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## PERSONAL HYGIENIC BEHAVIORS AND BACTERIAL VAGINOSIS

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### Abstract

**BACKGROUND**—Vaginal douching is consistently associated with bacterial vaginosis (BV), but whether it is a cause or result of BV remains unknown. The association between BV and other feminine hygienic behaviors is less studied; if BV symptoms caused behavior change then all hygiene behaviors might be more common among women with BV. Lack of association between non-douching hygiene behavior and BV would argue against reverse causation.

**METHODS**—In the Longitudinal Study of Vaginal Flora 3620 women had 13,517 visits where BV (Nugent score) was assessed. Associations between hygienic behavior and BV were assessed by Poisson regression.

**RESULTS**—After adjusting for demographic and sexual behavior factors, neither type of underwear (nylon vs. cotton Prevalence Ratio (PR) 1.05, 95% CI:0.97–1.13), menstrual protection (tampons vs. pads; PR:1.04, 95% CI:0.95–1.12; pads and tampons vs. pads 1.00, 95% CI:0.92–1.07), use of pads or panty liners when not menstruating (PR:0.99, 95% CI:0.95 – 1.05), nor weekly or greater use of hygiene spray (PR:1.01, 95% CI:0.94–1.09), powder (PR:1.02, 95% CI:0.96–1.07) or towelettes (PR: 1.03, 95% CI:0.94–1.13) were strongly associated with BV. PR for daily vs. less than daily bathing and showering were 1.06 (95% CI:1.02–1.12) and 1.04 (95% CI:1.00–1.09). Douching remained associated with BV (PR for weekly or greater vs. never 1.17, 95% CI:1.09–1.26) and was not substantially impacted by adjustment for other hygienic behavior.

**CONCLUSIONS**—Douching, but not other feminine hygiene behaviors, is significantly associated with BV, providing additional evidence that douching may be causally associated with BV and is not simply a response to BV symptoms.

### Keywords

Bacterial Vaginosis; Douching; Personal Hygiene

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### SUMMARY

Female hygienic behaviors, except douching, are not strongly associated with bacterial vaginosis, suggesting that douching as a hygienic behavior is not a response to symptoms.

## INTRODUCTION

Bacterial vaginosis (BV) is a condition of unknown etiology in which there is a global disturbance of vaginal microbial ecology described as the replacement of the usual lactic acid-producing lactobacillus predominant flora with an overgrowth of *Gardnerella vaginalis* and mixed anaerobic organisms.<sup>1</sup> It is the most common cause of symptomatic vaginal discharge in reproductive age women, and has been associated with a variety of conditions including post-surgical infection, pelvic inflammatory disease, preterm birth and HIV acquisition.<sup>2</sup> Observational studies have consistently demonstrated increased occurrence of BV among women who douche.<sup>3–5</sup> However, while associations between BV and other personal hygienic behaviors have been studied extensively among women in Africa,<sup>6–11</sup> hygiene behaviors other than douching have not been well studied among women in the United States. In one U.S. study BV was slightly, although not significantly more prevalent among women who bathed frequently but less prevalent among women who showered frequently.<sup>3</sup> This same study reported tampon use to be associated with reduced BV prevalence,<sup>3</sup> but no association between BV and menstrual protection products was found in another study.<sup>12</sup> In a study of adolescents, feminine deodorant spray use was increased among women with recently diagnosed sexually transmitted infection.<sup>13</sup>

Whether douching causes BV or subtle BV symptoms prompt a woman to douche is controversial. Study of other hygienic behaviors can provide insight into this question. If douching were merely a response to BV symptoms, then one would expect other genital hygienic behaviors such as use of deodorant sprays, wipes, etc, also to be more common among women with BV, even after controlling for douching. However, if douching were the only behavior associated with BV, this finding might provide evidence against douching being a response to BV symptoms. To address this question, we studied the association between personal hygienic practices and BV prevalence among women enrolled in the Longitudinal Study of Vaginal Flora.

