The Journal of Sex Research Vol. 34, No. 3, 1997 pp. 279-291

Sex and Mortality: Real Risk and Perceived Vulnerability

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The public's perceived susceptibility to health risks does not always accurately reflect the epidemiological estimates of actual risk. We assessed whether this discrepancy exists for HIV infection by outlining and comparing the actual statistical probabilities of acquiring HIV and another sexually transmitted disease (chlamydia) with the perceived probabilities of acquiring these diseases for heterosexuals who do not use intravenous drugs. Our analysis of heterosexual college students' perceived probabilities revealed that they do not distinguish between chlamydia and HIV infection: Their predictions are accurate estimates of the probability of chlamydial infection but overestimates of the probability of HIV infection. We also found no relationship between the frequency of participants' risk-reducing behaviors and their perceived probability of HIV infection.

The public's perceived susceptibility to health risks does not always accurately reflect the statistical estimates of actual risk (for review, see Weinstein, 1989). It is assumed that a discrepancy between perceived susceptibility and the epidemiological estimates of actual risk also exists for HIV infection. However, conclusive validation of this assumption is lacking. Rather than estimate participants' actual risk of HIV infection based on epidemiological data, researchers have tended to categorize various populations as "high" or "low" risk for HIV infection based on their assessment of the participants' reported behaviors (e.g., Bauman & Siegel, 1987; Gladis, Michela, Walter, & Vaughan, 1992; Hansen, Hahn, & Wolkenstein, 1990; van der Velde, van der Plight, & Hooykaas, 1994; for a discussion, see van der Pligt, Otten, Richard, & van der Velde, 1993). This methodological approach can lead to confusion concerning how "high risk" should be operationalized (e.g., what is the statistical probability of being infected if one is classified as "high risk?") and which reported behaviors define a "high risk" classification. Without consistent operational definitions of the various risk classifications, it is impossible to compare findings to the epidemiological estimates of actual risk for HIV infection (or even across studies).

Inconsistent operational definitions of various risk classifications have also led to different conclusions concerning whether behavioral changes should be expected for non-intravenous drug-using (non-IDU) heterosexual adults. For example, non-IDU heterosexual adults' reported high levels of risky sexual behavior have been interpreted as rational behavior based on the small likelihood that they would actually encounter a sexual partner with HIV infection (Fumento, 1990; Symons, 1993), rational behavior based on the assessment of the costs and benefits associated with sexual activity (Pinkerton & Abramson, 1992), and irrational behavior explained by their perceived unique invulnerability to HIV infection (Gerrard, Gibbons, & Warner, 1991; Gladis et al., 1992; Hansen et al., 1990; Mickler, 1993). At the heart of this debate is the disagreement concerning the probability that non-IDU heterosexual adults would contract HIV infection through unprotected sexual intercourse. The researchers using an explicit or implicit risk-classification technique do not quantify this probability. Without quantification, the debate cannot be resolved.

Another approach researchers have used to draw conclusions concerning the epidemiological accuracy of their participants' perceived probability of being infected with HIV has been to ask participants to estimate their likelihood of HIV infection (e.g., using percent probability of infection) and then make comparisons between the participants' estimates of their risk and the participants' estimates of the risk of another person who engages in similar behavior (e.g., Hansen et al., 1990; Mickler, 1993). Because the participants consistently estimate their risk as less than another's risk ("optimistic bias," Weinstein, 1989), the researchers concluded that participants do not have a realistic notion of their actual risk of HIV infection (e.g., Gladis et al., 1992; Hansen et al., 1990; Mickler, 1993). Although this method allows one to draw conclusions concerning personal vulnerability bias, it does not allow one to make conclusions concerning one's absolute risk. To draw conclusions concerning participants' realistic notions of a risk, the appropriate comparison is between the participants' estimates of their risk and the epidemiological estimates of their actual risk. Because the researchers never calculated the epidemiological estimates of the actual risks of their participants, their conclusions concerning their participants' realistic notions of HIV infection could not be validated. Resolving this issue is important because individuals'

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perceived susceptibility to HIV infection and its impact on their behavior is a key component in models that have been useful in designing and evaluating HIV-prevention programs (e.g., Health Belief Model: Janz & Becker, 1984; Theory of Reasoned Action: Fishbein & Middlestadt, 1989; Fisher, Fisher, & Rye, 1995).

To resolve these and related issues successfully, it is essential to have accurate estimates of individuals' perceived susceptibility to HIV infection and a thorough analysis of the actual risks of HIV infection. Researchers have described the statistical risks of HIV infection based on epidemiological data for some populations (Hearst & Hulley, 1988; Pinkerton & Abramson, 1993; Reiss & Leik, 1989). These statistical models, however, have yet to be compared with individuals' perceived susceptibility.

In this article, we outline and compare the statistical probabilities of acquiring HIV and another sexually transmitted disease (STD) (i.e., chlamydia) with the perceived probabilities of acquiring these diseases. Chlamydia was chosen for comparison because, like HIV infection, it is well known and a medically reportable disease (in most jurisdictions), but unlike HIV infection, it is relatively common and curable (Lee, 1989). Because the probabilities of HIV infection vary with population and mode of transmission, we focused only on male-to-female transmission through unprotected vaginal intercourse with partners who are non-IDU heterosexuals. We chose to limit our population to non-IDU heterosexuals because (a) in the U.S., HIV infection attributable to heterosexual transmission has increased since the early years of the HIV epidemic, [Centers for Disease Control (CDC, 1995)], (b) the majority of the U.S. population are non-IDU heterosexuals (Hearst & Hulley, 1988), and (c) this population shows inconsistencies in beliefs and perceptions as related to risky behavior (e.g., Bruce, Shrum, Trefethen, & Slovik, 1990; Bruce & Moineau, 1991; Catania, Stone, Binson, & Dolcioni, 1995; DiClemente, Forrest, & Mickler, 1990; Fisher & Misovich, 1990; Gerrard, Gibbons, Warner, & Smith, 1993). We chose to analyze male-to-female vaginal transmission because unprotected vaginal intercourse is a high-frequency behavior (Laumann, Michael, Michaels, & Gagnon, 1994) and the probability of male-to-female transmission is greater than that of female-to-male transmission (by using the more likely event, we give a worst case scenario: Hearst & Hulley, 1988; Stine, 1993).

We first examine the probabilities of HIV infection based on (a) estimates of prevalence in both the U.S. low-risk population (defined as non-IDU heterosexuals) and in the college population, (b) use of condoms, and (c) relationship strategy: single sexual encounters, serial monogamy, and extended relationships. We also compare these probabilities of infection to the probabilities of death from two familiar occurrences: pregnancy and driving. We then present the results of an empirical study that assessed college students' perceptions of risk of HIV infection and chlamydia, as well as the relationship between these perceptions and the participants' use of different risk-reducing strategies.

p(Risk)

An objective way to describe the physical risks associated with unprotected vaginal intercourse is to state the probability of the occurrence of the risk, given a single unprotected act of vaginal intercourse, p(Risk | 1). Another useful measure of physical risk is the probability of the occurrence of the risk, given a specific relationship strategy. In this article, we explore three relationship strategies: single sexual encounters, serial monogamy, and extended relationships (defined next).

Modeling Assumptions

We modeled p(Risk | 1) for a number of physical risks associated with unprotected vaginal intercourse. The formulas that we used to model p(Risk | 1) are simple. For example, the probability of contracting an STD for any given unprotected act of vaginal intercourse is modeled using the following formula: $p(STD \mid 1) = IR * PR$, where IR is the infectivity rate of the disease and PR is the prevalence of the disease in the population. Because we are modeling the risk of non-IDU heterosexuals, our prevalence rates are based on that population. Thus, we assume that non-IDU heterosexuals do not mix with other populations (we do not make this assumption when modeling the college population). Furthermore, this model does not adjust for demographics such as geographic location, race, etc. The assumptions of such a model may appear simplistic. However, if one wants to make conclusions concerning the accuracy of an individual's prediction of risk, one must compare the individual's perceived risk to some objective measure. We are making a first attempt at specifying such a measure. Although our model's predictions will not be precise, they will be reasonably accurate. Take, for example, the case of HIV infection. Because the overall prevalence of HIV and its infectivity rate is low, the inclusion of adjustments for population mixing and demographics would not change the predictions by more than an order of magnitude (one order of magnitude is 10 times the initial value). We suspect that participants' estimates would vary from the predicted rates by much more than that.

