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ORIGINAL RESEARCH ARTICLE

All STDs are not created equal: an analysis of the differential effects of sexual behaviour changes on different STDs

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Summary: The same sexual behaviours that transmit HIV are implicated in the transmission of certain other STDs, including chlamydia, gonorrhoea, and syphilis. Consequently, it is often assumed that preventive methods that are effective against HIV should be equally effective against other STDs. The purpose of this study was to examine this assumption. We applied a mathematical model of HIV/STD transmission to empirical data from a large HIV prevention intervention that stressed sexual behaviour change. We modelled the effects of two behavioural strategies—reducing the number of sex partners and increasing condom use—on the proportionate change in intervention participants' cumulative risk of acquiring HIV or a highly-infectious STD, such as gonorrhoea. The results of this modelling exercise indicate that decreasing the number of partners is a more effective strategy for reducing STD risk than it is for HIV risk. In contrast, condoms are somewhat more effective at reducing the cumulative transmission risk for HIV than for highly infectious STDs. The protection provided by condoms for multiple acts of intercourse critically depends on the infectiousness of the STD. The results of this study suggest caution in extrapolating from one STD to another, or from one behavioural risk reduction strategy to another.

Keywords: sexual behaviour, transmission, prevention

'In the beginning, God created the heavens, the earth, man and venereal diseases'—Philippe Ricord, 19th-century venerealogist

The same sexual behaviours that transmit the human immunodeficiency virus (HIV) are implicated in the transmission of certain other sexually transmitted diseases (STDs), such as chlamydia, gonorrhoea, and syphilis. Consequently, it is often assumed that preventive methods that are effective against HIV should be equally effective against other STDs, and *vice versa*[1]. This assumption is the basis for proposals to use non-HIV STDs as surrogate markers for HIV infection when evaluating the effectiveness of HIV prevention interventions that help participants change the sexual behaviours that place them at risk of infection[2,3]. The underlying premise is that if participants increase their condom use or take other steps to reduce their HIV risk, then these same behavioural changes will also reduce their risk of STD infection, as reflected in observed STD incidence rates. Conversely, it has been argued that the lack of a noticeable change in STD rates would suggest that the intervention was not effective[4].

But do different behavioural risk reduction strategies have equivalent effects on different STDs, or are some behavioural changes more effective at reducing risk for HIV, say, than for gonorrhoea? Individuals can decrease their HIV or STD risk in any of a number of ways, including using condoms more frequently, reducing the number of sex partners, having sex less often, or substituting less risky activities for more risky ones[5]. The effectiveness of these strategies in reducing STD transmission may depend upon the epidemiological characteristics of the particular STD. For example, reducing the number of sex partners may be especially effective at decreasing

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the risk of acquiring a highly-infectious STD such as gonorrhoea, but relatively less effective against HIV, which is much less easily transmitted.

To gain further insight into the relationship between behavioural risk reduction strategies—specifically, using condoms more frequently or decreasing the number of sex partners—and changes in the risk of acquiring different STDs, including HIV, we applied a mathematical model of HIV/STD transmission to data from a large, randomized HIV prevention intervention trial[6]. For each intervention participant, we estimated the proportion reduction (or increase) in HIV risk and risk for infection with a highly infectious STD. We compared individuals who changed condom use with those who changed the number of sex partners, and examined how these behavioural changes affected their HIV and STD risk. The results of this analysis suggest that the consequences of behavioural risk reduction strategies are not uniform across STDs, and therefore caution is needed in extrapolating from one STD to another, or from one behavioural change strategy to another.

Methods

To illustrate how different sexual behaviour changes—in particular, changes in condom use or changes in the number of sex partners—differentially affect the risk of acquiring HIV or a highly infectious STD, sexual behavioural data from the Project Light HIV prevention intervention[6,7] were converted into HIV and STD risk estimates using a mathematical model of HIV/STD transmission. In the model, the only difference between HIV and the STD is that HIV is assumed to be much more resistant to transmission, as described below. Here we briefly describe the source of the behavioural data, the HIV/STD transmission model, and the parameter estimates used in the analyses.

Behavioural data

The Project Light intervention trial was conducted at seven US sites, beginning in 1989[6,7]. High-risk participants, 74% of whom self-identified as African–American, were recruited from sexually transmitted disease clinics, primary care clinics, and other health service organizations. Participants received either a seven-session, small-group risk reduction counselling programme that emphasized motivation, skills, and self-efficacy related to HIV risk reduction, or a control intervention that consisted of a single, one-hour AIDS education session in which participants viewed a videotape on HIV prevention and engaged in a question and answer exchange[6,7]. Sexual behaviour surveys were administered at baseline and 3, 6, and 12 months after the conclusion of the intervention. The surveys asked participants about their sexual behaviours in the preceding 3-month period, eliciting information about the number of partners with whom they had sex, the number of acts of intercourse, and the use of condoms.