## MATERIALS AND METHODS

Data for this study are from the Longitudinal Study of Vaginal Flora, described previously.<sup>14</sup> This cohort study was intended to evaluate the natural history of BV. Non-pregnant women age 15–44 were recruited from August 1999 to February 2002 upon presentation for a routine health care visit at one of 12 clinics in the Birmingham, Alabama area. Women with significant medical or gynecological conditions were ineligible, as were women with conditions precluding informed consent and those planning to move from the area in the next 12 months. All participants provided written informed consent; the study was approved by the Institutional Review Boards of the University of Alabama at Birmingham, the Jefferson County Department of Health, and the NICHD.

Participating women were seen at a research clinic for an initial visit and then for quarterly visits, for a total of up to one year of observation. At each visit a pelvic examination was conducted at which time specimens were obtained for culture of *N. gonorrhoeae* and *T. vaginalis*, for ligase chain reaction for *C. trachomatis*, for vaginal pH, and for a wet prep evaluating clue cells, trichomonads and yeast. Vaginal Gram stains were also obtained and scored according to the method of Nugent;<sup>15</sup> 10% of Gram stains were re-read in a different laboratory, with a kappa coefficient of 0.81 for the diagnosis of BV. BV was defined as a Gram stain score of 7–10.

At each visit women underwent an extensive face-to-face private interview with a female interviewer, covering among other things demographic factors, personal hygiene, sexual behaviors, contraceptive use and vaginal symptoms. The initial questionnaire referred to

behaviors over the previous six months; subsequent questionnaires referred to behaviors since the previous visit. Specifically, the questionnaire at each visit asked about type of birth control used; frequency of bathing and of showering (for each behavior response options were daily, several times/week, about once/week, less than once/week, never); frequency of use of hygienic products including talcum or baby power on one's private parts, feminine towelettes or baby wipes, feminine hygiene spray, and vaginal suppositories (for each product -- never, less than once/month, at least once/month, at least once/week, daily, twice or more daily); and frequency of douching (daily, several times/week, about once/week, less than once/week, and never). Presence of menstrual periods was ascertained at each visit, although specific menstrual protection products (pads only, tampons only, pads and tampons, other) were ascertained only at baseline. Use of sanitary pads or panty liners when not menstruating, as well as type of underwear most commonly worn (cotton, nylon, crotchless or none, panty hose only) were also ascertained only at baseline. For analysis, categories were collapsed based on available numbers as noted in Table 2.

The initial analysis compared the prevalence of studied behaviors among women who reported douching or not douching at that study visit, and the prevalence of studied behaviors among women with and without BV at each visit. Statistical significance of these associations was determined by logistic regression under Generalized Estimating Equations<sup>16</sup> to account for the non-independence of visits by the same woman.

Next, the association between hygienic behaviors and BV was assessed. Prevalence ratios were determined from Poisson regression with robust (empirical) standard errors<sup>17</sup> under Generalized Estimating Equations.<sup>16</sup> In several analyses, log-binomial regression,<sup>18</sup> usually employed to estimate the prevalence ratio, failed to converge, so Poisson regression was always used to maintain comparability across different analyses. The first model presents the unadjusted prevalence ratio for BV among women practicing that behavior. The second model adjusts the association for other demographic and behavioral factors: race; age (continuous variable); body mass index (restricted cubic spline); marital status; years of education; smoking (cigarettes/day, restricted cubic spline, although presented categorically in Table 1); alcohol drinking; number of male sex partners during the interval under study, acquisition of a new sex partner, vaginal and receptive oral sex frequencies during the time period of the questionnaire; and current use of hormonal contraception or receipt of tubal ligation.<sup>19</sup> Oral contraceptives and progestin-only injectable/implantable contraceptives were considered together because they manifested similar associations with BV in the Flora study.<sup>19</sup> Race was considered as African-American versus other due to the small number of women who were neither African-American nor white, and the similarity of their BV prevalence to that of white women. The final model adjusted each hygienic behavior for these same demographic and behavioral factors, plus all the other hygienic behaviors. P-values were determined from the score statistic of a Poisson regression model with hygienic behaviors considered as categorical variables, as noted in the Tables. We evaluated the interaction between ethnicity and all hygienic behaviors simultaneously, and the interaction as between use of hormonal contraception and all hygienic behaviors simultaneously using the "chunk" test;<sup>20</sup> we also evaluated the interaction between showering and bathing. P-values for these tests used the score statistic. None of these tests was statistically significant ( $p=0.71$ ,  $0.91$  and  $0.62$  respectively); no other interactions were evaluated. Calculations utilized SAS software, version 9.1.3 (Cary, NC).