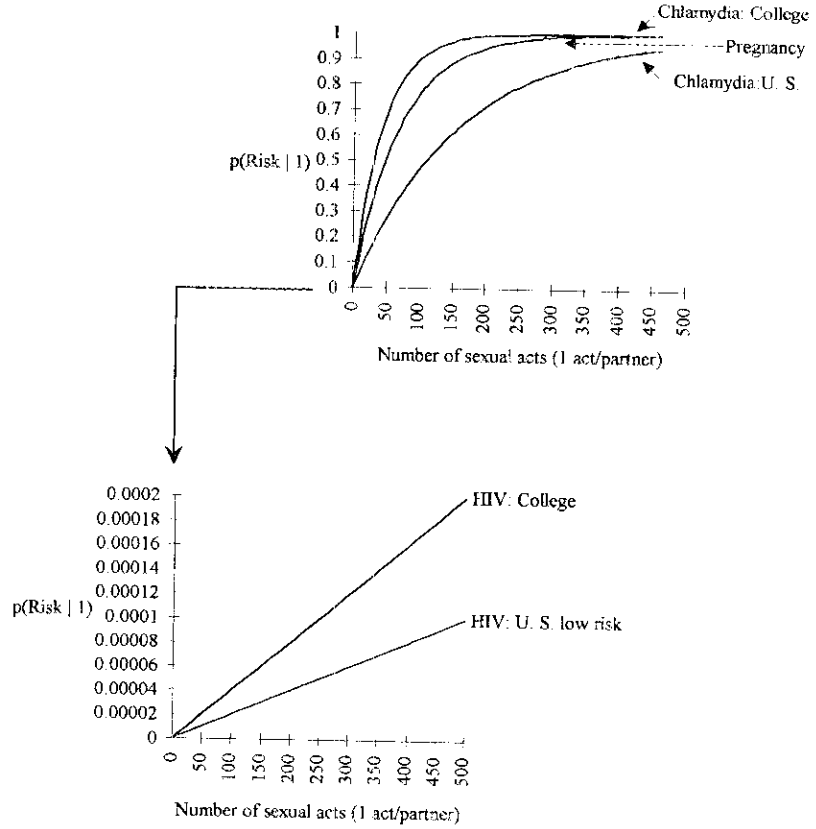
Two independent assumptions that are necessary for our model are the prevalence and infectivity rates of the diseases studied (see Table 1). For our model we assumed that the sexual partner had not been tested for the disease (fertility when modeling pregnancy). If the partner was tested, different prevalence numbers based on false positive and false negative rates would be used. Determining the prevalence of a disease in society is difficult. Ideally, one would randomly test a sample of participants from the population for the disease. This is often not possible. Researchers who assess prevalence rates frequently

test participants who visit a hospital or clinic. This sample is often biased because it is more likely that symptomatic participants than healthy participants would visit the hospital. This effect becomes pronounced when testing men who visit a clinic, because asymptomatic men rarely visit a clinic (e.g., Lee, 1989). However, asymptomatic women are likely to visit a clinic for yearly pelvic examinations. Therefore, we use female prevalence rates for all analyses.

Another difficulty with prevalence rates is that they may be in flux. Our model uses prevalence estimates that are approximately five years old (CDC, 1994; Gayle et al., 1990; Hearst & Hulley, 1988; Keim, Woodard, & Anderson, 1992). These are the most recent published reports that estimate HIV and chlamydia prevalence data (as opposed to listing only AIDS cases) for populations who engage in specific risk behaviors. Although the prevalence of HIV infection has increased, it will not significantly affect the conclusions we draw for several reasons. First, recent reports show that the HIV epidemic is plateauing in the U.S. and Europe (Cohen, 1995). Furthermore, our model uses the prevalence of HIV infection among non-IDU heterosexuals. Even though the incidence of AIDS cases among this population has increased (CDC, 1995), the absolute number of these infections remains low relative to the non-IDU heterosexual population in the U.S. (i.e., large relative increases translate into small absolute increases in prevalence). Finally, even increasing our HIV-infection prevalence estimates by an order of magnitude will not alter the conclusions of our analysis (see Reiss & Leik, 1989, for the statistical effects of high prevalence rates).

Infectivity rates are also controversial. They are frequently based on partner transmission studies. Because these studies rely on self-reported condom use and frequency of sexual intercourse, infectivity rates are always estimates. Our infectivity rate of HIV transmission is reported to be the upper bound of this estimate (Hearst & Hulley, 1988). Our infectivity rate for chlamydia is not based on a single sexual encounter and, thus, may also be inflated (Katz, Caine, & Jones, 1990). In both cases the inflated infectivity rate presents a worst case scenario.

Figure 1. The Probability of Conception, Contracting Chlamydia, and Contracting HIV, as a Function of the Number of Sexual Encounters



Note: The probability of conception for any given unprotected act of vaginal intercourse is p(pregnancy | 1) = *FR* * *FD* * *PR*, where *FR* is the fertility rate, *FD*, is the ratio of fertile sexually active days to infertile sexually active days, and PR is probability that both individuals are fertile. According to the CDC, the fertility rate on any sexual encounter during the female's ovulation is one in three (.33, CDC, personal communication, 3/15/95). The prevalence rate of fertile individuals in the United States is about .95, so *PR* would be about .9 (Mosher, 1988). The exact ratio *FD* is in dispute: Women are fertile for 1 day in a 28-day cycle; however, sperm is often viable for 3 days (Hatcher et al., 1994). Furthermore, many couples do not engage in vaginal intercourse during menstruation (CDC, personal communication, 3/15/95). Therefore, at least 4 values of FD are feasible: (1) 1/28 or .036, (2) 3/28 or .107, (3) 1/21 or .048, and (4) 3/21 or .143. We chose to specify *FD* = 1/21. One can adjust p(pregnancy | 1) according to one's *FD* preference. The p(STD | 1) for any given unprotected act of vaginal intercourse is p(STD | 1) = *IR* * *PR*, where *IR* is the infectivity rate of the disease and *PR* is the prevalence of the disease in the population.

Single Sexual Encounters

The most prevalent physical risk associated with unprotected vaginal intercourse is pregnancy. Figure 1 shows p(pregnancy | 1) as a function of number of unprotected acts of vaginal intercourse. The probability of pregnancy resulting from any single unprotected act of vaginal intercourse, p(pregnancy | 1), equals about .014 (i.e., the odds are 1 in 70).

The other class of physical risk associated with unprotected vaginal intercourse is infection by STDs. In this article, we analyzed p(STD | 1) for chlamydia and HIV. Figure 1 shows p(STD | 1) as a function of number of unprotected acts of vaginal intercourse for both the U.S. low-risk and college populations. Table 1 shows the infection rates, prevalence rates, and p(STD | 1) for both diseases in the U.S. low-risk and college populations.

Table 1

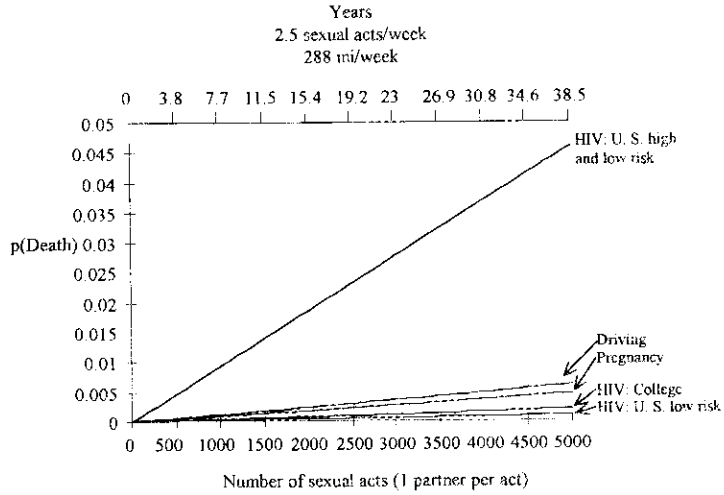
Infectivity Rate, Prevalence Rate, and p(STD | 1 Act) for HIV and Chlamydia in the U.S. Low-Risk and College Population

	Infectivity Rate	Prevalence Rate	p(STD | 1 Act)
U.S. Low-risk			
HIV	.002*	.0001+	.0000002
Chlamydia	.35#	.0024+	.0008
College			
HIV	.002*	.0002$	.0000004
Chlamydia	.35#	.0647&	.022645

*Hearst & Hulley, 1988
+CDC, 1994
#*Note:* This number may be an overestimation because it is not based on a single act of vaginal intercourse (Katz et al., 1990). It is, however, the best estimate to be found.
$Gayle et al., 1990
&Keim et al., 1992

We will only examine HIV infection and pregnancy as risks associated with unprotected vaginal intercourse that carry potentially fatal consequences (we do not examine the mortality rate of ectopic pregnancy and/or pelvic inflammatory disease that is directly attributable to chlamydial infection because of the difficulty of isolating chlamydia as the only source of these conditions). The mortality rate (*MR*) for pregnancy of women ages 20-24 is .00065 (Koonin, Astrash, Lawson, & Smith, 1991). Therefore, the probability of death from pregnancy on any given unprotected act of vaginal intercourse, $p(Death_P \mid 1)$, equals .0000009. Assuming that the mortality rate of HIV is 1.0, the probability of death from HIV on any given unprotected act of vaginal intercourse, $p(Death_H \mid 1)$, equals p(HIV | 1). [Although no one knows whether the mortality rate of HIV infection is 1.0, we make this assumption based on Stine (1993).]

