GENERAL GYNECOLOGY

The global epidemiology of bacterial vaginosis: a systematic review

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Bacterial vaginosis (BV) enhances the acquisition and transmission of a range of sexually transmitted infections including human immunodeficiency virus. This has made it more important to uncover the reasons why some populations have very high BV prevalences and others not. This systematic review describes the global epidemiology of BV. It summarizes data from peer-reviewed publications detailing the population prevalence of BV as diagnosed by a standardized and reproducible methodology—Nugent scoring system. BV variations between countries, and between ethnic groups within countries, are described. We evaluated 1692 English- and non-English-language articles describing the prevalence of BV using MEDLINE and the Web of Science databases. A total of 86 articles met our inclusion criteria. BV prevalences were found to vary considerably between ethnic groups in North America, South America, Europe, the Middle East, and Asia. Although BV prevalence is, in general, highest in parts of Africa and lowest in much of Asia and Europe, some populations in Africa have very low BV prevalences and some in Asia and Europe have high rates.

Key words: bacterial vaginosis, concurrency, epidemiology, ethnicity, sexual networks

"Bacterial vaginosis" (BV) is a term used to describe a disturbed vaginal microbiota dominated by mixed anaerobes, such as *Gardnerella* species, *Prevotella* species, and *Atopobium* species. Although mostly an asymptomatic condition,[1,2] the key importance of BV is in the range of associated adverse outcomes. Women who have BV are also at increased risk for the development of infection with herpes simplex virus type 2,[3] *Trichomonas vaginalis*, *Neisseria gonorrhoeae*,[4-6] and *Chlamydia trachomatis*.[4] BV has also been associated with an increased risk of human immunodeficiency virus (HIV) acquisition[7] and transmission.[8]

Both its etiology and the reason for the widely differing prevalences around the world remain unclear. BV has thus been referred to as "one of the most prevalent enigmas in the field of medicine."[9] There has been considerable debate in the literature as to whether BV is a sexually enhanced disease or a sexually transmitted disease.[10,11] The balance of evidence suggests that sexual transmission is at least an important aspect of its epidemiology.[12] A systematic review and metaanalysis of the relationship between sexual activity and BV found that BV "is significantly associated with sexual contact with new and multiple male and female partners and that decreasing the number of unprotected sexual encounters may reduce incident and recurrent infection."[11] Other reported risk factors include the intrauterine device,[13,14] black race/ethnicity,[15] douching,[16] smoking,[17,18] menses,[19] lack of male circumcision,[20] poverty,[1] low vitamin-D levels,[17] other dietary factors,[21,22] chronic stress,[23,24] and genetic variants of a wide range of host genes.[23,25] In many cases, however, follow-up studies have failed to reproduce these findings.[1,26] The use of hormonal contraception has been associated with a decreased incidence of BV.[14,27]

A significant omission in the literature on BV is a study describing the global epidemiology of BV. A first step in the investigation of a disease of unknown etiology is the mapping of its frequency distribution, followed by an analysis of what possible explanatory variables covary with it.[28] This is especially important in the field of sexually transmitted infections (STIs), where recent theoretical and empirical work has demonstrated the increasing importance of sexual networks in differential STI prevalences.[29] Since networks are properties of populations that cannot be reduced to the attributes of individuals, ecological type studies of population differences in STIs are an important and necessary type of investigation.[30] Evidence from the United States and Africa reveals that sexual networks are to a significant degree segregated along the lines of ethnicity/race.[31,32] Other lines of evidence have demonstrated that this segregation combined with differences in the structure of these sexual networks constitute an important determinant of the often large differences in STI rates between ethnic groups.[30,31] These considerations provide the rationale for describing the variations in BV prevalence by ethnic group alongside those of the international variations in BV prevalence.

An important development in BV epidemiology in the last 2 decades has been the development and validation of a standardized, reproducible, reliable, and widely used method of assessing the presence or absence of BV. Nugent scoring system (NSS) bases the diagnosis

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of BV on the interpretation of a Gram stain of vaginal secretions. The diagnosis of BV is defined as a Nugent score of ≥7 of 10.[33] The degree of interobserver and intraobserver variability is low compared to Amsel criteria (AC) and it has been established as a reproducible and reliable test.[34-36] NSS has thus been recommended to be used as the gold standard for the diagnosis of BV by a number of groups, including a National Institute of Health–sponsored working group on the topic.[37] The objective of this article is to describe the global epidemiology of BV by reviewing the available evidence of the prevalences of BV in different populations around the world.

METHODS

A search was conducted in the PubMed/MEDLINE and Web of Science databases in April 2012. Search terms included "bacterial vaginosis," "bacterial vaginitis," "bacterial vaginoses," "epidemiology," "incidence," and "prevalence." This resulted in the retrieval of 1692 articles. Cited references were also assessed for inclusion. Articles in English, French, Spanish, and Polish were considered for inclusion. No date restrictions were applied. Studies were then selected according to a 3-step process. First, studies were preferentially included if they were representative population-based or antenatal-based samples and the diagnosis of BV was based on NSS. This step yielded 46 studies. Second, if no studies based on representative samples from a particular country were available then other convenience samples where the diagnosis of BV was based on NSS were considered. These included studies sampling outpatient attendees, as long as the populations sampled were not constituted only by individuals presenting with STI symptoms. Surveys that exclusively sampled sex workers or HIV-positive populations were not included. This step yielded 21 studies. In addition, 4 studies that based the diagnosis of BV on Spiegel or Hay-Ison method were included. Like the NSS, these methods are Gram stain–based techniques that produce results so similar to NSS that they have been classified by some pathologists as interchangeable with the NSS.[35,36] One additional study that used BVBlue test (Gryphus Diagnostics, L.L.C., Birmingham, AL) was included. When compared to NSS, this test has a sensitivity of 92-100% and a specificity of 98%.[38,39] This step yielded a total of 26 studies. Third, if countries were still not represented, then we repeated steps 1 and 2 using surveys based on the less sensitive (and non-Gram stain–based) AC. In general, AC underestimates the BV prevalence as diagnosed by the NSS by 30-40%.[34,40,41] This step yielded 14 studies. The search strategy produced a total of 86 BV surveys that were utilized for our study.

