Correlates of Annual Testing for Sexually Transmitted Infections (STIs) in an Online Sample of Men Who Have Sex with Men (MSM): Study Sample Validity, Measure Reliability, and Behavioral Typologies

A DISSERTATION
SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL
OF THE UNIVERSITY OF MINNESOTA
BY

Jeremy Alexander Grey

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

B. R. Simon Rosser, Advisor
Pamela J. Schreiner, Co-Advisor

July, 2013

Acknowledgements

I could not have finished this dissertation without the support of many people. First, I would like to acknowledge my advisor, Simon Rosser, not only for his many hours of mentorship but also for spending a few hours one sunny day at Pride six years ago telling me about the exciting Internet-based HIV research going on at the University of Minnesota, which started me on this journey. I would also like to thank my other advisor, Pam Schreiner, for her willingness to have unstructured meetings at a moment's notice and for cracking the whip as needed. In addition, I am grateful to my committee members, Darin Erickson and Joe Konstan, for sharing their expertise during both the SEM Study and the dissertation process. Furthermore, working on the SEM Study would not have been the same without Alex Iantaffi's insights and direction; Derek Smolenski's masterful survey design and quantitative skills; and Michael Wilkerson's ability to translate qualitative findings to good research practice.

For being by my side in and out of the classroom for the past five years, I am forever indebted to Ami Buikema, Noelle Gronroos, and Lindsey Lesher. The program would have been a very lonely experience without celebrating our successes, commiserating over our frustrations, and laughing through it all together. Most importantly, I will never be able to express enough gratitude and love for my partner, Michael Satterberg, who has patiently stood by me through the last few years and boosted me up when I needed it.

Finally, although I don't know them by name, I want to thank all of the men who shared the intimate details about their lives that became the data used in this dissertation. Regardless of whether those data were accepted as valid, were reliable over a week, or clustered the way I hoped or expected, I literally could not have written this without them. In studying sexual behavior and related infections, we are only as capable of making discoveries as our participants' willingness to answer very personal questions.

Dedication

This dissertation is dedicated to my parents, Marianne and Jeffrey Grey, who praised my eccentricities, made me laugh when I was frustrated, coaxed me back whenever I wanted to walk away, and let me know that they loved me unconditionally.

Abstract

Objective: Testing for STIs has been prioritized as part of a comprehensive HIV/AIDS prevention plan. Internet-based studies of STI testing among men who have sex with men (MSM) are efficient methods of recruiting non-clinic samples from diverse geographic areas. However, online survey methods raise unique concerns regarding threats to the validity of study samples and unknown measurement properties. Thus, this dissertation had two aims. The first was to examine methods related to online survey research by evaluating a protocol to detect invalid survey entries and determining the test-retest reliability of online measures of sexual behavior and STI testing. The second aim was to use the validated sample and reliable measures to examine correlates of STI testing in the year prior to the survey.

Methods: In Manuscript 1, survey submissions were classified as valid and invalid according to a de-duplication and cross-validation protocol. Logistic regression models were used to determine associations between invalidity and key demographic and behavioral variables. In Manuscript 2, test-retest reliability over one week was evaluated using intraclass correlation coefficients (ICCs) and kappa statistics for measures of sexual behavior, HIV status, HIV testing, and STI diagnoses. Finally, in Manuscript 3, the valid sample from Manuscript 1 and measures that were evaluated in Manuscript 2 were used to examine the clustering and correlates of STI testing behaviors.

Results: In Manuscript 1, three components of the protocol for detecting invalid submissions were responsible for identifying the most invalid survey submissions: duplicate IP address, changed eligibility responses, and duplicate payment name. A total of 146 (11.6%) of the submissions were identified as invalid. Invalid submissions had lower odds of reporting HIV testing in the past year. Hispanic/Latino identity, age, and HIV status were also significantly associated with invalidity. In Manuscript 2, counts of sexual partners (three months), HIV status, HIV testing, and STI diagnoses were found to have substantial (0.61-0.80) to almost perfect (0.81-1.00) seven-day test-retest reliabilities, according to commonly used cutpoints. Partner-specific data, however, were only fairly or moderately reliable (0.21-0.60). Finally, in Manuscript 3, a latent class analysis indicated five STI testing classes: *no STIs*, *all STIs*, *bacterial STIs and hepatitis*, *bacterial STIs only*, and *hepatitis only*. The largest class was *no STIs*, indicating that 45.8% of the validated sample had not been tested for STIs in the past year. Predictors of being in a testing class versus no STI testing included age, education, outness about having sex with men, HIV status, and having a sexual partner in the last three months.

Conclusions: This dissertation served two primary aims. The first was to evaluate sample validity and measure reliability in an online study of MSM. The second was to apply the information from those analyses to examine the presence and correlates of a latent variable of STI testing. Across all three manuscripts, online survey research appears to be a viable method of studying STI testing in Internet-based samples of MSM.

Table of Contents

List of Tables

List of Figures

1. Introduction

The Centers for Disease Control and Prevention (CDC) recommend that all sexually active men who have sex with men (MSM) get tested for syphilis, chlamydia, and gonorrhea at least annually as part of a comprehensive plan to prevent the spread of human immunodeficiency virus (HIV) in the United States.[1] However, we identified no studies from the US that reported prevalence of testing for all three bacterial sexually transmitted infections (STIs) among the same sample or that studied both bacterial and viral (e.g., hepatitis A and B, herpes simplex virus, or human papilloma virus) STIs. Consequently, this dissertation aimed to examine annual testing for bacterial and viral STIs and its covariates in an Internet-based sample of US MSM. To that end, the three manuscripts were designed to identify threats to sample validity, the reliability of key study variables, and clustering among annual STI tests.

The dissertation begins with an overview of the symptoms, epidemiology, and prevention of the HIV and other STIs among MSM. A brief review of the role of the Internet in the spread and control of HIV/STIs in MSM is also included. Following this, methods of two surveys from the Sexually Explicit Media (SEM) Study, an Internet-based study of MSM, are described. Manuscript 1 reports the results of a de-duplication and cross-validation detection protocol to detect ineligible or repeat participants. Manuscript 2 evaluates the test-retest reliability of sexual risk behaviors and STI test results. Finally, Manuscript 3 uses the validated sample from Manuscript 1 and the measures evaluated in Manuscript 2 to examine clustering among STI testing behaviors as well as their covariates. A conclusion section reviews major findings and draws on the thesis as a whole.

2. Background and Significance

2.1. Terms and definitions

This review uses the terms *sexually transmitted infections*, or STIs, and *men who have sex with men*, or MSM. STIs are commonly distinguished in two ways. The first is as *ulcerative* or *non-ulcerative*. The second is as *bacterial* or *viral*. In addition, the epidemiology of the human immunodeficiency virus (HIV) and acquired immune deficiency syndrome (AIDS) are treated as distinct from other STIs.

The following two sections provide brief definitions of *sexually transmitted infections* (STIs) and *men who have sex with men* (MSM). Symptoms and treatment of HIV and STIs will be defined in the subsections of Section 1.2, *transmission and symptoms of HIV/STIs.* An appendix of commonly-used acronyms and their meanings is also included at the end of this document.

2.1.1. Sexually transmitted infections (STIs)

Throughout this dissertation, the term *sexually transmitted infections*, or STIs, is used. Although the Centers for Disease Control and Prevention (CDC) do not distinguish between sexually transmitted diseases (STDs) and sexually transmitted infections (STIs),[2] the Mayo Clinic defines the two terms as follows: "Sexually transmitted diseases (STDs) are infections generally acquired by sexual contact. The organisms that cause sexually transmitted diseases may pass from person to person in blood, semen, or vaginal and other bodily fluids. Many of the infections transmitted through sex cause no symptoms, which is one of the reasons experts prefer the term ‘sexually transmitted infections’ to ‘sexually transmitted diseases.’"[3] In order to improve clarity, this dissertation will use the term *sexually transmitted infections* (STIs) and refer to *symptomatic* and *asymptomatic* STIs as appropriate, such as when studies specify one or the other. When reviewing the range of STIs, they are further broken down into *ulcerative* and *non-ulcerative*, as per common practice.[2]

Consistent with other research, HIV and STIs are referred to separately throughout this dissertation. Hence, the term *STIs* in this dissertation refers to non-HIV sexually transmitted infections, while *HIV/STIs* is used to refer to all STIs, including HIV.

2.1.2. Men who have sex with men (MSM)

The population referred to as *men who have sex with men* (MSM) includes all men who have engaged in some form of sexual contact with another man. Depending on the study objectives, *MSM* may refer to men who have engaged in sex with another man at any point in their lifetime or within a defined period of time (e.g., within five years) regardless of their identity as gay or homosexual; bisexual; or straight or heterosexual. According to Young and Meyer's review of the history of the term, the CDC adopted and promoted the term *MSM* during the first decade of the HIV/AIDS epidemic in order to emphasize the mode of transmission of HIV rather than a particular identity or culture.[4]

The reason for this was both to describe and track risk populations accurately and to include non-gay identified men who considered themselves not a risk.[4]

Although the term has been criticized for failing to capture the sexual minority communities and contexts in which the epidemic exists, Young and Meyer acknowledge that identity labels are insufficient for epidemiologic studies and do not recommend a replacement for the term.[4] Savin-Williams also highlights that defining the population using identity rather than behavior may limit the population.[5] Thus, *MSM* will be used throughout this dissertation in order to be consistent with the current standard in the field.

2.2. Transmission and symptoms of HIV/STIs

The following sections contain brief overviews of the symptoms, transmission modes, and recommended treatments of HIV and of several STIs, particularly STIs for which there has been a demonstrated overrepresentation of MSM relative to the general population. The sections are divided into HIV and ulcerative and non-ulcerative STIs in accordance with how they are reported by the CDC.[2,6] Of note is that many STIs are asymptomatic and yet may increase the transmission risk of HIV,[7,8] which underlies the importance of the testing recommendations that are outlined in Section 3.4.2.

2.2.1. Transmission and symptoms of HIV

HIV is the virus that causes acquired immune deficiency syndrome (AIDS).[9] There are two types of HIV, HIV-1 and HIV-2.[9] Most cases in the United States are of

HIV-1, while HIV-2 exists primarily in Western Africa.[9] Both types act similarly by destroying CD4+ ("helper") T-cells and, thus, weakening the immune system.[9]

HIV is present in bodily fluids and tissues of individuals who are infected with HIV.[9] However, the virus is only transmitted when the blood, semen, vaginal secretions, or breast milk of an HIV-positive person is introduced via a mucous membrane, torn tissue, or a direct route to the bloodstream.[9] Since semen is one of the four main bodily fluids that carry HIV, sexual transmission, particularly during anal or vaginal sex, is the predominant mode of transmission in the United States.[6] Oral sex does not carry as high of a risk of transmission.[10]

Recent infection with HIV may result in fever or other flu-like symptoms within a few weeks, but a person with HIV can be asymptomatic for years. Current medications for treating HIV can reduce their viral load, which both slows the weakening of the immune system and reduces the risk of transmitting HIV to a partner. In addition to the infectious disease aspects of HIV, HIV can increase risk of other chronic conditions, including cardiovascular disease and certain cancers.

Highly active antiretroviral therapy (HAART), developed in the mid-1990s, resulted in a marked decrease in the number of persons living with HIV who progress to AIDS. AIDS is when a person's immune system has been damaged to the point that he or she cannot easily fight diseases and some cancers.[9] Although there is no cure for HIV, with proper adherence to HAART, individuals can postpone the onset of AIDS indefinitely and reduce the concentration of the virus in their system.

2.2.2. Transmission and symptoms of ulcerative STIs

Ulcerative STIs refer to sexually transmitted diseases that result in genital ulcers or sores. The two most common of these are syphilis and genital herpes, each of which is described in its own section.

Herpes simplex virus (HSV) transmission and symptoms

Genital herpes refers to infection with the herpes simplex viruses type 1 (HSV-1) or type 2 (HSV-2).[11] Most cases of genital herpes are caused by HSV-2.[11] Many people with HSV-1 or HSV-2 are asymptomatic. When they do appear, typically within two weeks of infection, symptoms include blisters on the genitals, rectum, or mouth (the most common site), which break and become ulcers that last for two to four weeks.[11] This pattern continues with decreasing frequency for years but may occur up to five times within the first year, with genital HSV-1 outbreaks recurring less frequently than HSV-2.[11] Both types of HSV are transmitted via contact with these sores, although any break in the skin can transmit the virus and sores may not be visible.[11] Though it is incurable, symptoms of herpes and transmission risk to partners can be reduced using antiviral medications.[12]

Syphilis transmission and symptoms

Syphilis is caused by the bacterium *Treponema pallidum*.[13] It is transmitted via direct contact with a syphilis sore during vaginal, anal, or oral sex.[13] In men, these sores can occur on the penis, lips, or anus or in the rectum or mouth.[13] Syphilis can remain asymptomatic or go unnoticed for years.[13]

Syphilis cases are often classified as primary or secondary (P or S), which indicates whether the individual is in the primary or secondary stage of infection.[2,13] Primary stage syphilis is characterized by one or more chancre sores that appear from 10 to three months after infection at the spot where syphilis entered the body.[13] During this stage, the sore lasts 3 to 6 weeks and heals without treatment. During secondary stage syphilis, the individual develops skin rashes or lesions on mucous membranes after the chancre has healed and may also develop flu-like symptoms.[13] These symptoms disappear whether or not the individual undergoes treatment, but the disease will progress to the *latent stage* if untreated. This stage involves damage to internal organs that may be sufficient to cause death. Neurosyphilis occurs in the brain or spinal cord. Although it has virtually disappeared after the introduction of penicillin, it has re-emerged among HIV-positive MSM.[14]

Fortunately, syphilis is easy to cure in the early stages with antibiotics,[13] although this treatment will not repair damage.[13] Consequently, it is important for individuals at risk of syphilis to be screened regularly.[13] Individuals with symptoms of syphilis, such as ulcers, should avoid having sex until they have healed.[13]

2.2.3. Transmission and symptoms of non-ulcerative STIs

Non-ulcerative STIs are those that do not result in genital sores. For MSM, the most common of these are chlamydia, gonorrhea, human papillomavirus (HPV), and hepatitis A and B. Hepatitis C, though common, is not often transmitted sexually among HIV-negative individuals and is not included in this review or in the analyses described in Manuscripts 1-3, although there is increasing evidence of sexual transmission among HIV-positive MSM.[15] Each of the remaining STIs is described in its own section.

Chlamydia transmission and symptoms

Chlamydia is caused by *Chlamydia trachomatis*, a bacterium.[16] It is one of the most common bacterial STIs[2] and is largely asymptomatic.[16] In men, when symptoms are present, they include discharge or a burning sensation during urination.[16] Rectal symptoms include rectal pain, discharge, or bleeding.[16] Laryngeal chlamydia is also possible.[16]

As with many other STIs, chlamydia can be prevented using a latex condom when it is used correctly.[16] Chlamydia is curable, however, with either a single dose of or a week-long regimen of antibiotics.[16] Lifelong resistance does not occur; re-infection is possible.[16]

Gonorrhea transmission and symptoms

Gonorrhea is similar to chlamydia in that it is caused by a bacterium, *Neisseria gonorrhoeae,* and is fairly common among adults in the United States.[17] It, too, can be asymptomatic. The symptoms are also similar: men may experience a burning sensation during urination or a white, yellow, or green discharge from the penis. Rectal infection includes discharge, anal itching, soreness, bleeding, or pain during bowel movements.[17] Infections in the throat are generally asymptomatic, but may cause a sore throat.[17]

Gonorrhea can be prevented with latex condoms.[17] Once infected, an individual can be cured with medication, although there are drug-resistant strains of the bacterium.[17] For this reason, it is important to adhere to medications until they have cleared the body of the infection.[17] Treatment will not reverse any permanent damage that the bacterium may have caused.[17]

Hepatitis A (HAV) transmission and symptoms

Hepatitis A refers to infection with the hepatitis A virus (HAV). HAV is most commonly transmitted by oral exposure to fecal contaminants, either in food or directly from other individuals.[18] It is less commonly transmitted in blood. Its status as a sexually transmitted disease relates to oral-anal contact (i.e., analingus, or "rimming") without a barrier (e.g., a dental dam) or improper hygiene after anal intercourse.

Condoms are not as effective at preventing HAV as they are at preventing other STIs. However, dental barriers during analingus and proper removal of condoms after anal sex can reduce the risk of HAV transmission. HAV can also be prevented with a vaccine, which is currently recommended for high-risk populations, including MSM.[19] Individuals who develop antibodies in response to HAV infection tend to be protected against reinfection for life.

Hepatitis B (HBV) transmission and symptoms

Hepatitis B refers to infection with the hepatitis B virus (HBV). HBV is most concentrated in blood but is also present in semen, vaginal secretions, and saliva. HBV is largely asymptomatic and is seldom chronic in adults, but it is transmitted more easily than other viral STIs, such as the hepatitis C virus (HCV) and HIV. It is transmitted via contact with blood, either via breaks in skin or mucous membranes.

HBV can be prevented with a vaccine. Therefore, CDC's strategy to prevent HBV focuses on identifying uninfected individuals, from infants to adults, and vaccinating them.[20,21] In 2008, this strategy was extended to specifically target adults who are at high risk of infection,[22] including MSM and IDUs.[2]

Human papillomavirus (HPV) transmission and symptoms

Human papillomavirus (HPV) is the virus that causes genital warts and anogenital cancers, although it is usually asymptomatic.[2] It is commonly transmitted during anal, oral, or vaginal sex and infects the skin in the genital, anal, oral, and oropharyngeal (back of the throat) areas. These are the areas in which cancers may develop from some of the

40 strains of HPV. Consequently, in MSM, HPV is attributed to an increased risk of anal cancer, particularly among HIV-positive individuals.

An HPV vaccine was introduced in 2006.[2] Although it was initially approved for use in females aged 26 and younger, in 2009, it was extended to males in the same age group.[2] The vaccine protects against types of HPV that are associated with anogenital cancers and specific types (6, 11, 16, and 18) that responsible for 90% of cases of genital warts.[2]

2.3. HIV and STI synergy

Ulcerative and non-ulcerative STIs increase susceptibility to HIV infection in HIV-negative individuals by increasing inflammation. Inflammation from any infection, whether ulcerative or non-ulcerative, increases the presence of CD4+ cells in body fluids, which are targets for HIV.[23] In the case of syphilis or herpes simplex virus (HSV), ulcers in skin and mucous membranes provide additional pathways through which HIV can enter the bloodstream.[24] Although ulcers are direct pathways for HIV, inflammation provides more opportunities for HIV to spread within the system once it is introduced.

Among HIV-positive persons, failure to treat STIs can cause the system to become immune suppressed and stimulate HIV shedding in the genital tract. These effects increase the HIV viral load and infectiousness of the individual, respectively.[24] There is evidence to suggest that HIV also alters the natural history of certain STIs. For instance, in the first decade of the HIV/AIDS epidemic, it was discovered that HIV-positive men were progressing to neurosyphilis more quickly than they had prior to infection.[25]

Further epidemiologic evidence to support the hypotheses that STIs contribute to susceptibility of HIV infection in HIV-negative individuals and infectiousness in HIV-positive individuals is provided under Section 2.4.5, which reviews the epidemiology of HIV and STI coinfection among MSM. Evidence that HIV affects the natural course of STIs and STIs affect medical effectiveness in HIV-positive individuals is also reviewed in that section. Attempts to reduce HIV infection by improving STI screening and treatment are reviewed under Section 2.6.2 as part of a review of HIV and STI control methods.

2.4. Epidemiology and public health burden of HIV/STIs among MSM

All U.S. states, the District of Columbia, and six territories (American Samoa, Guam, the Northern Mariana Islands, Puerto Rico, the Republic of Palau, and the U.S. Virgin Islands) submit confidential case reports of new HIV infections and AIDS diagnoses to local and state health departments.[6] These reports are then de-identified and sent to the Centers for Disease Control and Prevention (CDC) as part of the National HIV Surveillance Strategy.[6,26] Results of anonymous HIV tests are not part of national HIV surveillance reports; however, to receive treatment after diagnosis, HIV-positive diagnoses must be reported.[6]

Additional estimates of HIV risk behaviors are derived from the National HIV Behavioral Surveillance System (NHBS). NHBS is a collaboration between the CDC and 25 state and local health departments. Its focus is on individuals from three specific populations at high risk of HIV infection in the US: MSM, injecting drug users (IDU), and high-risk heterosexuals.[27]

Reports on STI prevalence in MSM are based on case report data submitted by clinics, diagnostic laboratories, and other healthcare providers in U.S. states and territories.[2] As part of the National Notifiable Diseases Surveillance System (NNDSS), clinicians are required to report cases of chlamydia, gonorrhea, hepatitis A, hepatitis B, and syphilis to city and state departments of health, who then submit case data to the CDC.[28,29] However, STI case reporting may not include relevant data regarding transmission, such as sex of sexual partners.[2] The STD Surveillance Network (SSuN) supplements these sources by creating a standardized, detailed reporting mechanism through a partnership of 12 health departments that collected case reports from 41 STI clinics.[30]

Recent surveillance data suggest that HIV diagnoses also appear to be increasing among certain subpopulations of MSM.[31] Some STIs, such as syphilis and gonorrhea, are also increasing in MSM.[32] In the following sections, after a brief discussion of issues related to estimating the size of the population of MSM in the US, the epidemiology of HIV, ulcerative STIs (syphilis and herpes) and non-ulcerative STIs (hepatitis A, hepatitis

B, gonorrhea, chlamydia, and human papillomavirus) among MSM in the United States will be reviewed.

Behavior alone does not account for all differences in rates of HIV and STI infection among MSM. Certain demographic characteristics (e.g., race and ethnicity, age, and socioeconomic status) are associated with disparate rates of risk behaviors and, consequently, infection with HIV among MSM. Thus, after a general review of the epidemiology of HIV, ulcerative STIs, and non-ulcerative STIs among MSM, research regarding these demographic associations and their hypothesized causes will be briefly reviewed in Section 2.5.

2.4.1. Estimating the size of the MSM population

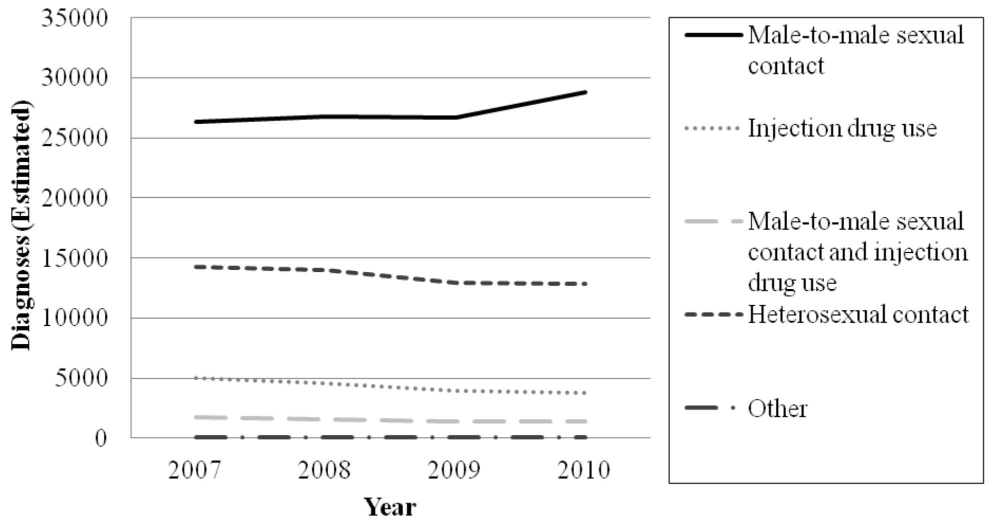
For at least the last decade, several national health studies that collect representative samples of the US population have included questions that can be used to estimate the size of the population of men who have sex with men. From the National Health and Nutrition Examination Survey (NHANES), researchers found that 5.2% of men participating in the survey reported ever having sex with another man, and 57% of those men reported having done so in the past year.[33] Other representative samples yielded estimates ranging from 2% in the National Survey of Men[34] to 5.8% from the National Survey of Family Growth.[35] However, as Savin-Williams has noted, estimates vary widely due to the timeframe of inquiry (e.g., ever had sex with men versus recent sex with men), differences in definition, and, perhaps, because the behavior is unstable over time.[5]

For HIV and STI prevention planning purposes and to estimate the size of the HIV and STI health disparities, it is important to estimate, as accurately as possible, the actual size of the MSM population in the US. Precise enumeration of MSM in the United States is difficult.[5] According to the best estimates available, based on population-based studies and Census data, the proportion of men aged 13 and older who engaged in same-sex behavior differed by recall period,[36] which was consistent with the critique by Savin-Williams.[5] Although it was estimated that 7.0% (95% CI: 4.7%-9.2%) of men had ever had sex with another man, 4.0% (95%CI: 2.8%-5.3%) had had sex with another man in the past five years.[37]

2.4.2. HIV among MSM

Now in its fourth decade, the human immunodeficiency virus (HIV), the virus that leads to acquired immune deficiency syndrome (AIDS), continues to affect men who have sex with men (MSM) more than any other subpopulation in the United States. For 2010, it was estimated that male to male sexual transmission of the virus accounted for 61% of the estimated 47,128 incident cases in the 46 states with confidential reporting.[6] Most notably, male-to-male sexual transmission is the only transmission category in recent years (2007-2010) in which the annual diagnoses have increased (Figure 1).[6]

Figure 1. Diagnoses of HIV infection, by year of diagnosis and transmission category, 2007–2010 (based on 46 states with confidential HIV infection reporting).



Source: Centers for Disease Control and Prevention[6]

Although CDC adjusts HIV incidence estimates for delays in reporting,[6] large proportions of individuals who are HIV-positive are unaware of their status. For instance, it was estimated that approximately 24% of MSM who were HIV-positive in 2006 were unaware of their status.[38] Estimates from the National HIV Behavioral Surveillance System (NHBS), which samples from areas in which HIV is overrepresented among MSM, were higher, with 44% of HIV-positive MSM unaware of their status (95% CI: 41%-46%) in 2008.[39] Using the five-year time period, Purcell et al. calculated an HIV incidence rate of 692 per 100,000 MSM in 2007, which more than 44 times the rate of other men.[37]

Among MSM, certain behavioral factors are associated with risk of acquiring HIV from an HIV-negative partner: condom use,[40-43] type of sex (e.g., oral or anal sex), anal sex role, and number of potential exposures, or frequency of risky sexual behavior. Other behaviors may be antecedents to sexual risk behavior. Methamphetamine use in the prior six months (OR=8.04, 95% CI: 2.00-32.20), amyl nitrite ("poppers") use in the prior six months (OR=6.20, 95% CI: 2.60-14.80), and having sex at a bathhouse in the previous year (OR=9.14, 95% CI: 3.70-22.30) were associated with seroconversion.[40] Regarding anal sex between men, being the receptive partner is associated with a greater risk of acquiring HIV from a seropositive partner than being the insertive partner,[41,43,44] although risk of contracting HIV was higher for both protected and unprotected receptive anal intercourse with known HIV-positive partners than with HIV-unknown partners.[41] For MSM in the US, researchers have estimated the risk of HIV transmission through unprotected receptive anal intercourse (URAI) with a partner of unknown serostatus to be 5 per 10,000, or 0.05%, per act.[44] The risk of transmission of HIV from URAI with a seropositive insertive partner is up to 50 times greater than from unprotected oral sex and approximately 20 times greater than from anal intercourse in which a condom is used.[10]

Unprotected receptive anal sex (URAI) with an HIV-unknown serostatus partner accounted for 15% of the transmissions among men a sample of 3,257 MSM from 6 cities in the United States.[41] Unprotected and protected receptive anal intercourse with an HIV-positive partner accounted for 12% and 11% of seroconversions in the sample, respectively.[41] Consequently, reducing number of sex partners and incidents of receptive anal intercourse were recommended as prevention strategies for MSM.[41]

The number of recent male sex partners is also associated with acquiring and potentially transmitting HIV. Although at least one partner must be HIV-positive for HIV transmission to occur, a higher number of reported HIV-negative sex partners (adjusted OR per partner = 1.14) accounted for 28% of transmissions in a six-city sample of MSM in the United States.[41] Similarly, for HIV-positive men, odds of unprotected anal intercourse were higher when number of sex partners in the previous year was greater (OR=1.07, 95% CI: 1.01-1.14).[40]

2.4.3. Ulcerative STIs among MSM

According to the most recent surveillance data from the 45 states and districts that report the gender of sex partners, 67% of the 13,744 P&S syphilis cases reported to the CDC in 2010 were among MSM.[2] Of these men, 25% had primary syphilis and 75% had secondary syphilis.[2] This statistic was true across all race and ethnic groups.[2] Furthermore, of 8,175 MSM who provided data to the NHBS system in 2008, 35% had been tested for syphilis in the 12 months prior to the survey. Of these, 7% tested positive for syphilis.[45] Using the same method as used for HIV by Purcell et al.,[37] the rate of P or S syphilis among MSM in the United States was 121 per 100,000 individuals, more than 46 times the rate of other men.[37]

Herpes simplex virus is not considered a notifiable disease and, as such, is not reported as part of CDC's surveillance of STIs.[2] Furthermore, since HSV-2 infections can be asymptomatic, passive surveillance may miss a significant proportion of cases. Using data pooled from NHANES 2001-2006, researchers found that prevalence of HSV-2 was higher among men who had had sex with a man in the last year (19.6%) than in non-MSM (12.5%), but that the results were not signficiant, possibly due to the small sample size of MSM and insufficient power.[33] In 2008, a community-based serological survey of 500 MSM in San Francisco found that seroprevalence of HSV-2 was higher, at 26.1% (95 % CI: 18.3%-33.9%),[46] although rates from San Francisco cannot be generalized to the entire country.