Figure 2. The Probability of Mortality From Pregnancy, HIV (in Both the U.S. Low-Risk and College Populations), and an Automobile Accident



Note: Number of sexual encounters are noted on the bottom axis, and years (assuming one drives 15,000 mi./year and has 2.5 unprotected acts of sexual intercourse per week) are noted at the top of the graph.
As can be seen, one is more likely to die from an automobile accident than from either pregnancy or HIV, when a different partner is assumed for every unprotected sexual encounter. We did not take into account the increased risk of lesions resulting from other STDs, which may affect the probability of contracting HIV. The probability of death from pregnancy on any given sexual encounter is $p(Death_P \mid 1) = FR * FD * PR * MR$. The mortality rate (*MR*) of women ages 20 - 24 is .00065 (Koonin et al., 1991).

Thus, in the U.S. low-risk population, $p(Death_H \mid 1) = .0000002$ and in the college population, $p(Death_H \mid 1) = .0000004$. Although neither fatal outcome is likely, the probability that a woman becomes pregnant and dies from that pregnancy is 4.5 times more likely than contracting HIV in the U.S. low-risk population and 2.25 times more likely than contracting HIV in the college population.

Figure 2 shows $p(Death_H \mid 1)$ for both the U.S. low-risk and college populations and $p(Death_P \mid 1)$ as a function of number of unprotected acts of vaginal intercourse. We also included $p(Death_H \mid 1)$ for the entire U.S. population based on Rosenberg's (1995) prevalence estimate of HIV infection among all 18- to 59-year-olds in the U.S. (0.0047), which includes both high- and low-risk populations. Thus, it represents a worst case scenario ($p(Death_H \mid 1) = .0000094$). To provide a familiar reference to these estimates of risk, we also included in Figure 2 the probability of death from driving accidents (Allman, 1985) during the same time frame (assuming 15,000 miles/year and 2.5 sexual acts/week).

These figures demonstrate that greatest risk associated with unprotected vaginal intercourse in the U.S. low-risk population is pregnancy, followed closely by contracting chlamydia. Indeed, after only 50 unprotected acts of vaginal intercourse with 50 different partners in the U.S. low-risk population, a woman runs a 55% chance of pregnancy and a 5% chance of contracting chlamydia. However, after 50 unprotected acts of vaginal intercourse with 50 different partners, one only has a .001% chance of contracting HIV in the U.S. low-risk population and a .002 % chance of contracting HIV in the college population. Therefore, at the present time HIV represents an unlikely consequence if one chooses a partner who is a non-IDU heterosexual or a college student.

Most sexually active adults do not choose a different partner for each unprotected act of vaginal intercourse,

but instead they engage in serial monogamy or have extended relationships. Therefore, the p(STD | 1) calculated previously is an overestimation of the risk of acquiring an STD on any given unprotected act of vaginal intercourse. Thus, we computed the risk of contracting an STD if one engages in multiple unprotected acts of vaginal intercourse with few partners. We do not present the comparable data for pregnancy because the prevalence rate of fertile adults is .95, which does not appreciably change the probabilities from those just presented.

Serial Monogamy and Extended Relationships

We calculated the risk of contracting either STD if one engages in serial monogamy (100 unprotected acts of vaginal intercourse per partner) or extended relationships (500 unprotected acts of vaginal intercourse per partner). The choice of 100 and 500 unprotected acts of vaginal intercourse was somewhat arbitrary. At an average of 2.5 unprotected acts of vaginal intercourse per week, 100 unprotected acts of vaginal intercourse represent a monogamous sexual relationship of about 9 months. Five hundred unprotected acts of vaginal intercourse represent a monogamous sexual relationship of about 3.75 years.

Figures 3 and 4 show p(chlamydia | N) and p(HIV | N), respectively, as a function of number of unprotected acts of vaginal intercourse (N) with 1, 100, and 500 unprotected acts of vaginal intercourse per partner in both the U.S. low-risk and college populations. These figures demonstrate that the risk of contracting chlamydia from unprotected vaginal intercourse is greatly reduced by restricting sexual activity to a single partner for extended periods of time. Because of the low prevalence rate of HIV, the two monogamous relationship strategies provide a much smaller reduction in the risk of contracting HIV (also see Pinkerton & Abramson, 1993; Reiss & Leik, 1989). Thus, if one chooses a sexual partner from the U.S. low-risk or college populations, relationship strategy has very little effect on the risk of contracting HIV. However, extended relationships may be beneficial because they afford an opportunity to determine one's partner's sexual and drug history more validly.

Figure 3. The Probability of Contracting Chlamydia as a Function of Number of Sexual Acts with 1, 100, and 500 Unprotected Sexual Acts Per Partner in Both the U.S. Low-Risk and College Populations

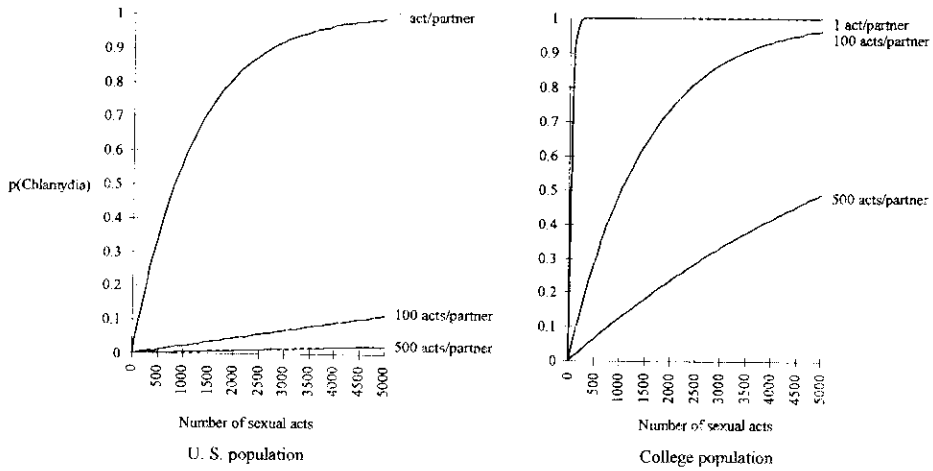
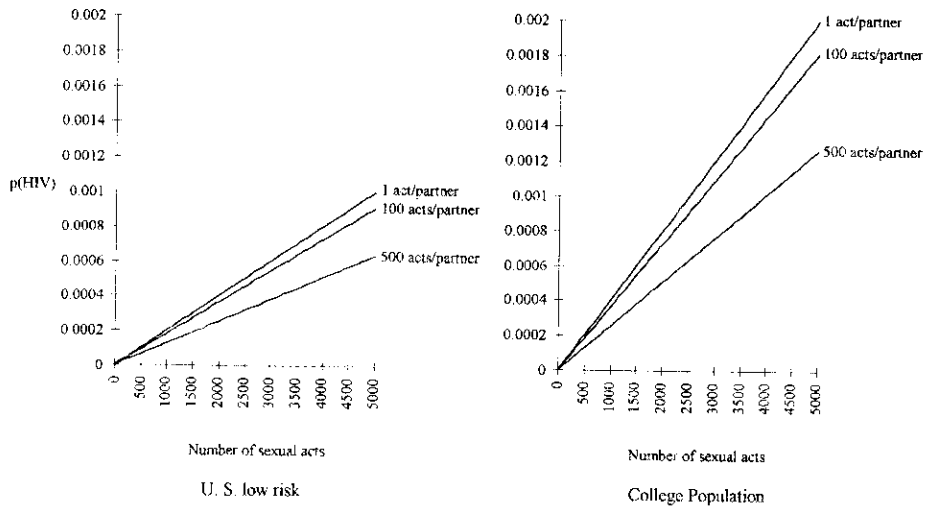


