Association of Lubricant Use with Women's Sexual Pleasure, Sexual Satisfaction, and Genital Symptoms: A Prospective Daily Diary Study

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ABSTRACT

Introduction. Although lubricant use is commonly recommended to women for solo and partnered sexual activities, little is known about women's use of lubricant or their relationship to sexual pleasure and satisfaction.
Aim. The aim of this study was to assess: (i) how adult women used lubricant during partnered and solo sexual activities; (ii) relations between women's reports of sexual pleasure and satisfaction and their use of a lubricant during a particular sexual event; and (iii) to what extent lubricant use was associated with subsequent genital symptoms.
Methods. A total of 2,453 women completed a 5-week internet-based, double-blind prospective daily diary study in which they were assigned to use one of six water- or silicone-based lubricants.
Main Outcome Measures. Baseline data included demographics, contraceptive use, and sexual behavior during the 4 weeks prior to study enrollment. Daily diary data included reports of penile–vaginal sex, penile–anal sex, solo sex, lubricant use, lubricant application, ratings of sexual pleasure and satisfaction, and genital symptoms.
Results. Water-based lubricants were associated with fewer genital symptoms compared with silicone-based lubricants. In addition, the use of a water-based or silicone-based lubricant was associated with higher ratings of sexual pleasure and satisfaction for solo sex and penile–vaginal sex. Water-based lubricant use was associated with higher ratings of sexual pleasure and satisfaction for penile–anal sex as compared with no lubricant use.
Conclusion. The water- and silicone-based lubricants used in this study were associated with significantly higher reports of sexual pleasure and satisfaction and rarely associated with genital symptoms. **Herbenick D, Reece M, Hensel D, Sanders S, Jozkowski K, and Fortenberry JD. Association of lubricant use with women's sexual pleasure, sexual satisfaction, and genital symptoms: A prospective daily diary study. J Sex Med **;**:**–**.**

Key Words. Lubricant; Sexual Pleasure; Sexual Satisfaction; Sexual Function; Dyspareunia; Genital

Introduction

Lubricants designed for use during sexual activity are commonly sold through drug stores, large retail chains, the internet, adult bookstores, women-oriented sex boutiques, and in-home sex toy parties in the United States [1–3]. In the past decade, an expanded range of lubricants has been marketed to adults in the United States, resulting in more consumer choices and a greater visibility of lubricant products in mainstream retail spaces and advertising [3].

In spite of their widespread availability, little is known about how and why women and men use lubricant during solo or partnered sexual activities or whether lubricant use has become less stigmatized with greater visibility and marketing of these products. Research on lubricant use has largely focused on men's use of lubricant during anal sex with other men and in the context of HIV risk [4,5]. Other research has focused on the extent to which adding lubricant to a condom affects the likelihood of condom breakage or slippage [6–8]. Such research is reflected in recommendations

from the U.S. Centers for Disease Control and Prevention (CDC) and the United States Food and Drug Administration (FDA) regarding the value of using water-based lubricant with condoms [9]. However, lubricant products are not regulated by the FDA and thus there are no uniform standards for testing prior to marketing.

Only a few studies have addressed women's use of, or interest is using, lubricant for sexual activities, and very little is known about lubricant use in the context of sexual pleasure, satisfaction, or enhancement, even in the midst of health concerns [10–12]. Women may experience variable amounts of vaginal lubrication and discharge in relation to age as well as contraceptive use [13–15]. However, cross-cultural research suggests that women generally prefer to have a moderate amount of vaginal wetness and may modulate this through the use of herbs or powders to make the vagina more dry or else they may add lubricant to make the vagina, or sex, to feel more wet [16]. The decision to enhance vaginal wetness through the use of a lubricant may be particularly challenging given that some lubricant products have been shown to adversely affect sperm motility [17,18]. A recent nationally representative survey of women ages 18 to 60 in the United States found that 62.0% of women had ever used lubricant during sexual activities and 25.3% had used lubricant during the previous month [19]. Another recent study of 6,725 women from 11 countries indicated that perceptions of vaginal dryness varied considerably by country as did women's awareness and use of lubricant [20].