To describe the epidemiology of BV by region, we developed a BV summary indicator. This summary indicator consisted of the percentage of studies done in the whole region that revealed a BV prevalence of ≥30%. Only studies using NSS were used in these calculations. For the purposes of presenting the BV summary indicator results, the regions of the world were grouped into low (0.1-0.2%), moderate (0.3-1%), and high (>1%) HIV prevalence regions. The regional HIV prevalence data are taken from the 2010 UNAIDS (the Joint United Nations Programme on HIV/AIDS) Global Report.[42]

Eleven studies where BV prevalences were broken down by ethnicity/race were used to describe the intranational epidemiology of BV.

Data extraction

For each study, we extracted the following information: date and location of study, study methodology including method of sample selection, exclusion criteria, response rate, and type of population sampled; mean or median age of sample, with range where available; method of diagnosis of BV, sample size; and prevalence of BV. Available evidence was then prepared in figure form to summarize the key study findings.

Data were grouped into 9 geographic regions, based largely on the World Health Organization classificatory system (a listing of countries in each region is presented in Table 1).[43] These regions were: North America; Latin America and the Caribbean; North Africa and the Middle East; sub-Saharan Africa; western Europe; eastern Europe and central Asia; East Asia and the Pacific; South Asia and Southeast Asia; and Australia and New Zealand.

RESULTS

Comparisons of the prevalence of BV by geographic area or country are hampered by a number of factors including differences in how the samples were selected and differences in the type of population surveyed—such as age composition and pregnancy. Despite these difficulties, certain trends are apparent.

Intranational comparisons

One of the most striking features is the extent to which BV prevalences vary by ethnic group within countries (Table 2). This has been most extensively documented and investigated in the United States. A series of surveys spanning 20 years (1 nationally representative,[1] 1 of all women entering the US Marines,[44] and 2 large samples of the antenatal population[45,46]) all revealed similar findings. BV prevalence was highest in blacks, and lowest in whites and Asians, with Hispanics having an intermediate prevalence. These differences remained remarkably stable through the period investigated.

BV prevalence in an antenatal population in the United Kingdom was considerably higher in Afro-Caribbeans than whites or Asians.[47] In Canada, BV rates were almost 3 times higher in the aboriginal population than the non-aboriginals.[48] Ethnically defined subpopulations in China,[49] Iran,[50] and Peru[51] all showed evidence of elevated BV prevalences compared to other national groupings.

International comparisons

Table 3 provides the details of BV prevalence by country. Table 4 summarizes BV prevalence by region according to the BV prevalence summary indicator. The regions of the world have been grouped into low (0.1-0.2%), moderate (0.3-1%), and high (>1%) HIV prevalence regions. In general BV prevalence, as assessed with the summary indicator, covaries fairly closely with regional HIV prevalence. Sub-Saharan Africa has the highest BV and HIV prevalence. Latin

TABLE 1
Countries in each of 9 World Health Organization regions

Australia and New Zealand
Australia, New Zealand
East Asia and the Pacific
Brunei Darussalam, China, Democratic People's Republic of Korea, Japan, Mongolia, Republic of Korea, Singapore, Cook Islands, Fiji, Kiribati, Marshall Islands, Micronesia (Federated States of), Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu
East Europe and central Asia
Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Montenegro, Poland, Romania, Russian Federation, Serbia, Slovakia, Tajikistan, former Yugoslav Republic of Macedonia, Turkey, Turkmenistan, Ukraine, Uzbekistan
Latin America and Caribbean
Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela (Bolivarian Republic of)
North Africa and Middle East
Algeria, Bahrain, Cyprus, Djibouti, Egypt, Iran (Islamic Republic of), Iraq, Israel, Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Malta, Morocco, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, United Arab Emirates, Yemen
North America
Canada, United States
South and Southeast Asia
Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Thailand, Timor-Leste, Vietnam
Sub-Saharan Africa
Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Côte d'Ivoire, Democratic Republic of Congo, Equatorial Guinea, Eritrea, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Togo, Uganda, United Republic of Tanzania, Zambia, Zimbabwe
Western Europe
Andorra, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Monaco, Netherlands, Norway, Portugal, San Marino, Slovenia, Spain, Sweden, Switzerland, United Kingdom

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America and the Caribbean have a somewhat higher prevalence of BV and HIV than the regions in the low HIV prevalence regions. Although BV prevalence tended to be highest in sub-Saharan Africa and lowest in Asia/Australasia/western Europe, there were populations with high and low BV prevalence in all of these regions.

Sub-Saharan Africa

BV prevalences were highest in southern and eastern Africa. Mozambique with a BV prevalence of 12.9% was an exception.[52] The survey here, however, was of young women (mean age 19.2 years), who were relatively sexually inexperienced and who had relatively low STI prevalences. An unpublished survey of a slightly older group (mean age 27.6) of 108 women attending a family planning clinic in Maputo, Mozambique, found a BV prevalence of 68.3%.[53] With the exception of The Gambia (BV prevalence 37%),[54] BV prevalence tended to be lower in West Africa.[55-58] Two large, population-based and methodologically sound surveys in Burkina Faso revealed low BV prevalences (6% and 8%).[57,58]

Latin America and Caribbean

BV prevalences tended to be intermediate in this region. Two populations, however, had noticeably higher BV prevalences—an antenatal population in Jamaica[59] and a rural population sample in Peru[60] had rates of 49% and 41%, respectively.

Western Europe

The prevalence of BV is low in this region. Only 3 countries in this region (Turkey,[61] Poland,[62] and Norway[63]) have populations where BV prevalence was >20%. In all 3 cases, the studies were small and possibly not that representative of the general population.