Figure 4. The Probability of Contracting HIV as a Function of Number of Sexual Acts with 1, 100, and 500 Unprotected Sexual Acts Per Partner in Both the U.S. Low-Risk and College Populations



Effects of Condoms

The potential physical risks of sexual intercourse can be reduced through the use of condoms (see Reiss & Leik, 1989). The true efficacy of condoms is not universally accepted; practical failure rates of condoms [i.e., the probability of failure on any single unprotected act of vaginal intercourse: p(CF)] between 100% and 0% have been documented (Cates & Stone, 1992). A typical failure rate of condoms is about 10-12% (Hatcher et al., 1994; Hearst & Hulley, 1988). Thus, condoms offer protection from physical risk on the order of about a degree of magnitude.

Predictions

In the current study we assessed the participants' perceived physical risks associated with unprotected vaginal intercourse. This study allowed us to assess the participants' perceptions of p(HIV | 1), p(chlamydia | 1), condom failure rates [i.e., p(CF)], and condom use strategies for males and females. Given the previous analysis

that showed that HIV infection through unprotected vaginal intercourse between non-IDU heterosexuals is a highly unlikely event, and that HIV infection is a highly publicized topic, we used Tversky and Kahneman's (1974) availability heuristic to make our hypothesis concerning the accuracy of our participants' perceptions of p(STD | 1). According to their model, the judged probability of the occurrence of an event depends on how easily the event is brought to memory. Therefore, this model predicts that salient events (events easily brought to memory) will be overestimated when the actual probability of occurrence is low. Conversely, a high probability event that is not easily brought to memory will be underestimated. The large amount of media attention devoted to the HIV epidemic has probably had the effect of making it a very salient event (e.g., Bennett & Sharpe, 1996). Therefore, we predict that participants will overestimate p(STD | 1), and that this effect will be more pronounced for HIV infection because p(chlamydia | 1) is a more likely event than p(HIV | 1). Although we make no specific predictions, we also examined gender differences and differences based on relationship strategy on p(STD | 1). Again, although we make no predictions, we also assessed the relationship between perceived p(STD | 1) and participants' reported risk-reducing behaviors.

To calculate p(HIV | 1) and p(chlamydia | 1), we asked participants to estimate the STD risk of an opposite-sex person (as opposed to estimating their own risk). This procedure was used to increase the external validity of the study because in real sexual situations one must assess the probability that a *potential sexual partner* has been exposed to an STD before deciding whether to engage in sexual intercourse. One's own infection status is unrelated to the risk of contracting a disease from one's potential partner. Because p(HIV | 1) and p(chlamydia | 1) are parameters describing the transmission rates of the diseases, and these parameters remain constant across individuals (although not across populations), the estimated probabilities should be valid regardless of the individual the participants were asked to assess (including themselves), as long as that individual was from the same population. Finally, we assessed whether the participants' perceptions of these parameters were related to their sexual behavior.

Method

Participants

Two hundred sixty-three participants were recruited from the campus of a mid-sized university in the southeastern United States. Of the 263 participants, 25 participants' data were removed from all analyses for misunderstanding the instructions (described in Results), and data from 5 participants (2 males and 3 females) who indicated that they had sexual encounters with same-gender partners were removed from all analyses. The demographic information for the remaining 233 participants is presented in Table 2. Data from the 16 participants who indicated that they were virgins were removed from all analyses assessing condom use.

Measures

In addition to demographic information, participants were asked to operationalize their perceptions of being at "high risk" by stating the odds (1 in ___) that a hypothetical person of the other gender would actually contract an STD. Participants were then asked to state how many different lifetime sexual partners would be necessary to put this hypothetical person of the other gender at high risk for two STDs: HIV infection and chlamydia. We also asked participants to consider HPV infection (genital warts) but excluded these data because accurate epidemiological data were lacking (HPV is not reportable). In addition, participants were asked to state the number of sexual partners who would place the hypothetical person at high risk for the disease, given the conditions of always and never using condoms. The hypothetical person was called John or Jane Doe and was described as 23 years old.

Participants were also asked several questions about their sexual behavior—including whether they had engaged in sexual intercourse, their age at first intercourse, and with how many different partners they had had intercourse during the last month, during the last year, and over their lifetimes. They were also asked to state with how many of their partners they had discussed their sexual histories before engaging in sexual intercourse for the first time. Participants were also asked to state how many times they had engaged in sexual intercourse during the last month and to state how many of those times had included condom use. Although participants were not asked their drug-use behavior, participants at this university have never reported IV drug-use behavior in similar surveys (Bruce, Pilgrim, & Spivey, 1994). Participants were also asked to describe their sexual partner(s) as only men, almost always men, men or women, almost always women, or only women.

Table 2

Mean (SD) of the Demographic Characteristics of Participants

	Men	Women
Number	106	127
Age	21.43 (3.47)	21.29 (4.62)
% Virgins	0.9	11.8
Age of first intercourse	16.32 (2.24)	16.78 (1.71)
Years sexually active	5.11 (3.44)	4.47 (4.03)
Partners per year	2.06 (2.09)	1.20 (0.89)
# Partners lifetime	12.08 (17.56)	4.76 (5.05)
% Condom use last month	48.59 (46.25)	30.46 (42.74)

Procedure

Female research assistants approached students randomly at different locations on the campus, such as fraternities, sororities, the library, and dining areas. Participants were simply asked if they had time to complete a short survey, and those who agreed were immediately given the one-page survey. The research assistant moved away from the participant to allow privacy. When finished, all participants folded their surveys in half and returned the completed forms to a ballot box to preserve their anonymity.

Results

From the data, we calculated perceived p(STD | 1), perceived p(CF), and the probability that the participants would have contracted an STD, given their sexual history and their perceived p(STD | 1) [termed p(STD | History)]. To calculate the participant's perceived p(STD | 1), we used the following formula (see Appendix A):

$$p(\text{STD} \mid 1) = 1 - ((1 - p(\text{STD} \mid \text{High Risk}))^{(1/NHR)}) \quad 1.1$$

where p(STD | High Risk) is the probability of having an STD if one is considered high risk for the infection (as defined in the survey), and *NHR* is the number of sexual partners one must have before being considered high risk (as defined in the survey).

To calculate the participant's perceived p(CF), we used the following formula:

$$p(\text{CF}) = p(\text{STD} \mid 1)_{\text{always}} / p(\text{STD} \mid 1)_{\text{never}} \quad 1.2$$

where $p(\text{STD} \mid 1)_{\text{always}}$ is the probability of contracting an STD on a single act of vaginal intercourse if one always uses a condom, and $p(\text{STD} \mid 1)_{\text{never}}$ is the probability of contracting an STD on a single act of vaginal intercourse if one never uses a condom.

Because we did not assess each participant's perceived probability of encountering a high-risk sexual partner, for each participant we could only determine a range of values for perceived p(STD | History). p(STD | 1) is a function of infectivity rate (*IR*) and prevalence rate (*PR*). Perceived p(STD | History) is bounded on the high side if we assume that $PR = 1$ and the low side if we assume that $IR = 1$. To calculate the value of perceived p(STD | History), we used the following formula:

$$1 - (1 - (PR * (1 - (1 - IR)^{\text{Acts}}))^{\text{Partners}} \quad 1.3$$

where *Partners* is the number of sexual partners the participant has ever had and acts = ((number of acts of vaginal intercourse in last month * 12) * years active) /partners. If a participant reported no acts of vaginal intercourse in the last month, then acts was set equal to the number of sexual partners. The probability that the participant used a condom was taken into account by adjusting *IR* for the participant's p(CF) for the proportion of acts of vaginal intercourse that the participants used a condom in the last month. The upper bound of perceived p(STD | History) was determined by setting $PR = 1$ and setting $IR = p(\text{STD} \mid 1)$. The lower bound of perceived p(STD | History) was determined by setting $PR = p(\text{STD} \mid 1)$ and setting $IR = 1$. Because the median value of the upper bound of perceived p(STD | History) = 1, the lower bound was used for all analyses. Therefore, our estimate of perceived p(STD | History) could be underestimated.

