

UCSF

UC San Francisco Previously Published Works

Title

Lubrication Practices and Receptive Anal Sex: Implications for STI Transmission and Prevention

Permalink

<https://escholarship.org/uc/item/47h8s8x8>

Journal

Sexual Medicine, 9(3)

ISSN

2050-1161

Authors

Lee, Austin
Gaither, Thomas W
Langston, Marvin E
et al.

Publication Date

2021-06-01

DOI

10.1016/j.esxm.2021.100341

Peer reviewed

MEN'S SEXUAL HEALTH

Lubrication Practices and Receptive Anal Sex: Implications for STI Transmission and Prevention



Austin Lee, BA,¹ Thomas W. Gaither, MD, MAS,^{1,2} Marvin E. Langston, PhD, MPH,³ Stephanie E. Cohen, MD, MPH,^{4,5} and Benjamin N. Breyer, MD, MAS^{1,6}

ABSTRACT

Introduction: Implications of lubricant use in men having sex with men (MSM) are poorly characterized, particularly associations with sexual behavior and rectal sexually transmitted infection (STI) risk.

Aim: We sought to clarify covariates associated with lubrication type including differing sexual preferences and rectal STI prevalence.

Methods: Primary English-speaking individuals ≥ 18 years old visiting San Francisco City Clinic (SFCC) between April and May of 2018 who endorsed lubricant use during receptive anal sex within the last 3 months were studied. Associations between lubrication type used and collected covariates were assessed using Kruskal-Wallis analysis of variance for continuous variables and Chi-squared test for categorical variables. We used logistic regression to examine the association between lubrication type and rectal STI test result.

Main Outcome Measures: Rectal STI test positivity.

Results: From all enrolled participants, 179 completed the survey and endorsed use of a lubricant during receptive anal sex within the last 3 months. Silicone lubricant users had the most sexual partners in the last 3 months (13 [mean] \pm 30 [SD], $P = .0003$) and were most likely to have a history of gonorrhea. Oil-based lubricant users had the most partners with whom they had receptive anal sex in the last 3 months (7 ± 6 , $P = .03$). Water-based lubricant users most commonly used a condom in their last sexual encounter and had the fewest sexual partners in the last 3 months (4 ± 4 , $P = .0003$). Spit/saliva lubricant use was associated with positive rectal STI result.

Conclusion: Silicone and oil-based lubricant users were more likely to report condomless receptive anal sex and to have a history of gonorrhea while spit/saliva lubricant use associated with positive rectal STI acquisition. **Lee A, Gaither TW, Langston ME, et al. Lubrication Practices and Receptive Anal Sex: Implications for STI Transmission and Prevention. Sex Med 2021;9:100341.**

Copyright © 2021 The Authors. Published by Elsevier Inc. on behalf of the International Society for Sexual Medicine. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Key Words: Sexually Transmitted Infection; Anorectal; Lubrication; Practice

Received August 31, 2020. Accepted February 14, 2021.

¹Department of Urology, University of California-San Francisco, San Francisco, CA, USA;

²Department of Urology, University of California-Los Angeles, Los Angeles, CA, USA;

³Division of Research, Kaiser Permanente Northern California, Oakland, CA, USA;

⁴Population Health Division, San Francisco Department of Public Health, San Francisco, CA, USA;

⁵Division of Infectious Diseases, University of California-San Francisco, San Francisco, CA, USA;

⁶Department of Biostatistics and Epidemiology, University of California-San Francisco, San Francisco, CA, USA

Copyright © 2021 The Authors. Published by Elsevier Inc. on behalf of the International Society for Sexual Medicine. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

<https://doi.org/10.1016/j.esxm.2021.100341>

Sex Med 2021;9:100341

INTRODUCTION

Rectal sexually transmitted infections (STIs) are common amongst men having sex with other men (MSM) that engage in condomless penile-anal sex.¹⁻⁴ Insufficient natural lubrication of the rectum can increase the risk of mucosal trauma and STI transmission during receptive anal sex.^{5,6} Recommendations for lubricant use to prevent rectal tissue damage have proved controversial, as some studies have found that those who use lubricants, particularly water-based lubricants, are more likely to be diagnosed with a rectal STI.^{7,8} Transmission patterns of certain rectal STIs such as *Neisseria gonorrhoeae*/*Chlamydia trachomatis* (GC/CT) and ulcerative STIs such as herpes simplex virus are of particular public health importance because of their association with concurrent human immunodeficiency virus (HIV) acquisition.⁹ Thus, efforts

to prevent rectal STI transmission may also mitigate incurred morbidity and mortality of HIV infection.

