Intravaginal Practices and Risk of Bacterial Vaginosis and Candidiasis Infection Among a Cohort of Women in the United States

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OBJECTIVE: To measure intravaginal practices among women of differing ages, ethnicities, and human immunodeficiency virus status and the association between intravaginal practices and bacterial vaginosis and candidiasis infection.

METHODS: Between 2008 and 2010, we recruited and followed sexually active women aged 18–65 years living in Los Angeles. At the enrollment and month 12 visit, participants completed a self-administered, computer-assisted questionnaire covering demographics, sexual behaviors, vaginal symptoms, and intravaginal practices over the past month. At each visit, bacterial vaginosis and candidiasis infection were diagnosed by Nugent criteria and DNA probe, respectively.

RESULTS: We enrolled 141 women. Two thirds (66%) reported an intravaginal practice over the past month; 49% reported insertion of an intravaginal product (other than tampons) and 45% reported intravaginal washing. The most commonly reported practices included insertion of commercial sexual lubricants (70%), petroleum jelly (17%), and oils (13%). In univariable analysis, intravaginal use of oils was associated with *Candida* species colonization (44.4% compared with 5%, $P<.01$). In multivariable analysis, women reporting intravaginal use of petroleum jelly over the past month were 2.2 times more likely to test positive for bacterial vaginosis (adjusted relative risk 2.2, 95% confidence interval 1.3–3.9).

CONCLUSION: Intravaginal insertion of over-the-counter products is common among women in the United States and is associated with increased risk of bacterial vaginosis. The context, motivations for, and effects of intravaginal products and practices on vaginal health are of concern and warrant further study.

(Obstet Gynecol 2013;121:773–80)

DOI: http://10.1097/AOG.0b013e31828786f8

LEVEL OF EVIDENCE: III

There is growing evidence that intravaginal practices and products can cause damage to vaginal and rectal tissues,[1,2] increase replication of human immunodeficiency virus (HIV) in vitro,[3] and that some intravaginal practices and products may be associated with increased risk for bacterial vaginosis and sexually transmitted infections, including HIV.[4] Intravaginal practices include a variety of behaviors including wiping, cleansing, douching, or the insertion of products, including sexual lubricants, into the vagina.[5] These behaviors may disturb the vaginal protective systems, which are based in part on hydrogen peroxide, lactobacilli, and pH. For example, soaps, detergents, and antiseptics used to wash inside the vagina can cause chemical damage and increase vaginal pH,[6] encouraging the growth of organisms associated with bacterial vaginosis.[7] To date, the majority of published studies on intravaginal practices in the United States have focused on vaginal douching with researchers suspecting that douching may be associated with bacterial vaginosis[8] and other common vaginal infections.[9] However, little is currently known about the prevalence of other types of intravaginal practices among women in the United States and their effects on vaginal health. The objective of this study was to

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Supported by the California HIV/AIDS Research Program (CR07-LA-582; CR07-ARA-581) and the UCLA AIDS Institute (CH05-LA-608).

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Financial Disclosure

The authors did not report any potential conflicts of interest.

ISSN: 0029-7844/13

examine the frequency of intravaginal practices, the types of products used, and their associations with bacterial vaginosis and candidiasis infection among both HIV-positive and HIV-negative African American, Latina, and Caucasian women. We hypothesized that intravaginal practices such as insertion of products and intravaginal washing may differ across racial groups and may increase risk for bacterial vaginosis and candidiasis infection. In this article, we report on those findings and discuss the implications for vaginal health.

MATERIALS AND METHODS

This prospective cohort study was implemented between 2008 and 2010 through a collaboration between the University of California, Los Angeles, and the AIDS Research Alliance of America in Los Angeles, California. The primary objectives of the cohort study were to estimate the frequency, distribution, and consistency of vaginal and rectal practices and products and their association with reproductive tract infections in an ethnically diverse population. The primary objective of this analysis was to estimate the risk of bacterial vaginosis and vaginal candidiasis in relation to intravaginal practices. Quantitative and qualitative analyses of the motivations for intravaginal washing and insertion of products are presented in separate analyses.

