# The Epidemiology of Vulvovaginal Candidiasis: Risk Factors

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**Abstract:** The effects of personal hygiene, sexual history, diet, and stress on the risk of vulvovaginal candidiasis were estimated from a case-control study of students attending a public university during 1986–87. Data from medical records and self-administered questionnaires were used to compare 85 cases to 1,245 other students using the Health Service, and to 113 subjects chosen from the total student population. Frequent sexual intercourse was the strongest risk factor (seven or more times a week versus none): OR = 4.3; 95% CI: 1.4, 12.9 (for cases versus Health Service controls). (*Am J Public Health* 1990; 80:329–331.)

## Introduction

Vulvovaginal candidiasis, a common, irritating and frequently recurring infection, has been associated with broad spectrum antibiotic treatment, diabetes, and pregnancy.[1] Although factors such as diet high in sugar, using tampons or perfumed toilet paper, or wearing tight clothing are suspected to increase risk of vulvovaginal candidiasis,[1,2] few studies have examined these factors in a systematic fashion. In this study, I explored the relationships between personal habits, behaviors, and vulvovaginal candidiasis by analyzing a subset of data from a Health Service-based case-control study of urinary tract infection.[3]

## Methods

Cases and controls were collected as part of a previously described study of urinary tract infection.[3] For that study, participants were recruited from women presenting with and without urinary symptoms to the University Health Service between September 1986 and December 1987. Prior to seeing a clinician, participants were given a self-administered questionnaire including questions about medical history, stress, clothing, diet, sexual activity, and birth control method during the past four weeks. The medical records of all participants recruited at the Health Service were reviewed to establish diagnosis and to confirm information on birth control method and history of other infections.

There were two control groups: women using the Health Service during the same time period as the cases (Health Service controls); and a sample stratified by year in school of 200 women enrolled at the University during January, 1988 (student population controls). Of these 200, 170 had complete and accurate addresses and 115 consented to participate. Student population controls completed essentially the same questionnaire distributed at the Health Service, but medical records were not reviewed.

### Case and Control Definition

A case was defined as any woman who was recruited during a visit for which the diagnosis listed in her medical

record was vulvovaginal candidiasis (n = 85). Health Service controls were women without a clinical diagnosis of vulvovaginal candidiasis recruited from the University Health Service. Population-based controls were limited to women who did not report current infection with either vulvovaginal candidiasis or a urinary tract infection. Both cases and controls were limited to non-pregnant women without urinary tract infection enrolled at the University.

### Analysis

Exploratory analyses were conducted using multilevel contingency tables with both stratification and multivariate techniques to control for confounding.[4,5] Odds ratios (OR) and associated 95 percent confidence intervals (95% CI) were calculated from the logistic regression models as described by Schlesselman.[4] A separate model was fit for each factor of interest with age, frequency of sexual intercourse, number of previous infections with vulvovaginal candidiasis, and, for Health Service controls, month of enrollment, included as covariates. Related variables, such as birth control methods, were fit in a single model. All factors of interest were considered as potential confounders of other factors but only those variables that made a difference were included as covariates in the final models. For example, the OR for feminine hygiene use for cases compared to Health Service controls was calculated from a logistic regression model with presence of vulvovaginal candidiasis as the dependent variable, and age, frequency of sexual intercourse, number of prior infections with *Candida*, month of enrollment, and feminine hygiene use as independent variables.

## Results

A total of 85 women met the study case definition; 1,245 Health Service and 113 population-sampled participants met the control definition. Study participants were similar to women students enrolled in the University with respect to year in school, age, ethnic group, and marital status. Cases and controls ranged in age from 17 to 72 (mean = 21.8 years). Age, year in school, and marital status were similar for cases and controls. Self-reported history of previous vulvovaginal candidiasis was common among both cases (77.7 percent) and controls (Health Service: 41.2 percent; student population: 19.6 percent). Most previous infections occurred within the past 12 months (cases: 74 percent, Health Service: 60 percent; student population: 62 percent).

