



Determinants of HIV Incidence Disparities Among Young and Older Men Who Have Sex with Men in the United States

William L. Jeffries IV^{1,4} · Kevin M. Greene² · Gabriela Paz-Bailey¹ · Donna Hubbard McCree¹ · Lamont Scales¹ · Richard Dunville³ · Suzanne Whitmore¹

Published online: 9 April 2018

© This is a U.S. Government work and not under copyright protection in the US; foreign copyright protection may apply 2018

Abstract

This study sought to determine why young men who have sex with men (MSM) have higher HIV incidence rates than older MSM in the United States. We developed hypotheses that may explain this disparity. Data came from peer-reviewed studies published during 1996–2016. We compared young and older MSM with respect to behavioral, clinical, psychosocial, and structural factors that promote HIV vulnerability. Compared with older MSM, young MSM were more likely to have HIV-discordant condomless receptive intercourse. Young MSM also were more likely to have “any” sexually transmitted infection and gonorrhea. Among HIV-positive MSM, young MSM were less likely to be virally suppressed, use antiretroviral therapy, and be aware of their infection. Moreover, young MSM were more likely than older MSM to experience depression, poly-substance use, low income, decreased health care access, and early ages of sexual expression. These factors likely converge to exacerbate age-associated HIV incidence disparities among MSM.

Keywords HIV · Men who have sex with men (MSM) · Age · Youth · Disparities · Literature review · Behavioral · Psychosocial · Clinical · Structural

Resumen

Este estudio buscó determinar por qué los hombres jóvenes que tienen sexo con hombres (HSH) tienen tasas de incidencia de VIH más altas que los HSH mayores en los Estados Unidos. Desarrollamos hipótesis que pueden explicar esta disparidad. Los datos provienen de estudios revisados por pares publicados durante 1996–2016. Comparamos a HSH jóvenes con mayores con respecto a los factores conductuales o de comportamiento, clínicos, psicosociales y estructurales que promueven la vulnerabilidad al VIH. En comparación con los HSH mayores, los HSH jóvenes eran más propensos a tener relaciones sexuales VIH discordantes pasivas sin condón. Los HSH jóvenes también eran más propensos a tener “cualquier” infección de transmisión sexual y gonorrea. Entre los HSH VIH positivos, los HSH jóvenes tenían menos probabilidades de tener menos carga viral, usar terapia antirretroviral y estar al tanto de su infección. Además, los jóvenes HSH tenían más probabilidades que los HSH mayores de experimentar depresión, uso de varias sustancias, bajos ingresos, menor acceso a la atención médica y edades tempranas de expresión sexual. Es probable que estos factores converjan para exacerbar las disparidades en la incidencia del VIH entre los HSH.

Palabras Clave VIH · hombres que tienen sexo con hombres · edad · jóvenes · disparidades · revisión de literatura · conductual · psicosocial · clínico · estructural

✉ William L. Jeffries IV
wjeffries@cdc.gov

¹ Division of HIV/AIDS Prevention, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention, Centers for Disease Control and Prevention, 1600 Clifton Road NE, Atlanta, GA 30329, USA

² Office of Health Equity, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention, Centers for Disease

Control and Prevention, 1600 Clifton Road NE, Atlanta, GA 30329, USA

³ Division of Adolescent and School Health, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention, Centers for Disease Control and Prevention, 1600 Clifton Road NE, Atlanta, GA 30329, USA

⁴ Centers for Disease Control and Prevention, 1600 Clifton Road, MS E40, Atlanta, GA 30333, USA

Introduction

In the United States, young gay, bisexual, and other men who have sex with men (MSM) have substantially higher HIV incidence rates than older MSM. (Studies vary in their use of age to designate men as young or older. In this article, we consider MSM aged ≤ 29 years to be young and MSM aged ≥ 30 years to be older.) A recent multiracial study found that HIV incidence among MSM aged 18–24 years was 2.5 times that of older MSM [1]. Age-related incidence disparities are particularly concerning for black MSM. Researchers recently reported that HIV incidence among black MSM aged 18–30 years was 4.3 times that of black MSM aged ≥ 31 years [2]. Such high incidence rates could result in most black MSM acquiring HIV infection by age 35 years [3]. Irrespective of age-related disparities among MSM, HIV incidence among young MSM of all races is high. A 21-city study reported a 2.9% incidence density among MSM aged 18–24 years [4], and another study reported a 24-month cumulative incidence rate of 7.3% among very young MSM (aged 16–20 years) [5]. Due to such high HIV incidence, MSM aged 13–29 years accounted for 48.5% of new HIV diagnoses among all MSM in 2016 [6]. Better understanding of the determinants of age-associated HIV incidence disparities might promote improved prevention efforts for all young MSM, especially black young MSM.

Researchers have identified some factors that contribute to these disparities. First, as HIV prevalence increases with age, HIV incidence decreases. This results in the pool of MSM who are HIV negative, but still at risk for HIV infection, being large among young MSM compared with older MSM [7]. Another potential explanation is that young MSM have an increased likelihood for condomless anal intercourse (CAI) [8], but studies have produced mixed results regarding age differences in CAI. Third, because of the elevated HIV prevalence among older MSM [9], young MSM are at high risk for acquiring HIV from older MSM due to some age-disassortative mixing in the sexual networks of MSM [10]. Although these explanations are invaluable, they focus solely on individual-level behaviors and sexual network characteristics. Contemporary epidemiologic studies emphasize the importance of also examining contextual factors that promote HIV infection [11]. Moreover, because MSM sub-groups that are at greatest risk for HIV do not always engage in greater levels of risk behaviors than other sub-groups, it is important to examine structural factors [12, 13].

Therefore, we sought to identify additional factors that might explain age-associated HIV incidence disparities among MSM. Social ecological theory informed our approach. This framework draws attention to behavioral,

clinical, psychosocial, and structural factors that promote health disparities [14]. Social ecological theory emphasizes that these types of factors are inextricably connected at different “levels” (e.g., individual and community) within social environments and collectively affect health [14].

Undoubtedly, behaviors such as CAI, multiple sex partners, and receptive anal intercourse (RAI) increase one’s risk for HIV acquisition, especially when these behaviors occur with known HIV-positive sex partners [2, 9, 15]. In the absence of knowing partners’ HIV statuses, having partners who have sex within high-prevalence sexual networks can also increase HIV infection risk. For example, the high background prevalence of HIV among older MSM contributes to high HIV incidence among young MSM [10, 16]. Clinical factors like STIs [17] and HIV infection unawareness [9]—which increases viral load among HIV-positive young MSM and, thereby, facilitates transmission to HIV-negative young MSM—also increase HIV risk. Relevant psychosocial factors include depression, which has been prospectively and independently associated with HIV acquisition [15]; identified as a syndemic factor that increases risk for HIV acquisition over time [18]; and associated with HIV-discordant sex among MSM [19]. Additionally, substance use reduces sexual inhibitions and produces biophysiological changes (e.g., vasodilation) that increase HIV susceptibility [20]. Stimulants (e.g., amphetamines) [15, 20, 21], injection drug use, poppers [21], and polysubstance use [21] are known predictors of HIV acquisition.

A key aspect of social ecological theory is its emphasis on the underlying structural factors that shape the inequitable distribution of disease across populations [14]. Structural factors associated with incident HIV infection among MSM include low socioeconomic status (i.e., education and income) [1, 4] and lack of health insurance [1]. These factors limit access to health care and HIV testing, which prevent ongoing HIV transmission [22]. A structural factor especially pertinent to young MSM is the increasing visibility of homosexuality, which may be inclining MSM to express their sexuality at younger ages. Early sexual debut results in young MSM initiating sex when they are less informed about safer sex decision making than older MSM [23]. If contemporary young MSM have begun to express their sexuality at younger ages than did young MSM in the past, then contemporary young MSM have increasingly become exposed to HIV when they are developmentally vulnerable and are, therefore, at increased risk for HIV infection [11].

