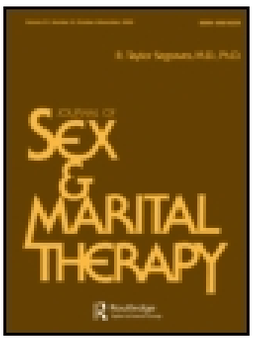

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An Objective Measure of Vaginal Lubrication in Women With and Without Sexual Arousal Concerns

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ABSTRACT

Changes in vaginal blood flow and lubrication are primary components of physiological sexual arousal in women. Despite the existence of well-established tools for measuring vaginal blood flow, there is not yet a consistently implemented measure of physiological lubrication. To address this methodological gap, researchers have begun examining the utility of litmus test strips, primarily in sexually healthy women. The present study builds on this work by examining the utility of an alternative tool, the Schirmer Tear Test strips, in women with ($n = 32$) and without ($n = 32$) sexual arousal concerns. Significant increases in physiological lubrication were found in response to a sexual film, and these changes were moderately correlated with self-reported genital arousal ($r = .41$) and lubrication ($r = .30$). No between-group differences in lubrication were observed. These results indicate the Schirmer Tear Test strips are sensitive enough to detect increases in lubrication and may be valuable in clinical and research assessments of female sexual arousal.

Genital sexual arousal in women involves changes in blood flow and lubrication. During periods of arousal, blood flow to the genitals increases, creating pressure on the vaginal walls. This pressure is believed to cause a seepage of moisture from within the vaginal walls onto the vaginal surface, known as vaginal lubrication (Levin, 2003). A number of techniques is currently available for measuring genital blood flow in a laboratory setting, of which vaginal photoplethysmography is most common (for a review of measurement techniques, see Kukkonen, 2015). The vaginal photoplethysmograph contains a light-emitting diode or transistor that emits infrared or incandescent light. The light reflects off blood within the vaginal walls and is subsequently reabsorbed by the probe (Hoon, Wincze, & Hoon, 1976; Sintchak & Geer, 1975). Vaginal photoplethysmography has consistently been found to be a sensitive and reliable marker of genital sexual arousal in women (e.g., Laan, Everaerd, & Evers, 1995).

In contrast to this well-established method of measuring genital blood flow, until recently, measures of physiological lubrication have been notably absent in research and clinical use. This is noteworthy given lubrication is a defining feature of sexual arousal concerns from both diagnostic (American Psychiatric Association, 2000; World Health Organization, 2019) and epidemiological (e.g., Lewis et al., 2010; Mitchell et al., 2013) perspectives, and that women with and without sexual arousal concerns identify lubrication as a highly valued marker of genital sexual arousal (Handy, Freihart, & Meston, under review). Although the vaginal photoplethysmograph measures blood flow which is considered a precursor to lubrication (Giraldi & Levin, 2006), research has yet to demonstrate the quantity of blood required to produce lubrication. As such, conclusions about a woman's lubrication response based solely on measures of genital blood flow

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is highly speculative. Furthermore, evidence from experimental research indicates weak correlations between genital blood flow and lubrication (Dawson, Sawatsky, & Lalumière, 2015; Sawatsky, Dawson, & Lalumière, 2018).

The dearth of research quantifying physiological lubrication in women is largely due to the lack of a consistently implemented and validated tool. Early studies surrounding physiological lubrication examined the use of cotton swabs (Stone & Gamble, 1959) and tampons (e.g., Godley, 1985; Odeblad, 1964; Preti, Huggins, & Silverberg, 1979) as methods of measuring the quantity and composition of lubrication during both unaroused and aroused states. However, due to the high absorbency and wicking capacity of tampons and cotton swabs, repeated testing is not recommended as the vaginal epithelium may become atypically dry (Levin, 2003).

The lack of an instrument for assessing physiological lubrication has led treatment developers to rely exclusively on women's subjective assessments, even among studies in which other physiological metrics of the vagina were able to be obtained (e.g., epithelial thickness; Chatsiproios, Schmidts-Winkler, König, Masur, & Abels, 2019). This reliance on self-report data for physiological concerns such as vaginal dryness is questionable, as there is research indicating discrete self-report data do not always align with physiological genital responses (e.g., Handy, Stanton, Pulverman, & Meston, 2018; Laan, van Driel, & van Lunsen, 2008).