To assess the effect of the participant's relationship strategy on perceived risk, we categorized participants as engaging in extended relationships (fewer than one sexual partner per year), serial monogamy (between, and including, one and two partners per year), or casual encounters (more than two partners per year).

All participants who indicated that it was easier to acquire an STD with a condom than without were considered to have misunderstood the questions, and their data were not analyzed. Sixteen men's and nine women's data were removed using this criterion. Because p(STD | 1), p(CF), and p(STD | History) were skewed, we transformed the data into ranks. This transformation allowed us to use parametric statistics (Conover & Iman, 1981) with all analyses performed on these ranks. Medians and inter-quartile ranges are presented in the various tables.

Table 3

Median (Inter-Quartile Range) of Females' Assessment of p(STD | 1) by Disease and Relationship Strategy When One Never Uses a Condom

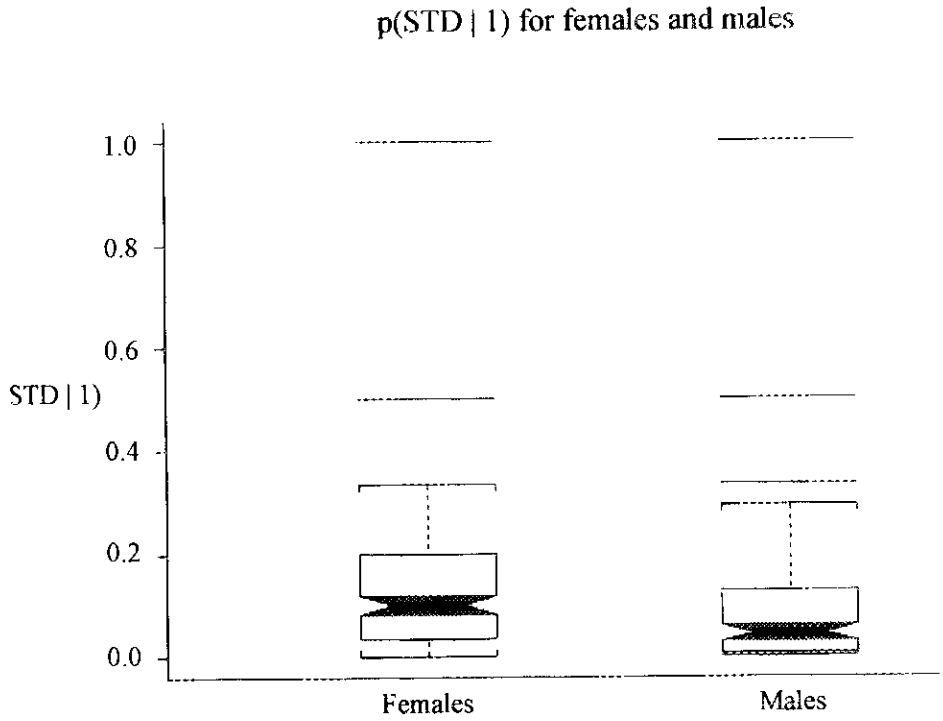
Disease	Relationship Strategy: Extended Relationship	Serial Monogamy	Casual Encounters
HIV	.1 (.19)	.1 (.16)	.11 (.21)
Chlamydia	.1 (.17)	.09 (.17)	.11 (.21)

p(STD | 1)

A three-way ANOVA was used to analyze the differences in p(STD | 1) by disease, gender, and relationship strategy for participants' estimates when a condom was never used. By analyzing the "condom never" condition, we get a measure of p(STD | 1) that does not take into account the benefits of using a condom. Under the heading p(CF), we do examine the perceived benefits of condom use by analyzing p(CF) and its relationship with the other variables.

Gender differences in the participants' perceptions of p(STD | 1) when one never used a condom were significant, $F(1,143) = 9.44$, $p = .003$. Men's perceptions of p(STD | 1) ($Mdn = .044$, $Q = .13$) were lower than women's perceptions ($Mdn = .1$, $Q = .18$) (see Figure 5). There were no other significant main or two-way interaction effects. There was, however, a significant three-way interaction among disease, gender, and relationship strategy, $F(2,141) = 5.81$, $p = .0038$. To determine the pattern of this effect, we ran a two-way ANOVA on disease and relationship strategy for each gender. Men's perceptions of p(STD | 1) were not significantly affected by either disease or relationship strategy. Women's, however, showed a strong

Figure 5. The Distribution of Participants' Perceived p(STD | 1) by Gender



Note: The median is represented by the heavy black line, with the gray notched area representing a rough 95% confidence interval around the median. Fifty percent of the data is contained in the box, and the tails of the distribution are represented by vertical lines capped by a horizontal line. Outliers are represented by horizontal lines completely detached from the box.

trend toward an interaction between disease and relationship strategy, $F(2,79) = 3.02, p = .05$, such that women who engaged in serial monogamy perceived p(chlamydia | 1) as less likely than p(HIV | 1). This effect, however, was minimal (see Table 3). Therefore, this analysis revealed that men perceived a lower likelihood of p(STD | 1) than did women.

p(CF)

A three-way ANOVA was used to analyze the differences in p(CF) by disease, gender, and relationship strategy. No significant effects were found. Both genders perceived the failure rate of condoms to be the same ($Mdn = .25, Q = .25$), regardless of disease or relationship strategy. Restated as condom protection, participants perceive a four-fold reduced risk when condoms are used during sexual intercourse.

The participants' condom use strategies were remarkably consistent. Fifty-one percent of participants did not use a condom during the previous month, whereas 32% always used a condom during that time period. Thus, only 17% of the participants used condoms sporadically. We classified participants into these three groups based on their condom-use practices (always, never, and sporadically). We then ran an ANOVA on p(CF) by this classification. Again, there was no significant effect. In addition, a two-way ANOVA revealed that condom use was not significantly related to either gender or relationship strategy. Finally, there were no significant correlations between condom use and p(STD | 1) or p(CF). Therefore, participants perceived no differential protective value of condom use, given their condom-use practices, relationship strategy, or gender. Furthermore, condom use was not related either to perceived susceptibility to STDs or perceived condom efficacy.

Sexual History

One strategy that may be used to reduce the probability of infection by an STD is to discuss sexual history with one's partner. This strategy is presumed to aid in making a judgment as to whether one's sexual partner engages in high-risk behavior. To assess the use of this strategy, we analyzed the proportion of lifetime partners with whom participants reported discussing sexual histories before engaging in vaginal intercourse, as a function of gender and relationship strategy. There was a main effect of gender, $F(1,175) = 12.44$, $p = .0005$, such that women ($Mdn = .90$, $Q = .60$) discussed sexual histories with their partners more often than men did ($Mdn = .40$, $Q = .67$). There was a main effect of relationship strategy, $F(2,175) = 15.31, p < .0001$. Fisher's *LSD* indicated that those participants in extended relationships ($N = 73$, $Mdn = 1.0$, $Q = .60$) discussed sexual histories with their partners more often than did those practicing serial monogamy ($N = 71$, $Mdn = .60$, $Q = .75$), who in turn discussed sexual histories with their partners more often than did those practicing casual encounters ($N = 37$, $Mdn = .17$, $Q = .32$). There was no interaction between gender and relationship strategy, $F(2,175) = 0.61$, ns. Interestingly, the proportion of lifetime partners that participants reported discussing sexual histories with before vaginal intercourse was uncorrelated with p(STD | 1), $r = .02$, ns.

p(STD | History)

Only those participants (49 men and 56 women) who included all information that was required to determine p(STD | History) were included in the following analysis. Table 5 contains the median and inter-quartile range of the participants' perceived and actual p(STD | History) for each relationship strategy.