Some reports suggest that lubricant may contribute to vulvovaginal irritation or burning [20]. However, empirical data are needed to assess the extent to which genital symptoms may be associated with lubricant use. Such data could help to inform lubricant recommendations that clinicians, health educators, and therapists offer to women, particularly to those with genital health concerns or sensitivities. In regard to efficacy, although clinicians and sexual health educators often recommend lubricant use to facilitate more comfortable or pleasurable sex [21,22] and lubricant use may be recommended to women who experience vaginal dryness for reasons related to age or health status [12,22–25], little is known about the role of lubricant use in women's quotidian sexual experiences.

Aims

The purpose of this study was to, in a prospective daily diary study, assess: (i) how adult women used lubricant during partnered and solo sexual activities; (ii) differences between women's reports of sexual pleasure and satisfaction and their use of a lubricant during a particular sexual event; and (iii) to what extent lubricant use was associated with subsequent genital symptoms.

Methods

Data were collected via a double-blind daily diary study in which women were provided with specific lubricant products that they were asked to use for solo and partnered sexual activities. All recruitment and data collection activities occurred via the internet. The Institutional Review Board at the primary author's academic institution approved all protocols associated with this study.

Participant Recruitment

E-mail recruitment messages were distributed to colleagues in the fields of sexual health and medicine, administrators of community and campus web sites associated with women's health and sexual health, LISTSERVS related to women's health and to leaders of organizations providing information or services to lesbians and bisexual women. Individuals within those groups were asked to disseminate the recruitment message to women associated with their group or to individuals in professional and social networks. Within days of beginning recruitment, the notice had been circulated by these individuals and their wider social network, and was ultimately re-posted widely on web sites related to women's health, sexuality, shopping, and coupons.

The text of the e-mail recruitment message invited women who were at least 18 years old and who were sexually active alone or with a partner to visit the study website to learn more about participating in an internet-based study about lubricant use and sexual behavior. The study website provided a detailed description of the 5-week daily diary study, eligibility requirements and incentives for participation. To be eligible, individuals had to be at least 18 years old, female, living in the United States, and sexually active alone or with a partner. "Sexually active" was defined as masturbating and/or being the receptive partner in vaginal penetration, anal penetration, or partnered masturbation at least four times, on average, in a typical month at the time of the study. Additionally, potential participants were asked to: (i) be willing to use water-based or silicone-based lubricant provided by the researchers, free of charge, during

masturbation or partnered sexual activities during the study; (ii) be able and willing to visit an internet site daily for 5 weeks to complete study questionnaires; (iii) have a valid e-mail address to communicate with the research team; (iv) be able to use water-based and silicone-based lubricant without allergic reactions; (v) be willing to continue the use of any methods currently in use to prevent sexually transmissible infections or pregnancy; and (vi) be living in the United States.

Interested individuals were asked to complete online questions (based on the above criteria) to determine their eligibility. If eligible, participants read and electronically signed a statement of informed consent that they were able to print and retain. Data were collected using both a baseline questionnaire (phase one) and daily diary questionnaires over a 5-week period (phase two), described in the further discussion.

Phase One: Baseline

Participants immediately entered Phase One of the study after completing the informed consent process. They provided a name and mailing address to which a study packet that contained three small bottles of lubricant and a printed copy of study instructions could be mailed. They completed a baseline questionnaire that included demographic items and questions related to their health status and recent (past 4 weeks) sexual behavior. Measures from the baseline questionnaire are described in detail in the Main Outcome Measures section.

Randomization and Blinding

After completion of the baseline questionnaire, participants were randomly assigned to one of six lubricant products. All participants received a plain package with an address label that reflected the authors' academic institution and that contained one of six commercially available study lubricants. Also included was a letter that contained a reminder about which weeks the study lubricant was to be used and a request to discontinue use and check in with a healthcare provider should they experience any discomfort or pain associated with lubricant use or sexual activity. Each lubricant was re-packaged in small (3 oz.), uniformly sized clear plastic bottles only marked with a plain white label that read "A" (N = 401; 16.3%), "B" (N = 411; 16.8%), "C" (N = 405; 16.5%), "D" (N = 399; 16.5%), "E" (N = 406; 16.6%), or "F" (N = 400; 16.3%). The study lubricants included four water-based lubricants and two silicone-based lubricants. The water-based lubricants were, in alphabetical order, Astroglide® (Biofilm, Inc., Vista, CA, USA), Just Like Me® (Pure Romance, Loveland, OH, USA), K-Y Liquid® (Johnson & Johnson, New Brunswick, NJ, USA) and Sweet Seduction® (Pure Romance). The silicone-based lubricants were Pure Pleasure® (Pure Romance) and Wet Platinum® (Trigg Laboratories, Valencia, CA, USA). Three of the lubricants are distributed by Pure Romance, a large in-home party company in the United States that provided in-kind support for the study by supplying and mailing study lubricants and gift card incentives. The remaining three lubricants were selected by the research team given their widespread availability in the United States. For the purposes of these analyses, the study lubricants are compared only by type (water-based vs. silicone-based) and not by brand.

