annual survey) linked to interview of randomly assigned college roommate</td>
<td>Dichotomous high school binge drinking among roommate</td>
</tr>
<tr>
<td>Eisenberg et al. (2014)</td>
<td>Use the natural experiment of assigned college roommates to estimate peer effects for substance use and other risky behaviors.</td>
<td>US 1641 first-year college students at 2 large and competitive universities: one public, one private from 2009-2010 18.4 years = mean age (at baseline) 46% male</td>
<td>Longitudinal</td>
<td>On-line interview linked to randomly assigned roommate interview</td>
<td>Frequency of binge drinking among roommate Closeness among roommates</td>
</tr>
<tr>
<td>Study</td>
<td>Objective</td>
<td>Study details¹</td>
<td>Study design</td>
<td>Data sources</td>
<td>Social network measure(s)</td>
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</tr>
<tr>
<td>Giese et al. (2017)</td>
<td>Explore the role of friendship reciprocity in shaping frequency and quantity of alcohol consumption among university Freshmen</td>
<td>Germany 57 first semester psychology students at the University of Konstanz from 2008-2009 20.9 years = mean age (at baseline) 25% male</td>
<td>Longitudinal</td>
<td>Interview with SNQ that asked participants to nominate the 3 people that they liked most that week from the full list of participants</td>
<td>Outdegree nominations and indegree nominations</td>
</tr>
<tr>
<td>Hahn et al. (2012)</td>
<td>Describe the proportion of binge drinking Analyze long-term changes of binge drinking status by social network structures measured in adolescence.</td>
<td>US; National Longitudinal Study of Adolescent Health in 2001–2002 15,197 participants age range: 18 to 27 46% male</td>
<td>Longitudinal</td>
<td>Interview with SNQ that featured complete school rosters and students were asked to nominate 5 male and 5 female friends.</td>
<td>group integration, prestige, density, and proximity to the best friend’s substance use</td>
</tr>
<tr>
<td>Hussong et al. (2003)</td>
<td>Test whether drinking motives mediate the relation between personality and alcohol use and whether these predictors affect drinking in an individuals' friends.</td>
<td>US 86 same-gendered best friends (43 dyads) at a large, SE state university 18 years = mean 49% male</td>
<td>Longitudinal</td>
<td>1.5-hr session in which observational assessments and a survey were completed An experience-sampling protocol involving daily assessments of substance use over the 28-day period following the initial visit</td>
<td>Friend’s personality, friend’s drinking motives, friend’s frequency of alcohol use and friend’s frequency of heavy alcohol use</td>
</tr>
<tr>
<td>Study</td>
<td>Objective</td>
<td>Study details¹</td>
<td>Data sources</td>
<td>Social network measure(s)</td>
<td>Statistical analyses²</td>
</tr>
<tr>
<td>---------------------</td>
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</tr>
<tr>
<td>Janulis et al.</td>
<td>Examine relationships between network (i.e., transitivity and network size), dyadic (e.g., age difference), and individual characteristics and drug and alcohol behavior with substance use alters to better understand the social and contextual factors associated with substance use behavior among YMSM.</td>
<td>US 156 young men who have sex with men 20.1 years = mean age (at baseline) 100% male</td>
<td>Cross-sectional Individual interviews and RDS recruitment data</td>
<td>Transitivity, network size, dyadic frequency and type of drug use</td>
<td>Logistic mixed models with random intercepts</td>
</tr>
<tr>
<td>Kenney et al.</td>
<td>Examined how misperceptions of residence hall peers, both overall using a global question and those designated as important peers using person-specific questions, were related to students’ personal drinking behaviors.</td>
<td>US 108 students living on a college campus in the NE 49% male</td>
<td>Cross-sectional Interview with SNQ of up to 10 people who lived in the residence hall</td>
<td>Self-reported and peer-reported alcohol consumption</td>
<td>Network autocorrelation models</td>
</tr>
<tr>
<td>Study</td>
<td>Objective</td>
<td>Study details¹</td>
<td>Study design</td>
<td>Data sources</td>
<td>Social network measure(s)</td>
</tr>
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<tr>
<td>Latkin et al.</td>
<td>Examine the prospective association between baseline self-reported drug and alcohol use of the network members of injection drug users, and self-reported sexual behaviors and alcohol use at 5-month follow-up.</td>
<td>US 71 nontreatment inner-city injection drug users who volunteered for a network-oriented HIV preventive intervention and 227 members of their drug networks from 1991-1992. 38 years = mean age. 85% male.</td>
<td>Longitudinal</td>
<td>Detailed, face-to-face interview on background, HIV-related behaviors in the prior 6 months, and SNQ where they were required to provide names and descriptive information on their network members. Indexes were compensated $25 for each drug-sharing network member that came in to be interviewed.</td>
<td>Drug networks’ mean baseline level of alcohol consumption.</td>
</tr>
<tr>
<td>Lau et al.</td>
<td>Explore sources of stability and change in young adults’ beliefs and behavior concerning drinking during the first 3 years of college.</td>
<td>US 947 students admitted to Carnegie Mellon University and their parents. 69% male. 18 years = mean age (at baseline).</td>
<td>Longitudinal</td>
<td>Interviews among participants, their parents and up to 2 other participants in the study-roommates and people named by the youths as their best friends at college.</td>
<td>Parents’ alcohol beliefs, parents’ alcohol consumption, peers’ alcohol beliefs, peers’ alcohol consumption.</td>
</tr>
<tr>
<td>Lorant et al.</td>
<td>Analyze the role of peers and of social position within a university network in drinking behavior.</td>
<td>Belgium 487 undergraduates in 2 faculties (Engineering and Psychology) in a university in 2010. 45% male.</td>
<td>Cross-sectional</td>
<td>Paper-pencil questionnaires with SNQ where participants were provided with a complete list of all students to identify those with whom they had the following relationships: friends, roommates, studying or working with, and spending leisure time with.</td>
<td>In-degree centrality, closeness, cross-gender relationships, social capital (i.e. effective size).</td>
</tr>
<tr>
<td>Study</td>
<td>Objective</td>
<td>Study details&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Study design</td>
<td>Data sources</td>
<td>Social network measure(s)</td>
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<tr>
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</tr>
<tr>
<td>Ott et al. (2016)</td>
<td>Learn about the unknown average number of alcoholic drinks consumed on drinking days and the association between certain personal characteristics and alcohol consumption</td>
<td>US; 125 students living on a college campus in the NE who nominated other network members or who were nominated by other network members; 47% male</td>
<td>Cross-sectional</td>
<td>Interview with SNQ of up to 10 people who lived in the residence hall</td>
<td>Self-reported and peer-reported alcohol consumption</td>
</tr>
<tr>
<td>Overbeek et al. (2010)</td>
<td>Assess the relative importance of best friends’ alcohol use versus general levels of alcohol use in the peer setting for predicting young adults’ alcohol use</td>
<td>Netherlands; 221 young adults in 28 peer groups; 46% male majority groups</td>
<td>Naturalistic observation study</td>
<td>10-minute questionnaire followed by 2 hours observed drinking in a bar-lab</td>
<td>Peers’ quantity of alcohol consumption during the observation period</td>
</tr>
<tr>
<td>Phua (2011)</td>
<td>Examine the influence of popularity and conforming to perceived peer norms on smoking and drinking among college fraternity members using social network analysis</td>
<td>US; college fraternity at private university in SW; 34 freshmen pledges; 20.1 years = mean age (at time period 1); 100% male</td>
<td>Longitudinal interview</td>
<td>Interview with SNQ of other fraternity members</td>
<td>Homophily Popularity models (indegree nominations)</td>
</tr>
</tbody>
</table>

<sup>1</sup> Includes information about study design, data sources, and social network measure(s).

<sup>2</sup> Includes information about statistical analyses and major findings related to the social network analyses.
<table>
<thead>
<tr>
<th>Study</th>
<th>Objective</th>
<th>Study details</th>
<th>Data sources</th>
<th>Social network measure(s)</th>
<th>Statistical analyses</th>
<th>Major findings related to the social network analyses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rosenquist et al. (2010)</td>
<td>Explore quantitatively whether alcohol consumption behavior spreads from person to person in a large social network of friends, coworkers, siblings, spouses, and neighbors, followed for 32 years.</td>
<td>US: The Framingham Heart Study 12,067 persons assessed at several time points between 1971 - 2003. 50.9 years = mean age 48% male</td>
<td>Longitudinal Participant data, collected every 2 to 4 years, includes physical examinations, laboratory tests, noninvasive cardiac and vascular testing, battery testing, questionnaire results, demographic information, and SNQ self-described social ties, collected in each of the 7 waves of the study.</td>
<td>Alcohol consumption of social network ties at various degrees of separation. Clustering in alcohol consumption (homophily, confounding, induction)</td>
<td>Longitudinal logistic regression models using GEE to account for multiple observations Observed clustering of alcohol consumption within the network compared with 1000 simulated networks with same topology and prevalence of drinking as the observed network, but with the incidence of drinking randomly distributed across nodes.</td>
<td>Participants are 50% more likely to drink heavily if a person they are directly connected drinks heavily. The size of the effect is 36% for people at 2 degrees of separation and 15% for people at 3 degrees of separation. The effect disappears at 4 degrees of separation. Each heavy drinker in a participant’s social network increased the likelihood of drinking heavily by 18% and decreased the likelihood of abstinence by 7% but had no effect on moderate alcohol consumption behavior. Female contacts are significantly more likely than male contacts to influence the spread of heavy alcohol consumption.</td>
</tr>
<tr>
<td>Tucker et al. (2015)</td>
<td>Investigated whether substance use among emerging adults living in disadvantaged urban areas was influenced by peer and family social network messages that variously encouraged and discouraged substance use.</td>
<td>US, Birmingham, Alabama 344 residents of lower income neighborhoods recruited via RDS 18.9 years = mean age 68% female</td>
<td>Cross-sectional Individual 1.5-hour interviews and RDS recruitment data</td>
<td>Peer substance users in participants’ immediate social networks</td>
<td>Linear regression</td>
<td>Substance use (alcohol and other drugs) by close network members was associated with global substance involvement but not alcohol involvement, specifically.</td>
</tr>
</tbody>
</table>

1Participant age and sex and study dates are included if it was reported in the article
2Includes statistical tests that specifically incorporated network measures

Notes: SNA = social network analysis; SNQ = social network questionnaire; RDS = Respondent driven sampling
References


### Appendix

Table A 2.1. PRISMA 2009 checklist

<table>
<thead>
<tr>
<th>Section/topic</th>
<th>#</th>
<th>Checklist item</th>
<th>Reported on page #</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TITLE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Title</td>
<td>1</td>
<td>Identify the report as a systematic review, meta-analysis, or both.</td>
<td>13</td>
</tr>
<tr>
<td><strong>ABSTRACT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structured summary</td>
<td>2</td>
<td>Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.</td>
<td>Reported separately</td>
</tr>
<tr>
<td><strong>INTRODUCTION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rationale</td>
<td>3</td>
<td>Describe the rationale for the review in the context of what is already known.</td>
<td>13-14</td>
</tr>
<tr>
<td>Objectives</td>
<td>4</td>
<td>Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).</td>
<td>14</td>
</tr>
<tr>
<td><strong>METHODS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protocol and registration</td>
<td>5</td>
<td>Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.</td>
<td>N/A</td>
</tr>
<tr>
<td>Eligibility criteria</td>
<td>6</td>
<td>Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.</td>
<td>15</td>
</tr>
<tr>
<td>Information sources</td>
<td>7</td>
<td>Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.</td>
<td>15, Table A 2.2</td>
</tr>
<tr>
<td>Search</td>
<td>8</td>
<td>Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.</td>
<td>Table A 2.2</td>
</tr>
<tr>
<td>Study selection</td>
<td>9</td>
<td>State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).</td>
<td>15-16</td>
</tr>
<tr>
<td>Data collection process</td>
<td>10</td>
<td>Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.</td>
<td>16</td>
</tr>
<tr>
<td>Data items</td>
<td>11</td>
<td>List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.</td>
<td>16</td>
</tr>
<tr>
<td>Risk of bias in individual studies</td>
<td>12</td>
<td>Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.</td>
<td>16, Tables A 2.3-A 2.4</td>
</tr>
<tr>
<td>Summary measures</td>
<td>13</td>
<td>State the principal summary measures (e.g., risk ratio, difference in means).</td>
<td>N/A</td>
</tr>
<tr>
<td>Synthesis of results</td>
<td>14</td>
<td>Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., $I^2$) for each meta-analysis.</td>
<td>16</td>
</tr>
<tr>
<td>Risk of bias across studies</td>
<td>15</td>
<td>Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).</td>
<td>N/A</td>
</tr>
<tr>
<td>Additional analyses</td>
<td>16</td>
<td>Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**RESULTS**

| Study selection | 17 | Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram. | Figure 2.1 |
| Study characteristics | 18 | For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations. | Tables 2.2-2.3 |
| Risk of bias within studies | 19 | Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12). | Table A 2.4 |
| Results of individual studies | 20 | For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot. | Table 2.3 |
| Synthesis of results | 21 | Present results of each meta-analysis done, including confidence intervals and measures of consistency. | N/A |
| Risk of bias across studies | 22 | Present results of any assessment of risk of bias across studies (see Item 15). | N/A |
| Additional analysis | 23 | Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]). | N/A |

**DISCUSSION**

| Summary of evidence | 24 | Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers). | 19-20 |
| Limitations | 25 | Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias). | 20-21 |
| Conclusions | 26 | Provide a general interpretation of the results in the context of other evidence, and implications for future research. | 21 |

**FUNDING**

| Funding | 27 | Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review. | Reported separately |
### Table A 2.2. Literature review database search strategy and terms

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("alcohol use" OR "alcohol user" OR "alcohol users" OR "alcohol misuse" OR "alcohol abuse" OR "alcohol abuser" OR "alcohol abusers" OR "alcohol addict" OR "alcohol addicts" OR "alcohol dependence" OR "alcohol dependent" OR "drinker" OR "drinkers" OR "drinking" OR "alcoholic" OR "alcoholics") AND TOPIC: ("social network" OR "social networks" OR "network analysis" OR "network analyses" OR "friendship network" OR "friendship networks" OR "peer networks" OR "peer network")
Table A 2.3. Quality assessment tool

1. Is the research question clear and adequately substantiated?
   0 = Inadequately described
   1 = Adequately described
   2 = Very clear and well substantiated
2. Does the study include dates and sources for data collection?
   0 = No
   1 = Yes
3. Is the description of the study setting adequate?
   0 = No
   1 = Yes
4. Adequate sample size, where applicable
   0 = No or cannot be determined
   1 = Yes
   Not applicable
5. Adequate response rate (>60%), where applicable
   0 = No or cannot be determined
   1 = Yes
   Not applicable
6. Adequate sample selection
   0 = No or cannot be determined
   1 = Yes
7. Exposure measurement: Does the study clearly describe collection of social network data (i.e., sociometric interviews)?
   0 = No description
   1 = Mentioned, little description
   2 = Detailed description
8. Outcome measurement: Does the study clearly describe the outcome measure?
   0 = No description of case definition
   1 = Self-reported by participant
   2 = Used a validated measure or provided valid justification for not doing so
9. Social network analysis
   0 = No social network measures calculated
   1 = Social network measures calculated but not correlated with outcome
   2 = Social network measures calculated and correlated with outcome and/or used to define comparison groups
10. Is the description of findings thorough and are the data presented adequately?
    0 = No
    1 = Adequate
    2 = Very thorough
11. Are the strengths and limitations adequately considered?
    0 = No
    1 = Yes
12. Are the study conclusions supported by the results?
    0 = No
    1 = Possibly
    2 = Yes
Table A 2.4. Quality assessment of articles selected for review

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Chapter 3   Determinants of hazardous drinking among black South African MSM

Introduction

Black South African men who have sex with men (MSM) consume high levels of alcohol (1-3). In one study, nearly two thirds of men reported drinking regularly, with nearly half reporting that they get drunk regularly (2). In another study, over half of men reported having 10 or more drinks in a typical day of drinking and more than three quarters of men were classified as having a drinking problem (3). In another study, nearly three quarters of men reported having sex while under the influence of alcohol (1). Alcohol use and abuse constitutes a major public health problem, contributing to injury, disease and death. Hazardous drinking is of particular concern among this population due to the high prevalence of HIV, which estimates range between 13% and 50% (1, 3, 4), and the increased risk of HIV infection associated with excessive drinking (5-8). Alcohol use has also been shown to have negative health consequences among people living with HIV, including lack of viral suppression, common comorbid conditions, and ultimately morbidity and mortality through both biological and behavioral mechanisms (9). Despite the known burden of hazardous drinking and its associated health risks, no study to date has identified risk factors for hazardous drinking among black South African MSM, nor any other African MSM population (10).