2.4.4. Non-ulcerative STIs among MSM

The STD Surveillance Network (SSuN) is a collaboration between 12 states and independently funded cities that involves collecting additional information on cases in order to better estimate the profile of STI cases.[2] For instance, investigators with SSuN obtained data on gender of sex partners, which is not explicitly asked as part of standard STI case reporting, from 5% (3,446) of the gonorrhea cases in the SSuN locales.[2] Although certain SSuN sites, such as San Francisco, estimated the proportion of gonorrhea cases attributed to MSM to be as high as 83%, MSM's proportion of gonorrhea cases across all SSuN areas was 23.2%.[2] The prevalence of chlamydia among MSM from 9 cities was 6% in 2005, with a range of 5% to 8% based on urethral testing.[47]

Although the availability of urine assays has increased testing for chlamydia among men,[2] chlamydia and gonorrhea among MSM may be underreported. Since rectal and pharyngeal infections are typically asymptomatic, screening for urethreal infection is more common. In a clinic-based sample of asymptomatic men who had no knowledge of having been exposed to either disease, 77% of cases of chlamydia and 95% of cases of gonorrhea would have been missed with urine-only screening.[48] Similar rates were found in the UK, where 70% of rectal cases of chlamydia would have been missed without routine screening.[49]

Regarding hepatitis A and hepatitis B, cases are reported to CDC using the National Notifiable Diseases Surveillance System (NNDSS). Through this system, 1,670 cases of acute hepatitis A and 3,350 cases of acute hepatitis B were reported in 2010.[18] Of these, 867 (52%) and 2,054 (61%), respectively, were diagnosed in men.[18] Unfortunately, estimating the proportion of HAV and HBV cases due to male-to-male sexual transmission is difficult: 806 (93%) of 867 reported cases of HAV and 1,810 (88%) of 2,054 reported cases of HBV in men did not contain data regarding whether or not they had engaged in same-sex sexual behavior.[18] Of the few cases that did, 3 (5%) and 42 (17%) were attributed to male-to-male transmission, respectively.[18]

Among young MSM in the San Francisco Bay Area who participated in a study that used venue-based sampling (identified by community advisors), prevalence of hepatitis A was found to be 28.0% (95% CI: 23.7%-32.6%). Having less than a high school education (compared to more than a high school education; OR=2.2, 95% CI: 1.2-

4.1) and 50 or more sexual partners over the lifetime (compared to fewer; OR=1.8, 95% CI: 1.1-3.0) were associated with being infected, as was being Latino (compared to being white; OR=5.3, 95% CI: 3.1-8.9).[50] Vaccination is possible, and MSM have been prioritized as a group to target for vaccination.[19]

Findings regarding HPV, as determined by the presence of genital warts, vary by region. According to data collected by the SSuN, men had a higher prevalence of genital warts than women across all sites. Rates were also higher among MSM than non-MSM in 7 of 12 geographical areas.[2]

2.4.5. HIV/STI coinfection among MSM

Among SSuN network clinics, 25%-54% (median=38%) of men who were diagnosed with P&S syphilis in 2010 were also infected with HIV.[2] STIs in general were higher among HIV-positive men, with 10.5% (vs. 2.6%) testing positive for P&S syphilis, 15.2% (vs. 10.3%) for urethral gonorrhea, 14.4% (vs. 8.1%) for rectal gonorrhea, 8.4% (vs. 7.8%) for urethral chlamydia, and 19.6% (vs. 11.7%) for rectal chlamydia.[2] Among individuals taking antiretroviral therapy in a cohort of HIV-positive persons receiving HIV treatment, 19% men had been diagnosed with an STI in the year since testing positive for HIV.[51] The most common new STI diagnosis was genital herpes (7%) followed by gonorrhea (6%).[51] A study in the UK found that MSM who were HIV-positive were at significantly greater risk of rectal chlamydia infection than those who were HIV-negative (RR=2.53, 95% CI: 1.56-4.08, $p<0.001$).[49]

Research has shown associations between being diagnosed with chlamydia, gonorrhea, and/or syphilis and subsequent HIV seroconversion (OR=5.75, 95% CI: 1.29-25.70).[40] Similarly, in a case-control study of MSM, researchers found greater odds of seroconversion among those who reported prior infection with HSV-2 (OR=1.8, 95% CI: 1.1-2.9) and more than 12 sex partners (OR=2.9; 95% CI: 1.4-6.3).[52] Those who reported fewer HSV outbreaks in the past year had lower odds of seroconversion (OR=0.3; 95% CI: 0.1-0.8).[52]

HIV-infected individuals with other STIs are at increased risk of transmitting the virus to their sex partners due to greater concentrations of HIV in body fluids. In a longitudinal study of recent HIV infection, researchers found that having had a recent STI was associated with increased transmission risk (RR = 12.13, 95% CI: 5.95-24.74, p = .0001).[53] This association was still significant after multivariable adjustment for age, viral load, and recency of HIV infection (RR = 5.32, 95% CI: 2.51-11.29, p = .0001).[53]

2.5. Demographic HIV/STIs disparities among MSM

The government currently recognizes several groups as being at increased risk of HIV/STIs, including certain subpopulations of MSM.[1,6] The following sections briefly review research regarding disparities in rates of HIV/STIs by race and of HIV by age and socioeconomic status among MSM. We could find no studies of STI disparities by age and socioeconomic status among MSM, specifically.

2.5.1. Race and HIV/STIs among MSM

Compared to white MSM, HIV prevalence and incidence rates appear to be higher among black MSM. Of the 8,153 MSM across 21 metropolitan statistical areas (MSAs) who were surveyed as part of the National HIV Behavioral Surveillance system (NHBS) in 2008, non-Hispanic black MSM had the highest prevalence (28%).[39] Hispanic, American Indian/Alaska Native, and Native Hawaiian/Pacific Islander MSM each had the next-highest prevalence at 18%, followed by those who identified as multiracial or another race (17%).[39] White MSM had the second-lowest prevalence at 16%, and Asian MSM had the lowest prevalence (8%).[39] In San Francisco, prevalence of HIV was estimated to be 40.1% (95% CI: 28.2%-53.4%) among black MSM, while prevalence among white MSM was estimated to be 24.7% (95% CI: 22.5%-27.1%).[54]

In a study of MSM across six cities in 2004, the rate of HIV-positive diagnosis per 100,000 male individuals was 70.8 for black MSM and 39.0 for Hispanic/Latino MSM, about 5 and 3 times higher, respectively, than that for white MSM (14.6).[55] In addition, using data from the National HIV Surveillance System and back-calculation methods to estimate HIV diagnoses and overall HIV prevalence by transmission category, it was estimated that 19.4% of white MSM who were HIV-positive were undiagnosed, while the estimated percentage of undiagnosed black MSM was 25.7%.[56]

Aside from HIV, incidence and prevalence of STIs may also differ across race and ethnic identities. Black men were diagnosed with gonorrhea at a rate of 433.6 cases per 100,000 members of the population, while Latino/Hispanic and white men were diagnosed at rates of 66.0 and 25.1 per 100,000, respectively.[2] Additionally, though not generalizable to the entire United States, a community-based serological survey conducted in San Francisco in 2008 found that, among HIV-positive MSM, prevalence of HSV-2 was significantly higher among black MSM (PR=1.6, 95% CI: 1.2-2.2).[46]

Disparities in HIV incidence and prevalence among racial and ethnic minorities appear to extend to young MSM.[57] Despite this, among young MSM (aged 13-29 years), black men did not differ from other men in terms of HIV testing (OR=1.10, 95% CI: 0.89-1.36) or UAI (OR=0.95, 95% CI=0.74-122), or receptive UAI (OR=1.17, 95% CI: 0.51-2.69).[58] In fact, young black MSM were at lower odds than other young MSM of having had UAI in the previous 6 months (OR=0.73, 95% CI: 0.59-0.89),[58] suggesting an interaction between race and age.

2.5.2. Age and HIV among MSM

Age is related to HIV prevalence and incidence, although the direction of the association varies. Partly due to HAART and increased survival time, HIV prevalence is higher among older MSM. New infections, however, are highest among MSM between the ages of 13 and 24. Roughly one third of the individuals who were diagnosed with HIV in 2010 were young adults.[31] Furthermore, from 2001 to 2004, rates of HIV among MSM increased by 14.1% per year for those aged 13 to 19 and 13.3% for those ages 20 to 24, while rates for all other age groups increased by 6.2% or less.[55] Although an estimated 21% of HIV-positive individuals in the United States in 2006 were unaware of their serostatus, the percentage was estimated to be 48% for HIV-positive youth.[38] Furthermore, in some urban samples, as many as 77% of those under the age of 30 who tested positive reported that they were not infected prior to testing.[59]

2.5.3. Socioeconomic status and HIV among MSM

HIV prevalence and incidence may also differ across levels of education and other indicators of socioeconomic status. Socioeconomic status is associated with seroconversion among MSM.[60] Data from the NHBS indicated that, among men surveyed across 21 cities in 2008, men in the lowest annual household income category had the highest HIV prevalence (26%, 95% CI: 21%-29%).[39] Additionally, MSM who received an HIV-positive diagnosis were more frequently tested by their private physician (27.1%), followed by AIDS clinics or testing outreach programs (20.4%) and hospitals (20.9%).[56] If the largest percentage of diagnosed cases came from individuals with access to a private physician, the disparity between those with and without healthcare may be more pronounced. Consistent with these findings, although not representative of the country as a whole, 29% of MSM tested as part of a sample of 2,508 homeless and marginally-housed individuals in San Francisco tested positive for HIV.[61]

2.6. Control and prevention of HIV/STIs among MSM

Since 1997, the CDC's Advisory Committee for HIV and STI Prevention, which is responsible for advising the CDC on HIV and STD prevention and treatment priorities, concluded that detection and treatment of curable STIs in areas where STIs are particularly prevalent should be implemented as part of a comprehensive HIV prevention plan.[62] The prevention and control of STDs are based on the following five major strategies: 1) educating at-risk individuals on preventing STIs through behavior change; 2) identifying individuals who are asymptomatic or do not get tested or treated routinely; 3) diagnosing and treating existing infections; 4) testing and treating partners of individuals who test positive for STIs; and 5) vaccinating individuals when possible.[1] Of the behavioral changes specified by the CDC, the following are relevant to MSM: a) abstinence or reduction of number of sex partners; b) vaccination; c) condoms (male or female); d) postexposure prophylaxis (PEP); e) pre-exposure prophylaxis (PrEP); and f) repeat testing.[1] A brief overview of condom use and alternatives are covered in the first section, followed by sections on testing and treatment and PEP/PrEP.

2.6.1. Condom use

Proper use of condoms or other barriers reduces risk of contracting HIV for every sexual behavior.[44] For MSM in the US, researchers have estimated the risk of HIV transmission through unprotected receptive anal intercourse (URAI) with a partner of unknown serostatus to be 5 per 10,000, or 0.05%, per act. [44] The risk of acquiring HIV from a seropositive insertive partner is up to 50 times greater from URAI than from unprotected oral sex and approximately 20 times greater than from anal intercourse in which a condom is used.[10]

Although they are not recommended officially, it is worth noting strategies that some MSM use to reduce risk when having unprotected anal intercourse. Among these are serosorting, strategic positioning, and withdrawal before ejaculation. Serosorting involves having anal sex only with individuals who are of the same HIV serostatus. With strategic positioning, HIV-negative MSM adopt the insertive role in anal sex with individuals who are HIV-positive, while HIV-positive individuals adopt the receptive role in anal sex with individuals who are HIV-negative. Withdrawing before ejaculation is self-explanatory and involves reducing the amount of viral exposure by reducing the amount of fluid exchanged during sex.[63]

Given the different risk associated with insertive versus receptive anal intercourse,[64] strategic positioning (e.g., choosing to top when having unprotected anal intercourse) may provide some protection from acquiring HIV.[65] Serosorting, or choosing to have unprotected anal intercourse with persons of the same HIV serostatus, is another method that some MSM use to reduce risk of acquiring or transmitting HIV. Finally, although it is not explicitly related to sexual risk among MSM, needle exchange programs have been implemented in certain jurisdictions for individuals who inject drugs.

2.6.2. HIV/STI testing and treatment

According to the most recent treatment guidelines as outlined by the CDC's Division of STD Prevention, sexually active MSM should be tested annually for HIV (if they have not been diagnosed previously), syphilis, urethral and rectal gonorrhea (*N.*

gonorrhoeae), and urethral and rectal chlamydia (*C. trachomatis*).[1] However, recent reports indicate low rates of annual testing for some STIs among MSM. In a national sample of MSM, only 39% had been tested for syphilis in the previous year.[66] Fewer (36%) had been tested for gonorrhea.[66] Still, compared to non-MSM, MSM appear to be significantly more likely to have been tested for STIs (RR=1.8, 95% CI: 1.6-2.1, $p<.05$).[67] Similarly, among individuals who tested HIV-positive, MSM were more likely than non-MSM to have been tested for HIV within the 12 months prior to their HIV-positive diagnosis.[68]

Reasons for not meeting the CDC's STI testing recommendations are unclear. In an online sample of MSM, only 30% had been offered an HIV test by a healthcare provider.[69] Testing for syphilis and gonorrhea was associated with being younger, black, having health insurance, and disclosing history of sex with men to a healthcare provider.[66] In a New York City-based study, MSM who did not identify as gay were less likely than gay men to have been tested for HIV in the previous year (PR=0.6, 95% CI: 0.4-0.9).[70]

Knowledge of HIV status appears to be related to HIV risk behavior. Among an Internet-based sample, men who engaged in higher-risk behaviors, such as unprotected receptive anal intercourse, tended to get tested more frequently than men who consistently use condoms.[71] Similar findings have been found in Australia, which has comparable HIV and STI testing guidelines for MSM.[72] Thus, although they incur a greater risk to acquiring HIV, men who engage in risky sexual behavior may be aware of this risk and get tested accordingly, although this finding was not true of men engaged in unprotected insertive anal sex.[71] Furthermore, across several studies, the frequency of unprotected anal and vaginal intercourse was an average of 53% lower among HIV-positive individuals who had been diagnosed over HIV-positive individuals who did not know that they were positive.[73]

Treatment of HIV with HAART was also shown to be "highly protective" in a multivariable analysis of MSM (RR=0.14, 95% CI: 0.07-0.27, $p<.05$),[53] which underscores the importance of testing for HIV and enrolling men in treatment. There is biological feasibility for treating STIs in order to prevent HIV infection, but reviews of the literature are mixed as to the effectiveness of this approach. Renzi et al. suggest that treating HSV-2 might reduce risk of acquiring HIV.[52]

2.6.3. Pre- and post-exposure prophylaxis (PrEP/PEP)

A once-daily tablet of oral antiretroviral chemoprophylaxis, also known as pre-exposure prophylaxis, or PrEP, has been demonstrated to reduce the risk of HIV infection among MSM.[74] Encouragingly, in a study conducted soon after the first studies demonstrating the potential of PreP as part of an HIV prevention strategy, MSM who have engaged in UAI with multiple partners were significantly more interested in using PreP compared to MSM who had not engaged in UAI (OR=1.72, 95% CI: 1.45-2.03).[75] Those who perceived their risk of acquiring HIV to be higher also expressed more interest in using PreP (OR=1.20, 95% CI: 1.15-1.25).[75] Although daily dosing with PreP may not be feasible for all MSM, intermittent dosage has also been suggested for men who do not engage in sexual activity more than three days a week.[76] Due to the need for advanced planning, it has been suggested that MSM who use sexual networking sites may particularly benefit from this approach.[76]

2.7. The role of the Internet in the spread and control of STIs among MSM

The Internet is popular among MSM,[67,77-79] Because of this, it is important to review its varied role in the spread and control of STIs among MSM. In an early study examining the characteristics of MSM and non-MSM who completed an online survey, Bull, McFarlane, and Rietmeijer[77] found that the population of men who sought sex online was "largely a White, adult, well-educated, and insured group… [that is] very different from the clients of public STI programs…" (p. 989). Since then, there has been further evidence to suggest that Internet samples capture diversity among MSM not seen in gay-specific venues. Some Internet samples have been older, less educated, less likely to identify as exclusively homosexual (i.e., to identify as bisexual), less likely to have a history of STIs, and less likely to be HIV-positive than samples recruited from bars.[80] After adjusting for these differences, sexual behavior was not significant between online and offline samples.[80]

Given the differences in online and offline samples and the apparent potential to reach demographics that, as reviewed above, are disproportionately affected by HIV, it is worth reviewing briefly the context of the Internet in the HIV and STI epidemics among

MSM over the last decade. Thus, the following sections contain brief overviews of the ways in which the Internet has been found to be related to HIV and STI risk behavior. The first section reviews studies that found that sex-seeking on the Internet was related to increased risk behaviors. Subsequent sections review specific ways that researchers and outreach workers have used the Internet to improve information about and testing for HIV and STIs among MSM.

2.7.1. The Internet as a risk environment

Seeking sex partners online has been identified as a risk factor for HIV and STI infection among MSM in the United States.[77] Early studies of the Internet as a unique risk environment found that using the Internet to find sex partners was associated with sexual risk behavior and higher odds of HIV and STI diagnoses.[81] However, subsequent studies by researchers who have examined differences between online and offline samples of MSM have found conflicting results. Even though, in some studies, sexual risk appears to be higher among men who met their partners online,[77] others have found no difference.[78,82,83] Similarly, regarding STIs, Al-Tayyib and colleagues found that, among clinic attendees who tested positive for chlamydia or gonorrhea, the relative risk of contracting an STI from a partner met online versus a partner met offline was not significantly different (RR=1.12, 95% CI: 0.84-1.49).[84] Other studies have found consistent results.[78,82,85]

One possible explanation for discrepant findings may be how risk is defined. Although it has been found that men who used the Internet to seek sex partners reported having significantly more partners than those who did not in the previous six months,[77] risk behaviors with their online partners may not differ from risk behaviors with offline partners. In a comparison of retrospective survey and daily diary data collected from an online sample of MSM, Mustanski[86] discovered that, while Internet sex-seeking behavior and unprotected anal intercourse with recent partners were related in data from an online survey, data from daily diaries (also online) indicated that men were significantly less likely to engage in UAI with partners met online compared to partners met in other ways. Put another way, men who seek sex partners online more often engage in risk behavior more frequently (in general), but their risk behaviors occur more often with partners met offline than partners met online.

Another potential mechanism by which the Internet poses risk to MSM is in deception regarding sexual intentions or HIV serostatus. Research suggests that men may misrepresent themselves to, and be deceived by, their prospective sexual partners regarding identity, body type, genital size, sexual interests, and relationship goals more often than when meeting partners offline.[87] However, although men claim to be deceived by their partners regarding their HIV status more often than they misrepresent their own, differences in misrepresentation of HIV serostatus did not appear to differ according to whether the partners were met online or offline.[87]

2.7.2. The Internet as an information resource

MSM use the Internet to find health information from gay-focused websites or general health websites.[88] However, among a sample of 324 HIV-positive adults, few made a distinction between high and low quality information.[89] Consequently, although the Internet is an educational resource regarding HIV and STI, there may be danger of misinformation. Fortunately, most HIV-related searches yield “clearing houses” with information regarding how HIV is transmitted, how to prevent transmission, and how to treat HIV.[90]

2.7.3. The Internet as a testing avenue

Part of the strategy to reduce HIV transmission among MSM in the US is to increase HIV testing.[1] In an Internet-based study, 82% of a sample of 6,163 HIV-negative or HIV-unknown MSM reported that they would be very likely or likely to take a free at-home HIV test that would be mailed to them.[91] Black MSM (AOR=1.3, 95% CI: 1.1-1.7) and men who had had UAI with a male partner in the last year (AOR=1.3, 95% CI: 1.1-1.5) were significantly more likely to agree to at-home HIV testing than white men and men who had not engaged in UAI.[91] This indicates that Internet-based distribution of HIV tests may be useful in reaching MSM with higher odds of HIV infection and MSM who are reluctant to seek testing at clinics or similar sites. Home testing may be a strategy that is limited to HIV testing, however. In a study involving the distribution of testing kits for gonorrhea, chlamydia, and trichomonas via a website, researchers found that only 31% of the 1,644 kits that were requested by men were returned for testing.[92]

Linkage to testing and care is also facilitated by the Internet. Partner notification systems have been implemented successfully online. Men who are diagnosed with HIV or STIs can anonymously inform recent sexual partners via email of their exposure. In an online sample of U.S. MSM, 70% indicated that, following an STI diagnosis, they would make use of a public health specialist to confidentially notify their sexual partners that they had been exposed and should be tested.[93]

3. Study Design

Data for all analyses in this dissertation come from two phases of the Sexually Explicit Media (SEM) Study. The SEM Study was conducted in order to "study exposure to and consumption of SEM by Internet-using MSM and to investigate a hypothesized relationship between SEM consumption and HIV risk behavior... [Its] primary significance to public health lies in its potential to assess what relationship, if any, exists between SEM consumption and HIV risk." Both the Reliability and Main Surveys were funded by the National Institute of Mental Health, grant number 1R01MH087231-01.

3.1. Sexually Explicit Media (SEM) Main Survey

Data from the Sexually Explicit Media (SEM) Main Survey were used for all analyses in Manuscripts 1 and 2. The SEM Main Survey was the third of three surveys (following the two that were administered for the SEM Reliability Survey Study, described in Section 3.2) conducted as part of Dr. B. R. Simon Rosser's grant, “Understanding Effects of Web-based Media on Virtual Populations.”

3.1.1. Overview, study design, and study population

Internet-using MSM (N=1,254) completed an online survey about their use of SEM and sexual behavior. Participants were recruited online between May 23rd, 2011, and August 7th, 2011, using banner advertisements on 148 gay-oriented websites affiliated with an advertising agency specializing in gay consumers. As part of the sampling strategy, impressions were increased to urban areas with a high proportion of African-American and Latino men and quotas were placed on white respondents in order to allow for over-recruitment of MSM of color.

Overall, 7,939,758 impressions were displayed during this period and banners had a click-through-rate (CTR) of 0.16%. Banner advertisements directed interested persons to a webpage hosted on a dedicated university server with appropriate encryption to ensure data security. A total of 5,201 MSM met the eligibility criteria, which included having prior sexual experience with a man, being 18 years of age or older, and living in the United States and its territories. The mean completion time for the survey was 42 minutes. Participants were compensated $25 for completing all tasks related to the study.

The Main Survey was limited to men aged 18 years or older who lived in the United States and had had sex with men at least once during the past five years. The eligibility criteria were confirmed using an online screening instrument that restricted access to individuals who indicated that they met each of the criteria.

3.1.2. Relevant study components

Internet protocol (IP) address and timestamp

All participants who completed the screening questionnaire were shown their responses and prompted to confirm them or change them if they were incorrect. Having confirmed their age, sex, country of residence, and gender of partners in the previous three years, only those who were eligible were shown the study information and allowed to consent to participate in the study. Due to quotas, race and ethnicity were also included as conditional eligibility criteria, with white non-Hispanic men being ineligible after 400 were recruited. No other racial or ethnic groups reached the set quota. Individuals who were ineligible were thanked for their interest and navigated away from the survey.

Participants were unable to change their responses after confirmation without re-accessing the survey. The implication of this is that each attempt at accessing the survey was recorded independently. By examining timestamps and IP addresses, it is possible to determine whether a prospective respondent completed a screener, was deemed ineligible, and then re-attempted the screener with different answers. Similarly, it is possible by studying timestamps to identify whether responding temporally overlaps between surveys (indicating the surveys could not be from the same person) and by studying how temporally close each attempt was to assess the likelihood that the two or more attempts were by the same person or by different people from the same IP address.

Cross-validation items

For several of the eligibility criteria, items were included in the survey in order to cross-validate participants' responses to the screener. Cross-validation items included age, asked categorically in the screener and as an open-ended numeric item at the end of the survey; United States residence, asked as zip code in both the screener and at the end of the survey and confirmed by IP address geolocation; and status as MSM, asked categorically in the screener and derived from counts of male sexual partners in the survey.

HIV/STI testing and diagnosis

As with the SEM Reliability Surveys, individuals were asked their HIV status as part of the demographics questionnaire. Response options included “HIV-positive,” “HIV-negative,” “I’m not sure, but I think HIV-positive,” “I’m not sure, but I think HIV-negative,” “I don’t know,” and “refuse to answer.” Those individuals who reported being HIV-positive were later asked the date that they tested positive for HIV. Those men who did not indicate that they had tested positive for HIV were asked how recently they were tested for HIV, with response options of “in the last three months,” “in the last year,” “one (1) to two (2) years ago,” “more than two (2) years ago,” “I have never been tested for HIV,” “I can’t remember,” “not applicable,” and “refuse to answer.” Regardless of their answer to this, men who had not reported testing HIV-positive were also asked the number of times they had been tested for HIV in the past twenty-four months.

Regarding sexually transmitted diseases, men were asked if they were tested for each of seven STIs in the past twelve months: syphilis, gonorrhea, chlamydia, HPV (genital or anal warts), genital herpes, hepatitis A, and hepatitis B. Response options were “yes, and I got the results,” “yes, but I did not get the results,” “no,” “I don’t know,” and “refuse to answer.” Participants were then asked if they were diagnosed with them, with response options of “yes,” “no,” “I don’t know,” and “refuse to answer.”

Sexual behavior

As with the SEM Reliability Surveys, men were asked questions regarding their sexual history over their lifetime and over the last three months. Participants reported lifetime number of male sexual partners (any kind of sex) and number of male, female, and transgender partners in the last three months (asked separately). After reporting the number of male partners in the last three months, participants were asked how many were primary partners, defined as “a regular sex partner such as a boyfriend, husband, domestic partner that you have been in a relationship with for at least three months.” The number of casual male partners was derived by subtracting the number of primary male partners from the total number of male partners.

Questions regarding the participants’ primary sexual partner were identical to those used for the reliability study. Men reported the length of their relationship, partner’s HIV serostatus, the date of their last sexual encounter with their partner, and frequencies of receptive and insertive anal sex with their partner over the last three months. Participants were also asked frequencies of condom use for the anal sex role they indicated.