We aimed to enroll a convenience sample of 150 sexually active women aged 18–65 years. Women were recruited through community education and outreach activities conducted by AIDS Research Alliance staff in HIV/AIDS service organizations, women's health clinics, community-based organizations, and HIV testing sites in Los Angeles. Women were invited to come to the AIDS Research Alliance clinic for screening and, if eligible, enrollment. To describe practices among a diverse group of women, we sought to enroll equal numbers of participants who self-identified as non-Hispanic white ("White"), non-Hispanic African American or black ("Black"), or Hispanic or Latina ("Latina"). We sought to include HIV-positive women (approximately 25% of the cohort) to estimate whether intravaginal practices differed in this group. Women who were planning to move from the area in the next 12 months were excluded. Ethics approval for the study was obtained from the institutional review boards of the University of California, Los Angeles and the AIDS Research Alliance. Participating women were seen at the AIDS Research Alliance research clinic for an initial visit and then after 12 months. Written informed consent was obtained from all participants before any study procedures.

At both the enrollment and month 12 visits, participants underwent an extensive, structured, self-administered, computer-assisted questionnaire covering demographic factors (eg, age, race and ethnicity, education), sexual behaviors, intravaginal practices, contraceptive use, and vaginal symptoms. Women were counseled on distinguishing between practices affecting the intravaginal environment (beyond the introitus) and the external genitalia (eg, mons pubic, vulva) at the beginning of and throughout the study questionnaire. The baseline and month 12 questionnaire referred to behaviors over the previous year and during the last month. The questionnaire was available in both English and Spanish. At enrollment and the month 12 visit, women underwent HIV and herpes simplex virus type 2 (HSV-2) antibody testing and counseling and were instructed how to provide a urine sample and two self-collected vaginal swabs, which were used for testing for vaginal infections.[10,11] Participants performed the self-collection of urine and vaginal swabs in privacy at the study clinic. Participants who tested positive were referred to an appropriate health care provider for treatment, medical care, and emotional support, as needed. Before the month 12 visit, AIDS Research Alliance study staff sent a reminder card to each participant followed by a phone call to minimize loss to follow-up.

At each visit, one Gram-stained slide was prepared from a vaginal swab. Slides were air-dried, fixed in methanol, and evaluated by a single technician who used oil immersion with ×1,000 magnification to quantify and score the specimens according to Nugent criteria to diagnose bacterial vaginosis.[12] Detection of *Trichomonas vaginalis* and *Candida* species by BD Affirm DNA probe was performed on a vaginal swab. The sensitivity, specificity, and clinical use of the Affirm test for diagnosing candidiasis infection is higher than wet mount and clinical evaluation; compared with yeast culture isolation, the sensitivity and specificity of the Affirm test in diagnosing candidiasis infection is 81% and 98.2%, respectively. HIV status was determined using the rapid HIV-1/2 antibody and positive results were confirmed by Western blot. HSV-2 status was determined by a type-specific serologic IgG antibody enzyme-linked immunosorbent assay using an index cutoff value of 3.5 to optimize specificity.[13] Polymerase chain reaction was used to detect *Chlamydia trachomatis* and *Neisseria gonorrhoea* in urine. Laboratory testing was conducted at the AIDS Research Alliance and Cedars Sinai Clinical Laboratories in Los Angeles, both of which participate in quality assurance programs and are CLIA-certified and licensed by the state of California's Department of Health Services.