Middle East/North Africa

There was a paucity of data from this region. Of the 4 studies from the region, 2 (1 from Sudan[64] and 1 from central Iran[65]) revealed low BV prevalences. The study from southern Iran found a high

TABLE 2
Bacterial vaginosis prevalence estimates by ethnic group, country, and year of study

Location	Study location, date	Study type,[a] selection process, and sample size	Median or mean age (±SE; range), y	Diagnostic process	Prevalence, %
United States	United States, 1984 through 1989[45]	In 7 urban medical centers in the United States, 13,747 predominantly low-socioeconomic-status women at 23-26 wks' gestation were recruited according to ethnic origin	24.1	BV was diagnosed by NSS in conjunction with vaginal pH >4.5	
		Blacks, 5285			22.7
		Whites, 4049			8.8
		Hispanics, 4240			15.9
		Asian-Pacific Islanders, 173			6.1
	US Marines, 1999[44]	All 2157 women entering US Marine Corp in 1-y period; full data available for 1938 (94%)	19.1 (±2.1; 17–33)	NSS	27
		Whites, 1092			24.7
		Hispanics, 387			29.5
		Blacks, 306			32
		Asian-Pacific Islanders, 63			11.1
		Native Americans, 44			34.1
		Other, 46			26.1
	NHANES, 2001 through 2004[1]	4646 women in nationally representative sample of US civilian noninstitutionalized population were interviewed; 3739 of these completed vaginal swab examination, were assessed for BV, and are presented here	15–49	NSS	29.2
		Non-Hispanic blacks, 978	15–49		51.4
		Hispanics, 971	15–49		31.9
		Non-Hispanic whites, 1533	15–49		23.2
	Chapel Hill, NC, 1995 through 1996[46]	819 women 24-29 wks pregnant were randomly selected at AN clinics; EC: nonsingleton pregnancy, mother age <17 y	24 (IQR 21–29)		19.3
		Blacks, 377			25.8
		Others, 55			12.7
		Whites, 387			14
	Pittsburg, PA, 2005 through 2006[84]	Prospective observational cohort study exploring effect of race of male sex partner on BV prevalence and incidence; all women with singleton pregnancies seeking AN care from single hospital; 526 women eligible, 325 women enrolled; EC: vaginal bleeding, diabetes, HIV positive		NSS	
		Female white – male white, 27	25 (18–41)		20.9
		Female white – male black, 16	23 (18–34)		48.7

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TABLE 2
Bacterial vaginosis prevalence estimates by ethnic group, country, and year of study *(continued)*

Location	Study location, date	Study type,[a] selection process, and sample size	Median or mean age (±SE; range), y	Diagnostic process	Prevalence, %
		Female black — male white, 5	23 (18—34)		41.6
		Female black — male black, 68	25 (17—42)		35.7
United Kingdom	Harrow, pre-1994[47]	Prospective descriptive cohort study to evaluate if BV in early pregnancy increased risk of premature delivery; 783 women between 9-24 wks' gestation who were making their first AN visit to Northwick Park Hospital, Harrow, were recruited	28.6	Spiegel criteria	10.9
		White, 361			12
		Afro-Caribbean, 24			41
		Asian, 179			6
		Other, 92			4
Iran	Fars Province, 1996 through 1997[50]	Stratified random sample in 2 tiers to yield numbers of women in proportions representative of 6 tribes of Qashqai; all 839 married women in selected subclans participated; EC: nonmarried, pregnant, menstruating	Ages given in 10-y categories only	NSS	50
		Stratified random sample in 2 tiers to yield numbers of women in proportions representative of 4 tribes of Mamasani Lor; all 274 married women in selected subclans participated; EC: nonmarried, pregnant, menstruating	Ages given in 10-y categories only	NSS	49
		388 urban women living in Shiraz; selection process not described; EC: nonmarried, pregnant, menstruation	Ages given in 10-y categories only	NSS	40
Canada	Edmonton (Alberta), 1995 through 1996[48]	Prospective cohort study; all expectant mothers in all obstetric practices affiliated with single teaching hospital in Edmonton invited to participate; 2047 women enrolled; 1811 followed up to delivery; prevalences given for BV in second trimester; prevalences for BV at any stage in pregnancy were 43% and 23% for aboriginal and non-aboriginal groups, respectively		NSS	13.6
		Non-aboriginal	NS	NSS	13
		Aboriginal	NS	NSS	33
Spain	Barcelona, 1995 through 1996[51]	293 consecutive pregnant women attending routine AN care at hospital	29.9	NSS	7.5
		White, 234			6.4
		Gypsy, 24			12.5
		Other, 35			11.4

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TABLE 2
Bacterial vaginosis prevalence estimates by ethnic group, country, and year of study *(continued)*

Location	Study location, date	Study type,[a] selection process, and sample size	Median or mean age (±SE; range), y	Diagnostic process	Prevalence, %
Peru	Rural areas, 1997 through 1998[51]	All women from 18 rural villages invited to participate in survey; sampled 752 women	36.9 (18–67)	NSS	40.8
		Aymara adjusted odds ratio 2.5 (95% confidence interval, 1.2–5.2) for prevalent BV			
China	Tibetan region of Sichuan[49]	397 women; selection criteria not clearly specified; EC: pregnant, ABs in last 30 d	18–72	Hay-Ison criteria	51.6
		Han, 61			44.2
		Tibetan, 291			60.8
		Other, 38			50.0

AB, antibiotic; *AN*, antenatal; *BV*, bacterial vaginosis; *EC*, exclusion criteria; *HIV*, human immunodeficiency virus; *IQR*, interquartile range; *NHANES*, the National Health and Nutrition Examination Survey; *NS*, not specified; *NSS*, Nugent scoring system.

[a] All studies were cross-sectional unless otherwise specified.