The present analysis focuses on the baseline and 12-month follow-up data, and excludes individuals for whom 12-month follow-up information was unavailable. We also excluded all participants who reported being abstinent at either baseline or follow-up (this was necessary because condom use is undefined for abstinent persons). Finally, because the purpose of this analysis is to examine how behavioural changes affect HIV/STD risks, we excluded participants whose behaviour was identical at the two time-points. Because this analysis is concerned only with the interaction between behavioural changes and HIV/STD risk, no distinction was drawn between participants in the seven-session intervention and those who received the video-based intervention. The final sample included 1604 women and 984 strictly heterosexual men (i.e. men who only had sex with women), which represents 74.9% of the 2142 women and 62.9% of the 1564 men who participated in the Project Light intervention trial[6]. Table 1 summarizes the sexual behaviour data for participants included in the final sample.

Mathematical modelling

A mathematical model of STD/HIV transmission was used to translate intervention participants' self-reported sexual behaviours into estimates of their HIV and STD risk at baseline and 12-month follow-up[8,9]. For HIV or a particular STD, the cumulative probability (risk) of infection for someone who engages in n acts of unprotected vaginal intercourse and k acts of protected vaginal intercourse with each of m partners is approximately

$$P = 1 - \{(1 - \pi) + \pi(1 - \alpha)^n(1 - (1 - \phi)\alpha)^k\}^m, \quad (1)$$

where π is the prevalence of infection among the sex partners, α is the per-act transmission probability ('infectivity') of unprotected vaginal intercourse,

Table 1. Mean sexual behaviour data for three-month recall period

		Baseline			Follow-up		
	n	Partners	Sex acts	Condom use (%)	Partners	Sex acts	Condom use (%)
Women	1604	2.5	29.9	17.6	1.6	26.7	35.1
Men	984	4.6	35.5	23.7	2.2	28.5	42.2

and ϕ denotes the effectiveness of condoms in preventing HIV/STD transmission. (In the present analysis, all acts of anal intercourse—less than 4% of the total number of acts of intercourse—were recoded as vaginal intercourse due to the paucity of anal intercourse infectivity estimates for STDs other than HIV. Men who reported sex with other men were excluded from the analysis for the same reason.) Separate HIV and STD risk estimates were calculated, using Equation 1, for sexual behaviours reported at baseline and follow-up; these risk estimates are denoted H_0, H_{12}, S_0, and S_{12}, respectively.

For the purposes of the present analysis, which examines how changes in behaviour affect STD risk, it does not matter whether those changes increase risk or decrease risk. Therefore, we wanted a measure of risk change that treats increases and decreases in risk equivalently. Moreover, in order to compare the effectiveness of different behavioural risk reduction strategies across STDs (including HIV) with widely varying transmission risks, a relative measure of risk change was needed[10]. Thus, for each intervention participant, we calculated the 'proportionate STD risk change,' defined as

$$(S_0 - S_{12})/S_0 \text{ if } S_0 \geqslant S_{12} \text{ or } (S_{12} - S_0)/S_{12} \text{ if } S_0 \leqslant S_{12}, \quad (2)$$

where S_0 is the baseline STD infection risk and S_{12} is the risk at follow-up (see Equation 1). The 'proportionate HIV risk change' was defined analogously as

$$(H_0 - H_{12})/H_0 \text{ if } H_0 \geqslant H_{12} \text{ or } (H_{12} - H_0)/H_{12} \text{ if } H_0 \leqslant H_{12}, \quad (3)$$

where H_0 and H_{12} are the baseline and follow-up HIV infection risks, respectively.

The proportionate risk change, which is a number between 0 and 1, represents the amount by which the participant's risk has changed, as a proportion of the larger risk value. Thus, a proportionate risk change of 0.5 indicates that the intervention participant either decreased his or her risk by 50% from baseline to follow-up, or decreased risk by 50% 'from' follow-up 'to' baseline. Because it assesses each participant's change in risk relative to his or her own baseline (or follow-up) risk, the proportionate risk change measure provides a common scale upon which to evaluate the impact of behavioural changes across participants with very different risk levels; it thereby prevents high-risk outliers from skewing the results. In this formulation, a reduction in risk from 0.05 to 0.02 is equivalent to a reduction from 0.5 to 0.2.