The outcome measures for this analysis were bacterial vaginosis and *Candida* colonization. Specimens with a Nugent score of 7–10 were considered positive for bacterial vaginosis.[12] A positive result for *Candida* colonization was defined as a positive result on the Affirm test, which indicates the presence of clinically significant levels of *Candida* species (greater than 1×10^4 *Candida* cells) in vaginal samples.[14] Definitions of intravaginal practices were modeled on the World Health Organization Gender Sexuality and Vaginal Practices Study group classification for vaginal practices[5] and refined after conducting in-depth interviews, which we conducted in the target population before the start of the cohort study. Intravaginal practices were defined as 1) intravaginal washing, which included intravaginal cleaning of the inside of the vagina, beyond the introitus, with soap, commercially prepared solutions, or other household products, with or without douching devices; and 2) intravaginal insertion of products, which included insertion of over-the-counter products (eg, petroleum jelly, sexual lubricants) into the vagina, beyond the introitus, with or without an applicator. Practices that involved the external genitalia were defined as washing or application of products to the vulva or mons pubis.

Data were analyzed using STATA 11.2. Sociodemographics, sexual behaviors, and the prevalence, frequency, and types of intravaginal practices were tabulated. Some reported practices to the external genitalia are also presented when meaningful differences were found. For binary measures, proportions were calculated, and for continuous measures (eg, age), we calculated the central location (medians), interquartile range, and range. These statistics are calculated overall, by participant race and ethnicity, and by bacterial vaginosis status and *Candida* colonization status at the enrollment visit. Univariable associations between participant characteristics, race, and bacterial vaginosis and *Candida* colonization are presented and differences analyzed using analysis of variance and Fisher's exact tests.

To examine the relationship at baseline between intravaginal practices and bacterial vaginosis, we fit univariate and multivariate Poisson regression models to estimate relative risks (RRs) and generated confidence intervals (CIs) by using robust standard errors.[15] To examine the relationship between intravaginal practices and bacterial vaginosis during follow-up, we fit a repeated-measures multivariate Poisson model adjusting for correlation within an individual and for potential confounding and generated robust standard errors.[16] The model controlled for factors that were considered a priori to be potential confounders from the literature (age, race, HIV status, intravaginal washing) and factors that were associated ($P<.05$) in univariable analyses with bacterial vaginosis (unprotected vaginal sex, number of male sexual partners, HSV-2 infection). There were too few participants with *Candida* colonization (less than 10 women) to support multivariable analysis.

RESULTS

One hundred fifty women were screened and consented, and 141 women were enrolled and completed the baseline questionnaire and sample collection. The median age of women in this cohort was 32 years (interquartile range 25–44, range 18–65 years). One third (34%) of women were White, 40% Black, and 26% Latina. The majority (89%) had completed at least a high school education (Table 1). Ninety-nine women returned for the exit visit at month 12 and completed the exit questionnaire and sample collection. Loss to follow-up was not associated with bacterial vaginosis, *Candida* colonization, vaginal symptoms, intravaginal practices, number of male partners, education, unprotected sex, or HIV status at baseline.

The majority (81%, 95% CI 73.4–87%) of women reported either washing the inside of their vagina or inserting an over-the-counter product (other than tampons) into their vagina over the past year (Table 1). Nearly half (45%, 95% CI 36.3–53.3%) of women reported washing the inside of the vagina during the past month (Table 1). Reports of intravaginal washing did not differ by age or HIV status. For example, 46% of women aged 18–25 years, 43% of women aged 26–33 years, 47% of women aged 34–44, and 44% of women aged 45–65 years reported intravaginal washing over the past month. Among all participants (n=141), Black women were more likely to report intravaginal washing with vinegar and water (41%) compared with White women (21%) or Latina women (19%) ($P=.03$). The median frequency of intravaginal washing was five times (interquartile range 2–14, range 1–66) over the past month and did not differ significantly by type of washing solution, race, age, or HIV status (data not shown). In comparison, 100% of women reported washing the external genitalia over the past month, and the median frequency of washing the external genitalia was 30 times (interquartile range 24–30, range 2–120).