To address this methodological gap, researchers have begun examining the use of litmus strips as a tool for measuring physiological lubrication. Carranza-Lira et al. (2003) measured changes in basal lubrication (i.e., lubrication during an unaroused state) in 40 postmenopausal women before and three months after initiating a regimen of estrogen-based hormone replacement therapy. The litmus strips, which were placed at the vaginal introitus (i.e., vaginal opening), detected significant increases in lubrication from pre- to post-treatment, providing objective evidence that the estrogen-based treatment was effective at increasing lubrication. Using litmus strips and the protocol outlined by Carranza-Lira et al. (2003), Dawson et al. (2015), Sawatsky et al. (2018), and Bouchard, Dawson, Shelley, and Pukall (2019) later examined changes in lubrication in response to sexual and nonsexual stimuli in small samples of sexually healthy, premenopausal women. In these studies, participants measured post-stimulus lubrication using blue litmus paper affixed to a plastic applicator. Participants held the applicator at the base of their vaginal opening for 60 s, and the test strips were measured immediately after the study session. These studies consistently found significantly greater levels of lubrication were found following the sexual films in comparison to the nonsexual films, suggesting that the litmus strips are sensitive enough to detect lubrication produced in response to sexual arousal.

These studies represent an important step forward in our understanding of women's physiological lubrication response and overall sexual function. The development of an objective measure of lubrication is both methodologically and clinically meaningful; it provides researchers and clinicians alike with a greater understanding of women's genital arousal patterns and treatment response (e.g., Carranza-Lira et al., 2003). Litmus strips, however, are designed to assess the relative acidic or basic nature of a liquid, rather than the quantification of liquids. It is possible that litmus strips may not be as sensitive to change as would be test strips specifically designed for moisture quantification. As such, the present study builds off this burgeoning body of research by examining the feasibility of an alternative tool for assessing physiological lubrication, Schirmer Tear Test strips, which were specifically designed for measuring the moisture production of mucous membranes. These test strips are approved by the Food and Drug Administration for the clinical assessment of dry eyes, and are also commonly used in clinical research examining moisture produced by mucous membranes such as the eyes (e.g., Sall, Stevenson, Mundorf, & Reis, 2000), nose (e.g., Lindemann et al., 2014), and mouth (e.g., López-Jornet, Camacho-Alonso, & Bermejo-Fenoll, 2006). It is plausible that these tests strips may be effective at detecting the moisture production of other mucous membranes such as the vagina. The present study also extends this area of research to include the assessment of women with sexual arousal concerns.

Table 1. Participant characteristics.

Variables	No arousal concerns ($n = 32$) *M* (SD)	Arousal concerns ($n = 32$) *M* (SD)
Age (range: 18–48)	25.00 (7.16)	23.59 (6.70)
	n **(%)**	***n*** **(%)**
Race/Ethnicity		
African American	2 (6)	3 (9)
Asian	8 (25)	2 (6)
Caucasian	17 (53)	17 (53)
Hispanic	5 (16)	8 (25)
Other	0 (0)	2 (6)
Highest Level of Education		
High school diploma/GED	3 (9)	2 (6)
Some college	12 (38)	20 (63)
College degree	13 (40)	9 (28)
Advanced degree	4 (13)	1 (3)
Relationship Status		
Single, not dating	1 (3)	3 (9)
Single, dating	7 (22)	12 (38)
In a committed relationship	19 (59)	16 (50)
Married	5 (16)	1 (3)

Note. M = mean; SD = standard deviation; GED = General Equivalency Development

This study had two primary aims: (1) to evaluate the use of the Schirmer Tear Test strips as a measure of physiological lubrication by comparing results before and after exposure to a sexual film, and by correlating these results with self-report measures of genital arousal and (2) to assess whether this test can differentiate women with and without sexual arousal concerns.

Method

Participants

Participants were recruited through online (e.g., social media, local university listservs) and printed (e.g., laundromats, coffee shops) advertisements. Women who expressed interest in this study were screened for eligibility over the phone. Women were eligible to participate in the study if they were at least 18 years old, premenopausal, fluent in English, sexually active within the past 4 weeks (to align with the timeframe assessed in the Female Sexual Function Index), heterosexual or bisexual (due to the content of the sexual stimuli), and if they reported no history of sexual abuse. In order to compare lubrication between women with and without sexual arousal concerns, it was further required that women who did not report sexual arousal concerns score above the clinical cutoff on the Female Sexual Function Index (26.55; Rosen et al., 2000; Wiegel, Meston, & Rosen, 2005), and those endorsing sexual arousal concerns score below the cutoff. In total, 67 women participated in this study. Three women were excluded due to incomplete survey responses, leaving a final analytic sample of 64 women. See Table 1 for descriptive statistics.