Researchers have observed elevated rates of concurrent psychosocial problems, including heavy alcohol use, among non-African LGBT populations (11-16), noting that they work synergistically to increase risk of HIV infection (16, 17). For example, mental health problems, including anxiety (18), and depression (19), often co-occur with substance use disorders, particularly alcohol dependence (13). Sexual minority stressors, such as internalized homophobia and external homophobia (i.e. experiences with sexual orientation-related discrimination), are
associated with increased alcohol-related problems (13, 14), and are likely of heightened
importance among black South African MSM where same-sex sexuality is highly stigmatized
(20-25). Social network characteristics are also potential determinants of hazardous drinking as
social networks are known to play a major role in many health-related behaviors (26-32). For
example, the drinking behavior of an individual’s social network members often provides a
crucial context for individual decisions on how much and how often to drink (33). One’s degree
of connectedness to a specific social network has been found to be positively associated with
one’s likelihood of reflecting the normative behavior of that group regarding substance use (34).
Peers’ alcohol use has been found to be a primary influence on an individual’s alcohol use (35, 36).
There is also a potential heightened importance of social networks among stigmatized
populations, such as black South African MSM (37).
This paper aims to describe alcohol use among black South African MSM and identify
determinants that put them at risk for hazardous drinking. The data for this project were collected
among black MSM living in Tshwane, South Africa. These men currently live in or have
recently moved from township communities. Township communities are peri-urban areas (the
landscape interface between town and country) previously segregated under Apartheid whose
residents continue to be characterized by limited resources, low levels of education, and high
rates of unemployment. Personal social networks are the primary context in which these men
learn how to express their sexuality, deal with stigma, and manage the risks of unprotected sex
(38). They meet potential sex partners predominantly through these social networks or at
drinking establishments. These circumstances combine to create a context where substance use,
particularly excessive substance use, is normative (1, 2, 4). Respondent-driven sampling (RDS)
was chosen as the method to recruit these men because it is the most reliable way to derive valid population estimates for hidden populations such as black South African MSM (39).

**Methods**

*Study population and procedures*

The data used for the current project was collected as part of a study whose primary objective was to determine the prevalence of HIV infection among black MSM in Tshwane (4). Participants were recruited using RDS (40, 41). Eligibility criteria for study participation included age older than 18; having engaged in oral, anal, or masturbatory sex with another man in the prior 12 months; living, working, or socializing in the Tshwane metro area; fluency in English, Sepedi (Northern Sotho), or isiZulu; and willingness to take an HIV rapid test.

Consistent with RDS methodology, seeds, 20 in total, distributed up to five coupons to eligible men from their social networks who they were willing to recruit into the study. The seeds were referred by the community advisory board, screened to ensure that they met all of the study eligibility criteria and then interviewed about their social network size and composition. All seeds were Black and were purposively selected based on geographic place of residence in the Tshwane metro area and age. Men enrolled in the study and completed study procedures, including a 90-minute interviewer-administered computer-assisted personal interview and an HIV blood test, which was conducted following a serial algorithm in accordance with South African national guidelines. All participants were screened by licensed nurses using two licensed rapid test kits (EZ Trust HIV 1 & 2, CS Innovation; First Response, Premier Medical Corporation). Non-reactive samples were interpreted as negative. Samples that were reactive on both tests were confirmed as positive. There were no indeterminate results. Staff provided participants with up to five recruitment coupons for further distribution. All study participants
received vouchers worth 150 South African Rand (~$12 US Dollars) to be redeemed at a supermarket as primary incentive for their own participation, as well as additional vouchers worth 50 South African Rand (~$4 US Dollars) as secondary incentives for each successful referral to the study. At one point, verification of the inclusion criteria was expanded in order to ensure that all participants met the inclusion criteria. We did not observe evidence of anything else that might have threatened the integrity of the recruitment process. Participants were linked to their referral chain using their coupon identification numbers. All study procedures were approved by the Institutional Review Board of the New York State Psychiatric Institute in the U.S. and the Research Ethics Committee of the Human Sciences Research Council in South Africa. Participants provided written informed consent for the survey. Study staff provided referrals for further HIV testing and counseling, mental health, or primary care as indicated.

Measures

Scales adapted for and previously validated in South Africa were used whenever possible. Multiple aspects of alcohol use practices were evaluated (42, 43). First, men were asked if they ever drank alcohol, then if they drank alcohol in the past year. Men replied ‘yes’ or ‘no’. They were then asked where they drink and what they drink. They were also asked if they drink before going out, if they pay for their own drinks, if they buy drinks for men that they want to have sex with, or if men who want to have sex with them buy them drinks. Men replied on 5-point scales (e.g. “Never” (0) – “Always” (4)). Hazardous drinking was evaluated using the Alcohol Use Disorders Identification Test - Consumption (AUDIT-C), (44, 45), a scale developed and validated by the World Health Organization for international use, including in South Africa (44-46), where it has been used in multiple studies (47-49). The AUDIT-C uses 3 items: how often the respondent drinks, how many drinks the respondent consumes in a typical day of drinking,
and how frequently the respondent drinks six or more drinks at a time. Of a maximum score of 12 on the AUDIT-C, a score of four or more indicates hazardous drinking for men (50). Drug use practices were measured by asking men if they had ever used marijuana, poppers, cocaine, opiates, hallucinogens, amphetamines, and other club drugs. If they replied yes to any of these, they were asked if they had used them in the past year.

The survey also measured demographic characteristics (age, education, income, residence), psychosocial factors and behavioral attributes. Men’s reasons for drinking were assessed using eleven items (51), representing three domains: drinking for a positive affect ($\alpha = 0.87$), drinking to cope with negative affect ($\alpha = 0.91$) and drinking to enhance social interactions ($\alpha = 0.80$); (overall $\alpha = 0.95$). A sample item on the drinking to enhance social interactions scale is: “In the past year, how often did you drink because a drink helps you to have better sex?” Men replied on a five-point scale (“Never” (1) – “Always” (5)). Men who did not drink were assigned to “Never” (1) on all of these items. The Sex-Related Alcohol Expectancy Scale (52, 53) was used to assess men’s expectancies about the effects of alcohol use on sexual behavior, representing three domains: enhancement of sexual experience ($\alpha = 0.93$), increased sexual risk taking ($\alpha = 0.91$), and disinhibition of sexual behavior ($\alpha = 0.88$) (54, 55); (overall $\alpha = 0.95$). A sample item is: “After a few drinks of alcohol I am more sexually responsive”. Men replied on a 4-point Likert scale (“Strongly disagree” (1) - “Strongly agree” (4)). Sexual attraction was assessed with the question “Do you currently feel more sexually attracted to men or to women?” and a 5-point response scale (1=“Only to women”; 5=”Only to men”). Men were coded as ‘Only attracted to men’ and ‘Also attracted to women’ because of the distribution of the participants’ responses. Sexual identification was assessed with the question “What word would you use to describe your sexuality? Would you call yourself gay, bisexual, or straight, or would you use another word?”
There were a few men (n=2) who described themselves as transgender and they were grouped with other gay men because of how they overlapped in terms of other measures of sexual identity (e.g. masculinity/femininity, sexual attraction to women, etc.). There were also a few straight men (n=15) who reported sex with other men in the previous 12 months who were grouped with bisexual men because of how they overlapped in terms of other measures of sexual identity. Self-perceived masculinity/femininity was assessed with a 6-item scale with 3 items assessing level of masculinity and femininity each (α = 0.95). Sexual identity confusion and internalized homophobia were assessed with subscales adapted from the Lesbian, Gay, and Bisexual Identity Scale (LGBIS) (57, 58). Sexual identity confusion was assessed with 4-items (e.g., “I am not totally sure what my sexual orientation is”) (α = 0.89). Internalized homophobia was assessed with 7-items (e.g., “I wish I were only sexually attracted to women”) (α = 0.85). Secrecy about one’s sexual orientation was assessed with a 8-item scale (α = 0.96). Gender dysphoria was assessed over the past year using a 16-item scaled adapted from the Gender Identity/Gender Dysphoria Questionnaire for Adolescents and Adults (60, 61) (α = 0.93). Sample items include: “How often have you thought of yourself as a woman in the past 12 months?” and “How often have you felt unhappy about having a male body in the past 12 months?” and used a 5-point response scale (1=“Never”; 5=”Always”). Sexual orientation-based discrimination was assessed using a 10-tem scale asking how often in the past year men had experienced such things as verbal insults, threats of physical violence, sexually harassment or rape because of having sex with men; items used a 4-point response scale (0=“Never”; 4=”Often”) (α = 0.87). Men were also asked if they had ever experienced sexual abuse as a child, and if they ever received money or other incentives in return for sex (transactional sex). The survey also had brief screening questions for two mental health conditions: anxiety and depression. Anxiety was considered
positive if the participant responded ‘yes’ to the following two yes/no items: “Have you ever in your life had an anxiety attack — suddenly feeling fear or panic?” and “Have you had an anxiety attack in the last 4 weeks?” (62). Depression was assessed using the 2 items: “Over the last 2 weeks, how often have you been troubled by any of the following problems: little interest or pleasure in doing things?” and “Over the last 2 weeks, how often have you been troubled by any of the following problems: feeling down, depressed or hopeless?” Each item featured a 5-point response scale (“Not at all” (0) – “Nearly every day” (3)) ($\alpha = 0.84$) (62, 63).

The data on social network characteristics were acquired by having used RDS (64). This data includes connectedness to a social network of MSM, which is estimated using outdegree centrality: the number of other men that a participant successfully recruited for inclusion in the study (65). Using this operationalization, connectedness reflects a participant’s ability to successfully recruit additional participants into the study. Reports of alcohol use among members of one’s social network who also participated in the study were used to estimate social network drinking. For this study, social network drinking behavior was calculated as the proportion of a participant’s ties that screened positive as hazardous drinkers using the AUDIT-C. That value was then weighted towards the mean by the inverse proportion of the number of ties that we had data on over the maximum number of ties.

*Statistical analyses*

The specific objectives of our analyses were to: 1) describe alcohol use and abuse among black South African MSM; 2) describe associations between individual characteristics, social network characteristics and hazardous drinking; 3) assess which characteristics are independently associated with hazardous drinking.
Tests to determine which variables were associated with hazardous drinking included t-tests for continuous and scaled variables and Chi-squared tests for dichotomous variables. All predictors explored in bivariate analyses were included in the final multivariable model. Multivariable analyses were run using logistic regression for the outcome of hazardous drinking (yes versus no). All statistical tests were 2-sided and p<.05 was considered statistically significant. Statistical analyses were performed with SPSS (version 17.0; SPSS, Chicago, IL) and R (version 3.3.2; R Core Team, Vienna, Austria) software packages.

Since RDS was the recruitment method used for this sample, all analyses were adjusted using an RDS II estimator (66, 67). This approach gives greater weight to those men with a small personal network size, since those men would be less likely to be recruited into the study. Equilibrium for certain characteristics was assessed and considered to be achieved when the proportions of the dichotomized variable changed by less than .02 between waves.

**Results**

**Sample characteristics**

In total 480 eligible participants were recruited in 18 waves between August 2011 and January 2013. All results presented are RDS-weighted. The mean number of peers recruited by each participant was 0.7. The coupon return rate was 32% (460/1417). Among the 20 seeds, 40% were less than 24 years old, 75% had some post-secondary education, 65% had a regular income, and 90% lived in a township (versus metropolitan Tshwane). Among the entire sample, most men (57%) were less than 24 years old, 52% had some post-secondary education, 35% had a regular income, and 57% lived in a township (see Table 3.1). The study reached equilibrium on the following characteristics in the respective waves: age (wave 2), education (wave 3), income (wave 3), township status (wave 12), sexual identity (wave 3), sexual attraction (wave 3) and
HIV status (wave 2). The sample has been described previously (4, 68). The prevalence of HIV among the sample was 30% and hazardous drinking was identified as an independent risk factor for HIV infection (aOR=1.8, 95%CI=1.1-3.1, p<.05) (4).

Alcohol and drug use
Most men (86%) had consumed alcohol in their lifetime, including 77% of men who had consumed alcohol in the past year. Among men who consumed alcohol in the past year, 49% consumed mostly beer, 36% consumed mostly cider (fermented alcoholic beverage made from apples), 9% (n=33) consumed mostly wine, and a small proportion (4%) consumed mostly spirits. The majority of men mostly consumed alcohol in bars and shebeens (informal drinking establishments located in townships) (53%), although many consumed alcohol equally as often at home as they did while going out (27%) or mostly at home (20%). Most men (53%) said they commonly consumed alcohol before going out to a bar or shebeen. More than half of men (51%) reported either buying alcohol for men that they wanted to have sex with or being bought alcohol by men who wanted to have sex with them.

In response to the items that comprise the AUDIT-C: 20% of men drank twice a week or more, 29% drank 2-4 times per month, and 28% drank once a month or less. A fifth of the men (21%) reported that they have 10 or more drinks on a typical day that they are drinking, 11% have 7 to 9 drinks, 23% have 5 or 6 drinks, 17% have 3 or 4 drinks, and only 5% have 1 or 2 drinks. A quarter of men (24%) reported that they have 6 or more drinks on a single occasion weekly, 22% have 6 or more drinks on a single occasion monthly, and 22% have 6 or more drinks on a single occasion less than monthly but not never. The mean AUDIT-C score was 4.7 and the median AUDIT-C score was 4.4. More than half of the men (62%, 95%CI=56%-68%) screened positive
as hazardous drinkers. Figure 3.1 shows the distribution of these men among the recruitment threads. The study reached equilibrium on hazardous drinking after 2 waves.

In the past year, 16% of men had used drugs. Men most commonly used marijuana (15%). A few men had used poppers (<1%), cocaine (1%), crack (<1%), crystal methamphetamine (<1%), methaqualone (<1%), hallucinogens (<1%), heroin (1%), or amphetamines (3%). Because hazardous drinking was found to be the vastly predominant form of substance use among this population, it served as the focus of all further analyses.