Significant steps were taken to ensure that participants remained blinded to the lubricant brands included in the study. In addition to having the lubricants repackaged into plain bottles marked only with letter codes, although Pure Romance mailed the lubricants, they did not include any materials that would have indicated that they were involved with the study. As a check on this process, three of the authors' colleagues were included in the list of names and addresses that were to receive study packages and all three colleagues received study packages in plain envelopes with institutional return address labels and no mention of Pure Romance or other brand names. In addition, during the process of obtaining informed consent, study incentives were described as gifts "to an online retail store that sells lubricants, massage products, bath products, books about sexuality, and other sexual enhancement products." Participants were not told that this online retail store was PureRomance.com until they had completed the study and received an email form with instructions for how to use their gift card.

The study was double blind. Neither the researchers nor the study participants knew which lubricant had been assigned to which participant until all participants completed the study. Upon completion, the researchers learned which codes corresponded to which lubricants and sent an e-mail to participants notifying them of the same. An extra measure of precaution was taken to remove bias in that all statistical analyses were conducted by the third author at another campus who was blind to the identification of the six lubricants used in the study and thus conducted all analyses with only the lubricants' letter codes available.

In addition to the free bottles of lubricant provided as part of the study, individuals were offered incentives for their participation. Those who completed at least 5 daily diary questionnaires for each of the 5 weeks were eligible to receive a $25 gift card to an online retailer. Those who completed surveys for at least 3 days per week were offered a $10 gift card.

Phase Two: Daily Diary

During the 5 weeks of Phase Two, participants received a daily e-mail reminder to complete an online diary questionnaire. During Week One, participants were asked to continue sexual behavior as usual, without use of the study lubricant. During Weeks Two and Three, participants were asked to use the study lubricant during sexual activities that occurred alone or with a partner. During Weeks Four and Five, participants were asked to stop the use of the study lubricant but continue usual sexual activities. Daily diary questionnaires assessed issues related to genital symptoms, sexual activities and lubricant use as described in detail below. Completion of the daily diary questionnaires took approximately 5–15 minutes each day depending on the extent of sexual activities, as some diary measures were contingent on specific sexual activities or lubricant use.

Main Outcome Measures

Two sources of data were used. Baseline questionnaires assessed participant demographics and sexual behaviors during the 4 weeks prior to study enrollment. Daily diaries provided information about event-level lubricant characteristics and the relationship of event-level lubricant use to event-level sexual behaviors.

Baseline demographic variables included age (years), race/ethnicity, education, relationship status, sexual orientation and contraceptive method. Baseline sexual behavior variables examined frequency of behavior reports from the past four weeks (never, once or twice, three to five times, 6–10 times, more than 10 times): self masturbation, partner-focused masturbation (by participant), participant-focused masturbation (by partner), giving oral sex, receiving oral sex, penile–vaginal sex, and penile–anal sex.

Event-level variables included reports of penile–vaginal sex only (no/yes), penile–anal sex only (no/yes) as well as solo sex (additive index of four no/yes behavior, dichotomized), based on measures used in previous event-level research [26–29]. Type of lubricant behavior (no lubricant, water-based study lubricant only, silicone-based study lubricant only and other [nonstudy] lubricant only) was assessed for each sexual event. Although participants were asked to not use study lubricant during Weeks 1, 4, and 5, use of non-study lubricant was not prohibited because some women require lubricant use for sexual comfort and safety. In each diary, participants were asked to report use of both study and non-study lubricant as well as their reason for use. Even though participants were asked to use a lubricant during two weeks of the study, they were not required to do so and they were also not asked to do so during the other weeks of the study. As such, we were interested in learning their reasons for use throughout the study period.