Questions regarding casual sexual partners were changed for the main study. Participants who reported having casual partners reported partner frequencies for protected and unprotected insertive and receptive anal sex. For each condom use and anal sex role pair, participants reported the frequency of partners who were HIV-positive, HIV-negative, and HIV-unknown. Drug and alcohol use for each type of partner was also asked.

As with the reliability study, all participants who indicated having had a sexual partner in the last three months were asked general questions regarding the relative frequency of each of 23 sexual behaviors, chosen based on their inclusion in gay SEM websites. For the proposed manuscripts, analyses will be limited to two items anal sex with a condom and anal sex without a condom. Response options were “never (0%),” “rarely (1-20%),” “sometimes (21-40%),” “about half of the time (41-60%),” “most of the time (61-80%),” “almost always (81-99%),” and “always (100%).”

3.1.3. Human subjects

After completing a questionnaire to verify eligibility, respondents received information regarding the study’s objectives and the tasks they would be asked to complete.[94] Respondents then indicated their consent to participate by verifying that they understood each of the points displayed on the Web page and advancing to the next screen. This method of online informed consent was approved by the University of Minnesota’s Institutional Review Board (IRB).

A Certificate of Confidentiality was obtained from the NIH, and the study was conducted under the oversight of the IRB of the researchers’ home institution. A refuse to answer response option allowed participants to decline to answer any item.

3.2. Sexually Explicit Media (SEM) Reliability Surveys

Data from the Sexually Explicit Media (SEM) Reliability Surveys were used for all analyses in Manuscript 2. The SEM Reliability Surveys were conducted as the first two of three surveys conducted as part of Dr. B. R. Simon Rosser's grant, "Understanding Effects of Web-based Media on Virtual Populations." Both the Reliability and Main Studies were funded by the National Institute of Mental Health, grant number 1R01MH087231-01.

3.1.1. Overview, study design, and study population

The SEM Reliability Surveys were conducted in order to examine the test-retest reliability of several of the proposed instruments for the main study among members of the target population. A total of 241 men completed identical surveys at two time points spaced one week apart.

Recruitment began in January, 2011, and data collection completed in February, 2011. The study employed a passive recruitment strategy. A marketing agency, Gay Ad Network, displayed banner ads on gay Web sites to persons in the United States according to their Internet protocol (IP) address in order to maximize the number of impressions to a U.S.-based MSM sample. A total of 448,472 impressions were made on 165 Web sites, with a click-through rate (CTR) of 0.31%.

Clicking on the advertisement directed individuals to an encrypted webpage hosted at the University of Minnesota. The study was limited to men 18 years old or older who lived in the United States and had had sex with a man at least once during the past five years. These eligibility criteria were confirmed using an online screening instrument that restricted access to individuals whose responses indicated that they met each of the criteria.

After confirming eligibility and reviewing the study information, participants who consented completed the first of two surveys and provided contact information for an invitation to complete the second survey. Of the 326 men who completed the first survey, 241 (74%) completed the follow-up survey. In both surveys, participants were instructed to respond to items for the same time period (i.e., to refer to the three months prior to the first survey and not include the week between the first and second surveys).

The median completion time for each survey was approximately 46 minutes. Participants were compensated $60 for completing all tasks related to the study.

3.1.2. Relevant study components

Sexual behavior

Men were asked questions regarding their sexual history over their lifetime and over the last three months. Most questions were asked in the form of frequencies, such as lifetime number of male sexual partners (any kind of sex) and number of male, female, and transgender partners in the last three months (asked separately). After reporting the number of male partners in the last three months, participants were asked how many were primary partners, defined as “a regular sex partner such as a boyfriend, husband, domestic partner that you have been in a relationship with for at least three months.” The number of casual male partners was derived by subtracting the number of primary male partners from the total number of male partners.

Participants who reported having a primary male partner received follow-up questions regarding their relationship. Men reported the length of their relationship with their primary partner, their partner’s HIV serostatus, the date of their last sexual encounter with their partner, and frequencies of receptive and insertive anal sex with their partner over the last three months. Participants were also asked frequencies of condom use for the anal sex roles they indicated.

Participants who reported having casual male partners were prompted for partner-level information regarding their most recent partners, up to three. Participants were asked questions regarding frequencies of insertive and receptive anal sex and, depending on their anal sex role, frequency of condom use. According to whether the partner was a regular partner or a one-time partner, determined by the number of times the participant reported having sex with the partner over the last three months, participants were asked about alcohol and drug use during one occasion or over the duration of the sexual relationship. Participants who had an ongoing sexual relationship with their casual partner were also asked the first and most recent dates of the relationship.

All participants who indicated having a sexual partner in the last three months were asked general questions regarding the relative frequency of 23 sexual behaviors:

solo masturbation, kissing, oral sex with a condom, oral sex without a condom, rimming with a dental dam, rimming without a dental dam, swapping ejaculate, group sex, anal penetration with sex toys, anal penetration with large objects, anal sex with a condom, anal sex without a condom, spanking, bondage and domination, sadomasochism, fetish or kink behaviors, forced sex, wearing leather, cross-dressing, sex with young men (referred to as "twinks"), sex with a member of the opposite sex, urination, and defecation or inclusion of feces. Response options were "never (0%)," "rarely (1-20%)," "sometimes (21-40%)," "about half of the time (41-60%)," "most of the time (61-80%)," "almost always (81-99%)," and "always (100%)."

HIV testing and HIV/STI diagnosis

Individuals were asked their HIV status as part of the demographics questionnaire. Response options included "HIV-positive," "HIV-negative," "I'm not sure, but I think HIV-positive," "I'm not sure, but I think HIV-negative," "I don't know," and "refuse to answer." Those individuals who reported being HIV-positive were later asked the date that they tested positive for HIV. Those men who did not indicate that they had tested positive for HIV were asked how recently they were tested for HIV, with response options of "in the last three months," "in the last year," "one (1) to two (2) years ago," "more than two (2) years ago," "I have never been tested for HIV," "I can't remember," "not applicable," and "refuse to answer." Regardless of their answer to this, men who had not reported testing HIV-positive were also asked the number of times they had been tested for HIV in the past twenty-four months.

Regarding sexually transmitted diseases, men were asked if they were diagnosed with any of seven STIs in the past twelve months: syphilis, gonorrhea, chlamydia, HPV (genital or anal warts), genital herpes, hepatitis A, and hepatitis B. Response options were “yes,” “no,” “I don’t know,” and “refuse to answer.” Although reliability of testing behavior would be pertinent, considering the subject of the third manuscript, data regarding testing for STIs were not collected as part of the reliability study.

3.1.3. Human subjects

After completing a questionnaire to verify eligibility, respondents received information regarding the study’s objectives and the tasks they would be asked to complete. Respondents then indicated their consent to participate by verifying that they understood each of the points displayed on the Web page and advancing to the next screen. This method of online informed consent was approved by the University of Minnesota’s Institutional Review Board (IRB).

A Certificate of Confidentiality was obtained from the National Institutes of Health (NIH), and the study was conducted under the oversight of the IRB of the researchers’ home institution. A refuse to answer response option allowed participants to decline to answer any item.

4. Manuscript 1: Invalid entries in an online survey of men who have sex with men (MSM): Influence on estimates of sexual risk behavior and HIV/STI testing

4.1. Abstract

Introduction: Internet-based studies are low-cost and efficient methods of conducting HIV research with sexual minority populations. They are also vulnerable to receiving submissions from ineligible individuals. To identify such invalid survey submissions, researchers have developed de-duplication and cross-validation protocols. However, these protocols often have different features, and updates are seldom studied according to their components. This manuscript had two aims. Aim 1 was to evaluate components of a de-duplication and cross-validation protocol in terms of how well they detected invalid entries. Aim 2 was to examine differences in demographic characteristics, rates of sexual risk behavior, and self-reported HIV and STI testing between invalid and valid subsamples identified by this protocol.

Methods: Data were collected as part of the Sexually Explicit Media (SEM) Study. The Sexually Explicit Media (SEM) Study was conducted from May to August, 2011, during which of 1,254 MSM submitted entries to an Internet-based survey. A de-duplication and cross-validation protocol was used to examine the data for evidence of multiple submissions and ineligibility. Chi-square analyses, logistic regression models, and negative binomial regression models were used to examine associations with invalidity.

Results: Of the 1,254 survey submissions, 146 (11.6%) were identified as invalid using the protocol. Variables derived from IP addresses were the most useful for identifying invalid submissions. Specifically, changes to screening questionnaire responses, repeated payment names, and repeated IP addresses identified the greatest number of invalid surveys. Odds of HIV testing in the past year and of requesting check payments were lower among invalid submissions. The invalid submissions also had at greater odds of reporting Latino/Hispanic identity and younger age. Few other demographic and behavioral differences were found between the valid and invalid samples.

Conclusion: Identification of invalid samples improved using the updates to the de-duplication and cross-validation protocol. With the inclusion of invalid samples, estimates of HIV testing would have been biased, with a lower proportion reporting HIV testing in the previous year. Researchers should consider collecting IP addresses as part of any comprehensive validation procedure. Furthermore, in contrast to previous research, results did not indicate a clear benefit to removing financial incentives.

4.2. Introduction

Internet-based research has created new opportunities for the field of epidemiology.[95] With proper design, researchers can improve data quality, decrease participant burden, and better protect subjects' confidentiality.[95] Relative to offline research, it is a cost-effective method to recruit thousands of individuals from a large geographic area.

In studies of human immunodeficiency virus (HIV) risk, it is possible to recruit large Internet-based samples of hard-to-reach populations, including men who have sex with men (MSM),[96-98] transgender individuals,[99,100] and illicit drug users.[101,102] While stigma may be a barrier to reaching individuals using offline methods, online methods appear to maintain a high level of confidentiality and can reach individuals who do not frequent venues where only some members of the population are found (e.g., gay bars or community spaces). Furthermore, with recent estimates placing the percentage of US men who have had sex with a man within the last five years at only 3.9%,[36] obtaining a random sample of MSM from the general population would require substantial effort. Therefore, online samples and self-reports of sexual behavior and sexual orientation are common methods in studies of MSM.[103]

Some of the strengths associated with online studies can also be weaknesses. With ease of access and relative anonymity come threats to sample validity. As Skitka and Sargis[104] point out, "[T]he tendency to take on false identities on the Web poses a problem for those whose research depends on successfully identifying specific personal characteristics of research participants" (p. 548). Ineligible individuals can change answers to screening questions to gain access to a study, and eligible individuals can participate multiple times by presenting themselves as different people.

In order to reduce threats to data integrity from invalid participation, researchers are encouraged to implement protocols for de-duplication (identifying multiple submissions from the same person) and validation (confirmation that participants meet study eligibility criteria).[103,105-107] Studies that have focused on de-duplication use methods such as tracking Internet protocol (IP) addresses and requiring personal information (e.g., email address or telephone number) for registration or payment.[105,108] To confirm validity, researchers have also examined the internal consistency of responses by including "cross-validation" items at different points in the survey, such as requiring a birth date at the beginning and an open-ended age item at the end.[107,109]

Several studies of MSM have adapted a protocol created by Konstan et al.[105,110,111] Konstan's original de-duplication and cross-validation protocol included the following elements: (1) cross-checking eligibility criteria such as MSM status, US residence, and age with answers to survey items and payment information; (2) identifying duplicate survey submissions by detecting duplicate IP addresses (full and partial), e-mail addresses, names, and payment information (check address or e-payment receipts); and (3) noting short completion times (i.e., 12 minutes or less).[107] Bowen et al.[105] used similar detection variables but also examined similarities in usernames and passwords and usernames created for the study's registration process. Furthermore, in a recent study, Bauermeister and colleagues[110] used two new methods of determining validity: using user-submitted data to profiles on public social network accounts and asking questions that helped explain reasons why multiple entries might be submitted from same residence/IP address (e.g., whether the respondent reported having roommates or a partner).[110]

The utility of these protocols has been demonstrated previously. As Konstan et al.[107] report, their protocol led to the detection of one individual in their online study of MSM who submitted 65 entries. Similarly, Bauermeister and colleagues[110] found that the associations of interest in their study of young MSM would have differed if they had not excluded data from suspicious submissions or checked for valid cases among those flagged. As a result, both studies found that associations between key study variables differed according to their method of classifying participants as valid or invalid.[110]

The use of such protocols is somewhat controversial. Researchers implementing similar protocols have found that reducing monetary incentives or implementing additional identity checks resulted in reduced rates of invalid participation.[112] They suggested that, due to reduce motivation using minimal incentives and automated participation was an easy alternative to implementing a full de-duplication and cross-validation protocol.[112] Furthermore, privacy advocates and institutional review boards have expressed concern about use of potentially identifiable data (e.g., IP address) without the explicit consent of the participant. Hence, practices differ between research groups and across countries.

We could find no studies since Konstan et al.[107] that evaluated specific components of a full protocol (i.e., not just multiple submissions, as Bowen et al.[105] reported). Hence, this manuscript had two primary aims. The first aim was to address the question, "What are the most useful variables to include in a de-duplication and cross-validation protocol?" Self-report and automated data (e.g., IP addresses) were inspected according to an extended version of Konstan et al.'s[107] protocol using in the Sexually Explicit Media (SEM) Study. The second aim was to examine differences between invalid and valid subsamples, particularly on key HIV risk and prevention variables (e.g., sexual risk behavior and STI testing).

4.3. Methods

4.3.1. Study Design

The Sexually Explicit Media (SEM) Study aimed to examine the relationship between the consumption of SEM (i.e. "pornography") and sexual behavior in MSM. Subjects were recruited into a cross-sectional online survey study between May 23, 2011, and August 7, 2011, using banner advertisements that were posted to 148 websites that target MSM. A total of 7,939,758 impressions were displayed during the data collection period, resulting in a click-through rate of 0.16%. Similar or lower click-through rates have been observed in other online studies.[98]

Clicking on a banner advertisement directed subjects to a screening questionnaire that confirmed eligibility. Individuals passed the screener if they reported being male US residents, aged 18 years or older, who had at least one male sex partner in the five years prior to the study and had not previously completed the survey. The study also implemented a block recruitment strategy according to race and ethnicity. Consequently, non-Hispanic white men became ineligible after the target recruitment of 400 was reached. No other racial or ethnic groups reached the ceiling for this criterion.

After completing the screening questionnaire, individuals were provided with a summary of their responses and were tasked to confirm them if they were accurate or change them if they were incorrect. Only those who met criteria after verifying their age, sex, country of residence, and sex partners in the previous five years could proceed to the consent process. Individuals who were ineligible were thanked for their interest and redirected from the survey. A total of 1,254 completed surveys were submitted. The median completion time was 40 minutes.

4.3.2. Measures

IP address

An IP address was logged each time the eligibility questionnaire was accessed. All devices that connect to the Internet are assigned an IP address, which is comprised of quadrants that are separated by decimal markers. The first three quadrants identify a network, and the fourth is unique the device. Thus, a computer and a tablet using the same network will share the first three quadrants and differ on the fourth.

IP addresses can be dynamic or static. With a dynamic IP address, Internet service providers (ISPs) assign a new IP address to a device every time it connects to the Internet.[113,114] Static IP addresses, however, do not change between sessions. For this reason, some researchers caution that the collection of IP address can be considered personally identifying information.[111,114] Others argue it does not identify a person but, rather, an address. The primary way to identify a user is from his or her Internet service provider (ISP), which would not likely release the information. Consequently, the identity of individuals generally remains unknown.[111,114,115]

For the current study, data related to IP address were added after the participants completed the survey. Variables included country and, when available, city and state of the ISP. All data were treated as protected health information (PHI) and were stored on a secure server in a password protected file with other identifying information about the participant, which was kept separate from the de-identified file containing participants' responses.

Timestamp

Two timestamps were collected for each visit to the online survey. One recorded the first time the survey was accessed and the other recorded the last activity on the survey. The time taken to complete the survey was computed as the difference between the two times. However, since participants were able to save their progress and complete the survey at a later time, participants could appear to take hours or days to complete the survey. Therefore, the *time taken* variable was useful only for detecting short completion times (determined *a priori* as under 20 minutes).

Demographics

Individuals were asked to provide their age, race, and ethnicity as part of the eligibility screener for the survey. In the screener, response options for age were categorical according to years: *under 16*, *16-17*, *18-24*, *25-34*, *35-44*, *45-54*, and *55 or older*. Hispanic/Latino ethnicity was asked as a *yes* or *no* question, and race was asked as discrete categories: *white*, *black or African American*, *American Indian or Alaska Native*, *Asian or Pacific Islander*, and *multiracial or other*. Each question was asked again as part of the survey, with age asked as an open-ended numeric item, Latino/Hispanic identity further specified (e.g., Mexican, Puerto Rican, etc.), and race asked as a multiple-answer item (e.g., "check all that apply"). In order to have sufficient groups for analysis, and due to low participation of some races in the sample, participants' race and ethnicity was re-categorized as *white (non-Hispanic)*, *black (non-Hispanic)*, *Latino/Hispanic*, and *multiracial or other (non-Hispanic)* for analysis. Age was also categorized as *17-24*, *25-34*, *35-44*, and *45 and over*. Although ineligible, two subjects reported being 17 at the time of the survey, so the category was extended for reporting the demographics of the invalid sample.

In addition to cross-validity items, participants were asked their sexual identity (*gay/homosexual*, *bisexual*, *straight*, *same-gender-loving*, *queer*, and *other*), level of education according to highest degree completed (*up to 11th*, *high school diploma/GED*, *some college but no degree*, *associate's degree*, *bachelor's degree*, and *graduate degree*), and annual income (open-ended). As with race and ethnicity, *other* responses for sexual orientation were recoded and sexual orientation was collapsed as *gay* and *not gay* due to low percentages of all other identity categories. Finally, income was categorized as *$0-24,999*, *$25,000-$49,999*, *$50,000-$74,999*, and *$75,000 or more.*

Sexual behavior

Participants reported the number of male partners they had in the three months prior to the survey. Follow-up items asked how many of this number were primary partners, defined as "a regular sex partner such as a boyfriend, husband, domestic partner that you have been in a relationship with for at least three months." The number of casual male partners was derived by subtracting the number of primary male partners from the total number of male partners. Participants who had casual partners were asked the number of partners with whom they engaged in protected and unprotected insertive and receptive anal sex.

HIV/STI testing

Individuals were asked their HIV status. Response options included "HIV-positive," "HIV-negative," "I'm not sure, but I think HIV-positive," "I'm not sure, but I think HIV-negative," "I don't know," and "refuse to answer." For the current study, "I'm not sure…" and "I don't know" responses were collapsed into a single *HIV-unsure* category. "Refuse to answer" responses were coded as missing.

Men who were HIV-negative or HIV-unsure were asked how recently they were tested for HIV. Response options were "in the last three months," "in the last year," "one (1) to two (2) years ago," "more than two (2) years ago," "I have never been tested for HIV," "I can't remember," "not applicable," and "refuse to answer." Men who reported being tested either in the last three months or in the last year were categorized as having been tested in the previous year. All other responses, including "I can't remember" and "not applicable" were coded as not having been tested in the previous year. "Refuse to answer" was coded as missing.

Regarding sexually transmitted diseases, men were asked if they were tested for seven STIs in the past twelve months: syphilis, gonorrhea, chlamydia, human papilloma virus (HPV; genital or anal warts), genital herpes, hepatitis A, and hepatitis B. Response options for each were "yes, and I got the results," "yes, but I did not get the results," "no," "I don't know," and "refuse to answer." Men were categorized as having received an STI diagnosis (whether negative or positive) if they reported having been tested and receiving the results. Individuals who did not receive their test results, were not tested, or did not know if they were tested were grouped as not having received a diagnosis for purposes of the current study. "Refuse to answer" responses were coded as missing.

4.3.3. De-duplication and cross-validation protocol

Survey submissions were identified or "flagged" as potentially invalid according to an extended version of the de-duplication and cross-validation protocol described by Konstan et al.[107] and Rosser et al.[116] During de-duplication, submissions were examined for common IP addresses (full and first three quadrants), payment names (check or PayPal receipt), payment addresses (check), and payment emails (PayPal). If two or more entries matched on any variable, a computer program flagged each entry as a possible repeated submission. Identical matches of payment information such as payment name and address or email handles, even on different domains, were considered multiple submissions. Entries without matching payment information but with matching IP addresses – including the first three quadrants of an IP address, which indicate the same network but not a specific machine – were further examined by the cross-validation procedures, since it was possible that multiple eligible individuals participated using the same device on the same network.

During cross-validation, participants' screener responses were compared to responses to similar items asked in the body of the survey. Relevant items were extracted from the survey and stored in a separate file containing the screening information. These items were age, asked as an open-ended numeric item and as a categorical, multiple-choice item in the screener; U.S. residence, asked as ZIP code in both the screener and the survey and confirmed by IP address; and status as a man who has sex with men, asked categorically in the screening questionnaire and derived from sexual partner frequencies in the body of the survey. Submissions were flagged automatically for incongruity between these items and then checked manually. Responses that were near-matches, such as nearby ZIP codes, were counted as valid. Submissions in which individuals reported being 18 to 24 years old in the screener but subsequently reported being 17 (an ineligible age) were also counted as invalid.

Finally, a new step was added to the protocol. Completed submissions were compared with earlier, ineligible attempts from the same IP address. Since potential participants were unable to change their responses to the screening questionnaire after confirming them, individuals who wished to gain entry to the survey had to re-access the screening questionnaire and complete it again. Thus, each attempt at the survey was recorded independently. By examining timestamps and IP addresses, it was possible to determine whether multiple screener entries were submitted from the same computer or network and if eligibility status changed within a short time frame. Eligible entries that were submitted from an IP address within 30 minutes of an ineligible entry were interpreted as attempts to determine the eligibility in order to gain entry to the study and deemed invalid.

For all analysis, duplicate and invalid submissions were considered to be one *invalid* group, since eligibility criteria included not having participated in the study previously. Following Konstan et al.,[107] the first entry of a repeat responder was considered valid as long as there was no indication of changed eligibility status.

4.3.4. Analyses

Suspicious cases were identified using the extended de-duplication and cross-validation protocol described above. The utility of each component was evaluated in two ways. First, the number and percentage of submissions that were flagged was summarized, followed by the number and percentage that were deemed invalid. Next, the percentage of invalid submissions that were flagged by each component was reported to demonstrate how influential that component was in identifying the invalid submissions.

Unadjusted logistic regression models were used to compare valid and invalid submissions on key demographic variables. These variables included age, race/ethnicity, sexual identity, urban or rural locality, level of education, and income category. HIV status (i.e., positive, negative, and unknown) and payment preference (i.e., check, PayPal, or no payment) were also compared between substamples. Following this, a multivariable logistic regression model was conducted using statistically significant predictors.

A series of negative binomial regression models was used to compare valid and invalid participants in terms of counts of total, primary, and casual sexual partners in the three months prior to the survey. Casual sexual partners were further specified by anal sex role and condom use. Negative binomial regression models were chosen based on indices of overdispersion in the data and for improvement in model fit over Poisson regression models. Unadjusted rate ratios (RRs) were computed as well as RRs that were adjusted for age and race/ethnicity, which were identified as statistically significant in the previous analysis.

Lastly, a series of logistic regression models was used to determine if validity status was a significant predictor of self-reported HIV and STI testing behavior. Data were analyzed using the Stata statistical package, version 12.1.[117]

4.4. Results

Out of 1,254 submissions, 25 (2.0%) were identified as multiple submissions and 125 (10.0%) as potentially ineligible according to the criteria of the extended de-duplication and cross-validation protocol. For each criterion, the number and percent of the total sample that were flagged as suspicious by each criterion and that were ultimately deemed invalid are reported in Table 1. The percentage of all invalid entries (n=146) that were flagged by each component are also summarized in that table. Since the protocol used all criteria, they were not mutually exclusive; frequencies and percentages of invalid submissions may sum to more than 146 and 100, respectively.

In terms of the highest percentage of invalid entries flagged, the most useful elements of the protocol were changes to the eligibility screener (74.7% of invalid entries), duplicate payment name (38.4% of invalid entries), and duplicate IP address, both the entire address (31.2% of invalid entries) and the first three quadrants (34.4% of invalid). Of the 109 enrollees who changed their responses to the screener, most (56.9%) changed more than one response (Table 2).

Demographics and payment preferences by validity status are reported in Table 3. Age, ethnicity, HIV status, and payment preference were significantly associated with invalidity. Individuals in the oldest category (45 and over) had lower odds of being identified as invalid compared to those in the lowest age category (17-24). Similarly, individuals who identified as Hispanic or Latino had greater odds of being invalid compared to non-Hispanic White participants.

Unadjusted bivariate logistic regression analyses indicated that those who requested payment via PayPal or no payment had greater odds of being deemed invalid than those who requested check payments (Table 3). Individuals who reported being HIV-positive were at lower odds of being identified as invalid compared to those who reported being HIV-negative. However, after multivariable adjustment for other significant covariates, HIV status was no longer statistically significant.

Negative binomial regression models indicated no statistically significant differences between valid and invalid participants in terms of reported number of sexual partners in the three months prior to the survey (Table 4). This was true of casual anal sex partners as well, regardless of anal sex role or condom use. Crude and adjusted models indicated that invalid participants who reported being HIV-positive or uncertain of their HIV status were at significantly lower odds of reporting receiving an HIV test in the previous year (adjusted OR=0.62, 95% CI=0.42-0.90); Table 5). However, valid and invalid respondents did not differ significantly in reported STI testing for any STIs in either the unadjusted or adjusted logistic regression models (Table 5).

4.5. Discussion

This manuscript had two aims. The first aim was to evaluate components of a de-duplication and cross-validation protocol. The second aim was to determine whether submissions identified as invalid differed significantly from those accepted as valid. For Aim 1, results highlighted several useful design elements that researchers may incorporate into online surveys. For Aim 2, age, ethnicity, and payment preference were associated with being deemed invalid. Among HIV-negative and HIV-unsure individuals, invalid submissions had lower odds of reporting an HIV test in the past year. Findings for each aim are discussed in their own sections below.

4.5.1. Useful components of the de-duplication and cross-validation protocol

Using the full de-duplication and cross-validation protocol, including the extended cross-validation, 146 (11.6%) of all survey entries were identified as invalid, which is approximately the same proportion as was found by Konstan and colleagues.[107] The three most useful components for identifying invalid participants were tracking multiple attempts at the screening questionnaire, identifying repeated payment last names, and examining repeated IP addresses. In general, components derived from IP address were the most useful in detecting invalid submissions; IP addresses were useful for detecting multiple submissions and as an indicator of geographic location. When combined with timestamps and eligibility confirmation, they also made it possible to determine when ineligible and eligible submissions were submitted from the same network.

By displaying participants' responses back to them and allowing them to make changes to their answers prior to submission, researchers can be more certain that subsequent changes to screening questionnaires are not corrections. Such changes, particularly within a short time frame, can be considered attempts to discover the correct set of criteria in order to gain entry to the study. This extended cross-validation component was an important addition to the SEM Study's protocol. While Konstan et al.'s,[107] Bowen et al.'s,[105] and Bauermeister et al.'s[110] protocols all involved the detection of multiple *completed* entries, the SEM Study also took into account evidence of possible eligibility changes from prior attempts at the survey. This resulted in the detection of many individuals (n=109, 8.7% of the study sample) who would not have been identified using the earlier protocols.

As reported by Konstan et al.[107] and confirmed by Bauermeister and colleagues,[110] manual inspection is a necessary follow-up to automatic flagging based on algorithms. With proper coding, statistical software can indicate when values are out of acceptable ranges (e.g., ages under 18) or text appears in multiple submissions (e.g., IP addresses).[107] However, some of the most useful components in terms of the percentage of total invalid entries identified required further examination of flagged submissions in order to correctly classify them as valid or invalid (e.g., duplicate payment information or IP address). This was true of Bauermeister et al.'s[110] study as well, in which 60% of entries initially identified as invalid were later determined to be valid.