Overall, nearly half (49%, 95% CI 40.4–57.5%) of women reported inserting an over-the-counter product (other than tampons) inside the vagina over the past month. Among women reporting insertion of intravaginal products, the most commonly reported products included commercial sexual lubricants

Table 1. Univariable Associations With Race or Ethnicity, Bacterial Vaginosis, and *Candida* Colonization: Characteristics of Participants Measured at Enrollment

		Race or Ethnicity			
	Total (n=141)	White (n=48)	Black (n=56)	Latina (n=37)	*P*
Age (y)	32 (25–44)	32 (25–46)	31 (24–44)	35 (24–42)	.56
Race					
Non-Hispanic White	48 (34.0)	—	—	—	
Non-Hispanic Black	56 (39.7)	—	—	—	
Hispanic or Latina	37 (26.2)	—	—	—	
Education					
Less than high school	16 (11.3)	3 (6.3)	8 (14.3)	5 (13.5)	
High school graduate	46 (32.9)	13 (28.3)	19 (34.6)	14 (37.8)	
Some college	51 (36.4)	19 (41.3)	18 (32.7)	14 (37.8)	
College graduate	26 (18.6)	12 (23.9)	10 (18.2)	4 (10.8)	.66
Sexual history					
Ever vaginal intercourse in lifetime	132 (93.6)	44 (95.6)	52 (92.9)	36 (97.3)	.38
Ever anal intercourse in lifetime	96 (68.1)	32 (66.7)	38 (67.9)	26 (70.3)	.89
No. of male partners (past mo)	1 (1–1)	1 (1–1)	1 (1–1)	1 (1–2)	.29
Any unprotected vaginal sex (past mo)	51 (36.2)	15 (31.3)	22 (39.3)	14 (37.8)	.68
Frequency of vaginal sex (past mo)	5 (2–12)	7 (4–15)	5 (1–10)	6 (2–12)	.60
Received oral sex (past mo)	73 (51.8)	26 (54.2)	23 (41.1)	24 (64.9)	.07
Currently pregnant	3 (2.1)	0	2 (3.6)	1 (2.7)	.49
Currently using oral contraceptives*	12 (9.8)	4 (9.5)	5 (10.4)	3 (9.4)	1.0
Sexually transmitted infections or vaginal conditions					
Bacterial vaginosis	29 (20.6)	8 (17.0)	11 (19.6)	10 (27.0)	.49
Candida colonization	9 (6.4)	2 (4.2)	5 (8.9)	2 (5.4)	.68
HIV	38 (27.0)	13 (25.5)	15 (26.8)	10 (27.0)	.99
HSV-2	73 (51.8)	20 (41.7)	34 (60.7)	19 (51.4)	.17
Trichomonas vaginalis	5 (3.6)	2 (4.3)	2 (3.6)	1 (2.7)	.99
Chlamydia trachomatis	1 (0.7)	0	1 (1.8)	0	1.0
Neisseria gonorrhoeae	1 (0.7)	1 (2.1)	0	0	1.0
Vaginal symptoms					
Unusual vaginal discharge and fishy odor over the past mo	22 (15.6)	7 (14.6)	9 (16.1)	6 (16.2)	1.0
Unusual thick, white vaginal discharge and itching or irritation over past mo	31 (22.0)	12 (25.0)	13 (23.2)	6 (16.2)	.64
Any intravaginal practice (washing or insertion of products)					
Over past y	114 (80.5)	41 (85.4)	42 (75.0)	31 (83.8)	.39
Over past mo	93 (66.0)	33 (68.8)	33 (58.9)	27 (73.0)	.34
Any intravaginal washing					
Over past y	80 (56.7)	24 (50.0)	37 (66.1)	19 (51.4)	.16
Over past mo	63 (44.7)	18 (37.5)	31 (55.4)	14 (37.8)	.15
Any intravaginal insertion of products					
Over past y	86 (61.0)	36 (75.0)	24 (42.9)	26 (70.3)	<.01
Over past mo	69 (48.9)	28 (58.3)	18 (32.1)	23 (62.2)	<.01
Solutions used for intravaginal washing over the past mo†	80	24	37	19	
Commercially prepared douche	18 (22.7)	8 (33.3)	8 (22.2)	2 (10.5)	.21
Vinegar and water	40 (50.0)	10 (41.7)	23 (62.2)	7 (36.8)	.12
Soap and water	31 (39.2)	8 (33.3)	15 (41.7)	8 (42.1)	.83
Water alone	27 (34.2)	7 (29.2)	12 (33.3)	8 (42.1)	.69
Types of products inserted intravaginally over the past mo‡	86	36	24	26	
Petroleum jelly	15 (17.4)	5 (13.9)	8 (33.3)	2 (7.7)	.05
Oils (eg, baby oil)	11 (12.8)	2 (5.6)	6 (25.0)	3 (11.5)	.09
Commercial sexual lubricant	60 (69.7)	26 (72.2)	15 (62.5)	19 (73.1)	.73
Over-the-counter antifungal cream	17 (19.7)	2 (5.6)	10 (41.7)	5 (19.2)	.08