*Reasons for drinking and Sex-Related Alcohol Expectancies*

Table 3.2 shows the results of how reasons for drinking and sex-related alcohol expectancies correlated with hazardous drinking. Men who screened positive as hazardous drinkers were more likely to endorse drinking for a positive affect (p<.001), drinking to cope with negative affect (p<.001) and drinking to enhance social interactions (p<.001). Men who screened positive as hazardous drinkers were more likely to expect alcohol to enhance sexual experience (p<.001), increase sexual risk taking (p<.001) and disinhibit sexual behavior (p<.001).

*Correlates of hazardous drinking*

In bivariate analyses, men who screened positive as hazardous drinkers were more likely to have a secondary education or lower (P=.03), identify as straight or bisexual (versus gay; p=.01), be attracted to both men and women (P<.001), have ever received money or other incentives in return for sex (p<.001), have been sexually abused as a child (p<.001), have higher levels of probable anxiety (p<.001), experience more gender dysphoria (p<.01), and have higher levels of probable depression (p=<.01) (see Table 1). Men who screened positive as hazardous drinkers were not more connected, on average, to this social network of MSM (p=.77). Men who screened
positive as hazardous drinkers had a higher proportion of friends, on average, who were also hazardous drinkers (p=<.01)

Table 3.3 shows the results of both unweighted and RDS-weighted multivariable analyses looking at independent correlates of hazardous drinking. The measures of association from the unweighted and RDS-weighted analyses are similar in terms of their direction and strength of association. There are multiple discrepancies in terms of achieving statistical significance.

Among RDS-weighted analyses, living in a township (versus the city of Pretoria) (aOR=1.9, 95%CI=1.2-3.1, p<.01), more gender dysphoria (aOR=1.4, 95%CI=1.0-1.8, p=.03), having ever received money or other incentives in return for sex (aOR=2.4, 95%CI=1.3-4.3, p<.01), having been sexually abused as a child (aOR=2.6, 95%CI=1.1-6.4, p=.03), having anxiety (aOR=5.4, 95%CI=1.2-24.3, p=.03), and social network drinking behavior (aOR=5.4, 95%CI=1.2-24.3, p=.03) were positively associated with hazardous drinking. Being sexually attracted only to men (aOR=0.3, 95%CI=0.1-0.8, p=.01) was negatively associated with hazardous drinking.

Discussion

Black South African MSM were found to have high levels of alcohol use; nearly two thirds (62%, 95%CI=56%-68%) of them screened positive as hazardous drinkers. Various factors were found to increase men’s likelihood of being hazardous drinkers. Men who live in a township (versus the city of Pretoria), men with higher levels of gender dysphoria, men who had ever received money or other incentives in return for sex, men who had been sexually abused as a child, and men with anxiety were all more likely to be hazardous drinkers. Men who reported being sexually attracted only to men were less likely to be hazardous drinkers. Men whose social networks included a higher proportion of hazardous drinkers were more likely to be hazardous drinkers themselves.
The high levels of alcohol use found in the current study are comparable to what has been described in other studies conducted among black South African MSM, which focused on alcohol use as a risk factor for risk behavior (2) or HIV infection (1, 3). In one study, nearly two thirds of men reported drinking regularly, with nearly half reporting that they get drunk regularly (2). In another study, over half of men reported having 10 or more drinks in a typical day of drinking and more than three quarters of men were classified as having a drinking problem (3). In another study, nearly three quarters of men reported having sex while under the influence of alcohol (1). Substance use is a major health concern among this population, especially given its association with high risk sexual behavior (5-8) in this setting of high HIV prevalence (1, 3, 4). Despite the heavy burden of alcohol use, among these men and other African MSM populations, the authors were unable to identify any implemented interventions that have targeted alcohol use among these men or any other African MSM population (10). Clearly, this is a public health problem that merits further attention.

Men who were hazardous drinkers were more likely to endorse drinking for a positive affect, drinking for negative effect and drinking to enhance social interaction. Men who were hazardous drinkers were also more likely to expect alcohol to enhance sexual experience, increase sexual risk taking and disinhibit sexual behavior. Much of the research on reasons for drinking and sex-related alcohol expectancies indicate that drinking is more likely to have an intended effect on people that endorse these beliefs (69-73), thus suggesting that hazardous drinking additionally leads to increased sexual risk behavior.

The current project is the first to identify determinants of hazardous drinking among a sample of African MSM. Living in a township (versus metropolitan Tshwane), a construct that captures the vulnerability of living in a low resource setting, was found to increase men’s likelihood of being
hazardous drinkers. This risk factor has been observed as an important indicator of social vulnerability and predictor of health risk in studies conducted among black South African MSM (74-77).

Other indicators of social vulnerability were also found to increase men’s likelihood of being hazardous drinkers. The relationships we observed are in accordance with what has been found among non-African MSM populations. Indicators of sexual minority stress, such as gender dysphoria, have been found to be associated with substance abuse (13, 14, 18). In this study, gender dysphoria predicted hazardous drinking while controlling for other same-sex characteristics, suggesting that there is something uniquely detrimental about these feelings that they contribute to hazardous drinking. Similar to our findings, other studies have found childhood sexual abuse (78, 79) and mental health indicators, including anxiety (13, 18), to predict substance abuse among non-African MSM populations. These findings are of heightened concern because of how these co-occurring health problems work synergistically to increase risk of HIV infection (16, 17).

Men who reported being sexually attracted to both men and women were more likely to be hazardous drinkers than men who reported sexual attraction to only men. This result was observed while controlling for other potentially more proximal psychosocial characteristics that might help explain the association, such as sexual identity confusion or internalized homophobia. Another potential explanation for this might be that local community social support networks are stronger for gay MSM than they are for bisexual MSM. Further research into the dynamics of how sexual identity contributes to risk among these men, both in terms of hazardous drinking and sexual vulnerability, is needed.
The current project is also the first to consider social network characteristics in the evaluation of substance use among a sample of African MSM. We found that the size of men’s social network did not impact men’s likelihood of being a hazardous drinker, although the drinking behavior of their social network members did. This finding speaks to the importance of the characteristics of social network ties because they provide a context for behavior and norms (30, 80-82), more than concern for the presence of social network ties in themselves (i.e. being connected versus isolated) (29, 34, 83). This is an area that merits further exploration, particularly given the heightened importance of social networks in this setting (37) and their potential as conduits for an intervention (84).

There are certain limitations to the current study. The cross-sectional research design limits the ability to infer causality. For example, we assume that the drinking behaviors of one’s social network members influences one’s own drinking behavior. However, these findings may also reflect that men who drink more tend to befriend other men who drink more. The social network data used in the study was limited to recruitment information collected routinely as part of the application of RDS. The social network data available could be considered sociocentric in that multiple members of men’s social networks were interviewed; however the study did not utilize a social network design and thus much information about these men’s social networks is missing. For instance, we do not know about connections between men other than the ones who recruited each other. Also, we did not collect any information about the nature of the relationships between men, including if they were sexual partners. The measures that we did estimate, such as connectedness (outdegree centrality), reflects a participant’s ability to successfully recruit additional participants into the study as much as it likely reflects their actual connectedness to other MSM in Tshwane. There were also certain findings that were not in agreement with our
expectations. For example, it is not clear why being sexually attracted only to men decreased men’s likelihood of being a hazardous drinker when in previous research this was found to predict alcohol dependence (13). Furthermore, some potential risk factors were not found to be associated with hazardous drinking. This likely speaks to the exploratory nature of this study, given the lack of previous research among African MSM populations, as well as the complexity of substance use and psychosocial health among men in this setting (4, 85, 86). These issues merit further exploration. The outcome measure, hazardous drinking, as assessed by the AUDIT-C, was chosen because hazardous drinking is of concern in this context of high HIV prevalence, particularly as heavy alcohol consumption, or binge drinking, might increase risky sexual behavior. Using the AUDIT-C criteria to identify hazardous drinkers, though, could include regular, moderate drinkers. Further analyses are warranted that explore different operationalizations of alcohol use and the prevalence of binge drinking, as well as dependent drinking. Unfortunately, the study did not collect information on being on treatment for HIV. Given how few men knew their current HIV status, the limited availability of antiretroviral therapy (ART) during the study period and the criteria for starting treatment at the time, we suspect that few men were on ART. The mental health measures, anxiety and depression, were limited to 2 brief screening questions each and are not robust measures of psychiatric disorder. The current study was conducted among black South African MSM and may have limited generalizability outside of that setting. The constructs used were almost exclusively developed in Western settings, and while many of them have previously been demonstrated to be reliable and valid, including many in South Africa, there may be additional culture-specific factors that have not been accounted for. Lastly, the data collected are self-reported and could have been subject to social desirability or recall bias.
In summary, the current study expands the literature by providing further evidence of the severity of excessive alcohol use among black South African MSM. Various determinants of hazardous drinking were identified, including many indicators of social vulnerability. The findings are of concern because these health problems often work synergistically to increase risk of HIV infection. The drinking habits of men’s social network ties also was highly correlated with men’s own drinking habits. These findings should be taken into consideration by efforts aimed at reducing hazardous drinking among this critical population. Specifically, intervention strategies should consider targeting MSM who are the most vulnerable, those who live in townships, who have had to engage in sex for money or favors, who have a history of childhood sexual abuse or who suffer from other mental health problems. Possible interventions might include those that not only target individuals but their social networks. Efforts aimed at reducing hazardous drinking are greatly needed. Specifically, interventions that use social network data to reduce hazardous drinking appear to be warranted. Network interventions include opinion leader interventions, where influential members of a social network are used to disseminate behavior change messages, or using other more strategically located members to diffuse behavior change messages through a social network. When considering social network approaches to designing an intervention, it is important to note that social network interventions are not a one-size-fits-all model, but that they depend on the goals and objectives for that intervention.
Figures

Figure 3.1. Distribution of hazardous drinkers among networks, with 3 distinct network chains extracted.
### Tables

**Table 3.1. Characteristics of MSM by hazardous drinking**

<table>
<thead>
<tr>
<th>Demographic characteristics</th>
<th>Total</th>
<th>Hazardous drinking</th>
<th>No hazardous drinking</th>
<th>$\chi^2$</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>N (%)</td>
<td>N (%)</td>
<td>N (%)</td>
<td>N (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23 or younger</td>
<td>272</td>
<td>171</td>
<td>101</td>
<td>0.3</td>
<td>0.61</td>
</tr>
<tr>
<td>24 or older</td>
<td>208</td>
<td>126</td>
<td>82</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary or lower</td>
<td>229</td>
<td>153</td>
<td>76</td>
<td>4.5</td>
<td>0.03</td>
</tr>
<tr>
<td>Post secondary</td>
<td>251</td>
<td>144</td>
<td>107</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Regular income</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>311</td>
<td>192</td>
<td>119</td>
<td>0.0</td>
<td>0.97</td>
</tr>
<tr>
<td>Yes</td>
<td>168</td>
<td>104</td>
<td>64</td>
<td></td>
<td></td>
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<tr>
<td><strong>Living in a township</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>204</td>
<td>109</td>
<td>95</td>
<td>10.2</td>
<td>0.00</td>
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<tr>
<td>Yes</td>
<td>274</td>
<td>186</td>
<td>88</td>
<td></td>
<td></td>
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<tr>
<td><strong>Psychosocial factors (dichotomous)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sexual identification</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gay or transgender</td>
<td>332</td>
<td>192</td>
<td>140</td>
<td>6.7</td>
<td>0.01</td>
</tr>
<tr>
<td>Bisexual or straight</td>
<td>145</td>
<td>102</td>
<td>43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sexual attraction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Only attracted to men</td>
<td>320</td>
<td>177</td>
<td>143</td>
<td>17.5</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Also attracted to women</td>
<td>160</td>
<td>120</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ever received money or incentives for sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>369</td>
<td>209</td>
<td>160</td>
<td>18.5</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Yes</td>
<td>111</td>
<td>88</td>
<td>23</td>
<td></td>
<td></td>
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<tr>
<td>Sexually abused as a child</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>429</td>
<td>254</td>
<td>175</td>
<td>12.2</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Yes</td>
<td>51</td>
<td>43</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td>Total</td>
<td>Hazardous drinking</td>
<td>No hazardous drinking</td>
<td>17.4</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>--------------</td>
<td>-------</td>
<td>--------------------</td>
<td>-----------------------</td>
<td>------</td>
<td>-------</td>
</tr>
<tr>
<td>No</td>
<td>431</td>
<td>253</td>
<td>178</td>
<td>89%</td>
<td>59%</td>
</tr>
<tr>
<td>Yes</td>
<td>51</td>
<td>43</td>
<td>8</td>
<td>11%</td>
<td>84%</td>
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### Psychosocial factors (continuous)\(^1\)

<table>
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<tr>
<th>Factor</th>
<th>mean</th>
<th>SD</th>
<th>mean</th>
<th>SD</th>
<th>mean</th>
<th>SD</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femininity(^2)</td>
<td>2.9</td>
<td>1.1</td>
<td>2.9</td>
<td>1.1</td>
<td>3.0</td>
<td>1.0</td>
<td>0.7</td>
<td>0.47</td>
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<tr>
<td>Sexual identify confusion(^3)</td>
<td>2.0</td>
<td>0.6</td>
<td>2.1</td>
<td>0.6</td>
<td>2.0</td>
<td>0.5</td>
<td>-1.6</td>
<td>0.12</td>
</tr>
<tr>
<td>Secretiveness about sexuality(^3)</td>
<td>2.2</td>
<td>0.9</td>
<td>2.2</td>
<td>0.9</td>
<td>2.2</td>
<td>0.9</td>
<td>0.1</td>
<td>0.92</td>
</tr>
<tr>
<td>Internalized homophobia(^2)</td>
<td>2.1</td>
<td>0.5</td>
<td>2.2</td>
<td>0.5</td>
<td>2.1</td>
<td>0.5</td>
<td>-1.2</td>
<td>0.24</td>
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<tr>
<td>Gender dysphoria(^4)</td>
<td>0.7</td>
<td>1.0</td>
<td>0.8</td>
<td>1.1</td>
<td>0.5</td>
<td>0.9</td>
<td>-2.9</td>
<td>0.00</td>
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<tr>
<td>Sexual orientation-based discrimination(^3)</td>
<td>1.5</td>
<td>0.6</td>
<td>1.5</td>
<td>0.6</td>
<td>1.5</td>
<td>0.5</td>
<td>-1.6</td>
<td>0.10</td>
</tr>
<tr>
<td>Depression(^3)</td>
<td>1.5</td>
<td>0.7</td>
<td>1.6</td>
<td>0.8</td>
<td>1.4</td>
<td>0.6</td>
<td>-2.6</td>
<td>0.01</td>
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</table>

### Social network characteristics\(^1\)

<table>
<thead>
<tr>
<th>Factor</th>
<th>mean</th>
<th>SD</th>
<th>mean</th>
<th>SD</th>
<th>mean</th>
<th>SD</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social network connectedness(^5)</td>
<td>0.7</td>
<td>1.1</td>
<td>0.7</td>
<td>1.1</td>
<td>0.8</td>
<td>1.1</td>
<td>0.3</td>
<td>0.77</td>
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<tr>
<td>Social network drinking behavior(^6)</td>
<td>0.6</td>
<td>0.1</td>
<td>0.7</td>
<td>0.1</td>
<td>0.6</td>
<td>0.2</td>
<td>-3.9</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