With 59%–74% of MSM reporting lubricant usage during anal intercourse, lubricant usage is a modifiable lifestyle factor that can have significant public health impact.^{10,11} Several different types of lubricant are commonly used in receptive anal sex.¹² Saliva is a common lubricant but is often criticized as a potential means for STI transmission given it is a bodily fluid.^{13,14} Water-based lubricants are also common amongst MSM engaging in receptive anal sex.¹⁵ Other lubricants that are oil or silicone-based are also cited for use during receptive anal sex with a recent study indicating oil-based lubricants associated more with rectal chlamydia and gonorrhea infection.⁷

Despite the high frequency of lubricant usage and preliminary associations to rectal STI transmission, current understanding of what demographic and medical covariates may associate with lubrication usage remains limited. There is further lack of granularity in whether covariates differ based on the lubrication type. Of particular interest for preventative public health measures is the gap in knowledge regarding associations between lubrication usage and rectal STI acquisition or sexual preferences such as usage of protection and number of partners. Further characterizing these associations may provide clinically actionable recommendations including appropriate risk stratification of different lubricant usage and targeted counseling for lubricant-associated preferences. In this secondary analysis, we explore covariates that may associate with different lubrication usage, with emphasis on associations to sexual preferences or rectal STI acquisition. We hypothesized that there would be no correlation between lubricant usage and demographic, medical history, and sexual history covariates. We also hypothesized that there would be a weak positive correlation between spit/saliva lubricant use and increased rectal STI acquisition.

MATERIALS AND METHODS

Study Population

The study population for this analysis is a subcohort from another initial, published study that evaluates the association between pubic hair grooming and STI diagnosis.¹⁶ In that study, eligible participants were identified amongst individuals visiting the San Francisco Department of Public Health City Clinic between April and May of 2018 based on the inclusion criteria: primary English speaker, age ≥ 18 . From those eligible in the initial study, the informed consented participants who completed the survey and reported receptive anal sex in the past 3 months were eligible for this secondary post-hoc analysis.

Covariates

We collected data on our primary exposure of lubricant usage by asking participants to identify the type of lubricant they used during receptive anal sex (silicone, water-based, oil-based,

spit/saliva, other). The survey was designed to only allow for endorsement of one lubricant type. Other collected covariates included baseline demographics, STI-focused medical history, and sexual history.

Rectal STI Assessment

One of the key covariates evaluated for association to lubrication type was having a positive test for either rectal gonorrhea, rectal chlamydia or rectal herpes simplex virus-1 or 2 (HSV-1 or HSV-2). Diagnosis was determined by nucleic acid amplification testing for chlamydia and gonorrhea (Aptima Combo2-Hologic, Marlborough, MA), PCR testing for HSV-1 and HSV-2 (Cobas-Roche, Basel, Switzerland), and physical examination for rectal warts.

Statistical Analysis

We report covariates stratified by lubrication type usage. Continuous variables are reported using mean and standard deviation with Kruskal-Wallis analysis of variance performed to assess differences across lubrication type. Categorical variables are reported by count and percentage of total with Chi-squared test performed to assess differences across lubrication type. Univariate associations between lubricant type and rectal STI positivity were evaluated using logistic regression. Multivariate logistic regressions on rectal STI positivity were also performed. The comparator group for both univariate and multivariable logistic regression was the silicone lubrication group due to its sample size and informative index of comparison to different lubricants. *P* values less than .05 were defined as statistically significant. All data analysis was done using STATA V15 (Statacorp, College Station, TX). This study was approved by the institutional review board at the corresponding author's institution (IRB No. 17-23739).

RESULTS

Study Population

We enrolled 333 individuals in our study and 314 completed the survey. Of the 314 who completed the survey, 179 reported receptive anal sex while using a lubricant within the past 3 months and were eligible for this analysis. The median age of the 179 eligible participants was 32, interquartile range (IQR) 27–40. Spit/saliva lubricant was the most commonly used (27%), followed by silicone (26%), water-based (25%), oil-based (12%), and other (11%).

Covariates by Lubrication Type

No differences were found in demographic characteristics and STI-focused medical history when stratified by lubricant type.