4.5.2. Differences between valid and invalid subsamples

The second aim of this study was to determine whether submissions that were determined to be invalid differed from those that were accepted as valid. In addition to age and ethnicity differences between valid and invalid samples, invalid submissions from individuals who were HIV-negative or HIV-unsure had lower odds of reporting an HIV test in the last year. Differences in reported number of sexual partners in the three months prior to the survey were not statistically significant, however. Finally, findings regarding payment preferences were complex and, in part, counterintuitive.

Associations between invalidity and the demographic composition of the sample were consistent with previous research and with what would be expected from changes to the eligibility screening questionnaire. For example, Bauermeister et al.[110] also found that invalid cases were younger and more likely to be Hispanic or Latino than valid cases. In the current study, the lowest age category may have been the easiest one to switch to after individuals realized that they were too young. Likewise, the association between invalidity and Latino/Hispanic identity is possibly due to the quota on non-Hispanic white participants; a change to Latino/Hispanic identity was common when re-attempting the eligibility screening questionnaire. Consequently, researchers who wish to improve racial and ethnic diversity in their sample might consider methods other than quotas in online surveys, since this may encourage individuals to misreport race or ethnicity in order to participate. For studies that require sufficient diversity for statistical comparisons, implementing a registration process to separate the screening survey from the research study would make repeated attempts at the screening questionnaire more difficult and allow researchers more time to vet submissions.

The data on HIV testing suggest that certain key research questions may be biased by invalid submissions. In this case, inclusion of invalid submissions would have resulted in a lower observed percentage of HIV testing among the study sample. Depending on the reasons for asking this question (e.g., as part of an intervention or needs assessment), such bias may have profound consequences.

Associations between invalid submissions and payment preferences were mixed. On one hand, it is unsurprising that PayPal payments were preferred over check payments in invalid submissions; it is easier to remain anonymous using this method. Checks require both a name and address, and it is easier to create multiple unique payment profiles than it is to have multiple legal names and addresses.

The finding that *no payment* was selected more in the invalid group than in the valid group suggests that there may be motivations for invalid participation beyond incentives. This is interesting in light of the findings of previous studies which concluded that lower or no incentives result in lower rates of invalid participation.[112] Given the intriguing subject matter of the current study (e.g., pornography), it may also be that individuals simply wanted to see the content of the survey (e.g., voyeuristic but ineligible persons) or to influence its findings (e.g., individuals with political motivations for or against the gay movement). Regardless, motivation for participating multiple times or despite ineligibility deserve further investigation.

4.6. Limitations

It is important to note several limitations of the current study. First, there were differences between the protocol used in this manuscript and those used in other published work.[107,110] After examining the time taken to complete the survey, there were no major concerns; depending on skip patterns and computer skills, it was conceivable that some individuals could complete the survey in the observed time intervals. Second, although a proxy for relationship status was asked as part of the survey (e.g., “how many primary partners do you have?”), there were no specific questions regarding cohabitation, either with a partner or roommate. Thus, the plausibility of multiple entries from unique, eligible persons at the same IP address could not be ascertained beyond examining payment information. Third, in order to maintain confidentiality and, to the highest degree possible, anonymity of the study sample, social networking sites were not used to verify eligibility. This was a limiting factor for detecting repeat respondents, since payment information was not always easy to match using coding algorithms. Individuals attempted to vary the way their names or addresses were presented for checks, such as using first or last initials in place of names, and names were also not always available for unverified PayPal accounts.

The findings of this study may not extend to other online survey research. Other methods of recruitment and screening may yield different rates of invalid participation, and additional variables may clarify whether or not submissions are invalid (e.g., roommate data[110] or additional identifying information[105]). However, even with other modes of recruitment, implementing protocols is important for improving confidence in sample validity and inferences.

4.7. Future Research

De-duplication and cross-validation protocols have their place within a broader plan of recruitment. As evidenced by the high number of individuals who changed their answers to the eligibility screener, a deduplication and cross-validation protocol should be considered essential to any rigorous online study of MSM. The original protocol by Konstan et al.[111] provides a good basis for new protocols. However, as online research evolves and the ways invalid participants attempt to "game the system" become more sophisticated, researchers should continue to modify their protocols to find better ways to prevent invalid submissions during the study period or remove them from the final dataset. Such protocols need to be tailored to the study population and study, a point emphasized in the prior research.

Future research should examine ways to further improve de-duplication and cross validation efforts. Two issues warrant further study. First, protocols could clarify for participants how many surveys will be accepted from the same IP address. This way, accidental multiple submissions might be prevented. However, enforcing this raises issues of concern for confidentiality. Although software programs can prevent multiple submissions from the same IP address, notifying participants that a prior submission was received from the IP address could lead one individual to deduce that another network user (e.g., roommate, partner) participated in the study. Furthermore, revealing that only one submission per IP address will be accepted might lead individuals who wish to participate multiple times to use more sophisticated methods, such as IP proxies, to gain access.

Second, the human subjects concerns regarding using social networks, as in Bauermeister,[110] or even IP addresses, deserve further examination. Do researchers have an ethical responsibility to inform individuals that their IP address is collected or that their payment information may be used to verify their responses? When and under what circumstances is it ethical to track such data on enrollees? Will informing subjects that their IP address is being tracked deter both ineligible individuals and eligible individuals with privacy concerns from participating? Given the current political climate regarding data privacy, sleuthing raises interesting practical and ethical considerations. Research regarding participants' perceptions of IP address as sensitive data would help elucidate this area.

4.8. Conclusion

Protocols for identifying potentially ineligible or repeat submissions to online surveys should be included in all Internet-based studies. Since the protocols themselves are relatively easy to implement with proper planning, the potential to identify approximately ten percent of a sample as invalid further justifies their use. The current study demonstrated that the most useful components for de-duplication and cross-validation protocols were derived from IP addresses or from payment information that spanned payment mode (e.g., check and PayPal). Invalid and valid subsamples differed in ways that might have biased findings using age, race/ethnicity, education, and HIV testing as variables of interest. While the utility of these protocols was reaffirmed, additional research regarding methods of improving these protocols while protecting human subjects was recommended.

4.9. Tables

Table 1. Number of submissions flagged and confirmed invalid by each component of the de-duplication and cross-validation protocol in the SEM Main Survey Study (N=1,254).

	Full sample		Invalid sample (n=146)
Protocol component	**Flagged suspicious n (%)**	**Deemed invalid[a] n (%)**	**Flagged by component (%)**
De-duplication			
Payment last name duplicate	293 (23.4)	48 (3.8)	32.9
Check address duplicate	20 (1.6)	13 (1.0)	8.9
Payment e-mail address duplicate	8 (0.6)	8 (0.6)	5.5
IP address			
Complete	90 (7.2)	39 (3.1)	26.7
First 3 quadrants	103 (8.2)	43 (3.4)	29.5
Cross-validation			
Age invalid (< 18)	2 (0.2)	2 (0.2)	1.4
Age mismatch (> 1 year's difference)	32 (2.6)	19 (1.5)	13.0
Changed screener to be eligible	109 (8.7)	109 (8.7)	74.7
Payment e-mail address invalid	0	-	-
IP address not US	35 (2.8)	35 (2.8)	24.0
No lifetime male partners	0	-	-
Time taken ≤ 20 minutes	38 (3.0)	20 (1.6)	13.7
Zip code			
Not valid US	8 (0.6)	5 (0.4)	3.4
Mismatch	69 (5.5)	12 (1.0)	8.2

Note. Protocol components are not mutually exclusive. Totals may sum to more than 146.
[a]*Invalid* refers to participants determined to be ineligible after they participated.

Table 2. Changes to screening questionnaire to meet eligibility (n=109).

Change	n	%
Age	2	1.8
Race/ethnicity	16	14.7
Gender	1	0.9
U.S. residence	14	12.8
Sex with men	14	12.8
Multiple	62	56.9

Table 3. Demographic characteristics and payment preferences of valid and invalid submissions (N=1,254).

	Total		Valid		Invalid			
	n	%	n	%	n	%	OR[a] (95% CI)	AOR[b] (95% CI)
Total			1,108	86.8	146	11.6		
Age								
17-24	445	35.5	379	34.2	66	45.2	Ref.	Ref.
25-34	394	31.4	345	31.1	49	33.6	0.82 (0.55, 1.21)	0.88 (0.59, 1.32)
35-44	204	16.3	185	16.7	19	13.0	0.59 (0.34, 1.01)	0.67 (0.38, 1.16)
45+	211	16.8	199	18.0	12	8.2	0.35 (0.18, 0.66)**	0.46 (0.23, 0.90)*
Race/ethnicity								
White (non-Hispanic)	526	41.9	481	43.4	45	30.8	Ref.	Ref.
Black (non-Hispanic)	141	11.2	131	11.8	10	6.8	0.82 (0.40, 1.66)	0.75 (0.37, 1.56)
Hispanic/Latino	367	29.3	303	27.3	64	43.8	2.26 (1.50, 3.39)***	2.10 (1.38, 3.21)***
Other/Multi (non-Hispanic)	220	17.5	193	17.4	27	18.5	1.50 (0.90, 2.48)	1.32 (0.78, 2.21)
Sexual identity								
Gay	209	16.7	178	16.1	31	21.4	Ref.	
Not gay	1,041	83.3	927	83.9	114	78.6	1.42 (0.92, 2.17)	
Education								
Less than 4-year degree	641	51.1	558	50.4	83	56.8	Ref.	
4-year degree or higher	613	48.9	550	49.6	63	43.2	0.77 (0.54, 1.09)	
Annual income								

$0-$24,999	495	43.9	444	44.1	51	41.8	Ref.	
$25,999-$49,999	338	30.0	298	29.6	40	32.8	1.17 (0.75, 1.81)	
$50,000-$74,999	155	13.7	136	13.5	19	15.6	1.22 (0.69, 2.13)	
$75,000+	140	12.4	128	12.7	12	9.8	0.82 (0.42, 1.58)	
HIV status								
HIV+	119	9.5	114	10.3	5	3.4	0.30 (0.12, 0.75)*	0.40 (0.16, 1.03)
HIV-	961	76.7	839	75.8	122	83.6	Ref.	Ref.
Unsure	173	13.8	154	13.9	19	13.0	0.85 (0.51, 1.42)	0.73 (0.44, 1.24)
Payment								
Check	378	30.1	322	29.1	56	38.4	Ref.	Ref.
Paypal	764	60.9	696	62.8	68	46.6	1.78 (1.22, 2.60)**	1.75 (1.19, 2.57)**
None	112	8.9	90	8.1	22	15.1	2.50 (1.47, 4.24)***	2.75 (1.59, 4.75)***

Note. Frequencies may not add up to total (N=1,254) due to *refuse to answer* responses.

[a]*OR* refers to the crude/unadjusted *odds ratio*.

[b]*AOR* refers to the *adjusted odds ratio*, or the odds ratio after adjusting for other significant covariates.

Table 4. Rate ratio of number of sexual partners (last three months) by validity status (type of partner, sex role, and condom use).[a]

	N[b]	RR[c] (95% CI)	ARR[d] (95% CI)
Total partners	1219	1.04 (0.62, 1.74)	0.97 (0.58, 1.64)
Primary partners	1048	1.24 (0.83, 1.86)	1.22 (0.81, 1.84)
Casual partners	1025	1.05 (0.68, 1.18)	1.04 (0.66, 1.62)
Insertive anal sex			
With condom	751	1.21 (0.77, 1.91)	1.17 (0.77, 1.91)
Without condom	751	1.08 (0.68, 1.73)	1.04 (0.64, 1.68)
Receptive anal sex			
With condom	750	0.87 (0.55, 1.38)	0.79 (0.50, 1.27)
Without condom	750	1.08 (0.67, 1.74)	0.96 (0.59, 1.56)

*p<.05, **p<.01, ***p<.001

[a]For these analyses, *valid* was the reference group.

[b]Sample sizes are the number who responded to each item.

[c]*RR* refers to the *rate ratio*.

[d]*ARR* refers to the *adjusted rate ratio*, which was adjusted for age and race/ethnicity.

Table 5. Odds of reporting HIV or STI test (last year) by validity status.[a]

	N	Tested n (%)	OR (95% CI)	AOR[a] (95% CI)
HIV[b]	1122	746 (66.5)	0.63 (0.44, 0.92)*	0.62 (0.42, 0.90)*
Chlamydia	1240	593 (47.8)	0.95 (0.67, 1.36)	0.89 (0.62, 1.28)
Gonorrhea	1241	614 (49.5)	0.94 (0.66, 1.34)	0.91 (0.63, 1.30)
Hepatitis A	1240	542 (43.7)	0.88 (0.62, 1.26)	0.88 (0.61, 1.27)
Hepatitis B	1240	549 (44.3)	0.92 (0.64, 1.31)	0.92 (0.64, 1.32)
Herpes	1240	481 (38.8)	1.00 (0.70, 1.44)	0.95 (0.66, 1.38)
HPV	1240	472 (38.1)	0.84 (0.58, 1.22)	0.79 (0.54, 1.16)
Syphilis	1241	616 (49.6)	0.94 (0.66, 1.33)	0.92 (0.64, 1.32)

*$p<.05$, **$p<.01$, ***$p<.001$

[a]For these analyses, *valid* is the reference group.

[a]Model adjusted for age and race/ethnicity.

[b]Individuals who reported being HIV-positive were not asked this question and are not included in this analysis.

5. Manuscript 2: Test-retest reliability of self-reported sexual behavior and HIV/STI diagnoses in an online sample of men who have sex with men (MSM)

5.1. Abstract

Introduction: Test-retest reliability of self-reported measures of sexual behavior, HIV status, HIV testing, and STI diagnoses has not been reported for Internet-based surveys of men who have sex with men (MSM). The purpose of this manuscript was to evaluate the one-week test-retest reliability of self-reported sexual behavior and STI diagnoses. Predictors of inconsistent reporting over a one-week interval were also be examined.

Methods: The Sexually Explicit Media (SEM) Reliability Study was conducted from January to February, 2011. Using banner advertisements posted to gay-targeted websites, we enrolled 239 MSM who completed two identical surveys spaced one week apart. The survey asked questions about sexual behavior in the previous three months, HIV status, HIV testing, and STI diagnoses. Test-retest reliability was evaluated using intraclass correlation coefficients (ICCs) for numeric variables and kappa statistics for categorical variables. Crude and adjusted logistic regression models were used to predict odds of reporting different frequencies of partners on the two surveys according to demographics, number of partners, Internet use, and social desirability.

Results: Test-retest reliability was substantial (κs>.7, ICCs>.6) for recall of total, primary, and casual sexual partners in the last three months. Recall of anal sex role and condom use was similarly reliable (κs and ICCs >.6). Odds of inconsistent reporting of the number of casual partners with whom the participant had unprotected anal intercourse was greater among individuals with some higher education but no degree (OR=2.16, 95%CI=1.22-9.27) and those who were HIV-positive (OR=7.16, 95% CI=1.20-42.6). In addition, relative frequency measures of protected and unprotected anal sex, as a percentage of total sexual encounters, was almost perfect (ICCs>.8). Partner-specific counts of behaviors with primary partners were also substantially reliable (ICCs>.7), but those for casual partners were fair or moderate (ICCs between .2 and .6). Finally, self-reported HIV status and HIV testing were almost perfect (κs>.8).

Conclusion: Test-retest reliabilities of sexual behavior and STI diagnosis items in the online sexual behavior surveys were substantial or almost perfect. They were also similar to those observed in offline studies of MSM. Counts of partners should be prioritized over partner-specific behavioral frequencies, which may be more cognitively demanding and better suited to diary methods. Researchers should keep in mind that the reliability of counts of UAI partners may differ according to HIV status, with poorer reliability associated with surveys from HIV-positive respondents.

5.2. Introduction

Internet-based studies have become a popular approach for HIV prevention research and intervention with MSM.[86,88,94,118-136] Compared to offline studies, online studies are cost-efficient methods to increase geographic coverage, improve participant confidentiality, and better recruit hard-to-reach individuals.[98,137] Individuals may also be more likely to report sensitive information due to perceived anonymity.[138] In fact, an online supplement to the National HIV Risk Behavior Surveillance (NHBS) System has been piloted,[139] and Internet-based HIV and STI screening methods are being studied.[92]

Whether collected online or offline, HIV and STI sexual risk behavior and HIV/STI testing are commonly self-reported using interviews or questionnaires. Confidence in estimates based on these data is necessary for identifying relevant cofactors and intervention effects. Any bias may decrease the validity of findings. For self-report data, one source of measurement error is individuals' misreporting of behaviors.[140] To the extent that the behaviors are not directly observable by the researchers, reliability, or the consistency of data, is an indicator of the threat of inaccurate participant recall to data integrity and valid inferences.[140]

Several test-retest reliability studies of sexual behavior data from offline samples of MSM have been published.[141-144] All of these were based on data collected offline using either face-to-face interviews or self-administered questionnaires (SAQs). According to the commonly used benchmarks set by Landis and Koch,[145] results from recent studies suggest that the test-retest reliability of HIV- and STI-related variables can be *almost perfect* (.81-1.00) among young MSM using interviews (ICC=.95 for lifetime number of male sexual partners, ICC=.96 for number of same-sex partners in the last three months).[146] In contrast, Saltzman et al.[142] reported that, after categorizing count data and using kappa statistics, test-retest reliability was only *moderate* (.41-.60) for sexual behavior items in the last six months, while demographic items (e.g., education or income) were *almost perfect* (>.80). More *static* sexual items, however, such as lifetime number of sexual partners, were *substantial* (.61-.80).[142] For each behavior, reliability was higher when reporting number of partners rather than frequency of events.[142]

Determining web-based estimates of measures that have performed well using traditional methods is consistent with recommendations for the use of online surveys in epidemiologic studies.[95] Despite several published reliability studies of offline sexual behavior surveys, we could find no published articles detailing test-retest reliability of sexual behavior surveys administered online. Researchers who have made direct comparisons of test-retest reliability between Internet-based and offline questionnaires of non-sexual behaviors have found that measurement properties are comparable. For example, few significant differences in the test-retest reliability of self-reported alcohol use[147,148] and smoking temptation and cessation[149] have been found between online and offline formats.

There are reasons to expect data integrity to differ between Internet-based and offline survey studies. On the one hand, adaptability, interactivity, and a greater perception of confidentiality may lead to improved recall by research participants. As with computer-assisted structured interviews (CASI), online survey administration preserves privacy and offers researchers strict control over skip patterns. Furthermore, given the interactive capabilities of Internet-administered surveys, it may be possible to improve recall with tools similar to those used in interviews, particularly Timeline Follow-Back (TLFB) methods. Individuals can use calendars to report dates, use partner names that automatically appear in relevant follow-up questions. Questions can also include prompts that are calculated from previous responses (e.g., "of the 5 men with whom you had sex in the last three months…").

On the other hand, there are reasons to expect poorer data integrity from online survey methods. Distractions, both in the physical environment and online, may lead to inaccurate or rushed responses. Some studies suggest that persons online may think and process information differently, leading to online responses being more broad "top of thinking" estimates, whereas pen and paper or in-person interviews may cue the person to provide more careful exact responses. Sample validity, discussed in Manuscript 1,[150] is also a concern. Furthermore, unlike with face-to-face interviews or questionnaires administered in the presence of a researcher, individuals cannot ask clarifying questions to make sure that they understand the question.

For the current manuscript, we aimed to evaluate the test-retest reliability of self-reported sexual behavior, HIV testing, and STI diagnoses from an online sample of MSM. Prior to conducting reliability analyses, however, individuals who completed both reliability surveys were compared to those who only completed the first survey, in order to determine possible biases due to attrition. For examining reliability, we used Landis's and Koch's[145] guidelines to evaluate reliability statistics: *slight* (0.00-0.20), *fair* (0.21-0.40), *moderate* (0.41-0.60), *substantial* (0.61-0.80), and *almost perfect* (0.81-1.00). (Landis and Koch also suggest *poor* reliability as being less than zero, but this is not relevant to the current study since it is not possible for the computed reliability coefficients to be negative.) Three types of sexual behavior data were evaluated. The first was counts of male sexual partners in the last three months, specified by type of partner (i.e., primary or casual), anal sex role (i.e., insertive or receptive), and condom use (i.e. protected or unprotected). The second involved the estimated proportion of all sexual encounters that included specific sexual acts (e.g., the proportion of all sexual encounters during which the participant had anal sex without condoms). Third, estimated counts of sexual acts (e.g., number of acts of anal sex) or occurrences (e.g., number of sessions of sex) with up to four recent partners (one primary and three casual) were collected. Predictors of inconsistent reporting of sexual partner frequencies across a one-week interval were also examined. Finally, in addition to the three types of sexual behavior, test-retest reliability of other commonly-used variables in HIV research, such as HIV status, HIV testing, and STI diagnoses, were analyzed.

5.3. Methods

5.3.1. Study Design

The SEM Reliability Surveys were conducted as a pilot study of measures for a larger Internet-based survey of MSM. Participants completed identical surveys for the same period on two occasions spaced one week apart. Data were collected from January to February, 2011.

The study employed a passive recruitment strategy. Gay Ad Network, an LGBT marketing agency, displayed banner ads on Web sites that target gay audiences. Ads were restricted to persons in the United States according to Internet protocol (IP) address in order to maximize the number of impressions to an MSM sample from the United States. In total, 448,472 impressions were made on 165 Web sites. The click-through rate was 0.31%.

Clicking on the advertisement directed individuals to a webpage hosted at the University of Minnesota. The study was limited to men who were at least 18 years of age, lived in the United States, and who reported having sex with a man at least once during the past five years. Eligibility criteria were confirmed using an online screening instrument. Access to the survey was restricted to individuals whose responses indicated that they met each of the criteria.

Consent was obtained by displaying information regarding the risks and benefits of the study. Eligible participants who consented completed the first of two surveys and provided contact information. Invitations with links to complete the second survey were sent one week after completion of the first survey. Of the 326 men who completed the first survey, 239 (73%) completed the follow-up survey. For both surveys, participants were instructed to respond to items for the same period (i.e., to respond regarding the three months prior to the first survey and not including the week between the surveys). Early test-retest studies of HIV/AIDS risk behaviors did not specify this; without it, it was uncertain whether differences in reliability between time points were due to different time periods , rather than poor recall.[151]

The median completion time for each survey was approximately 46 minutes. Participants were compensated $60 for completing both surveys. Individuals who completed only the first survey were not compensated. The researchers obtained a Certificate of Confidentiality from the National Institutes of Health (NIH), and the study was conducted under the oversight of the IRB of the researchers' home institution.

5.3.2. Measures

Partner counts

Participants were asked questions regarding their sexual history over their lifetime and over the three months prior to the first survey. Most questions were asked in the form of counts, such as lifetime number of male sexual partners (any kind of sex) and number of male, female, and transgender partners in the last three months (asked separately). After reporting the number of male partners in the last three months, participants were asked how many were primary partners, defined as "a regular sex partner such as a boyfriend, husband, domestic partner that you have been in a relationship with for at least three months." The number of casual male partners was derived by subtracting the number of primary male partners from the total number of male partners. Responses were then trichotomized as *none*, *one*, and *two or more* casual partners. This categorization reflects the CDC testing guidelines, which specify that individuals with multiple casual partners should be tested more frequently.

Relative frequencies

All participants who indicated having at least one male sexual partner in the last three months were asked general questions regarding the proportion of all sexual activity that included each of several behaviors. Among these were anal sex with a condom and anal sex without a condom. Response options were "never (0%)," "rarely (1-20%)," "sometimes (21-40%)," "about half of the time (41-60%)," "most of the time (61-80%)," "almost always (81-99%)," and "always (100%)."

Partner-level counts

Participants were asked for partner-level counts of behaviors (e.g., number of times they had sex with specific people) in addition to counts of partners (described previously). Men who reported having a male primary partner received follow-up questions regarding their relationship. Participants reported the date of their last sexual encounter with their partner as well as the number of times they engaged in receptive and insertive anal sex with him over the three months. Follow-up prompts asked number of times the participants did and did not use condoms during receptive and insertive anal sex, asked separately.

Respondents who reported having casual partners reported partner-level information regarding up to three most recent partners. For each partner, participants created a name (real or pseudonym) that appeared in subsequent questions regarding frequencies of insertive and receptive anal sex, with and without condoms. Participants responded to different questions based on whether each partner was a one-time partner or a regular partner. This was determined by the number of times the participant reported having sex with the partner over the last three months (e.g., *once* or *more than once*). For example, if an individual reported only one sexual encounter with a casual partner, he responded with number of times they had sex on that one occasion. If an individual indicated that he and his casual partner had had sex on multiple occasions, he responded with the number of times they had sex over the course of their casual sexual relationship.

HIV testing and HIV/STI diagnoses

Individuals reported their HIV status as part of the demographics questionnaire. Response options included “HIV-positive,” “HIV-negative,” “I’m not sure, but I think HIV-positive,” “I’m not sure, but I think HIV-negative,” “I don’t know,” and “refuse to answer.” For the purpose of analysis, all individuals who reported being unsure of their status (positive or negative) or who responded “I don’t know” formed a single category, *HIV-unsure*. Thus, the three categories of HIV status were *HIV-negative*, *HIV-positive,* and *HIV-unsure.* “Refuse to answer” responses were coded as missing. A three-category approach to reliability was chosen due to low cell counts in the five-category model, which would have led to less stable reliability estimates. Furthermore, differences between *unsure* and definitive answers such as *HIV-positive* and *HIV-negative* were seen as more relevant for practice.

Men who reported that they had not tested positive for HIV were asked how recently they had an HIV test. Response options were “in the last three months,” “in the last year,” “one (1) to two (2) years ago,” “more than two (2) years ago,” “I have never been tested for HIV,” “I can’t remember,” “not applicable,” and “refuse to answer.” For analyses, these responses were re-categorized into three groups as *never*, *within the past year*, and *more than a year ago*. Responses from individuals who refused to answer, who reported that they did not remember, or who reported that the question was not applicable were regarded as missing. As with HIV status, HIV testing was collapsed due to sparse cells and because collapsed categories represented the same response.

For non-HIV STI history, participants were asked if they had been diagnosed with any of the following in the past twelve months: syphilis, gonorrhea, chlamydia, HPV (genital or anal warts), genital herpes, hepatitis A, and hepatitis B. Response options were “yes,” “no,” “I don’t know,” and “refuse to answer.” For the following analyses, participants who responded "yes" were categorized as *diagnosed* while those who responded “no” or “I don’t know” were categorized as *not diagnosed.* Data regarding STI testing were not collected as part of this study.

Demographics

Test-retest reliability of demographic characteristics was not computed. However, demographics were used to predict inconsistent reporting of sexual behavior and HIV/STI items (described below). Demographic questions included age, race and ethnicity, sexual orientation, years of education, and annual income. Most participants who completed both surveys were non-Hispanic and white (*n*=190, 80.2%) and gay-identified (n=207, 86.6%). Consequently, categories were collapsed at analysis due to low frequencies. For race and ethnicity, Black, Asian, Native American, Hispanic or Latino individuals, and individuals who reported multiple races or ethnicities were analyzed as a single group: *non-white* (n=47, 19.8%). Additionally, non-gay sexual identities, such as bisexual, straight, and queer, comprised a *bisexual/other* category (n=32, 13.4%).

Participants reported the number of years of education according to the following question: "How many full years of school have you completed, starting from grade 1 (e.g., for 9th grade, enter 9; for high school, enter 12; for 4 years of college, enter 16)." Years of education was categorized as *12 or fewer years*, *13 to 15 years*, and *16 or more years* for analysis in order to approximate the degree categories high school or less, some college or Associate's degree, and Bachelor's degree or higher. Annual income was also asked as an open-ended item and was categorized as *$0 to $24,999*, *$25,000 to $49,999*, and *$50,000 or more*.