We examined dichotomized reports (no/yes) of vaginal symptoms experienced with each sexual event, including tearing, discomfort, pain at entry, pain at penetration, pain after penetration, burning, itching, and bleeding. Finally, sexual pleasure (a single 4-point item: not at all pleasurable, a little pleasurable, moderately pleasurable, very pleasurable) and sexual satisfaction (a single 5-point item; very dissatisfied, moderately dissatisfied, about equally dissatisfied and satisfied, moderately satisfied, and very satisfied) were Likert type items assessing the experience of specific sexual events and which have been previously used in other research [28,29].

Data Analyses

For bivariate event-level analyses, chi-square tests were used to assess the relationships between categories of lubricant use and post-event symptoms. Repeated measures analysis of variance was used to examine differences in mean event-level sexual pleasure and sexual satisfaction across lubricant use categories and across multiple within person events. All models were examined separately for penile–vaginal sex, penile–anal sex, and for solo sex events; analyses were performed using SPSS 16.0 (SPSS Inc., Chicago, IL, USA).

Results

Participant Demographics

A total of 2,453 women completed the study. As seen in Table 1, they ranged in age from 18 to 68 years and most (85.4%; N = 2,096) described their ethnicity as White. A total of 40.8% (N = 1,001)

Table 1 Sociodemographic and clinical characteristics of the sample (N = 2,453)

Participant characteristics	
Age (mean, SD)	32.69 (9.18)
Education (N, %)	
Less than high school graduate	44 (1.8)
High school graduate	460 (18.8)
Some college or two year degree	1,001 (40.8)
College graduate	644 (26.3)
Graduate school	266 (10.8)
Other	33 (1.3)
Relationship status (N, %)	
Single, not married or partnered	237 (9.7)
Married	1,412 (57.6)
Partnered, living with partner	425 (17.3)
Partnered, not living with partner	273 (11.1)
Separated, divorced or widowed	71 (2.9)
Other	30 (1.2)
Sexual orientation (N, %)	
Heterosexual	2,122 (86.5)
Bisexual	207 (8.4)
Lesbian	54 (2.2)
Questioning/uncertain	20 (0.8)
Asexual	3 (0.1)
Other	36 (1.5)
Race (N, %)	
American Indian or Alaska Native	12 (0.5)
Asian or Asian American	112 (4.6)
Black or African American	110 (4.5)
Native Hawaiian or other Pacific Islander	7 (0.2)
White	2,096 (85.4)
Multiracial	53 (2.2)
Other	41 (1.7)
Contraception (N, %)	
Oral contraceptive pill	473 (19.5)
Norplant	3 (0.1)
Depo Provera	49 (1.6)
Hormonal Patch	15 (0.6)
Nuva ring	77 (3.2)
Male condom	800 (33.0)
Female condom	32 (1.3)
Diaphragm	19 (0.8)
Intrauterine device	123 (5.1)
Spermicide	89 (3.7)
Tubal ligation	272 (11.2)
Vasectomy	175 (7.2)
Natural family planning	400 (16.5)
No method	562 (22.9)

SD = standard deviation.

had some college education and 56.9% (N = 1,396) were married and living with their spouse. Most (86.5%; N = 2,122) self-identified as heterosexual. Although over half of the women 53.6% (N = 1,315) reported multiple methods of contraception in the past, during the study the most common methods of contraception were the pill 19.4% (N = 473); the male condom 33.0% (N = 800), and natural family planning 16.5% (N = 400). A minority of women 23.3% (N = 562) reported using no contraception.

Baseline Sexual Behaviors

Baseline (past month) sexual behaviors are presented in Table 2. Most participants had engaged in solo-masturbation, partnered masturbation, oral sex (receiving and performing), and vaginal sex during the previous month. Approximately one-fifth of women had engaged in penile–anal sex during the previous month and slightly less than one-third had engaged in other types of (non-penile) anal penetration. Vaginal sex was the most frequent sexual behavior reported in the previous month with nearly one-third of participants reporting more than 10 occurrences during the previous month.

Event-Level Sexual Behaviors, Lubricant Use, and Vaginal Symptoms

Participants contributed 49 287 diary days; 21.5% (N = 10 629) of which involved some act of partnered sex and 8.1% (N = 4,126) of which involved some act of solo sex. Of all partnered sex days, penile–vaginal sex alone was reported on 94.1% of days (N = 10 004), and anal sex alone was reported on 0.6% (N = 73) of days. Lubricant use occurred on 60.4% (N = 6,048) of vaginal sex only days and on 84.8% (N = 62) of anal sex only events, and over half (53.2%, N = 2,136) of all the solo sex events. Saliva was rarely used during solo masturbation (2.8%; N = 60) or intercourse events (7.1%, N = 429).

