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Personal Lubricant Use and Bacterial Vaginosis:
Does Race Matter?

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Personal Lubricant Use and Bacterial Vaginosis: Does Race Matter?

By

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B.S., University of Michigan, 2005

Advisor: Kevin Ault, M.D.

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Abstract

Personal Lubricant Use and Bacterial Vaginosis:
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By Alison Cowan

Background: Bacterial vaginosis is an extremely common disruption in the vaginal flora with important public health consequences. Known risk factors for bacterial vaginosis include race, sexual activity, and douching, among others. There is very little published in the literature regarding the association of personal lubricants and bacterial vaginosis.

Methods: We conducted a cross-sectional study of healthy women between the ages of 12 and 45 to determine whether they had asymptomatic bacterial vaginosis. Four hundred and ten women equally representing Asian, black, Hispanic, and white self-identified racial groups were asked to provide vaginal samples and complete a detailed sexual history questionnaire. Logistic regression analysis was performed to estimate the relationship between lubricant use and bacterial vaginosis.

Results: Asymptomatic bacterial vaginosis was detected in 26.8 percent of participants. There was no statistically significant relationship between lubricant use and bacterial vaginosis identified. However, a stratified analysis revealed a significant interaction between black race and lubricant use (OR = 3.25 among black participants versus 0.434 among non-black, Breslow day test of homogeneity p = 0.0063). A multivariate model adjusting for douching, sexual activity, and race demonstrated that lubricant use was associated with an increased odds of bacterial vaginosis among black women, but not among Hispanic or white women, although this trend was not statistically significant (p-value for interaction of Black women and lubricant use 0.0667). Asian women were excluded from the analysis due to insufficient numbers reporting lubricant use (n=10).

Conclusions: While there is no apparent relationship between lubricant use and bacterial vaginosis, our study revealed a potential interaction between race and lubricant use. It appears that African American women who use lubricants may be at increased risk for bacterial vaginosis as compared to white and Hispanic women. This may be due to differences in the underlying vaginal microbial system. The impact of lubricant use on vaginal microbial composition and bacterial vaginosis merits further study.

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Introduction

Commercially available vaginal lubricants represent an inadequately understood group of products which are both widely available and widely used today. Despite the fact that there are innumerable brands and types of these products on the market, very little is known about their impact on the vagina. The products contain various microbicides, cleansers, and other chemicals, any one of which could presumably impact the vaginal environment by altering the pH, selectively inhibiting certain groups of bacteria present in the vagina, or through any number of other potential effects.

The vaginal microbial environment is complex, and disturbances of the normal microbial structure have been associated with a harmful infection known as bacterial vaginosis (1, 2). Bacterial vaginosis is often thought of as a disruption in the normal vaginal flora, whereby the "healthy" *Lactobacillus* species are overtaken by less desirable organisms from a variety of bacterial groups (2).

There is a lack of data in the literature to describe the potential impact of vaginal lubricant use on the vaginal ecological environment, and it is possible that some vaginal lubricants may be harmful to the normal microbes present in the vagina, thereby predisposing women to developing bacterial vaginosis. To investigate whether such an association exists, we conducted a cross-sectional study of healthy women of child-bearing age, to assess their rates of asymptomatic infection with bacterial vaginosis as well as their use of various lubricants available on the market.

Background

Bacterial vaginosis is a common and often silent infection that negatively impacts women's health on a global scale. It is thought to arise from a characteristic disruption in the normal vaginal flora that is associated with an increased susceptibility to many sexually transmitted infections, including gonorrhea, herpes, trichomoniasis, and most importantly, HIV infection (1-3). Bacterial vaginosis also has a well-established association with an increased risk for preterm delivery, further extending its negative public health impact (4). Examining the problem of bacterial vaginosis in pregnancy alone, it has been estimated that 800,000 women with bacterial vaginosis become pregnant annually, and that 80,000 preterm deliveries could be prevented if treatment for bacterial vaginosis were successful in preventing the deliveries (5).