Measures

Experimental stimulus

The experimental stimulus consisted of a 10-min film presentation composed of a 4-min neutral clip and a 6-min sexual clip. The neutral clip was comprised of a 1-min display of the text "Relax" followed by a 3-min panoramic nature scene. The sexual clip depicted a heterosexual couple engaging in sexual activity, progressing from 2 min of foreplay to 2 min of oral sex to 2 min of vaginal intercourse. The film was selected based on prior use in similar studies wherein it was shown to increase sexual arousal in women (e.g., Handy & Meston, 2018).

Lubrication

Schirmer Tear Test strips were used to measure lubrication. The Schirmer Tear Test is a Food and Drug Administration-approved measurement of tear production. These test strips are commonly used to assess moisture in the eyes (Sall et al., 2000) as well as mucous membranes such as those in the nose (Lindemann et al., 2014) and mouth (López-Jornet et al., 2006). The test strips are ruled in millimeter increments and are 40 mm in length. Test strips were adhered via double-sided tape to wooden applicators beginning at 5 mm, allowing for a standardized length of the test strip (i.e., 5 mm) to be inserted into the vaginal opening. Moisture absorption was indicated via color change, and the highest continuous point of absorbed moisture was recorded.

Self-reported genital arousal

Self-reported genital arousal was measured via the genital arousal subscale of the Film Scale (Heiman & Rowland, 1983). This subscale contains five items that specifically assess genital responses, including genital "warmth," "wetness/lubrication," "pulsing/throbbing," "tenseness/tightness," and "any genital feeling." Items are rated on a 7-point Likert scale ranging from 1 (not at all) to 7 (intensely). Responses to these five items are summed (range: $5-35$) to create a composite score of self-reported genital arousal, where greater scores indicate greater levels of genital arousal. The item "wetness/lubrication" was also examined separately as an indicator of self-reported lubrication.

Sexual function

The Female Sexual Function Index (FSFI; Rosen et al., 2000) and a sexual arousal assessment were administered in order to classify women with and without sexual arousal concerns.

Female Sexual Function Index. The Female Sexual Function Index (FSFI; Rosen et al., 2000) is a 19-item self-report questionnaire that assesses desire, arousal, lubrication, orgasm, satisfaction, pain, and overall sexual functioning. Total scores range from 1.2 to 36, where poorer sexual function or sexual inactivity is represented by lower scores. The FSFI has been found to have good internal reliability ($r = 0.89$-0.97), test-retest reliabilities ($\alpha = 0.79$–0.88), and has confirmed discriminant validity in distinguishing women with sexual complaints from women without those complaints (Rosen et al., 2000; Ryding & Blom, 2015; Wiegel et al., 2005).

Sexual arousal assessment. The sexual arousal assessment was developed to assess for arousal concerns based on *ICD-10* criteria for female sexual arousal disorder (World Health Organization, 2004). The assessment includes a series of questions regarding the participants' current ability to become sexually aroused. The questions examine whether: (a) women had ever experienced various genital sensations (e.g., warmth, wetness, tingling); (b) there had been any change in the extent to which these sensations are experienced during sexual activity (i.e., no change in genital sensations, decreased sensations, or absent sensations); (c) any changes were situational in nature; (d) women self-identified as having an arousal problem; and (e) women were distressed by this problem (see Handy, Stanton, & Meston, 2018).

Participants were included in the sexual arousal concerns group if they reported scores on the FSFI that fell below the clinical cutoff of 26.55 (Wiegel et al., 2005) and reported having an arousal-specific concern on the sexual arousal assessment. Women were categorized as having an arousal-specific concern per the sexual arousal assessment if they reported: (a) experiencing decreased or absent genital sensations for the past six months or longer; (b) their arousal problem was generalized, rather than situational, in nature; (c) self-identifying as having an arousal problem; and (d) that they were distressed by this problem. Participants were included in the no arousal concerns group if they scored above the clinical cutoff score on the FSFI and did not endorse any items on the sexual arousal assessment.