## RESULTS

The study recruited 3620 women, who completed 13,587 study visits; BV status was missing for 70 visits (due to incomplete visits, broken slides or inadequate sample), leaving 13,517 eligible visits. Characteristics of the women at the time of the initial study visit are presented

in Table 1. In addition to the characteristics described in the table, women with BV were on average older than women without BV (mean(SD) age, 25.1(6.7) versus 24.6(6.7) years, respectively,  $p=0.02$ ). Women with BV also had higher median (inter-quartile range) BMI, (29.1(10.7) versus 27.7(11.0)  $\text{kg/m}^2$ ,  $p<0.001$ ). BV was present at 5,467 (40.4%) of the 13,517 visits with available data.

Associations between each studied hygienic behavior and douching, and between each behavior and BV, are presented in Table 2. Most genital hygienic measures were more common among women who douched, as were tampon use, use of pads and panty liners when not menstruating, and usually wearing nylon underwear. Neither frequency of showering nor of bathing was statistically significantly associated with douching, although African-American women were more likely than women of other races to bathe versus shower and also more likely to douche (data not shown). Associations between hygienic behaviors and BV were more variable. BV was positively associated with bathing frequency, use of powder and feminine hygiene spray, and usual type of underwear. BV was less common among women experiencing amenorrhea, but type of menstrual protection was not associated with BV.

After controlling for only the demographic and non-hygiene behavioral factors noted in the Methods, less than weekly use of towlettes was associated with an increased prevalence of BV, but more frequent use was not. Use of vaginal suppositories, feminine deodorant spray, or powder on the genitals was not associated with BV (Table 3). Daily bathing was associated with increased BV prevalence. Underwear material was not associated with BV. Although BV was less common among amenorrheic women, type of menstrual protection was not associated with BV among women experiencing menstrual periods (prevalence ratio for tampons only versus pads only: 1.04, 0.95 -- 1.12; prevalence ratio for pads and tampons versus pads only: 1.00, 0.92 – 1.07). As has been reported previously from this study,<sup>5</sup> douching was associated with a modest, but statistically significant increase in BV prevalence.

The fully adjusted model was based on 12,900 visits (95.4% of visits with data on BV) After further adjustment of the hygienic behaviors for all other hygienic behaviors, in addition to the demographic and non-hygiene behavioral factors, neither powder, towlettes, feminine hygiene spray nor vaginal suppositories had overall statistically significant associations with BV, although less than weekly use of towlettes was associated with increased BV prevalence (Table 3). Daily bathing, compared with less than daily, was also associated with increased BV prevalence. Amenorrheic women continued to have reduced BV prevalence, and type of menstrual protection continued to be unassociated with BV. The association between douching and BV was minimally changed: compared to women who did not douche, the prevalence ratio for BV among women who douched less than weekly was 1.14 (1.08 – 1.20), and the prevalence ratio for BV among women who douched weekly or more often was 1.17 (1.09 – 1.26). When no douching, douching less than weekly and douching weekly or more were considered as a continuous variable with values of 0, 1 and 2, the trend for increased douching to be associated with increased BV prevalence was highly statistically significant. ( $p<0.0001$ ). None of the other hygienic behaviors similarly categorized (powder, towlettes, and spray) even approached statistical significance.