Given these factors, we sought to better explain age-associated HIV incidence disparities among MSM. We hypothesized that if young MSM experience more vulnerability than older MSM along these factors, then these factors may help to explain their elevated HIV incidence rates. Our hypotheses were as follows:

Behavioral

1. Young MSM are more likely than older MSM to engage in sexual risk behavior;
2. Young MSM are more likely than older MSM to have HIV-positive sex partners;

Clinical

3. Young MSM are more likely than older MSM to have STIs;
4. HIV-positive young MSM are more likely than HIV-positive older MSM to be viremic;

Psychosocial

5. Young MSM are more likely than older MSM to have depression;
6. Young MSM are more likely than older MSM to use substances;

Structural

7. Young MSM are more likely than older MSM to have low socioeconomic status;
8. Young MSM have less access to health care and HIV testing than older MSM; and
9. Young MSM have earlier ages of sexual expression than older MSM.

Methods

Search Strategy

During January–July 2016, we searched EMBASE, PsycINFO, PubMed, and Sociological Abstracts to acquire U.S. studies published during January 1996–July 2016 (Appendix in Table 2). In each database, we cross-referenced search terms for MSM (i.e., “men who have sex with men,” “MSM,” “gay,” “bisexual,” “gay and bisexual,” “sexual minority,” and “queer”) and HIV (i.e., “human immunodeficiency virus,” “HIV,” “risk behavior,” “infection,” “transmission,” “sexually transmitted disease,” “STD,” “sexually transmitted infection,” and “STI”). After acquiring studies, the 7 members of our research team, all of whom have academic and applied public health training, identified studies for inclusion. Team members recorded descriptive information for each study, including findings relevant for our review, on an abstraction form. The first author then validated all study information after conducting an independent review of the studies.

Inclusion Criteria

We established inclusion criteria to ensure that our review yielded data necessary for our study. All studies had to present data describing age’s association with factors related to at least 1 of our hypotheses. Consistent with the large volume of studies and surveillance reports that considered young MSM to be aged ≤ 29 years—and in consideration of the large number of HIV diagnoses that occur among MSM aged 20–24 and 25–29 years compared with older age groups [6]—we considered young MSM to be those who had not yet reached 30 years of age. We excluded studies containing only MSM aged ≤ 29 years. When multiple research teams analyzed the same data set that provided data for a hypothesis, we used only the most recent or most comprehensive analysis, unless study authors used different measures to assess outcomes. This strategy prevented us from including associations from 1 data set multiple times if associations were replicated across studies.

Analytic Approach

Millett et al.’s approach for explaining black-white HIV disparities among MSM guided our analysis [24]. This approach is useful in exploratory analyses that attempt to explain disparate HIV-related outcomes, and it can inform the subsequent development of meta-analyses that quantify disparities [13]. Additionally, understanding why 2 groups differ in their likelihoods of experiencing a health outcome (e.g., incident HIV infection) necessitates knowing if these groups differ in factors that are already known to contribute to that outcome [25]. Therefore, we considered studies that supported a hypothesis to be those in which young MSM were more likely than older MSM to exhibit characteristics of the hypothesis (e.g., younger age at sexual debut). We report findings from all studies that met inclusion criteria. Supportive studies reported statistically significant findings ($ps < .05$), 95% confidence intervals that excluded zero, or differences from a census (i.e., case surveillance data).

Because study authors differentially measured age (e.g., categorically vs. continuously) and assessed its association with outcomes, we summarized findings based on the degree to which age was generally associated with outcomes. However, we noted instances in which young MSM in distinct age categories had different likelihoods of behavioral, clinical, psychosocial, and structural factors. Because multivariable analyses can obscure associations that exist between variables [26], and because different studies use different multivariable models, we report results of studies’ bivariate findings except in a few instances in which studies only reported multivariable findings. To weigh the strength of evidence in support of hypotheses, we accounted for studies’

sample sizes, sample compositions, and designs (i.e., use of prospective analyses or probability-based data).

Results

Our search yielded 3132 studies, and 95 met inclusion criteria. We organized hypotheses with respect to their foci on primarily behavioral, clinical, psychosocial, and structural factors. Table 1 summarizes findings for hypotheses, or hypotheses' components, supported by published studies.

Behavioral Hypotheses

Hypothesis 1 Young MSM are more likely than older MSM to engage in sexual risk behavior.

Any CAI

A total of 33 studies examined “any” CAI. Eight found that young MSM were more likely than older MSM to have any CAI [27–34] (2 of these examined HIV-discordant CAI [33, 34]), 21 found no age-related association [23, 35–54] (4 of these examined HIV-discordant CAI [51–54]), and 4 found that young MSM were less likely to have CAI [55–58] (1 of these examined HIV-discordant CAI [58]).

Within studies, inconsistent findings sometimes occurred. Occasionally, within stratified sub-groups (i.e., HIV-negative men [59] and men with primary sex partners [60]) young MSM were more likely than older MSM to have CAI, but no age-related associations existed for other sub-groups (i.e., HIV-positive men [59] and men without primary partners [60], respectively). Other studies found that young MSM were more likely to have CAI with some, but not all, types of partners (e.g., main vs. non-main) [61, 62].

Condomless Insertive Anal Intercourse (CIAI)

A total of 15 studies examined CIAI. Only 3 found that young MSM were more likely than older MSM to have CIAI [63–65] (1 of these examined HIV-discordant CIAI [65]), 6 found no age-related association [23, 29, 41, 47, 54, 66] (1 of these examined HIV-discordant CIAI [54]), and 4 found that young MSM were less likely to have CIAI [55, 67–69]. Within 2 studies, age-related associations were mixed and varied by partner type (i.e., casual vs. primary [60] and HIV-positive vs. HIV-negative [70]).

Condomless Receptive Anal Intercourse (CRAI)

A total of 16 studies examined CRAI. Four found that young MSM were more likely than older MSM to have CRAI [29,

47, 63, 71], 6 found no age-related association [23, 41, 64, 66, 72, 73], and 3 found that young MSM were less likely to have CRAI [55, 67, 68]. However, in 3 studies that specifically examined HIV-discordant CRAI—including 1 that used a probability-based sample [65]—young MSM consistently were more likely than older MSM to have HIV-discordant CRAI [2, 54, 65].

Number of Recent Sex Partners

A total of 10 studies examined the number of recent sex partners. Only 3 studies found that young MSM had a greater number of sex partners than older MSM [49, 52, 71], 3 found no age-related association [35, 42, 74], and 4 found that young MSM had fewer partners [29, 64, 70, 75].

RAI

The 3 studies that examined RAI supported the hypothesis [42, 55, 76]. Young MSM were more likely to identify as a “bottom” [42] and less likely to be “top” during their recent same-sex encounters [76]. Although 1 study only included Asian/Pacific Islander MSM [55], these men's younger partners tended to be receptive during CAI.

Summary of Hypothesis 1

Studies yielded inconsistent findings regarding the association between age and most sexual risk behaviors among MSM. However, young MSM consistently were more likely than older MSM to have HIV-discordant CRAI and RAI.

Hypothesis 2 Young MSM are more likely than older MSM to have HIV-positive sex partners.

Known HIV-Positive Partners

The only study that provided data for this component found that young MSM were less likely than older MSM to have known HIV-positive partners [47].

Older Partners

Only 2 studies examined having older partners. Although 1 found that young MSM were more likely than older MSM to have older partners, it used data collected from HIV-positive men during 1993–1994 [49]. The other found no age-related association, but it was limited to 18–35 year-old black and Latino MSM [72].