Table 2 Frequency of participant (N = 2,453) baseline sexual behavior, past 4 weeks

	Not at all	1–2 times	3–5 times	6–10 times	>10 times
Sexual behavior	N (%)	N (%)	N (%)	N (%)	N (%)
Self masturbation	475 (19.4)	690 (28.1)	596 (24.3)	319 (13.0)	295 (12.0)
Masturbated a partner with hand	416 (17.0)	640 (26.1)	735 (30.0)	344 (14.0)	242 (9.9)
Partner masturbated with hand	380 (15.5)	630 (25.7)	717 (29.2)	398 (16.2)	257 (10.5)
Gave oral sex	550 (22.4)	642 (26.2)	679 (27.2)	310 (12.6)	199 (8.1)
Received oral sex	690 (28.1)	697 (28.4)	557 (22.7)	262 (10.7)	173 (7.1)
Penile–vaginal sex	230 (9.4)	207 (8.4)	588 (24.0)	643 (26.2)	718 (29.3)
Penile–anal sex	1,953 (79.6)	291 (11.9)	89 (3.6)	19 (0.8)	19 (0.8)
Anal sex (non-penile)	1,755 (71.5)	344 (14.0)	163 (6.6)	69 (2.8)	40 (1.6)

Table 3 Bivariate event-level lubricant characteristics with penile–vaginal, penile–anal, and solo sex

	Penile–vaginal sex only (N = 6,048)	Penile–anal sex only (N = 62)	Solo sex only (N = 2,136)
Application venue* N (%)			
On my genitals	3,596 (59.4)	38 (61.3)	925 (41.3)
On partner's genitals	3,265 (53.9)	50 (80.6)	—
On sex toy	538 (8.8)	16 (26.8)	960 (44.9)
On my or on my partner's fingers	3,190 (52.7)	37 (59.7)	—
On my fingers	—	—	1,360 (63.7)
Lubricant application on female's genitals, N (%)			
Female applied (yes)	1,502 (24.8)	6 (9.8)	—
Partner applied (yes)	2,502 (41.3)	32 (52.5)	—
Both applied (yes)	951 (15.7)	15 (24.6)	—
Lubricant was not applied to female's genitals	1,251 (20.6)	8 (13.1)	—
Lubricant application on partner's genitals N (%)			
Female applied (yes)	2,022 (33.4)	12 (19.9)	—
Partner applied (yes)	1,756 (20.6)	31 (50.0)	—
Both applied (yes)	597 (9.7)	12 (19.9)	—
Lubricant was not applied to partner's genitals (yes)	1,773 (29.4)	5 (8.0)	—
Reasons for lubricant use, N (%)			
To make sex more pleasurable (yes)	4,293 (70.9)	45 (72.5)	1,332 (62.4)
Not enough natural lubricant (yes)	3,265 (53.9)	30 (48.3)	935 (43.7)
Like sex to feel very wet (yes)	1,762 (29.1)	21 (33.8)	699 (32.7)
Using lubricants is fun (yes)	2,239 (37.0)	23 (33.1)	826 (38.2)
Sex feels uncomfortable without lubricants (yes)	1,502 (24.8)	18 (29.0)	326 (15.2)
To reduce risk of tearing (yes)	1,301 (21.5)	33 (53.2)	255 (11.9)
Other (yes)	218 (3.6)	29 (6.6%)	87 (4.1)

*Subcategories do not sum to 100%, as multiple application venues were possible when lubricant use was reported.

Of all vaginal sex-only events, over 60% were rated on the Likert scales as very pleasurable (N = 6,317) and very satisfying (N = 6,159); 65.7% of events with lubricant were rated on the Likert scales as very pleasurable (N = 3,974) and 64.4% of events with lubricant were rated as very satisfying (N = 3,899). About 60% of anal sex-only events were rated as very pleasurable (N = 44), while about half (N = 39) were rated as very satisfying. Most anal sex events with lubricant were rated as very pleasurable (85.6%; N = 53) or very satisfying (80.6%; N = 50). Over 40% of solo sex events were rated as very pleasurable (N = 1,864) or very satisfying (N = 1,749). Over half of solo sex events associated with lubricant use were rated as very pleasurable (54.7%: N = 1,169) and very satisfying (50.8%; N = 1,087).

