

Original Paper

# Factors Associated With Condom Breakage During Anal Intercourse: A Cross-Sectional Study of Men Who Have Sex With Men Recruited in an Online Survey

Min Kim<sup>1</sup>, MPH; Jennie McKenney<sup>1</sup>, MPH, PhD; Christine M Khosropour<sup>2</sup>, MPH, PhD; Adam B Prater<sup>3</sup>, MPH, MD; Eli S Rosenberg<sup>1</sup>, PhD; Aaron J Siegler<sup>1</sup>, MHS, PhD; Patrick S Sullivan<sup>1</sup>, PhD, DVM

<sup>1</sup>Rollins School of Public Health, Department of Epidemiology, Emory University, Atlanta, GA, United States

<sup>2</sup>University of Washington, Department of Medicine, University of Washinton, Seattle, WA, United States

<sup>3</sup>Emory University, Department of Radiology and Imaging Sciences, University of Emory, Atlanta, GA, United States

**Corresponding Author:**

Jennie McKenney, MPH, PhD

Rollins School of Public Health

Department of Epidemiology

Emory University

1518 Clifton Road 4th Floor

Atlanta, GA,

United States

Phone: 1 404 727 5294

Fax: 1 404 727 5294

Email: [jennie.l.mckenney@emory.edu](mailto:jennie.l.mckenney@emory.edu)

## Abstract

**Background:** Within the United States, HIV affects men who have sex with men (MSM) disproportionately compared to the general population. In 2011, MSM represented nearly two-thirds of all new HIV infections while representing less than 2% of the US male population. Condoms continue to be the foundation of many HIV prevention programs; however, the failure rate of condoms during anal intercourse among MSM is estimated to be 0.5% to 8%, and condom breakages leave those affected at high risk for HIV transmission.

**Objective:** Estimate the frequency of condom breakage and associated demographic and behavioral factors during last act of anal intercourse using data from a national online HIV prevention survey of MSM.

**Methods:** From March 19 to April 16, 2009, data were collected on 9005 MSM through an online survey of US MSM recruited through a social networking site. Using multivariable logistic regression and controlling for several demographic and sexual risk behaviors, we estimated odds ratios of the association between condom breakage and several risk factors.

**Results:** In the study, 8063 participants reported having at least one male sexual partner in the last 12 months. The median age of participants was 21 years (range 18-65). More than two-thirds (68.2%, 5498/8063) reported anal intercourse during last sex and 16.90% (927/5498) reported using a condom during last anal intercourse act. Condom breakage was reported by 4.4% (28/635) participants who engaged in receptive anal intercourse and 3.5% (16/459) participants who engaged in insertive anal intercourse, with an overall failure rate of 4.0% (95% CI 3.2%-6.0%). Age (adjusted odds ratio [aOR] per 5 years: 0.53 (95% CI 0.30-0.94), number of male sex partners (aOR per 5 sex partners: 1.03 (95% CI 1.00-1.08), and being high or buzzed during sex with a casual sex partner (aOR: 3.14, 95% CI 1.02-9.60) were associated with condom breakage.

**Conclusions:** Our results indicate condom breakage is an important problem for MSM that may be more common for younger men, for men with more partners, and during sex with casual partners after alcohol consumption or drug use. A better understanding of why condom breakage occurs more often in these groups is needed to improve educational efforts. Further, during this time of expanded interest in new condom designs, consideration should be given to how condom design might minimize breakage during anal sex.

(*JMIR Public Health Surveill* 2016;2(1):e7) doi: [10.2196/publichealth.5298](https://doi.org/10.2196/publichealth.5298)

## KEYWORDS

MSM; anal intercourse; condoms; condom failure

## Introduction

Men who have sex with men (MSM) continue to be disproportionately affected by HIV/AIDS in the United States. MSM represent less than 2% of the male population in the United States, but male-to-male sexual contact remains the predominant mode of HIV transmission, accounting for an estimated 65% of all new HIV diagnoses in 2011 [1,2]. Further, since 2008, the proportion of HIV diagnoses attributable to male-to-male sexual contact and the rate of HIV transmission among MSM continued to increase while trends for other transmission categories and groups have remained the same or declined [1-3]. The high prevalence of condomless anal intercourse among MSM coupled with the fact that anal intercourse is associated with greater HIV transmission probabilities compared to vaginal intercourse provides some explanation of the large burden of disease experienced among MSM [4-9].

Despite suboptimal utilization, male condoms have been and remain a constant in HIV prevention programs due to their effectiveness in reducing transmission of HIV/STIs when used correctly and consistently [10-17]. To date, however, the US Food and Drug Administration has only cleared condoms for use during vaginal intercourse and has warned against the use of condoms during anal intercourse [18]. Because of the physiological differences between anal intercourse and vaginal intercourse, such as friction and compression, it is possible that condoms break differentially by application [19-20].

Condom failure, defined as breakage or slippage of a condom during intercourse, can obviate the prevention benefit of condom usage, but data on condom failure rates and condom failure during specific sex acts have produced a wide range of failure rates [10,21-28]. In two separate studies, D'Anna et al reported higher rates of condom breakage or slippage during vaginal intercourse among heterosexual couples (6%) compared to anal intercourse among MSM couples (3%) [22,23]. Other studies have shown similarly low rates of condom failure (per condom use) among those engaging in anal intercourse (2%-3%), compared to vaginal intercourse [10,24-26].