Table 1 Supported hypotheses that may explain HIV incidence disparities among young and older men who have sex with men (MSM)

	Equival support for the hypothesis	Limitations of studies that yield inconsistencies for the supported hypothesis
<i>Behavioral hypotheses</i>		
1. Young MSM are more likely than older MSM to engage in sexual risk behavior HIV-discordant condomless receptive anal intercourse	Koblin et al. [2] Nelson et al. [54] Schwarcz et al. [65] Choi et al. [55] Klein [42] Jameson et al. [76]	
Receptive anal intercourse		
<i>Clinical hypotheses</i>		
3. Young MSM are more likely than older MSM to have STIs “Any STI”	Bocour et al. [49] ^a Koblin et al. [2] ^a Mansergh et al. [77] Mayer et al. [34] ^a Al-Tayyib et al. [78] ^a Javanbakht et al. [79] ^a Mansergh et al. [77] Mimiaga et al. [80] ^a Su et al. [82] Torrone et al. [83] Beer et al. [87] Friedman et al. [86] Beer et al. [87] Paz-Bailey et al. [22] Centers for Disease Control and Prevention [9] German et al. [88]	Nelson et al. [54]: used self-reported data from men who viewed sexually explicit online data (young MSM were less likely to have “any STI”) Scheer et al. [47]: used self-reported data collected during 1993–1994 (age was not associated with having “any STI”) Bocour et al. [49]: used self-reported data and only included HIV-positive men (age was not associated with having gonorrhea)
Gonorrhea		
Increasing primary and secondary syphilis diagnoses		
4. HIV-positive young MSM are more likely than HIV-positive older MSM to be viremic Virally unsuppressed		
Not use antiretroviral therapy		
Unaware of HIV infection		Young et al. [89]: only included indigent, substance-using men in Los Angeles (age was not associated with infection unawareness)
<i>Psychosocial hypotheses</i>		
5. Young MSM are more likely than older MSM to have depression Depression	Salomon et al. [70] ^b Bogart et al. [90]	Brewer et al. [71]: only included black MSM (age was not associated with depression) DeSantis et al. [36]: included predominantly Latino MSM in a small sample (n = 205; age was not associated with depression)

Table 1 (continued)

	Equivocal support for the hypothesis	Limitations of studies that yield inconsistencies for the supported hypothesis
6. Young MSM are more likely than older MSM to use substances		Maksut et al. [91]; only included black MSM (age was not associated with depression) Reisner et al. [19]; only included black MSM in a small sample (n = 197; age was not associated with depression) Wohl et al. [92]; only included HIV-positive black and Latino MSM in a small sample (n = 199; age was not associated with depression)
Polysubstance use	Nakamura et al. [93]	Friedman et al. [86]; only included bisexual MSM and used a short-term measure of polysubstance use (age was not associated with polysubstance use)
	Parsons et al. [98]	Nehl et al. [100]; only included Asian/Pacific Islander men who were mostly foreign born (young MSM were less likely to engage in polysubstance use)
	Stall et al. [99]	
<i>Structural hypotheses</i>		
7. Young MSM are more likely than older MSM to have low socioeconomic status	Salomon et al. [70]	Koblin et al. [2]; only included black MSM (young MSM had greater income than older MSM)
Income	Scheer et al. [47]	Maksut et al. [91]; only included black MSM in Atlanta (age was not associated with income)
	Shapiro and Vives [32]	Wohl et al. [92]; only included HIV-positive black and Latino MSM in Los Angeles (age was not associated with income)
8. Young MSM have less access to health care and HIV testing than older MSM		
Health care	Scheer et al. [47]	
	Paz-Bailey et al. [22]	
	Koblin et al. [2]	
	Irvin et al. [102]	
	Baytop et al. [50]	
Lifetime HIV testing	Centers for Disease Control and Prevention [103]	Koblin et al. [2]; only included only black MSM (age was not associated with ever testing for HIV)
	Margolis et al. [104]	
	Mdodo et al. [105]	
	Mimiaga et al. [106]	
	Rendina et al. [107]	
	Shapiro and Vives [32]	

Table 1 (continued)

Equivocal support for the hypothesis	Limitations of studies that yield inconsistencies for the supported hypothesis
<p data-bbox="252 144 279 720">9. Young MSM have earlier ages of sexual expression than older MSM</p> <p data-bbox="279 144 422 720"> Glick et al. [115] Groo et al. [116] Nelson et al. [54] Friedman et al. [114] </p>	<p data-bbox="252 720 422 1449"> Most supportive studies assessing age-associated differences in STIs used diagnostic tests or medical records (vs. self-reports) to assess STIs: Bocour et al. [49], Koblin et al. [2], Mayer et al. [34], Al-Tayyib et al. [78], and Javanbakht et al. [79] The strongest depression data came from Salomon et al. [70], which used a large, racially diverse sample from 6 U.S. cities (n=4295). Studies reporting that age was not associated with depression only included black or Latino MSM </p>

Summary of Hypothesis 2

Although 1 relatively outdated study found that young MSM were more likely than older MSM to have older partners, studies have not shown that young MSM were more likely to have known HIV-positive partners.

Clinical Hypotheses

Hypothesis 3 Young MSM are more likely than older MSM to have STIs.

Any STI

A total of 7 studies examined “any” STI. Five found that young MSM were more likely to have any STI [2, 34, 49, 77, 78] (1 of these examined “chlamydia or gonorrhea” [78]), 1 found no age-related association [47], and 1 found that young MSM were less likely to have any STI [54]. It is noteworthy that 4 of the 5 supportive studies confirmed infections with diagnostic tests [2, 34, 78] or medical records [49]. The study that found no association used self-reported, outdated data collected during 1993–1994 [47]. The study that found that young MSM were less likely than older MSM to have any STI used self-reported data exclusively from men who viewed sexually explicit online media [54].

Gonorrhea

A total of 4 studies examined gonorrhea. Three found that young MSM were more likely to have gonorrhea infection [77, 79, 80], and 1 found no age-related association [49]. Of the 3 studies that supported this component, 2 used diagnostic tests to confirm infections [79, 80], of which 1 used a very large sample of HIV-positive and HIV-negative MSM (n=21,927) [80]. The study that found no age-related association used a small sample (n=336) that only included HIV-positive MSM recruited during 1993–1994 [49].

Chlamydia

A total of 3 studies examined chlamydia. Two found that young MSM were more likely to have chlamydia infection [49, 79], but 1 found no age-related association [80]. The 2 supportive studies have limitations because they included only HIV-positive [49] or incarcerated [79] MSM. The study that found no age-related association used a large sample of HIV-positive and HIV-negative MSM (n=21,927) [80].

Syphilis

A total of 4 studies examined syphilis. One found that young MSM were more likely than older MSM to test positive for

early syphilis (primary, secondary, or early latent) [79]. However, 2 studies found no age-related association for early syphilis [49, 81], and 1 found that young MSM were less likely to be seroreactive for syphilis (including infection that could have been treated previously) [80]. The studies that supported and contradicted the hypothesis both used large, racially/ethnically diverse samples of MSM ($n > 7000$).

We identified 2 additional studies that examined age-related trends in primary and secondary syphilis diagnoses during 2004–2008. During this time, primary and secondary syphilis increased among all MSM [82, 83]. However, relative increases in diagnoses among black, Latino, and white MSM aged 25–29 years were greater than increases among older black, Latino, and white MSM, respectively. Moreover, black and Latino MSM aged 13–24 years experienced greater relative increases in syphilis than older black and Latino MSM, respectively. Black MSM in all age groups had greater relative increases than age-matched Latino and white MSM [83].

Herpes Simplex Virus 2

Only 2 studies examined herpes simplex virus 2. Both found that young MSM were less likely than older MSM to test positive for herpes [84, 85].

Summary of Hypothesis 3

The most generalizable data suggested that young MSM were more likely than older MSM to have “any” STI and gonorrhea. Findings for chlamydia and syphilis were inconsistent. However, primary and secondary syphilis diagnoses increased more among young (vs. older) MSM during 2004–2008.

Hypothesis 4 HIV-positive young MSM are more likely than HIV-positive older MSM to be viremic.