1. Higher scores indicate higher levels of the construct; 2. Range 1-5; 3. Range 1-4; 4. Range 0-4; 5. Range 0-5; 6. Range 0-1.
Table 3.2.  Reasons for drinking, sex-related alcohol expectancies by hazardous drinking

<table>
<thead>
<tr>
<th>Reasons for drinking</th>
<th>Total</th>
<th>Hazardous drinking</th>
<th>No hazardous drinking</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean</td>
<td>SD</td>
<td>mean</td>
</tr>
<tr>
<td>Drinking for positive affect</td>
<td>2.5</td>
<td>1.2</td>
<td>3.1</td>
</tr>
<tr>
<td>Drinking for negative affect</td>
<td>2.1</td>
<td>1.1</td>
<td>2.5</td>
</tr>
<tr>
<td>Drinking to enhance social interactions</td>
<td>2.4</td>
<td>1.2</td>
<td>2.9</td>
</tr>
<tr>
<td>All reasons for drinking</td>
<td>2.3</td>
<td>1.1</td>
<td>2.8</td>
</tr>
<tr>
<td>Sex-related alcohol expectancies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhancement of sexual experience</td>
<td>2.6</td>
<td>0.6</td>
<td>2.7</td>
</tr>
<tr>
<td>Increased sexual risk taking</td>
<td>2.3</td>
<td>0.6</td>
<td>2.4</td>
</tr>
<tr>
<td>Disinhibition of sexual behavior</td>
<td>2.3</td>
<td>0.6</td>
<td>2.4</td>
</tr>
<tr>
<td>All sex-related alcohol expectancies</td>
<td>2.4</td>
<td>0.6</td>
<td>2.3</td>
</tr>
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</table>
Table 3.3. Risk factors for hazardous drinking, unweighted and RDS-weighted

<table>
<thead>
<tr>
<th>Demographic characteristics</th>
<th>Unweighted</th>
<th></th>
<th></th>
<th>RDS-weighted</th>
<th></th>
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<tr>
<td></td>
<td>aOR</td>
<td>95% CI</td>
<td>P</td>
<td>aOR</td>
<td>95% CI</td>
<td>P</td>
</tr>
<tr>
<td>Older than 24</td>
<td>0.7</td>
<td>0.5 – 1.1</td>
<td>0.16</td>
<td>0.7</td>
<td>0.4 – 1.1</td>
<td>0.12</td>
</tr>
<tr>
<td>Post secondary education</td>
<td>1.0</td>
<td>0.7 – 1.6</td>
<td>0.85</td>
<td>0.9</td>
<td>0.5 – 1.3</td>
<td>0.48</td>
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<tr>
<td>Has a regular income</td>
<td>1.4</td>
<td>0.9 – 2.1</td>
<td>0.21</td>
<td>1.2</td>
<td>0.7 – 1.9</td>
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<td>1.0 – 2.4</td>
<td>0.07</td>
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<td>1.2 – 3.1</td>
<td>&lt;0.01</td>
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</table>

<table>
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<tr>
<th>Psychosocial factors¹</th>
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<td>Identify as gay or transgender</td>
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<td>0.5 – 2.9</td>
<td>0.62</td>
<td>1.4</td>
<td>0.5 – 3.6</td>
<td>0.49</td>
</tr>
<tr>
<td>Only sexually attracted to men</td>
<td>0.5</td>
<td>0.2 – 1.0</td>
<td>0.05</td>
<td>0.3</td>
<td>0.1 – 0.8</td>
<td>0.01</td>
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<tr>
<td>Femininity²</td>
<td>0.8</td>
<td>0.6 – 1.0</td>
<td>0.06</td>
<td>0.8</td>
<td>0.6 – 1.1</td>
<td>0.14</td>
</tr>
<tr>
<td>Sexual identity confusion³</td>
<td>1.1</td>
<td>0.7 – 1.7</td>
<td>0.63</td>
<td>1.1</td>
<td>0.7 – 1.7</td>
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<td>Secretiveness about sexuality³</td>
<td>1.1</td>
<td>0.8 – 1.5</td>
<td>0.75</td>
<td>0.9</td>
<td>0.7 – 1.3</td>
<td>0.64</td>
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<td>0.4 – 1.2</td>
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<td>1.1</td>
<td>0.6 – 1.9</td>
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<td>0.9 – 1.6</td>
<td>0.13</td>
<td>1.4</td>
<td>1.0 – 1.8</td>
<td>0.03</td>
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<tr>
<td>Sexual orientation-based discrim 3</td>
<td>0.9</td>
<td>0.6 – 1.4</td>
<td>0.61</td>
<td>0.8</td>
<td>0.5 – 1.2</td>
<td>0.31</td>
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<tr>
<td>Ever received money or incentives for sex</td>
<td>2.7</td>
<td>1.5 – 4.9</td>
<td>&lt;0.01</td>
<td>2.4</td>
<td>1.3 – 4.3</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Sexually abused as a child</td>
<td>2.0</td>
<td>1.1 – 7.7</td>
<td>0.08</td>
<td>2.7</td>
<td>1.1 – 6.5</td>
<td>0.03</td>
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<tr>
<td>Anxiety</td>
<td>2.9</td>
<td>1.1 – 7.7</td>
<td>0.04</td>
<td>6.1</td>
<td>2.1 – 17.3</td>
<td>0.00</td>
</tr>
<tr>
<td>Depression³</td>
<td>1.1</td>
<td>0.7 – 1.5</td>
<td>0.76</td>
<td>1.0</td>
<td>0.7 – 1.5</td>
<td>0.91</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Social network characteristics¹</th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
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<tbody>
<tr>
<td>Social network connectedness⁵</td>
<td>1.1</td>
<td>0.9 – 1.3</td>
<td>0.28</td>
<td>1.1</td>
<td>0.9 – 1.3</td>
<td>0.41</td>
</tr>
<tr>
<td>Social network drinking behavior⁶</td>
<td>3.9</td>
<td>1.0 – 16.0</td>
<td>0.06</td>
<td>5.4</td>
<td>1.2 – 24.3</td>
<td>0.03</td>
</tr>
</tbody>
</table>

1. Higher scores indicate higher levels of the construct; 2. Range 1-5; 3. Range 1-4; 4. Range 0-4; 5. Range 0-5; 6. Range 0-1.
References


October 31, 2017

To whom this may concern:

The papers submitted for Justin Knox’s dissertation reflect his own work prior to any editorial input from either of us as co-authors.

Sincerely,

Theo Sandfort

[Signature]

Deborah Hasin

[Signature]
Determinants of hazardous drinking among black South African men who have sex with men

Justin Knox, Vasu Reddy, Tim Lane, Gina Lovasi, Deborah Hasin, Theo Sandfort

**ABSTRACT**

*Background:* There is a known heavy burden of hazardous drinking and its associated health risks among black South African MSM; however, no study to date has identified risk factors for hazardous drinking among this population. *Methods:* A cross-sectional survey was conducted among 480 black South African MSM recruited using respondent-driven sampling. All analyses were adjusted using an RDS II estimator. Multivariable logistic regression was used to assess the relationship between demographic characteristics, psychosocial factors, behavioral attributes and hazardous drinking. *Results:* More than half of the men (62%, 95%CI = 56%-68%) screened positive as hazardous drinkers. In multivariable analyses, living in a township (versus the city of Pretoria) (aOR = 1.9, 95%CI = 1.2-3.1, p < .01), more gender dysphoria (aOR = 1.4, 95%CI = 1.0-1.8, p = .03), having ever received money or other incentives in return for sex (aOR = 2.4, 95%CI = 1.3-4.3, p < .01), having been sexually abused as a child (aOR = 2.6, 95%CI = 1.1-6.4, p = .03), having anxiety (aOR = 5.4, 95%CI = 1.2-24.3, p = .03), and social network drinking behavior (aOR = 5.4, 95%CI = 1.2-24.3, p = .03) were positively associated with hazardous drinking. *Discussion:* Hazardous drinking is highly prevalent among black South African MSM. Multiple indicators of social vulnerability were identified as independent determinants of hazardous drinking. These findings are of heightened concern because these health problems often work synergistically to increase risk of HIV infection and should be taken into consideration by efforts aimed at reducing hazardous drinking among this critical population.

1. Introduction

Black South African men who have sex with men (MSM) consume high levels of alcohol (Lane et al., 2011, 2008; Rispel et al., 2011). In one study, nearly two thirds of men reported drinking regularly, with nearly half reporting that they get drunk regularly (Lane et al., 2008). In another study, over half of men reported having 10 or more drinks in a typical day of drinking and more than three quarters of men were classified as having a drinking problem (Lane et al., 2011). In another study, nearly three quarters of men reported having sex while under the influence of alcohol (Rispel et al., 2011). Alcohol use and abuse constitutes a major public health problem, contributing to injury, disease and death. Hazardous drinking is of particular concern among this population due to the high prevalence of HIV, which estimates range between 13% and 50% (Lane et al., 2011; Rispel et al., 2011; Sandfort et al., 2015), and the increased risk of HIV infection associated with excessive drinking (Bryant, 2006; Kalichman et al., 2007; Rehm et al., 2012; Woolf-King and Maisto, 2011). Alcohol use has also been shown to have negative health consequences among people living with HIV, including lack of viral suppression, common comorbid conditions, and ultimately morbidity and mortality through both biological and behavioral mechanisms (Williams et al., 2016). Despite the known burden of hazardous drinking and its associated health risks, no study to date has identified risk factors for hazardous drinking among black South African MSM; however, no study to date has identified risk factors for hazardous drinking among this population.
African MSM, nor any other African MSM population (Sandfort et al., in press).

Researchers have observed elevated rates of concurrent psychosocial problems, including heavy alcohol use, among non-African LGBT populations (McKirnan and Peterson, 1989a,b; Sandfort et al., 2001, 2014; Stall et al., 2003, 2001), noting that they work synergistically to increase risk of HIV infection (Jie et al., 2012; Stall et al., 2003). For example, mental health problems, including anxiety (Rosario et al., 2006), and depression (Wang et al., 2007), often co-occur with substance use disorders, particularly alcohol dependence (Stall et al., 2001). Sexual minority stressors, such as internalized homophobia and external homophobia (i.e., experiences with sexual orientation-related discrimination), are associated with increased alcohol-related problems (McKirnan and Peterson, 1989b; Stall et al., 2001), and are likely of heightened importance among black South African MSM where same-sex sexuality is highly stigmatized (Adam et al., 2009; Muraguri et al., 2012; Niang et al., 2003; Smith et al., 2009; van Griensven, 2007; van Griensven and Sanders, 2008). Social network characteristics are also potential determinants of hazardous drinking as social networks are known to play a major role in many health-related behaviors (Doherty et al., 2005; Friedman and Aral, 2001; Luke and Harris, 2007; Smith et al., 2004; Smith and Christakis, 2008; Umberson and Montez, 2010; Youm and Laumann, 2002). For example, the drinking behavior of an individual’s social network members often provides a crucial context for individual decisions on how much and how often to drink (Valente, 2003). One’s degree of connectedness to a specific social network has been found to be positively associated with one’s likelihood of reflecting the normative behavior of that group regarding substance use (Alexander et al., 2001). Peers’ alcohol use has been found to be a primary influence on an individual’s alcohol use (Gaughan, 2003; Windle, 2000). There is also a potential heightened importance of social networks among stigmatized populations, such as black South African MSM (Larkin et al., 2013).

This paper aims to describe alcohol use among black South African MSM and identify determinants that put them at risk for hazardous drinking. The data for this project were collected among black MSM living in Tshwane, South Africa. These men currently live in or have recently moved from township communities. Township communities are peri-urban areas (the landscape interface between town and country) previously segregated under Apartheid whose residents continue to be characterized by limited resources, low levels of education, and high rates of unemployment. Personal social networks are the primary context in which these men learn how to express their sexuality, deal with stigma, and manage the risks of unprotected sex (Rabie and Lesch, 2009). They meet potential sex partners predominantly through these social networks or at drinking establishments. These circumstances combine to create a context where substance use, particularly excessive substance use, is normative (Lane et al., 2008; Rispel et al., 2011; Sandfort et al., 2015). Respondent-driven sampling (RDS) was chosen as the method to recruit these men because it is the most reliable way to derive valid population estimates for hidden populations such as black South African MSM (Magnani et al., 2005).

2. Materials and methods

2.1. Study population and procedures

The data used for the current project was collected as part of a study whose primary objective was to determine the prevalence of HIV infection among black MSM in Tshwane (Sandfort et al., 2015). Participants were recruited using RDS (Heckathorn, 1997; Heckathorn et al., 2002). Eligibility criteria for study participation included age older than 18; having engaged in oral, anal, or masturbatory sex with another man in the prior 12 months; living, working, or socializing in the Tshwane metro area; fluency in English, Sepedi (Northern Sotho), or isiZulu; and willingness to take an HIV rapid test. Consistent with RDS methodology, seeds, 20 in total, distributed up to five coupons to eligible men from their social networks who they were willing to recruit into the study. The seeds were referred by the community advisory board, screened to ensure that they met all of the study eligibility criteria and then interviewed about their social network size and composition. All seeds were Black and were purposively selected based on geographic place of residence in the Tshwane metro area and age. Men enrolled in the study and completed study procedures, including a 90-min interviewer-administered computer-assisted personal interview and an HIV blood test, which was conducted following a serial algorithm in accordance with South African national guidelines. All participants were screened by licensed nurses using two licensed rapid test kits (EZ Trust HIV 1 and 2, CS Innovation; First Response, Premier Medical Corporation). Non-reactive samples were interpreted as negative. Samples that were reactive on both tests were confirmed as positive. There were no indeterminate results. Staff provided participants with up to five recruitment coupons for further distribution. All study participants received vouchers worth 150 South African Rand (≈12 US Dollars) to be redeemed at a supermarket as primary incentive for their own participation, as well as additional vouchers worth 50 South African Rand (≈4 US Dollars) as secondary incentives for each successful referral to the study. At one point, verification of the inclusion criteria was expanded in order to ensure that all participants met the inclusion criteria. We did not observe evidence of anything else that might have threatened the integrity of the recruitment process. Participants were linked to their referral chain using their coupon identification numbers. All study procedures were approved by the Institutional Review Board of the New York State Psychiatric Institute in the U.S. and the Research Ethics Committee of the Human Sciences Research Council in South Africa. Participants provided written informed consent for the survey. Study staff provided referrals for further HIV testing and counseling, mental health, or primary care as indicated.

2.2. Measures

Scales adapted for and previously validated in South Africa were used whenever possible. Multiple aspects of alcohol use practices were evaluated (Heath and Martin, 1991; Heath, 1991). First, men were asked if they ever drank alcohol, then if they drank alcohol in the past year. Men replied ‘yes’ or ‘no.’ They were then asked where they drink and what they drink. They were also asked if they drink before going out, if they pay for their own drinks, if they buy drinks for men that they want to have sex with, or if men who want to have sex with them buy them drinks. Men replied on 5-point scales (e.g., “Never” (0) – “Always” (4)). Hazardous drinking was evaluated using the Alcohol Use Disorders Identification Test – Consumption (AUDIT-C), (Bohn et al., 1995; Saunders et al., 1993), a scale developed and validated by the World Health Organization for international use, including in South Africa (Bohn et al., 1995; Myer et al., 2008; Saunders et al., 1993), where it has been used in multiple studies (Jewkes et al., 2006; Peltzer et al., 2011; Peltzer et al., 2006). The AUDIT-C uses 3 items: how often the respondent drinks, how many drinks the respondent consumes in a 12-month period, and how often they consume more drinks at a time. Of a maximum score of 12 on the AUDIT-C, a score of four or more indicates hazardous drinking for men (Bush et al., 1998). Drug use practices were measured by asking men if they had ever used marijuana, poppers, cocaine, opiates, hallucinogens, amphetamines, and other club drugs. If they replied yes to any of these, they were asked if they had used them in the past year.