Data on predictors of condom failure among MSM is limited. Penile length and circumference, absence of lubricants, race, and lower socioeconomic status have all been associated with higher rates of condom failure [29,30]. Further identification of behaviors associated with condom failure is key in order to identify high-risk groups and behaviors that would benefit from targeted condom education. Using data from a national online HIV prevention survey of MSM, we aimed to document how often condom breakage was reported to occur during anal intercourse between MSM and to identify demographic and behavioral characteristics associated with condom breakage during an act of anal intercourse.

## Methods

### Recruitment and Ethics

We utilized data from the Barriers to Online Prevention Research survey of US MSM collected between March 19, 2009 and April 16, 2009. The methods have been previously reported [31]. Briefly, participants were recruited from MySpace, a large social networking site, using banner advertisements. Advertisements were directed at male users of MySpace 18 years or older who resided within the United States. Once the banner advertisement was clicked, individuals were screened for eligibility and provided informed consent. Eligible participants included men 18 years or older who had at least one male sex partner in the past year and were residents of the United States. Eligible men were then asked to complete a Health Insurance Portability and Accountability Act-compliant online survey on SurveyGizmo (Boulder, CO). The survey took approximately 30 to 45 minutes to complete, and no compensation was provided to participants. The study protocol was approved by the Emory University Institutional Review Board.

### Data Collection

Participants were asked a series of questions regarding demographics, sexual history, most recent sex act, and most recent sexual partner. Specifically, participants were asked to report the number of male sexual partners in the last 12 months and if they were high or buzzed during last act sex act. Participants were also asked questions pertaining to their most recent sex partner, such as if he was a main or casual partner. A main partner was defined as someone that the participant felt committed to above all others, and a casual partner was defined as one whom the participant did not feel committed to above all others. With regard to their last sexual partner, participants were asked whether they engaged in anal and/or oral sex with him, if a condom was used, and if the condom broke during last anal intercourse. A copy of the survey items relevant to the present study can be seen in [Multimedia Appendix 1](#).

Our outcome measure, condom breakage, was assessed via a categorical response to two separate questions designed to capture both receptive and anal insertive sex acts. Men were first asked if they had receptive anal intercourse, insertive anal intercourse, or both during their last sex episode. Based on their responses, men were asked separately about condom use when they were the receptive and/or insertive partner. Questions were: "Did [your last sexual partner] use a condom the last time you had *receptive* anal sex?" and "Did you use a condom the last time you had *insertive* anal sex?" Responses for both questions included "He (I) did not use a condom," "He (I) used a condom part of the time," "He (I) used a condom the whole time," "He (I) used a condom but it broke," "Don't know," or "Prefer not to answer." Condom breakage was defined as answering "He (I) used a condom but it broke" for either insertive or receptive anal sex acts with the last male sex partner of the participant.

## Data Analysis

Data were analyzed using SAS version 9.4 (SAS Institute). Participants included in the final analysis reported engaging in receptive or insertive anal intercourse with their last male partner in the past 12 months and using a condom during last anal intercourse. Bivariate analyses were conducted to examine unadjusted correlates of condom breakage. For continuous variables, a Wilcoxon rank-sum  $z$  test (two-sided) was used due to the nonnormally distributed nature of the variables. Statistically significant covariates ( $P$  value  $\leq .05$ ) were included in the final model, as were variables found to be associated with condom breakage in previous studies [20-22,25,32,33].

The dependent variable, condom breakage, was calculated as a proportion and modeled the event level for both receptive and insertive anal intercourse at last sex. Thus, one participant could contribute two observations (one for receptive and one for insertive sex) from his last sexual episode. Multivariable analysis was conducted using multivariable logistic regression controlling for repeated observations. Odds ratios and 95% confidence intervals were calculated for categorical variables. For

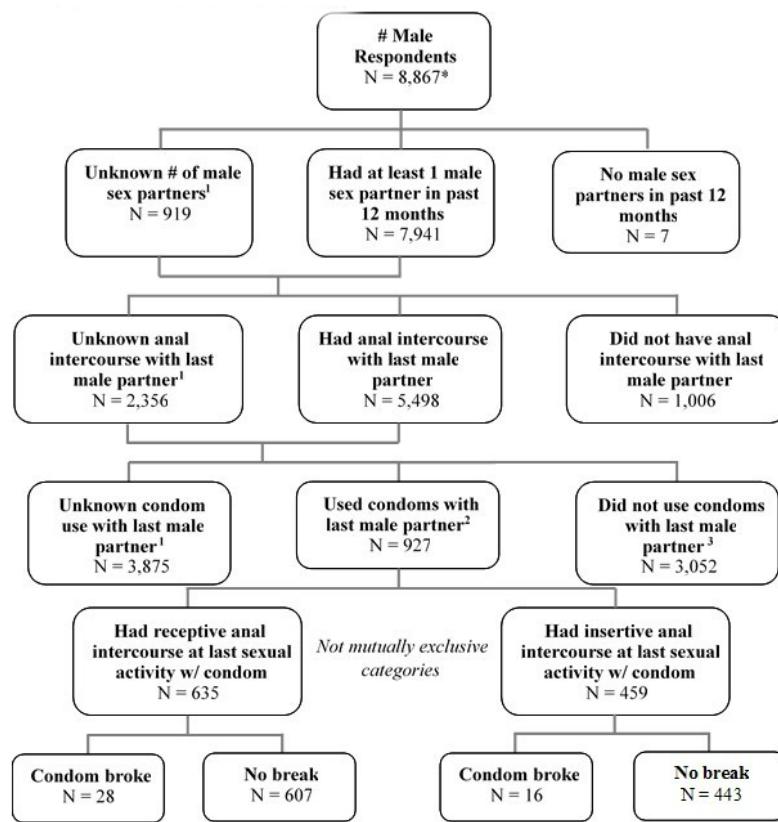
continuous variables, odds ratios and confidence intervals per unit of 5 were calculated.