For penile–vaginal sex, vaginal symptoms were reported for less than two percent of all events. The most common symptoms, discomfort and pain at entry, were reported for about 8% of penile–vaginal sex events. Symptoms for solo sex were also rare; the most common reports, itching and pain at entry, occurred in less than 3% of all solo sex events.

Event-Level Lubricant Use

Table 3 illustrates the bivariate event-level distribution of lubricant application characteristics for penile–vaginal, penile–anal and solo sex events. For penile–vaginal sex, lubricant was applied most often to a woman's genitals (59.4% of events) and slightly less frequently to her partner's genitals (53.9%) or to her or her partner's fingers (52.7%).

For anal sex, lubricant was commonly applied to her partner's genitals (80.6% of events). When lubricant was applied to her partner's genitals, it was most frequently applied by her partner (42.3%). When applied to her partner's genitals, the participant often reported having applied the lubricant (33.4%). Partner-initiated application was common for anal sex, either on the woman's anogenital area (52.5%) or on his anogenital area (50.0%).

For solo masturbation, the majority (63.67%) of reported lubricant use was applied to the participant's fingers as opposed to directly on a sex toy (e.g., vibrators, dildos, or other sex toys), or directly on her genitals. Finally, for penile–vaginal sex, penile–anal sex, and for solo sex, participants most often reported that they were motivated to use lubricant in order to make sex more pleasurable (penile–vaginal: 72.4% of events; anal sex: 72.5% of events; solo sex: 62.3%). For less than 25% of any sexual events, participants reported that they used a lubricant in order to avoid discomfort or to reduce the risk of tearing the vulva/vagina or the anus.

Event-Level Lubricant Use, Lubricant Type, and Vaginal Symptoms

Table 4 provides the bivariate event-level distribution of lubricant use and lubricant type with associated vaginal symptoms for penile vaginal sex and solo sex. Among events *without* lubricant, entry pain was the most commonly reported symptom for penile–vaginal sex, associated with 9.4% of events; itching was the most common symptom for solo-sex, accounting for 2.2% of events. For penile–vaginal sex without lubricant, post-coital bleeding was the least reported symptom; among solo sex events, bleeding and penetration pain were absent from any reports.

For penile–vaginal and solo sex, when lubricant was used, the use of water-based lubricant was generally associated with fewer symptoms compared with the use of silicone-based and participants' own ("other") lubricant. However, entry pain was the most common symptom reported among all penile–vaginal sex events that included the use of lubricant, reported with 4.1% of events that used a water-based lubricant, 10.6% that included silicone-based lubricant, and 6.2% of events that included the use of a non-study lubricant. About 4.1% of silicone-based lubricant solo sex events, and 4.2% of solo sex events associated with non-study lubricant were associated with entry pain compared with 2.8% of solo events associated with use of water-based lubricant.

Event-Level Lubricant Use, Lubricant Type and Sexual Pleasure and Sexual Satisfaction

Event-level ratings of sexual pleasure and sexual satisfaction for lubricant use and lubricant type during penile–vaginal sex, penile–anal, and solo sex are summarized in Table 5. Among penile–vaginal sex events, participants' self-reports on measures of sexual pleasure and sexual satisfaction were significantly higher for events that included the use of a water-based lubricant or silicone-based lubricant compared with events for which no lubricant was used. For penile–anal events, ratings of sexual pleasure and satisfaction were significantly higher for events associated with water-based lubricant over no lubricant. In addition, all lubricant types were associated with significantly higher sexual pleasure and satisfaction scores for solo sex events; there was no difference in sexual pleasure and sexual satisfaction between lubricant types.

Discussion

Our study is the first large-scale assessment of women's lubricant use during solo and partnered

Table 4 Bivariate event-level vaginal symptoms with types of lubricant used during penile–vaginal and solo sex