Internet use

Average hours of Internet use per week was calculated by summing responses to several items. Participants reported their average time spent online for work-related or educational activities, sex-related activities, and personal activities not related to work, education, or sex.

Socially desirable responding

Self-presentation bias is a potential source of measurement error in self-reported sexual behavior studies.[152-154] Social desirability may lead individuals to provide answers that are consistent with their perceived norms and values even if they are not true. In studies of MSM and sexual risk behavior, socially desirable responses can lead to under-reporting of risk behavior.[154] A short form of the Marlowe-Crowne Socially Desirable Responding Scale (M-C SDS) was used to measure socially desirable responding among participants.[155,156] The revised M-C SDS is comprised of ten true/false statements from personality inventories that describe 1) "socially undesirable actions" or 2) "socially ideal responses," which are reverse-scored. Participants were asked to respond *true* or *false* to indicate whether each statement applies to them.

Inconsistent responses

An indicator of category mismatch was used to determine predictors of inconsistent reporting between the two survey administrations. As with previous research,[157] *inconsistent* is used to describe individuals' mismatches between time points, rather than *unreliability*, which is a measurement property based on a sample. Inconsistent risk categorization was used rather than absolute differences. Consequently, *inconsistent responding* was defined as a difference between categories (e.g., *no partners*, *one partner*, and *two or more partners*) between times one and two. For instance, if an individual reported having zero partners on the first survey and reported having two or more on the second survey, the individual was coded as *inconsistent*, or not matching. Similar categories and indicators were created for number of casual sexual partners with whom the individual had unprotected anal intercourse.

5.3.3. Analyses

We conducted three sets of analyses to examine reliability of sexual behavior and STI diagnoses using Stata/IC 12.1.[117] The first set of analyses examined potential bias due to attrition by comparing completers and noncompleters. Demographic characteristics and sexual behaviors were compared between individuals who completed both surveys and those who completed only the first survey using chi-square analyses and *t*-tests. Logistic regression models were used as a follow-up to predict odds of completing both surveys according to levels of significant covariates.

The second set of analyses evaluated test-retest reliability of sexual partner frequencies, relative frequencies of sexual behaviors, partner-level behavioral frequencies, and STI diagnoses. Test-retest reliability refers to the performance of a measure over time, or whether an individual will report consistent responses when asked at different time points. For categorical measures, the kappa statistic (κ) indicates agreement between scores beyond what would be expected by chance. For continuous measures, the intraclass correlation coefficient (ICC) indicates the within-subject proportion of the variance in responses. ICC is recommended over Pearson and Spearman correlations because the latter two measure relative agreement instead of absolute agreement, and both ignore systematic error.[140]

ICCs were calculated for count variables using variance components derived from multilevel regression models estimated using restricted maximum likelihood. Kappa statistics were used to examine categorized counts. As with Nyitray et al.,[146] based on the advice of Schroder et al.,[140] kappa statistics for STIs with fewer than five cases were not computed. As a follow-up to analyses regarding the reliability of partner-level data, validity of self-reported dates of sex with partners were examined as percentages that matched between time points and percentages that fell within the defined period of time (i.e., the three months prior to the first survey). For evaluation, kappa statistics and ICCs were interpreted according to the benchmarks proposed by Landis and Koch[145]: *slight* (0.00-0.20), *fair* (0.21-0.40), *moderate* (0.41-0.60), *substantial* (0.61-0.80), and *almost perfect* (0.81-1.00).

Finally, the third set of analyses examined predictors of inconsistent reporting of the numbers of total sexual partners and casual sexual partners with whom the participant had unprotected anal intercourse (UAI) over the past three months. Logistic regression models were conducted to compute odds of inconsistent reporting according to age, race and ethnicity, education, income, and HIV status. Socially desirable responding and hours spent online were also examined. Significant covariates from bivariate models were then included in a multivariable-adjusted model.

5.4. Results

Demographics for all participants who completed the baseline survey are presented in Table 6. Chi-square tests comparing individuals who completed both surveys to those who did not indicated only one significant demographic predictor of completion: education. Individuals with 13 to 15 years of education had lower odds of completing the survey than individuals with a four-year degree or higher (OR=0.49, 95% CI=0.27-0.87). We examined but found no statistically significant differences in reported number of total, primary, or casual partners between those who completed the baseline survey and those who completed both (Table 7).

Reliability of sexual partner frequencies are reported in Table 8. Reliability statistics for the categorized version of sexual partners (e.g., *none*, *one*, and *two or more*) are reported on the lefthand side of Table 8. Kappa statistics ranged from 0.61 (protected-insertive and unprotected-receptive anal intercourse) to 0.76 (primary partners). ICCs, or the proportion of the variance accounted for by individuals, are reported on the righthand side of Table 8. They ranged from 0.65 (total partners) to 0.77 (casual partners) for counts of sexual partners in the last three months. In addition, test-retest reliabilities for relative frequency of anal sex with condoms (ICC=0.80) and without condoms (0.83) are reported in Table 9.

Test-retest reliability coefficients for counts of insertive and receptive anal intercourse with primary partners are listed in Table 10. Reported protected insertive and unprotected receptive anal intercourse were substantially or almost perfectly reliable over a one-week interval (ICCs: .73-.96); test-retest reliability coefficients were also substantial for unprotected insertive anal intercourse (.73) and protected receptive anal intercourse (.74). Finally, when reporting counts of sexual events with casual partners, test-retest reliability was fair to moderate; coefficients indicated that reliability was greatest for the most recent partner, followed by second- and third-most recent partners, respectively (Table 11).

Approximately 10-21% of the dates reported were beyond the time period being examined (Table 12). Even among those who reported having had sex with a primary partner in the last three months, only 15 (14.4%) reported the same date of last intercourse at both time points. Fewer than a quarter of respondents matched dates for casual sexual partners (Table 12). The median difference between dates ranged from over a week for primary partners to nearly three weeks for the third most recent casual partner (Table 12). Finally, although participants were prompted to respond regarding *most recent*, *second most recent*, and *third most recent* casual sexual partners, over half (60.2%, n=80) reported their partners out of order during the first survey. The percentage was similar for the second survey (59.7%, n=83).

Test-retest reliability of HIV status and last HIV test is reported in Table 13, showing both to be reliable. Few participants ($n<14$) reported being diagnosed with an STI in the year prior to the first survey (Table 13). Only chlamydia, gonorrhea, and HPV were sufficiently prevalent to compute kappa statistics. Kappa statistics for those three diagnoses ranged from 0.70 to 0.76 (Table 13).

There were no significant predictors of inconsistent reporting of total sexual partners over one week (Table 14). Inconsistent reporting of number of UAI partners differed by level of education and by HIV status (Table 15). Men who had more than a high school education but less than the equivalent of bachelor's degree were at higher odds of inconsistent reporting of UAI with casual partners compared to men who had the equivalent of a bachelor's degree or higher (Table 15). There were no significant differences between those with a high school education or less and those with some college (OR=0.57, 95% CI=0.19-1.71) or a college degree (OR=1.33, 95% CI=0.49-3.64). Additionally, compared to men who were HIV-negative, men who reported being HIV-positive were at higher odds of reporting different frequencies of UAI between the two time points (Table 15). There was no statistically significant difference between those who were unsure of their HIV status and those who were HIV-negative (OR=0.98, 95% CI=0.36-2.67) or HIV-positive (OR=0.17, 95% CI=0.03-1.04), although the latter is likely due to lack of power due to sample size. Both associations remained significant after adjustment.

5.5. Discussion

One-week test-retest reliability of sexual behavior, HIV status, HIV testing, and STI diagnoses was substantial (0.71-0.80) to almost perfect (0.81-1.00) in the current study. For reliability of sexual behaviors, relative frequency measures had almost perfect reliability (ICCs: .80-.83; see Table 9) and number of sexual acts had substantial to almost perfect reliabilities (ICC: .73-.96), but number of sexual occurrences had only fair to moderate reliability (ICCs: .31-.60). Inconsistent counts of UAI partners were associated with having some higher education but no degree and being HIV-positive, although there were no significant predictors of inconsistent reporting of total male partners.

Given that they were substantial or almost perfect according to the Landis and Koch[145] cutpoints, researchers studying sexual risk behavior and STI diagnoses might expect similar reliability of measures using questions and methods like the current study. Although reliability coefficients between .6 and .8 may seem low compared to clinical measures, previous studies and benchmarks[145] indicate that this is an acceptable level of reliability for self-reported behavioral data. Our findings compare well to test-retest reliability studies that used paper-and-pencil measures, which found similar or lower coefficients.[142,158] For researchers who require less precision in estimating sexual risk behavior, relative frequencies also provide almost perfect reliability coefficients over a one-week interval.

Partner-level data were reliable for primary partners but, with casual partners, the reliability decreased according to how recent the last sexual encounter was. The fair-to-moderate reliability of partner-specific data for casual sexual partners suggest that collecting data at this level according to the methods utilized in this study may not be reliable for online studies of sexual behavior. Without the aid of an interviewer, the task of enumerating sexual events with specific sexual partners over a 90-day period may be too demanding a task for individuals, as evidenced by the low percentage of matching dates reported in Table 12. During interviews, researchers can ask follow-up questions or clarify instructions. They may also use tools to aid recall, such as other events that occurred around the same time as the sexual event. Participants in the current study did not have those benefits; interactive calendar tools, though helpful in determining days of the week, did not list holidays or indicate when the period of interest (i.e., three months prior) began. The survey was also not programmed to remind participants of the dates they reported in previous items or to correct respondents if they reported partners out of order. Researchers considering studies involving partner-specific data and timed events should first conduct formative research to develop and test the reliability of their procedures. Specifically, TLFB procedures that appear robust in face-to-face interviews may not be reliable in online formats.

Due to the poor performance of partner-specific items, researchers who are interested in collecting partner-level data online might consider alternative methods. For instance, data regarding sexual behavior with specific partners have been collected successfully using online diaries in prospective studies.[86,118,119,127] A major benefit is that the recall period is shortened (i.e., the events did not occur long ago), which reduces the cognitive demands of the task.[159] Another option would be to add features to online surveys in order to make the task of enumeration easier for participants. Examples include limiting the range of eligible dates to those that are valid or offering hints when numbers do not sum accurately (e.g., when participants report 10 acts of receptive anal intercourse but only 9 total acts of anal intercourse).

Self-reported HIV status and HIV testing behavior had almost perfect reliability, while the data on STI diagnoses had substantial reliability. Given that HIV status is relatively static, one would expect it to be as reliable as many demographic characteristics, particularly over an interval during which is not likely to change. Furthermore, HIV testing and positive STI diagnoses are likely rare experiences, which makes the cognitive task of recalling of whether or not they occurred easier. When considered in light of other research that found a high degree of reliability between self-reported STI diagnosis and official reports from other sources,[160] collecting data regarding STI diagnoses in online studies of MSM by self-report may be sufficient to examine certain hypotheses.

The association between being HIV-positive and reporting different numbers of UAI partners between the two surveys has several plausible interpretations. For one, UAI has different cognitive implications for HIV-positive and HIV-negative men. While condom use is important for all MSM for prevention of STIs, HIV-negative men who engage in UAI may have better recall due to the risk of seroconverting. Another possible explanation is that some individuals with advanced infection with HIV may have experienced memory difficulties due to HIV-related cognitive impairment.[161]

While significant predictors of inconsistent reporting are important, some null findings have implications as well: participants' Internet use, number of sexual partners, and tendency to respond in a socially desirable way did not appear to be related to inconsistencies in reporting total number of male sexual partners or number of UAI partners. It is useful to know that individuals with multiple sexual partners were not statistically more likely to report different numbers between surveys than individuals with one or no partners, or that Internet use was not found to be related to consistent responses over time in an Internet-based survey. Moreover, those who aim to please, or are more socially desirable in their responding, did not have significantly greater odds of reporting consistent frequencies across survey administrations.

5.6. Limitations

Caution must be taken when generalizing the results. First, although few differences were observed between those who completed only one survey versus those who completed both, education was related to both dropping out between time points and to inconsistent reporting. Thus, it may be that attrition among this group biased the results. Second, kappa statistics for chlamydia, gonorrhea, and HPV diagnoses may not be stable. As Shroeder and colleagues[140] point out, kappa statistics are only as reliable as the sample size they were derived from. With so few cases, the estimates can be highly variable. Finally, although it was argued that the collapsed categories reflected how variables are used in practice, it may be that the recoded versions of both HIV status and HIV testing inflated the reliability coefficients for those items. Researchers who are concerned with changes between HIV status categories such as “unsure but think I might be HIV-positive” and “unsure but think I might be HIV-negative” or precise numbers of sexual partners should not assume that such items will perform as well as the three-category versions.

5.7. Future research

The current study indicated that measures of sexual behavior and HIV/STI testing can be as reliable in online studies as what has been found in offline versions. Researchers implementing cross-sectional studies using the same questions with similar populations might expect them to have similar properties. However, when possible, test-retest reliability estimates should be re-studied for new populations and changes to the survey items or administration mode (e.g., paper-and-pencil or interview).

Although reliability among broad measures, such as counts, was substantial or almost perfect, future research should examine methods of improving the reliability of partner-level sexual behavior in online survey research. Individuals who are recruited using methods similar to the SEM study could be randomized to complete sexual behavior questionnaires that utilize several interactive methods. For instance, reminding individuals of the names that they provided at Time 1 might help to make responses more consistent over time. Specifying and limiting dates only to those that are valid (e.g., dates that fall within the 90-day window) would allow researchers to see how much their data improve when limits are imposed versus when participants are allowed to report any date. Visually rich timeline follow-back interactive calendars that include major holidays or for which participants complete personally significant timelines (e.g., birthdays, anniversaries) prior to filling in sexual event data may also increase reliability.

5.8. Conclusion

Test-retest reliability of counts of recent sexual partners, reported HIV status, HIV testing behavior, and STI diagnoses can be substantial or almost perfect in online studies of MSM. However, detailed information regarding behaviors with specific partners, which ranged from fair to moderate, may be better suited to daily diary or interview methods. Odds of inconsistent reporting of sexual risk behavior, specifically UAI, was greater among individuals with more than a high school education but less than an undergraduate degree and those who were HIV-positive. A problem was observed also with event-level data. Further research to resolve these issues was identified.

5.9. Tables

Table 6. Baseline demographic characteristics of participants who completed the baseline survey only or who completed both surveys of the SEM Reliability Study.

	Baseline Only (N=87) n (%)	Both Surveys (N=239) n (%)	χ^2	OR (95% CI)
Age			1.15	
18-24	28 (32.5)	74 (31.0)		
25-34	30 (34.9)	75 (31.4)		
35-44	12 (14.0)	45 (18.8)		
45+	16 (18.6)	45 (18.8)		
Race/ethnicity			0.03	
White (non-Hispanic)	69 (79.3)	190 (80.2)		
Non-white	18 (20.7)	47 (19.8)		
Sexual identity			1.89	
Gay	70 (80.5)	207 (86.6)		
Bisexual/other	17 (19.5)	32 (13.4)		
Education			6.57*	
12 or fewer years	16 (18.4)	35 (14.6)		0.61 (0.31, 1.21)
13-15 years	27 (31.0)	47 (19.7)		0.49 (0.27, 0.87)*
16+ years	44 (50.6)	157 (65.7)		Ref.
Annual income			1.83	
$0-$24,999	38 (43.7)	107 (44.7)		
$25,000-$49,999	27 (31.0)	58 (24.3)		
$50,000+	22 (25.3)	74 (30.0)		
HIV status			1.16	
HIV+	7 (8.1)	13 (5.4)		
HIV-	69 (79.3)	201 (84.1)		
Unsure	11 (12.6)	25 (10.5)		

*$p<.05$

Table 7. Number of partners (last three months) reported by participants who completed the baseline survey only and participants who completed both surveys of the SEM Reliability Study.

	Completed Survey 1 Only		Completed Both Surveys		
	n	**M (SD)**	**n**	**M (SD)**	***t***
Total partners	86	3.85 (6.95)	235	4.78 (10.2)	-0.78
Primary partners	69	0.72 (1.33)	209	0.89 (2.12)	-0.63
Casual partners	69	4.07 (6.70)	205	4.59 (10.2)	-0.39
Insertive					
With condom	50	1.26 (2.16)	138	2.36 (6.68)	-1.71
Without condom	50	1.12 (3.16)	138	1.08 (3.06)	0.08
Receptive					
With condom	50	1.98 (4.60)	138	2.00 (5.70)	-0.02
Without condom	50	1.48 (3.96)	138	0.74 (1.82)	1.28

Table 8. Test-retest reliability of categories (0, 1, or 2 or more) and counts of sexual partners (last three months), by type of partner.

		Categorical				Count
	n[a]	0 partners n (%)	1 partner n (%)	≥2 partners n (%)	κ (95% CI)	ICC (95% CI)
Total partners	234	30 (12.7)	87 (36.7)	120 (50.6)	0.72 (0.65, 0.80)	0.65 (0.58, 0.72)
Primary partners	199	83 (41.7)	100 (50.3)	16 (8.0)	0.76 (0.66, 0.83)	0.68 (0.61, 0.76)
Casual partners	191	66 (35.6)	29 (15.2)	96 (50.3)	0.70 (0.64, 0.76)	0.77 (0.71, 0.83)
Insertive anal sex						
With condom	122	55 (45.1)	33 (27.1)	34 (27.9)	0.61 (0.47, 0.74)	0.66 (0.56, 0.76)
Without condom	122	78 (63.9)	25 (20.5)	19 (15.6)	0.63 (0.46, 0.79)	0.67 (0.58, 0.77)
Receptive anal sex						
With condom	122	62 (50.8)	25 (20.5)	35 (28.7)	0.70 (0.58, 0.83)	0.74 (0.66, 0.82)
Without condom	122	82 (67.2)	24 (19.7)	16 (13.11)	0.61 (0.46, 0.70)	0.70 (0.61, 0.79)

[a]This *n* refers to the total number of individuals who responded to this item.

Table 9. Test-retest reliability of relative frequency of anal sex[b] (last three months).

		Time 1	Time 2	
	n[a]	M (SD)	M (SD)	ICC (95% CI)
Anal sex with condom	186	2.88 (2.17)	3.02 (2.23)	0.80 (0.75, 0.85)
Anal sex without condom	191	3.03 (2.16)	3.08 (2.12)	0.83 (0.79, 0.88)

[a]This *n* refers to the total number of individuals who responded to this item.
[b]Relative frequency was measured as a proportion of all sexual encounters that included anal sex, according to the following scale: 1 = *never (0%)*, 2 = *rarely (1-20%)*, 3 = *sometimes (21-40%)*, 4 = *about half of the time (41-60%)*, 5 = *most of the time (61-80%)*, 6 = *almost always (81-99%)*, and 7 = *always (100%)*.

Table 10. Test-retest reliability of times respondent had sex with primary partner (last three months).

	n[a]	Time 1 M (SD)	Time 2 M (SD)	ICC (95% CI)
Insertive anal sex	105	5.09 (10.0)	5.01 (9.58)	0.90 (0.86, 0.94)
With condom	60	1.43 (3.42)	1.50 (3.52)	0.96 (0.94, 0.98)
Without condom	60	6.90 (10.7)	6.10 (11.0)	0.74 (0.62, 0.85)
Receptive anal sex	105	5.68 (10.3)	5.27 (9.63)	0.89 (0.85, 0.93)
With condom	60	1.23 (4.19)	0.80 (1.92)	0.73 (0.61, 0.85)
Without condom	60	7.63 (10.9)	7.57 (11.1)	0.92 (0.88, 0.96)

[a]The *n* in the table refers to the number of individuals who responded to each item.

Table 11. Test-retest reliability of occasions[a] respondent had sex with casual partners (last three months).

Casual partner	n[b]	Time 1 M (SD)	Time 2 M (SD)	ICC (95% CI)
Most recent	122	6.25 (19.0)	3.95 (12.6)	0.60 (0.48, 0.71)
Second most recent	89	2.55 (4.64)	3.51 (12.9)	0.46 (0.29, 0.62)
Third most recent	67	1.88 (1.45)	2.01 (2.00)	0.31 (0.09, 0.53)

[a]Here, *occasions* is used to distinguish this number from the number of times they had sex. For example, respondents could have sex with their partner multiple times during a single occasion (e.g., one night).
[b]The *n* in the table refers to the number of individuals who responded to each item.

Table 12. Date validity[a] and date differences between Survey 1 and Survey 2 regarding last sexual intercourse, by partner type.

	n	Match n (%)	Difference between dates (in days) Median (IQR)	Beyond 90-day range Survey 1 n (%)	Beyond 90-day range Survey 2 n (%)
Primary partner	104	15 (14.4)	8.5 (2, 22)	17 (14.3)	12 (10.5)
Casual partners					
Most recent	118	20 (16.9)	13.0 (1, 78)	13 (9.9)	24 (17.4)
Second most recent	82	17 (20.7)	14.5 (2, 66)	12 (11.9)	21 (20.8)
Third most recent	65	12 (18.5)	20.0 (3, 62)	11 (14.3)	15 (19.5)

[a]*Date validity* refers to being within the time range defined by the study (i.e., three months prior to the first survey).
[b]The *n* in the table refers to the number of individuals who responded to each item.

Table 13. Test-retest reliability of HIV status, HIV testing, and STI diagnoses.

	Time 1		Time 2		
	n	%	n	%	κ (95% CI)[a]
HIV status					0.83 (0.75, 0.91)
HIV-positive	197	82.1	192	80.0	
HIV-negative	16	6.7	15	6.3	
HIV-unsure	27	11.2	33	13.7	
HIV testing					0.83 (0.78, 0.88)
Last 12 months	143	66.2	142	65.7	
More than 12 months	45	20.8	49	22.7	
Never	28	12.0	25	11.6	
Chlamydia					0.76 (0.50, 1.00)
Diagnosed	7	2.92	6	2.50	
Not diagnosed	233	97.08	234	97.50	
Gonorrhea					0.74 (0.54, 0.94)
Diagnosed	10	4.17	14	5.83	
Not diagnosed	230	95.83	226	94.17	
Hepatitis A					–
Diagnosed	2	0.83	1	0.42	
Not diagnosed	238	99.17	239	99.58	
Hepatitis B					–
Diagnosed	3	1.25	2	0.83	
Not diagnosed	237	98.75	238	99.17	
Herpes					–
Diagnosed	3	1.25	1	0.42	
Not diagnosed	237	98.75	239	99.58	
HPV					0.70 (0.44, 0.95)
Diagnosed	10	4.14	7	2.92	
Not diagnosed	230	95.83	233	97.08	
Syphilis					–
Diagnosed	3	1.25	3	1.25	
Not diagnosed	237	98.75	237	98.75	

[a]Kappa statistics were not computed for STIs with fewer than 5 cases.

Table 14. Predictors of inconsistent reporting of total sexual partners (last three months).

	Mismatch n (%)	OR (95% CI)
Age		
18-24	23 (30.1)	2.34 (0.91, 6.02)
25-34	12 (17.4)	1.11 (0.40, 3.09)
35-44	8 (17.0)	1.08 (0.36, 3.29)
45+	7 (15.9)	Ref.
Race/ethnicity		
White (non-Hispanic)	41 (22.3)	Ref.
Non-white	9 (17.7)	0.75 (0.34, 1.66)
Sexual identity		
Gay	40 (19.6)	Ref.
Bisexual/other	8 (30.8)	1.82 (0.74, 4.49)
Education		
12 or fewer years	9 (27.3)	1.50 (0.63, 3.56)
13-15 years	11 (21.2)	1.07 (0.49, 2.33)
16+ years	30 (20.0)	Ref.
Annual income		
$0 - $24,999	29 (27.4)	1.95 (0.90, 4.23)
$25,000 - $49,999	10 (16.4)	1.02 (0.40, 2.59)
$50,000+	11 (16.2)	Ref.
HIV status		
HIV+	40 (20.4)	1.42 (0.43, 4.69)
HIV-	4 (26.7)	Ref.
Unsure	6 (25.0)	1.30 (0.48, 3.49)
Number of male partners (three mo.)	--	1.00 (0.97, 1.03)
Average hours spent online per week	--	1.01 (0.99, 1.02)
MC-SDS	--	0.88 (0.75, 1.04)

Table 15. Predictors of inconsistent reporting of number of casual sexual partners with whom respondents had unprotected anal intercourse (last three months).

	Mismatch n (%)	OR (95% CI)	AOR (95% CI)
Age			
18-24	24 (44.4)	1.94 (0.69, 5.45)	
25-34	14 (36.8)	1.42 (0.47, 4.25)	
35-44	12 (44.4)	1.94 (0.61, 6.21)	
45+	7 (29.2)	Ref.	
Race/ethnicity			
White (non-Hispanic)	47 (43.1)	Ref.	
Non-white	10 (29.4)	0.55, 0.24, 1.26)	
Sexual identity			
Gay	50 (39.4)	Ref.	
Bisexual/other	6 (46.2)	1.32 (0.42, 4.16)	
Education			
12 or fewer years	9 (27.3)	1.33 (0.49, 3.64)	1.72 (0.60, 4.94)
13-15 years	11 (21.2)	2.33 (1.07, 5.07)*	2.16 (1.22, 9.27)*
16+ years	30 (20.0)	Ref.	Ref.
Annual income			
$0 - $24,999	31 (44.3)	1.47 (0.64, 3.34)	
$25,000 - $49,999	13 (36.1)	1.04 (0.40, 2.72)	
$50,000+	13 (35.1)	Ref.	
HIV status			
HIV+	7 (77.9)	5.86 (1.16, 29.5)*	7.16 (1.20, 42.6)*
HIV-	43 (37.4)	Ref.	Ref.
Unsure	7 (36.8)	0.98 (0.36, 2.67)	0.87 (0.30, 2.52)
Number of male partners (last three months)	--	1.02 (0.99, 1.05)	
Average hours spent online per week	--	1.01 (1.00, 1.02)	1.01 (1.00, 1.02)
Social desirability (M-C SDS)	--	1.04 (0.87, 1.25)	

*p<.05

6. Manuscript 3: Covariates of STI testing among an online sample of MSM: A latent class analysis

6.1. Abstract

Introduction: Annual testing for several sexually transmitted infections (STIs) is recommended for men who have sex with men (MSM) in the United States. However, the availability of tests for these STIs differs according to structural and individual factors. As a result, testing behaviors may cluster. If so, it may be possible to identify predictors of membership in these testing groups over those who are not tested annually.

Methods: The Sexually Explicit Media (SEM) Study was conducted from May to August, 2011. Online banner advertisements recruited 1,254 MSM to complete an Internet-based survey, with 1,108 submissions determined to be valid for analysis. Participants were asked questions regarding sexual behavior and testing for HIV and several STIs, including syphilis, gonorrhea, chlamydia, human papilloma virus (HPV), herpes simplex virus (HSV-2), hepatitis A, and hepatitis B. A latent class analysis was conducted to determine the presence of classes based on patterns of non-HIV STI testing behavior. Finally, unadjusted and adjusted multinomial logistic regression models were used to determine covariates of class membership.

Results: A five-class model describing STI testing was selected. Classes were defined according to testing behavior as *no STIs, all STIs, bacterial STIs and hepatitis*, *bacterial STIs only*, and *hepatitis only*. Significant unadjusted predictors of class membership included age, education, city residence, outness, HIV status, and number of sexual partners. After multivariable adjustment, all variables remained significant. Individuals who were HIV-positive, had casual sexual partners in the previous three months, and were more open regarding their sexuality had higher odds of being testing for all STIs compared to being tested for none. Individuals who were unsure of their HIV status, which suggested that they had not had a recent HIV test, had lower odds of being in almost any testing group compared to the *no STI tests* group. Few significant predictors of membership in other testing classes relative to *no STI tests* were identified, possibly due to low sample size.

Conclusion: Reported STI testing behavior appeared to cluster into five classes. Most individuals reported being tested for either no STIs (the largest class) or all STIs, which was associated with age, education, outness, HIV status, and having had recent casual partners. Future research into using the Internet as a means to test individuals identified as having lower odds of STI testing in the current study was suggested.