## Results

A total of 9005 participants completed the initial screening questions and gave consent; 133 surveys were linked to duplicate IP addresses and were therefore excluded. Of the 8872 unique surveys completed, 62.0% (5498/8872) were completed by men who reported anal intercourse at last sex; 44.0% (3875/8872) did not know if they used a condom at last anal intercourse. A total of 10.4% (927/8872 of the surveys were completed by participants who reported condom use at last sex and thus were eligible for multivariable analysis. Figure 1 describes how participants were classified and identified for inclusion in the analysis.

Demographic information on the 927 participants who reported using a condom at last anal intercourse and the 3052 participants who reported not using a condom at last anal intercourse is provided in Table 1.

**Figure 1.** Inclusion criteria flowchart.



\* Excludes 138 duplicate records with the same IP address.

<sup>1</sup> Includes participants who dropped out of the survey, refused to answer the question, didn't know, or skipped the question.

<sup>2</sup> Used condoms for either receptive or anal intercourse with another male at last sexual activity (this does not mean they had to use condoms for both anal and receptive intercourse if the participant was involved in both sexual activities).

<sup>3</sup> Participant did not use condoms for both receptive and insertive anal intercourse (if involved with both or either activities).

**Table 1.** Demographic and behavioral characteristics of men at last act of anal intercourse with a male sexual partner, stratified by condom use, among participants of an online HIV prevention survey, United States, March-April 2009.

Characteristics	Used condoms <sup>a</sup> (N=927)	Did not use condoms <sup>a</sup> (N=3052)	Total(N=3979) n (%)
	n (%)	n (%)	
<b>Race/ethnicity<sup>b</sup></b>			
Black/African-American	150 (16.3)	354 (11.7)	504 (12.8)
Latino/Hispanic	365 (39.8)	962 (31.8)	1327 (33.7)
White/Caucasian	281 (30.6)	1375 (45.5)	1656 (42.0)
Other <sup>c</sup>	122 (13.3)	331 (11.0)	453 (11.5)
<b>Education</b>			
≤ High school diploma/GED	394 (43.4)	1269 (42.0)	1663 (42.3)
> High school diploma/GED	516 (56.7)	1752 (58.0)	2268 (57.7)
Age (years), median (range) <sup>b</sup>	21.0 (18-65)	22.0 (18-65)	21.0 (18-65)
<b>Sexual identity<sup>b</sup></b>			
Heterosexual/straight	669 (72.6)	2366 (78.2)	3035 (76.9)
Homosexual/gay	236 (25.6)	628 (20.8)	864 (21.9)
Other <sup>d</sup>	17 (1.8)	32 (1.1)	49 (1.2)
Number of male sex partners in last 12 months, median (range) <sup>b</sup>	5.0 (1-365)	3.0 (1-365)	4 (1-365)
<b>Type of MRMSP<sup>b</sup></b>			
Main	448 (52.1)	2039 (71.1)	2487 (66.7)
Casual	412 (47.9)	829 (28.9)	1241 (33.3)
<b>Race/ethnicity of MRMSP<sup>b</sup></b>			
Black/African-American	157 (17.2)	360 (12.0)	517 (13.2)
Latino/Hispanic	298 (32.7)	793 (26.4)	1091 (27.9)
White/Caucasian	366 (40.2)	1592 (53.1)	1958 (50.1)
Other <sup>c</sup>	90 (9.9)	256 (8.5)	346 (8.8)
<b>Racial concordance with MRM-SP<sup>e</sup></b>			
Yes	500 (55.4)	1695 (56.9)	2195 (56.5)
No	403 (44.6)	1286 (43.1)	1689 (43.5)
Age of MRMSP, median (range) <sup>b</sup>	23 (18-70)	24 (18-70)	23 (18-70)
<b>Age discrepancy with MRMSP</b>			
Participant is at least 5 years younger	232 (25.0)	740 (24.3)	972 (24.4)
Participant is within 5 years in age	612 (66.0)	2045 (67.0)	2657 (66.8)
Participant is at least 5 years older	83 (9.0)	267 (8.8)	350 (8.8)
<b>MRMSP is an exchange partner<sup>f</sup></b>			
Yes	28 (3.1)	64 (2.1)	92 (2.3)
No	888 (96.9)	2977 (97.9)	3865 (97.7)
<b>High or buzzed during sex<sup>g</sup></b>			
Yes	225 (25.3)	681 (23.2)	906 (23.7)

Characteristics	Used condoms <sup>a</sup> (N=927)	Did not use condoms <sup>a</sup> (N=3052)	Total(N=3979) n (%)
No	665 (74.7)	2259 (76.8)	2924 (76.3)
<b>HIV status of MRMSP</b>			
HIV positive	32 (5.3)	116 (5.0)	148 (5.1)
HIV negative	577 (94.8)	2186 (95.0)	2763 (94.9)

<sup>a</sup>Column percentages may not add up to 100% due to rounding; missing values were not included.

<sup>b</sup>*P* value ≤.05.

<sup>c</sup>Other races include Asian/Pacific Islander, Native American/Alaskan Native, multiple, and other races.

<sup>d</sup>Other sexual identities include bisexual and other.

<sup>e</sup>A participant is racially concordant with MRMSP if he/she reports the same race/ethnicity as the MRMSP.

<sup>f</sup>Exchange partner is defined as a partner with whom the participant had sex in exchange for things they needed (eg, money, drugs, food, shelter, or transportation).