Procedure

Upon arrival to the laboratory, participants received an explanation of all study procedures and instruments, and they were provided the opportunity to ask the researcher any questions that arose. After providing informed consent, women were supplied with a labeled diagram of the vulvar region and with a detailed description of where to insert the test strip (i.e., at the bottommost location of the vaginal opening, or 6 o'clock). Participants then completed a demographic questionnaire and the measure of self-reported genital arousal.

Women were then instructed to undress from the waist down and engaged in the first measure of physiological lubrication, which followed procedures reported in previous research (Carranza-Lira et al., 2003; Dawson et al., 2015; Sawatsky et al., 2018). During this task, women were seated in a chair with their feet elevated on an ottoman. To avoid transference of moisture from the labia to the test strip, women were instructed to part their labia with one hand. Using a mirror as a guide, women inserted the test strip with their free hand until the tip of the wooden applicator touched their vaginal skin. This was done to ensure that the test strips were inserted at a standardized depth (5 mm) and location (6 o'clock) for each woman.

Women held the test strip in place for 60 s. At 60 s, women were instructed to remove the test strip, place it in a plastic bag, and cover up with a drape provided by the researchers. When alerted that the participant was covered, one researcher entered the room to obtain the test strip. Two researchers then independently recorded the length of moisture that had been absorbed into the test strip immediately after leaving the participant's room. Inter-rater reliability for this study was excellent ($\kappa = .98$). To minimize potential bias, researchers running the study sessions were blind to the sexual function status of the participants. To account for unaroused (i.e., baseline) levels of vaginal moisture and capture lubrication that was secreted in response to the sexual film, this procedure was conducted immediately before and after watching the film presentation.

Participants then completed the self-report measure of genital arousal for a second time to assess changes in response to the sexual film. Women were instructed to get dressed and then open the testing room door. They were debriefed and compensated with $20 for their time. This study was approved by the Institutional Review Board at the University of Texas at Austin.

Statistical analyses

Primary analyses were conducted in R 3.2.3 using Base R (R Core Team, 2019). Between-group analyses were performed using Welch's *t*-tests, multivariate analyses of variance (MANOVAs), and Pearson's product–moment correlations. A binary logistic regression was conducted to determine whether results from the Schirmer Tear Test could differentiate women with and without sexual arousal concerns. Exponentiated coefficients from this model were extracted to calculate an odds ratio, and accuracy statistics (i.e., whether the test strips can classify women with vs. without an arousal concern) were performed using fitted values from the original model. See Hosmer, Lemeshow, and Sturdivant (2013) for a description of this statistical approach.

Results

Aim I: Compare pre- and post-film measures of lubrication and correlate with self-report measures of genital arousal

Changes in physiological lubrication in response to the sexual film

On average, women's baseline lubrication was 3.19mm ($SD = 3.28$) with a median of 2.75 mm. Post-film levels of lubrication increased, on average, to 6.27 mm ($SD = 4.96$) with a median of 6.00 mm. Results from a paired samples *t*-test indicate that this represents a significant increase in lubrication from pre- to post-film, $t(63) = 6.017$, $p < .0001$, $d = 0.751$ supporting the use of

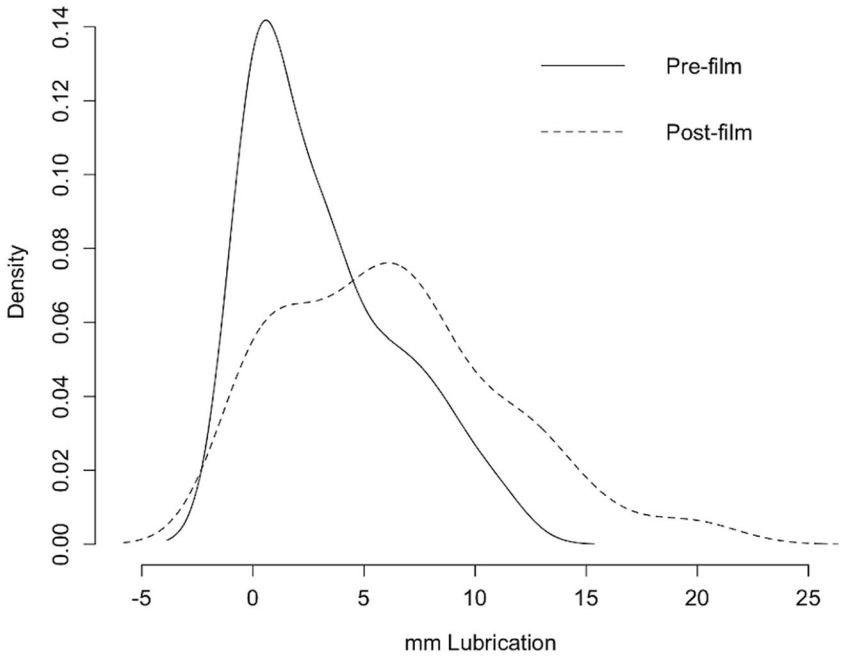

Figure 1. Density plot reflecting the distribution of pre- and post-film measures of physiological lubrication across all women. The rightward shift in central density at the post-film time point indicates greater amounts of lubrication in response to the sexual film.