Despite its association with several negative health outcomes for women and their neonates, our understanding of bacterial vaginosis remains inadequate. The condition can be thought of either as an infection or as a disruption of the normal vaginal ecology, and is thought to arise from an increased preponderance of organisms such as *Gardnerella vaginalis*, *Mycoplasma hominis*, *Ureaplasma urealyticum*, and other anaerobes (6). This increase in anaerobes is accompanied by a decrease in the "normal" vaginal flora, the most stable form of which is thought to be dominated by hydrogen peroxide-producing *Lactobacillus* species (7). It appears that in response to environmental perturbations, *Lactobacillus* species found in the healthy vagina are replaced by a heterogenous mix of anaerobes that make up the clinical diagnosis of bacterial vaginosis.

One problem that arises in investigating bacterial vaginosis lies in discovering which particular environmental perturbations might be responsible for the disruption in vaginal flora. Epidemiologically, bacterial vaginosis behaves similarly to a sexually transmitted infection, yet no single infectious agent has been identified (8). We are therefore left to find and quantify risk factors in an effort to better detect and possibly prevent the condition.

Risk Factors for Bacterial Vaginosis

Bacterial vaginosis has been associated with a number of risk factors in the literature, one of the strongest of which is race. Even after adjusting for socioeconomic and behavioral differences between races, bacterial vaginosis has consistently been found to be more prevalent among black/African American women than other groups (7, 9, 10). Furthermore, African American women are at a comparatively high risk for HIV infection; the current HIV infection rate for African American women is approximately fifteen times that of white women, and four times that of Hispanic women (11). Given that bacterial vaginosis is associated with increased HIV susceptibility as well as increased viral shedding, it represents a potentially important target to decrease HIV acquisition rates among this particularly vulnerable group (3).

In addition to race, bacterial vaginosis has been associated with certain behaviors, such as douching and hormonal contraceptive use, with the former being associated with an increased risk of bacterial vaginosis and the latter a decreased risk (12, 16). There has been controversy over whether bacterial vaginosis arises because of douching behavior, or whether douching behavior arises due to unpleasant symptoms, such as vaginal odor,

that are associated with bacterial vaginosis. However, recent evidence suggests that douching in itself does appear to predispose women to acquisition of bacterial vaginosis, rather than vice versa (13). Therefore, because bacterial vaginosis can occur in the absence of an evident transmission between individuals, it appears to have some features of a disruption in the normal vaginal ecology, as opposed to purely an infection.

On the other hand, bacterial vaginosis does in many ways behave similarly to a sexually transmitted infection. It has been associated with sexual activity in general, as well as with certain sexual behaviors, such as anal sex and homosexual sex between women (7, 14, 15). These associations lead some to consider bacterial vaginosis to be a sexually transmitted infection, despite the fact that no causative agent has been identified that could explain its transmission. A negative association between condom use and bacterial vaginosis lends further support to the notion that bacterial vaginosis should be considered a sexually transmitted condition (9).

Vaginal Lubricants and Bacterial Vaginosis

Personal lubricants are a heterogeneous class of mixtures. Commonly available over the counter, many of them contain agents such as chlorhexidine, a microbicidal agent, as well as other compounds such as propylene glycol, glycerin, and parabens. The effects of these compounds on the vaginal flora are unknown at this time.

The limited data available do suggest that at least some of the personal lubricants commercially available could be irritants to the female genital tract (17.) However, the possible impact of personal lubricants on bacterial vaginosis has not been investigated thus far. To help meet this need, we conducted a cross-sectional study of women to

examine whether there appears to be any association between bacterial vaginosis and personal lubricant use.

Materials and Methods

Study Participants

Data from this study were collected as part of a cross-sectional study of vaginal flora in women of child-bearing age in Atlanta and Baltimore. Approximately one hundred women in each of four self-identified races (white, black/African American, Hispanic/Latina, and Asian) were enrolled in the study. Participants included non-pregnant women aged 12 to 45 were recruited from April 2008 through December 2008 using advertisements placed in the community and on www.craigslist.org. Women with significant medical and gynecological problems were excluded, as were women currently pregnant, those who received vaccinations within the preceding thirty days, and women currently using NuvaRing™. Any women with current symptoms of a vaginal infection or recent treatment for bacterial vaginosis were also excluded from participating. All participants provided written informed consent, and the study was approved by the Institutional Review Board of Emory University in Atlanta, Georgia.