<sup>g</sup>Includes being high or buzzed with alcohol, drugs not prescribed by a doctor, or both during sex.

Most participants were members of a racial or ethnic minority: 33.7% (1327/3979) were Hispanic, 12.8% (504/3979) were black non-Hispanic, and 11.5% (453/3979) were multiracial. Most reported having attended some college, and three-quarters of all participants were aged 18 to 26 years. The median number of male sex partners in the past 12 months was 3, and over half of participants' last male sex partners were casual partners. Nearly 20% (906/3979) of participants had used drugs or alcohol prior to engaging in sex at last sexual episode, and almost 2% (92/3979) of participants reported exchange sex with their most recent male sex partner.

Of the 927 participants included in the final analysis, 69.0% (635/927) reported using a condom during receptive anal intercourse and 50.0% (459/927) reported using a condom during insertive anal intercourse. Overall, condom breakage was reported in 4.0% (44/1094, 95% CI 3.2%-6.0%) of the total distinct episodes of anal intercourse. Condom breakage

was reported by 4.4% (28/635) participants who engaged in receptive anal intercourse and 3.5% (16/459) participants who engaged in insertive anal intercourse.

Results from the multivariable analysis are presented in Table 2. Younger age and being buzzed or high before or during sex with a casual partner were associated with condom breakage during last anal intercourse, while number of male sexual partners in the past year was marginally significant. Participants' odds of condom breakage increased 3% for every 5 male sex partners reported in the past year (adjusted odds ratio 1.03, 95% CI 1.00-1.08). Participants who reported being high or buzzed at last sex with a casual sex partner had 3 times the odds of condom breakage compared to participants who reported being high or buzzed at last sex with a main partner (95% CI 1.02-9.6). The odds of condom breakage were 0.53 for every 5-year increase in age of a participant (95% CI 0.30-0.94).

**Table 2.** Associations between demographic and behavioral factors and condom breakage among men who had anal intercourse with their last male sex partner, in an online HIV prevention survey, United States, March-April 2009.

Characteristics	Broken condom <sup>ab</sup> (N=41)	No broken <sup>ab</sup> condom (N=881)	Crude odds ratio (95% CI)	Adjusted odds ratio (95% CI)
	n (%)	n (%)		
<b>Race/ethnicity</b>				
Black/African-American	10 (7)	139 (93)	1.95 (0.79-4.80)	2.13 (0.79-5.77)
Latino/Hispanic	13 (4)	349 (96)	1.01 (0.4-2.34)	0.78 (0.29-2.08)
Other <sup>c</sup>	8 (7)	113 (93)	1.92 (0.74-4.99)	1.98 (0.6-5.76)
White/Caucasian	10 (4)	271 (96)	Referent	Referent
<b>Education</b>				
≤ High school diploma/GED	19 (5)	374 (95)	1.32 (0.69-2.53)	0.84 (0.39-1.81)
> High school diploma/GED	19 (4)	493 (96)	Referent	Referent
Age (year), median (range) <sup>d</sup>	20 (18-47)	21 (18-65)	0.69 (0.48-1.01)	0.53 (0.30-0.94)
<b>Number of male sex partners in last 12 months<sup>d</sup></b>	6 (1-364)	4 (1-87)	1.05 (1.02-1.07)	1.03 (1.00-1.08)
<b>MRMSP is an exchange partner<sup>e</sup></b>				
Yes	4 (14)	24 (86)	3.93 (1.29-11.91)	0.63 (0.06-6.31)
No	36 (4)	848 (96)	Referent	Referent
<b>Type of MRMSP</b>				
Main	23 (5)	421 (92)	1.45 (0.74-2.81)	See interaction
Casual	15 (4)	397 (96)	Referent	See interaction
<b>High or buzzed during sex<sup>f</sup></b>				
Yes	16 (7)	209 (93)	2.33 (1.20-4.56)	See interaction
No	21 (3)	640 (96)	Referent	See interaction
<b>Interaction, high or buzzed during sex</b>				
Casual partner	10 (9)	107 (91)	—	3.14 (1.02-9.60)
Main partner	4 (5)	82 (95)	—	Referent
<b>Interaction, not high or buzzed during sex</b>				
Casual partner	4 (1)	274 (99)	—	0.31 (0.08-1.27)
Main partner	17 (5)	324 (95)	—	Referent

<sup>a</sup>Column percentages may not add up to 100% due to rounding; missing values were not included.

<sup>b</sup>Condom break is defined as a break in the condom during either insertive or receptive anal intercourse (or both) during last sexual activity with a male partner. No condom breakage is defined as no break in the condom at last sexual activity (with both insertive and receptive anal intercourse) with a male partner.

<sup>c</sup>Other races include Asian/Pacific Islander, Native American/Alaskan Native, multiple, and other races.

<sup>d</sup>Per 5-unit increase.

<sup>e</sup>Exchange partner is defined as a partner with whom the participant had sex in exchange for things they needed (eg, money, drugs, food, shelter, or transportation).

<sup>f</sup>Includes being high or buzzed with alcohol, drugs not prescribed by a doctor, or both during sex.

## Discussion

### Principal Findings

Results from our multivariable analysis of condom breakage among US MSM revealed an overall condom breakage rate of 4%. Condom breakage rates did not differ between participants who reported receptive and insertive anal intercourse. Younger age, a greater number of sexual partners reported in the last 12 months, and being buzzed or high at last sex with a casual partner were associated with condom breakage.