these test strips. Women's average change in lubrication, which was measured as post-film minus pre-film levels of lubrication, was 3.08 mm ($SD = 4.09$) with a median of 2.75 mm. Data exhibited a floor effect at zero, thus pre- and post-film levels of lubrication were positively skewed (0.83 and 0.67, respectively). Despite this, pre- and post-film tails were reflective of a roughly normal distribution, with slightly fatter tails at the post-film time point (kurtosis of 2.61 and 3.05, respectively; see Figure 1).

A MANOVA model indicated that women with and without arousal concerns did not differ on pre- or post-film measures of lubrication, $F(61) = 0.168$, $p = .84$. A Welch's t-test comparing changes in lubrication between the two groups of women confirmed this finding, $t(61.996) = 0.234$, $p = .815$. This suggests that, though there were significant increases in lubrication from pre- to post-film for both groups of women, no notable differences in this change emerged based on women's sexual function. Three-quarters of women in the arousal concerns group (78.12%; $n = 25$) and 75% ($n = 24$) of those in the no concerns group exhibited increases in physiological lubrication in response to the sexual film. See Table 2 for descriptive statistics of the measures of arousal.

Changes in self-reported genital arousal in response to the sexual film

To confirm that the sexual stimulus was effective at increasing women's self-reported genital arousal response, a paired samples t-test was conducted comparing pre- to post-film levels of this construct. Indeed, women reported significant increases in genital arousal, $t(63) = 9.341$, $p < .0001$, $d = 1.168$, from pre- to post-film. On average, women experienced an increase of 7.35 units ($SD = 6.30$) on the Likert scale, with a median of 6.50. With regards to the individual item assessing lubrication, a significant increase from pre- to post-film was also found, $t(63) = 8.365$, $p < .0001$, $d = 1.051$. On average, women reported an increase of 1.60 units ($SD = 1.53$) on the Likert scale, with a median of 1.00. This suggests that, in addition to increasing women's perception of their overall genital arousal response, the films were effective at increasing women's perception of their lubrication response, specifically.

Table 2. Descriptive statistics of physiological lubrication, self-reported genital arousal, and self-reported lubrication by group.

	No arousal concerns ($n = 32$)	Arousal concerns ($n = 32$)
Variables (in mm)	*M* (SD)	*M* (SD)
Pre-film physiological lubrication	2.96 (3.08)	3.42 (3.50)
Pre-film self-reported genital arousal	8.43 (3.15)	7.65 (3.92)
Pre-film self-reported lubrication	1.84 (0.88)	1.71 (1.08)
Post-film physiological lubrication	6.16 (4.81)	6.38 (5.18)
Post-film self-reported genital arousal	18.12 (7.61)	12.69 (5.22)
Post-film self-reported lubrication	4.06 (1.72)	2.71 (1.08)

Note: M = mean; SD = standard deviation; mm = millimeters. Self-reported genital arousal ranges from 5 to 35 and lubrication ranges from 1 to 7. Higher scores indicate greater arousal/lubrication.

A second MANOVA model was run to assess group differences in pre- and post-film measures of self-reported genital arousal. The model was significant, $F(61) = 5.674$, $p = .005$, indicating that either pre- or post-film levels of this construct differed between the groups. An examination of this model revealed a significant group difference at the post-film time point such that, after viewing the sexual film, women with sexual arousal concerns reported significantly lower levels of genital arousal, $F(1) = 11.1$, $p = .001$. A Welch's t-test comparing changes in self-reported genital arousal for each group confirmed this finding, $t(54.132) = 3.158$, $p = .002$, $d = 0.789$. This indicates that women with sexual arousal concerns reported perceiving a lesser genital arousal response than did women without sexual arousal concerns.