Bacterial Vaginosis			*Candida* Colonization		
Negative (n=112)	Positive (n=29)	*P*	Negative (n=132)	Positive (n=9)	*P*
32 (25–44)	37 (26–44)	.69	32 (25–44)	34 (20–37)	.59
40 (83.3)	8 (16.7)		46 (95.8)	2 (4.2)	
45 (80.4)	11 (19.6)		51 (91.1)	5 (8.9)	
27 (73.0)	10 (27.0)	.49	35 (94.6)	2 (5.4)	.68
13 (81.3)	3 (18.7)		14 (87.5)	2 (12.5)	
32 (69.6)	14 (30.4)		41 (89.1)	5 (10.9)	
44 (86.3)	7 (13.7)		51 (100)	0	
22 (84.6)	4 (15.4)	.22	24 (92.3)	2 (7.7)	.11
106 (94.6)	28 (96.6)	.25	125 (94.7)	9 (100)	1.0
73 (65.2)	23 (79.3)	.13	90 (68.2)	6 (66.9)	.72
1 (1–1)	1 (1–1.5)	.59	1 (1–1)	1 (1–2)	.77
36 (32.1)	15 (51.7)	.05	48 (36.4)	3 (33.3)	1.0
5 (1–12)	6 (3–11)	.44	6 (2–12)	5 (2–5)	.40
57 (50.9)	16 (55.2)	.68	70 (53.3)	3 (33.3)	.31
2 (1.8)	1 (3.5)	.51	1 (0.8)	2 (22.2)	.01
10 (10.5)	2 (7.4)	1.0	12 (10.4)	0	1.0
—	—	—	26 (19.7)	3 (33.3)	.39
6 (5.4)	3 (10.3)	.39	—	—	—
31 (27.7)	4 (24.1)	.82	34 (25.8)	4 (44.4)	.25
55 (53.4)	18 (75.0)	.05	69 (52.3)	4 (44. 4)	.59
4 (3.6)	1 (3.5)	.98	5 (3.8)	0	1.0
0	1 (3.5)	1.0	1 (0.8)	0	1.0
1 (0.9)	0	1.0	1 (0.8)	0	1.0
19 (16.9)	3 (10.3)	0.38	—	—	—
—	—	—	27 (20.5)	4 (44.4)	.10
90 (80.4)	24 (82.8)	1.0	106 (80.3)	8 (88.9)	1.0
72 (64.9)	21 (72.4)	.51	87 (65.9)	6 (66.7)	1.0
55 (49.1)	18 (62.1)	.28	67 (50.8)	6 (66. 7)	.49
46 (41.1)	17 (58.6)	.11	28 (21.8)	4 (44.4)	.21
68 (60.7)	18 (62.1)	1.0	81 (61.4)	5 (55.6)	.74
53 (47.3)	16 (55.2)	.53	64 (48.5)	5 (55.6)	.74
17 (15.2)	1 (3.5)	.08	17 (12.9)	1 (11.1)	1.0
27 (24.1)	13 (44.8)	.03	36 (27.3)	4 (44.4)	.27
23 (20.5)	8 (27.6)	.46	27 (20.5)	4 (44.4)	.11
20 (17.9)	7 (24.1)	.49	24 (18.6)	3 (33.3)	.38
9 (8.0)	6 (20.7)	.05	14 (10.6)	1 (11.1)	1.0
8 (7.1)	3 (10.3)	.69	7 (5.3)	4 (44.4)	<.01
51 (45.5)	9 (31.0)	.21	58 (43.9)	2 (22.2)	.30
15 (13.4)	2 (6.9)	.52	14 (10.6)	3 (33.3)	.08