The overall condom breakage rate of 4% is in line with previous studies [10,14-18], but there is considerable variability among breakage rates from prior studies [33-40]. Golombok et al found a condom failure rate of 2% in a group of 283 homosexual couples in the United Kingdom, but the study focused on sexual activity among long-term couples, which does not represent the MSM population [19]. Our sample was younger, and more than half of sex partners were reported to be casual partners. A 6-month condom breakage risk of 31% was found in a cohort study of MSM in Atlanta, GA [35]. The high frequency of condom breakage found in the aforementioned Atlanta cohort study compared to other studies is likely due to the longer recall period (6 months), allowing for a higher number of sex acts to occur. Further, the study revealed 40% of black MSM reported breakage or incomplete use; the population was twice as likely to report condom breakage as white MSM. Similar point estimates were seen from our analysis; however, our sample size was not sufficient to assess the relationship. The wide variability of condom failure rates among these studies is most likely a reflection of the diverse population of MSM and sample sizes under study [36-40].

For every 5 male sexual partners, we found that the odds of condom breakage increased by 3%. There are likely user characteristics of participants with large numbers of sexual partners not captured by our survey that explain the statistical association with condom breakage. Participants with a larger number of male sexual partners might have engaged in more aggressive coital behaviors than those with fewer sexual partners, leading to greater stress on the condom [41,42]. Further, participants with a large number of male sexual partners may have a predisposition to inappropriately use lubricant, resulting in condom failure [43]. MSM who report high numbers of sexual partners represent a risk group commonly targeted for behavioral interventions, as having multiple sexual partners is an established risk factor for HIV acquisition [38]. Results from our study suggest that behavioral prevention interventions targeted to this high-risk group should also include more thorough condom education.

Several studies demonstrated that drug and alcohol use is associated with an increased risk of HIV acquisition among heterosexual men engaging in vaginal intercourse and MSM engaging in anal intercourse [44,45]. Alcohol use during sex is higher among casual partners compared to main partners; however, few studies have assessed the association between condom failure and partner type, modified by alcohol and drug use before or during sex [46,47]. Results from our study suggest that being high or buzzed during sex with a casual partner was

associated with increased odds of condom breakage compared to being high or buzzed with a main partner. Alcohol and drug use may prolong ejaculation and thereby prolong sex, increasing the risk of condom failure [27]. Moreover, alcohol and drug use may impede the proper application and usage of condoms, increasing condom failure rates [27]. These results suggest that public health prevention interventions need to increase awareness of the effects of drug and alcohol use during sex, specifically targeting MSM who engage in sex with casual partners.

### Limitations

There are several limitations to this study. Most notably, our respondents are not representative of all MSM in the United States. Due to the nature of the survey, participants had to be proficient with computers, making them more likely to have a higher education and income than the general population of MSM. Our study used a cross-sectional study design to evaluate condom breakage at last intercourse and therefore did not capture condom use or breakage over time. Safe sex behaviors fluctuate over time [31], making a prospective study more appropriate to capture the time-dependent nature of condom use and failure. We did not ascertain a history of lubrication use or lubrication use during last sex act. Therefore, our sample may represent men who were less likely to use lubrication, and thus, factors associated with condom breakage may actually be factors associated with lubrication use. The majority of studies that have evaluated condom failure define it as condom breakage or slippage during sex [36-39]. Our study only used condom breakage as a measurement of condom failure. Omission of condom slippage data resulted in our inability to report condom failure more generally. Our study uses older data; however, our finding of a condom breakage rate of 4% is in line with previous and more recent studies [10,14-18]. Finally, responses may have been affected by social desirability bias and recall bias, resulting in misclassification of outcomes [48].

### Conclusion

Results from our study highlight condom breakage rates among a diverse sample of MSM from the United States. While condoms remain a strong component of prevention policy, our findings indicate condoms may not suffice as a sole means of reducing HIV transmission risk within the context of a high per-act transmission risk of anal sex [6]. Combining condoms with other prevention modalities such as preexposure prophylaxis can help mitigate risk that occurs after condom breakage [49]. Even in the context of preexposure prophylaxis, more efforts should be made to improve condom use practices that might lead to condom failure [49]. MSM who report a high number of sexual partners as well as those who use drugs and/or alcohol before or during sex with a casual partner are at an increased risk for condom failure and would benefit from targeted condom education programs to help mitigate their risks. As innovation continues to occur in the design of condoms, it will be important to consider if there are new types or designs of condoms that might decrease condom breakage during anal intercourse [49]. To best understand when, why, and how condom failures occur, further studies are needed to capture the time-dependent nature of condom use; these should include

high-risk sexual behaviors; precoital factors, such as condom storage; and coital factors, such as duration of sex act and use of lubricants. As HIV continues to disproportionately affect

United States MSM and anal intercourse remains a significant mode of HIV transmission, condom failure among this population needs to be addressed through multiple approaches.

## Acknowledgments

This work was facilitated by the Center for AIDS Research at Emory University (P30AI050409) and funded through a CFAR-03 grant.

## Conflicts of Interest

PS is editor-in-chief of JMIR Public Health and Surveillance. This paper was handled independently by an associate editor, with PS not involved in any decision-making. Other authors have nothing to declare.

## Multimedia Appendix 1

Barriers to Online Prevention Survey.