A separate MANOVA model was conducted to assess for possible group differences in self-reported lubrication. The model was significant, $F(61) = 7.264$, $p = .001$, and an ANOVA conducted on this model indicated that the group differences in lubrication were present at the post-film time point, $F(1) = 13.96$, $p = .0004$. This finding was confirmed by a Welch's t-test conducted on changes in self-reported lubrication, $t(58.759) = 3.426$, $p = .001$, $d = 0.856$. These results indicate that women with sexual arousal concerns reported experiencing significantly less lubrication at the end of the film compared to women without these concerns.

Correlations between physiological lubrication and self-reported genital arousal

Pearson's product-moment correlations were performed to examine whether changes in physiological lubrication were associated with changes in women's self-reported experience genital arousal. Indeed, increases in lubrication were moderately correlated with changes in self-reported genital arousal ($r = .41$) and lubrication ($r = .30$). This suggests that, in general, physiological lubrication appears to be related to women's perceptions of their arousal.

To determine the effect of sexual function on these relationships, separate correlations were calculated for women with and without sexual arousal concerns. When examining the relationship between changes in physiological lubrication and self-reported genital arousal by group, moderately strong correlations emerged for women with and without sexual arousal concerns ($r = .41$ and .46, respectively). However, when assessing the relationship between changes in physiological and self-reported lubrication, a notably weaker relationship emerged for women *with* than *without* sexual arousal concerns ($r = .13$ vs. .47, respectively). This suggests that women with sexual arousal concerns may have greater difficulty estimating specific aspects of genital arousal (i.e., lubrication) than genital arousal in general.

Aim II: Assessing whether Schirmer Tear Test strips can differentiate women with and without sexual arousal concerns

A binary logistic regression was conducted to determine whether the Schirmer Tear Test can differentiate women with and without sexual arousal concerns. The model was not significant, $\beta = 0.014$, $p = .812$, indicating that the test strips could not differentiate the sexual functioning of

participants. As physiological lubrication increased by one standardized unit, the odds of reporting an arousal problem increased by 1.014 (95% CI: 0.89–1.14). A comparison of the predicted probabilities against true class values indicated that the logistic regression correctly classified 54.68% of women. These findings support the lack of group differences evidenced between women with and without sexual arousal concerns on this measure. Taken together, these results suggest that any physiological differences in lubrication that may exist may not be substantial enough to be detected by Schirmer Tear Test strips in a laboratory setting.

Discussion

The present study evaluated the use of Schirmer Tear Test strips for measuring physiological lubrication in women and is the first laboratory study to compare the lubrication responses of women with and without sexual arousal concerns. Significant increases in physiological lubrication in response to a sexual film were evidenced in both groups of women, indicating that the test strips were sensitive enough to detect laboratory-induced changes in lubrication. These results are promising and suggest that Schirmer Tear Test strips may be a useful addition to the tools researchers use for measuring genital arousal in women. Given the diagnostic (American Psychiatric Association, 2000; World Health Organization, 2018), epidemiological (Lewis et al., 2010; Mitchell et al., 2013), and personal (Handy, Freihart, & Meston, under review) importance of lubrication in women's experience of arousal, it is crucial that objective measures be incorporated into research and clinical work to gain more accurate assessments of this construct.

We found no between-group differences in lubrication, and an analysis of the test strip's ability to discriminate between women with and without sexual arousal concerns was not significant; only 54% of cases were correctly classified. We offer two possible explanations for the lack of significant differences in lubrication between women with and without sexual arousal concerns. First, it is possible that there truly are no between-group differences in pre- or post-film measures of physiological lubrication for these populations. This is corroborated by a large body of research examining changes in mean blood flow from pre- to post-film that has similarly not found differences among women with and without sexual dysfunction (e.g., Heiman et al., 2011; Laan et al., 2008; Rellini & Meston, 2011; Salemink & van Lankveld, 2006). However, research that examines changes in blood flow *over time* has found that women with and without sexual dysfunction have distinct trajectories of genital responding (Handy, Stanton, Pulverman, et al., 2018). Handy, Stanton, and Meston (2018) found that, though women with clinical and sub-clinical sexual dysfunction did not differ from sexually functional women on pre- or post-film levels of genital arousal, the slopes of their paths of arousal did differ. It is therefore possible that the discrete approach to measuring lubrication employed in the present study is correctly capturing between-group *similarities* in pre- and post-film levels of arousal, but simply does not account for changes in slope, which is where between-group differences may lie. If future research finds that this is, indeed, the case, the development of pharmacological treatments designed to alter the time of onset of lubrication may be useful.