6.2. Introduction

The Centers for Disease Control and Prevention (CDC) recommend that all sexually active men who have sex with men (MSM) be tested annually for several sexually transmitted infections (STIs).[1] These include syphilis, gonorrhea (urethral, rectal, and oral), and chlamydia (urethral and anal).[1] Testing for herpes simplex virus 2 (HSV-2) is also recommended for individuals who do not know their status, as is vaccination for hepatitis A and B for those who are not immune to infection.[19,21] High risk men, defined as MSM with multiple partners, MSM with anonymous partners, illicit drug-using MSM, and MSM using methamphetamines, are all recommended to get tested more frequently (e.g., every 3 or 6 months).[1]

Despite the CDC's guidelines, recent reports indicate that fewer than half of MSM identified by the CDC's STI testing recommendations receive annual tests for syphilis or gonorrhea.[66] In a national sample of MSM, only 39% had been tested for syphilis in the previous year.[66] Fewer (36%) had been tested for gonorrhea.[66]

At the individual level, research has shown that having health insurance is related to testing for syphilis and gonorrhea, as is being younger and identifying as black.[66] Disclosing a history of sex with men was also positively associated with screening for syphilis and gonorrhea. In New York City, MSM who did not identify as gay were less likely than gay men to have been tested for HIV in the previous year (prevalence ratio = 0.6, 95% confidence interval = 0.4, 0.9).[70] Furthermore, individuals who do not have symptoms may not be tested, which leads to less testing for STIs that are typically asymptomatic.[48]

Beyond testing for bacterial STIs, data are also mixed regarding correlates of hepatitis B vaccination. Rhodes, DiClemente, Yee, and Hergenrather[162] found that 42% of men in an online sample from the United States reported at least one dose of hepatitis B vaccination. Those who had been vaccinated were younger (OR=0.7 per 10 year increments of age, 95% CI=0.59-0.84, p=0.002) more knowledgeable about the vaccine (OR=1.4, 95% CI=1.03-1.83, p=0.0007), and had talked to a health care provider about hepatitis (OR=1.98, 95% CI=1.31-2.98, p=0.006).[80]

Individual characteristics are not the only cause of different testing behaviors; testing venue may also influence which tests are offered to individuals. In a national survey of U.S. men and women, most (49%) were screened for STIs through a private practice. MSM who attend clinics are tested for syphilis more often than gonorrhea and chlamydia. Among clinics, screening was found to be highly variable for HIV-positive MSM.[163] Perhaps due to funding priorities reflecting what tests are offered, tests for herpes simplex virus (HSV) are not prevalent among clinics, with 37% lacking any test.[164] Even between types of clinicians, STI screening practices vary.[165]

Given the variability of reasons for testing, venues where individuals seek treatment for STIs,[166] and differences in provider's screening practices,[163,165,167,168] individuals may receive different sets of STI tests (e.g., only syphilis or syphilis, chlamydia, and gonorrhea). Furthermore, if screening for STIs tends to cluster into groups of STI tests, we do not know covariates of each testing pattern. Therefore, this manuscript had two aims. The first was to examine clustering among STI screening behaviors in an online sample of MSM. With this information, it would be possible to determine how many men in the sample are tested for STIs according to CDC guidelines, which tests are administered to the same individuals, and to identify what gaps exist in testing. The second aim was to determine covariates of latent class membership. With this information, we can identify whether certain demographic groups of MSM vary in what tests they receive which in turn can inform the need for targeted testing interventions.

6.3. Methods

6.3.1. Study Design

Internet-using MSM (N=1,254) completed an online survey about their use of sexually explicit media (SEM) and sexual behavior. Participants were recruited online between May and August, 2011, using banner advertisements on 148 gay-oriented websites affiliated with an advertising agency specializing in gay consumers. As part of the sampling strategy, impressions were increased to urban areas with a high proportion of African-American and Latino men, and quotas were placed on non-Hispanic white respondents in order to allow extra time and resources to recruit MSM of color. Banner advertisements were restricted to persons in the United States according to Internet protocol (IP) address and were placed on gay Web sites in order to maximize the number of impressions to a U.S.-based MSM sample.

Nearly eight million impressions of the banners were made during this period, which yielded a click-through-rate (CTR) of 0.16%, comparable to other online studies of MSM.[98] Banner advertisements directed interested persons to a webpage hosted on a dedicated university server with appropriate encryption to ensure data security. All participants who completed the screening questionnaire were shown their responses and prompted to confirm them prior to submission or change them if they were incorrect. After subjects verified their age, sex, country of residence, and gender of partners in the previous three years, those who were eligible were shown the study information and asked to provide informed consent to participate. Due to quotas, race and ethnicity were also included as conditional eligibility criteria, with white non-Hispanic men being ineligible after 400 were recruited. (No other racial or ethnic groups reached the set quota.) Individuals who were ineligible were thanked for their interest and navigated away from the survey.

The results of a de-duplication and fraud detection protocol indicated that 146 survey entries were invalid.[150] An additional 30 individuals were missing data on STI testing and were not included in analyses. Thus, the final analytic sample size was therefore 1,078.

6.3.2. Measures

HIV status and STI testing

Individuals were asked their HIV status. Response options included “HIV-positive,” “HIV-negative,” “I’m not sure, but I think HIV-positive,” “I’m not sure, but I think HIV-negative,” “I don’t know,” and “refuse to answer.” For analysis, “not sure” and “I don’t know” categories were combined into one status, *HIV-unsure.* Participants who indicated testing HIV-negative or who were unsure of their HIV status were also asked how recently they were tested for HIV. Response options were “in the last three months,” “in the last year,” “one (1) to two (2) years ago,” “more than two (2) years ago,” “I have never been tested for HIV,” “I can’t remember,” “not applicable,” and “refuse to answer.” “In the last three months” and “in the last year” were coded as *tested in the last year*, while all other responses aside from “refuse to answer” were coded as *not tested in the last year*. “Refuse to answer” responses were coded as missing.

Regarding sexually transmitted diseases, participants were asked if they were tested for each of the following seven STIs in the past twelve months: syphilis, gonorrhea, chlamydia, HPV (genital or anal warts), genital herpes, hepatitis A, and hepatitis B. Response options were “yes, and I got the results,” “yes, but I did not get the results,” “no,” “I don’t know,” and “refuse to answer.” For the current analysis, a binary variable was created for each STI. Being tested and receiving the diagnosis was considered a “yes” response, while being tested and not receiving the results was considered a “no” response, since testing without diagnosis does not fulfill the purpose of testing as outlined by public health priorities. “I don’t know” responses were also included as “no” responses, while “refuse to answer” responses were coded as missing.

Sexual behavior

Participants reported their sexual history over the previous three months. Questions were asked regarding lifetime number of male sexual partners (any kind of sex) and number of male partners in the last three months (asked separately). As a follow up to the number of male partners in the last three months, participants were asked how many were primary partners, defined as “a regular sex partner such as a boyfriend, husband, domestic partner that [they] have been in a relationship with for at least three months.” The number of casual male partners was derived by subtracting the number of primary male partners from the total number of male partners. For the current analyses, a three-level variable indicating “no sex,” “sex with primary partner only,” and “sex including casual partners” was created in order to examine differences according to the type of sexual partner (if any) participants had recently had, with individuals who had not had sex in the past three months as the reference category.

Sexual orientation and outness

Participants were asked to define their sexual orientation as “gay/homosexual,” “bisexual,” “straight,” “same-gender-loving,” “queer,” or “other.” For the current study, “gay/homosexual” was coded as *gay*, while “bisexual,” “straight,” “same-gender-loving,” “queer,” and “other” were coded as *not gay*. Individuals also reported the degree to which they are out about their sexual orientation to family, friends, and coworkers on a scale from *1 – (0%, not out at all)* to *5 (100% - out to everyone)*. Most of the sample was “out to all,” while 20% was “out to most” of their family, friends, and acquaintances. Outness was dichotomized to reflect participants’ being *out to half or less* or *out to more than half* of the individuals in their lives. Those who were out to more than half were used as the referent group.

Drug use

Drug use was asked using the following question: “In the past three (3) months, how often have you used any of the following drugs illegally or inappropriately (e.g., abuse of prescription drugs?)” Response options included *not at all*, *less than monthly*, *once a month*, *once a week*, *daily,* and *refuse to answer*. Individuals who reported using cocaine, methamphetamines, club drugs, or opioids were counted as having used illegal drugs for the purpose of analysis. Additional drugs, such as marijuana, sedatives, and medication for erectile dysfunction are sometimes legal and, thus, were not counted, although medical marijuana use is rare. The reference group was men who had not used illegal drugs in the past three months.

Additional demographics

Individuals were asked their age, race, and ethnicity. Due to low participation of some races and ethnicities in the sample, participants' race/ethnicity was analyzed using a four-category variable: *white (non-Hispanic)*, *black (non-Hispanic)*, *Latino/Hispanic*, and *multiracial or other (non-Hispanic)*. Age was also categorized as *18-24*, *25-34*, *35-44*, and *45 and over*, which was consistent with the categories using in offline STI studies of MSM.[66] Participants also reported level of education according to highest degree completed; urban, suburban, or small town/rural residence; and annual income (open-ended). Years of education was categorized as *high school or less*, *some college or Associate's degree*, and *Bachelor's degree or higher*; urbanicity was dichotomized as *urban/other*, and income was categorized as *$0-24,999*, *$25,000-$49,999*, *$50,000 or more* according to sample proportions. Due to a high proportion of *refuse to answer* responses for income, *refuse to answer* was modeled as an additional category.

6.3.3. Analyses

Latent class analysis (LCA) is a procedure similar to factor analysis that allows researchers to determine typologies based on observed categorical variables.[169] For this aim, LCA was conducted using items regarding testing for STIs in the past year according to the model in Figure 2. HIV testing was not included as part of this analysis because it was not asked of all individuals and because STI testing guidelines, unlike HIV testing guidelines, do not differ according to HIV status.

The number of classes was determined using a Bayesian approach to model selection.[170] Starting with the independence model, the Aikaike information criterion (AIC),[171] Bayesian information criterion (BIC),[172] and the likelihood ratio statistic (G^2) were calculated and plotted (Figure 3). If the addition of classes failed to decrease the AIC, BIC, and/or G^2, the previous model was considered the final model.

Homogeneity and separation of the latent classes were also used to compare models. *Homogeneity* refers to the degree to which response patterns within the latent classes are consistent between members of the class, such that individuals within a particular class tend to respond the same way to the items that make up the latent class model.[173] *Separation* refers to the degree to which response patterns differ between members of different classes, or how well a particular response pattern can estimate the probability of membership in one latent class over others using the item-response probabilities.[174] All latent class analyses were performed using SAS PROC LCA in SAS v. 9.3.[175]

After determining number of classes for the STI screening latent variable, participants were classified according to posterior probabilities of class membership. Chi-squared analyses were used to analyze significant differences in the proportion of categorical covariates that are related to health disparities and testing for STIs and HIV, such as race and ethnicity, age, education, income, and urban residence. In addition to demographics, HIV status, sexual orientation, outness, drug use, and type of sexual partners in the last three months were used to predict testing class. Significant bivariate associations were then examined according to a multinomial logistic model using SAS PROC LOGISTIC. All analyses were conducted using SAS v.9.3.[175]

6.4. Results

AIC and G^2 indices of model fit improved through ten classes (Figure 3, Table 16), likely due to the large sample. BIC improved through only five classes. Since BIC may be a better estimator of model fit for large samples,[170] only four- and five-class models were considered further. Ultimately, a five-class model was chosen based on latent class separation (Figure 4), class proportions (Table 17), and interpretability. The majority of the predictive probabilities of latent class membership were above 0.8 (n=1094, 98.7%), although several (n=14, 1.3%) ranged from 0.6 to 0.8. The average posterior latent class probabilities for each assigned class are reported in Table 18.

The following labels were applied to the latent classes based on response probability patterns (Figure 4): *no STIs* (45.8%), *all STIs* (33.5%), *bacterial STIs and hepatitis A and B* (6.0%), *bacterial STIs only* (9.6%), and *hepatitis only* (5.2%). Individuals in the *no STIs* group had a low probability of being tested for any of the seven STIs asked in the survey, while those in *all STIs* group had a high probability of testing for all seven STIs. The *bacterial STIs only* group had a high probability of testing for syphilis, chlamydia, and gonorrhea and low probabilities of testing the remaining four STIs, while *hepatitis only* had a high probability of testing only for hepatitis A and B but not for any other STIs. The remaining group, *bacterials STIs and hepatitis,* included individuals who had high probabilities of testing for syphilis, chlamydia, gonorrhea, hepatitis A, and hepatitis B but low probabilities of testing for herpes and HPV.

Table 19 reports summaries of demographic, socioeconomic, and behavioral variables by latent class. Chi-squared statistics indicating bivariate associations between each variable and latent class membership are also included (see Table 19). Significant predictors of latent class membership relative to the largest class, *no STIs*, included age, education, annual income, city residence, outness, HIV status, and type of sexual partner(s), if any, in the three months prior to the survey.

Significant predictors were retained for a multivariate multinomial logistic regression model (Table 20). Most significant associations were found between the *no STIs* and *all STIs* groups, which were the two largest classes and accounted for 79.3% of the study sample. Comparing just these two classes, individuals who were relatively young (25-34, compared to the highest age group, 44 and older; OR=2.18, 95% CI: 1.39-3.42) and those who had some post-secondary education but no undergraduate degree (compared to those with a Bachelor's degree or higher; OR=1.45, 95% CI=1.05-2.01) had higher odds of testing.

Those who were open about being MSM to most or all of their acquaintances had higher odds of being in the *all STIs* class than MSM who were out to half or fewer of their acquaintances (OR=1.65, 95% CI=1.18-2.29). In addition, those who reported being HIV-positive had greater odds of being tested for all STIs than HIV-negative MSM (OR=1.78, 95%CI=1.06-2.97), while those who reported being unsure of their HIV status had significantly lower odds of being tested (OR=0.26, 95% CI=0.16-0.42). Finally, those who reported having primary partners (OR=1.66, 95% CI=1.02-2.70) or casual partners (OR=2.19, 95% CI=1.42-3.37) had greater odds of being tested than those who reported no partners in the past three months.

Significant predictors of membership in other classes relative to *no STIs* were few. Comparing individuals who reported being tested only for hepatitis A and B with those who were not tested, individuals in the youngest age group (18-24) were at significantly lower odds than those in the highest (44 and older; OR=0.29, 95% CI=0.11-0.76); Table 20). Men who reported living in a city were at greater odds of reporting testing for bacterial STIs only than those not living in a city (OR=1.69, 95% CI=1.08, 2.65). Finally, being HIV-uncertain was negatively associated with being tested for bacterial STIs (syphilis, chlamydia, and gonorrhea only; OR=0.42, 95% CI=0.21-0.85) and for those three plus hepatitis A and B (OR=0.27, 95% CI=0.09-0.77). For the same two testing groups, having primary or casual partners was significantly associated with being tested compared to not being tested for anything (Table 20). No other demographic, socioeconomic, or behavioral variables were statistically significant.

6.5. Discussion

This manuscript had two aims. The first aim was to determine whether STI testing patterns clustered in a meaningful way. The second aim was to examine covariates of latent class membership according to demographic, identity, and behavioral variables.

For the first aim, we found five distinct patterns of STI testing among MSM in the US: *no STIs, all STIs* (i.e., all STIs asked in the survey, or syphilis, chlamydia, gonorrhea, hepatitis A, hepatitis B, herpes simplex virus, and HPV), *bacterial STIs and hepatitis*, *bacterial STIs only* (i.e., syphilis, chlamydia, and gonorrhea), and *hepatitis only*. Of concern, almost half (45.6%) reported no STI testing in the prior year, and an additional 5.4%, the *hepatitis-only* group, were not tested for bacterial STIs.[1] The second largest group (33.2%) reported testing for all STIs asked in the survey. Taking three of the classes together, one can infer that approximately half (49.0%) of the study sample (i.e., all those in the *all STIs*, *bacterial STIs and hepatitis*, and *bacterial STIs only* classes) met at least some of the CDC's primary recommendation, which is for MSM to be tested annually (or more frequently) for the three bacterial STIs, syphilis, chlamydia, and gonorrhea.[1]

For the second aim, the five classes raised interesting questions regarding the accuracy of self-reported STI testing as well as reasons for class membership. First, although STI testing guidelines do not mention screening for viral STIs as part of annual screening recommendations for MSM (hepatitis B should be screened for, but only prior to vaccination),[1] most individuals who indicated receiving an STI test in the last year reported being tested for all of them. It is possible that regional testing practices and STI-specific outreach programs may have tested for some but not all STIs. It also may be that individuals in this category are aware of STI testing but not of which tests they received. Second, the youngest age group had lower odds of being tested for hepatitis A and B than the oldest age groups. Because routine vaccination against hepatitis A and B has been recommended for infants and children and required for college-aged students,[20,176] younger MSM may be less likely to need a recent test for hepatitis A or B because they were vaccinated at a young age.[162]

Given that they were the two largest classes, it is unsurprising that more statistically significant differences were found between the *no STIs* and *all STIs* groups than between the other three. Many observed differences between the *no STIs* and *all STIs* groups were consistent with the extant literature. For instance, although disclosure of MSM status to healthcare providers was not directly measured, being out (a general openness about sexual orientation) was related to testing for STIs, which has been demonstrated previously.[69] Younger age was also found to be related to syphilis and gonorrhea testing when compared to individuals aged 44 years and older,[66] although this was only true of *testing for all STIs* in the current study.

Findings regarding HIV status were also expected. HIV-positive individuals are more likely to have been tested for HIV (since it is required for diagnosis), which can be administered in conjunction with other STI tests. They may also receive regular STI tests as part of ongoing care. In contrast, individuals who are unsure of their HIV status most likely have not received a recent test for HIV or other STIs.

Those who reported having only primary partners in the prior three months had higher odds of being tested than those who had no partners. Since categories reflected testing in the past year, individuals may have been tested prior start of their primary partnership, which could have been as recent as three months prior to the survey. Furthermore, even if individuals only had sex with their primary partners, those partners may have had additional sexual partners in that time. In addition to those who had only primary partners, those who reported having casual partners also had higher odds of being tested for STIs. This was true for all categories but hepatitis only, for which the lack of statistical significance may have been an artifact of sample size.

It is useful to supplement offline research regarding HIV and STI testing with estimates from Internet-based samples. Most STI testing and prevalence data are based on clinic samples.[177] Online surveys may provide estimates of STI testing from a more diverse sample of the MSM population than samples recruited from clinics or from urban areas. Online samples likely draw from a larger pool than traditional time-space sampling, involve geographically isolated and others who may be less likely to participate in offline studies, and because of this, may reflect more diversity. Individuals who participate in online studies include those who would not be reached at bars, (either for research or for HIV outreach). In the current study, 49% of the study sample belonged to groups that included testing for syphilis and gonorrhea, which is higher than the prevalence estimate from the National HIV Behavioral Surveillance System (NHBS), 34%.[66]

6.6. Limitations

There are significant limitations to the current study. First, what may be the biggest determinants of testing, such as availability by testing venue, are unknown. The findings reported here may simply be proxies of these unmeasured variables. Second, the degree to which individuals can be certain that they were tested for particular STIs, or even know that they were tested for some STIs, cannot be known. Some STIs are more easily recognized than others, which may lead some participants to have selective recall. Similarly, a major limitation of this analysis is assuming that those who reported *received a test but did not receive diagnosis* and *I don't know* were equivalent to those who reported *not tested* for each of the STIs; it may be that those who reported either response belonged in the *tested* category and that testing was underreported.

6.7. Future research

This study was one of the first to examine STI testing in a sample of MSM recruited online. As a first study, there were a limited number of variables that could be included. Future research should investigate additional factors that may influence MSM's STI screening behaviors, including testing venue, reasons for or for not testing, availability of tests, whether or not a test was offered by the clinician, and specific sites of testing (e.g., rectal versus urethral).

In terms improving STI testing among MSM, several findings warrant further study. Since the current study was undertaken, developments in STI testing have occurred that will expand access to STI testing. For example, research has been conducted for mail-in tests for STIs (e.g., rectal swabs and urine samples for detection of bacterial STIs).[178] Furthermore, the promotion of PrEP among MSM, with its requirement that physicians screen regularly for some STIs, may also change patterns of STI testing. The precise implications of these changes for STI testing and, more broadly, for MSM health care are not known but warrant study.

Finally, research should also investigate known correlates of HIV and STI testing further. For instance, learning why individuals who are less out had lower odds of STI testing might lead to new interventions. If we are able to reach these men using Internet-based surveys, it may be that Internet-based screening practices could be improved using methods such as mail-in testing kits.

6.8. Conclusion

STI testing behavior in the previous year clustered into five groups. Younger age and having some education was associated with testing for all STIs over testing for none, as was being open about one's sexuality to most people and having a sexual partner the last three months. HIV-positive MSM were also at higher odds of STI testing, possibly due to ongoing care. Although the prevalence of testing for bacterial STIs in this sample was higher than among offline surveys, nearly half of respondents were not tested for any STIs in the past year. It may be that efforts to target men who are not open about being

MSM should be increased, perhaps by recruiting them online to use new methods such as mail-in testing kits.

6.9. Figures

Figure 2. Latent class analysis (LCA) model.

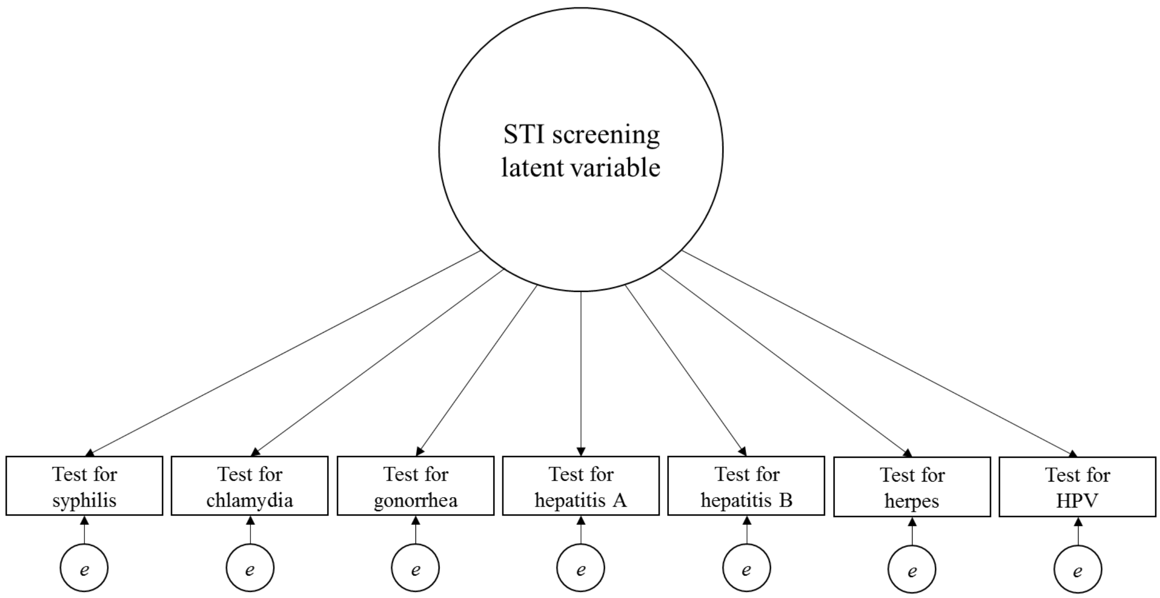


Figure 3. Plot of Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and likelihood ratio test statistic (G^2) by number of classes.

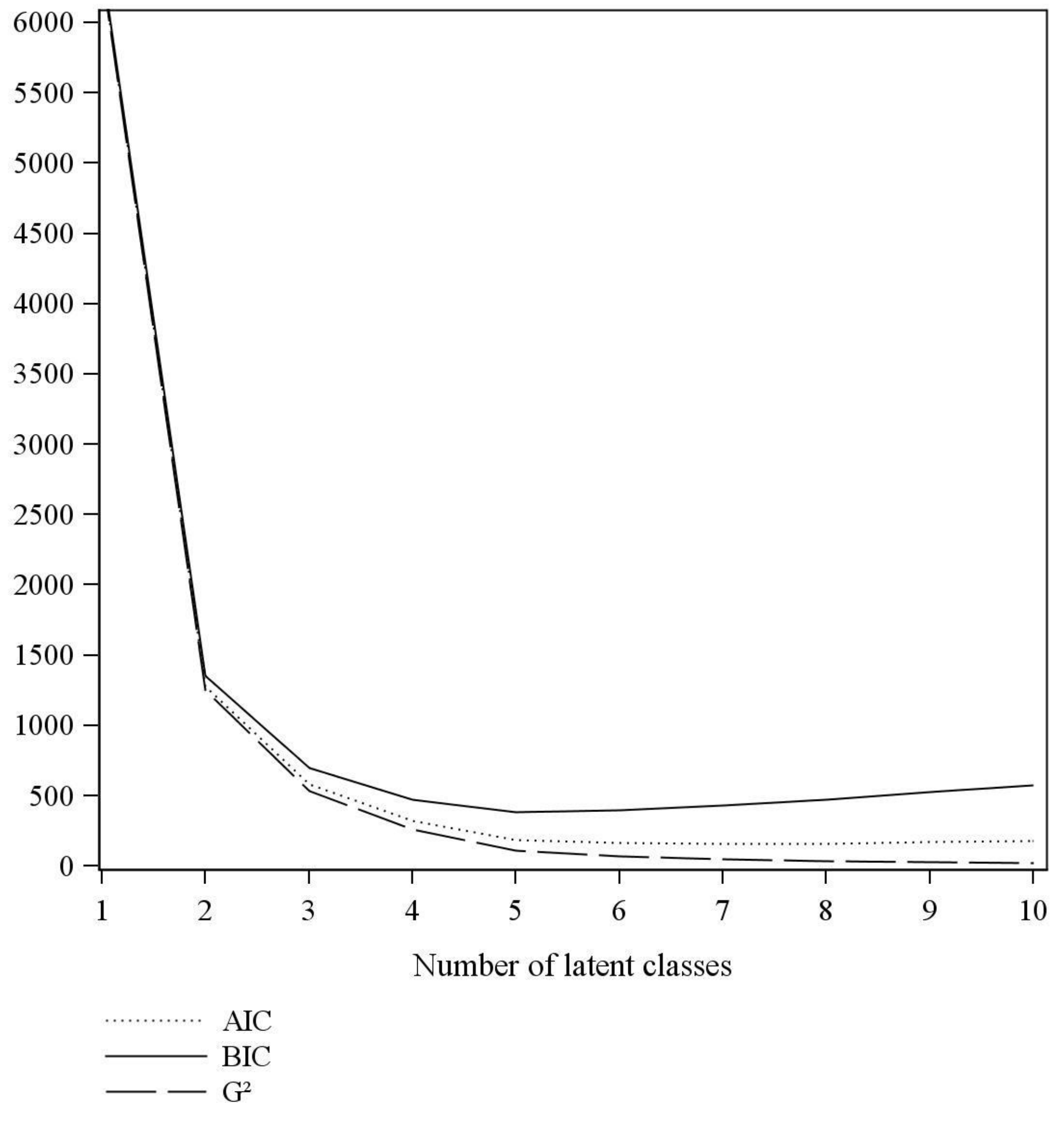
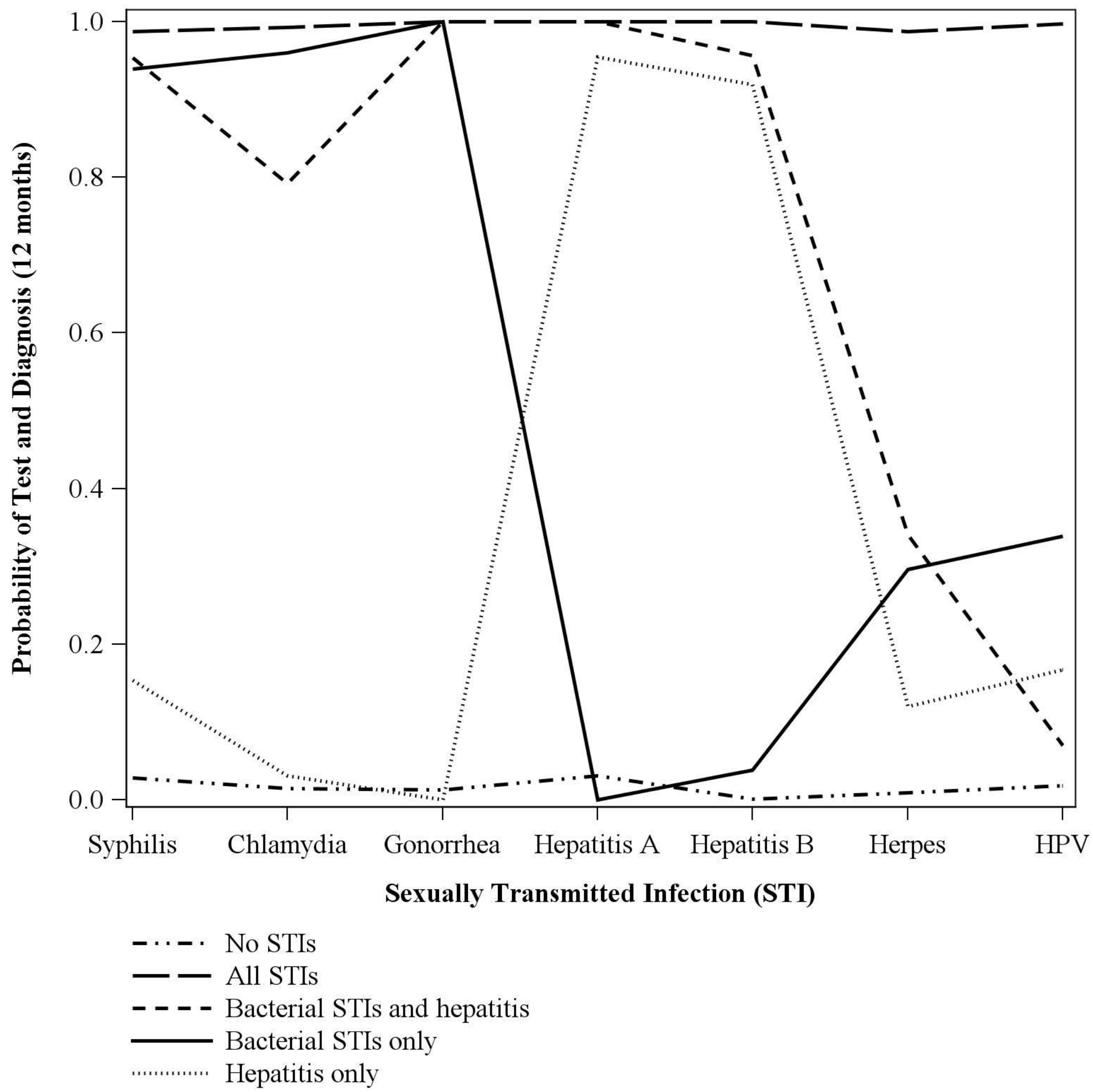


Figure 4. Probability of receiving a test result for each of seven STIs in the previous 12 months according to 5 latent classes.