Viral Suppression

The 3 studies that examined viral suppression supported this hypothesis. Young HIV-positive MSM were less likely than older HIV-positive MSM to be virally suppressed [86, 87] and use antiretroviral therapy [22, 87]. Robust data appeared in a nationally representative, probability-based study [87] and a study that recruited MSM from 21 cities [22].

HIV Infection Unawareness

A total of 3 studies examined HIV infection unawareness. Two found that young HIV-positive MSM were more likely than older HIV-positive MSM to be unaware of their

infection [9, 88], but 1 found no age-related association [89]. Of note, the 2 supportive studies both replicated findings across 2 data collection waves [9, 88], and 1 included 8153 men in 21 cities [9]. The study that found no age-related association only included indigent, substance-using MSM in 1 city [89].

Summary of Hypothesis 4

HIV-positive young MSM consistently were less likely than HIV-positive older MSM to be virally suppressed and use antiretroviral therapy. The strongest data for HIV infection unawareness suggested that HIV-positive young MSM were more likely to be unaware.

Psychosocial Hypotheses

Hypothesis 5 Young MSM are more likely than older MSM to have depression.

A total of 7 studies provided data for depression. Two found that young MSM were more likely than older MSM to have depression [70, 90], but 5 found no age-related association [19, 36, 71, 91, 92].

The 2 supportive studies both used racially/ethnically diverse samples, and 1 used a large sample from 6 cities ($n = 4295$) [70]. The 5 studies that found no age-related association included only black MSM [19, 71, 91], predominantly Latino MSM [36], or only HIV-positive black and Latino MSM [92]. Moreover, 3 of these 5 studies had very small samples ($n = 205$ [36], 197 [19], and 199 [92]).

Summary of Hypothesis 5

Data from racially/ethnically diverse samples suggested that young MSM as a whole had more depression than older MSM. However, age was not associated with depression in studies limited to black or Latino MSM.

Hypothesis 6 Young MSM are more likely than older MSM to use substances.

Amphetamines

A total of 9 studies examined amphetamines. Four found that young MSM were more likely than older MSM to use amphetamines [47, 70, 93, 94], 2 found no age-related association [42, 95], and 2 found that young MSM were less likely to use amphetamines [49, 96]. One study produced mixed findings: MSM aged 20–29 years were less likely than MSM aged 30–39 years to use amphetamines, but they did not statistically differ from MSM aged ≥ 40 years [62].

Cocaine (Including Crack)

A total of 5 studies examined cocaine. One found that young MSM were more likely than older MSM to use cocaine, but no age-related association existed for crack [70]. Another study found no age-related association for cocaine [96], but 3 found that young MSM were less likely to use cocaine [49, 62, 94] (1 of these examined crack) [94].

Injection Drug Use

A total of 4 studies examined injection drug use. Two found no association between age and injection drug use [49, 97], and 2 found that young MSM were less likely than older MSM to inject drugs [47, 70].

Polysubstance Use

A total of 5 studies examined polysubstance use. Three found that young MSM were more likely than older MSM to engage in polysubstance use [93, 98, 99], 1 found no age-related association [86], and 1 found that young MSM were less likely to engage in polysubstance use [100].

Of note, the 3 studies that supported this component used multiracial samples—1 used a probability-based sample of MSM [99]—and assessed polysubstance use during the past 2–6 months. The 1 study that found no age-related association used an imprecise measure for young age (≤ 39 years) and only assessed polysubstance during the past month [86]. The study that found that young MSM were less likely to engage in polysubstance use was limited to mostly foreign-born Asian/Pacific Islander MSM [100].

Poppers

A total of 3 studies examined poppers. One found no association between age and poppers use [49], and 2 found that young MSM were less likely than older MSM to use poppers [47, 70].

Substance Use During Sex

A total of 3 studies examined substance use during sex. One found that young MSM were more likely than older MSM to use amphetamines during sex, but less likely to use crack during sex [94]. Two found no age-related association for “any” substance use during sex [91, 101].

Summary of Hypothesis 6

The strongest and most generalizable data for polysubstance use suggested that young MSM were more likely than older

MSM to engage in this behavior. Findings for other substances were inconsistent.

Structural Hypotheses

Hypothesis 7 Young MSM are more likely than older MSM to have low socioeconomic status.

Education

A total of 5 studies examined education. Two found that young MSM had less education than older MSM [32, 70], 2 found no age-related association [42, 91], and 1 found that young MSM had more education [2].

Although 1 study that supported this component used a large, multiracial sample ($n = 4295$) [70], the other only included 60 Asian/Pacific Islander MSM [32]. Studies that found no age-related association included only MSM who sought CAI via the Internet [42] or black MSM [91]. The study that contradicted the hypothesis only included black MSM [2].

Income

A total of 6 studies examined income. Three found that young MSM had less income than older MSM [32, 47, 70], 2 found no age-related association [91, 92], and 1 found that young MSM had greater income [2].

It is noteworthy that 2 of the 3 studies that supported this component used large, multiracial samples ($ns = 2189$ [47] and 4295 [70]), although 1 only included 60 Asian/Pacific Islander MSM [32]. However, the 2 studies reporting no association used single-city samples limited to HIV-negative black MSM [91] or HIV-positive black and Latino MSM [92]. The 1 study that contradicted the hypothesis only included black MSM [2].

Summary of Hypothesis 7

Studies suggested that young MSM as a whole, but not black or Latino MSM, had less income than older MSM. Findings for education were relatively inconsistent.

Hypothesis 8 Young MSM have less access to health care and HIV testing than older MSM.

Health Care

The 4 studies that examined health care access supported this hypothesis [2, 22, 47, 102]. Younger age was associated with lacking medical insurance [47] and, among HIV-positive MSM, not being in medical care [22]. Among black

MSM, younger age was associated with lacking a usual place of health care [2], lacking access to necessary care [2], and not visiting a medical provider recently [102].

Lifetime HIV Testing

A total of 8 studies examined lifetime HIV testing. Seven found that young MSM were less likely to ever test for HIV than older MSM [32, 50, 103–107], but 1 found no age-related association [2]. Most of the 7 supportive studies used multiracial samples [103–107], including 1 that used a large sample ($n = 7271$) from 21 cities [103]. The study that found no age-related association only included black MSM.

Recent HIV Testing

A total of 12 studies examined recent HIV testing. Two found no association between age and recent testing [28, 108], and 10 found that young MSM were more likely than older MSM to recently test for HIV [29, 49, 103, 105, 107, 109–113]. Nine of these 10 studies used multiracial samples—1 used an all-black sample [111]—including 1 that used a large sample ($n = 7271$) from 21 cities [103]. Studies finding no age-related association included only black and Latino MSM [28] or men in 1 city [108].

Summary of Hypothesis 8

Young MSM consistently had less access to health care than older MSM. Notwithstanding minor inconsistencies, young MSM were less likely to ever test for HIV, but more likely to recently test.

Hypothesis 9 Young MSM have earlier ages of sexual expression than older MSM.

The 4 studies that provided data for this hypothesis supported it [54, 114–116]. Two, including 1 that used probability-based data [115], found that young MSM began having anal intercourse at younger ages than did older MSM [115, 116]. A cohort-based study reported that men born in the 1990s initiated anal intercourse at younger ages than men born in the 1970s and 1980s, but not before those born before 1970 [54]. A study examining “gay-related developmental milestones,” including sexual debut and “coming out,” found that gay-related development began at younger ages among young MSM [114].

Summary of Hypothesis 9

Young MSM consistently had earlier ages of sexual expression than older MSM.

Discussion

In this study, we used social ecological theory as a framework for identifying potential determinants of age-associated HIV-incidence disparities among MSM. In doing so, we build upon previous studies’ contributions. Clearly, young MSM are at greater risk for HIV than older MSM because the relatively low HIV prevalence among young MSM results in a high number of young (vs. older) MSM being vulnerable to HIV acquisition [7]. However, as our findings suggest, multiple behavioral, clinical, psychosocial, and structural factors likely exacerbate this phenomenon.