## DISCUSSION

We found that after adjustment for demographic, sexual behavior and other behavioral factors, non-douching personal hygienic behaviors which might be practiced in response to vaginal symptoms were by and large not strongly associated with prevalent BV. We also found that hygienic behaviors less likely to be a direct response to vaginal symptoms (i.e. type of underwear and menstrual protection) were not strongly associated with BV. In contrast, douching remained associated with BV in a dose response manner, both before and after

adjustment for other hygienic behaviors. If women douched in response to subtle BV symptoms then one would expect other behaviors done to prevent or reduce vaginal odor or irritation also to be more common among women with BV. Therefore, the lack of consistent association observed between non-douching hygienic behavior and BV in this study provides evidence against the hypothesis that the consistent observational association between douching and BV is due to women douching in response to subtle symptoms of BV.

Although a variety of vaginal practices, such as type of menstrual protection<sup>10</sup> insertion of herbs and astringents into the vagina,<sup>21</sup> vaginal ‘finger cleansing’, external genital wiping,<sup>6</sup> as well as bathing have been extensively studied among African women, relatively few studies of non-douching genital hygiene behavior have been conducted in the United States. Holzman and colleagues reported increased BV prevalence among women who bathed rather than showered, but the difference was not statistically significant after adjustment.<sup>3</sup> They also reported non-significantly lower BV prevalence among women who used tampons, although Schwebke and colleagues found tampon use to be unassociated with BV.<sup>12</sup> Misra found that women who douched were also more likely to use feminine spray, wash or towelettes, as well as to use powder on their genitals, but the relationship between these behaviors and BV was not explored.<sup>22</sup>

Strengths of our study included large sample size, repeated measurements and inclusion of an extensive array of behaviors in our questionnaire. The study also has limitations. Type of underwear and use of pads or panty liners were assessed only at study entry; and although the presence of menstrual periods was assessed at every visit we collected data on menstrual protection only at baseline. Therefore, the association between these behaviors and BV may have been misclassified. If misclassification is random with regard to BV that may have developed after baseline, then associations between BV and underwear, menstrual protection and non-menstrual use of pads or panty liners would be biased toward finding no association. However, if women changed their use of these products specifically in response to symptoms of BV (such as changing from nylon to cotton underwear), then the direction of bias may be less predictable. We did not collect data on brand of pads or tampons, and thus cannot address how absorbency or chemical composition of these products might influence the vaginal environment. Our question on ‘vaginal suppositories’ was nonspecific, and we do not know what, if any medications they might have contained (although use of suppositories was rare).

Approximately half of the women used some type of hormonal contraception. Although all injectable/implantable contraceptives contain only progestin, we did not collect data on the specific composition of the oral contraceptives used. Thus we cannot explore the role of specific hormones in BV. The interaction between use of hormonal contraception and hygienic behavior on BV was not statistically significant ( $p=0.91$ ); thus we found no evidence that the association between hygienic behaviors and BV was different in users of hormonal contraceptives than among non-users. Nevertheless our results might not apply to other populations where hormonal contraception was less common.

Approximately 600 visits were excluded from the adjusted analyses due to missing data on demographic and/or behavioral variables (4.6% of all visits with data on BV). While this might be addressed by complex methods such as multiple imputation,<sup>23</sup> simple deletion of observations with missing data is a reasonable option when these deletions comprise less than 5% of otherwise eligible observations.<sup>24</sup> Although our study collected data longitudinally, this analysis was cross-sectional. Since many previous reports of the association between hygienic behaviors and BV were also cross-sectional, we used a cross-sectional analysis to maintain comparability to previous reports. In addition, our intention was to compare the cross-sectional association between douching and BV to the cross-sectional associations between other



hygienic behaviors and BV, thus we do not believe this to be a substantial limitation. However, one should not infer that any statistically significant associations found are causal.

In summary, we found that the associations between non-douching hygienic behaviors and BV were not strong and for the most part not statistically significant. In contrast, douching was associated with increased BV prevalence. These results do not support the premise that the increased prevalence of BV among women who douche is because BV prompts the douching.