HIV, human immunodeficiency virus, HSV-2, herpes simplex virus, type 2.
Data are median (interquartile range), n (%), or n unless otherwise specified.
* Denominator excludes the three women who were pregnant and 13 women with missing information on oral contraceptive use.
† Among those reporting intravaginal washing over past y.
‡ Among those reporting intravaginal product use over past y.

(70%), petroleum jelly (17%), oils (13%), and antifungal cream (20%). Older women were more likely to report insertion of intravaginal products than younger women; 70% of women aged 45–65 years, 70% of women aged 34–44 years, 58% of women aged 26–33 years, and 48% of women aged 18–25 years reported intravaginal product use over the past month (nonparametric Wilcoxon rank-sum test for trend across ordered groups, P=.03). However, the types of intravaginal products used did not vary significantly by age. Among women reporting intravaginal insertion of over-the-counter products, Black women were more likely to report intravaginal use of petroleum jelly (33%) compared with White women (14%) or Latina women (8%) (P=.05) (Table 1). Among those reporting intravaginal product use, the median frequency of use was five times (interquartile range 3–10, range 1–26) over the past month.

Where measurements of intravaginal practices were available at the 12-month visit, the majority reported washing practices consistent with baseline data; 72% reported the same intravaginal washing practice at both study visits, 20% reported either the same washing practice or did not wash, and 8% reported different washing practices at each visit. Similarly, the majority of women reported intravaginal product use during follow-up consistent with baseline data; 68% reported the same practice at both study visits, 17% reported either the same practice or no practice, and 15% reported different practices at each visit.

At enrollment, 21% (95% CI 14.2–28.2%) of participants tested positive for bacterial vaginosis and 6% (95% CI 2.9–11.3%) for *Candida* colonization (Table 1). Approximately 16% (95% CI 10–22.7%) of participants reported symptoms consistent with bacterial vaginosis, including abnormal vaginal discharge or a fishy odor during the past month. Approximately 22% (95% CI 15.4–29.7%) reported vaginal symptoms during the past month consistent with candidiasis infection, including abnormal, thick, white vaginal discharge and itching or irritation. Reported vaginal symptoms were not associated with testing positive for bacterial vaginosis (P=.19) or *Candida* species (P=.10) (Table 1). The proportion of women reporting vaginal symptoms did not differ significantly by race (Table 1), age, education, or HIV status (data not shown).

Women who had vaginal symptoms were asked what they used to treat vaginal symptoms. No woman reported using sexual lubricants, petroleum jelly, or oils to alleviate vaginal symptoms. One third (35%) of women with yeast symptoms compared with 5% of those without symptoms reported use of an over-the-counter antifungal cream over the past month (P<.01). This may have limited our ability to detect *Candida* colonization in women who were symptomatic. There was no evidence of an association between use of antifungal creams and bacterial vaginosis diagnosis (P=.38) or bacterial vaginosis symptoms (P=.52).