[[PDF File \(Adobe PDF File, 231KB\)](#) [Multimedia Appendix 1](#)]

## References

1. HIV Surveillance Report, 2011. Centers for Disease Control and Prevention URL: [http://www.cdc.gov/hiv/pdf/statistics\\_2011\\_hiv\\_surveillance\\_report\\_vol\\_23.pdf](http://www.cdc.gov/hiv/pdf/statistics_2011_hiv_surveillance_report_vol_23.pdf) [accessed 2016-01-24] [WebCite Cache ID 6emmEQSUY]
2. Purcell DW, Johnson CH, Lansky A, Prejean J, Stein R, Denning P, 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 J.* 2012;6:98-107. [FREE Full text] [doi: [10.2174/1874613601206010098](https://doi.org/10.2174/1874613601206010098)] [Medline: [23049658](https://pubmed.ncbi.nlm.nih.gov/23049658/)]
3. HIV Surveillance Supplemental Report. Atlanta, GA. Centers for Disease Control and Prevention; 2012. URL: [http://www.cdc.gov/hiv/pdf/statistics\\_hssr\\_vol\\_17\\_no\\_4.pdf](http://www.cdc.gov/hiv/pdf/statistics_hssr_vol_17_no_4.pdf) [WebCite Cache ID 6dlx4fp5]
4. Finlayson TJ, Le B, Smith A, Bowles K, Cribbin M, Miles I, 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.* Oct 28, 2011;60(14):1-34. [FREE Full text] [Medline: [22031280](https://pubmed.ncbi.nlm.nih.gov/22031280/)]
5. Grulich AE, Zablotska I. Commentary: probability of HIV transmission through anal intercourse. *Int J Epidemiol.* Aug 2010;39(4):1064-1065. [FREE Full text] [doi: [10.1093/ije/dyq101](https://doi.org/10.1093/ije/dyq101)] [Medline: [20511336](https://pubmed.ncbi.nlm.nih.gov/20511336/)]
6. Baggaley RF, White RG, Boily M. HIV transmission risk through anal intercourse: systematic review, meta-analysis and implications for HIV prevention. *Int J Epidemiol.* Aug 2010;39(4):1048-1063. [FREE Full text] [doi: [10.1093/ije/dyq057](https://doi.org/10.1093/ije/dyq057)] [Medline: [20406794](https://pubmed.ncbi.nlm.nih.gov/20406794/)]
7. Boily M, Baggaley RF, Wang L, Masse B, White RG, Hayes RJ, et al. Heterosexual risk of HIV-1 infection per sexual act: systematic review and meta-analysis of observational studies. *Lancet Infect Dis.* Feb 2009;9(2):118-129. [FREE Full text] [doi: [10.1016/S1473-3099\(09\)70021-0](https://doi.org/10.1016/S1473-3099(09)70021-0)] [Medline: [19179227](https://pubmed.ncbi.nlm.nih.gov/19179227/)]
8. Wilson DP, Law MG, Grulich AE, Cooper DA, Kaldor JM. Relation between HIV viral load and infectiousness: a model-based analysis. *Lancet.* Jul 26, 2008;372(9635):314-320. [doi: [10.1016/S0140-6736\(08\)61115-0](https://doi.org/10.1016/S0140-6736(08)61115-0)] [Medline: [18657710](https://pubmed.ncbi.nlm.nih.gov/18657710/)]
9. Jin F, Jansson J, Law M, Prestage GP, Zablotska I, Imrie JCG, et al. Per-contact probability of HIV transmission in homosexual men in Sydney in the era of HAART. *AIDS.* Mar 27, 2010;24(6):907-913. [FREE Full text] [doi: [10.1097/QAD.0b013e3283372d90](https://doi.org/10.1097/QAD.0b013e3283372d90)] [Medline: [20139750](https://pubmed.ncbi.nlm.nih.gov/20139750/)]
10. Rietmeijer CA, Krebs JW, Feorino PM, Judson FN. Condoms as physical and chemical barriers against human immunodeficiency virus. *JAMA.* Mar 25, 1988;259(12):1851-1853. [Medline: [2830416](https://pubmed.ncbi.nlm.nih.gov/2830416/)]
11. Pinkerton SD, Abramson PR. Effectiveness of condoms in preventing HIV transmission. *Soc Sci Med.* May 1997;44(9):1303-1312. [Medline: [9141163](https://pubmed.ncbi.nlm.nih.gov/9141163/)]
12. Holmes KK, Levine R, Weaver M. Effectiveness of condoms in preventing sexually transmitted infections. *Bull World Health Organ.* Jun 2004;82(6):454-461. [FREE Full text] [Medline: [15356939](https://pubmed.ncbi.nlm.nih.gov/15356939/)]
13. Warner L, Stone KM, Macaluso M, Buehler JW, Austin HD. Condom use and risk of gonorrhea and Chlamydia: a systematic review of design and measurement factors assessed in epidemiologic studies. *Sex Transm Dis.* Jan 2006;33(1):36-51. [Medline: [16385221](https://pubmed.ncbi.nlm.nih.gov/16385221/)]
14. Niccolai LM, Rowhani-Rahbar A, Jenkins H, Green S, Dunne DW. Condom effectiveness for prevention of Chlamydia trachomatis infection. *Sex Transm Infect.* Aug 2005;81(4):323-325. [FREE Full text] [doi: [10.1136/sti.2004.012799](https://doi.org/10.1136/sti.2004.012799)] [Medline: [16061540](https://pubmed.ncbi.nlm.nih.gov/16061540/)]
15. Ahmed S, Lutalo T, Wawer M, Serwadda D, Sewankambo NK, Nalugoda F, et al. HIV incidence and sexually transmitted disease prevalence associated with condom use: a population study in Rakai, Uganda. *AIDS.* Nov 9, 2001;15(16):2171-2179. [Medline: [11684937](https://pubmed.ncbi.nlm.nih.gov/11684937/)]