6.10. Tables

Table 16. Model fit improvement by number of latent classes.

Number of latent classes	df	Log likelihood	AIC	BIC	G^2
1	120	-5294.64	6384.48	6419.54	6370.48
2	112	-2735.24	1281.69	1356.82	1251.69
3	104	-2375.86	578.92	694.11	532.92
4	96	-2237.73	318.66	473.92	256.66
5	88	-2162.37	183.93	**379.27**	105.93
6	80	-2143.69	162.59	397.99	68.59
7	72	-2133.51	158.23	433.70	48.23
8	64	-2124.43	**156.07**	471.60	30.07
9	56	-2121.69	166.57	522.17	24.57
10	48	-2118.33	175.85	571.53	**17.85**

Table 17. Latent class prevalences and probability of reporting test for each sexually transmitted infection (STI) in the previous 12 months.

	Tested for				
Test	**No STIs (45.6%)**	**All STIs (33.2%)**	**Bacterial STIs & hepatitis (6.2%)**	**Bacterial STIs only (9.6%)**	**Hepatitis only (5.4%)**
Syphilis	0.03	**0.99**	**0.95**	**0.94**	0.15
Chlamydia	0.02	**0.99**	**0.79**	**0.96**	0.03
Gonorrhea	0.01	**1.00**	**1.00**	**1.00**	0.00
Hepatitis A	0.03	**1.00**	**1.00**	0.00	**0.96**
Hepatitis B	0.00	**1.00**	**0.96**	0.04	**0.92**
Herpes	0.01	**0.99**	0.34	0.30	0.12
HPV	0.02	**1.00**	0.07	0.34	0.17

Note. In the above groups, the label *bacterial STIs* refers to syphilis, chlamydia, and gonorrhea, while *hepatitis* refers to both hepatitis A and hepatitis B. *All STIs* refers to syphilis, chlamydia, gonorrhea, hepatitis A, hepatitis B, herpes simplex virus, and human papilloma virus. Probabilities of class membership greater than .5 have been bolded to aid interpretation.

Table 18. Mean probability of latent class membership by assigned class.

	Tested for				
Class	**No STIs (45.6%)**	**All STIs (33.2%)**	**Bacterial STIs & hepatitis (6.2%)**	**Bacterial STIs only (9.6%)**	**Hepatitis only (5.4%)**
Nothing	**0.99**	0.00	0.00	0.00	0.01
All bacterial & viral	0.00	**0.99**	0.01	0.00	0.00
Bacterial & hepatitis	0.00	0.07	**0.93**	0.00	0.00
Bacterial only	0.00	0.00	0.01	**0.99**	0.00
Hepatitis only	0.03	0.00	0.00	0.00	**0.97**

Note. In the above groups, the label *bacterial STIs* refers to syphilis, chlamydia, and gonorrhea, while *hepatitis* refers to both hepatitis A and hepatitis B. *All STIs* refers to syphilis, chlamydia, gonorrhea, hepatitis A, hepatitis B, herpes simplex virus, and human papilloma virus. Probabilities of class membership greater than .5 have been bolded to aid interpretation.

Table 19. Participant demographics, sexual partners, and drug use by latent class membership (N=1,078).

	Latent Class											
	No Testing (45.8%)		All Bacterial & Viral STIs (33.5%)		Bacterial STIs & Hepatitis (6.0%)		Bacterial STIs Only (9.6%)		Hepatitis Only (5.2%)			
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	χ^2	df
Age											32.874***	12
18-24 years	190	(38.5)	129	(35.9)	15	(23.1)	26	(24.8)	8	(14.3)		
25-34 years	127	(25.8)	127	(35.4)	20	(30.8)	40	(38.1)	23	(41.1)		
35-44 years	84	(17.0)	53	(14.8)	13	(20.0)	19	(18.1)	10	(17.9)		
45 years or older	92	(18.7)	50	(13.9)	17	(26.2)	20	(19.0)	15	(26.8)		
Race/Ethnicity											9.057	12
White (non-Hispanic)	220	(44.6)	148	(41.2)	26	(40.0)	50	(47.6)	29	(51.8)		
Black (non-Hispanic)	58	(11.8)	44	(12.3)	9	(13.8)	9	(8.6)	6	(10.7)		
Latino/Hispanic	129	(26.2)	110	(30.6)	15	(23.1)	29	(27.6)	10	(17.9)		
Other/Multiple (non-Hispanic)	86	(17.4)	57	(15.9)	15	(23.1)	17	(16.2)	11	(19.6)		
Education											16.753*	8
High school or less	58	(11.8)	34	(9.5)	3	(4.6)	3	(2.9)	3	(5.4)		
Some college/ Associate's	186	(37.7)	160	(44.6)	27	(41.5)	37	(35.2)	25	(44.6)		
Bachelor's or higher	249	(50.5)	165	(46.0)	35	(53.8)	65	(61.9)	28	(50.0)		
Annual Income											17.182	12
Refuse to answer	43	(8.7)	35	(9.7)	5	(7.7)	5	(4.8)	5	(8.9)		
$0-$24,999	216	(43.8)	129	(35.9)	24	(36.9)	44	(41.9)	19	(33.9)		
$25,000-$49,999	128	(26.0)	113	(31.5)	14	(21.5)	25	(23.8)	14	(25.0)		
$50,000 or more	106	(21.5)	82	(22.8)	22	(33.8)	31	(29.5)	18	(32.1)		

Residence											10.630*	4
Does not live in a city	254	(51.5)	174	(48.5)	25	(38.5)	38	(36.2)	28	(50.0)		
Lives in a city	239	(48.5)	185	(51.5)	40	(61.5)	67	(63.8)	28	(50.0)		
Sexual Orientation											1.488	4
Gay-identified	414	(84.0)	302	(84.1)	56	(86.2)	89	(84.8)	44	(78.6)		
Not gay-identified	79	(16.0)	57	(15.9)	9	(13.8)	16	(15.2)	12	(21.4)		
Outness											15.688**	4
Out to half or less	158	(32.0)	75	(20.9)	15	(23.1)	23	(21.9)	18	(32.1)		
Out to most or all	335	(68.0)	284	(79.1)	50	(76.9)	82	(78.1)	789	(73.2)		
HIV Status											53.203***	8
HIV+	32	(6.5)	43	(12.0)	12	(18.5)	12	(11.4)	9	(16.1)		
HIV-	353	(71.6)	292	(81.3)	49	(75.4)	83	(79.0)	42	(75.0)		
Unsure	108	(21.9)	24	(6.7)	4	(6.2)	10	(9.5)	5	(8.9)		
Sexual Partners (90 Days)											30.691***	8
None	98	(19.9)	37	(10.3)	4	(6.2)	8	(7.6)	12	(21.4)		
Primary only	117	(23.7)	86	(24.0)	10	(15.4)	24	(22.9)	15	(26.8)		
Casual (1+)	278	(56.4)	236	(65.7)	51	(78.5)	73	(69.5)	29	(51.8)		
Illegal Drug Use											5.268	4
No	457	(92.7)	319	(88.9)	57	(87.7)	98	(93.3)	51	(91.1)		
Yes	36	(7.3)	40	(11.1)	8	(12.3)	7	(6.7)	5	(8.9)		

*p<.05, **p<.01, ***p<.001

Note. In the above groups, the label *bacterial STIs* refers to syphilis, chlamydia, and gonorrhea, while *hepatitis* refers to both hepatitis A and hepatitis B. *All STIs* refers to syphilis, chlamydia, gonorrhea, hepatitis A, hepatitis B, herpes simplex virus, and human papilloma virus.

Table 20. Adjusted multinomial logistic regression models predicting STI testing latent class (N=1,078).

	Latent Class							
	All STIs (vs. *no STIs*)		**Bacterial STIs & hepatitis** (vs. *no STIs*)		**Bacterial STIs Only** (vs. *no STIs*)		**Hepatitis Only** (vs. *no STIs*)	
	OR	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**
Age								
18-24 years	1.42	(0.89, 2.26)	0.53	(0.23, 1.22)	0.85	(0.42, 1.70)	**0.29**	**(0.11, 0.76)**
25-34 years	**2.18**	**(1.39, 3.42)**	1.08	(0.52, 2.26)	1.65	(0.88, 3.07)	1.37	(0.66, 2.86)
35-44 years	1.37	(0.83, 2.28)	1.01	(0.45, 2.26)	1.15	(0.57, 2.34)	0.89	(0.38, 2.13)
45 years or older	Ref.		Ref.		Ref.		Ref.	
Education								
High school or less	1.22	(0.72, 2.06)	0.73	(0.20, 2.62)	0.33	(0.10, 1.15)	1.02	(0.28, 3.71)
Some college	**1.45**	**(1.05, 2.01)**	1.44	(0.80, 2.58)	0.99	(0.60, 1.61)	1.74	(0.95, 3.18)
Bachelor's or higher	Ref.		Ref.		Ref.		Ref.	
Residence								
Does not live in a city	Ref.		Ref.		Ref.		Ref.	
Lives in a city	1.10	(0.82, 1.46)	1.58	(0.92, 2.73)	**1.69**	**(1.08, 2.65)**	1.02	(0.58, 1.79)
Outness								
Out to half or less	Ref.		Ref.		Ref.		Ref.	
Out to most or all	**1.65**	**(1.18, 2.29)**	1.37	(0.73, 2.55)	1.46	(0.87, 2.44)	0.87	(0.48, 1.60)
HIV Status								
HIV+	**1.78**	**(1.06, 2.97)**	2.01	(0.92, 4.383)	1.40	(0.67, 2.93)	1.98	(0.85, 4.60)
HIV-	Ref.		Ref.		Ref.		Ref.	
Unsure	**0.26**	**(0.16, 0.42)**	**0.27**	**(0.09, 0.77)**	**0.42**	**(0.21, 0.85)**	0.41	(0.16, 1.07)
Sexual Partners (90 Days)								
None	Ref.		Ref.		Ref.		Ref.	
Primary only	**1.66**	**(1.02, 2.70)**	1.81	(0.55, 6.03)	2.06	(0.88, 4.84)	0.96	(0.42, 2.18)
Casual (1+)	**2.19**	**(1.42, 3.37)**	**4.45**	**(1.55, 12.79)**	**3.07**	**(1.41, 6.67)**	0.89	(0.43, 1.84)

Note. Reported odds ratios are for each class compared to the *no STIs* class. *Note*. In the above groups, the label *bacterial STIs* refers to syphilis, chlamydia, and gonorrhea, while *hepatitis* refers to both hepatitis A and hepatitis B. *All STIs* refers to syphilis, chlamydia, gonorrhea, hepatitis A, hepatitis B, herpes simplex virus, and human papilloma virus. Confidence intervals that do not include 1.00 have been bolded for ease of interpretation.

7. Conclusions

7.1. Overview

The primary aim of this dissertation was to examine clustering and covariates of STI testing behaviors in an online sample of MSM. The Internet-based nature of the study led to two additional aims: evaluation of a protocol to improve sample validity and examination of the test-retest reliability of study measures. In the following sections, conclusions from each manuscript will be reviewed. Following that, general findings across the three papers and their implications for public health practice will be discussed.

7.2. Conclusions from Manuscript 1

Manuscript 1 demonstrated that protocols to detect invalid submissions can identify sizeable proportions of an Internet-based sample as invalid. In our study, 10% were removed from analysis due to suspicious responses and indicators of repeat participation. The necessity of the protocols was also reaffirmed, since sample composition and HIV testing, an important variable in the field of HIV research, differed between study samples.

Debates over offering incentives and collecting IP addresses in Internet-based research remain unresolved. Two key findings are highlighted. First, suggestions that eliminating payment reduces invalid participation were not supported; submissions in which individuals requested no payment had greater odds of being invalid than those who requested checks. While this is logical since checks are a more identifiable form of payment due to the need for a name and mailing address, it suggests that payment is not the only motivator of invalid submissions.

Second, variables derived from IP address were found to be most useful in detecting invalid submissions compared to other aspects of the de-duplication and cross-validation protocol. Although this does not answer the question of whether it is ethical to collect IP addresses or whether IP addresses are sensitive information, their utility in improving the data integrity of online studies is clear.

7.3. Conclusions from Manuscript 2

Manuscript 2 was one of the first studies of test-retest reliability of sexual behavior and HIV/STI variables conducted on data collected using Internet-based methods. In general, the reliability of key items was substantial (0.71-0.80) to almost perfect (0.81-1.00). Relative frequency items, in particular, had almost perfect reliability. Number of sexual partners were also substantial or almost perfect. However, partner-specific reports were only fairly (0.31-0.40) to moderately (0.41-0.60) reliable.

Tasks that required more precision, such as reporting dates, did not function as well as enumeration items, and the reliability of counts of sexual partners was associated with having some higher education but no degree and being HIV-positive, although there were no significant predictors of inconsistent reporting of total male partners.

7.4. Conclusions from Manuscript 3

A latent class analysis of STI testing behaviors indicated a latent variable of STI testing behavior with five testing classes: *no STIs*, *all STIs* (e.g., all STIs asked in the survey), *bacterial STIs and hepatitis*, *bacterial STIs only*, and *hepatitis only*. Across these classes, one can infer that approximately half of the study sample (all those tested for bacterial STIs) met at least some of the CDC's primary recommendation, which is for MSM to be tested at least annually for syphilis, chlamydia, and gonorrhea.[2]

7.5. Overall conclusions

First, an extension to existing protocols for ensuring sample validity was shown to be useful in identifying invalid submissions. Related to this, support for collecting IP addresses as a method of pairing survey responses without identifying data was also found, while no evidence was found to argue against using financial incentives, since at least a subset of invalid submissions had greater odds of selecting no payment. Second, in one of the first studies of its kind, test-retest reliability was computed for Internet-based versions common measures used in HIV and STI research. The poor performance of partner-specific data was also described, which may serve as a guide for researchers contemplating online research methods for detailed data on sexual behavior; other approaches may be better suited to their research questions. Finally, it was discovered that STI testing behaviors can cluster among MSM recruited online, and that the largest group was those who had not been tested for STIs in the year prior to the survey.

Internet samples are subject to threats to validity that offline samples are not as prone to, and, prior to Manuscript 2, it was not known how stable estimates derived from Internet samples were over time. When looking at the results of these studies, we see that measurement properties are similar to those observed in offline studies but that STI testing rates are higher among the sample recruited for the SEM Main Study than those seen in offline studies of MSM.[66] With the validated sample and substantial or almost perfect reliability, plus the fact that that social desirability was unrelated to inconsistent reporting, we can be more confident in the finding that half of men recruited using the methods described are tested according to the recommendations for MSM in the US and half are not. To improve testing among this population, researchers might consider using the gaps identified, such as the lower odds of testing among individuals who are not out about their sexuality, to target subsets of Internet-using MSM with Internet-mediated STI screening methods, such as mail-in kits.

The structure of the current analyses may be useful for researchers who wish to use Internet-based samples for epidemiological studies. Validating and reporting rates of invalid submissions among study samples and, when possible, examining measurement properties can increase credibility for the validity of inferences from Internet-based survey data. Future research regarding ways to improve the detection of invalid submissions, direct measurement comparisons between online and offline survey items, and ways to improve STI testing among this sample is recommended.

References

1. Workowski K, Berman S. Sexually transmitted diseases treatment guidelines, 2010. *MMWR Recomm Rep.* 2010;59(RR-12):1.

2. Centers for Disease Control and Prevention. *Sexually transmitted disease surveillance, 2010.* Atlanta, GA: U.S. Department of Health and Human Services;2011.

3. Mayo Clinic. Sexually transmitted diseases (STDs): Definition. 2012; http://www.mayoclinic.com/health/sexually-transmitted-diseases-stds/DS01123. Accessed Aug 14, 2012.

4. Young RM, Meyer IH. The trouble with "MSM" and "WSW": Erasure of the sexual-minority person in public health discourse. *Am J Public Health.* 2005;95(7):1144-1149.

5. Savin-Williams RC. How many gays are there? It depends. *Nebr Symp Motiv*. 2009;54:5-41.

6. Centers for Disease Control and Prevention. *HIV surveillance report, 2010.* Atlanta, GA: U.S. Department of Health and Human Services;2012.

7. Fleming DT, Wasserheit JN. From epidemiological synergy to public health policy and practice: The contribution of other sexually transmitted diseases to sexual transmission of HIV infection. *Sex Transm Infect.* 1999;75(1):3-17.

8. Rieg G, Butler DM, Smith DM, Daar ES. Seminal plasma HIV levels in men with asymptomatic sexually transmitted infections. *Int J STD AIDS.* 2010;21(3):207-208.

9. Centers for Disease Control and Prevention. Basic information about HIV and AIDS. 2012; http://www.cdc.gov/hiv/topics/basic/index.htm. Accessed July 14, 2013.

10. Centers for Disease Control and Prevention. Incorporating HIV prevention into the medical care of persons living with HIV: Recommendations of CDC, the Health Resources and Services Administration, the National Institutes of Health, and the HIV medicine association of the Infectious Diseases Society of America. *MMWR Recomm Rep.* 2003;52.

11. Centers for Disease Control and Prevention. *Genital herpes - CDC fact sheet.* Atlanta, GA: US Department of Health & Human Services,;2013.

12. Corey L, Wald A, Patel R, et al. Once-daily Valacyclovir to reduce the risk of transmission of genital herpes. *N Engl J Med.* 2004;350(1):11-20.

13. Centers for Disease Control and Prevention. *Syphilis - CDC fact sheet.* Atlanta, GA: US Department of Health and Human Services;2013.

14. Symptomatic early neurosyphilis among HIV-positive men who have sex with men--four cities, United States, January 2002-June 2004. *MMWR Morb Mortal Wkly Rep.* 2007;56(25):625-628.

15. Matthews GV, Hellard M, Kaldor J, Lloyd A, Dore GJ. Further evidence of HCV sexual transmission among HIV-positive men who have sex with men: Response to Danta et al. *AIDS.* 2007;21(15):2112-2113.

16. Centers for Disease Control and Prevention. *Chlamydia - CDC fact sheet.* Atlanta, GA: US Department of Health and Human Services;2013.

17. Centers for Disease Control and Prevention. *Gonorrhea - CDC fact sheet.* Atlanta, GA: US Department of Health and Human Services;2013.

18. Centers for Disease Control and Prevention. *Viral hepatitis surveillance -- United States, 2010.* Atlanta, GA: US Department of Health & Human Services;2010.

19. Prevention of hepatitis A through active or passive immunization: Recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep.* 1999;48(RR-12):1-37.

20. Mast EE, Margolis HS, Fiore AE, et al. A comprehensive immunization strategy to eliminate transmission of hepatitis B virus infection in the United States: Recommendations of the Advisory Committee on Immunization Practices (ACIP) part i: Immunization of infants, children, and adolescents. *MMWR Recomm Rep.* 2005;54(RR-16):1-31.

21. Mast EE, Weinbaum CM, Fiore AE, et al. A comprehensive immunization strategy to eliminate transmission of hepatitis B virus infection in the United States:

Recommendations of the Advisory Committee on Immunization Practices (ACIP) part II: Immunization of adults. *MMWR Recomm Rep.* 2006;55(RR-16):1-33.

22. Weinbaum CM, Williams I, Mast EE, et al. Recommendations for identification and public health management of persons with chronic hepatitis B virus infection. *MMWR Recomm Rep.* 2008;57(RR-8):1-20.

23. Kalichman SC. Prevalence of sexually transmitted co-infections in people living with HIV/AIDS: Systematic review with implications for using HIV treatments for prevention. *Sex Transm Infect.* 2011;87(3):183-190.

24. Stamm WE, Handsfield HH, Rompalo AM, Ashley RL, Roberts PL, Corey L. The association between genital ulcer disease and acquisition of HIV infection in homosexual men. *JAMA.* 1988;260(10):1429-1433.

25. Johns DR, Tierney M, Felsenstein D. Alteration in the natural history of neurosyphilis by concurrent infection with the human immunodeficiency virus. *New Engl J Med.* 1987;316(25):1569-1572.

26. Hall HI, Hughes D, Dean HD, Mermin JH, Fenton KA. HIV infection - United States, 2005 and 2008. *MMWR Surveill Summ.* 2011;60 Suppl:87-89.

27. Gallagher KM, Sullivan PS, Lansky A, Onorato IM. Behavioral surveillance among people at risk for HIV infection in the US: The National HIV Behavioral Surveillance System. *Public Health Rep.* 2007;122(Suppl 1):32-38.

28. Summary of notifiable diseases--United States, 2010. *MMWR Morb Mortal Wkly Rep.* 2012;59(53):1-111.

29. Council of State and Territorial Epidemiologists. *List of nationally notifiable conditions;*2009.

30. Rietmeijer CA, Donnelly J, Bernstein KT, et al. Here comes the SSuN: Early experiences with the STD Surveillance Network. *Public Health Rep.* 2009;124(Suppl 2):72.

31. Hall HI, Song R, Rhodes P, et al. Estimation of HIV incidence in the United States. *JAMA.* 2008;300(5):520-529.

32. Heffelfinger JD, Swint EB, Berman SM, Weinstock HS. Trends in primary and secondary syphilis among men who have sex with men in the United States. *Am J Public Health.* 2007;97(6):1076-1083.

33. Xu F, Sternberg M, Markowitz L. Men who have sex with men in the United States: Demographic and behavioral characteristics and prevalence of HIV and HSV-2 infection: Results from National Health and Nutrition Examination Survey, 2001-2006. *Sex Transm Dis.* 2010;37(6):399.

34. Billy JO, Tanfer K, Grady WR, Klepinger DH. The sexual behavior of men in the United States. *Fam Plann Perspect.* 1993;25(2):52-60.

35. Chandra A, Mosher WD, Copen C, Sionean C. Sexual behavior, sexual attraction, and sexual identity in the United States: Data from the 2006-2008 National Survey of Family Growth. *Natl Health Stat Report.* 2011(36):1-36.

36. Purcell DW, Johnson CH, Lansky A, et al. Estimating the population size of men who have sex with men in the United States to obtain HIV and syphilis rates. *Open AIDS Journal*. 2012;6(1):98-107.

37. Purcell DW, Johnson CV, Lansky A, et al. Calculating HIV and syphilis rates for risk groups: Estimating the national population size of men who have sex with men. *2010 National STD Prevention Conference*. Atlanta, GA2010.

38. Campsmith ML, Rhodes PH, Hall HI, Green TA. Undiagnosed HIV prevalence among adults and adolescents in the United States at the end of 2006. *J Aquir Immune Defic Syndr.* 2010;53(5):619.

39. Prevalence and awareness of HIV infection among men who have sex with men --- 21 cities, United States, 2008. *MMWR Morb Mortal Wkly Rep.* 2010;59(37):1201-1207.

40. Brewer DD, Golden MR, Handsfield HH. Unsafe sexual behavior and correlates of risk in a probability sample of men who have sex with men in the era of highly active antiretroviral therapy. *Sex Transm Dis.* 2006;33(4):250-255.

41. Buchbinder SP, Vittinghoff E, Heagerty PJ, et al. Sexual risk, nitrite inhalant use, and lack of circumcision associated with HIV seroconversion in men who have sex with men in the United States. *J Acquir Immune Defic Syndr.* 2005;39(1):82-89.

42. Vittinghoff E, Padian NS. Attributable risk of exposures associated with sexually transmitted disease. *J Infect Dis.* 1996;174(Supplement 2):S182.

43. Vittinghoff E, Douglas J, Judson F, McKirnan D, MacQueen K, Buchbinder SP. Per-contact risk of human immunodeficiency virus transmission between male sexual partners. *Am J Epidemiol.* 1999;150(3):306-311.

44. Varghese B, Maher JE, Peterman TA, Branson BM, Steketee RW. Reducing the risk of sexual HIV transmission: Quantifying the per-act risk for HIV on the basis of choice of partner, sex act, and condom use. *Sex Transm Dis.* 2002;29(1):38.

45. Finlayson TJ, Le B, Smith A, et al. HIV risk, prevention, and testing behaviors among men who have sex with men--National HIV Behavioral Surveillance System, 21 U.S. Cities, United States, 2008. *MMWR Surveill Summ.* 2011;60(14):1-34.

46. Bohl DD, Katz KA, Bernstein K, et al. Prevalence and correlates of herpes simplex virus type-2 infection among men who have sex with men, San Francisco, 2008. *Sex Transm Dis.* 2011;38(7):617-621.

47. Satterwhite CL, Joesoef MR, Datta SD, Weinstock H. Estimates of chlamydia trachomatis infections among men: United States. *Sex Transm Dis.* 2008;35(11):S3.