The survey also measured demographic characteristics (age, education, income, residence), psychosocial factors and behavioral attributes. Men’s reasons for drinking were assessed using eleven items (Golding et al., 1992), representing three domains: drinking for a positive affect (α = 0.87), drinking to cope with negative affect (α = 0.91) and drinking to enhance social interactions (α = 0.80); (overall α = 0.95). A sample item on the drinking to enhance social...
interactions scale is: “In the past year, how often did you drink because a drink helps you to have better sex?” Men replied on a five-point scale (“Never” (1) – “Always” (5)). Men who did not drink were assigned to “Never” (1) on all of these items. The Sex-Related Alcohol Expectancy Scale (Dermer and Cooper, 1994a,b) was used to assess men’s expectations about the effects of alcohol use on sexual behavior, representing three domains: enhancement of sexual experience ($\alpha = 0.93$), increased sexual risk taking ($\alpha = 0.91$), and disinhibition of sexual behavior ($\alpha = 0.88$) (Kalichman and Simbayi, 2004; Morojele et al., 2006); (overall $\alpha = 0.95$). A sample item is: “After a few drinks of alcohol I am more sexually responsive”. Men replied on a 4-point Likert scale (“Strongly disagree” (1) – “Strongly agree” (4)). Sexual attraction was assessed with the question “Do you currently feel more sexually attracted to men or to women?” and a 5-point response scale (1 = “Only to women”; 5 = “Only to men”). Men were coded as ‘Only attracted to men’ and ‘Also attracted to women’ because of the distribution of the participants’ responses. Sexual identification was assessed with the question “What word would you use to describe your sexuality? Would you call yourself gay, bisexual, or straight, or would you use another word?” There were a few men (n = 2) who described themselves as transgender and they were grouped with other gay men because of how they overlapped in terms of other measures of sexual identity (e.g., masculinity/femininity, sexual attraction to women, etc.). There were also a few straight men (n = 15) who reported sex with other men in the previous 12 months who were grouped with bisexual men because of how they overlapped in terms of other measures of sexual identity. Self-perceived masculinity/femininity was assessed with a 6-item scale with 3 items assessing level of masculinity and sexual identity. Self-perceived masculinity/femininity was assessed with the question “about one’s sexual orientation was assessed with an 8-item scale (Day and Schoenrade, 1997) ($\alpha = 0.96$). Gender dysphoria was assessed over the past year using a 16-item scaled adapted from the Gender Identity/Gender Dysphoria Questionnaire for Adolescents and Adults (Deogracias et al., 2007; Singh et al., 2010) ($\alpha = 0.93$). Sample items include: “How often have you thought of yourself as a woman in the past 12 months?” and “How often have you felt unhappy about having a male body in the past 12 months?” and used a 5-point response scale (1 = “Never”; 5 = “Always”). Sexual orientation-based discrimination was assessed using a 10-tam scale asking how often in the past year men had experienced such things as verbal insults, threats of physical violence, sexual harassment or rape because of having sex with men; items used a 4-point response scale (0 = “Never”; 4 = “Often”) ($\alpha = 0.87$). Men were also asked if they had ever experienced sexual abuse as a child, and if they ever received money or other incentives in return for sex (transactional sex). The survey also addressed two mental health conditions: anxiety and depression. Anxiety was considered positive if the participant responded ‘yes’ to the following two yes/no items: “Have you ever in your life had an anxiety attack – suddenly feeling fear or panic?” and “Have you had an anxiety attack in the last 4 weeks?” (Kroenke et al., 2010). Depression was assessed using the 2 items: “Over the last 2 weeks, how often have you been troubled by any of the following problems: little interest or pleasure in doing things?” and “Over the last 2 weeks, how often have you been troubled by any of the following problems: feeling down, depressed or hopeless?” Each item featured a 5-point response scale (“Not at all” (0) – “Nearly every day” (3)) ($\alpha = 0.84$) (Kroenke et al., 2003; Kroenke et al., 2010).

The data on social network characteristics were acquired by having used RDS (Wejnert, 2010). This data includes connectedness to a social network of MSM, which is estimated using outdegree centrality: the number of other men that a participant successfully recruited for inclusion in the study (Valente et al., 2004). Reports of alcohol use among members of one’s social network who also participated in the study were used to estimate social network drinking. For this study, social network drinking behavior was calculated as the proportion of a participant’s ties that screened positive as hazardous drinkers using the AUDIT-C. That value was then weighted towards the mean by the inverse proportion of the number of ties that we had data on over the maximum number of ties.

2.3. Statistical analyses

The specific objectives of our analyses were to: 1) describe alcohol use and abuse among black South African MSM; 2) describe associations between individual characteristics, social network characteristics and hazardous drinking; 3) assess which characteristics are independently associated with hazardous drinking.

Tests to determine which variables were associated with hazardous drinking included t-tests for continuous and scaled variables and Chi-squared tests for dichotomous variables. All predictors explored in bi-variate analyses were included in the final multivariable model. Multivariable analyses were run using logistic regression for the outcome of hazardous drinking (yes versus no). All statistical tests were 2-sided and $p < .05$ was considered statistically significant. Statistical analyses were performed with SPSS (version 17.0; SPSS, Chicago, IL) and R (version 3.3.2; R Core Team, Vienna, Austria) software packages.

Since RDS was the recruitment method used for this sample, all analyses were adjusted using an RDS II estimator (Salganik and Heckathorn, 2004; Volz and Heckathorn, 2008). This approach gives greater weight to those men with a small personal network size, since those men would be less likely to be recruited into the study. Equilibrium for certain characteristics was assessed and considered to be achieved when the proportions of the dichotomized variable changed by less than .02 between waves.

3. Results

3.1. Sample characteristics

In total 480 eligible participants were recruited in 18 waves between August 2011 and January 2013. All results presented are RDS-weighted. The mean number of peers recruited by each participant was 0.7. The coupon return rate was 32% (460/1417). Among the 20 seeds, 40% were less than 24 years old, 75% had some post-secondary education, 65% had a regular income, and 90% lived in a township (versus metropolitan Tshwane). Among the entire sample, most men (57%) were less than 24 years old, 52% had some post-secondary education, 35% had a regular income, and 57% lived in a township (see Table 1). The study reached equilibrium on the following characteristics in the respective waves: age (wave 2), education (wave 3), income (wave 3), township status (wave 12), sexual identity (wave 3), sexual attraction (wave 3) and HIV status (wave 2). The sample has been described previously (Knox et al., 2017; Sandfort et al., 2015). The prevalence of HIV among the sample was 30% and hazardous drinking was identified as an independent risk factor for HIV infection ($\text{aOR} = 1.8$, $95\% CI = 1.1–3.1$, $p < .05$) (Sandfort et al., 2015).

3.2. Alcohol and drug use

Most men (86%) had consumed alcohol in their lifetime, including 77% of men who had consumed alcohol in the past year. Among men who consumed alcohol in the past year, 49% consumed mostly beer, 36% consumed mostly cider (fermented alcoholic beverage made from apples), 9% (n = 33) consumed mostly wine, and a small proportion (4%) consumed mostly spirits. The majority of men mostly consumed alcohol in bars and shebeens (informal drinking establishments located in townships) (53%), although many consumed alcohol equally as often
at home as they did while going out (27%) or mostly at home (20%). Most men (53%) said they commonly consumed alcohol before going out to a bar or shebeen. More than half of men (51%) reported either buying alcohol for men that they wanted to have sex with or being bought alcohol by men who wanted to have sex with them.

In response to the items that comprise the AUDIT-C: 20% of men drank twice a week or more, 29% drank 2–4 times per month, and 28% drank once a month or less. A fifth of the men (21%) reported that they have 10 or more drinks on a typical day that they are drinking, 11% have 7–9 drinks, 23% have 5 or 6 drinks, 17% have 3 or 4 drinks, and only 5% have 1 or 2 drinks. A quarter of men (24%) reported that they have or more drinks on a single occasion weekly, 22% have 6 or more drinks on a single occasion monthly, and 22% have 6 or more drinks on a single occasion less than monthly but not never. The mean AUDIT-C score was 4.7 and the median AUDIT-C score was 4.4. More than half of the men (62%, 95%CI = 56%–68%) screened positive as hazardous drinkers. Fig. 1 shows the distribution of these men among the recruitment threads. The study reached equilibrium on hazardous drinking after 2 waves.

In the past year, 16% of men had used drugs. Men most commonly used marijuana (15%). A few men had used poppers (< 1%), cocaine (1%), crack (< 1%), crystal methamphetamine (< 1%), methaqualone (< 1%), hallucinogens (< 1%), heroin (1%), or amphetamines (3%). Because hazardous drinking was found to be the vastly predominant form of substance use among this population, it served as the focus of all further analyses.

### Table 1

Characteristics of MSM and hazardous drinking among n = 480 black MSM in Tshwane, South Africa (RDS-weighted).

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Hazardous drinking</th>
<th>No hazardous drinking</th>
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<th>P</th>
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<tr>
<td></td>
<td>N (%)</td>
<td>N (%)</td>
<td>N (%)</td>
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<tr>
<td>Demographic characteristics</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23 or younger</td>
<td>272 (57%)</td>
<td>171 (63%)</td>
<td>101 (37%)</td>
<td>0.3</td>
<td>0.61</td>
</tr>
<tr>
<td>24 or older</td>
<td>208 (43%)</td>
<td>126 (61%)</td>
<td>82 (39%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary or lower</td>
<td>229 (48%)</td>
<td>153 (67%)</td>
<td>76 (33%)</td>
<td>4.5</td>
<td>0.03</td>
</tr>
<tr>
<td>Post secondary</td>
<td>251 (52%)</td>
<td>144 (57%)</td>
<td>107 (43%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular income</td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
<td>0.97</td>
</tr>
<tr>
<td>No</td>
<td>311 (65%)</td>
<td>192 (62%)</td>
<td>119 (38%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>168 (35%)</td>
<td>104 (62%)</td>
<td>64 (38%)</td>
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<tr>
<td>Living in a township</td>
<td></td>
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<td>10.2</td>
<td>0.00</td>
</tr>
<tr>
<td>No</td>
<td>204 (43%)</td>
<td>109 (53%)</td>
<td>95 (47%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>274 (57%)</td>
<td>186 (68%)</td>
<td>88 (32%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychosocial factors (dichotomous)</td>
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<td></td>
<td>6.7</td>
<td>0.01</td>
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<td>Sexual identification</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gay or transgender</td>
<td>332 (70%)</td>
<td>192 (58%)</td>
<td>140 (42%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bisexual or straight</td>
<td>145 (30%)</td>
<td>102 (70%)</td>
<td>43 (30%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sexual attraction</td>
<td></td>
<td></td>
<td></td>
<td>17.5</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Only attracted to men</td>
<td>320 (67%)</td>
<td>177 (55%)</td>
<td>143 (45%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Also attracted to women</td>
<td>160 (33%)</td>
<td>120 (75%)</td>
<td>40 (25%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ever received money or incentives for sex</td>
<td></td>
<td></td>
<td></td>
<td>18.5</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>No</td>
<td>369 (77%)</td>
<td>209 (57%)</td>
<td>160 (43%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>111 (23%)</td>
<td>88 (79%)</td>
<td>23 (21%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sexually abused as a child</td>
<td></td>
<td></td>
<td></td>
<td>12.2</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>No</td>
<td>429 (89%)</td>
<td>254 (59%)</td>
<td>175 (41%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>51 (11%)</td>
<td>43 (84%)</td>
<td>8 (16%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td></td>
<td></td>
<td></td>
<td>17.4</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>No</td>
<td>431 (89%)</td>
<td>253 (59%)</td>
<td>178 (41%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>51 (11%)</td>
<td>43 (84%)</td>
<td>8 (16%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychosocial factors (continuous)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Femininityb</td>
<td>2.9 (1.1)</td>
<td>2.9 (1.1)</td>
<td>3.0 (1.0)</td>
<td>0.7</td>
<td>0.47</td>
</tr>
<tr>
<td>Sexual identity confusionc</td>
<td>2.0 (0.6)</td>
<td>2.1 (0.6)</td>
<td>2.0 (0.5)</td>
<td>–1.6</td>
<td>0.12</td>
</tr>
<tr>
<td>Secretiveness about sexualityd</td>
<td>2.2 (0.9)</td>
<td>2.2 (0.9)</td>
<td>2.2 (0.9)</td>
<td>0.1</td>
<td>0.92</td>
</tr>
<tr>
<td>Internalized homophobiae</td>
<td>2.1 (0.5)</td>
<td>2.2 (0.5)</td>
<td>2.1 (0.5)</td>
<td>–1.2</td>
<td>0.24</td>
</tr>
<tr>
<td>Gender dysphoriad</td>
<td>0.7 (1.0)</td>
<td>0.8 (1.1)</td>
<td>0.5 (0.9)</td>
<td>–2.9</td>
<td>0.00</td>
</tr>
<tr>
<td>Sexual orientation-based discriminationf</td>
<td>1.5 (0.6)</td>
<td>1.5 (0.6)</td>
<td>1.5 (0.5)</td>
<td>–1.6</td>
<td>0.10</td>
</tr>
<tr>
<td>Depressionf</td>
<td>1.5 (0.7)</td>
<td>1.6 (0.8)</td>
<td>1.4 (0.6)</td>
<td>–2.6</td>
<td>0.01</td>
</tr>
<tr>
<td>Social network characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social network connectedness</td>
<td>0.7 (1.1)</td>
<td>0.7 (1.1)</td>
<td>0.8 (1.1)</td>
<td>0.3</td>
<td>0.77</td>
</tr>
<tr>
<td>Social network drinking behaviorf</td>
<td>0.6 (0.1)</td>
<td>0.7 (0.1)</td>
<td>0.6 (0.2)</td>
<td>–3.9</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>

Higher scores indicate higher levels of the construct.

- Range 1–5.
- Range 1–4.
- Range 0–4.
- Range 0–5.
- Range 0–1.
3.4. Correlates of hazardous drinking

In bivariate analyses, men who screened positive as hazardous drinkers were more likely to have a secondary education or lower ($P = .03$), identify as straight or bisexual (versus gay; $p = .01$), be attracted to both men and women ($p < .001$), have ever received money or other incentives in return for sex ($p < .001$), have been sexually abused as a child ($p < .001$), have higher levels of anxiety ($p < .001$), experience more gender dysphoria ($p < .01$), and have higher levels of depression ($p < .01$) (see Table 1). Men who screened positive as hazardous drinkers were not more connected, on average, to this social network of MSM ($p = .77$). Men who screened positive as hazardous drinkers had a higher proportion of friends, on average, who were also hazardous drinkers ($p < .01$).