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prevalence of BV among randomly sampled urban dwellers (40%) and even higher rates among 2 distinct nomadic ethnic groups (49% and 50%).[50] The relatively high BV prevalence in the Egyptian study (33%) is hard to interpret as it intentionally sampled a relatively high-risk antenatal population (threatened premature labor or premature rupture of membranes).[66]

North America

BV prevalence was low in North America excluding among blacks in the United States[1,44,45] and aboriginals in Canada.[48]

East, South, and Southeast Asia and Australia/New Zealand

The prevalence of BV was on the whole low throughout this large region with a few noticeable exceptions. Two populations had rates >30%: a survey of women attending a family planning clinic in Manado, Indonesia (32%),[67] and the Tibetan region of Sichuan, China (52%).[49] A number of features of this Sichuan study should be noted. Firstly, the sampling strategy is not clearly outlined and thus it is unclear how representative these samples are. Secondly, the diagnosis of BV used was based on a version of the Hay-Ison grading and thus the differences in prevalence between different groups (eg, Tibetans and Han) are likely more instructive than the absolute BV prevalence for the population as a whole. The 4 other surveys from China, although all using AC for the diagnosis of BV, were all based on large, representative, population-based samples. All found the BV prevalence to be uniformly low in the rest of the country.[68-71]

Comment

This study represents an attempt at describing the geographic and ethnic patterning of BV globally. The advent of a standardized diagnostic process in the form of NSS has made this possible. There are, however, a number of limitations with the study. Firstly, this study described large gaps in the literature. There are large populations in the world, such as China, where the prevalence of BV has not been evaluated by the NSS. In other parts of the world, there are no published reports on BV prevalence diagnosed by any methodology. One cannot fill these gaps by generalizing the findings from other specific subpopulations in the same region. Secondly, some of the studies referred to here were weak in terms of being representative population samples. Some studies did not adequately describe methodological details such as their sampling strategy and response rates. Thirdly, the populations are not all directly comparable. The types of populations sampled included general population samples and clients attending antenatal, family planning, youth, and general outpatient clinics. Apart from the National Health and Nutrition Examination Survey (NHANES) III,[1] the studies are unlikely to be statistically representative of the entire national population. In general, the surveys were not detailed or large enough to report age-specific BV prevalences. This is unlikely to affect our results as in the only nationally representative sample of BV, prevalence varied little with age.[1] Fourthly, it is now established that the populations of bacteria that colonize the vagina can oscillate rapidly such that a larger proportion of persons will have BV diagnosed on at least 1 occasion by NSS when a population is sampled more frequently than the one-off measurements made in the cross-sectional surveys that constitute the majority of the studies detailed here.[72-75] Finally, the limitations of the NSS should be borne in mind. Although the NSS is a reliable and reproducible test, it requires the testing facilities to invest in training and quality-control procedures to maintain

TABLE 3
Bacterial vaginosis prevalence estimates by region, country, and year of study

Location	Study location, date	Study type,[a] selection process, and sample size	Median or mean age (±SE; range), y	Diagnostic process	BV prevalence, %
Latin America/Caribbean					
Argentina	Santa Fe, 2001 through 2003[85]	400 consecutive patients (with or without STI symptoms) presenting to gynecological practice, excluding pregnant patients	(15–55)	NSS	13.5
Brazil	Vitoria, Espirito Santo, 2003 through 2004[86]	Random women attending PHC clinic; EC: having been submitted to gynecological examination in <1 y before, and history of recent treatment (in last 3 mo) for genital infections	30 (14–49)	NSS	21.3
	Alagoas, 1997[87]	Random selection of 341 women from 4 rural villages; 83% response rate	34.4 (15–63)	NSS	15.3
	Serra Pelada, Para, 2004[88]	All 1500 women in town were invited to participate in health survey; first 5 presenting each day were assessed, until 209 sampled	38 (IQR 28–47)	NSS	18.7
	Botucatu, Sao Paulo, 2006 through 2007[89]	245 random pregnant women attending routine AN services at 18 PHC clinics	24.8 (14–44)	NSS	21.6
	Pacoti, Ceara, pre-2007[90]	Random survey of community; 592 women tested; response rate not reported	32 (12–49)	NSS	20.1
Chile	Santiago, 2006[91]	100 randomly sampled women from FP clinics; EC: pregnant, menstruating, ABs in last 30 d	15–49	NSS	32
Colombia	Bogota, 1999 through 2001[79]	155 women, 18-35 wks pregnant presenting for routine ANC were randomly selected; part of International Infections in Pregnancy study; all slides were analyzed at 1 central laboratory by experienced team; EC: ABs in preceding 2 wks, symptoms of vaginitis	28 (14–43)	NSS	9
Ecuador	La Concordia, pre-2010[92]	213 adolescents sampled from 2 schools; not clear how random selection was	14.9 (13–17)	Hay-Ison scoring	31.5
Jamaica	Kingston, 1999[59]	269 pregnant women, who were first-time attendees, at 4 AN clinics in Kingston in their second or third trimester	23 (14–40)	NSS	49.1
Peru	Rural areas, 1997 through 1998[60]	All women from 18 rural villages invited to participate in survey; sampled 752 women	36.9 (18–67)	NSS	40.8
	Lima, Trujillo, Chiclayo[93]	995 women between 18-30 y were randomly selected from 20 neighborhoods in Lima, 6 in Trujillo, and 8 in Chiclayo (3 coastal cities); all neighborhoods were poor; 779 (80.7%) were tested for BV	23.8 (18–30)	BVBlue (Gryphus Diagnostics, L.L.C., Birmingham, AL)	26.6

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TABLE 3
Bacterial vaginosis prevalence estimates by region, country, and year of study *(continued)*