16. Gallo MF, Steiner MJ, Warner L, Hylton-Kong T, Figueroa JP, Hobbs MM, et al. Self-reported condom use is associated with reduced risk of chlamydia, gonorrhea, and trichomoniasis. *Sex Transm Dis.* Oct 2007;34(10):829-833. [doi: [10.1097/OLQ.0b013e318073bd71](https://doi.org/10.1097/OLQ.0b013e318073bd71)] [Medline: [17579339](#)]
17. Reece M, Herbenick D, Schick V, Sanders SA, Dodge B, Fortenberry JD. Condom use rates in a national probability sample of males and females ages 14 to 94 in the United States. *J Sex Med.* Oct 2010;7 Suppl 5:266-276. [doi: [10.1111/j.1743-6109.2010.02017.x](https://doi.org/10.1111/j.1743-6109.2010.02017.x)] [Medline: [21029384](#)]
18. Silverman BG, Gross TP. Use and effectiveness of condoms during anal intercourse. A review. *Sex Transm Dis.* Jan 1997;24(1):11-17. [Medline: [9018778](#)]
19. Golombok S, Harding R, Sheldon J. An evaluation of a thicker versus a standard condom with gay men. *AIDS.* Jan 26, 2001;15(2):245-250. [Medline: [11216934](#)]
20. van Griensvan GJ, Samuel MC, Winklestein W. The success and failure of condom use by homosexual men in San Francisco. *J Acquir Immune Defic Syndr.* Apr 1993;6(4):430-431. [Medline: [8455150](#)]
21. Buchbinder SP, Douglas JM, McKirnan DJ, Judson FN, Katz MH, MacQueen KM. Feasibility of human immunodeficiency virus vaccine trials in homosexual men in the United States: risk behavior, seroincidence, and willingness to participate. *J Infect Dis.* Nov 1996;174(5):954-961. [FREE Full text] [Medline: [8896495](#)]
22. D'Anna LH, Korosteleva O, Warner L, Douglas J, Paul S, Metcalf C, et al. Factors associated with condom use problems during vaginal sex with main and non-main partners. *Sex Transm Dis.* Sep 2012;39(9):687-693. [FREE Full text] [doi: [10.1097/OLQ.0b013e31825ef325](https://doi.org/10.1097/OLQ.0b013e31825ef325)] [Medline: [22895490](#)]
23. D'Anna LH, Margolis AD, Warner L, Korosteleva OA, O'Donnell L, Rietmeijer CA, et al. Safe in the City Study Group. Condom use problems during anal sex among men who have sex with men (MSM): findings from the Safe in the City study. *AIDS Care.* 2012;24(8):1028-1038. [FREE Full text] [doi: [10.1080/09540121.2012.668285](https://doi.org/10.1080/09540121.2012.668285)] [Medline: [22519680](#)]
24. Golombok S, Sheldon J. Evaluation of a thicker condom for use as a prophylactic against HIV transmission. *AIDS Educ Prev.* Oct 1994;6(5):454-458. [Medline: [7818981](#)]
25. Stone E, Heagerty P, Vittinghoff E, Douglas JM, Koblin BA, Mayer KH, et al. Correlates of condom failure in a sexually active cohort of men who have sex with men. *J Acquir Immune Defic Syndr Hum Retrovirol.* Apr 15, 1999;20(5):495-501. [Medline: [10225233](#)]
26. Gross M, Buchbinder SP, Holte S, Celum CL, Koblin BA, Douglas JM. Use of Reality "female condoms" for anal sex by US men who have sex with men. HIVNET Vaccine Preparedness Study Protocol Team. *Am J Public Health.* Nov 1999;89(11):1739-1741. [Medline: [10553399](#)]
27. de Wit J, de Vroome E, van Griensvan B. Failure rate of condoms among gay men. 1992. Presented at: VIII International Conference on AIDS; 1992:5178; Amsterdam, Netherlands.
28. Detels R, English P, Visscher BR, Jacobson L, Kingsley LA, Chmiel JS, et al. Seroconversion, sexual activity, and condom use among 2915 HIV seronegative men followed for up to 2 years. *J Acquir Immune Defic Syndr.* 1989;2(1):77-83. [Medline: [2918462](#)]
29. Reece M, Herbenick D, Sanders SA, Monahan P, Temkit M, Yarber WL. Breakage, slippage and acceptability outcomes of a condom fitted to penile dimensions. *Sex Transm Infect.* Apr 2008;84(2):143-149. [doi: [10.1136/sti.2007.028316](https://doi.org/10.1136/sti.2007.028316)] [Medline: [17971373](#)]
30. Smith AM, Jolley D, Hocking J, Benton K, Geroji J. Does penis size influence condom slippage and breakage? *Int J STD AIDS.* Aug 1998;9(8):444-447. [Medline: [9702591](#)]
31. Sullivan PS, Khosropour CM, Luisi N, Amsden M, Coggia T, Wingood GM, et al. Bias in online recruitment and retention of racial and ethnic minority men who have sex with men. *J Med Internet Res.* May 2011;13(2):e38. [FREE Full text] [doi: [10.2196/jmir.1797](https://doi.org/10.2196/jmir.1797)] [Medline: [21571632](#)]
32. Golombok S, Sketchley J, Rust J. Condom failure among homosexual men. *J Acquir Immune Defic Syndr.* 1989;2(4):404-409. [Medline: [2666641](#)]
33. Tindall B, Swanson C, Donovan B, Cooper DA. Sexual practices and condom usage in a cohort of homosexual men in relation to human immunodeficiency virus status. *Med J Aust.* Sep 18, 1989;151(6):318-322. [Medline: [2593942](#)]
34. van Griensven G, de Vroome E, Tielman R, Coutinho R. Failure rate of condoms during anogenital intercourse in homosexual men. *Genitourin Med.* Oct 1988;64(5):344-346. [FREE Full text] [Medline: [3203934](#)]
35. Hernández-Romieu AC, Siegler AJ, Sullivan PS, Crosby R, Rosenberg ES. How often do condoms fail? A cross-sectional study exploring incomplete use of condoms, condom failures and other condom problems among black and white MSM in southern U.S.A. *Sex Transm Infect.* Dec 2014;90(8):602-607. [doi: [10.1136/sextans-2014-051581](https://doi.org/10.1136/sextans-2014-051581)] [Medline: [25080511](#)]
36. Weinstock HS, Lindan C, Bolan G, Kegeles SM, Hearst N. Factors associated with condom use in a high-risk heterosexual population. *Sex Transm Dis.* 1993;20(1):14-20. [Medline: [8430354](#)]
37. Richters J, Donovan B, Geroji J, Watson L. Low condom breakage rate in commercial sex. *Lancet.* 1988;2(8626-8627):1487-1488. [Medline: [2904595](#)]
38. Messiah A, Dart T, Spencer BE, Warszawski J. Condom breakage and slippage during heterosexual intercourse: a French national survey. French National Survey on Sexual Behavior Group (ACSF). *Am J Public Health.* Mar 1997;87(3):421-424. [Medline: [9096545](#)]