Age-related differences in some sexual risk behaviors existed. Although we did not find that young MSM were more likely than older MSM to have known HIV-positive partners, they were more likely than older MSM to have RAI and HIV-discordant CRAI. HIV-discordant CRAI is the most risky sexual behavior for HIV acquisition [117]. Previous studies suggested that RAI and HIV-discordant CRAI may often occur when young MSM have sex with older partners [7, 10, 16]. Despite the limited data that we acquired for having older partners, studies have shown that age-related interpersonal dynamics can prompt young MSM to be anally receptive [55] and, for black young MSM, less empowered to negotiate condom use during sex with older MSM [118]. In 1 analysis, the association between having CAI and having older partners was strongest for black young MSM compared with other young MSM [119]. These data suggest that the increased likelihood for HIV-discordant CRAI among young MSM and, perhaps HIV-discordant CRAI with older men, promotes age-associated disparities in HIV incidence, especially for black MSM.

Other characteristics of sexual networks, including age-concordant sex, are also relevant. Young MSM consistently had earlier ages of sexual expression than older MSM. This phenomenon has increased the amount of time during which contemporary cohorts of young MSM are exposed to HIV, and it has resulted in young MSM initiating sex when they are developmentally vulnerable. Young MSM were also more likely than older MSM to have “any” STI and gonorrhea, which is consistent with age-related findings from population-based data for U.S. men and women [120]. Most notably, primary and secondary syphilis disproportionately increased among young MSM during 2004–2008. This suggests that young MSM are increasingly having sex within networks where syphilis and HIV are becoming more prevalent [83]. Therefore, the likelihood of young MSM acquiring HIV from other young MSM, and not older MSM alone, has likely increased over time.

Psychosocial challenges likely enhance HIV risk among young MSM. They had increased likelihood for polysubstance use and, in multiracial samples, depression. Together,

these factors can reduce sexual inhibitions and sydemically interact with other factors that promote HIV acquisition [18]. Although we did not find that young MSM were more likely than older MSM to use substances during sex, our findings do suggest that young MSM may be at increased risk for experiencing reduced cognition and impaired decision making prior to and during sexual encounters. These factors, in turn, increase their vulnerability to HIV infection [77].

The aforementioned factors emerge within broader contexts of socioeconomic vulnerability. Compared with older MSM, young MSM had lower income and less access to health care. These factors are determinants of HIV-related disparities [12]. Therefore, it was not surprising that young MSM were less likely to ever test for HIV and, if HIV-positive, use antiretroviral therapy, be virally suppressed, and have awareness of their infection. Socioeconomic and other structural barriers make it difficult for HIV-positive young MSM to be engaged along the HIV care continuum. These barriers also make young MSM vulnerable to transmitting HIV to their partners, including other young MSM. Although studies did not find greater socioeconomic vulnerability among black young (vs. older) MSM, socioeconomic vulnerability likely has dire health-related consequences for black young MSM. Black young MSM fare worse than non-black young MSM with regard to poverty, insurance coverage, engagement in HIV care, and viral suppression [13].

This review has limitations. We could not draw strong conclusions for some hypotheses due to having limited data. This was notable for our hypothesis regarding age-related differences in having older and known HIV-positive partners. Second, some supported hypotheses had few studies that consistently provided evidence to support them. An example includes HIV infection unawareness, for which our inclusion criteria yielded relatively few studies. Third, although black young MSM are more vulnerable to HIV than other young MSM, the lack of studies examining age-associated differences among black MSM prevented us from highlighting more factors that are potentially relevant for black young MSM. Finally, given the exploratory nature of our study, we did not use methodologies (e.g., meta-analyses) that could quantify differences in factors that contribute to HIV acquisition among young and older MSM. Therefore, our review provides no effect-size data for the relationship between age and the factors that we examined. Future studies should examine age in relation

to HIV risk factors to provide better understanding of age-associated HIV incidence disparities among MSM. Meta-analyses, prospective designs, and greater attention to black young MSM would provide critical insights.

Our review identified behavioral, clinical, psychosocial, and structural factors that could promote high HIV incidence among young MSM. Interventions that address these factors might prevent CRAI, delay sexual debut among young MSM, and decrease risks from sex with older MSM. Increasing uptake of HIV pre-exposure prophylaxis among HIV-negative young MSM, as well as early linkage to care and initiation of antiretroviral therapy for HIV-positive young MSM, could reduce HIV acquisition and transmission among young MSM. Screening and treatment for other STIs, mental health problems, and substance use would also be beneficial. Myriad, interrelated factors shape HIV risk and contexts in which this risk emerges among young MSM [11]. Multifaceted prevention strategies that address these factors could help to reduce age-associated HIV incidence disparities among MSM.

Acknowledgments We are grateful to Katherine L. Tucker for assistance with the literature search. Jeanne Bertolli, PhD, MPH, John T. Brooks, MD, Wayne A. Duffus, MD, PhD, and Aidsa Rivera, MS provided helpful thoughts on earlier drafts of this article. This research was supported in part by an appointment to the Research Participation Program at the Centers for Disease Control and Prevention administered by the Oak Ridge Institute for Science and Education through an interagency agreement between the U.S. Department of Energy and the Centers for Disease Control and Prevention.

Disclaimer The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with human participants performed by any of the authors.

Appendix

See Table 2

Table 2 Literature review methodology

Search dates	Databases	Search terms for MSM*	Search terms for HIV*	Inclusion criteria
January 2016–July 2016	EMBASE	“men who have sex with men”	“human immunodeficiency virus”	Published during January 1996–July 2016
	PsycINFO	“MSM”	“HIV”	Presented data describing age’s association with factors related to at least 1 hypothesis
	PubMed	“gay”	“risk behavior”	Contained MSM aged ≤ 29 years and > 30 years
	Sociological Abstracts	“bisexual” “gay and bisexual” “sexual minority” “queer”	“infection” “transmission” “sexually transmitted disease” “STD” “sexually transmitted infection” “STI”	Avoided replicating associations from another study that used the same data set

*The literature search cross-referenced search terms for MSM and search terms for HIV