Table 3 shows the results of both unweighted and RDS-weighted multivariable analyses looking at independent correlates of hazardous drinking. The measures of association from the unweighted and RDS-weighted analyses are similar in terms of their direction and strength of association. There are multiple discrepancies in terms of achieving statistical significance. Among RDS-weighted analyses, living in a township (versus the city of Pretoria) (aOR = 1.9, 95%CI = 1.2–3.1, $p < .01$), more gender dysphoria (aOR = 1.4, 95%CI = 1.0–1.8, $p = .03$), having ever received money or other incentives in return for sex (aOR = 2.4, 95%CI = 1.3–4.3, $p < .01$), having been sexually abused as a child (aOR = 2.6, 95%CI = 1.1–6.4, $p = .03$), having anxiety (aOR = 5.4, 95%CI = 1.2–24.3, $p = .03$), and social network drinking behavior (aOR = 5.4, 95%CI = 1.2–24.3, $p = .03$) were positively associated with hazardous drinking. Being sexually attracted only to men (aOR = 0.3, 95%CI = 0.1–0.8, $p = .01$) was negatively associated with hazardous drinking.

4. Discussion

Black South African MSM were found to have high levels of alcohol use; nearly two thirds (62%, 95%CI = 56%–68%) of them screened positive as hazardous drinkers. Various factors were found to increase men’s likelihood of being hazardous drinkers. Men who live in a township (versus the city of Pretoria), men with higher levels of gender dysphoria, men who had ever received money or other incentives in return for sex, men who had been sexually abused as a child, and men with anxiety were all more likely to be hazardous drinkers. Men who reported being sexually attracted only to men were less likely to be...

### Table 2

Reasons for drinking, sex-related alcohol expectancies and hazardous drinking among n = 480 black MSM in Tshwane, South Africa.

<table>
<thead>
<tr>
<th>Reasons for drinking</th>
<th>Total mean</th>
<th>SD</th>
<th>Hazardous drinking mean</th>
<th>SD</th>
<th>No hazardous drinking mean</th>
<th>SD</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking for positive affect</td>
<td>2.5</td>
<td>1.2</td>
<td>3.1</td>
<td>0.9</td>
<td>1.5</td>
<td>0.8</td>
<td>-19.5</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Drinking for negative affect</td>
<td>2.1</td>
<td>1.1</td>
<td>2.5</td>
<td>1.1</td>
<td>1.4</td>
<td>0.7</td>
<td>-12.5</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Drinking to enhance social interactions</td>
<td>2.4</td>
<td>1.2</td>
<td>2.9</td>
<td>1.1</td>
<td>1.5</td>
<td>0.9</td>
<td>-14.9</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>All reasons for drinking</td>
<td>2.3</td>
<td>1.1</td>
<td>2.8</td>
<td>0.9</td>
<td>1.5</td>
<td>0.8</td>
<td>-17.0</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Sex-related alcohol expectancies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhancement of sexual experience</td>
<td>2.6</td>
<td>0.6</td>
<td>2.7</td>
<td>0.5</td>
<td>2.4</td>
<td>0.7</td>
<td>-6.0</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Increased sexual risk taking</td>
<td>2.3</td>
<td>0.6</td>
<td>2.4</td>
<td>0.5</td>
<td>2.2</td>
<td>0.7</td>
<td>-3.4</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Disinhibition of sexual behavior</td>
<td>2.3</td>
<td>0.6</td>
<td>2.4</td>
<td>0.5</td>
<td>2.1</td>
<td>0.7</td>
<td>-5.9</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>All sex-related alcohol expectancies</td>
<td>2.4</td>
<td>0.6</td>
<td>2.3</td>
<td>0.6</td>
<td>2.5</td>
<td>0.4</td>
<td>-5.6</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>
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hazardous drinkers. Men whose social networks included a higher proportion of hazardous drinkers were more likely to be hazardous drinkers themselves.

The high levels of alcohol use found in the current study are comparable to what has been described in other studies conducted among black South African MSM, which focused on alcohol use as a risk factor for risk behavior (Lane et al., 2008) or HIV infection (Lane et al., 2011; Rispel et al., 2011). In one study, nearly two thirds of men reported drinking regularly, with nearly half reporting that they get drunk regularly (Lane et al., 2008). In another study, over half of men reported having 10 or more drinks in a typical day of drinking and more than three quarters of men were classifi ed as having a drinking problem (Lane et al., 2011). In another study, nearly three quarters of men reported having sex while under the influence of alcohol (Rispel et al., 2011). Substance use is a major health concern among this population, especially given its association with high risk sexual behavior (Bryant, 2006; Kalichman et al., 2007; Rehm et al., 2012; Woolf-King and Maisto, 2011) in this setting of high HIV prevalence (Lane et al., 2011; Rispel et al., 2011; Sandfort et al., 2015). Despite the heavy burden of alcohol use, among these men and other African MSM populations, the authors were unable to identify any implemented interventions that have targeted alcohol use among these men or any other African MSM population (Sandfort et al., in press). Clearly, this is a public health problem that merits further attention.

Men who were hazardous drinkers were more likely to endorse drinking for a positive affect, drinking for negative effect and drinking to enhance social interaction. Men who were hazardous drinkers were also more likely to expect alcohol to enhance sexual experience, increase sexual risk taking and disinhibit sexual behavior. Much of the research on reasons for drinking and sex-related alcohol expectancies indicate that drinking is more likely to have an intended effect on people that endorse these beliefs (Bryant et al., 2007; Dermen et al., 1998; Fromme et al., 1999; Gordon et al., 1997; McKirnan et al., 2001), thus suggesting that hazardous drinking additionally leads to increased sexual risk behavior.

The current project is the first to identify determinants of hazardous drinking among a sample of African MSM. Living in a township (versus metropolitan Tshwane), a construct that captures the vulnerability of living in a low resource setting, was found to increase men’s likelihood of being hazardous drinkers. This risk factor has been observed as an important indicator of social vulnerability and predictor of health risk in studies conducted among black South African MSM (Knox et al., 2013, 2011, 2010; Sandfort et al., 2013).

Other indicators of social vulnerability were also found to increase men’s likelihood of being hazardous drinkers. The relationships we observed are in accordance with what has been found among non-African MSM populations. Indicators of sexual minority stress, such as gender dysphoria, have been found to be associated with substance abuse (McKirmam and Peterson, 1989b; Rosario et al., 2006; Stall et al., 2001). In this study, gender dysphoria predicted hazardous drinking while controlling for other same-sex characteristics, suggesting that there is something uniquely detrimental about these feelings that they contribute to hazardous drinking. Similar to our findings, other studies have found childhood sexual abuse (Diaz et al., 1999; Paul et al., 2001) and mental health indicators, including anxiety (Rosario et al., 2006; Stall et al., 2001), to predict substance abuse among non-African MSM populations. These findings are of heightened concern because of how these co-occurring health problems work synergistically to increase risk of HIV infection (Jie et al., 2012; Stall et al., 2003).

Men who reported being sexually attracted to both men and women were more likely to be hazardous drinkers than men who reported sexual attraction to only men. This result was observed while controlling for other potentially more proximal psychosocial characteristics that might help explain the association, such as sexual identity confusion or internalized homophobia. Another potential explanation for this might be that local community social support networks are stronger for gay MSM than they are for bisexual MSM. Further research into the dynamics of how sexual identity contributes to risk among these men, both in terms of hazardous drinking and sexual vulnerability, is needed.

The current project is also the first to consider social network characteristics in the evaluation of substance use among a sample of African MSM. We found that the size of men’s social network did not impact men’s likelihood of being a hazardous drinker, although the drinking behavior of their social network members did. This finding speaks to the importance of the characteristics of social network ties because they provide a context for behavior and norms (Friedman et al., 2007; Latkin et al., 2009; Luke and Harris, 2007; Valente and Fosados, 2006), more than concern for the presence of social network ties in

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Risk factors for hazardous drinking among n = 480 black MSM in Tshwane, South Africa.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unweighted</td>
</tr>
<tr>
<td></td>
<td>aOR</td>
</tr>
<tr>
<td>Demographic characteristics</td>
<td></td>
</tr>
<tr>
<td>Older than 24 (vs. 24 or younger)</td>
<td>0.7</td>
</tr>
<tr>
<td>Post secondary education (vs. high school or less)</td>
<td>1.0</td>
</tr>
<tr>
<td>Has a regular income (vs. not)</td>
<td>1.4</td>
</tr>
<tr>
<td>Living in a township (vs. not)</td>
<td>1.5</td>
</tr>
<tr>
<td>Psychosocial factors</td>
<td></td>
</tr>
<tr>
<td>Identify as gay or transgender (vs. bisexual or straight)</td>
<td>1.2</td>
</tr>
<tr>
<td>Only sexually attracted to men (vs. also attracted to women)</td>
<td>0.5</td>
</tr>
<tr>
<td>Femininity</td>
<td>0.8</td>
</tr>
<tr>
<td>Sexual identity confusion</td>
<td>1.1</td>
</tr>
<tr>
<td>Secretiveness about sexuality</td>
<td>1.1</td>
</tr>
<tr>
<td>Internalized homophobia</td>
<td>0.7</td>
</tr>
<tr>
<td>Gender dysphoria</td>
<td>1.2</td>
</tr>
<tr>
<td>Sexual orientation-based discrimination</td>
<td>0.9</td>
</tr>
<tr>
<td>Ever received money or incentives for sex (vs. not)</td>
<td>2.7</td>
</tr>
<tr>
<td>Sexually abused as a child (vs. not)</td>
<td>2.0</td>
</tr>
<tr>
<td>Depression</td>
<td>2.0</td>
</tr>
<tr>
<td>Social network characteristics</td>
<td></td>
</tr>
<tr>
<td>Social network connectedness</td>
<td>1.1</td>
</tr>
<tr>
<td>Social network drinking behavior</td>
<td>3.9</td>
</tr>
</tbody>
</table>

1. Higher scores indicate higher levels of the construct.
themselves (i.e., being connected versus isolated) (Alexander et al., 2001; Helleringer and Kohler, 2007; Smith et al., 2004). This is an area that merits further exploration, particularly given the heightened importance of social networks in this setting (Latkin et al., 2013) and their potential as conduits for an intervention (Latkin, 1998).

There are certain limitations to the current study. The cross-sectional research design limits the ability to infer causality. For example, we assume that the drinking behaviors of one’s social network members influences one’s own drinking behavior. However, these findings may also reflect that men who drink more tend to befriend other men who drink more. There were also certain findings that were not in agreement with our expectations. For example, it is not clear why being sexually attracted only to men decreased men’s likelihood of being a hazardous drinker when in previous research this was found to predict alcohol dependence (Stall et al., 2001). Furthermore, some potential risk factors were not found to be associated with hazardous drinking. This likely speaks to the exploratory nature of this study, given the lack of previous research among African MSM populations, as well as the complexity of substance use and psychosocial health among men in this setting (Cook et al., 2013; Sandfort et al., 2016, 2015). These issue merit further exploration. Unfortunately, the study did not collect information on being on treatment for HIV. Given how few men knew their current HIV status, the limited availability of antiretroviral therapy (ART) during the study period and the criteria for starting treatment at the time, we suspect that few men were on ART. The current study was conducted among black South African MSM and may have limited generalizability outside of that setting. The constructs used were almost exclusively developed in Western settings, and while many of them have previously been demonstrated to be reliable and valid, including many in South Africa, there may be additional culture-specific factors that have not been accounted for. Lastly, the data collected are self-reported and could have been subject to social desirability or recall bias.

In summary, the current study expands the literature by providing further evidence of the severity of excessive alcohol use among black South African MSM. Various determinants of hazardous drinking were identified, including many indicators of social vulnerability. The findings are of concern because these health problems often work synergistically to increase risk of HIV infection. The drinking habits of men’s social network ties also was highly correlated with men’s own drinking habits. These findings should be taken into consideration by efforts aimed at reducing hazardous drinking among this critical population. Specifically, intervention strategies should consider targeting MSM who are the most vulnerable, those who live in townships, who have had to engage in sex for money or favors, who have a history of childhood sexual abuse or who have engaged in sex that is connected with their work and dedication, in particular Kate Collier and William Tsang.

Acknowledgements

We thank OUT Well-being, the communities that partnered with us in conducting this research, and the study participants for their contributions. We also thank study staff at all participating institutions for their work and dedication, in particular Kate Collier and William Tsang.

References


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Contributors

All authors have seen, approved, and contributed significantly to this manuscript. For a breakdown of contributions: Conceived and designed the experiments: TS, VR, TL. Performed the experiments: TS, VR. Analyzed the data: JK, TS. Wrote the paper: JK, VR, TL, GL, DH, TS.

Conflict of interest

None of the authors have conflict of interest to disclose.
Chapter 4  Safer sex intentions as a modifier of the relationship between substance use and sexual risk behavior during a specific sexual encounter

Introduction

Because of the global burden of HIV, especially in sub-Saharan Africa, a better understanding of the relationship between substance use and HIV risk behavior is a public health priority, particularly among populations with high rates of HIV transmission (1-4). Most research supports that substance use and sexual risk behavior are associated, including in sub-Saharan Africa (2-5). However, detailed reviews of the literature on this topic have noted inconsistencies, with many studies not identifying an association (6-9).

Possible explanations for these inconsistencies include the unmeasured moderating effects of other psychosocial factors (4, 8, 10-20). Such factors impact the magnitude or even the direction of the effect of an exposure on an outcome. In a recent study conducted among black South African men who have sex with men (MSM), we found that reasons for drinking and intentions to engage in safer sex modified the relationship between substance use and HIV risk behavior, but that alcohol expectancies did not (18). Specifically, alcohol use led to sexual risk behavior among men who endorsed drinking to enhance social interaction but not among men who did not, while drug use led to increased sexual risk behavior among men who intended to engage in safer sex but not among men who did not (18).

Indeed, the effects of substance use on sexual behavior are not necessarily homogeneous; they may be contingent on other factors. For example, expectancies about how alcohol will affect one’s behavior have been shown to predict actual behavior when drinking (8, 10-15). In addition, not just what people expect to happen when they drink but their motives for drinking have also been found to influence the effects of alcohol (21). Reasons for drinking have also been found to

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interact with other situational characteristics to influence levels of alcohol consumption (22). Among MSM, reasons for drinking were found to influence how much men drink, although they were not found to have a direct effect on sexual risk behavior (23). Safer sex intentions are also important to consider as modifiers of the effect of substance use on sexual risk behavior because people who use condoms when they are not intoxicated also tend to use them when they are intoxicated, just as people who do not use condoms when they are not intoxicated tend to not use them when they are intoxicated (8).

One limitation to studies that have examined effect modification when looking at the relationship between substance use and sexual risk behavior (13, 15), including our own among black South African MSM, (18) is that they relied on general measures of substance use and sexual risk behavior over a specific time frame but without regard to their temporal overlap. More exact temporal data, such as event-level data, can be used to discern whether substances were used in close enough temporal proximity to engaging in sexual activity that it could influence this behavior (3, 4, 8). Event-level data additionally allows for simultaneous consideration of other important individual-, event- and partnership- level characteristics (24-26).