	Penile–vaginal sex					Solo sex				
Vaginal symptoms	No lubricant (N = 4,132)	Water lubricant (N = 3,283)	Silicone lubricant (N = 1,592)	Other lubricant (N = 1,337)	X^2 (df)	No lubricant (N = 1,879)	Water lubricant (N = 1,046)	Silicone lubricant (N = 508)	Other lubricant (N = 423)	X^2 (df)
Tearing	37 (0.8)	17 (0.5)	17 (1.1)	1 (0.0)	10.5 (3)*	5 (0.2)	4 (0.3)	1 (0.1)	0 (0.0)	2.2 (3)
Discomfort	370 (8.9)	102 (3.1)	156 (9.7)	61 (4.5)	55.7 (3)*	12 (0.6)	18 (1.6)	14 (2.7)	10 (2.3)	19.8 (3)*
Entry pain	392 (9.4)	133 (4.1)	170 (10.6)	84 (6.2)	35.4 (3)*	28 (1.4)	30 (2.8)	21 (4.1)	18 (4.2)	18.9 (3)*
Penetration pain	270 (6.5)	95 (2.8)	139 (8.7)	62 (4.6)	40.7 (3)*	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	—
After penetration pain	193 (4.6)	63 (1.9)	70 (4.3)	37 (2.7)	11.4 (3)*	7 (0.4)	11 (1.1)	10 (1.9)	6 (1.4)	16.4 (3)*
Burning	93 (2.2)	54 (1.5)	50 (5.0)	28 (2.1)	8.4 (3)*	17 (0.9)	26 (2.5)	13 (2.6)	8 (1.8)	16.1 (3)*
Itching	31 (0.7)	28 (0.8)	22 (1.4)	15 (1.1)	10.7 (3)*	37 (1.9)	18 (1.7)	6 (1.2)	9 (2.1)	1.3 (3)
Bleeding	28 (0.7)	15 (0.4)	25 (3.5)	6 (0.4)	18.1 (3)*	0 (0.0)	3 (0.2)	1 (0.1)	2 (0.4)	5.5 (3)

*$P < 0.05$.

Table 5 Event-level sexual pleasure and sexual satisfaction ratings, by lubricant use, and lubricant type for penile–vaginal and solo sex (masturbation)

		Sexual pleasure, M (SD)	Sexual satisfaction, M (SD)
Vaginal sex	No lubricant	3.49 (0.69)[a]	4.42 (0.80)[a]
	Water lubricant	3.58 (0.64)[b]	4.55 (0.73)[b]
	Silicone Lubricant	3.56 (0.65)[b]	4.50 (0.76)[b]
	Other lubricant	3.54 (0.66)[a,b]	4.49 (0.78)[a,b]
	F (3, 6,043)	11.14*	12.85*
Solo sex	No lubricant	3.17 (0.73)[a]	4.10 (0.86)[a]
	Water lubricant	3.42 (0.69)[b]	4.33 (0.81)[b]
	Silicone lubricant	3.47 (0.71)[b]	4.38 (0.81)[b]
	Other lubricant	3.43 (0.70)[b]	4.35 (0.83)[b]
	F (3, 514)	44.63*	28.49*
Anal sex	No lubricant	3.63 (0.61)[a]	4.59 (0.64)[a]
	Water lubricant	3.83 (0.44)[b]	4.80 (0.54)[b]
	Silicone lubricant	3.78 (0.45)[a,b]	4.78 (0.44)[a,b]
	Other lubricant	3.79 (0.52)[a,b]	4.81 (0.45)[a,b]
	F (3, 514)	4.69*	5.16*

*Cells whose subscripts differ indicate significant differences, $P < 0.05$.
NOTE: Sexual pleasure and satisfaction were significantly higher for water and silicone lubricant over no lubricant for vaginal sex, for any solo sex, and for anal sex.
SD = standard deviation.

sexual behaviors. Both water-based and silicone-based lubricants were associated with higher ratings of pleasure and satisfaction during solo and partnered sexual events. Also, women rarely reported genital symptoms in association with lubricant use. Water-based lubricant, in particular, was associated with significantly fewer reports of genital symptoms in relation to penile–vaginal intercourse. It is not known what features of water-based lubricants (such as texture or thickness) may be related to generally more positive outcomes than no lubricant or silicone-based lubricant though future research might test whether this finding can be replicated and, if so, how to better understand the contributions that water-based lubricants may make to facilitating sex with fewer genital symptoms.

A strength of the study is that lubricant assignment and data analyses were double blind and participants had not been told, until study completion, which lubricants had been chosen for the study. In addition, the prospective daily diary method allowed for event-level measurement of participants' ratings of sexual pleasure and satisfaction. Also, given the range of sexual activities for which women may use lubricant, the study was not limited to an assessment of penile–vaginal intercourse, which was important given the number of women who identified as bisexual or lesbian. The sample size also represents a strength of the study as a large number of sex acts were reported, which facilitated the statistical analysis of low probability events such as vaginal symptoms associated with sexual activities.