Silicone lubricant users had the most sexual partners in the last 3 months (13 [mean] \pm 30 [SD]) while water-based lubricant users had the fewest (4 \pm 4; *P* = .0003). Oil-based lubricant

users and spit/saliva lubricant users had the most condomless receptive anal sex partners in the last 3 months (6 ± 5 and 6 ± 8 , respectively) while water-based lubricant users had the least (2 ± 3 ; $P = .03$). Oil-based lubricant users had the most condomless insertive anal sex partners in the last 3 months (7 ± 6) while water-based lubricant users and other lubricant type users (2 ± 2) had the least (2 ± 2 for both; $P = .03$). Water-based lubricant users (31%) and other lubricant type users (32%) most commonly used a condom in their last sexual encounter (31% and 32%, respectively) while silicone lubricant users and spit/saliva lubricant users least frequently reported condom usage in their last sexual encounter (11% for both; $P = .04$). Silicone lubricant users were most likely to have a history of gonorrhea at any site (72%) while other lubricant type users were the least likely (37%; $P = .006$; Table 1).

In our study group, 12% were diagnosed with any rectal STI, 4% were diagnosed with rectal gonorrhea, 8% were diagnosed

with rectal chlamydia, 1% were diagnosed with rectal herpes, 0% were diagnosed with rectal warts, and 27% were diagnosed with any STI not limited to manifestations just in the rectum but manifesting anywhere in the body.

Univariate regression analyses yielded no association between lubricant type and rectal STI diagnosis (Table 2). Multivariable regression analyses controlling for age, total number of sexual partners, and whether the last sexual encounter was without a condom yielded a significant association between rectal STI diagnosis and spit/saliva lubricant (OR: 4.43, 95% CI: 1.03–19.08, $P = .05$; Table 2).

DISCUSSION

In this STI-clinic based, exploratory analysis of MSM who reported having receptive anal sex in the prior 3 months, there was an association between spit/saliva lubricant usage

Table 1. Covariates by lubrication type

	Silicone (n = 46)	Water-based (n = 45)	Oil-based (n = 21)	Spit/saliva (n = 48)	Other (n = 19)	P value
<i>Demographics</i>						
Age (mean \pm SD)	38 \pm 12	34 \pm 10	35 \pm 11	33 \pm 10	32 \pm 13	0.09
Male (n, %)	42 (93)	37 (82)	17 (81)	44 (92)	18 (95)	0.5
Race						0.1
Asian (n, %)	7 (15)	9 (20)	2 (10)	6 (13)	4 (21)	
Black (n, %)	1 (2)	7 (16)	3 (14)	4 (9)	3 (16)	
Hispanic/Latino (n, %)	12 (26)	13 (29)	6 (29)	14 (30)	6 (32)	
White (n, %)	26 (57)	15 (33)	10 (48)	23 (49)	4 (21)	
Other (n, %)	0 (0)	1 (2)	0 (0)	0 (0)	2 (11)	
Sexual Orientation						0.1
Gay/Bisexual Men (n, %)	40 (91)	32 (73)	16 (80)	38 (81)	16 (89)	
Straight Men (n, %)	1 (2)	5 (11)	1 (5)	5 (11)	1 (6)	
Lesbian/Bisexual Women (n, %)	1 (2)	0 (0)	2 (10)	0 (0)	0 (0)	
Straight Women (n, %)	2 (5)	7 (16)	1 (5)	4 (9)	1 (6)	
<i>Medical History</i>						
On PrEP (n, %)	23 (66)	19 (49)	7 (50)	22 (55)	8 (44)	0.5
HPV vaccinated (n, %)	8 (17)	7 (16)	7 (33)	10 (21)	7 (37)	0.2
HAV vaccinated (n, %)	39 (85)	32 (71)	14 (67)	37 (77)	14 (74)	0.5
HBV vaccinated (n, %)	41 (89)	37 (82)	19 (90)	44 (92)	16 (84)	0.7
Reporting new symptoms as reason for visit (n, %)	21 (46)	21 (47)	13 (62)	20 (42)	11 (58)	0.5
<i>Sexual History</i>						
# of total partners (last 3 mos) (mean \pm SD)	13 \pm 30	4 \pm 4	11 \pm 8	8 \pm 9	5 \pm 5	0.0003
# of condomless receptive anal sex partners (last 3 mos) (mean \pm SD)	4 \pm 5	2 \pm 3	6 \pm 5	6 \pm 8	3 \pm 7	0.03
# of condomless insertive anal sex partners (last 3 mos) (mean \pm SD)	6 \pm 7	2 \pm 2	7 \pm 6	5 \pm 6	2 \pm 2	0.03
Used condom in last encounter (n, %)	5 (11)	14 (31)	4 (19)	5 (11)	6 (32)	0.04
History of chlamydia ever (n, %)	29 (63)	24 (53)	14 (67)	29 (60)	11 (58)	0.8
History of gonorrhea ever (n, %)	33 (72)	18 (40)	15 (71)	29 (60)	7 (37)	0.006
<i>Outcomes</i>						
Rectal STI diagnosed at visit (n, %)	3 (7)	4 (9)	3 (14)	9 (19)	3 (16)	0.4