This paper used data from a specific sexual event to assess the direct effect between substance use and sexual risk behavior and then to assess effect modification of this relationship by alcohol expectancies, reasons for drinking and safer sex intentions. To investigate these issues, we used data from a study of black MSM from the metropolitan area of Tshwane (Pretoria), South Africa, a population with a heavy burden of substance use, sexually transmitted infections (self-reported) and HIV (27-29).
Methods

Participants
Black South African MSM were recruited using respondent-driven sampling (RDS) (30, 31), a strategy commonly used for populations that are difficult to include in research. RDS is preferable to convenience sampling because it helps improve the generalizability of the findings to the underlying population. Eligibility criteria included: age between 18 and 44; having engaged in oral, anal, or masturbatory sex with a man in the prior 12 months; living, working, or socializing in the Tshwane (Pretoria) metropolitan area; fluency in English, Sepedi (Northern Sotho), or Tswana (Setswana); and willingness to take a rapid HIV test. Consistent with RDS methodology, seed participants were purposively selected based on geographic place of residence and their potential to propagate large and diverse recruitment chains (27). Twenty seeds were selected and asked to distribute three to five recruitment coupons to eligible men from their social networks, defined as other men who have sex with men over the age of 18 who they know and would be willing to recruit into the study. All participants were linked using recruitment coupon identification numbers. Once men were enrolled in the study and completed study procedures, staff provided them with recruitment coupons for further distribution. Although not an eligibility requirement, the race/ethnicity of all seeds was Black as the focus of the study was on black South African MSM. Over three quarters of South Africans are Black. The racial/ethnic segregation demonstrated by the sample reflects the racial/ethnic segregation that continues to characterize much of South Africa. Further details regarding the methods for this study have been previously provided (27).
Procedures

All participants completed a 90-minute interviewer-administered computer-assisted personal interview. All interviews were conducted in a private space, either the office of the Human Sciences Research Council in the center of Tswhane (Pretoria) or in one of the surrounding townships, e.g., in a community health center, depending on the participant’s preference. Research staff involved in screening, interviewing, HIV testing, and instruction for participant recruitment were trained in a three-day session. All study participants received gift cards to be redeemed for purchase of products at a supermarket as primary incentive for their own participation, as well as an additional gift card for each successful referral to the study. All study procedures were approved by the Institutional Review Board of the New York State Psychiatric Institute in the U.S. and the Research Ethics Committee of the Human Sciences Research Council in South Africa. Participants provided separate written informed consent for the survey and HIV testing components of the study. Study staff provided referrals for confirmatory HIV testing and counseling in the case of a positive test result, as well as mental health, or primary care services as indicated.

Measures

Participants were asked about their last sexual event (LSE) that involved anal sex, including partnership characteristics such as how long ago they met their partner, where they met, their relationship to the partner, and other relational attributes: concordance in age, race, neighborhood, socioeconomic status, and gender expression. Participants were also asked questions regarding event-level characteristics of the sexual encounter, such as where it took place, whether it was in exchange for money or food, whether drugs or alcohol were used and whether condoms were used. All measures regarding the LSE were calculated as characteristics
of the partnership, for which there is precedent (24, 25), except for substance use for which we used respondent substance use as we are interested specifically in how the effect of this factor on sexual risk behavior was influenced by other individual-level constructs (i.e. reasons for consuming alcohol, expectancies about its effects, and intentions to engage in safer sex) which were collected only for the respondent. Unprotected anal intercourse (UAI) was defined as having participated in anal intercourse without the use of a condom at any time during the LSE. Scales were primarily those adapted for and previously validated in South Africa. The AUDIT-C uses 3 items: how often the respondent drinks, how many drinks the respondent consumes in a typical day of drinking, and how frequently the respondent drinks six or more drinks at a time. Of a maximum score of 12 on the AUDIT-C, a score of four or more indicates hazardous drinking for men (32, 33). The presence of a drug use problem over the past year was assessed using the 9-item Drug Abuse Screening Test (DAST) (33); (Cronbach’s α = 0.81). A sample item is “Do you ever feel bad or guilty because of your drug use?” (Yes, No). Drug abuse was defined as answering yes to one or more items. The Sex-Related Alcohol Expectancy Scale (32, 33) was used to assess expectancies about the effects of alcohol use on sexual behavior, representing three domains: enhancement of sexual experience, increased sexual risk taking, and disinhibition of sexual behavior; (α = 0.95). A sample item is: “After a few drinks of alcohol I am more sexually responsive”. Men replied on a 4-point Likert scale (“Strongly disagree” (1) - “Strongly agree” (4)). Additionally, men were asked about reasons for drinking related to enhancing social interaction (21). The two items used were: “How often did you drink because a drink helps you to relax around people?” and “How often did you drink because a drink helps you to have better sex?”; (α = 0.80). Men replied on a five point scale (“Never” (1) – “Always” (5)). Men who did not drink were assigned to “Never” (1) on all of these items. Three items were used to assess
intentions to engage in safer sex. Men were asked how likely it is that they will always use a condom when having insertive anal sex, when having receptive anal sex, and how likely it is they will discuss safer sex; (α = 0.89). Men replied on a 4-point scale (“Very Unlikely” (1) - “Very Likely” (4)). The survey also addressed demographic characteristics, including age, education and income.

Statistical analyses

Since RDS was the method used for the recruitment of this sample, all data were adjusted prior to analyses using an RDS II estimator (34, 35). This approach gives greater weight to those participants with a small personal network size, since those men presumably would be less likely to be recruited into the study.

Tests to determine which variables were associated with UAI included t-tests for continuous and scaled variables and Chi-squared tests for dichotomous variables. Multivariable analyses were run using multiple logistic regression. Initially, a main effect between substance use and UAI was tested. Effect modification was then tested by adding multiplicative interaction terms for substance use and each hypothesized effect modifier to the regression model. If effect modification was identified, stratified multivariable analyses with all covariates were run among groups at low and high levels of the relevant modifying construct. Statistical tests were 2-sided and p<.05 was considered statistically significant. SPSS 17.0 was used for all statistical analyses.

Results

In total, 480 eligible participants were recruited in 18 waves between August 2011 and January 2013. Six men did not have data on the outcome variable (UAI at the LSE) and were excluded from all analyses. Most (56%) participants were less than 24 years old, more than half (53%) had completed high school, and 35% had a regular income (see Table 4.1).
Nearly a third (30%, n=139) of men reported that they used drugs or alcohol prior to their LSE. Of these 139 men, 89% screened positive as hazardous drinkers and 23% screened positive as having problematic drug use. One fifth (20%) of the sample reported engaging in unprotected anal intercourse (UAI) during the LSE. Nearly two thirds (66%) of men said the LSE occurred with a steady partner, with an even higher proportion (80%) occurring among men who had previously had sex with each other (see Table 4.2).

There was no difference in the frequency of UAI among men who used drugs or alcohol immediately prior to having sex (19%) compared to the frequency of UAI among men who had not used drugs or alcohol immediately prior to having sex (20%, p=.86). There was a higher frequency of UAI among steady partners (p<.01), partners who lived in the same neighborhood (p<.01), and age-discordant couples (p<.001). In multivariable analyses including all participants, and all individual-, partnership- and situational characteristics, substance use prior to the LSE did not have a main effect on UAI (p=.97). Discordance in age (aOR=4.2, 95%CI=1.8-9.8, p<.01) and partners living in the same neighborhood (aOR=1.8, 95%CI=1.0-3.1, p<.05) were both independently associated with UAI.

Men who engaged in UAI during the LSE endorsed more statements regarding drinking to enhance social interaction (p<.01), had higher expectancies about the effects of alcohol (p<.001), and had lower intentions to engage in safer sex (p<.001) (see Table 4.1).

Interaction terms for substance use and expectancies about its effects, reasons for consuming alcohol, and intentions to engage in safer sex were added to the multivariable model looking at the effect of substance use prior to the LSE on UAI. The effect of substance use prior to the LSE on UAI was modified by safer sex intentions (p<.01) but not expectancies about the effects of alcohol (p=.66) nor reasons for consuming alcohol (p=.15) (see Table 4.3).
Given the observed effect modification by safer sex intentions, the sample was stratified into men with lower safer sex intentions (n=268) and men with higher safer sex intentions (n=206). UAI was more frequent among men with lower safer sex intentions (28%) than among men with higher safer sex intentions (9%) (p<.001). In multivariable analyses controlling for individual-, partnership- and situational characteristics, substance use prior to the LSE was not associated with UAI (p=.06) among those with lower safer sex intentions. Among those with higher safer sex intentions, substance use prior to the LSE was positively associated with UAI (aOR=5.8, 95%CI=1.6-21.3, p<.01).

**Discussion**

The purpose of this study was to use event-level data to assess if substance use increases sexual risk behavior among black South African MSM and whether the relationship between substance use and sexual risk behavior is modified by expectancies about the effects of alcohol, reasons for consuming alcohol, or intentions to engage in safer sex. We found that men who drank or used drugs prior to their last sexual encounter were not more likely to engage in risky sexual behavior than men who did not drink or use drugs prior to their last sexual encounter. Although we did not observe a main effect, we found that that the effect of substance use on sexual risk behavior was modified by safer sex intentions. Among men with high intentions to engage in safer sex, men who drank or used drugs prior to their last sexual encounter were more likely to engage in risky sexual behavior.

Our findings demonstrating the modifying effects of safer sex intentions on the relationship between substance use and sexual risk behavior are in accordance with our findings from a previous study showing that drug use was associated with increased sexual risk behavior among men who intended to engage in safer sex but not among men who did not (18). Taken together,
these findings may help to explain inconsistencies in studies looking at substance use and sexual risk behavior (6-9), including among black South African MSM (28, 36). Varying distributions of other conditions needed for substance use to lead to increased sexual risk behavior (such as safer sex intentions) help explain why the relationship between substance use and sexual risk behavior has not always been observed (12, 37, 38).

Our finding that substance use was associated with increased sexual risk behavior only among those with higher safer sex intentions confirms that safer sex intentions are an important component of safer sex behavior.(39) As further testament to this, we also observed a strong negative association between safer sex intentions and sexual risk behavior in bivariate analyses. Efforts to reduce HIV risk behavior should focus on both increasing safer sex intentions and negating the impact of substance use on sexual risk behavior otherwise they may yield little benefit.

Further understanding of the determinants that lead to sexual risk behavior in this context of high HIV prevalence is important for informing HIV prevention efforts. Given the high HIV prevalence in this population and the variability in safer sex intentions, these men may have developed a sense of fatalism regarding HIV infection, a topic of some importance for future studies. Awareness of HIV status and perception of HIV risk were also low, with only a third (34.7%) of men having tested for HIV in the past 6 months and among HIV positive men in the sample, nearly half (48.3%) thought that it was unlikely or very unlikely that they were HIV-infected.(27)

Our finding that drinking or using drugs prior to having sex did not have a main effect on risky sexual behavior among the entire sample is in line with other studies that did not find a link between substance use and sexual risk behavior, including studies conducted in sub-Saharan
Africa,(6-8) but is in contrast to the large body of evidence suggesting that these behaviors are associated.(2-5) Our findings that reasons for drinking and expectancies about alcohol did not impact the relationship between alcohol use and sexual risk behavior are also in contrast to other research on the modifying effects of alcohol expectancies (10, 13-15, 17) and reasons for drinking.(18, 19) The high levels of substance use and UAI that we observed, despite the high prevalence of HIV infection and limited awareness of current HIV status among these men (18, 27) are also in accordance with what has been previously observed in this setting (27, 28, 36, 40).

There are certain limitations to the current study. First, drug and alcohol use prior to the sexual encounter could have been assessed with more precision. We assessed alcohol and drug use with one single item and were not able to distinguish between them. Given the prevalence of alcohol use compared to drug use among the men who reported drug or alcohol use prior to the last sexual encounter (96% of men drank alcohol in the past year while only 30% used drugs; only 1 man exclusively used drugs), we assume that alcohol use represents most substance use in this context. Furthermore, we think this likely represents hazardous alcohol use as 89% of the men who reported drug or alcohol use prior to the last sexual encounter screened positive as hazardous drinkers (23% reported problematic drug use). Future studies should distinguish between drug or alcohol use. The single-item measure that we used also did not collect information on the quantity or timing of the substance use. Given the varying physiological effects of different drugs and alcohol, with variation in physiological effects even within a particular substance depending on the timing and amount consumed, this would be helpful to take into account. Also, we did not include a measure of strategies that persons may employ to lower their risk of HIV that are not condom-based (e.g., strategic positioning) but instead
assumed that all UAI was sexual risk behavior. Our justification for this decision is that we considered any UAI in this situation to represent risk of HIV infection given the high prevalence of HIV and the low proportion of men who were aware of their HIV status. (41) Also, the scales used were almost exclusively developed in Western settings, and while all of them have previously been demonstrated to be reliable and valid, including many in South Africa, there may be additional culture-specific factors, such as social norms regarding substance use or sexual behavior, that have not been accounted for. Also, the study was conducted among black South African MSM and generalizability outside of that setting is unknown. Lastly, the data collected are self-reported and could have been subject to social desirability or recall bias.

The current study contributes to a more complete understanding of substance use and its relationship to sexual risk behavior by demonstrating the moderating effects of safer sex intentions. Understanding more about the context in which substance use leads to sexual risk behavior is important information for identifying effective strategies for reducing HIV transmission among this critical population. Based on these findings, efforts to reduce HIV risk behavior should focus on both increasing safer sex intentions and negating the impact of substance use on sexual risk behavior otherwise they may yield little benefit. Given that South Africa has a high prevalence of hazardous drinking, a growing problem with drug use, (42) and the highest burden of HIV in the world, identifying and addressing factors that contribute to these public health problems and applying that knowledge is of critical importance.
### Tables

Table 4.1. Demographic characteristics and potential modifiers of the effect of substance use on sexual risk behavior by having engaged in unprotected anal intercourse (UAI) at last sexual encounter (LSE)

<table>
<thead>
<tr>
<th>Demographic characteristics</th>
<th>Total</th>
<th>UAI</th>
<th>No UAI</th>
<th>χ²</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographic characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23 or younger</td>
<td>56.3</td>
<td>267</td>
<td>21.7</td>
<td>58</td>
<td>78.3%</td>
</tr>
<tr>
<td>24 or older</td>
<td>43.7</td>
<td>207</td>
<td>17.4</td>
<td>36</td>
<td>82.6%</td>
</tr>
<tr>
<td><strong>Educational attainment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ Grade 12</td>
<td>47.3</td>
<td>224</td>
<td>23.2</td>
<td>52</td>
<td>76.8%</td>
</tr>
<tr>
<td>&gt; 12 Grade or diploma</td>
<td>52.7</td>
<td>250</td>
<td>16.8</td>
<td>42</td>
<td>83.2%</td>
</tr>
<tr>
<td><strong>Income</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No regular income</td>
<td>64.8</td>
<td>307</td>
<td>20.8</td>
<td>64</td>
<td>79.2%</td>
</tr>
<tr>
<td>Regular income</td>
<td>35.2</td>
<td>167</td>
<td>18.0</td>
<td>30</td>
<td>82.0%</td>
</tr>
<tr>
<td><strong>Potential effect modifiers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expectancies about the effects of alcohol</td>
<td>2.43</td>
<td>0.55</td>
<td>2.63</td>
<td>0.41</td>
<td>2.38</td>
</tr>
<tr>
<td>Drink alcohol to enhance social interaction</td>
<td>2.39</td>
<td>1.24</td>
<td>2.70</td>
<td>1.34</td>
<td>2.31</td>
</tr>
<tr>
<td>Intentions to engage in safe sex</td>
<td>3.23</td>
<td>0.67</td>
<td>2.71</td>
<td>0.79</td>
<td>3.36</td>
</tr>
</tbody>
</table>