39. Spruyt A, Steiner MJ, Joanis C, Glover LH, Piedrahita C, Alvarado G, et al. Identifying condom users at risk for breakage and slippage: findings from three international sites. *Am J Public Health*. Feb 1998;88(2):239-244. [Medline: [9491014](#)]
40. Crosby R, Mena L, Yarber WL, Graham CA, Sanders SA, Milhausen RR. Condom use errors and problems: a comparative study of HIV-positive versus HIV-negative young black men who have sex with men. *Sex Transm Dis*. Nov 2015;42(11):634-636. [doi: [10.1097/OLQ.0000000000000356](#)] [Medline: [26462188](#)]
41. Halperin DT. Heterosexual anal intercourse: prevalence, cultural factors, and HIV infection and other health risks, Part I. *AIDS Patient Care STDS*. Dec 1999;13(12):717-730. [Medline: [10743535](#)]
42. Steiner M, Piedrahita C, Glover L, Joanis C. Can condom users likely to experience condom failure be identified? *Fam Plann Perspect*. 1993;25(5):220-223. [Medline: [8262171](#)]
43. Grady WR, Tanfer K. Condom breakage and slippage among men in the United States. *Fam Plann Perspect*. 1994;26(3):107-112. [Medline: [8070546](#)]
44. Powis B, Griffiths P, Gossop M, Strang J. Heterosexual anal intercourse, health risks and drug use: a review with special attention to drug users. *Drug Alcohol Rev*. 1995;14(2):223-229. [doi: [10.1080/09595239500185281](#)] [Medline: [16203314](#)]
45. Stone E, Seage G, Vittinghoff E. Predictors of condom failure in a cohort of sexually active gay and bisexual men. 1996. Presented at: XI International Conference on AIDS; 1996; Vancouver, Canada.
46. Venable PA, McKirnan DJ, Buchbinder SP, Bartholow BN, Douglas JM, Judson FN, et al. Alcohol use and high-risk sexual behavior among men who have sex with men: the effects of consumption level and partner type. *Health Psychol*. Sep 2004;23(5):525-532. [doi: [10.1037/0278-6133.23.5.525](#)] [Medline: [15367072](#)]
47. Purcell DW, Parsons JT, Halkitis PN, Mizuno Y, Woods WJ. Substance use and sexual transmission risk behavior of HIV-positive men who have sex with men. *J Subst Abuse*. 2001;13(1-2):185-200. [Medline: [11547619](#)]
48. Sackett DL. Bias in analytic research. *J Chronic Dis*. 1979;32(1-2):51-63. [Medline: [447779](#)]
49. Grant RM, Lama JR, Anderson PL, McMahan V, Liu AY, Vargas L, et al. Preexposure chemoprophylaxis for HIV prevention in men who have sex with men. *N Engl J Med*. Dec 30, 2010;363(27):2587-2599. [FREE Full text] [doi: [10.1056/NEJMoa1011205](#)] [Medline: [21091279](#)]

## Abbreviations

**MSM:** men who have sex with men

Edited by G Eysenbach; submitted 29.Oct.2015; peer-reviewed by R Milhausen, G Prestage, M Gates; comments to author 19.Nov.2015; accepted 04.Dec.2015; published 22.Feb.2016

Please cite as:

Kim M, McKenney J, Khosropour CM, Prater AB, Rosenberg ES, Siegler AJ, Sullivan PS

Factors Associated With Condom Breakage During Anal Intercourse: A Cross-Sectional Study of Men Who Have Sex With Men Recruited in an Online Survey

*JMIR Public Health Surveill* 2016;2(1):e7

URL: <http://publichealth.jmir.org/2016/1/e7/>

doi: [10.2196/publichealth.5298](#)

PMID: [27227161](#)

©Min Kim, Jennie McKenney, Christine M Khosropour, Adam B Prater, Eli S Rosenberg, Aaron J Siegler, Patrick S Sullivan. Originally published in JMIR Public Health and Surveillance (<http://publichealth.jmir.org>), 22.Feb.2016. This is an open-access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/2.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in JMIR Public Health and Surveillance, is properly cited. The complete bibliographic information, a link to the original publication on <http://publichealth.jmir.org>, as well as this copyright and license information must be included.