Participants were seen for a one-time outpatient visit. Women were scheduled for visits when they were not menstruating, and were asked to refrain from sexual intercourse for two days prior to the study visit. Participants self-collected a vaginal swab for Nugent scoring, a pH measure of the vaginal fluid, and completed a pregnancy test to verify that they were not pregnant at the time of the visit.

Study Questionnaire

On the day of the visit, participants were also asked to complete a detailed questionnaire designed to capture information about their sexual health and behaviors.

The questionnaire captured information such as personal hygiene habits, douching, sexual behaviors, contraceptive use, and menstrual and reproductive history. The questionnaire specifically asked about timing of douching and reasons for doing so, about sexual behaviors such as intercourse with women, men, and specifically vaginal and anal intercourse, as well as use of sex toys. Women were also asked about personal lubricant use. They were asked about personal lubricant use categorically, as well as asked to check which types of lubricants were used. The list provided included the following categories: saliva, Astroglide™, KY Jelly™, Vaseline™, Crisco™, and "Other."

The questionnaire was administered in a private area, without the presence of study personnel. Prior to receiving the questionnaire, participants were advised that no study personnel would be reviewing their answers immediately after collection, and this measure would further protect each participant's anonymity.

Laboratory Methods

Nugent scoring was chosen to identify participants with asymptomatic bacterial vaginosis. Nugent scores are based on the types of bacteria seen on microscopic examination of vaginal fluid, with a decrease in *Lactobacillus* morphotypes scored as between 0 to 4, an increase in *Gardnerella vaginalis* morphotypes scored as 0 to 4, and an increase in *Mobiluncus* species 0 to 4. For the data analysis, bacterial vaginosis was classified as a Nugent score greater than or equal to 7 as described by Nugent et al (18). Slides collected for Nugent scoring were evaluated by a study clinician who was blinded from the questionnaire data.

Statistical Analysis

The initial analysis found that there were insufficient Asian women (n=10) who used lubricant to include in a subsequent multivariate analysis; therefore, Asian women were excluded from all subsequent analyses. A univariate analysis compared the proportion of the variables reported in the questionnaire among women with asymptomatic bacterial vaginosis versus without. Statistical significance of these univariate associations was measured using the chi-square test of association (Table 1 and 2).

Next, a stratified analysis was performed to assess whether any variables appeared to be confounding or interacting with the measured association between bacterial vaginosis and lubricant use (Table 3).

Lastly, a multivariate model of lubricant use was constructed using logistic regression modeling strategies outlined by Klein and Kleinbaum (19). First, a hierarchically well-formulated model was created that included all possible variables in the model. The variables included were based upon known risk factors in the literature in conjunction with the univariate analyses described above. Therefore, the initial model included the exposure of interest, lubricant use, along with race (white, black, and Hispanic), age, douching, oral contraceptive use, condom use, and currently being sexually active. Because of possible interaction between age and lubricant use as well as race and lubricant use, both of these were considered in the initial model.

We evaluated all interaction terms using a likelihood ratio “chunk” test. After this step, backwards elimination was performed, in which the non-significant interaction between age and lubricant use was eliminated. The interaction with race was

subsequently retained in the model, and further model building was performed by assessing confounding followed by precision. For additional information on how the model was created, see Appendix.

Results

There were a total of 287 women for whom information on both lubricant use and bacterial vaginosis status was available, and 57 women reported using personal lubricants of some type. Characteristics of women who use lubricant and women who had bacterial vaginosis are presented in Tables 1 and 2. BV was present in 26.8 % of the population studied.