48. Marcus J, Bernstein K, Kohn R, Liska S, Philip S. Infections missed by urethral-only screening for chlamydia or gonorrhea detection among men who have sex with men. *Sex Transm Dis.* 2011;38(10):922-924.

49. Annan NT, Sullivan A, Nori A, et al. Rectal chlamydia—a reservoir of undiagnosed infection in men who have sex with men. *Sex Transm Infect.* 2009;85(3):176-179.

50. Katz MH, Hsu L, Wong E, Liska S, Anderson L, Janssen RS. Seroprevalence of and risk factors for hepatitis A infection among young homosexual and bisexual men. *J Infect Dis.* 1997;175(5):1225-1229.

51. Kalichman SC, Cherry C, White D, Jones Ml, Kalichman M. The Achilles' Heel of HIV treatment for prevention. *J Int Assoc Physicians AIDS Care.* 2011;10(6):365-372.

52. Renzi C, Douglas Jr JM, Foster M, et al. Herpes simplex virus type 2 infection as a risk factor for human immunodeficiency virus acquisition in men who have sex with men. *J Infect Dis.* 2003;187(1):19-25.

53. Fisher M, Pao D, Brown AE, et al. Determinants of HIV-1 transmission in men who have sex with men: A combined clinical, epidemiological and phylogenetic approach. *AIDS.* 2010;24(11):1739-1747.

54. Schwarcz S, Scheer S, McFarland W, et al. Prevalence of HIV infection and predictors of high-transmission sexual risk behaviors among men who have sex with men. *Am J Public Health.* 2007;97(6):1067-1075.

55. Hall HI, Byers RH, Ling Q, Espinoza L. Racial/ethnic and age disparities in HIV prevalence and disease progression among men who have sex with men in the United States. *Am J Public Health.* 2007;97(6):1060-1066.

56. Chen M, Rhodes PH, Hall IH, Kilmarx PH, Branson BM, Valleroy LA. Prevalence of undiagnosed HIV infection among persons aged ≥13 years — National HIV Surveillance System, United States, 2005-2008. *MMWR Surveill Summ.* 2012;61(2):57-64.

57. Prejean J, Song R, Hernandez A, et al. Estimated HIV incidence in the United States, 2006-2009. *PLoS One.* 2011;6(8):e17502.

58. Millett GA, Peterson JL, Flores SA, et al. Comparisons of disparities and risks of HIV infection in black and other men who have sex with men in Canada, UK, and USA: A meta-analysis. *Lancet.* 2012;380(9839):341-348.

59. MacKellar DA, Valleroy LA, Secura GM, et al. Unrecognized HIV infection, risk behaviors, and perceptions of risk among young men who have sex with men: Opportunities for advancing HIV prevention in the third decade of HIV/AIDS. *J Acquir Immune Defic Syndr.* 2005;38(5):603-614.

60. Williams DR. The health of men: Structured inequalities and opportunities. *Am J Public Health.* 2003;93(5):8.

61. Robertson MJ, Clark RA, Charlebois ED, et al. HIV seroprevalence among homeless and marginally housed adults in San Francisco. *Am J Public Health.* 2004;94(7):1207-1217.

62. Centers for Disease Control and Prevention. *HIV prevention through early detection and treatment of other sexually transmitted diseases -- United States recommendations of the Advisory Committee for HIV and STD Prevention.* Atlanta, GA: US Department of Health & Human Services;1998.

63. Parsons JT, Schrimshaw EW, Wolitski RJ, et al. Sexual harm reduction practices of HIV-positive gay and bisexual men: Serosorting, strategic positioning, and withdrawal before ejaculation. *AIDS.* 2005;19 Suppl 1:S13-25.

64. Koblin BA, Husnik MJ, Colfax G, et al. Risk factors for HIV infection among men who have sex with men. *AIDS.* 2006;20(5):731-739.

65. Guy R, Wand H, Wilson D, et al. Using population attributable risk to choose HIV prevention strategies in gay men. *BMC Public Health.* 2011;11(1):247-256.

66. Tai E, Sanchez T, Lansky A, Mahle K, Heffelfinger J, Workowski K. Self-reported syphilis and gonorrhoea testing among men who have sex with men: National HIV Behavioural Surveillance System, 2003-5. *Sex Transm Infect.* 2008;84(6):478-482.

67. Bull S, McFarlane M, Rietmeijer C. HIV and sexually transmitted infection risk behaviors among men seeking sex with men on-line. *Am J Public Health.* 2001;91(6):988-989.

68. Previous HIV testing among adults and adolescents newly diagnosed with HIV infection - National HIV Surveillance System, 18 jurisdictions, United States, 2006-2009. *MMWR Morb Mortal Wkly Rep.* 2012;61:441-445.

69. Wall K, Khosropour C, Sullivan P. Offering of HIV screening to men who have sex with men by their health care providers and associated factors. *J Int Assoc Physicians AIDS Care.* 2010;9(5):284.

70. Pathela P, Hajat A, Schillinger J, Blank S, Sell R, Mostashari F. Discordance between sexual behavior and self-reported sexual identity: A population-based survey of New York City men. *Ann Intern Med.* 2006;145(6):416-425.

71. Stupiansky NW, Rosenberger JG, Schick V, Herbenick D, Novak DS, Reece M. Factors associated with sexually transmitted infection testing among men who utilize an Internet-based men who have sex with men community. *AIDS Patient Care STDS.* 2010;24(11):713-717.

72. Guy R, Goller JL, Spelman T, et al. Does the frequency of HIV and STI testing among men who have sex with men in primary care adhere with Australian guidelines? *Sex Transm Infect.* 2010;86(5):371-376.

73. Marks G, Crepaz N, Senterfitt JW, Janssen RS. Meta-analysis of high-risk sexual behavior in persons aware and unaware they are infected with HIV in the United States: Implications for HIV prevention programs. *J Aquir Immune Defic Syndr.* 2005;39(4):446-453.

74. Grant RM, Lama JR, Anderson PL, et al. Preexposure chemoprophylaxis for HIV prevention in men who have sex with men. *N Engl J Med.* 2010;363(27):2587-2599.

75. Krakower DS, Mimiaga MJ, Rosenberger JG, et al. Limited awareness and low immediate uptake of pre-exposure prophylaxis among men who have sex with men using an Internet social networking site. *PLoS One.* 2012;7(3):e33119.

76. Volk JE, Liu A, Vittinghoff E, et al. Sexual frequency and planning among at-risk men who have sex with men (MSM) in the US: Implications for event-based intermittent pre-exposure prophylaxis (iPrEP). *J Acquir Immune Defic Syndr.* 2012.

77. Benotsch EG, Kalichman S, Cage M. Men who have met sex partners via the Internet: Prevalence, predictors, and implications for HIV prevention. *Arch Sex Behav*. 2002;31(2):177-183.

78. Bolding G. Gay men who look for sex on the Internet: Is there more HIV/STI risk with online partners? *AIDS.* 2005;19(9):961-968.

79. Grov C, Hirshfield S, Remien RH, Humberstone M, Chiasson MA. Exploring the venue's role in risky sexual behavior among gay and bisexual men: An event-level analysis from a national online survey in the US. *Arch Sex Behav.* 2011:1-12.

80. Rhodes SD, DiClemente RJ, Cecil H, Hergenrather KC, Yee LJ. Risk among men who have sex with men in the United States: A comparison of an Internet sample and a conventional outreach sample. *AIDS Educ Prev.* 2002;14(1):41-50.

81. Klausner J, Wolf W, Fischer-Ponce L, Zolt I, Katz M. Tracing a syphilis outbreak through cyberspace. *JAMA.* 2000;284(4):447-449.

82. Chiasson MA, Hirshfield S, Remien RH, Humberstone M, Wong T, Wolitski RJ. A comparison of on-line and off-line sexual risk in men who have sex with men: An event-based on-line survey. *J Aquir Immune Defic Syndr.* 2007;44(2):235-243.

83. Mettey A, Crosby R, DiClemente RJ, Holtgrave DR. Associations between internet sex seeking and STI associated risk behaviours among men who have sex with men. *Sex Transm Infect.* 2003;79(6):466-468.

84. Al-Tayyib AA, McFarlane M, Kachur R, Rietmeijer CA. Finding sex partners on the Internet: What is the risk for sexually transmitted infections? *Sex Transm Infect.* 2009;85(3):216-220.

85. Jenness SM, Neaigus A, Hagan H, Wendel T, Gelpi-Acosta C, Murrill CS. Reconsidering the Internet as an HIV/STD risk for men who have sex with men. *AIDS Behav.* 2010;14(6):1353-1361.

86. Mustanski B. Are sexual partners met online associated with HIV/STI risk behaviours? Retrospective and daily diary data in conflict. *AIDS Care.* 2007;19(6):822-827.

87. Ross MW, Rosser BRS, Coleman E, Mazin R. Misrepresentation on the Internet and in real life about sex and HIV: A study of Latino men who have sex with men. *Cult Health Sex.* 2006;8(02):133-144.

88. Wilkerson JM, Smolenski DJ, Horvath KJ, Danilenko GP, Rosser BRS. Online and offline sexual health-seeking patterns of HIV-negative men who have sex with men. *AIDS Behav.* 2010;14(6):1362-1370.

89. Benotsch EG, Kalichman S, Weinhardt LS. HIV-AIDS patients' evaluation of health information on the Internet: The digital divide and vulnerability to fraudulent claims. *J Consult Clin Psychol.* 2004;72(6):1004-1011.

90. Horvath KJ, Harwood E, Courtenay-Quirk C, et al. Online resources for persons recently diagnosed with HIV/AIDS: An analysis of HIV-related webpages. *J Health Commun.* 2012;15(5):516-531.

91. Sharma A, Sullivan PS, Khosropour CM. Willingness to take a free home HIV test and associated factors among Internet-using men who have sex with men. *J Int Assoc Physicians AIDS Care.* 2011;10(6):357-364.

92. Chai SJ, Aumakhan B, Barnes M, et al. Internet-based screening for sexually transmitted infections to reach nonclinic populations in the community: Risk factors for infection in men. *Sex Transm Dis.* 2010;37(12):756-763.

93. Mimiaga MJ, Fair AD, Tetu AM, et al. Acceptability of an Internet-based partner notification system for sexually transmitted infection exposure among men who have sex with men. *Am J Public Health.* 2008;98(6):1009-1011.

94. Rosser B, Gurak L, Horvath KJ, Michael Oakes J, Konstan J, Danilenko GP. The challenges of ensuring participant consent in Internet-based sex studies: A case study of the Men's INTernet Sex (MINTS-I and II) studies. *J Comput-Mediat Commun.* 2009;14(3):602-626.

95. van Gelder MMHJ, Bretveld RW, Roeleveld N. Web-based questionnaires: The future in epidemiology? *Am J Epidemiol.* 2010;172(11):1292.

96. Bowen A. Internet sexuality research with rural men who have sex with men: Can we recruit and retain them? *J Sex Res.* 2005;42(4):317-323.

97. Rosser BRS, Konstan J, Gurak L, et al. Recruiting high risk Latino MSM for Internet prevention research Paper presented at: STD/HIV Prevention and the Internet Conference; August 25-27, 2003; Washington, DC

98. Salyers Bull S, Lloyd L, Rietmeijer C, McFarlane M. Recruitment and retention of an online sample for an HIV prevention intervention targeting men who have sex with men: The Smart Sex Quest Project. *AIDS Care.* 2004;16(8):931-943.

99. Bockting WO, Miner M, Robinson BE, et al. Use of the Internet to reach the U.S. Transgender population for HIV/STD prevention research. Paper presented at: STD/HIV Prevention and the Internet Conference; August 25-27, 2003; Washington, DC.

100. Rosser BS. Capturing the social demographics of hidden sexual minorities: An internet study of the transgender population in the United States. *Sex Res Soc Policy.* 2007;4(2):50-64.

101. Duncan D. The general well-being of recreational drug users: A survey on the WWW. *The International journal on drug policy.* 2000;11(5):315-323.

102. Nicholson T. A survey of adult recreational drug use via the World Wide Web: The Drugnet Study. *J Psychoactive Drugs.* 1999;31(4):415-422.

103. Pequegnat W, Rosser BRS, Bowen AM, et al. Conducting Internet-based HIV/STD prevention survey research: Considerations in design and evaluation. *AIDS Behav.* 2007;11(4):505-521.

104. Skitka LJ, Sargis EG. The Internet as psychological laboratory. *Annu Rev Psychol.* 2006.

105. Bowen AM, Daniel CM, Williams ML, Baird GL. Identifying multiple submissions in Internet research: Preserving data integrity. *AIDS Behav.* 2008;12(6):964-973.

106. Gosling SD, Vazire S, Srivastava S, John OP. Should we trust web-based studies? A comparative analysis of six preconceptions about Internet questionnaires. *Am Psychol.* 2004;59(2):93-104.

107. Konstan JA, Simon Rosser B, Ross MW, Stanton J, Edwards WM. The story of subject naught: A cautionary but optimistic tale of Internet survey research. *J Comput-Mediat Commun.* 2005;10(2):article 11.

108. Birnbaum MH. Human research and data collection via the Internet. *Annu Rev Psychol.* 2004;55:803-832.

109. Rosser BRS, Miner MH, Bockting WO, et al. HIV risk and the Internet: Results of the Men's INTernet Study (MINTS). *AIDS & Behavior.* 2009;13(4):746-756.

110. Bauermeister JA, Pingel E, Zimmerman M, Couper M, Carballo-Diéguez A, Strecher VJ. Data quality in HIV/AIDS web-based surveys: Handling invalid and suspicious data. *Field Method.* 2012;000(00):1-20.

111. Konstan JA, Rosser BRS, Horvath KJ, Gurak L, Edwards W. Protecting subject data privacy in Internet-based HIV/STI prevention survey research. In: Conrad FG, Schober MF, eds. *Envisioning the survey interview of the future*. New York: John Wiley & Sons; 2008.

112. Nosen E, Woody SR. Online surveys: Effect of research design decision on rates of invalid participation and data credibility. *Grad Student J Psychol.* 2008;10:3-14.

113. Chiasson MA, Parsons JT, Tesoriero JM, Carballo-Dieguez A, Hirshfield S, Remien RH. HIV behavioral research online. *J Urban Health.* 2006;83(1):73-85.

114. Nosek BA, Banaji MR, Greenwald AG. E-research: Ethics, security, design, and control in psychological research on the Internet. *Journal of Social Issues.* 2002;58(1):161-176.

115. Im E-O, Chee W. Issues in protection of human subjects in Internet research. *Nurs Res.* 2002;51(4):266.

116. Rosser BRS. Online HIV prevention and the Men's INTernet Study-II (MINTS-II): A glimpse into the world of designing highly-interactive sexual health Internet-based interventions. Paper presented at: World Congress for Sexology; July 10-15, 2005; Montreal, Canada.

117. StataCorp. *Stata statistical software: Release 12.* College Station, TX: StataCorp LP;2011.

118. Mustanski B. Moderating effects of age on the alcohol and sexual risk taking association: An online daily diary study of men who have sex with men. *AIDS Behav.* 2008;12(1):118-126.

119. Mustanski B. The influence of state and trait affect on HIV risk behaviors: A daily diary study of MSM. *Health Psychol.* 2007;26(5):618.

120. Mustanski B, Lyons T, Garcia SC. Internet use and sexual health of young men who have sex with men: A mixed-methods study. *Arch Sex Behav.* 2011;40(2):289-300.

121. Mustanski BS. Getting wired: Exploiting the Internet for the collection of valid sexuality data. *J Sex Res.* 2001;38(4):292-301.

122. Bowen AM, Horvath KJ, Williams ML. A randomized control trial of Internet-delivered HIV prevention targeting rural MSM. *Health Educ Res.* 2007;22(1):120-127.

123. Coleman E, Horvath KJ, Miner M, Ross MW, B.R.S. R, MINTS. Compulsive sexual behavior and risk for unsafe sex in online liaisons for men who use the Internet to seek sex with men: Results of the Men's INTernet Sex (MINTS-II) Study. Paper presented at: XVI International AIDS Conference; August 17, 2006; Toronto, Canada.

124. Coleman E, Horvath KJ, Miner MH, et al. Compulsive sexual behavior and risk for unsafe sex among men who use the Internet to seek sex with men. *Arch Sex Behav.* 2010;39:1045-1053.

125. Hooper S, Rosser BRS, Horvath KJ, Oakes JM, Danilenko G, Men's INTernet Sex II (MINTS-II) Team. An online needs assessment of a virtual community: What men who use the Internet to seek sex with men want in Internet-based HIV prevention. *AIDS Behav*. 2008;12:867-875.

126. Hooper S, Rosser BRS, Horvath KJ, Remafedi G, Naumann C, Men's INTernet Study II (MINTS-II) Team. An evidence-based approach to designing appropriate and effective Internet-based HIV prevention interventions: Results of the Men's INTernet Sex (MINTS-II) Study needs assessment. Paper presented at: XVI International AIDS Conference; August 17, 2006; Toronto, Canada.

127. Horvath KJ, Beadnell B, Bowen AM. A daily web diary of the sexual experiences of men who have sex with men: Comparisons with a retrospective recall survey. *AIDS Behav*. 2007;11(4):537-548.

128. Horvath KJ, Konstan J, Rosser BRS, MINTS. Online antecedents of sexual risk behavior among men who have sex with men. Paper presented at: XVI International AIDS Conference; August 17, 2006; Toronto, Canada.

129. Horvath KJ, Oakes JM, Rosser BRS. Sexual negotiation and HIV serodisclosure among men who have sex with men with their online and offline partners. *J Urban Health.* 2008;85(5):744-758.

130. Horvath KJ, Rosser BRS, Remafedi G. The sexual behavior of young Internet-using men who have sex with men. *Am J Public Health.* 2008;98:1059-1067.

131. Peterson JL, Oakes M, Horvath KJ, Rosser BRS. Sexual risk and Internet use among African American men who have sex with men. Paper presented at: Society for Community Research and Action, American Psychological Association, 2008; Pasadena, CA.

132. Rosser BRS, Oakes JM, Horvath KJ, Konstan JA, Danilenko GP, Peterson JL. HIV sexual risk behavior by men who use the Internet to seek sex with men: Results of the Men's INTernet Sex Study-II (MINTS-II). *AIDS Behav.* 2009;13(3):488-498.

133. Rosser BRS, Oakes JM, Konstan J, et al. Reducing HIV risk behavior of MSM through persuasive computing: Results of the Men's INTernet Study (MINTS-II). *AIDS.* 2010;24(13):2099-2107.

134. Rosser BRS, Oakes JM, Konstan J, et al. The effect of state-level homosexuality laws on alcohol use and HIV risk behavior on men who have sex with men: Results from the Structural INTerventions to lower STI/HIV (SILAS) Study. *submitted for publication.* 2011.

135. Rosser BRS, Wilkerson JM, Smolenski D, et al. The future of Internet-based HIV prevention: A report on key findings from the Men's INTernet Sex (MINTS-I, II) Studies. *AIDS Behav.* 2011;15(1):91-100.

136. Wilkerson JM, Iantaffi A, Smolenski DJ, et al. Consumption of sexually explicit media and sexual beliefs and behaviors among men who have sex with men. *submitted for publication.* 2012.

137. Riggle EDB, Rostosky SS, Reedy CS. Online surveys for BGLT research: Issues and techniques. *J Homosex.* 2005.

138. Turner CF, Ku L, Rogers SM, Lindberg LD, Pleck JH, Sonenstein FL. Adolescent sexual behavior, drug use, and violence: Increased reporting with computer survey technology. *Science.* 1998;280(5365):867-873.

139. Sanchez T, Smith A, Denson D, Dinenno E, Lansky A. Developing a web-based HIV behavioral surveillance pilot project among men who have sex with men. *Open AIDS J.* 2012;6:224-231.

140. Schroder K, Carey M, Vanable P. Methodological challenges in research on sexual risk behavior: II. Accuracy of self-reports. *Ann Behav Med.* 2003;26(2):104-123.

141. Jaccard J, McDonald R, Wan CK, Dittus PJ, Quinlan S. The accuracy of self-reports of condom use and sexual behavior. *J Appl Soc Psychol.* 2002;32(9):1863-1905.

142. Saltzman SP, Stoddard AM, McCusker J, Moon MW, Mayer KH. Reliability of self-reported sexual behavior risk factors for HIV infection in homosexual men. *Public Health Rep.* 1987;102(6):692.

143. Downey L, Ryan R, Roffman R, Kulich M. How could I forget? Inaccurate memories of sexually intimate moments. *J Sex Res.* 1995;32(3):177-191.

144. Schrimshaw EW, Rosario M, Meyer-Bahlburg HF, Scharf-Matlick AA. Test-retest reliability of self-reported sexual behavior, sexual orientation, and psychosexual milestones among gay, lesbian, and bisexual youths. *Arch Sex Behav.* 2006;35(2):225-234.

145. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics.* 1977:159-174.

146. Nyitray AG, Harris RB, Abalos AT, Nielson CM, Papenfuss M, Giuliano AR. Test-retest reliability and predictors of unreliable reporting for a sexual behavior questionnaire for US men. *Arch Sex Behav.* 2010;39(6):1343-1352.

147. Miller ET, Neal DJ, Roberts LJ, et al. Test-retest reliability of alcohol measures: Is there a difference between Internet-based assessment and traditional methods? *Psychol Addict Behav.* 2002;16(1):56-63.

148. Khadjesari Z, Murray E, Kalaitzaki E, et al. Test–retest reliability of an online measure of past week alcohol consumption (the TOT-AL), and comparison with face-to-face interview. *Addict Behav.* 2009;34(4):337-342.

149. Callas PW, Solomon LJ, Hughes JR, Livingston AE. The influence of response mode on study results: Offering cigarette smokers a choice of postal or online completion of a survey. *J Med Internet Res.* 2010;12(4):e46.

150. Grey JA, Rosser BRS, Konstan J, Erickson DJ. Invalid entries in an online survey of men who have sex with men (MSM): Influence on estimates of sexual risk behavior and HIV/STI testing. 2013.

151. Williams ML, Freeman RC, Bowen AM, et al. A comparison of the reliability of self-reported drug use and sexual behaviors using computer-assisted versus face-to-face interviewing. *AIDS Educ Prev.* 2000;12(3):199-213.

152. Catania JA, Gibson DR, Chitwood DD, Coates TJ. Methodological problems in AIDS behavioral research: Influences on measurement error and participation bias in studies of sexual behavior. *Psychological bulletin.* 1990;108(3):339-362.

153. Catania JA, McDermott LJ, Pollack LM. Questionnaire response bias and face-to-face interview sample bias in sexuality research. 1986.

154. DiFranceisco W, McAuliffe TL, Sikkema KJ. Influences of survey instrument format and social desirability on the reliability of self-reported high risk sexual behavior. *AIDS Behav.* 1998;2(4):329-337.

155. Strahan R, Gerbasi KC. Short, homogeneous versions of the Marlowe-Crowne Social Desirability Scale. *J Clin Psychol.* 1972.

156. Crowne DP, Marlowe D. A new scale of social desirability independent of psychopathology. *J Consult Psychol.* 1960;24(4):349.

157. Catania JA, Gibson DR, Marin B, Coates TJ, Greenblatt RM. Response bias in assessing sexual behaviors relevant to HIV transmission. *Eval Program Plann.* 1990;13(1):19-29.

158. McLaws ML, Oldenburg B, Ross MW, Cooper DA. Sexual behaviour in AIDS-related research: Reliability and validity of recall and diary measures. *J Sex Res.* 1990;27(2):265-281.

159. Thompson CP, Mingay D. Estimating the frequency of everyday events. *Appl Cogn Psychol.* 1991.

160. Niccolai LM, Kershaw TS, Lewis JB, Cicchetti DV, Ethier KA, Ickovics JR. Data collection for sexually transmitted disease diagnoses: A comparison of self-report, medical record reviews, and state health department reports. *Ann Epidemiol.* 2005;15(3):236-242.

161. Sacktor N, McDermott MP, Marder K, et al. HIV-associated cognitive impairment before and after the advent of combination therapy. *J Neurovirol.* 2002;8(2):136-142.

162. Rhodes SD, DiClemente RJ, Yee LJ, Hergenrather KC. Correlates of hepatitis B vaccination in a high-risk population: An Internet sample. *Am J Med.* 2001;110(8):628-632.

163. Hoover KW, Butler M, Workowski K, et al. STD screening of HIV-infected MSM in HIV clinics. *Sex Transm Dis.* 2010;37(12):771-776.

164. Warren T, Gilbert L, Mark H. Availability of serologic and virologic testing for herpes simplex virus in the largest sexually transmitted disease clinics in the United States. *Sex Transm Dis.* 2011;38(4):267-269.

165. Montaño DE, Phillips WR, Kasprzyk D, Greek A. STD/HIV prevention practices among primary care clinicians: Risk assessment, prevention counseling, and testing. *Sex Transm Dis.* 2008;35(2):154-166.

166. Brackbill RM, Sternberg MR, Fishbein M. Where do people go for treatment of sexually transmitted diseases? *Fam Plann Perspect.* 1999;31(1):10-15.

167. St. Lawrence JS, Montaño DE, Kasprzyk D, Phillips WR, Armstrong K, Leichliter JS. STD screening, testing, case reporting, and clinical and partner notification practices: A national survey of US physicians. *Am J Public Health.* 2002;92(11):1784-1788.

168. Hoover KW, Butler M, Workowski KA, et al. Low rates of hepatitis screening and vaccination of HIV-infected MSM in HIV clinics. *Sex Transm Dis.* 2012;39(5):349.

169. McCutcheon AL. *Latent class analysis.* Vol 64: Sage Publications, Inc; 1987.

170. Raftery AE. Bayesian model selection in social research. *Sociological methodology*. 1995;25:111-164.

171. Akaike H. Factor analysis and AIC. *Psychometrika.* 1987;52(3):317-332.

172. Schwarz G. Estimating the dimension of a model. *Ann Stat.* 1978;6(2):461-464.

173. Collins LM, Lanza ST. *Latent class and latent transition analysis: With applications in the social, behavioral, and health sciences*. Hoboken, NJ: John Wiley & Sons, Inc.; 2010.

174. Collins LM, Fidler PL, Wugalter SE, Long JD. Goodness-of-fit testing for latent class models. *Multivariate Behavioral Research.* 1993;28(3):375-389.

175. SAS Institute Inc. *Sas version 9.3.* Cary, NC;2010.

176. Fiore AE, Wasley A, Bell BP. Prevention of hepatitis A through active or passive immunization. *Recommendations of the Advisory Committee on Immunization Practices (ACIP) MMRW.* 2006;55:1-23.

177. Mimiaga MJ, Helms DJ, Reisner SL, et al. Gonococcal, chlamydia, and syphilis infection positivity among MSM attending a large primary care clinic, Boston, 2003 to 2004. *Sex Transm Dis.* 2009;36(8):507-511.

178. Tucker JD, Bien CH, Peeling RW. Point-of-care testing for sexually transmitted infections: Recent advances and implications for disease control. *Current Opinion in Infectious Diseases.* 2013;26(1):73-79.

Appendix: Abbreviations and acronyms

AIDS	acquired immune deficiency syndrome
CDC	Centers for Disease Control and Prevention
GUD	genital ulcer disease
HAART	highly active antiretroviral therapy
HAV	hepatitis A virus
HBV	hepatitis B virus
HCV	hepatitis C virus
HIPS	HIV Intervention and Prevention Studies
HIV	human immunodeficiency virus
HPV	human papillomavirus
HSV-2	herpes simplex virus
ICC	intraclass correlation coefficient
IP	Internet protocol
MSM	men who have sex with men
NHBS	National HIV Behavioral Surveillance
NIH	National Institutes of Health
OR	odds ratio
PR	prevalence ratio
RR	rate ratio
SAQ	self-administered questionnaire
SEM	sexually explicit media
SSuN	STD Surveillance Network
TLFB	Timeline Follow Back
URL	uniform resource locator