A three-way ANOVA was run on the participants' perceived p(STD | History) by disease, gender, and relationship strategy. There was a significant main effect of relationship strategy, $F(2,90) = 5.53, p = .005$. Fisher's *LSD* indicated that the p(STD | History) for the extended relationship group was significantly

Table 4

Median (Inter-Quartile Range) of the Perceived and Actual p(STD | History) for Each Relationship Strategy

		p(STD | History)		
			Actual	
Relationship Strategy	*N*	Perceived	Chlamydia	HIV
Extended relationship	36	.1 (.27)	.125 (.1)	.0001 (.0002)
Serial monogamy	36	.23 (.67)	.28 (.33)	.00004 (.0002)
Casual encounters	24	.61 (.87)	.666 (.56)	.00007 (.0002)

lower than that of the serial monogamy and casual encounters groups (see Table 4). No other significant effects were found. Therefore, participants perceived themselves to be at the same risk for both HIV and chlamydia, and they perceived their risk to increase with increased numbers of sexual partners.

A three-way ANOVA was also used to analyze the participants' actual p(STD | History) by disease, gender, and relationship strategy. To compute the probability of infection given the participant's sexual history, we used the infectivity and prevalence rates for the college population because we tested college students. There was a significant main effect of relationship strategy, $F(2,112) = 6.15$, $p = .003$. Fisher's *LSD* indicated that the p(STD | History) for the casual encounters group was significantly higher than that of the serial monogamy and extended relationship groups (see Table 4). There was also a significant main effect of disease, $F(1,112) = 2145.35$, $p < .0001$. Participants had a higher risk of contracting chlamydia ($Mdn = .075$, $Q = .13$) than HIV ($Mdn = .00006$, $Q = .002$). Finally, a significant interaction between disease and relationship strategy was found, $F(2,112) = 30.23$, $p < .0001$. Fisher's *LSD* indicated that p(HIV | History) was greatest for the extended relationships group, whereas the p(chlamydia | History) was least for the extended relationship group (see Table 4). This is a result of the higher average number of acts of vaginal intercourse the extended relationship group participants had compared to the serial monogamy group. Because of the low prevalence of HIV in the population, a few unprotected acts of vaginal intercourse with a few partners is not as risky as many unprotected acts of vaginal intercourse with a single partner.

To assess whether participants' perceived risks were different from their actual risks, paired sample *t*-tests were computed for each disease by relationship strategy (see Table 4). Participants' perceived estimates were not significantly different than the actual estimates for the risk of contracting chlamydia for all relationship strategies (all $ts < 1.15$, ns). Participants' perceived estimates were significantly greater than the actual estimates for the risk of contracting HIV for all relationship strategies (all $ts > 4.65$, $p < .001$).

Discussion

We calculated participants' perceived probability of contracting an STD by assessing the various individual components needed for that calculation. The advantage of this technique over the risk-classification technique is that participants were making probability decisions about a hypothetical partner similar to those made in a real sexual situation (e.g., assessing a potential sexual partner's sexual history, the prevalence of HIV in that population). Thus, these estimates may have a high degree of ecological validity. The disadvantage of this technique is that it does not assess "personal invulnerability" or "optimistic bias" (i.e., the notion that individuals believe that they are more immune to negative consequences than others; Weinstein, 1989). The studies that demonstrate a "personal invulnerability" component assess the participants' perceived probability that they have contracted or will contract the disease (e.g., Gerrard & Warner, 1994; Gladis et al., 1992; Hansen et al., 1990). These assessments are contaminated by the participants' appraisals of the effectiveness of their risk-reducing behaviors (e.g., trusting their instincts about the risk category of their partner). Thus, these assessments are not pure estimates of perceived p(STD | 1); the current study obtains such a measure.

Not surprisingly, our data suggest that participants have misconceptions about STDs. These misconceptions manifested themselves in several important ways. First, participants' perceived p(STD | 1) was unaffected by disease. Although the participants' estimates were correct when assessing the probability of contracting chlamydia, they were strongly inflated when assessing the probability of contracting HIV. Students did not seem to understand that each disease is unique in its transmission and prevalence rates. Second, men's perceived p(STD | 1) was lower than that of women's. This result cannot be attributed to the fact that men truly are at less risk for the STD, because men were judging the risk of a hypothetical woman contracting the disease. This implies that the gender differences are related to variables other than STD education. Finally, participants perceived that condoms fail in one out of every four uses. Although this is a high failure rate compared to norms discussed earlier, we have no way of assessing whether it is the practical failure rate encountered by students (given their experiences).

Our primary interest was whether participants overestimated the probability of HIV infection through unprotected vaginal intercourse. The data reveal that participants overestimate the objective risk of college students by more than 100,000 times the objective risk (i.e., five orders of magnitude). If we use Rosenberg's (1995) prevalence estimates for the entire U.S. population, participants overestimate the objective risk by more than 10,000 times the objective risk (i.e., four orders of magnitude).

If we assume that the prevalence of HIV infection in the entire U.S. population is 1.0 and a condom is not used (i.e., 1 in 500, Hearst & Hulley, 1988), our participants still overestimate the probability of contracting HIV infection by more than 10 times this hypothetical risk (i.e., one order of magnitude). Thus, our participants overestimated the risk of HIV infection through unprotected vaginal intercourse using both reasonable and unreasonable prevalence estimates.

If we assume that our participants' actual risk is similar to that of other heterosexual samples from a college population, our participants' overestimation of their risk of contracting HIV is not unique in the AIDS literature. Researchers have, however, presented their participants' estimates of HIV infection as deflated (e.g., Gerrard & Warner, 1994; Hansen et al., 1990; Mickler, 1993). For example, Mickler (1993) found that participants estimate their risk of HIV infection to be about 8% (compared to the highest estimation of our participants' actual risk of .0001%). She implied that the 8% estimate was low when she stated, "The target audience must be convinced that they, too, are vulnerable to HIV infection" (p. 52). Furthermore, because her participants' estimations of a hypothetical other's risk of HIV infection were greater than their own, she concluded that her participants have a perceived sense of invulnerability. Similarly, Hansen et al. (1990) stated that their participants' estimate of a 1 in 1,000,000 chance of having HIV was a "significant denial of one's own risk of getting AIDS" (p. 626). Indeed, Hansen et al.'s participants' 1 in 1,000,000 estimate was accurate, and Mickler's participants' 8% estimate was inflated. These incorrect conclusions concerning participants' risk denial underscore the need for researchers to attempt to estimate their participants' risk of HIV infection based on epidemiological estimations of actual risk.

Our participants' overestimations of the risk of contracting HIV on any single unprotected act of vaginal intercourse is consistent with a prediction that takes into account Tversky and Kahneman's (1974) availability heuristic. This model predicts that the judged probability of a low-occurrence event depends on the salience of that event. For non-IDU heterosexuals, HIV infection through unprotected vaginal intercourse is both a highly salient and low-probability event. Therefore, this model correctly predicts that participants should overestimate its occurrence. However, our participants were accurate when they estimated p(chlamydia | 1). This may be because chlamydial infection is a more likely event and, perhaps, a less salient event.

Our students' inflated perception of the risk of contracting HIV did not translate into risk-reduction behavior. Neither condom use, relationship strategy, nor the proportion of lifetime partners with whom participants reported discussing sexual histories before vaginal intercourse was correlated with either p(STD | 1) or p(CF). Thus, if one accepts these measures as valid indices of risk-reduction behavior, one should conclude that the current perceived HIV- and chlamydial-specific risks associated with unprotected vaginal intercourse play a minor role at best in influencing current risk-reduction behavior. This may not be surprising for HIV risk because the federal government's "America responds to AIDS" campaign may have increased non-IDU heterosexuals' perceptions of HIV risk beyond epidemiological estimates of actual risk (Bennett & Sharpe, 1996). Therefore, the high-risk estimates that we collected may represent a truncated range that reduces the correlation between perceived risk and all other variables. In addition, condom use may be influenced by other perceived risks such as human papilloma virus infection and pregnancy.

Although other researchers have found little or no relationship between perceptions of HIV risk and risk-reduction behaviors (for review, see Gerrard, Gibbons, & Bushman, 1996), their findings may be suspect because the researchers assessed personal susceptibility (e.g., one's perception that he or she will contract HIV infection over an extended period of time). Weinstein and Nicolich (1993) have shown that because perceived personal susceptibility and one's risk-reducing behavior may influence each other, the correlation between these two variables is not static over time. That is, if one perceives that his or her personal susceptibility is high, he or she may change his or her behavior, which in turn will reduce perceived personal susceptibility. Our study, in contrast, assessed a population parameter, p(STD | 1). This parameter represents the likelihood of contracting an STD from a single, well-specified act. Although p(STD | 1) may influence behavior, it cannot be influenced by behavior change (both past and future). That is, engaging in risk-reducing behavior should not change one's perceived probability of contracting HIV on any single unprotected act of vaginal intercourse. Thus, our assessment of the relationship between perceived risk and risk-reducing behavior offers an alternative measure that should lessen the likelihood of the problematic issues discussed by Weinstein and Nicolich (1993), and more recently by Gerrard et al. (1996).