Several known risk factors for bacterial vaginosis were examined in the study and were found to be significantly associated with bacterial vaginosis. Black race and douching were significantly positively associated with bacterial vaginosis, while white race and use of hormonal contraception were negatively associated with bacterial vaginosis. Women who reported being sexually active trended towards being more likely to have bacterial vaginosis. This finding is consistent with reports in the literature, but was not statistically significant in our population (7-9).

While less is known about characteristics of women who use lubricants, it was found that, as expected, being sexually active and having vaginal or anal intercourse were significantly associated with using lubricants.

A stratified analysis was performed to assess potential confounding and interaction (Table 3.) The stratified analysis revealed a significant interaction between black race and lubricant use. In addition, a dichotomous variable representing age over thirty versus under thirty neared significance ($p=0.076$.)

In constructing the multivariate logistic regression model, several risk factors were included because they were known to be associated in the literature with bacterial vaginosis and/or were found to be associated with bacterial vaginosis or lubricant use in

our univariate analysis. These included douching, current sexual activity, race, the interaction between race and lubricant use, current oral contraceptive use, and condom use. While the literature does support that lesbian women have a higher risk for bacterial vaginosis, there were insufficient numbers of women reporting lesbian encounters to allow this variable to be included in the analysis (8,9). Anal sex and last menstrual period were also excluded from the multivariate analysis because of insufficient data.

The final logistic regression model obtained to estimate the association between lubricant use and bacterial vaginosis controls for douching, current sexual activity, and race (Table 4). Race alone was found to be associated with bacterial vaginosis, while currently being sexually active approached statistical significance in the model ($p = 0.0595$). While there was no statistically significant relationship between lubricant use and bacterial vaginosis in our population ($p=0.262$), there was a nearly statistically significant interaction between black race and lubricant use ($p = 0.0667$).

After adjustment for race, douching, and sexual activity, it was found that the odds of bacterial vaginosis among black lubricant users appears to be higher than for white or Hispanic women (OR = 2.562, 95% CI 0.972 – 7.528) (Table 5.)

Discussion

Our study did not find a significant association between bacterial vaginosis and lubricant use alone, but did suggest that the effect of lubricants might be different for different races. In particular, it appears that lubricants are associated with an increased rate of bacterial vaginosis among African American women, a phenomenon that was not observed for white or Hispanic women.

One hypothesis that could explain this differential susceptibility is that some evidence indicates differences in the underlying vaginal flora between women of different races (20). Given that the underlying "normal" flora appear to differ between different groups, it is possible that some of these bacterial communities are less resilient to certain environmental perturbations, such as vaginal lubricant use.

Our study has several limitations. First, in an attempt to protect participant privacy and anonymity, we chose to administer the questionnaire without the presence of study personnel. Though we requested that participants look over the form before returning it to personnel, there was no oversight to ensure either that the forms were completed, or that the participant understood each question being asked. Therefore, there were missing responses for a number of variables, and there could potentially be an identifiable difference between those who chose to respond to a question compared with those who did not. For example, there were a number of missing responses to questions about anal sex, and it is possible that a higher proportion of individuals who did not answer the question engaged in anal sex than the subset of individuals who did respond, and chose not to answer the question because of perceived social unacceptability.

A second limitation of the study lies in the imperfect measure of "race." Race is a social, rather than biologic construct, and it is an imprecise measure by which to group individuals. Our data would have been improved had we collected information on socioeconomic factors such as education and income level that often are tied to race, but not synonymous with it.

An additional limitation of the study lies in the heterogeneity of the exposure variable, defined simply as "lubricant use." There were insufficient data to estimate the association between individual lubricant types and bacterial vaginosis, and as a result the entire group of lubricants was lumped into a single category. In truth, there are likely important differences between these lubricant brands, and some of the brands might turn out to be important in promoting the normal vaginal ecosystem, while others could have a deleterious impact. Therefore, the lack of a statistically significant association between lubricant use and bacterial vaginosis found in this study should not deter further study of the issue.