As only six brands of lubricant were assessed, a limitation is that these results cannot be generalized to brands of lubricants that were not assessed. It cannot be said that all lubricants are associated with rare reports of genital symptoms as some lubricants may be associated with significantly higher or lower reports of genital symptoms. Future research should experimentally test a wider range of lubricants, and among men too, so that individuals can make informed choices about lubricant use. The research is limited by the measures used, many of which were written for this study, given the lack of event-level research on this topic. Other researchers might have measured event-level pleasure, satisfaction, lubricant use, or lubricant application in different ways that could have yielded different results. Also, women who do not like to use lubricants or who have experienced problems with lubricant use in the past may not have chosen to participate in the study (or, in cases of known allergies to lubricants, would have been ineligible to participate). If such women had participated, findings related to genital symptoms, use behaviors or pleasure and satisfaction may have differed. Similarly, it is possible that women who use lubricant but who have found a lubricant that they are highly satisfied with may have chosen to not participate in the study. Had they participated, findings may have differed.

Women who enrolled in the study had, as a whole, received more formal education than women in the general population and were mostly in established relationships and thus results cannot be generalized to women as a whole. It is also not

known how many women in the study had previously used lubricant, or were regular lubricant users, either of which may have influenced study participants and results. Also, factors other than lubricant use such as women's age, health condition and relationship characteristics (or other variables not measured, such as time spent in foreplay or quality of partnered communication) could have influenced their reported levels of satisfaction and pleasure. As such, more research is needed to understand the role of lubricant in women's sexual experiences.

Given the widespread availability and use of lubricants in some economically developed countries, information on women's experiences and genital symptoms in connection to lubricant use is important. Women and their partners routinely have questions about the safety of different types or brands of lubricants, the extent to which they may make sex feel more comfortable or pleasurable or whether certain lubricants may pose an increased risk of yeast or bacterial infections [1,2]. Indeed, some research has found that the use of saliva as a lubricant may increase the risk of a woman acquiring a yeast infection [30]. Also, recent research has found an association between bacterial vaginosis and lubricant use among women who have sex with women [31]. Having an understanding about natural (saliva) and store-bought lubricant options can help women and their partners make more informed choices regarding lubricant use and sexual activity. In discussing sexual behavior or genital symptoms with their patients, clinicians should also make their patients aware of the potential for allergic reactions, such as to latex condoms or silicone lubricants, which may contribute to genital symptoms.

In light of these concerns, it is important for research to examine the role that lubricants play in women's sexual lives. Sex, at times, may feel uncomfortable or painful for some women [32–35]. Using a lubricant may help to facilitate more comfortable, pleasurable sex. Some participants, at the conclusion of the study, wrote to the researchers to say that they had long experienced genital pain and/or vulvodynia and that the study lubricant helped. One woman who had experienced painful sex for years said that her use of the study lubricant she was assigned to use was the first time she had been able to experience comfortable sex in years. Although it is sometimes assumed that women with vulvodynia, dyspareunia, other genital pain disorders, and/or concomitant health conditions should avoid the use of lubricants, this study may indicate greater attention should be paid to the ingredients of the lubricants in addition to their importance in improving comfort and/or pleasure for women during sexual activity.

Further research is needed to assess which lubricants may be associated with the most favorable outcomes for women diagnosed with vulvodynia, lichen sclerosus, recurrent yeast infections, or other vulvovaginal conditions that may predispose them to genital pain.

Even for women who do not experience uncomfortable or painful sex, lubricant use may contribute to sexual pleasure or satisfaction. A sizeable proportion of women and their partners applied lubricant to each others' genitals suggesting that lubricant use and its application may be part of partnered foreplay or sex play. As lubricants have become more mainstream, the marketing and advertising related to lubricant use suggests that lubricants may be part of an individual or couple's sexual enhancement rather than exist solely as a product intended to respond to a deficit of natural lubrication or other sexual problems.

Conclusion

The water-based and silicone-based lubricants used in the study were associated with significantly higher reports of sexual pleasure and satisfaction and rarely associated with genital symptoms. Further research on a wider range of lubricants is warranted as is research on lubricant use among men and also among samples of women who have been diagnosed with vulvovaginal conditions.

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