Location	Study location, date	Study type,[a] selection process, and sample size	Median or mean age (±SE; range), y	Diagnostic process	BV prevalence, %
North America					
Canada	Toronto (Ontario), 2008 through 2009[94]	73 women attending OPD for insertion of IUCD		NSS	7.1
	Edmonton, 1994 through 1995[95]	2047 consecutive routine pregnant patients seen by 4 obstetricians (3 OPD-, 1 hospital-based); response rate 91.5%	29.1 (±5.1)	NSS	14
United States	NHANES, 2001 through 2004[1]	4646 women in nationally representative sample of US civilian noninstitutionalized population were interviewed; of these 3739 completed vaginal swab examination and were assessed	15–49	NSS	29.2
	United States, 1984 through 1989[45]	Random sample of 13,747 predominantly low-socioeconomic-status women at 23-26 wks' gestation from 7 urban medical centers	24.1	NSS in conjunction with vaginal pH >4.5	16.3
	US Marines, 1999[44]	All 2157 women entering US Marine Corp in 1-y period; full data available for 1938 (94%)	19.1 (17–33)	NSS	27
	Philadelphia, PA, 1999 through 2001[79]	69 women, 18-35 wks pregnant presenting for routine ANC were randomly selected; part of International Infections in Pregnancy study; all slides were analyzed at 1 central laboratory by experienced team; EC: ABs in preceding 2 wks, symptoms of vaginitis	31 (15–46)	NSS	5.8
Western Europe					
Czech Republic	Brno, 1990[96]	600 women randomly selected from local population; sampling methodology and response rate not clear	NS	AC	11.5
Denmark	Odense, 1992 through 1994[97]	Population-based sample of 2927 pregnant women; 81.4% response rate	28	AC	13.7
Finland	Aland Islands, 1993 through 2008[99]	Every 5 y, all women between ages of 20-60 y who turn 20, 25, 30, 35, 40, 45, 50, 55, or 60 y of age that year were invited to participate in cervical cancer screening program; Pap smears were evaluated for BV via NSS (no. screened for BV: 1993 = 819; 1998 = 824; 2003 = 790; 2008 = 771)	20–60	NSS	15.6 (1993) 8.6 (2008)
Greece	Athens, 2005[98]	1197 pregnant women between 22-25 wks' gestation reporting for second-trimester fetal anomaly scan; response rate not reported; EC: previous preterm deliveries, abortion, recent AB use	Age reported in 4 ranges only	NSS and vaginal pH >4.5	7.9

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TABLE 3
Bacterial vaginosis prevalence estimates by region, country, and year of study *(continued)*

Location	Study location, date	Study type,[a] selection process, and sample size	Median or mean age (±SE; range), y	Diagnostic process	BV prevalence, %
Ireland	Dublin, 1999 through 2001[79]	203 women, 18-35 wks pregnant presenting for routine ANC were randomly selected; part of International Infections in Pregnancy study; all slides were analyzed at 1 central laboratory by experienced team; EC: ABs in preceding 2 wks, symptoms of vaginitis	28 (16–44)	NSS	5.9
Italy	Lombardo, Italy, 1989 through 1994[100]	1955 consecutive AN women in their eighth and ninth month were screened; EC: AB use and any genitourinary symptoms; 514 women excluded on this basis	NS	NSS	8.7
Norway	Tromso, 1996[63]	168 consecutive applicants for first-trimester abortion	NS	NSS	24
Portugal	Lisbon, 1993 through 1994[101]	All 840 who attended specific FP clinic in Lisbon over 2-y study period were recruited; response rate NS	33% 20–29, 40% 30–39	AC	7
Spain	Barcelona, 1998[102]	492 randomly selected women with singleton pregnancies <28 wks' gestation sampled from routine ANC clinics; EC: ABs in preceding 4 wks	27 (±5.5)	NSS	4.5
	Barcelona, 1995 through 1996[51]	293 consecutive pregnant women attending routine ANC at hospital	29.9	NSS	7.5
Sweden	Stockholm and Eskilstuna, 1989 through 1991[61]	1011 women randomly selected from FP and youth clinics	25.7 (±6.9)	AC	13.7
Turkey	Trabzon, 2002[61]	86 consecutive women attending FP clinic for IUCD insertion	27.3 (16–40)	NSS	23.2
United Kingdom	London, 1998 through 2000[103]	Prospective cohort study of 1216 pregnant women <10 wks' gestation presenting to 34 GPs in South London	31 (16–48)	NSS	14.5
	Harrow, pre-1994[47]	Prospective descriptive cohort study to evaluate if BV in early pregnancy increased risk of premature delivery; 783 women between 9-24 wks' gestation who were making their first AN visit to Northwick Park Hospital, Harrow, were recruited	28.6	Spiegel criteria	10.9
Eastern Europe and central Asia					
Bulgaria	Plovdiv, pre-1998[104]	200 sexually active women presenting to dermatology and venereology clinics for routine checkup	17–34 (24.8)	NSS	17.5
Poland	Zabrze, 2001 through 2003[62]	450 consecutive AN patients (6-39 wks' gestation) EC: nonsingleton pregnancy, vaginal bleeding, placenta previa	NS	AC	19.1

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TABLE 3
Bacterial vaginosis prevalence estimates by region, country, and year of study *(continued)*

Location	Study location, date	Study type,[a] selection process, and sample size	Median or mean age (±SE; range), y	Diagnostic process	BV prevalence, %
	Lodz, 2001[105]	A group of 196 pregnant women at 8-16 wks' gestation were selected randomly from patients of 10 district maternity units in Lodz region; EC: nonsingleton pregnancies	NS	Spiegel criteria	28.5
Middle East/ North Africa					
Egypt	Assiut, 2001 through 2002[66]	480 women 28-37 wks pregnant with threatened premature labor or premature rupture of membranes attending Assiut University Hospital were approached; 468 (97.5%) participated	NS	AC	33.3
Iran	Zanjan, pre-2009[65]	500 nonpregnant, married women randomly selected from 5 PHC clinic attendees in Zanjan	36 (15–45)	NSS	16.2
	Fars Province, 1996 through 1997[50]	Stratified random sample in 2 tiers to yield numbers of women in proportions representative of 6 tribes of Qashqai all 839 married women in selected subclans participated; EC: nonmarried, pregnant, menstruating	Ages given in 10-y categories only	NSS	50
		Stratified random sample in 2 tiers to yield numbers of women in proportions representative of 4 tribes of Mamasani Lor; all 274 married women in selected subclans participated; EC: nonmarried, pregnant, menstruating	Ages given in 10-y categories only	NSS	49
		388 urban women living in Shiraz; selection process not described; EC: nonmarried, pregnant, menstruation	Ages given in 10-y categories only	NSS	40
	Hamedan, 2005[64]	540 women attending university hospital in Hamedan were recruited to case-control study (270 cases of vaginitis and 270 controls); controls were clients without symptoms of vaginitis; no clear definition of cases or controls provided; selection process NS; BV prevalence in cases and controls, 28.5% and 0.4%, respectively	NS	NSS	0.4–28.5
Sudan	Haj Yousif District, pre-2000[64]	338 women randomly sampled from periurban community; EC: menstruation	15–69	NSS	17.2
Australia/ New Zealand					
Australia	Melbourne, 2008[26]	528 university students who responded to posters on campus; received US$20	17–21	NSS	4.7