Further study of the relationship between bacterial vaginosis and lubricant use, as well as the interaction between race and lubricant use, is warranted. A prospective study of individual lubricants could provide valuable information about their relationship with bacterial vaginosis, and the vaginal ecosystem. It is not appropriate to assume at this time that the effect of lubricants is the same for women of different racial and ethnic backgrounds.

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Tables

Table 1: Frequency of Risk Factors in Women with Bacterial Vaginosis

Variable	BV Positive (n)	BV Positive (%)	BV Negative (n)	BV Negative (%)	X^2	p-value
Age_old	47	55.95	107	48.86	1.223	0.269
Black/African Am.	42	50.00	64	29.22	11.522	0.0007
Hispanic/Latina	32	38.10	66	30.10	1.757	0.185
White	10	11.90	89	40.64	22.788	<0.0001
Lubricant Use	17	22.08	40	19.05	0.325	0.569
Douching	23	28.05	35	16.13	5.408	0.020
Current OCP	12	14.46	66	30.41	7.945	0.005
Sex_active	69	86.25	163	76.89	3.119	0.077
Anal Sex	10	18.18	16	10.81	1.951	0.163
WSW	4	5.13	8	3.86		0.7413**
Vaginal Sex	66	86.84	162	79.02	2.214	0.137
Condom Use	19	22.89	55	25.35	0.195	0.659
LMP_week	8	10.96	17	8.85	0.2742	0.6005

** Fisher's Exact Test reported.
Age_old: Age over 30
Lubricant use: Participant reported using any lubricant in the 60 days preceding the study.
Current OCP: Current use of oral contraceptive pill (any brand.)
Sex_active: Participant reported being sexually active at the time of the study.
Anal Sex: Participant reported engaging in anal sex any time in the 60 days preceding the study date.
WSW: Participant reported engaging in sexual activities with another woman in the 60 days preceding the study date.
Vaginal sex: Participant reported having vaginal intercourse in the 60 days preceding the study date.
Condom use: Participant reported using condoms in the 60 days preceding the study date.
LMP_week: Participant report the first day of her last menstrual period as occurring within the 7 days preceding the study date.

Table 2: Characteristics of Women Who Use Lubricants

Variable	Lubricant User (n)	Lubricant User (%)	Lubricant Non-User (n)	Lubricant Non-User (%)	X^2	p-value
Age_old	32	56.14	116	49.79	0.740	0.390
Black/African Am.	21	36.84	79	33.91	0.175	0.656
Hispanic/Latina	13	22.81	77	33.05	2.244	0.134
White	23	40.35	77	33.05	1.081	0.298
Douching	14	25.00	41	17.83	1.492	0.222
Current OCP	20	35.09	58	25.22	2.249	0.134
Sex_Active	51	91.07	174	78.03	4.880	0.027
Anal Sex	10	25.00	18	11.39	4.868	0.027
WSW	3	5.26	9	4.13	--	0.779 **
Vaginal Sex	54	94.74	169	77.88	8.468	0.004
Condom Use	17	29.82	56	24.35	0.7224	0.395
LMP_week	1	1.85	24	12.00	4.935	0.026

See Table 1 for abbreviations.

Table 3: Stratification Across Variables for the Association Between Lubricant Use and Bacterial Vaginosis

Control Variable	**Substratum OR1 (=0)**	**Substratum OR2 (=1)**	**MH Adjusted OR**	**Breslow Day**
Age_old	0.546	1.92	1.185	0.076
Race_black	0.434	3.25	1.184 (N/A)	0.0063*
Race_hispanic	1.587	0.612	1.249	0.226
Race_white	1.80	0.338	1.372	0.120
Douching	1.153	1.300	1.193	0.872
Current OCP	1.109	2.333	1.32	0.320
Sex_active	0.834	1.138	1.039	0.302
Anal Sex	1.091	0.551	0.932	0.479
WSW	1.083	7.00	1.202	0.193
Vaginal Sex	0.813	1.200	1.122	0.371
Condom Use	1.544	0.597	1.223	0.230
LMP_week	1.021	--- zero cell	1.109	0.1511

Race_black: Represents Black/African American versus all other races.
Race_hispanic: Hispanic versus other races.
Race_white: White versus other races.
Other abbreviations as in Table 1.