When controlled for the confounding effects of age, frequency of sexual intercourse, and month of enrollment, women reporting one previous infection, compared to none, were about twice as likely to have a current infection (Health Service: OR = 1.55; 95% CI: 1.35, 1.78; population: OR = 2.06; 95% CI: 1.58, 2.69), and those with two infections about three times as likely (Health Service: OR = 2.39; 95% CI: 1.81, 3.16; population: OR = 4.25; 95% CI: 2.49, 7.25).

Cases were twice as likely as controls to have been sexually active during the past four weeks; the odds ratio increased with increasing frequency of sexual intercourse for both control groups (Table 1). However, having a new partner or engaging in sexual intercourse with multiple partners during the past four weeks showed no association

**TABLE 1—Associations between Vulvovaginal Candidiasis and Selected Behaviors during the Past Four Weeks**

| Variables | Cases (n = 85) | | Health Service Controls (n = 1245) | | | Population Controls (n = 113) | | |
|---|---|---|---|---|---|---|---|---|
| | # | % | # | % | OR (95% CI) | # | % | OR (95% CI) |
| Weekly frequency of sexual intercourse during the past 4 weeks | | | | | | | | |
| never | 19 | 22.4 | 557 | 44.7 | reference | 68 | 60.2 | reference |
| < 1 time | 14 | 16.5 | 192 | 15.4 | 1.31 (1.10, 1.57) | 15 | 13.3 | 1.44 (1.10, 1.90) |
| 1–2 times | 20 | 23.5 | 231 | 18.6 | 1.73 (1.22, 2.45) | 11 | 9.7 | 2.08 (1.21, 3.60) |
| 3–6 times | 25 | 29.4 | 218 | 17.5 | 2.27 (1.34, 3.84) | 17 | 15.0 | 3.00 (1.32, 6.82) |
| 7+ times | 7 | 8.2 | 47 | 3.8 | 2.98 (1.48, 6.00) | 2 | 1.8 | 4.34 (1.45, 12.93) |
| Birth control method† (sexually active women only) | | | | | | | | |
| No method | 15 | 22.7 | 16 | 1.3 | reference | 9 | 20.9 | reference |
| Oral contraceptives | 35 | 53.0 | 373 | 55.4 | 1.11 (0.60, 2.02) | 23 | 53.5 | 1.52 (0.61, 3.74) |
| Diaphragm | 10 | 15.2 | 74 | 37.9 | 1.23 (0.40, 3.80) | 6 | 14.0 | 1.67 (0.30, 9.44) |
| Spermicides | 18 | 27.3 | 79 | 11.7 | 1.01 (0.43, 2.35) | 9 | 20.9 | 1.40 (0.36, 5.53) |
| Other methods | 21 | 32.8 | 264 | 40.0 | 0.95 (0.51, 1.78) | 22 | 51.2 | 1.01 (0.38, 2.70) |

NOTE: Odds ratios and their 95 percent confidence intervals (OR, 95% CI) were adjusted for frequency of sexual intercourse, previous infections with vulvovaginal candidiasis, age, and for Health Service controls, month of enrollment, using a logistic regression model (see methods).
†Categories not mutually exclusive. Percents do not sum to 100, as some women used more than one method during the previous four weeks.

with *Candida*. Moreover, no one birth control method was associated with infection (Table 1).

Student population controls were more likely to use colored toilet paper and take tub baths than cases, but Health Service controls reported similar exposures to cases (Table 2). Other suspected risk factors, direction wiped following toileting, menstrual protection, use of feminine hygiene products and clothing showed little association with vulvovaginal candidiasis (Table 2). Diet and stress also showed no association.