Generally, participants' actual risks of contracting STDs were as expected. Participants showed a high probability of contracting chlamydia and a minimal risk of contracting HIV. This is the pattern of results one would predict, given the prevalence of these diseases in college populations. Interestingly, participants engaging in extended relationships had a greater risk of contracting HIV than those engaging in either serial monogamy or casual encounters. This is the result one would expect, given both the low prevalence of HIV and the high rate of unprotected sexual intercourse between partners in extended relationships (Pinkerton & Abramson, 1993). As can be seen in Figure 4, relationship strategy is only minimally related to p(HIV).

Implications

What can we conclude from these results? First, and most telling, is that participants are not underestimating the probability of contracting HIV infection. Indeed, participants' perceived p(HIV | 1) is more than 100,000 times greater than the actual p(HIV | 1). This may not be surprising, given the recent reports that the federal government's "America responds to AIDS" campaign exaggerated the prevalence of HIV infection in the U.S. general population, rather than target individuals who were engaging in known high-risk behavior (Bennett & Sharpe, 1996). Our data indicate that the "it can happen to you" message may have been effective at inducing high perceptions of susceptibility, but these attitudes are not correlated with risk-reduction behavior. Therefore, high perceived risk may have reached the limits of its influence on risk-reducing behavior. To influence risk-reducing behavior further, educators should consider expanding their message beyond the traditional "it can happen to you." Further research is needed to clarify what specific approaches may elicit risk-reduction behavior change.

Second, the risk of contracting HIV is very low if both sexual partners are non-IDU heterosexuals. The low prevalence rate, together with the difficulty of transmission, combine to reduce the risk of contraction. Understanding this allows educators to discriminate between effective and ineffective risk-reducing behaviors. For example, our data show that simply limiting the number of one's sexual partners is an ineffective risk-reducing behavior: Those with the highest probability of contracting HIV were those who practiced extended relationships (a result of the high number of acts of vaginal intercourse; see also Pinkerton & Abramson, 1993). Educators who espouse limiting the number of one's sexual partners alone as an effective risk-reducing behavior may provide a false sense of security to their students. This conclusion is based on non-IDU heterosexual populations. Assessing one's partner's sexual and drug history can substantially reduce the probability of unknowingly engaging in risky sexual behavior with a partner who is infected with HIV [e.g., compare risks based on Rosenberg's (U.S. high- and low-risk) and Hearst and Hulley's (U.S. low-risk) estimates in Figure 2].

Claims that the probability of HIV infection is high for unprotected vaginal intercourse with non-IDU heterosexual partners could have disastrous effects in the future. In a recent article in *Science*, Cohen (1995) reported that different HIV strains exist. The HIV strain found in the U.S. and Europe, termed HIV-1B, has a low infectivity rate through unprotected vaginal intercourse (the strain analyzed in this article). Importantly, the HIV strain found in Asia and Africa, termed HIV-1E, may have a high infectivity rate through unprotected vaginal intercourse (as a result of the virus' propensity to multiply in Langerhans' cells found in the vagina and penile foreskin). The HIV-1B epidemic is reported to be plateauing or decreasing, whereas the HIV-1E epidemic is reported to be increasing. If researchers or educators "cry wolf" by exaggerating the risk of contracting HIV-1B currently, the public may discount the researchers' future estimates of contracting HIV-1E as exaggerations when it migrates to the U.S. and Europe.

There are limitations to our findings. We used a probabilistic model to determine risk. We did not take into account such factors as ethnicity, geographic locations, etc. Furthermore, our model using the U.S. low-risk population prevalence assumes that one can determine whether one's partner is a non-IDU heterosexual. One may debate whether this assumption is valid. Although these factors may influence the results slightly, they would not alter the conclusion. Our participants overestimated the risk of contracting HIV on a single unprotected act of vaginal intercourse by a factor of 100,000 (more than 5 orders of magnitude). Our participants' estimations were inflated even when compared to a situation in which a partner is known to be HIV seropositive and a condom is not used (i.e., 1 in 500, Hearst & Hulley, 1988). Thus, the accuracy of our model is not a factor in the conclusion that participants overestimate the probability of contracting HIV infection. In addition, we did not assess our participants' needle-sharing behavior. Although this behavior could increase our participants' likelihood of HIV infection, we were primarily concerned with assessing participants' perceived risk of HIV infection and chlamydia associated with vaginal intercourse. It would be beneficial for researchers to address participants' perceived likelihood of contracting HIV from needle sharing.

The probability of contracting HIV infection through unprotected vaginal intercourse in the non-IDU heterosexual population is small. Researchers have concluded that participants underestimate their risk of HIV infection. These conclusions were based on comparisons between the participants' estimates of their risk and the participants' estimates of another's risk. However, the current study shows that participants overestimate the perceived risk of HIV infection when compared to objective risk. Although our model of HIV transmission predicted a very low probability of infection through vaginal intercourse, we do not advocate unprotected vaginal intercourse with multiple partners. Our model of the U.S. low-risk population assumed that one can determine whether one's partner is a non-IDU heterosexual (no such assumption was made for the model of the college population). This is probably not possible if one has sexual intercourse with casual acquaintances who may not accurately disclose their sexual and drug-use history (e.g., Cochran & Mays, 1990). Similarly, we are not suggesting that HIV infection for non-IDU heterosexuals is so unlikely that it is an unimportant health risk. For persons aged

25-44, HIV infection is currently the number one cause of death for men and the number four cause of death for women (National Centers for Health Statistics, 1994). Thus, it is a major health risk for a relatively healthy young population. As its prevalence increases (or HIV-1E migrates to the U.S.), so will the p(HIV | 1). Therefore, it is a health risk of great importance, and it would be irresponsible not to devote resources to the search for a cure, vaccination, and effective educational practices.

References

Allman, W. F. (October, 1985). We have nothing to fear. *Science 85, 6,* 38-41.

Bauman, L. J., & Siegel, K. (1987). Misperceptions among gay men of the risk for AIDS associated with their sexual behavior. *Journal of Applied Social Psychology, 17,* 329-350.

Bennett, A., & Sharpe, A. (1996, May 1). AIDS fight is skewed by federal campaign exaggerating risks. *The Wall Street Journal,* pp. A1, A6.

Bruce, K. E., & Moineau, S. (1991). A comparison of STD clinic patients and undergraduates: Implications for AIDS prevention. *Health Values, 15,* 5-12.

Bruce, K. E., Shrum, J. C., Trefethen, C., & Slovik, L. F. (1990). Students' attitudes about AIDS, homosexuality, and condoms. *AIDS Education and Prevention, 2,* 220-234.

Bruce, K. E., Pilgrim, C. A., & Spivey, R. L. (1994). Assessing the impact of Magic Johnson's HIV positive announcement on a university campus. *Journal of Sex Education and Therapy, 20,* 264-276.

Catania, J. A., Stone, V., Binson, D., & Dolcioni, M. M. (1995). Changes in condom use among heterosexuals in Wave 3 of the AMEN survey. *The Journal of Sex Research, 32,* 193-200.

Cates, W., & Stone, K. M. (1992). Family planning, sexually transmitted diseases and contraceptive choice: A literature update-part 1. *Family Planning Perspectives, 24,* 75-84.

Centers for Disease Control. (1995). First 500,000 AIDS cases--United States, 1995. *Morbidity and Mortality Weekly Report, 44*(46), 849-853.

Centers for Disease Control, Division of STD/HIV Prevention. (1994). *Sexually Transmitted Disease Surveillance, 1993.* U.S. Department of Health and Human Services, Public Health Service. Atlanta: Centers for Disease Control and Prevention.

Cochran, S. D., & Mays, V. M. (1990). To the editor: Sex, lies, and HIV. *The New England Journal of Medicine, 322,* 774-775.

Cohen, J. (1995). Differences in HIV strains may underlie disease patterns. *Science, 270,* 30-31.

Conover, W. J., & Iman, R. L. (1981). Rank transformations as a bridge between parametric and nonparametric statistics. *The American Statistician, 35,* 124-129.