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**Table 1**

Demographic and sexual behavioral characteristics associated with bacterial vaginosis

Characteristic	N*	Percent with bacterial vaginosis
Ethnicity		
African-American	2872	44.5
Other	724	24.2
Completed years of education		
<12	1274	41.2
12	1391	43.6
>12	925	34.5
Marital Status		
Never married	2523	42.0
Currently married	585	31.3
Other	488	42.8
Cigarettes per day		
0	2385	38.5
1-9	790	46.8
10+	399	39.1
Frequency of alcohol drinking		
None	1510	38.2
Less than weekly	1156	37.5
Weekly or more	923	47.4
Hormonal contraception		
Yes	1756	34.8
No	1840	45.8
Tubal ligation		
Yes	560	49.6
No	3033	38.6
Frequency of vaginal intercourse in past six months (per week)		
0	476	31.3
1	1048	41.5
2-3	1042	40.4
4-6	706	40.1
7+	293	50.5
Male sex partners in past six months		
0	487	31.6
1	2544	40.8
2+	553	46.5
Frequency of receptive oral sex in past six months (per week)		
0	2219	41.1
1	687	37.4



Characteristic	N*	Percent with bacterial vaginosis
2+	648	41.1
New sex partner in past six months		
Yes	206	33.0
No	3282	40.8

\* 3620 women had a baseline study visit. Numbers for each characteristic do not sum to 3620 due to missing data for that characteristic or for bacterial vaginosis.

**Table 2**

Association of Personal Hygienic Practices with Bacterial Vaginosis and with Douching

Characteristic	N*	Percent practicing douching	Percent with bacterial vaginosis
Frequency of showering		P=0.08	P=0.17
Less than daily	4797	45.3	42.8
Daily	8688	42.1	39.2
Frequency of bathing		P=0.07	P<0.001
Less than daily	7182	40.4	36.7
Daily	6303	46.5	44.7
Use of powder on genitals		P<0.001	P=0.003
Never	10337	39.5	39.1
Less than weekly	657	51.7	39.0
Weekly or more	2495	56.7	46.4
Use of towlette on genitals		P<0.001	P=0.26
Never	12441	42.6	40.4
Less than weekly	425	46.8	39.8
Weekly or more	622	53.6	43.1
Use of feminine hygiene spray		P<0.001	P=0.01
Never	11969	40.6	39.8
Less than weekly	381	68.3	44.6
Weekly or more	1140	62.4	46.3
Use of vaginal suppositories		P=0.003	P=0.29
No	13221	42.9	40.4
Yes	261	62.2	44.4
Use of pads or panty liners when not menstruating		P=0.009	P=0.24
No	8793	42.1	40.0
Yes	4679	45.6	41.5
Menstrual protection		**	***
Pads only	4851	44.5	44.0
Tampons only	1960	50.8	43.1
Pads and tampons	2908	44.8	39.9
Amenorrhea	3728	36.5	34.9
Usual underwear material		P<0.001	P=0.009
Cotton	11392	41.9	39.9
Nylon	1907	51.6	44.9
Other	167	42.5	29.3
Douching frequency			P<0.001
Never	7644	-	34.9
Less than weekly	4501	-	46.7
Weekly or more often	1326	-	51.3

\* Number of study visits at which the practice was reported

\*\* Douching significantly less common among women experiencing amenorrhea ( $p < 0.001$ ), and among women experiencing menstrual periods type of menstrual protection was significantly associated with douching ( $p = 0.008$ )

\*\*\* BV significantly less common among women experiencing amenorrhea ( $p < 0.001$ ), but among women experiencing menstrual periods type of menstrual protection was not significantly associated with BV ( $p = 0.11$ )