## Discussion

To my knowledge, no previous controlled study has reported a relationship between sexual activity and vulvovaginal candidiasis although case reports suggest a correlation.[1]

Sexual intercourse might facilitate movement of *Candida* into the vagina and result in local minor trauma, creating conditions suitable for yeast to invade tissues. Some authors have suggested that *Candida* can be sexually transmitted;[6] however, in this study neither beginning a new relationship nor having multiple sexual partners in the previous four weeks was associated with candidiasis after controlling for frequency of sexual intercourse.

Although similar with respect to demographic variables to all University students, it is possible that women using the Health Service are a select group. They were more likely to be sexually active and use contraceptives than the student population controls. The resulting selection bias might decrease the observed associations between sexual activity, or variables related to sexual activity, and candida when cases are compared to Health Service controls. Further, Health

**TABLE 2—Associations between Vulvovaginal Candidiasis and Selected Behaviors during the Past Four Weeks**

| Variables | Cases (n = 85) | | Health Service Controls (n = 1245) | | | Population Controls (n = 113) | | |
|---|---|---|---|---|---|---|---|---|
| | # | % | # | % | OR (95% CI) | # | % | OR (95% CI) |
| Wipe back to front vs reverse | 21 | 25.0 | 403 | 33.0 | 0.86 (0.51, 1.45) | 59 | 52.2 | 0.34 (0.16, 0.71) |
| Infrequent bowel movements | 13 | 15.3 | 148 | 11.9 | 1.26 (0.68, 2.31) | 11 | 9.7 | 1.63 (0.60, 4.44) |
| Use colored toilet paper | | | | | | | | |
| never | 25 | 29.8 | 505 | 41.0 | reference | 62 | 54.9 | reference |
| rare | 30 | 35.7 | 372 | 30.2 | 1.07 (0.88, 1.31) | 29 | 25.7 | 1.41 (0.71, 2.00) |
| some | 17 | 20.2 | 215 | 17.5 | 1.14 (0.77, 1.70) | 15 | 13.3 | 1.99 (0.99, 4.00) |
| frequently | 11 | 13.1 | 118 | 9.6 | 1.22 (0.67, 2.33) | 7 | 6.2 | 2.81 (0.99, 8.01) |
| always | 1 | 1.2 | 22 | 1.8 | 1.31 (0.59, 2.91) | — | — | — |
| Menstrual protection | | | | | | | | |
| napkins | 11 | 13.1 | 214 | 17.2 | reference | 26 | 23.4 | reference |
| tampons | 31 | 36.9 | 384 | 30.8 | 1.19 (0.58, 2.43) | 27 | 24.3 | 1.34 (0.48, 3.76) |
| tampons & napkins | 39 | 46.4 | 578 | 46.4 | 1.20 (0.61, 2.38) | 49 | 44.1 | 1.43 (0.56, 3.65) |
| Tub baths (ever) | 33 | 39.3 | 433 | 35.3 | 0.90 (0.56, 1.45) | 18 | 16.1 | 3.49 (1.54, 7.95) |
| Feminine hygiene products | 15 | 17.7 | 76 | 6.1 | 1.81 (0.94, 3.49) | 1 | 0.9 | 12.89 (1.39, 119.79) |
| Underwear fabric | | | | | | | | |
| always cotton | 23 | 27.1 | 335 | 26.9 | reference | 38 | 33.6 | reference |
| mix of fabrics | 57 | 67.1 | 820 | 65.9 | 0.94 (0.56, 1.57) | 71 | 62.8 | 1.05 (0.50, 2.21) |
| synthetic only | 5 | 5.9 | 90 | 7.2 | 0.99 (0.36, 2.75) | 4 | 3.5 | 0.96 (0.16, 5.88) |
| Wearing tight clothing | 6 | 7.1 | 105 | 8.4 | 0.70 (0.29, 1.69) | 8 | 7.1 | 1.72 (0.48, 6.19) |
| UTI in past year | 20 | 23.5 | 204 | 16.6 | 1.28 (0.72, 1.38) | 7 | 6.2 | 2.27 (0.74, 7.03) |

NOTE: Odds ratios and their 95 percent confidence intervals (OR, 95% CI), were adjusted for frequency of sexual intercourse, previous infections with vulvovaginal candidiasis, age, and for Health Service controls, month of enrollment, using a logistic regression model (see methods).