DiClemente, R. J., Forrest, K. A., & Mickler, S. (1990). College students' knowledge and attitudes about AIDS and changes in HIV-preventive behaviors. *AIDS Education and Prevention, 2,* 201-212.

Fishbein, M., & Middlestadt, S. E. (1989). Using the theory of reasoned action as a framework for understanding and changing AIDS-related behaviors. In V. M. Mays, G. W. Albee, & S. F. Schneider (Eds.), *Primary prevention of AIDS: Psychological approaches* (pp. 93-110). Newbury Park, CA: Sage.

Fisher, J. D., & Miscovich, S. J. (1990). Evolution of the college students' AIDS-related behavioral responses, attitudes, knowledge, and fear. *AIDS Education and Prevention, 2,* 322-337.

Fisher, W. A., Fisher, J. D., & Rye, B. J. (1995). Understanding and promoting AIDS-preventive behavior: Insights from the theory of reasoned action. *Health Psychology, 14,* 255-264.

Fumento, M. (1990). *The myth of heterosexual AIDS.* New York: Basic Books.

Gayle, H. D., Keeling, R. P., Garcia-Tunon, M., Kilbourne, B. W., Narkunas, J. P., Ingram, F. R., Rogers, M. F., & Curran, J. W. (1990). Prevalence of the human immunodeficiency virus among university students. *The New England Journal of Medicine, 323,* 1538-1541.

Gerrard, M., Gibbons, F. X., & Bushman, B. J. (1996). Relation between perceived vulnerability to HIV and precautionary sexual behavior. *Psychological Bulletin, 119,* 390-409.

Gerrard, M., Gibbons, F. X., & Warner, T. D. (1991). Effects of reviewing risk-related behavior on perceived vulnerability among women marines. *Health Psychology, 10,* 173-179.

Gerrard, M., Gibbons, F. X., Warner, T. V., & Smith, G. E. (1993). Perceived vulnerability to HIV infection and AIDS preventive behavior: A critical review of the evidence. In J. B. Pryor & G. D. Reeder (Eds.), *The social psychology of HIV infection* (pp. 59-84). Hillsdale, NJ: Lawrence Erlbaum.

Gerrard, M., & Warner, T. D. (1994). Comparison of marine and college women's HIV/AIDS-relevant sexual behaviors. *Journal of Applied Social Psychology, 24,* 959-980.

Gladis, M. M., Michela, J. L., Walter, J. L., & Vaughan, R. D. (1992). High school students' perceptions of AIDS risk: Realistic appraisal or motivated denial. *Health Psychology, 11,* 307-316.

Hansen, W. B., Hahn, G. L., & Wolkenstein, B. H. (1990). Perceived personal immunity: Beliefs about susceptibility to AIDS. *The Journal of Sex Research, 27,* 622-628.

Hatcher, R. A., Trussell, J., Stewart, F., Stewart, G. K., Kowal, D., Guest, F., Cates, W., & Policar, M. S. (1994). *Contraceptive technology* (16th rev. ed.). New York: Irvington.

Hearst, N., & Hulley, S. (1988). Preventing the heterosexual spread of AIDS: Are we giving our patients the best advice? *Journal of the American Medical Association, 259,* 2428-2432.

Janz, N. K., & Becker, M. H. (1984). The health belief model: A decade later. *Health Education Quarterly, 11,* 1-47.

Katz, B. P., Caine, V. A., & Jones, R. B. (1990). Estimation of transmission probabilities for chlamydial infection. In International Symposium on Human Chlamydial Infections (Eds.), *Chlamydial infections: Proceeds of the seventh international symposium on human chlamydial infections* (pp. 567-570). New York: Cambridge University Press.

Keim, J., Woodard, M. P., & Anderson, M. K. (1992). Screening for *Chlamydia trachomatis* in college women on routine gynecological exams. *Journal of American College Health, 41,* 17-23.

Kline, A., & Strickler, J. (1993). Perceptions of risk for AIDS among women in drug treatment. *Health Psychology, 12,* 313-323.

Koonin, L. M., Astrash, H. K., Lawson, H. W., & Smith, J. C. (1991). Maternal mortality surveillance, United States, 1979-1986. *Morbidity and Mortality Weekly Report, 40,* 1-13.

Laumann, E., Michael, R., Michaels, S., & Gagnon, J. (1994). *The social organization of sexuality.* Chicago: University of Chicago Press.

Lee, H. (1989). Genital chlamydial infection in female and male college students. *Journal of American College Health, 37,* 288-291.

Mickler, S. E. (1993). Perceptions of vulnerability: Impact on AIDS-preventive behavior among college adolescents. *AIDS Education and Prevention, 5,* 43-53.

Mosher, W. D. (1988). Fecundity and infertility in the United States. *American Journal of Public Health, 78,* 181-182.

National Center for Health Statistics. (1994). Annual summary of births, marriages, divorces, and deaths: United States, 1993. *Monthly Vital Statistics Report, 42*(13), 18-20.

Pinkerton, S. D., & Abramson, P. R. (1993). Evaluating the risks. A Bernoulli process model of HIV infection and risk reduction. *Evaluation Review, 17,* 504-528.

Pinkerton, S. D., & Abramson, P. R. (1992). Is risky sex rational? *The Journal of Sex Research, 29,* 561-568.

Reiss, I. L., & Leik, R. K. (1989). Evaluating strategies to avoid AIDS: Number of partners vs. use of condoms. *The Journal of Sex Research, 26,* 411-433.

Rosenberg, P. S. (1995). Scope of the AIDS epidemic in the United States. *Science, 270,* 1372-1375.

Stine, G. J. (1993). *Acquired Immune Deficiency Syndrome.* Englewood Cliffs, NJ: Prentice Hall.

Symons, D. (1993). How risky is risky sex? *The Journal of Sex Research, 30,* 344-346.

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science, 185,* 1124-1131.

van der Pligt, J., Otten, W., Richard, R., & van der Velde, F. (1993). Perceived risk of AIDS: Unrealistic optimism and self-protective action. In J. B. Pryor & G. D. Reeder (Eds.), *The social psychology of HIV infection* (pp. 39-58). Hillsdale, NJ: Lawrence Erlbaum.

van der Velde, F. N., van der Plight, J., & Hooykaas, C. (1994). Perceiving AIDS-related risk: Accuracy as a function of differences in actual risk. *Health Psychology, 13,* 25-33.

Weinstein, N. D. (1989). Perceptions of personal susceptibility to harm. In V. M. Mays, G. W. Albee, & S. F. Schneider (Eds.), *Primary prevention of AIDS: Psychological approaches* (pp. 142-167). Newbury Park, CA: Sage.

Weinstein, N. D., & Nicolich, M. (1993). Correct and incorrect interpretations of correlations between risk perceptions and risk behaviors. *Health Psychology, 12,* 235-245.

Appendix A

The following is the derivation of formula 1.1. The derivation assumes a single unprotected act of vaginal intercourse per sexual partner. Although this may overestimate p(STD | 1), the estimates are probably accurate within an order of magnitude (i.e., 10 times the original value). This degree of error has no impact on the conclusions, because our participants overestimated p(HIV | 1) by over 100,000 times the objective risk. In addition, this error may be offset in our calculation of p(STD | History) because we used the most conservative calculation for that formula.

The following formula estimates the probability of getting an STD given NHR acts of vaginal intercourse with NHR different people:

$$p(\text{STD} \mid \text{NHR}) = 1 - ((1-p(\text{STD} \mid 1))^{\text{NHR}})$$

where *NHR* is the number of partners to be considered at High Risk (also equivalent to "High Risk" in the text). To derive this, we took the probability of not getting an STD given a single act of vaginal intercourse to the power of NHR. This equals the probability of not getting an STD given NHR acts of vaginal intercourse with NHR different people. We then subtracted this from one to get the probability of getting an STD given NHR acts of vaginal intercourse with NHR different people. Finally, we solved for p(STD | 1):

$$1 - p(\text{STD} \mid \text{NHR}) = (1-p(\text{STD} \mid 1))^{\text{NHR}}$$

$$(1 - p(\text{STD} \mid \text{NHR}))^{1/\text{NHR}} = 1-p(\text{STD} \mid 1)$$

$$1 - ((1 - p(\text{STD} \mid \text{NHR}))^{1/\text{NHR}}) = p(\text{STD} \mid 1)$$

Manuscript accepted November 4, 1996