References

- Sullivan PS, Rosenberg ES, Sanchez TH, et al. Explaining racial disparities in HIV incidence in black and white men who have sex with men in Atlanta, GA: a prospective observational cohort study. *Ann Epidemiol.* 2015;25:445–54.
- Koblin BA, Mayer KH, Eshleman SH, et al. Correlates of HIV acquisition in a cohort of black men who have sex with men in the United States: HIV Prevention Trials Network (HPTN) 061. *PLoS ONE.* 2013;8:e70413.
- Matthews DD, Herrick AL, Coulter RWS, et al. Running backwards: consequences of current HIV incidence rates for the next generation of black MSM in the United States. *AIDS Behav.* 2015;20:7–16.
- Balaji AB, Bowles KE, Le BC, Paz-Bailey G, Oster AM, NHBS Study Group. High HIV incidence and prevalence and associated factors among young MSM, 2008. *AIDS.* 2013;27:269–78.
- Garofalo R, Hotton AL, Kuhns LM, Gratzner B, Mustanski B. Incidence of HIV infection and sexually transmitted infections and related risk factors among very young men who have sex with men. *J Acquir Immune Defic Syndr.* 2016;72:79–86.
- Centers for Disease Control and Prevention. Diagnoses of HIV Infection in the United States and Dependent Areas, 2016 2017. <https://www.cdc.gov/hiv/library/reports/hiv-surveillance.html>. Accessed 03 May 2018.
- Morris M, Dean L. Effect of sexual behavior change on long-term human immunodeficiency virus prevalence among homosexual men. *Am J Epidemiol.* 1994;140:217–32.
- Mansergh G, Marks G. Age and risk of HIV infection in men who have sex with men. *AIDS.* 1998;12:1119–28.
- Centers for Disease Control and Prevention. Prevalence and awareness of HIV infection among men who have sex with men—21 cities, United States, 2008. *MMWR Morb Mortal Wkly Rep.* 2010;59:1201–7.
- Coburn BJ, Blower S. A major HIV risk factor for young men who have sex with men is sex with older partners. *J Acquir Immune Defic Syndr.* 2010;54:113–4.
- Mustanski BS, Newcomb ME, Du Bois SN, Garcia SC, Grov C. HIV in young men who have sex with men: a review of epidemiology, risk and protective factors, and interventions. *J Sex Res.* 2011;48:218–53.
- Buot M-LG, Docena JP, Ratemo BK, et al. Beyond race and place: distal sociological determinants of HIV disparities. *PLoS ONE.* 2014;9:e91711.
- 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;380:341–8.
- Krieger N. *Epidemiology and the people’s health: theory and context.* New York: Oxford University Press; 2011.
- Koblin BA, Husnik MJ, Colfax G, et al. Risk factors for HIV infection among men who have sex with men. *AIDS.* 2006;20:731–9.
- Hurt CB, Matthews DD, Calabria MS, et al. Sex with older partners is associated with primary HIV infection among men who have sex with men in North Carolina. *J Acquir Immune Defic Syndr.* 2010;54:185–90.
- Galvin SR, Cohen MS. The role of sexually transmitted diseases in HIV transmission. *Nat Rev Microbiol.* 2004;2:33–42.
- Mimiaga MJ, O’Cleirigh C, Biello KB, et al. The effect of psychosocial syndemic production on 4-year HIV incidence and risk behavior in a large cohort of sexually active men who have sex with men. *J Acquir Immune Defic Syndr.* 2015;68:329–36.
- Reisner SL, Mimiaga MJ, Skeer M, et al. Clinically significant depressive symptoms as a risk factor for HIV infection among black MSM in Massachusetts. *AIDS Behav.* 2009;13:798–810.
- Plankey MW, Ostrow DG, Stall R, et al. The relationship between methamphetamine and popper use and risk of HIV seroconversion in the multicenter AIDS cohort study. *J Acquir Immune Defic Syndr.* 2007;45:85–92.
- Ostrow DG, Plankey MW, Cox C, et al. Specific sex-drug combinations contribute to the majority of recent HIV seroconversions among MSM in the MACS. *J Acquir Immune Defic Syndr.* 2009;51:349–55.

22. Paz-Bailey G, Pham H, Oster AM, et al. Engagement in HIV care among HIV-positive men who have sex with men from 21 cities in the United States. *AIDS Behav.* 2014;18:348–58.
23. Appleby PR, Marks G, Ayala A, Miller LC, Murphy S, Mansergh G. Consideration of future consequences and unprotected anal intercourse among men who have sex with men. *J Homosex.* 2005;50:119–33.
24. Millett GA, Peterson JL, Wolitski RJ, Stall R. Greater risk for HIV infection of black men who have sex with men: a critical literature review. *Am J Public Health.* 2006;96:1007–19.
25. Diez Roux AV. Conceptual approaches to the study of health disparities. *Ann Rev Public Health.* 2012;33:41–58.
26. McClelland MJ. Multiple regression and causal analysis. Long Grove: Waveland Press; 2002.
27. Grov C, Parsons JT, Bimbi DS. Sexual compulsivity and sexual risk in gay and bisexual men. *Arch Sex Behav.* 2010;39:940–9.
28. Lauby JL, Marks G, Bingham T, et al. Having supportive social relationships is associated with reduced risk of unrecognized HIV infection among black and Latino men who have sex with men. *AIDS Behav.* 2012;16:508–15.
29. McAuliffe TL, Kelly JA, Sikkema KJ, et al. Sexual HIV risk behavior levels among young and older gay men outside of AIDS epicenters: findings of a 16-city sample. *AIDS Behav.* 1999;3:111–9.
30. Muriuki AM, Fendrich M, Pollack LM, Lippert AM. Civic participation and risky sexual behavior among urban U.S. men who have sex with men. *J HIV AIDS Soc Serv.* 2011;10:376–94.
31. Ramirez-Valles J, Garcia D, Campbell RT, Diaz RM, Heckathorn DD. HIV infection, sexual risk behavior, and substance use among Latino gay and bisexual men and transgender persons. *Am J Public Health.* 2008;98:1036–42.
32. Shapiro J, Vives G. Demographic and attitudinal variables related to high-risk behaviors in Asian males who have sex with other men. *AIDS Patient Care STDs.* 1999;13:667–75.
33. Chen YH, Raymond HF, Grasso M, Nguyen B, Robertson T, McFarland W. Prevalence and predictors of conscious risk behavior among San Franciscan men who have sex with men. *AIDS Behav.* 2013;17:1338–43.
34. Mayer KH, O'Cleirigh C, Skeer M, et al. Which HIV-infected men who have sex with men in care are engaging in risky sex and acquiring sexually transmitted infections: findings from a Boston community health centre. *Sex Transm Infect.* 2010;86:66–70.
35. Bland SE, Mimiaga MJ, Reisner SL, et al. Sentencing risk: history of incarceration and HIV/STD transmission risk behaviours among Black men who have sex with men in Massachusetts. *Cult Health Sex.* 2012;14:329–45.
36. De Santis JP, Colin JM, Provencio Vasquez E, McCain GC. The relationship of depressive symptoms, self-esteem, and sexual behaviors in a predominantly Hispanic sample of men who have sex with men. *Am J Mens Health.* 2008;2:314–21.
37. Diaz RM, Stall RD, Hoff C, Daigle D, Coates T. HIV risk among Latino gay men in the Southwestern United States. *AIDS Educ Prev.* 1996;8:415–29.
38. Drabkin AS, Sikkema KJ, Wilson PA, et al. Risk patterns preceding diagnosis among newly HIV-diagnosed men who have sex with men in New York City. *AIDS Patient Care STDs.* 2013;27:333–41.
39. Gillis J, Meyer-Bahlburg HFL, Exner TM, Ehrhardt AA. The predictive utility of an expanded AIDS Risk Reduction Model (ARRM) among adult gay and bisexual men. *Can J Hum Sex.* 1998;7:31–49.
40. Grosskopf NA, Harris JK, Wallace BC, Nanin JE. Online sex-seeking behaviors of men who have sex with men in New York City. *Am J Mens Health.* 2011;5:378–85.
41. Jones KT, Johnson WD, Wheeler DP, Gray P, Foust E, Gaiter J. Nonsupportive peer norms and incarceration as HIV risk correlates for young black men who have sex with men. *AIDS Behav.* 2008;12:41–50.
42. Klein H. A comparison of HIV risk practices among unprotected sex-seeking older and younger men who have sex with other men. *Aging Male.* 2012;15:124–33.
43. Magnus M, Kuo I, Phillips G 2nd, et al. Elevated HIV prevalence despite lower rates of sexual risk behaviors among black men in the District of Columbia who have sex with men. *AIDS Patient Care STDs.* 2010;24:615–22.
44. Mayer KH, Ducharme R, Zaller ND, et al. Unprotected sex, underestimated risk, undiagnosed HIV and sexually transmitted diseases among men who have sex with men accessing testing services in a New England bathhouse. *J Acquir Immune Defic Syndr.* 2012;59:194–8.
45. 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;12:118–26.
46. Rosser BR, Miner MH, Bockting WO, Ross MW, Konstan J, Gurak L, et al. HIV risk and the internet: results of the Men's INternet Sex (MINTS) study. *AIDS Behav.* 2009;13:746–56.
47. Scheer S, Douglas JM Jr, Vittinghoff E, et al. Feasibility and suitability of targeting young gay men for HIV vaccine efficacy trials. *J Acquir Immune Defic Syndr.* 1999;20:172–8.
48. Smolenski DJ, Ross MW, Risser JM, Rosser BR. Sexual compulsivity and high-risk sex among Latino men: the role of internalized homonegativity and gay organizations. *AIDS Care.* 2009;21:42–9.
49. Bocour A, Renaud TC, Wong MR, Udeagu CC, Shepard CW. Differences in risk behaviors and partnership patterns between younger and older men who have sex with men in New York City. *J Acquir Immune Defic Syndr.* 2011;58:417–23.
50. Baytop C, Royal S, McCree DH, et al. Comparison of strategies to increase HIV testing among African-American gay, bisexual, and other men who have sex with men in Washington, DC. *AIDS Care.* 2014;26:608–12.
51. Brennan DJ, Welles SL, Miner MH, Ross MW, Rosser BR. HIV treatment optimism and unsafe anal intercourse among HIV-positive men who have sex with men: findings from the positive connections study. *AIDS Educ Prev.* 2010;22:126–37.
52. Dolcini MM, Catania JA, Stall RD, Pollack L. The HIV epidemic among older men who have sex with men. *J Acquir Immune Defic Syndr.* 2003;33:S115–21.
53. Miner MH, Peterson JL, Welles SL, Jacoby SM, Rosser BR. How do social norms impact HIV sexual risk behavior in HIV-positive men who have sex with men?: multiple mediator effects. *J Health Psychol.* 2009;14:761–70.
54. Nelson KM, Gamarel KE, Pantalone DW, Carey MP, Simoni JM. Sexual debut and HIV-related sexual risk-taking by birth cohort among men who have sex with men in the United States. *AIDS Behav.* 2016;20:2286–95.
55. Choi KH, Operario D, Gregorich SE, Han L. Age and race mixing patterns of sexual partnerships among Asian men who have sex with men: implications for HIV transmission and prevention. *AIDS Educ Prev.* 2003;15:53–65.
56. Rosser BR, 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;13:488–98.
57. Taylor BS, Chiasson MA, Scheinmann R, et al. Results from two online surveys comparing sexual risk behaviors in Hispanic, black, and white men who have sex with men. *AIDS Behav.* 2012;16:644–52.
58. Menza TW, Kerani RP, Handsfield HH, Golden MR. Stable sexual risk behavior in a rapidly changing risk environment: findings from population-based surveys of men who have sex