Service users may be more likely to have diseases associated with sexual activity and thus be more likely to adopt behaviors thought to limit infection. This may account for the differences in associations when cases are compared to student population rather than Health Service controls. Cases and controls completed the same questionnaires minimizing any misclassification with respect to exposure. Because case status was based solely on clinical diagnosis, undoubtedly some misclassification of disease occurred. However, the bias should have been at random, biasing the results toward no difference between groups.

This study showed a strong association between sexual intercourse and vulvovaginal candidiasis among non-pregnant women. Other suggested factors—wearing tight clothing, hose or synthetic underwear; type of menstrual protection; use of feminine hygiene sprays; and diet—were not associated with candidiasis. Most women with recurring vulvovaginal candidiasis tend to avoid all suggested risk factors,[1] which do not include sexual intercourse. Although these findings need confirmation, suggesting to women suffering recurring vulvovaginal candidiasis that they temporarily decrease frequency of sexual intercourse has more scientific basis than some of the other standard advice (wear cotton underwear), would do no harm, and might potentially avoid recurrence.

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# Recurring Urinary Tract Infection: Incidence and Risk Factors

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Abstract: Urinary tract infection (UTI) is a common infection among young women, with a high recurrence rate. This study documents the six-month incidence of second UTI among a cohort of women with one initial UTI and the factors associated with recurrence. Among the cohort of 113 women, 30 (26.6 percent) experienced at least one culture-confirmed recurrence within the six months following initial infection. The presence of hematuria and urgency as symptoms of initial infection were the strongest predictors of second infection. Behavioral factors associated with initial infection (frequency of sexual intercourse, diaphragm use, and voiding after sexual intercourse) did not distinguish between women who would and would not experience a second UTI during the six-month follow-up period. (Am J Public Health 1990; 80:331–333.)

## Introduction

Urinary tract infection occurs frequently among young women, with over one-fourth having a second infection.[1] Why otherwise healthy women with no known anatomical abnormalities have multiple recurrences is a subject of some controversy, although both host and agent characteristics have been suspected. However, most authors would agree with Kunin's statement that the risk of a second infection is greater than the first, and that the first "sets the stage" for recurring infection.[2]

## Methods

All cases of first UTI among college women enrolled in a previously described case-control study* were eligible to participate in the follow-up study. A UTI was defined as the presence of significant bacteriuria ($\geq$10,000 colonies of a single bacteria per milliliter urine) and one or more urinary symptoms: hematuria, dysuria, frequency, urgency, or suprapubic pressure. Urinalyses and urine cultures were performed on all women presenting with urinary symptoms using standard techniques.* History of UTI was assessed by review of medical records and self-report.

Prior to enrollment, participants completed a self-administered questionnaire which contained a consent form approved by the University of Michigan Institutional Review Board and questions on medical history, stress, clothing, diet, sexual activity, and birth control method. Responses to questions regarding birth control method, sexual activity, history of UTI, and demographics and the presence of UTI were confirmed by review of medical records. At the end of the six-months follow-up, participants' medical records were again reviewed to record the number and timing of UTIs treated.

Symptoms (frequency, dysuria, nocturia, urgency, hematuria, fever, chills, back or flank pain, and any other symptoms specified by the respondent), costs of treatment, measures of disease impact, and whether a woman had changed her health habits following the UTI were assessed via a self-administered questionnaire sent to all participants two weeks following enrollment.

Since bacteria normally found in the intestine cause the majority of UTIs in this age group, a woman may be

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*Foxman B, Chi JW: Health behavior and urinary tract infection 1990; J Clinic Epidemiol (in press).