In univariable analyses, testing positive for bacterial vaginosis was associated with unprotected vaginal sex, intravaginal washing with vinegar and water, intravaginal insertion of petroleum jelly, and testing positive for HSV-2 infection (Table 1). In multivariate analyses of baseline and follow-up data, we found that intravaginal use of petroleum jelly was associated with increased risk of bacterial vaginosis; women who

Table 2. Risk for Bacterial Vaginosis Associated With Intravaginal Practices: Crude and Controlled for Confounding

	Crude Baseline*		Adjusted Baseline†		Adjusted Repeated Measures‡	
	RR (95% CI)	*P*	Adjusted RR (95% CI)	*P*	Adjusted RR (95% CI)	*P*
Intravaginal use of petroleum jelly during the past mo§	2.2 (1.1–4.5)	.03	2.3 (1.1–4.9)	.03	2.2 (1.3–3.9)	<.01
Intravaginal washing during the past mo‖	1.7 (0.9–3.3)	.11	1.5 (0.8–3.1)	.22	1.2 (0.7–2.0)	.46

RR, relative risk; CI, confidence interval.

* Crude analyses included only the primary exposure and outcome variable of interest bacterial vaginosis.

† Adjusted baseline analysis included both intravaginal petroleum jelly use and intravaginal washing in the same model and adjusted for other potential confounding factors collected at enrollment including age, race, any vaginal exposure to semen over the past month, number of male sexual partners over the past mo, human immunodeficiency status, and herpes simplex virus-2 status.

‡ This adjusted repeated measures model used generalized estimating equations, generated robust standard errors, and adjusted for correlation within an individual. This model included bacterial vaginosis, intravaginal petroleum jelly use, and intravaginal washing as time-varying factors in the same model and controlled for potential confounding by factors collected at enrollment (age, race) as well as time-varying factors (any exposure to semen over the past mo, number of male sexual partners over the past month, human immunodeficiency virus status, and herpes simplex virus-2 status).

§ Referent group are women not using petroleum jelly.

‖ Referent group are women not reporting intravaginal washing over the past mo.

reported any intravaginal insertion of petroleum jelly over the past month were 2.2 times more likely to test positive for bacterial vaginosis than women who did not use petroleum jelly (adjusted RR 2.2, 95% CI 1.3–3.9, $P<.01$) controlling for intravaginal washing, age, race, HIV status, vaginal exposure to semen over the past month, the number of male sexual partners over the past month, and HSV-2 status (Table 2). We did not find an increased risk for bacterial vaginosis among women reporting intravaginal insertion of commercial lubricants or oils (data not shown). Also, we did not find evidence of interaction between intravaginal use of petroleum jelly and intravaginal washing, HIV, age, or race on occurrence of bacterial vaginosis. We had limited power to estimate a potential dose–response relationship between frequency of intravaginal petroleum jelly use and bacterial vaginosis.

Although the risk of bacterial vaginosis appeared greater among women who reported intravaginal washing over the past month, this result was not statistically significant (adjusted RR 1.2, 95% CI 0.7–2.0, $P=.46$) (Table 2). This could be the result of the relatively small sample size and the fact that women in our study used various substances for intravaginal washing, which undoubtedly varied substantially in their chemical constituents and concentrations. As a result of small numbers of women reporting specific washing practices, we had limited power to estimate the effect of specific solutions on risk of bacterial vaginosis.

In univariable analyses, testing positive for *Candida* colonization was associated with intravaginal insertion of oil (44.4% compared with 5%, $P<.01$) and currently being pregnant (Table 1). We did not find an increased risk for *Candida* colonization among women reporting intravaginal insertion of commercial lubricants or petroleum jelly.