Second, it is possible that women's sexual responses were inhibited due to the testing environment. A study by Bloemers et al. (2010) found no differences in physiological responding between women with and without sexual dysfunction in the laboratory, but they *did* find significant differences when the same measure was conducted in their home environment. The authors suggested that sexually functional women may have an inhibited genital arousal response in the laboratory, causing their ultimate level of genital responding to mimic that of women with sexual dysfunction. A benefit to the use of the Schirmer Tear Test is that it is highly portable and could easily be used in a home environment; other measures of sexual arousal typically require equipment that cannot reasonably be implemented in the home without unique ambulatory equipment. Future research should examine the lubrication response of women with and without sexual

dysfunction in their own home, as this approach may more accurately reflect any group differences that exist.

The present study also examined correlations among physiological lubrication and self-reported genital arousal and lubrication. Moderate correlations were found between physiological lubrication and self-reported genital arousal in both groups of women. This finding is supported by results presented in Dawson et al. (2015) and Sawatsky et al. (2018), which reported correlations of .51 and .37, respectively. The authors suggest that women may use cues such as the experience of lubrication when estimating their overall genital arousal response, which would theoretically manifest in these moderate correlations. It is important to note, however, that a much weaker correlation emerged between physiological and self-reported lubrication for women with ($r = .13$) compared to without ($r = .47$) sexual arousal concerns. Women with sexual arousal concerns reported lower levels of lubrication despite experiencing a physiological response similar to that of women with no arousal concerns, manifesting as this low correlation. It is possible that, because these women report struggling with sexual arousal, they may believe they "should" have a greater lubrication response than they experienced, and therefore rate this as occurring to a lesser degree than did their healthy counterparts. If this is the case, women who present clinically with sexual arousal concerns may benefit from cognitive restructuring around expectations for their arousal response. This interpretation is similar to Barlow's model of sexual dysfunction (Barlow, 1986), which suggests that an individual's assumptions of how they should perform may be a maintaining factor in their experience of sexual dysfunction.

There are a few limitations to the present study that are worth noting. First, we recruited women with sexual arousal concerns in general, rather than women with concerns surrounding lubrication specifically. It is possible that examining women with lubrication concerns may have yielded different results and, possibly, significant between-group effects. A second limitation to the present study is that the measure of lubrication was self-administered. Although participants were thoroughly instructed on how and where to insert the test strip to minimize between-person variability, it is possible that not all participants inserted the test strip correctly. This could have interfered with the accuracy of these particular data and impacted the study results. The applicators used in this study were also wooden, which could have absorbed moisture and possibly influenced results. Researchers may wish to use plastic in lieu of wooden applicators in future studies. Furthermore, to keep the timing of the lubrication measure as close to the film as possible, the order of assessing self-reported genital arousal and physiological lubrication was reversed from pre-to post-film. This could have biased some of women's self-reported responses. Finally, women participated in this study during various phases of their menstrual cycle, which could have influenced individual patterns of lubrication; a large body of research supports the hormonal modulation of genital arousal, including lubrication (Davis, Worsley, Miller, Parish, & Santoro, 2016; Santoro, Worsley, Miller, Parish, & Davis, 2016). Future research should examine possible variations in women's physiological responses based on their menstrual phase or their use of exogenous hormones.

Despite these limitations, the Schirmer Tear Test appears to be a viable method of assessing physiological lubrication in women. These test strips identified significant increases in lubrication from before to after exposure to a sexual film, and these increases were correlated with increases in self-report measures of genital arousal. Using direct, objective measures of lubrication will help researchers better understand women's sexual arousal responses and, clinically, may assist with treatment development and evaluation. Treatment development is generally more effective when its targets have greater specificity (e.g., Siev & Chambless, 2007). As such, shifting from self-report to physiological assessments may increase the efficacy of treatments in this area.

As this was a preliminary study examining the feasibility of the Schirmer Tear Test strips, future research is needed to determine the psychometric properties of this method (e.g., response specificity, test–retest reliability) prior to incorporating these test strips into clinical practice.

Given the lack of research on this topic and the importance of lubrication in women's overall sexual arousal response, researchers are encouraged to include physiological measures of lubrication in future sexual psychophysiology studies.

Disclosure statement

No potential conflict of interest was reported by the authors.

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