Table 2. Univariate and multivariate logistic regressions of rectal STI acquisition by lubricant type

	Odds ratio	95% CI		P value	Standard error
		Lower	Upper		
Univariate					
<i>Water-Based</i>	1.40	0.29	6.63	.67	1.11
<i>Oil-Based</i>	2.39	0.44	12.98	.31	2.06
<i>Spit/Saliva</i>	3.30	0.83	13.10	.09	2.32
<i>Other</i>	2.69	0.49	14.71	.25	2.33
Constant	0.07	0.02	0.22	.00	0.04
Multivariate					
<i>Water-Based</i>	1.93	0.37	10.06	.44	1.62
<i>Oil-Based</i>	2.79	0.49	15.89	.25	2.48
<i>Spit/Saliva</i>	4.43	1.03	19.08	.05	3.30
<i>Other</i>	3.80	0.62	23.08	.15	3.50
Age	1.03	0.99	1.07	.17	0.02
Number of sexual partners	1.01	0.99	1.03	.35	0.01
Last encounter without a condom	1.31	0.34	5.07	.69	0.91
Constant	0.02	0.00	0.15	.00	0.02

and rectal STI positivity. We also found that those who reported using silicone and oil-based lubricant had a higher number of sexual partners in the prior 2 months and were more likely to report a history of gonorrhea. These findings are consistent with previous studies that report associations between lubrication use and STI positivity.^{8,17} Gorbach et al. noted that in a cohort of 380 patients, use of any lubricant increased risk of positive STI testing (OR: 2.98, 95% CI: 1.09–8.15).⁸ They, however did not assess risk of specific lubricant types as individual predictors of STI positivity. Similarly, Cornelisse et al. denoted saliva's positive association with anorectal chlamydia in univariate regression (OR: 1.97, 95% CI: 1.26–3.09). The association did not hold for multivariate regression after adjusting for number of sexual partners, HIV status, known contact with chlamydia, and condom use.¹⁷ Differences in findings from our study may be attributable to differences in surveyed population, types of lubrication studied, how lubricant use was defined, and how rectal STI was defined in each study.

Spit/saliva lubricant positively associated with rectal STI diagnosis in multivariate regression. Previous studies have identified oropharyngeal colonization with chlamydia and gonorrhea in MSM who presented for testing for extra-genital STIs.^{18,19} Unlike commercial lubricants that are sterilely prepared, spit/saliva hosting existing pathogens may pose a mode of transmission for STIs in receptive anal sex. The mechanism by which other lubricants may contribute to STI transmission remain under investigation. Some studies suggest that for water-based lubricants, hyperosmolarity of the lubricant relative to surrounding rectal epithelium results in cell damage. This, in turn, is thought to make the rectal tissue more susceptible to STI acquisition.^{20–22} For oil-based lubricants, MSM report significantly increased condom breakage which may also facilitate STI transmission.²³

In addition, those who reported using silicone or oil-based lubricants had a higher number of total sexual partners and receptive anal sex partners and were least likely to report having

used a condom at their last sexual encounter. Silicone and oil-based lubricants are hydrophobic and more durable for use in sexual activity. Whether individuals with a higher number of partners specifically selected these lubricant types because of their durability is unknown. Notably, oil-based lubricant can lead to condom breakage which may explain why few individuals who reported using condoms also reported using oil-based lubricant. Water-based lubricant in contrast may be used for a range of sexual activity. Whether the versatility of application for water-based lubricant results in a diverse user base with composite lower risk sexual activity is unknown.