These data do not allow us to estimate the precise timing of vaginal symptoms, intravaginal product use, and bacterial vaginosis or *Candida* colonization. Therefore, it is theoretically possible that women with bacterial vaginosis are using petroleum jelly to treat vaginal symptoms, and this explains some or all of the observed association between petroleum jelly use and bacterial vaginosis. We explored this possibility in three ways. First, we explored the association between testing positive for bacterial vaginosis and reports of vaginal symptoms over the past month. Vaginal symptoms were not associated with bacterial vaginosis or *Candida* colonization in this group (Table 1). Second, we asked women who had vaginal symptoms what they used to treat vaginal symptoms. No woman reported using petroleum jelly or oils to alleviate those symptoms. Finally, we restricted the multivariable model to women without vaginal symptoms and the relative risk for bacterial vaginosis among women who reported intravaginal use of petroleum jelly was slightly higher and the CI was wider (adjusted RR 2.4, 95% CI 1.3–4.5, $P=.01$). Thus, our data do not support the idea that this association is explained by the women with bacterial vaginosis or *Candida* colonization treating their symptoms with either petroleum jelly or oil.

DISCUSSION

We found that intravaginal practices are common and diverse in this population of women. Two thirds of women report an intravaginal practice over the past month with nearly half reporting intravaginal washing and half reporting insertion of an intravaginal product. Most notable is we found that intravaginal use of petroleum jelly is associated with an increased risk of bacterial vaginosis. Our findings are supported by a cross-sectional study conducted among Kenyan sex workers, which also found that bacterial vaginosis was associated with intravaginal use of petroleum jelly (odds ratio 2.8, 95% CI 1.4–5.6).[17] Our study was not designed to determine the biologic mechanism for this association. However, it is possible that the alkaline pH of petroleum jelly could promote the growth of bacterial vaginosis-associated bacteria. Additional controlled studies evaluating the effects of specific products on vaginal microbiota, tissue effects, and local immune response may help to establish a causal relationship between intravaginal practices and bacterial vaginosis and clarify where the harm of vaginal practices may lie and the potential biologic mechanism.

The strengths of this study lie in the setting and design. This was an in-depth prospective cohort study on the prevalence of intravaginal practices, including but not limited to intravaginal washing, in the United States. This study included both HIV-positive and HIV-negative women and women of diverse ages and ethnicities, which allowed greater understanding of potential differences between groups, and greater generalizability. Using a cohort design allowed us to collect data on practices over time and to assess the degree to which practices are consistent within a woman. The use of a self-administered questionnaire rather than in interviewer-administered questionnaire may have limited reporting bias of stigmatized behaviors.

A limitation of the study was the relatively small sample and the small number of women diagnosed with *Candida* colonization. In addition, we cannot exclude the possibility of residual confounding from mismeasured factors or unmeasured factors such as antibiotic treatment of bacterial vaginosis or candidiasis infection or for phase

of the menstrual cycle. Loss to follow-up may be an additional limitation; however, loss to follow-up was not associated with bacterial vaginosis, candidiasis infection, intravaginal practices, or other potential risk factors for bacterial vaginosis or candidiasis infection.

Previous studies have found that women with bacterial vaginosis are at greater risk for adverse health effects such as pelvic inflammatory disease, preterm birth, spontaneous abortion, HIV, sexually transmitted infections, and increased shedding of HIV in the genital tract. Efforts to prevent modifiable risk factors for bacterial vaginosis should be explored. For example, behavioral interventions that have been successful in helping young U.S. women to stop intravaginal washing[18] might be adapted for other types of vaginal practices such as intravaginal insertion of petroleum jelly to encourage less harmful practices.

Bacterial vaginosis and candidiasis infection are two of the most common causes of health care problems for women in the United States, the two most common causes of vaginitis, and a frequent reason for patient visits to obstetrician–gynecologists. It has been estimated that vaginitis is responsible for between five and 10 million clinic visits annually in the United States with related health care costs of over $1 billion each year.[19,20] There has been surprisingly little research evaluating the types of solutions and products women insert into their vagina and the effect of these products on vaginal health.[21] Because a large number of women worldwide engage in intravaginal practices, if these practices increase the risk of acquiring vaginal infections even slightly, the population-attributable risks and related costs could be large for such common practices, especially in settings and populations where these practices are most frequent. Therefore, it is vital that we develop a better understanding of which intravaginal practices and products are common in various communities, what motivates women to participate in these practices, and their effects on vaginal health.

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