Table 4: Final Model After Consideration of Confounding and Precision

Variable	Parameter Estimate	Standard Error	p-value
Lubricant Use	-1.216	1.085	0.262
Black/African Am.	1.246	0.443	0.005
Hispanic/Latina	1.002	0.444	0.024
Douching	0.333	0.350	0.342
Sex_Active	0.815	0.432	0.0595
Black*Lubricant	2.225	1.213	0.0667
Hispanic*Lubricant	0.727	1.300	0.576
Intercept	-2.621	0.511	<0.0001

-2LogL = 279.793
Black*Lubricant: Interaction between black race and lubricant use.
Hispanic*Lubricant: Interaction between Hispanic race and lubricant use.
Other abbreviations as in Table 1.

Table 5: Odds Ratio Estimates for Final Model

Variable	OR Estimate	95% Confidence Interval
Lubricant Use:		
White	0.279	(0.0331, 2.348)
Black/African Am.	2.562	(0.972, 7.528)
Hispanic/Latina	0.613	(0.149, 2.480)
Douching	1.395	(0.703, 2.769)
Sex_Active	2.259	(0.968, 5.271)
Race		
White	1.00	-----
Black/African Am.	3.476	(1.459, 2.485)
Hispanic/Latina	2.724	(1.140, 6.509)

Abbreviations as in Table 1.

Appendix

Describing the Rationale for Model Selection:

Model selection was performed using the logistic regression modeling strategy as outlined in Kleinbaum and Klein's *Logistic Regression: A Self Learning Text* (19).

Selection of the initial model was performed after consideration of risk factors for bacterial vaginosis in the literature, as well as univariate analysis of the data set.

Table 1: Initial Model Containing All Risk Factors and Interaction Terms

Variable	**Parameter Estimate**	**Standard Error**	**p-value**
Lubricant Use	-4.784	2.833	0.091
Age	0.018	0.571	0.450
Black/African Am.	1.053	0.459	0.022
Hispanic/Latina	0.764	0.467	0.102
Douching	0.224	0.366	0.541
OCP Use	-0.594	0.416	0.153
Condom Use	-0.230	0.355	0.518
Sexually Active	0.962	0.459	0.036
Age*Lubricant	0.114	0.080	0.156
Black*Lubricant	2.052	1.250	0.100
Hispanic*Lubricant	0.491	1.246	0.714
Intercept	-2.944	0.893	0.0010

-2LogL = 269.918

Table 2: Model Containing No Interaction Terms

Variable	Parameter Estimate	Standard Error	p-value
Lubricant	0.124	0.374	0.740
Age	0.031	0.023	0.174
Black/African Am.	1.443	0.424	0.0007
Hispanic/Latina	0.855	0.442	0.053
Douching	0.249	0.356	0.485
OCP Use	-0.613	0.406	0.131
Condom Use	-0.260	0.554	0.457
Sexually Active	1.074	0.455	0.023
Intercept	-3.599	0.874	<0.0001

-2LogL = 277.563

LRT Comparing Model 1 to Model 2: X^2 = 7.645, 3df, p = 0.054

Table 3: Model removing the least significant interaction term, AgeXLubricant Use

Variable	Parameter Estimate	Standard Error	p-value
Lubricant	-1.202	1.092	0.271
Age	0.029	0.023	0.194
Black/African Am.	1.010	0.458	0.028
Hispanic/Latina	0.711	0.466	0.127
Douching	0.226	0.363	0.533
OCP Use	-0.6347	0.413	0.124
Condom Use	-0.242	0.354	0.495
Sexually Active	0.965	0.454	0.034
Black*Lubricant	2.210	1.220	0.070
Hispanic*Lubricant	0.718	1.313	0.585
Intercept	-3.252	0.874	0.0002

Because the interaction between race and lubricant neared statistical significance, it was left in the model. The next step in model selection involved first, the assessment of confounding, and second, the optimization of precision in the model.