Our study has limitations. As a cross-sectional survey, there exists a response bias for participants willing to engage in our study and absence of temporality in determining direction of our associations. We are also limited by potential confounders including type and frequency of sexual activity and pattern of condom usage used between different lubricant users. Given the global STI prevalence in our study population was 27%, participants may have been contracting infection through other means than receptive anal sex. We did not control for other sexual practices (eg, rimming, oral sex) which may have differentially impacted STI transmission between lubrication groups. Pertaining condom usage, though we were able to control for whether a patient used a condom in their last sexual encounter, we did not have access to longitudinal data on historic condom usage across many sexual encounters. Our proxy of condom usage in the most recent sexual encounter may not accurately signify an individual's overall condom usage behavior as well as potential heterogeneity in correct condom use. Lubrication use is also a self-reported predictor rather than something objectively assessed during sex. In our study, participants selected the specific type of lube they used during anal sex (silicone-based, oil-based, water-based, spit/saliva, other). When identifying category however, there were no specifications as to what defined a lube type and whether this was the only lubrication type they were

using. Participants may have thus misclassified lubricant type or not accounted for use of different types across varying encounters.

Our initial hypothesis that if different lubricant types were used, then there would be no notable differences in demographics, medical histories, and sexual histories was refuted. Our other hypothesis that if spit/saliva were used, then there would be higher rate of STI positivity was confirmed. These findings that silicone and oil-based lubricants associate with higher number of sexual partners and decreased condom usage, and spit/saliva associates with STI acquisition contribute to the limited literature on the implications of lubricant use in anal sex. As an exploratory, post-hoc analysis, our study raises testable hypotheses that should be further explored in both mixed methods and larger, randomized studies. These testable hypotheses include: (1) if silicone and oil-based lubricants are the preferred lubricant, then these individuals will endorse less frequent condom usage as well as higher partner frequency (2) if spit/saliva is the preferred lubricant, then these individuals will have an increased risk of rectal STI acquisition. A joint qualitative and quantitative approach may elucidate the understanding of lubricant use in anal sex in a manner that overcomes the limitations of each approach taken alone. In tandem with future studies evaluating these hypotheses, our preliminary findings may eventually facilitate counseling conversations and screening recommendations for providers caring for MSM engaging in receptive anal sex to ameliorate STI transmission. Given the high prevalence of STIs among MSM, additional strategies for STI prevention should also be explored.

Corresponding Author: Benjamin N. Breyer, MD, MAS, FACS, University of California, San Francisco, Zuckerberg San Francisco General Hospital and Trauma Center, 1001 Potrero Suite 3A, San Francisco, CA 94110, USA. Tel.: 14152068805; Fax: 14152064499; E-mail: Benjamin.Breyer@ucsf.edu

Conflict of interest: None.

Funding: None.

IRB approval: 17-23739.

STATEMENT OF AUTHORSHIP

Austin Lee: Methodology, Formal Analysis, Investigation, Data Curation, Writing – Original Draft, Writing – Review & Editing; Thomas W. Gaither: Conceptualization, Methodology, Formal Analysis, Investigation, Data curation; Marvin E. Langston: Writing – Review & Editing; Stephanie E. Cohen: Writing – Review & Editing; Benjamin N. Breyer: Writing – Review & Editing, Supervision.