- with men in Seattle, Washington, 2003–2006. *AIDS Behav.* 2011;15:319–29.
59. Jeffries WL 4th, Marks G, Lauby J, Murrill C, Millett G. Homophobia is associated with sexual behavior that increases risk of acquiring and transmitting HIV Infection among black men who have sex with men. *AIDS Behav.* 2013;17:1442–53.
 60. Crepaz N, Marks G, Mansergh G, Murphy S, Miller LC, Appleby PR. Age-related risk for HIV infection in men who have sex with men: examination of behavioral, relationship, and serostatus variables. *AIDS Educ Prev.* 2000;12:405–15.
 61. Joseph HA, Flores SA, Parsons JT, Purcell DW. Beliefs about transmission risk and vulnerability, treatment adherence, and sexual risk behavior among a sample of HIV-positive men who have sex with men. *AIDS Care.* 2010;22:29–39.
 62. Pappas MK, Halkitis PN. Sexual risk taking and club drug use across three age cohorts of HIV-positive gay and bisexual men in New York City. *AIDS Care.* 2011;23:1410–6.
 63. Calabrese SK, Reisen CA, Zea MC, Poppen PJ, Bianchi FT. The pleasure principle: the effect of perceived pleasure loss associated with condoms on unprotected anal intercourse among immigrant Latino men who have sex with men. *AIDS Patient Care STDs.* 2012;26:430–5.
 64. Eaton LA, Cain DN, Pope H, Garcia J, Cherry C. The relationship between pornography use and sexual behaviours among at-risk HIV-negative men who have sex with men. *Sex Health.* 2012;9:166–70.
 65. 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;97:1067–75.
 66. Fendrich M, Avci O, Johnson TP, Mackesy-Amiti ME. Depression, substance use and HIV risk in a probability sample of men who have sex with men. *Addict Behav.* 2013;38:1715–8.
 67. Rosenberger JG, Reece M, Schick V, et al. Condom use during most recent anal intercourse event among a U.S. sample of men who have sex with men. *J Sex Med.* 2012;9:1037–47.
 68. Stein D, Silvera R, Hagerty R, Marmor M. Viewing pornography depicting unprotected anal intercourse: Are there implications for HIV prevention among men who have sex with men? *Arch Sex Behav.* 2012;41:411–9.
 69. Hampton MC, Halkitis PN, Storholm ED, et al. Sexual risk taking in relation to sexual identification, age, and education in a diverse sample of African American men who have sex with men (MSM) in New York City. *AIDS Behav.* 2013;17:931–8.
 70. Salomon EA, Mimiaga MJ, Husnik MJ, et al. Depressive symptoms, utilization of mental health care, substance use and sexual risk among young men who have sex with men in EXPLORE: implications for age-specific interventions. *AIDS Behav.* 2009;13:811–21.
 71. Brewer RA, Magnus M, Kuo I, Wang L, Liu TY, Mayer KH. The high prevalence of incarceration history among Black men who have sex with men in the United States: associations and implications. *Am J Public Health.* 2014;104:448–54.
 72. Joseph HA, Marks G, Belcher L. Older partner selection, sexual risk behaviour and unrecognised HIV infection among black and Latino men who have sex with men. *Sex Transm Infect.* 2011;87:442–7.
 73. Osmond DH, Pollack LM, Paul JP, Catania JA. Changes in prevalence of HIV infection and sexual risk behavior in men who have sex with men in San Francisco: 1997–2002. *Am J Public Health.* 2007;97:1677–83.
 74. Leichliter JS, Haderkhanaj LT, Chesson HW, Aral SO. Temporal trends in sexual behavior among men who have sex with men in the United States, 2002 to 2006–2010. *J Acquir Immune Defic Syndr.* 2013;63:254–8.
 75. Rosenberg ES, Sullivan PS, Dinenco EA, Salazar LF, Sanchez TH. Number of casual male sexual partners and associated factors among men who have sex with men: results from the National HIV Behavioral Surveillance system. *BMC Public Health.* 2011;11:189.
 76. Jameson DR, Celum CL, Manhart L, Menza TW, Golden MR. The association between lack of circumcision and HIV, HSV-2, and other sexually transmitted infections among men who have sex with men. *Sex Transm Dis.* 2010;37:147–52.
 77. Mansergh G, Flores S, Koblin B, Hudson S, McKirnan D, Colfax GN. Alcohol and drug use in the context of anal sex and other factors associated with sexually transmitted infections: results from a multi-city study of high-risk men who have sex with men in the USA. *Sex Transm Infect.* 2008;84:509–11.
 78. 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;85:216–20.
 79. Javanbakht M, Murphy R, Harawa NT, et al. Sexually transmitted infections and HIV prevalence among incarcerated men who have sex with men, 2000–2005. *Sex Transm Dis.* 2009;36:S17–21.
 80. 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;36:507–11.
 81. Wong W, Chaw JK, Kent CK, Klausner JD. Risk factors for early syphilis among gay and bisexual men seen in an STD clinic: San Francisco, 2002–2003. *Sex Transm Dis.* 2005;32:458–63.
 82. Su JR, Beltrami JF, Zaidi AA, Weinstock HS. Primary and secondary syphilis among black and Hispanic men who have sex with men: case report data from 27 States. *Ann Intern Med.* 2011;155:145–51.
 83. Torrone EA, Bertolli J, Li J, et al. Increased HIV and primary and secondary syphilis diagnoses among young men—United States, 2004–2008. *J Acquir Immune Defic Syndr.* 2011;58:328–35.
 84. 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;38:617–21.
 85. Okafor N, Rosenberg ES, Luisi N, et al. Disparities in herpes simplex virus type 2 infection between black and white men who have sex with men in Atlanta, GA. *Int J STD AIDS.* 2015;26:740–5.
 86. Friedman MR, Stall R, Silvestre AJ, et al. Stuck in the middle: longitudinal HIV-related health disparities among men who have sex with men and women. *J Acquir Immune Defic Syndr.* 2014;66:213–20.
 87. Beer L, Oster AM, Mattson CL, Skarbinski J. Disparities in HIV transmission risk among HIV-infected black and white men who have sex with men, United States, 2009. *AIDS.* 2014;28:105–14.
 88. German D, Sifakis F, Maulsby C, et al. Persistently high prevalence and unrecognized HIV infection among men who have sex with men in Baltimore: the BESURE study. *J Acquir Immune Defic Syndr.* 2011;57:77–87.
 89. Young SD, Shoptaw S, Weiss RE, Munjas B, Gorbach PM. Predictors of unrecognized HIV infection among poor and ethnic men who have sex with men in Los Angeles. *AIDS Behav.* 2011;15:643–9.
 90. Bogart LM, Wagner GJ, Galvan FH, Landrine H, Klein DJ, Sticklor LA. Perceived discrimination and mental health symptoms among Black men with HIV. *Cult Divers Ethnic Minor Psychol.* 2011;17:295–302.
 91. Maksut JL, Eaton LA, Siembida EJ, Driffin DD, Baldwin R. An evaluation of factors associated with sexual risk taking among Black men who have sex with men: a comparison of younger and older populations. *J Behav Med.* 2016;39:665–74.