Kenyon. Global epidemiology of bacterial vaginosis. Am J Obstet Gynecol 2013. *(continued)*

TABLE 3
Bacterial vaginosis prevalence estimates by region, country, and year of study *(continued)*

Location	Study location, date	Study type,[a] selection process, and sample size	Median or mean age (±SE; range), y	Diagnostic process	BV prevalence, %
New Zealand	Otago, 2005 through 2007[106]	69 pregnant women randomly selected attending ANC; selected as controls for case-control study; EC: ABs or corticosteroids preceding 14 d, diabetes mellitus, vaginal bleeding	32	NSS	8.7
South and Southeast Asia					
Bangladesh	Dhaka, 2001 through 2002[107]	399 randomly selected married women who were attending 5 PHC clinics in city	NS	NSS	23.2
India	Lucknow, pre-2010[108]	200 pregnant women attending routine AN clinic at tertiary hospital	NS	NSS	13
	New Delhi, 2003 through 2004[109]	506 symptomatic pregnant women attending AN clinic; EC: ABs in last 14 d, medical illness	22 (18–35)	NSS	8.6
	Goa, 2001 through 2003[110]	Random sample of 2494 nonpregnant women from communities in North Goa; response rate 83.1%	32.3 (18–45)	NSS	17.8
	Mysore, 2005 through 2006[111]	898 Sexually active women recruited at 2 reproductive health clinics; EC: no sex in last 3 mo	15–30	NSS	19.1
	Chennai, 2002[112]	487 women from urban slum area who were enrolled into HIV intervention were evaluated for BV; response rate NS; EC: pregnant	33 (18–40)	NSS	24.6
Indonesia	Jakarta, 1989 through 1990[113]	490 pregnant women at 3 hospitals in Jakarta tested for BV at 16-20 wks' gestation	NS	NSS	17
	Manado, 1999[67]	Women attending FP clinic were invited to participate; response rate NS; 406 women participated in study and 357 were fully tested for BV	NS	NSS	32.5
Laos	Vientiane, 2001 through 2002[114]	500 consecutive AN clients; EC: >20 wk pregnant, any bleeding in pregnancy	25.7 (17–40)	NSS	22
	Vientiane, 2000 through 2001[115]	1125 patients attending gynecology OPD attached to referral hospital for first time; EC: ABs in preceding 2 wks, pregnant	15–49	NSS	25
Myanmar	Yangon, 1999 through 2001[79]	227 women, 18-35 wks pregnant, presenting for routine ANC were randomly selected; part of International Infections in Pregnancy study; all slides were analyzed at 1 central laboratory by experienced team; EC: ABs in preceding 2 wks, symptoms of vaginitis	28 (11–42)	NSS	15.6
Pakistan	Rawalpindi, 2007 through 2008[116]	100 consecutive patients in preterm labor; EC: nonsingleton pregnancy	NS	AC	21

Kenyon. Global epidemiology of bacterial vaginosis. Am J Obstet Gynecol 2013. *(continued)*

TABLE 3
Bacterial vaginosis prevalence estimates by region, country, and year of study *(continued)*

Location	Study location, date	Study type,[a] selection process, and sample size	Median or mean age (±SE; range), y	Diagnostic process	BV prevalence, %
	Rawalpindi, 2001 through 2002[117]	500 married women randomly sampled from city of Rawalpindi via 2-stage sampling process; EC: unmarried, not living with husband	15–49	NSS	10.3
Philippines	Manila, 1999 through 2001[79]	202 women, 18-35 wks pregnant presenting for routine ANC were randomly selected; part of International Infections in Pregnancy study; all slides were analyzed at 1 central laboratory by experienced team; EC: ABs in preceding 2 wks, symptoms of vaginitis	26 (15–43)	NSS	7.5
Thailand	Khon Kaen, 1995[118]	118 pregnant women attending ANC clinic at Srinagarind Hospital; EC: ABs in preceding 2 wks	25 (15–40)	NSS	15.9
	Khon Kaen, 1999 through 2001[79]	200 women, 18-35 wks pregnant presenting for routine ANC were randomly selected; part of International Infections in Pregnancy study; all slides were analyzed at 1 central laboratory by experienced team; EC: ABs in preceding 2 wks, symptoms of vaginitis	25 (16–42)	NSS	11.5
	Bangkok, 1999 through 2001[79]	200 women, 18-35 wks pregnant presenting for routine ANC were randomly selected; part of International Infections in Pregnancy study; all slides were analyzed at 1 central laboratory by experienced team; EC: ABs in preceding 2 wks, symptoms of vaginitis	25 (16–42)	NSS	12.5
Vietnam	Nghe An Province, 2004[119]	Cross-sectional survey of 505 pregnant women attending AN clinics from 10 communes in Nghe An Province; all pregnant women in region attending PHC clinics were invited to participate; 86% response rate	27 (15–49)	NSS	7
	Bavi District, 2006[120]	Community-based cross-sectional random sample (2 stage) of 1012 married women from 17 randomly selected clusters; EC: menstruating	36 (18–49)	NSS	11
	Haiphong, pre-2006[121]	284 women were randomly selected from rural village and requested to participate in survey; 197 (69.7%) participated	35.7	NSS	27.4
East Asia and the Pacific					
China	Beijing, 2009[68]	6339 randomly sampled women from 12 districts in Beijing; 99.9% response rate; inclusion criteria: married, nonpregnant, 25-54 y, no gynecological treatment for 1 y	39.6 (15–54)	AC	8.7