1. Higher scores indicate higher levels of the construct.  2. Range: 1-4.  3. Range: 1-5.
Table 4.2.  Partnership and event characteristics of the last sexual encounter (LSE) by having engaged unprotected anal intercourse (UAI)

<table>
<thead>
<tr>
<th>Table 4.2</th>
<th>Partnership and event characteristics of the last sexual encounter (LSE) by having engaged unprotected anal intercourse (UAI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
</tr>
<tr>
<td><strong>Partnership characteristics</strong></td>
<td></td>
</tr>
<tr>
<td>First time with that partner</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>20.4%</td>
</tr>
<tr>
<td>No</td>
<td>79.6%</td>
</tr>
<tr>
<td>Steady partner</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>65.9%</td>
</tr>
<tr>
<td>No</td>
<td>34.1%</td>
</tr>
<tr>
<td>Met through friends/colleagues</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>29.5%</td>
</tr>
<tr>
<td>No</td>
<td>70.5%</td>
</tr>
<tr>
<td>Live in the same neighborhood</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>62.6%</td>
</tr>
<tr>
<td>No</td>
<td>37.4%</td>
</tr>
<tr>
<td>Same age</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>21.7%</td>
</tr>
<tr>
<td>No</td>
<td>78.3%</td>
</tr>
<tr>
<td>Same race</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>93.5%</td>
</tr>
<tr>
<td>No</td>
<td>6.5%</td>
</tr>
<tr>
<td>Same SES</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>18.7%</td>
</tr>
<tr>
<td>No</td>
<td>81.3%</td>
</tr>
<tr>
<td>Same masculinity/femininity</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>4.3%</td>
</tr>
<tr>
<td>No</td>
<td>95.7%</td>
</tr>
<tr>
<td>Event characteristics</td>
<td></td>
</tr>
<tr>
<td>Sex took place at home</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>92.6%</td>
</tr>
<tr>
<td>No</td>
<td>7.4%</td>
</tr>
<tr>
<td>Sex was transactional</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>7.9%</td>
</tr>
<tr>
<td>No</td>
<td>92.1%</td>
</tr>
<tr>
<td>Respondent substance use</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>29.4%</td>
</tr>
<tr>
<td>No</td>
<td>70.6%</td>
</tr>
</tbody>
</table>

88
Table 4.3. Multivariable analyses looking at the effect of substance use on unprotected anal intercourse (UAI) at last sexual encounter (LSE) and potential effect modifiers

<table>
<thead>
<tr>
<th></th>
<th>aOR</th>
<th>95% CI</th>
<th>Wald</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary exposure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respondent substance use</td>
<td>0.98</td>
<td>0.57-1.69</td>
<td>0.01</td>
<td>.95</td>
</tr>
<tr>
<td><strong>Potential effect modifiers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expectancies about the effects of alcohol * Substance use</td>
<td>0.20</td>
<td>.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drink alcohol to enhance social interaction * Substance use</td>
<td>2.08</td>
<td>.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intentions to engage in safe sex * Substance use</td>
<td>11.91</td>
<td>&lt;.01</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Multivariable models included all individual-, partnership- and event-level characteristics as covariates.
References

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Chapter 5  CONCLUSION

Background

The goal of this dissertation was to assess determinants of hazardous drinking and explore the relationship between substance use and HIV risk behavior among black South African MSM with a focus on the role of social networks. This is an area of interest because Black South African MSM face a set of circumstances that put them at an elevated risk for hazardous drinking and HIV infection. Social networks are also presumed to be of heightened importance among black South African MSM because of the limited ways that they can interact in a setting where same-sex sexuality is highly stigmatized (1-6) and there is no commercial gay subculture (e.g. gay friendly bars and clubs). Addressing these aims was further motivated by 1) the lack of a previous systematic review of the literature describing the influence of social network characteristics among adults; 2) the lack of evidence identifying determinants of hazardous drinking among an South African MSM population despite the known heavy burden of alcohol use in many of these populations; and 3) inconsistencies in reports on the relationship between alcohol use and sexual risk behavior. A comprehensive, systematic review of the literature was conducted to evaluate whether social network characteristics have been shown to influence adults’ drinking behaviors, both in terms of characteristics of their network structures and characteristics of their network ties. This review helped establish the importance of social network characteristics with regards to alcohol use among adults. I then conducted an empirical assessment of determinants of hazardous drinking, which included individual psychosocial risk factors and social network characteristics. Finally, I conducted an analysis of whether substance use predicts HIV risk behavior during a defined sexual encounter, including whether the relationship between substance use and HIV risk behavior is modified by reasons for substance
use, expectations about their effect on sexual behavior, and safe sex intentions. Below, the primary results are summarized and implications are discussed.

**Summary of Results**

For the review in Chapter 2, 18 studies were identified and evaluated to determine how social network analysis methodologies had been applied to empirical data to investigate alcohol consumption among adult populations. Overall, these studies found that characteristics of one’s peers as well as social network structure influenced people’s alcohol consumption in a variety of ways and across settings. Studies that explored the homophily (i.e. the phenomenon that individuals choose to befriend others who are like them) of social networks observed that members of a shared social network became more alike over time in terms of drinking (7, 8) and that selection and induction were both likely contributing factors (8, 9). These results suggest that social network effects, including both peer characteristics and social structure, influence alcohol consumption among adults.

For the empirical analyses in Chapter 3, Black South African MSM were found to have high levels of alcohol use; nearly two thirds of them screened positive as hazardous drinkers. Various factors were found to increase men’s likelihood of being hazardous drinkers. Men who live in a township (versus the city of Pretoria), men with higher levels of gender dysphoria, men who had ever received money or other incentives in return for sex, men who had been sexually abused as a child, and men with anxiety were all more likely to be hazardous drinkers. Men who reported being sexually attracted only to men were less likely to be hazardous drinkers. Men whose social networks included a higher proportion of hazardous drinkers were more likely to be hazardous drinkers themselves. The high levels of alcohol use found in the current study are comparable to what has been described in other studies conducted among black South African MSM (10-12).
That indicators of social vulnerability were found to increase men’s likelihood of being hazardous drinkers is similar to what has been found in other studies (13-17). Indicators of social vulnerability have also been found to be predictors of other risk behaviors among black South African MSM (18-21). These findings heighten concern because of how these co-occurring health problems work synergistically to increase risk of HIV infection (22, 23).

For the empirical analyses in Chapter 4, event-level data was used to assess if substance use increases sexual risk behavior among black South African MSM, and whether the relationship between substance use and sexual risk behavior is modified by expectancies about the effects of alcohol, reasons for consuming alcohol, or intentions to engage in safer sex. I found that men who drank or used drugs prior to their last sexual encounter were not more likely to engage in risky sexual behavior. Although I did not observe a main effect, we found that that the effect of substance use on sexual risk behavior was modified by safer sex intentions. Among men with high intentions to engage in safer sex, men who drank or used drugs prior to their last sexual encounter were more likely to engage in risky sexual behavior. My finding that drinking or using drugs prior to having sex did not have a main effect on risky sexual behavior among the entire sample is in line with other studies that did not find a link between substance use and sexual risk behavior, including studies conducted in sub-Saharan Africa,(24-26) but is in contrast to the large body of evidence suggesting that these behaviors are associated.(27-30) My findings that reasons for drinking and expectancies about alcohol did not impact the relationship between alcohol use and sexual risk behavior are in contrast to other research on the modifying effects of alcohol expectancies (31-35) and reasons for drinking.(36, 37) The high levels of substance use and UAI that were observed, despite the high prevalence of HIV infection and limited awareness
of current HIV status among these men (37, 38) are also in accordance with what has been previously observed in this setting (12, 38-40).

**Limitations and Strengths**

The analyses presented in this dissertation have several limitations. First, the systematic review conducted in Chapter 2 has limitations both in terms of the study results that it summarizes and in terms of the review itself. First, only 18 studies were identified and deemed eligible to be included based on relevance and quality. This is likely because the use of social network analysis to study alcohol use among adults is much more challenging than studying peer effects among other age groups (i.e. adolescents), where social network data is easier to collect and peer effects seemingly more salient. The limited number of articles could also be because the use of social network methods was not indicated in the title or abstract and thus they would not have been identified during the literature search. Second, the results of social network analysis studies are context specific, and insights are likely to vary based on setting and the exposures and outcomes that were measured. Attempts to synthesize across the included studies were difficult given their heterogeneity. The empirical analyses conducted for Chapters 3 & 4 also had their own limitations. For both, the cross-sectional research design limits the ability to infer causality. Both analyses were conducted among black South African MSM and may have limited generalizability outside of that setting. The constructs used were almost exclusively developed in Western settings, and while many of them have previously been demonstrated to be reliable and valid, including in South Africa, there may be additional culture-specific factors that have not been accounted for. Lastly, the data collected are self-reported and could have been subject to social desirability or recall bias. Specific to Chapter 3, an additional limitation is that data was not available regarding being on treatment for HIV. Given how few men knew their current HIV
status, the limited availability of antiretroviral therapy (ART) during the study period and the criteria for starting treatment at the time, I suspect that few men were on ART. Specific to Chapter 4, additional limitations are that alcohol and drug use in association with engaging in sex using were assessed using one single item and I was not able to distinguish between them. Also, the data did not include a measure of strategies that persons may employ to lower their risk of HIV that are not condom-based (e.g., strategic positioning); instead I assumed that all UAI was sexual risk behavior.

Notwithstanding these limitations, this dissertation has many important strengths. Chapter 2 provides a systematic review of the literature on a topic that has received attention through empirical investigations but which has not been systematically reviewed. Chapters 3 is the first analysis to identify risk factors for hazardous drinking (41) among a population that is known to be disproportionately affected by this problem (38-40, 42). In doing so, I not only considered a rich set of psychosocial factors that were available in the data but I also utilized data on men’s social networks. Chapter 4 improved upon previous analyses examining substance use and sexual risk behavior among black South African MSM by applying more temporal precision and additionally considering other situational- and relationship-characteristics (42). Chapters 3 & 4 both contributed important findings regarding substance use and HIV infection among an understudied and underserved population. While black South African MSM are an important minority sample in their own right, they are of additional importance in this case because valuable insight can be gained by focusing on this minority population. At times, certain processes are magnified among minority populations and we can see things more clearly that are otherwise harder to recognize in broader population studies. For example, in some contexts there may be an increased level of risk, but most studies will not encounter a high enough proportion
of people who experience this particular context in order for its effect to become illuminated. Or certain minority populations, such as black South African MSM, may have more variability in their levels of alcohol consumption or their intentions to engage in safe sex that allow us to see how these characteristics might influence other behaviors, such as the influence of substance use on HIV risk behavior. By studying populations such as black South African MSM, we learn about the potential risk of these contexts that gives us more information about that context, and not just about the minority population. In this sense, this dissertation contributes to a greater understanding about the determinants of hazardous drinking and HIV risk behavior, more generally. This was considered in the interpretation of my findings.

**Implications and Future Directions**

The findings from this dissertation have several important implications for interventions that address hazardous drinking and limiting ongoing HIV transmission and for future studies on substance use and HIV risk among black South African MSM. With regards to interventions, the review conducted in Chapter 2 found that social networks influence alcohol use and that social network analysis remains a powerful tool with the potential to explore these effects. The fact that relatively few studies were identified that have used social network analysis to study alcohol consumption among adult populations suggests that these approaches are underutilized. Chapter 3 provides further evidence of the severity of excessive alcohol use among black South African MSM and that efforts aimed at reducing hazardous drinking are greatly needed. Various determinants of hazardous drinking were identified, including many indicators of social vulnerability. The findings are of concern because these health problems often work synergistically to increase risk of HIV infection (22, 23). The drinking habits of men’s social network ties also was highly correlated with men’s own drinking
habits. These findings should be taken into consideration by efforts aimed at reducing hazardous drinking among this critical population. Specifically, intervention strategies should consider targeting MSM who are the most vulnerable, those who live in townships, who have had to engage in sex for money or favors, who have a history of childhood sexual abuse or who suffer from other mental health problems. Possible interventions might include those that not only target individuals but their social networks (43). Chapter 4 contributes to a more complete understanding of substance use and its relationship to sexual risk behavior by demonstrating the moderating effects of safer sex intentions. Understanding more about the context in which substance use leads to sexual risk behavior is important for identifying effective strategies for reducing HIV transmission among this critical population. Based on my findings, efforts to reduce HIV risk behavior should focus on both increasing safer sex intentions and negating the impact of substance use on sexual risk behavior otherwise they may yield little benefit.

This dissertation also has several implications for future research studies. The findings from the review conducted in Chapter 2 can be used to inform researchers about structures and characteristics of social networks among adults, their role in the spread of alcohol use, and the potential for interventions that utilize pre-existing social networks to help reduce the burden of harmful alcohol consumption. Future studies that use social network analysis could agree to use a more standardized set of methods so that they are comparable across studies. They could also make an increased effort to learn about non-college adults, those at the same age who are not in college, and those past the typical college age. Chapter 3 identified numerous factors that increased men’s likelihood of being hazardous drinkers, although many potential risk factors were not found to be associated with hazardous drinking. This speaks to the exploratory nature of these analyses, given the lack of previous research among African MSM populations, as well as
the complexity of substance use and psychosocial health among men in this setting (44-46). These issues merit further exploration. Chapter 4 contributes to a more complete understanding of substance use and its relationship to sexual risk behavior by demonstrating the moderating effects of safer sex intentions. Future research studies could improve upon my analyses by distinguishing between alcohol and drug use prior to a specific sexual encounter. Future studies should also explore the variability I observed in safer sex intentions, including whether black South African MSM may have developed a sense of fatalism regarding HIV infection. Finally, future studies should explore other potential sources of effect modification, as well as other factors that potentially contribute to inconsistencies among research studies assessing the association between substance use and HIV risk behavior, such as the heterogeneity in measures used to assess substance use and HIV risk behavior.

In conclusion, this dissertation increased our understanding of social networks, substance use and HIV risk behavior among black South African MSM. A recent review demonstrating the paucity of research on interventions directed at substance use and HIV risk among these men and other critical, African MSM populations attests to the urgent need for information to inform potential interventions (41). The review in Chapter 2 suggests the importance of using pre-existing social networks to deliver potential interventions. The empirical analyses in Chapter 3 suggest that the most vulnerable members of this community are at increased risk and should be targeted. The empirical analyses in Chapter 4 suggest that efforts to reduce HIV risk behavior should focus on both increasing safer sex intentions and negating the impact of substance use on sexual risk behavior. Taken together, these studies provide insight for developing potential interventions. Specifically, interventions that use social network data to facilitate behavioral change appear to be warranted (43). Network interventions include opinion leader interventions (47-49), where
influential members of a social network are used to disseminate behavior change messages, or using other more strategically located members to diffuse behavior change messages through a social network (50). When considering social network approaches to designing an intervention, it is important to note that social network interventions are not a one-size-fits-all model, but that they depend on the goals and objectives for that intervention (43). Given that South Africa has a high prevalence of hazardous drinking (10-12), a growing problem with drug use (47), and the highest burden of HIV in the world (48), efforts to address these public health problems are desperately needed.
References