92. Wohl AR, Galvan FH, Carlos JA, et al. A comparison of MSM stigma, HIV stigma and depression in HIV-positive Latino and African American men who have sex with men (MSM). *AIDS Behav.* 2013;17:1454–64.
93. Nakamura N, Semple SJ, Strathdee SA, Patterson TL. Methamphetamine initiation among HIV-positive gay and bisexual men. *AIDS Care.* 2009;21:1176–84.
94. Ober A, Shoptaw S, Wang PC, Gorbach P, Weiss RE. Factors associated with event-level stimulant use during sex in a sample of older, low-income men who have sex with men in Los Angeles. *Drug Alcohol Depend.* 2009;102:123–9.
95. Wohl AR, Frye DM, Johnson DF. Demographic characteristics and sexual behaviors associated with methamphetamine use among MSM and non-MSM diagnosed with AIDS in Los Angeles County. *AIDS Behav.* 2008;12:705–12.
96. Young SD, Shoptaw S. Stimulant use among African American and Latino MSM social networking users. *J Addict Dis.* 2013;32:39–45.
97. Ghanem A, Little SJ, Drumright L, Liu L, Morris S, Garfein RS. High-risk behaviors associated with injection drug use among recently HIV-infected men who have sex with men in San Diego, CA. *AIDS Behav.* 2011;15:1561–9.
98. Parsons JT, Grov C, Golub SA. Sexual compulsivity, co-occurring psychosocial health problems, and HIV risk among gay and bisexual men: further evidence of a syndemic. *Am J Public Health.* 2012;102:156–62.
99. Stall R, Mills TC, Williamson J, et al. Association of co-occurring psychosocial health problems and increased vulnerability to HIV/AIDS among urban men who have sex with men. *Am J Public Health.* 2003;93:939–42.
100. Nehl EJ, Han JH, Lin L, Nakayama KK, Wu Y, Wong FY. Substance use among a national sample of Asian/Pacific Islander men who have sex with men in the U.S. *J Psychoact Drugs.* 2015;47:51–9.
101. Lelutiu-Weinberger C, Pachankis JE, Golub SA, Walker JJ, Bamonte AJ, Parsons JT. Age cohort differences in the effects of gay-related stigma, anxiety and identification with the gay community on sexual risk and substance use. *AIDS Behav.* 2013;17:340–9.
102. Irvin R, Wilton L, Scott H, et al. A study of perceived racial discrimination in Black men who have sex with men (MSM) and its association with healthcare utilization and HIV testing. *AIDS Behav.* 2014;18:1272–8.
103. Centers for Disease Control and Prevention. HIV testing among men who have sex with men—21 cities, United States, 2008. *MMWR Morb Mortal Wkly Rep.* 2011;60:694–9.
104. Margolis AD, Joseph H, Belcher L, Hirshfield S, Chiasson MA. 'Never testing for HIV' among men who have sex with men recruited from a sexual networking website, United States. *AIDS Behav.* 2012;16:23–9.
105. Mdodo R, Thomas PE, Walker A, et al. Rapid HIV testing at gay pride events to reach previously untested MSM: U.S., 2009–2010. *Public Health Rep.* 2014;129:328–34.
106. Mimiaga MJ, Landers SJ, Conron KJ. Prevalence and correlates of lifetime HIV testing in a population-based sample of men who have sex with men in Massachusetts. *AIDS Patient Care STDs.* 2011;25:323–6.
107. Rendina HJ, Jimenez RH, Grov C, Ventuneac A, Parsons JT. Patterns of lifetime and recent HIV testing among men who have sex with men in New York City who use Grindr. *AIDS Behav.* 2014;18:41–9.
108. Lo YC, Turabelidze G, Lin M, Friedberg Y. Prevalence and determinants of recent HIV testing among sexually active men who have sex with men in the St. Louis metropolitan area, Missouri, 2008. *Sex Transm Dis.* 2012;39:306–11.
109. Reilly KH, Neaigus A, Jenness SM, Wendel T, Marshall DM 4th, Hagan H. Factors associated with recent HIV testing among men who have sex with men in New York City. *AIDS Behav.* 2014;18:297–304.
110. Hoenigl M, Anderson CM, Green N, Mehta SR, Smith DM, Little SJ. Repeat HIV-testing is associated with an increase in behavioral risk among men who have sex with men: a cohort study. *BMC Med.* 2015;13:218.
111. Mannheimer SB, Wang L, Wilton L, et al. Infrequent HIV testing and late HIV diagnosis are common among a cohort of black men who have sex with men in 6 US cities. *J Acquir Immune Defic Syndr.* 2014;67:438–45.
112. Nelson KM, Thiede H, Jenkins RA, Carey JW, Hutcheson R, Golden MR. Personal and contextual factors related to delayed HIV diagnosis among men who have sex with men. *AIDS Educ Prev.* 2014;26:122–33.
113. Rowe C, Matheson T, Das M, et al. Correlates of recent HIV testing among substance-using men who have sex with men. *Int J STD AIDS.* 2016;28(6):594–601.
114. Friedman MS, Marshal MP, Stall R, Cheong J, Wright ER. Gay-related development, early abuse and adult health outcomes among gay males. *AIDS Behav.* 2008;12:891–902.
115. Glick SN, Morris M, Foxman B, et al. A comparison of sexual behavior patterns among men who have sex with men and heterosexual men and women. *J Acquir Immune Defic Syndr.* 2012;60:83–90.
116. Grov C, Bimbi DS, Nanin JE, Parsons JT. Race, ethnicity, gender, and generational factors associated with the coming-out process among gay, lesbian, and bisexual individuals. *J Sex Res.* 2006;43:115–21.
117. Patel P, Borkowf CB, Brooks JT, Lasry A, Lansky A, Mermin J. Estimating per-act HIV transmission risk: a systematic review. *AIDS.* 2014;28:1509–19.
118. Fields EL, Bogart LM, Smith KC, Malebranche DJ, Ellen J, Schuster MA. HIV risk and perceptions of masculinity among young black men who have sex with men. *J Adol Health.* 2012;50:296–303.
119. Newcomb ME, Mustanski B. Racial differences in same-race partnering and the effects of sexual partnership characteristics on HIV risk in MSM: a prospective sexual diary study. *J Acquir Immune Defic Syndr.* 2013;62:329–33.
120. Satterwhite CL, Torrone E, Meites E, et al. Sexually transmitted infections among US women and men: prevalence and incidence estimates, 2008. *Sex Transm Dis.* 2013;40:187–93.