Kenyon. Global epidemiology of bacterial vaginosis. Am J Obstet Gynecol 2013. *(continued)*

TABLE 3
Bacterial vaginosis prevalence estimates by region, country, and year of study *(continued)*

Location	Study location, date	Study type,[a] selection process, and sample size	Median or mean age (±SE; range), y	Diagnostic process	BV prevalence, %
	Shandong, 2004[69]	Population-based cluster-random sample of 4039 married women in rural part of province; EC: pregnant	20–49	AC	5.9
	Beijing, pre-2010[70]	6337 women randomly sampled from 137 communes	25–54	AC	8.7
	Sichuan, 2003 through 2004[71]	2000 married women sampled via community-based cluster random sample	34.3 (20–49)	AC	15.4
	Tibetan region of Sichuan, 2007[49]	Conducted at Songpan County, where Tibetans make up about 37% of total population; all women aged 18-72 y were eligible for this study, but selection methodology not clearly outlined; 397 women studied; EC: pregnant, ABs in last 30 d	18–72	Hay-Ison criteria	51.6
Japan	Hokkaido, 1993 through 2000[122]	6083 consecutive AN clients (4-40 wks) attending Otaru Kyokai Hospital	27.6 (14–46)	NSS	18.2
	Gifu, 1995[118]	118 pregnant women attending ANC clinic at Iwasa Hospital; EC: ABs in preceding 2 wks	28 (21–37)	NSS	13.6
Papua New Guinea	Asaro Valley, 1995[123]	2-stage randomly selected sample of 201 women from 15 villages from rural Asaro Valley	15–45	AC	9
Sub-Saharan Africa					
Botswana	Gaborone, 2000[124]	703 randomly selected women attending AN clinics; EC: used ABs in previous 2 wks	25 (15–43)	NSS	38.1
Burkina Faso	Boulgou, Poni, Seno, and Yatenga Provinces, 2003[58]	2133 randomly sampled pregnant women from 98 AN clinics in 4 provinces; 93% response rate	24 (15–49)	NSS	6.4
	Ouagadougou, 2003[57]	2-stage clustered population-based survey of 883 women aged 15-49 y in Ougadougou; response rate 77.7%	15–49	NSS	7.9
Central African Republic	Bangui, 1996[125]	481 women seen at 3 AN clinics; response rate NS		NSS	29.1
The Gambia	Farafenni, 1999[54]	20 of 40 villages in region were sampled; all women aged 15-54 y were invited to participate; 1348 of 1871 (72%) participated; no EC	15–54	NSS	37
Ghana	Accra, 2001[56]	100 nonpregnant women sampled from FP clinic	28 (19–48)	NSS	25
Mozambique	Maputo, 2003[52]	435 first-time female attendees of youth-friendly clinic	19.2 (14–24)	NSS	12.9
Nigeria	Benin City, 2005[55]	241 healthy premenopausal women (healthy defined as "having no symptoms or signs of major disease including HIV") attending reproductive health care service in Benin City	32 (±16)	NSS	14.2

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TABLE 3
Bacterial vaginosis prevalence estimates by region, country, and year of study *(continued)*

Location	Study location, date	Study type,[a] selection process, and sample size	Median or mean age (±SE; range), y	Diagnostic process	BV prevalence, %
South Africa	Durban, 1994 through 1995[126]	168 consecutive women presenting to large urban hospital for first AN visit; EC: >30 wks' gestation	24 (16–44)	NSS	52
	Elandsdoorn, pre-2011[127]	101 women coming for HIV testing at testing center; 51% tested HIV positive	NS	NSS	34
	Rural KwaZulu, 2002[128]	277 consecutive clients presenting to ANC and FP clinics at 2 rural PHC clinics	23 (14–52)	NSS	58
	Khayelitsha, 2000 through 2002[129]	Nested case-control study of 5110 women enrolled in cervical cancer screening trial in periurban, mostly informal housing settlement; trial was open to all women in community; during follow-up for up to 36 mo, 86 new HIV seroconverters (case patients) were identified; 324 nonseroconverting control subjects were frequency matched to case patients by age and duration of follow-up; BV prevalence was 58.3% and 68.7% in controls and cases, respectively	35–65	NSS	58.3
Tanzania	Moshi, 1999[130]	382 randomly selected women attending maternal and child health and FP clinics (179 were pregnant); BV prevalence in pregnant women 31.4%, nonpregnant women 36.0%, and all women 33.9%	26.6 (16–46)	AC	33.9
	Moshi, 2002 through 2004[131]	2654 pregnant women in third trimester randomly selected from 2 PHC clinics (BV prevalence in HIV-positive and -negative women, 37.2% and 19.6%, respectively)	24 (14–43)	AC	20.9
Uganda	Rakai, pre-2006[20]	1264 wives or long-term partners of men enrolled into RCT to evaluate effect of circumcision on HIV transmission; 95.2% of women were HIV negative at baseline	NS	NSS	34.3
Zimbabwe	Harare, 2000[132]	393 consecutive, consenting women, presenting to 2 PHC clinics in Harare for ANC, FP, or bringing their children to attend preventive care clinics	15–49	NSS	30.3
	Harare, 1999 through 2001[79]	210 women, 18-35 wks pregnant, presenting for routine ANC were randomly selected; part of International Infections in Pregnancy study; all slides were analyzed at 1 central laboratory by experienced team; EC: ABs in preceding 2 wks, symptoms of vaginitis	23 (12–41)	NSS	24.4

The dates referred to in the table are when the surveys were done and not when the studies were published.