Table 4: Assessing Confounding and Precision

Variable Dropped	OR	<=10% GS?	95% CI	CI Width
None (G.S.)	White 0.301 Black 2.734 Hispanic 0.616	n/a	(0.035, 2.554) (0.917, 8.149) (0.148, 2.560)	2.519 7.232 2.412
Age	White 0.323 Black 2.936 Hispanic 0.630	No for all 3	(0.0383, 2.726) (0.992, 8.689) (0.153, 2.603)	2.688 7.700 2.450
Douching	White 0.296 Black 2.445 Hispanic 0.644	Yes for Black No for White, Hispanic	(0.035, 2.503) (0.855, 6.991) (0.158, 2.625)	2.468 6.136 2.467
OCP Use	White 0.276 Black 2.557 Hispanic 0.630	No for all 3	(0.0328, 2.328) (0.868, 7.532) (0.153, 2.600)	2.295 6.664 2.447
Sexually Active	White 0.362 Black 3.833 Hispanic 0.613	Yes for White, Black No for Hispanic	(0.043, 3.047) (1.33, 11.051) (0.150, 2.498)	3.004 9.721 2.348
Condom Use	White 0.295 Black 2.722 Hispanic 0.606	No for all 3	(0.0347, 2.511) (0.916, 8.093) (0.146, 2.510)	2.476 7.177 2.364
Age and OCP Use	White 0.293 Black 2.748 Hispanic 0.639	No for all 3	(0.0349, 2.459) (0.940, 8.040) (0.156, 2.619)	2.424 7.100 2.463
Age and Condom	White 0.320 Black 2.933 Hispanic 0.619	No for all 3	(0.038, 2.700) (0.993, 8.658) (0.150, 2.550)	2.662 7.665 2.400
Condom and OCP	White 0.296 Black 2.742 Hispanic 0.613	No for all 3	(0.0354, 2.485) (0.939, 8.005) (0.151, 2.490)	2.450 7.066 2.339
Age, Condom, and OCP	White 0.279 Black 2.562 Hispanic 0.607	No for all 3	(0.0331, 2.348) (0.872, 7.528) (0.149, 2.480)	2.315 6.656 2.331

Threshold used for 10% Rule: White (0.2705, 0.3306)
Black (2.4606, 3.007)
Hispanic (0.5543, 0.6775)

To assess confounding, the odds ratio estimates for each model above were compared with the "gold standard" model that included all possible variables (gold standard model seen in Table 3). Although a somewhat subjective test, the variables for sexual activity and douching were found to change the odds ratio estimates for lubricant use when dropped from the model; therefore, the decision was made to retain them in the final model. For the remaining variables, precision was assessed. Highlighted models were eligible for final selection based on precision. Based on these results, it appears as though the final model should drop age, condom use, and OCP use, due to this model's narrower confidence intervals, and hence greater precision.

Table 5: Final Model After Consideration of Confounding and Precision

Variable	Parameter Estimate	Standard Error	p-value
Lubricant Use	-1.216	1.085	0.262
Black/African Am.	1.246	0.443	0.005
Hispanic/Latina	1.002	0.444	0.024
Douching	0.333	0.350	0.342
Sexually Active	0.815	0.432	0.0595
Black*Lubricant	2.225	1.213	0.0667
Hispanic*Lubricant	0.727	1.300	0.576
Intercept	-2.621	0.511	<0.0001

-2LogL = 279.793

Table 6: Odds Ratio Estimates

Variable	OR Estimate	95% Confidence Interval
Lubricant Use:		
White	0.279	(0.0331, 2.348)
Black/African Am.	2.562	(0.972, 7.528)
Hispanic/Latina	0.613	(0.149, 2.480)
Douching	1.395	(0.703, 2.769)
Sexually Active	2.259	(0.968, 5.271)
Race		
White	1.00	-----
Black/African Am.	3.476	(1.459, 2.485)
Hispanic/Latina	2.724	(1.140, 6.509)