**Table 3**  
Unadjusted and Adjusted Association Between Personal Hygienic Practices and Bacterial Vaginosis

Hygienic Practice	Unadjusted			Adjusted <sup>1</sup>			Adjusted <sup>2</sup>		
	Prevalence Ratio	95% CI	P	Prevalence Ratio	95% CI	P	Prevalence Ratio	95% CI	P
Frequency of showering									
Less than daily	1.00			1.00			1.00		
Daily	0.97	0.93 – 1.01		1.03	0.98 – 1.07		1.04	1.00 – 1.09	
Frequency of bathing									
Less than daily	1.00			1.00			1.00		
Daily	1.13	1.08 – 1.18		1.05	1.01 – 1.10		1.06	1.02 – 1.12	
Use of powder on genitals									
Never	1.00			1.00			1.00		
Less than weekly	0.99	0.90 – 1.08		0.97	0.88 – 1.07		0.95	0.86 – 1.04	
Weekly or more	1.10	1.04 – 1.16		1.04	0.99 – 1.10		1.02	0.96 – 1.07	
Use of towelette on genitals									
Never	1.00		P=0.27	1.00		P=0.07 <sup>3</sup>	1.00		P=0.11 <sup>3</sup>
Less than weekly	1.08	0.98 – 1.19		1.13	1.02 – 1.25		1.12	1.01 – 1.24	
Weekly or more	1.04	0.95 – 1.14		1.05	0.96 – 1.15		1.03	0.94 – 1.13	
Use of feminine hygiene spray									
Never	1.00		P=0.013	1.00		P=0.22 <sup>3</sup>	1.00		P=0.65 <sup>3</sup>
Less than weekly	1.11	1.00 – 1.22		1.07	0.97 – 1.18		1.05	0.95 – 1.15	
Weekly or more	1.10	1.02 – 1.18		1.04	0.97 – 1.12		1.01	0.94 – 1.09	
Any use of vaginal suppositories	1.08	0.94 – 1.24		1.00	0.88 – 1.15		0.97	0.85 – 1.11	
Use of sanitary napkins or panty liners when not menstruating	0.96	0.90 – 1.03		0.98	0.93 – 1.04		0.99	0.95 – 1.05	
Menstrual protection									
Amenorrhea	1.00			1.00			1.00		
Pads only	1.25	1.16 – 1.34		1.16	1.08 – 1.25		1.15	1.07 – 1.24	
Tampons only	1.21	1.10 – 1.33		1.20	1.10 – 1.25		1.17	1.07 – 1.28	
Pads and tampons	1.13	1.03 – 1.23		1.14	1.04 – 1.24		1.12	1.03 – 1.22	
Usual underwear material									
Cotton	1.00		P=0.009 <sup>3</sup>	1.00		P=0.09 <sup>3</sup>	1.00		P=0.17 <sup>3</sup>

Hygienic Practice	Unadjusted		Adjusted <sup>1</sup>		Adjusted <sup>2</sup>	
	Prevalence Ratio	95% CI	Prevalence Ratio	95% CI	Prevalence Ratio	95% CI
Nylon	1.10	1.02 – 1.19	1.06	0.99 – 1.14	1.05	0.97 – 1.13
Other	0.73	0.52 – 1.03	0.81	0.60 – 1.11	0.82	0.60 – 1.12
Douching frequency		P<0.001 <sup>3</sup>		P<0.001 <sup>3</sup>		P<0.001 <sup>3</sup>
Never	1.00		1.00		1.00	
Less than weekly	1.24	1.17 – 1.30	1.15	1.10 – 1.21	1.14	1.08 – 1.20
Weekly or more often	1.32	1.23 – 1.41	1.19	1.11 – 1.28	1.17	1.09 – 1.26

<sup>1</sup> Adjusted for age, ethnicity, body mass index, marital status, years of education, cigarette smoking, alcohol consumption, number of recent sex partners, new sex partner during the interval covered by the questionnaire, frequency of vaginal sex, frequency of receptive oral sex, current use of hormonal contraception, and ever receipt of tubal ligation.

<sup>2</sup> Adjusted for above factors, plus the other behaviors in the Table.

<sup>3</sup> P-value for categories simultaneously compared to reference category, from score statistic.