AB, antibiotic; *AC*, Amsel criteria; *AN*, antenatal; *ANC*, antenatal care; *BV*, bacterial vaginosis; *EC*, exclusion criteria; *FP*, family planning; *GP*, general practitioner; *HIV*, human immunodeficiency virus; *IQR*, interquartile range; *IUCD*, intrauterine contraceptive device; *NHANES*, the National Health and Nutrition Examination Survey; *NS*, not specified; *NSS*, Nugent scoring system; *OPD*, outpatient department; *PHC*, primary health care; *RCT*, randomized controlled trial; *STI*, sexually transmitted infection.

[a] All studies were cross-sectional unless otherwise specified.

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its accuracy. The extent to which this is the case was not stipulated in a large number of the studies we reviewed. In addition, the NSS only provides gross morphologic information about the bacterial composition of the vagina. It provides a limited understanding of the composition and relative abundance of the vaginal microbiota. A large number of studies are investigating the use of various nucleic acid amplification and other strategies[76] to better describe the makeup of the vaginal microbiota.[12,77,78] Once a reproducible and standardized strategy to more adequately define the vaginal microbiome of BV is agreed upon then the epidemiology of BV will need to be reevaluated.

We have sought to minimize the limitations of the data. Only studies that complied with predetermined selection criteria were used. When prospective studies were included, only cross-sectional BV prevalence was reported. Despite the methodological difficulties, the available evidence suggests that BV prevalences diagnosed via NSS are valid and reproducible. Studies of BV prevalence in the United States find similar variations in BV prevalence between the ethnic groups whether testing navy recruits, pregnant women, or nationally representative samples. These variations have remained remarkably stable over the 20 years they have been tested. The International Infections in Pregnancy study was useful in assessing if between-country variations in BV prevalence might be due to variations in how the NSS is applied.[79] In this study from 8 centers in 7 countries, all the slides were analyzed by 1 laboratory. The variations in BV prevalences found in this study were commensurate with those from the other studies. As an example, the BV prevalence was statistically significantly higher in Zimbabwe (the only site from southern-eastern Africa) than any other site.

How can the large differences in BV prevalence by ethnicity and geographical region be best explained? One way to address this question is to see which of the long list of factors identified in the individual-level risk factor analyses (listed in the introduction) covaries with BV prevalence. It is apparent that none of these risk factors covaries particularly closely with BV. Four examples will suffice. High circumcision rates may partly explain the lower BV prevalence in parts of West Africa than southern-eastern Africa, but they do not explain the low BV prevalence in Asia—which has, for most of the region, very low circumcision rates.[80] As far as the importance of poverty is concerned, many of the communities with elevated BV rates may have high rates of poverty, but not all have, and the part of the world that contains the majority of the world's population living on <$1.25 per day (South Asia)[81] has a relatively low BV prevalence. Thirdly, being black was found to be a residual risk for BV in the United States.[1,11,15] The strength and persistence of this association in studies from the United States has led a number of researchers to conclude that "differences in the structure and composition of microbial communities may underlie well-known differences in the susceptibility of (black) women to BV."[82] African race per se is, however, unlikely to be a necessary or sufficient etiological agent for BV as there are a number of populations in sub-Saharan Africa, such as Burkina Faso, where well-conducted surveys have established that the prevalence of BV is low. Fourthly, an increased number of sexual partners in the recent past has been shown to be a significant individual-level risk factor for BV in a number of studies.[11] Numbers of sexual partners over the past year and lifetime do not, however, covary with BV prevalences at a population level. Thus populations with high BV prevalence in Africa do not have more sexual partners than regions where BV prevalence is mostly low, such as Europe.[83] The same is true as far as interethnic variations in BV prevalence are concerned in the United States. Goldenberg et al,[45] for example, found that blacks, despite a markedly higher BV prevalence, tended to have a later age of sexual debut and a lower

TABLE 4
Summary prevalence of BV and HIV by world region

Variable	HIV prevalence 2009 (% aged 15-49 y)[a]	BV summary indicator[b]
Low		
Australia and New Zealand	0.1	0 (0/2)
East Asia and the Pacific	0.1	0 (0/2)
Western Europe	0.2	0 (0/10)
North Africa and Middle East	0.2	0 (0/6)
Range (median)	0.1—0.2 (0.2)	(0-0) 0
Moderate		
South and Southeast Asia	0.3	5 (1/19)
Latin America and Caribbean	0.5	30 (3/10)
North America	0.5	0 (0/6)
Eastern Europe and central Asia	0.8	0 (0/1)
Range (median)	0.3—0.8 (0.5)	0-30 (5)
High		
Sub-Saharan Africa	5.0	50 (6/12)

Regions are divided into low (0.1—0.2%), moderate (0.3—1%), and high (>1%) HIV prevalence regions.[a]

BV, bacterial vaginosis; *HIV*, human immunodeficiency virus.

[a] Data taken from 2010 UNAIDS (the Joint United Nations Programme on HIV/AIDS) Global Report[42]; [b] Refers to percent of surveys done in whole region that revealed BV prevalence of ≥30% (no. of surveys with BV prevalence of ≥30%/total no. of surveys done in region). Only studies using Nugent scoring system were used in these calculations.

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number of partners in the last year and over their lifetime compared to whites.

The long list of risk factors evaluated thus far in BV research are all individual-level factors that may be determinants of who within a population will be at risk for BV. By ignoring network-level considerations, they may, however, miss the causes of variation in population prevalence. What is needed then are firstly the ecological correlation studies described above. Secondly, prospective, multilevel studies are required that are able to assess both individual- and network-level risk factors, and how they interact with the vaginal microbiome, human genotypic variations, and regular STIs to influence BV incidence. If BV is indeed a significant risk factor for HIV acquisition and transmission, then uncovering the reasons why some populations have such elevated BV prevalences becomes all the more urgent. ■

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