REFERENCES

- Davis TW, Goldstone SE. Sexually transmitted infections as a cause of proctitis in men who have sex with men. *Dis Colon Rectum* 2009;52:507–512.
- Frieden TR, Harold Jaffe DW, Rasmussen SA, et al. Morbidity and Mortality Weekly Report Sexually Transmitted Diseases Treatment Guidelines, 2015. Centers for Disease Control and Prevention MMWR Editorial and Production Staff (Serials) MMWR Editorial Board; 2015.
- Cornelisse VJ, Sherman CJ, Hocking JS, et al. Concordance of chlamydia infections of the rectum and urethra in same-sex male partnerships: a cross-sectional analysis. *BMC Infect Dis* 2017;17. doi: [10.1186/s12879-016-2141-7](https://doi.org/10.1186/s12879-016-2141-7).
- Jin F, Prestage GP, Mao L, et al. Incidence and risk factors for urethral and anal gonorrhoea and chlamydia in a cohort of HIV-negative homosexual men: the health in men study. *Sex Transm Infect* 2007;83:113–119.
- Fox J, Fidler S. Sexual transmission of HIV-1. *Antiviral Res* 2010;85:276–285. doi: [10.1016/j.antiviral.2009.10.012](https://doi.org/10.1016/j.antiviral.2009.10.012).
- Prevention and Treatment of HIV and Other Sexually Transmitted Infections Among Men Who Have Sex With Men and Transgender People HIV/AIDS programme. n.d.
- Maierhofer C, Rice CE, Wang S-H, et al. Lubricant use and rectal chlamydial and gonococcal infections among men who engage in receptive anal intercourse. *Sex Transm Dis* 2016;43:423–428.
- Gorbach PM, Weiss RE, Fuchs E, et al. The slippery slope: lubricant use and rectal sexually transmitted infections: a newly identified risk. *Sex Transm Dis* 2012;39:59–64.
- Ward H, Rönn M. Contribution of sexually transmitted infections to the sexual transmission of HIV. *Curr Opin HIV AIDS* 2010;5:305–310.
- Javanbakht M, Stahlman S, Pickett J, et al. Prevalence and types of rectal douches used for anal intercourse: results from an international survey. *BMC Infect Dis* 2014;14. doi: [10.1186/1471-2334-14-95](https://doi.org/10.1186/1471-2334-14-95).
- Rolle CPM, Bolton MD, Kelley CF. Use of a prospective sex diary to study anal lubricant and enema use among high risk men who have sex with men - implications for human immunodeficiency virus prevention. *Sex Transm Dis* 2016;43:476–478.
- Romijnders KAGJ, Nyoni JE, Ross MW, et al. Lubricant use and condom use during anal sex in men who have sex with men in Tanzania. *Int J STD AIDS* 2016;27:1289–1302.
- Butler LM, Osmond DH, Jones AG, et al. Use of saliva as a lubricant in anal sexual practices among homosexual men. *J Acquir Immune Defic Syndr* 2009;50:162–167. doi: [10.1097/QAI.0b013e31819388a9](https://doi.org/10.1097/QAI.0b013e31819388a9).
- Jones DL, Weiss SM, Chitalu N, et al. Acceptability and use of sexual barrier products and lubricants among HIV-seropositive Zambian men. *AIDS Patient Care STDS* 2008;22:1015–1020.
- Strömdahl S, Onigbanjo Williams A, Eziefule B, et al. Associations of consistent condom use among men who have sex with men in Abuja, Nigeria. *AIDS Res Hum Retroviruses* 2012;28:1756–1762.
- Gaither TW, Fergus K, Sutcliffe S, et al. Pubic hair grooming and sexually transmitted infections. *Sex Transm Dis* 2020;47:419–425.

17. Cornelisse VJ, Fairley CK, Read TRH, et al. Associations between anorectal chlamydia and oroanal sex or saliva use as a lubricant for anal sex. *Sex Transm Dis* 2018;45:506–510.
18. Barbee LA, Dombrowski JC, Kerani R, et al. Effect of nucleic acid amplification testing on detection of extragenital gonorrhea and chlamydial infections in men who have sex with men sexually transmitted disease clinic patients. *Sex Transm Dis* 2014;41:168–172.
19. Cornelisse VJ, Chow EPF, Huffam S, et al. Increased detection of pharyngeal and rectal gonorrhea in men who have sex with men after transition from culture to nucleic acid amplification testing. *Sex Transm Dis* 2017;44:114–117.
20. Dezzutti CS, Brown ER, Moncla B, et al. Is wetter better? An evaluation of over-the-counter personal lubricants for safety and anti-HIV-1 activity. *PLoS One* 2012;7. doi: [10.1371/journal.pone.0048328](https://doi.org/10.1371/journal.pone.0048328).
21. Begay O, Jean-Pierre N, Abraham CJ, et al. Identification of personal lubricants that can cause rectal epithelial cell damage and enhance HIV type 1 replication in vitro. *AIDS Res Hum Retroviruses* 2011;27:1019–1024.
22. Fuchs EJ, Lee LA, Torbenson MS, et al. Hyperosmolar sexual lubricant causes epithelial damage in the distal colon: Potential implication for HIV transmission. *J Infect Dis* 2007;195:703–710.
23. Crosby R, Diclemente RJ, Yarber WL, et al. An event-specific analysis of condom breakage among African American men at risk of HIV acquisition. *Sex Transm Dis* 2008;35:174–177.