Parameter values

The per-act infectivity of HIV for receptive (male-to-female) intercourse was set to 0.001 and the infectivity for insertive (female-to-male) intercourse was set to 0.0006[11–14]. The present analysis mainly contrasts HIV (a low infectivity pathogen) with a highly infectious STD, such as gonorrhoea. We set the infectivity of the STD to 0.2 for receptive intercourse and 0.1 for insertive intercourse. For purposes of comparison, the per-act infectivity of symptomatic gonorrhoea probably exceeds 0.2, whereas the infectivities of syphilis, chlamydia, and hepatitis B are thought to lie between 0.005 and 0.1[15–18].

An estimated 2% of high-risk heterosexuals in major US metropolitan areas are infected with HIV[19]. The base-case analysis assumed a 2% prevalence of HIV and STD infection among intervention participants' sex partners. As shown below, the results of the analyses are not especially sensitive to assumptions about the prevalence of HIV and STD. In particular, the main results would be unchanged if the prevalence of HIV were one-tenth the base-case value or smaller.

Sexual behaviour information was obtained from the surveys administered at baseline and 12-month follow-up, as noted above. Participants were classified as having 'changed' condom use if the difference in baseline and follow-up condom use rates was at least 10%. This was done to ensure that only meaningful changes in condom use were counted, and to exclude relatively insignificant differences, such as a change from using condoms for eight out of 20 acts of intercourse to nine of 20. (The arbitrarily-selected 10% condom use threshold was varied in the sensitivity analyses to assess whether this choice of threshold values affected the main findings of the study.) Condoms were assumed to be 90% effective, on a per-act basis, for both HIV and STDs[20].

Statistical procedures

To evaluate whether participants' baseline to follow-up changes in numbers of sex partners and/or condom use resulted in significant mean proportionate risk changes for HIV and the STD, we performed a pair of 2×2 analyses of variance (ANOVAs). These analyses examined the independent and interactive effects of both behaviour-change factors on HIV and STD risk outcomes. We also performed a Chi-square test to assess whether participants who only changed condom use were more likely than participants who only changed numbers of partners to experience a greater reduction in HIV risk than in STD risk.

Sensitivity analyses

We conducted sensitivity analyses to investigate whether substantively different results would have been obtained if different parameter values had been used in the modelling. First, we examined how the mean proportionate STD risk change varied as a function of the STD prevalence and

per-act transmission probability. Second, we re-ran the main analyses with condom effectiveness set to 100%, and again with it set to a smaller value (80%). Third, we varied the minimum difference in condom use, from baseline to follow-up, that was required for a participant to be classified as having 'changed' his or her condom use. This parameter was set to 10% in the base-case analysis and to 5% and 20% in the sensitivity analyses.

We also examined the effect of separately quadrupling the reported number of acts of intercourse and the number of partners. Although it is reasonable to suppose that a person would engage in four times as many acts of intercourse in a 12-month period as he or she would in 3 months (the period assessed in Project Light), the annual number of partners is likely to be less than four times the number reported in a 3-month period. Therefore, to simulate a 12-month assessment period we conducted a sensitivity analysis in which the number of acts of intercourse was quadrupled and the number of partners was doubled.

Finally, we ran an analysis in which the prevalence of HIV and STD infection among sex partners was assumed to increase as a linear function of the number of partners. Specifically, for someone who had m sex partners, we multiplied the base-case HIV and STD prevalence by $[1 + 0.1 \times (m - 1)]$, provided that this value was equal to five or less (otherwise we multiplied the base-case prevalences by five). The resulting prevalence values varied from the base-case value of 0.02, to 0.1, depending on the number of sex partners. This analysis was motivated by the possibility that people who have many sexual partners would be more likely to have sex with other people who themselves have many partners, and who, consequently, would be more likely to be infected with HIV or another STD.

Results

Figure 1 illustrates the relationship between the absolute change in HIV risk ($H_0 - H_{12}$), from baseline to 12-month follow-up, and the corresponding change in risk ($S_0 - S_{12}$) for a highly infectious STD, such as gonorrhoea. The majority of the points (90.3%), each of which represents one or more of the 2588 participants, fall in the first and third quadrants, indicating that most participants either decreased (quadrant 1) or increased (quadrant 3) both their HIV risk and their STD risk. Twenty-seven participants experienced no change in their HIV or STD risk and were omitted from further analyses. An additional group of 146 women and 79 men decreased one risk while increasing the other (quadrants 2 and 4). This group was analysed separately from the main sample of 1440 women and 896 men (for whom HIV and STD risk changed in the same direction), as described below.

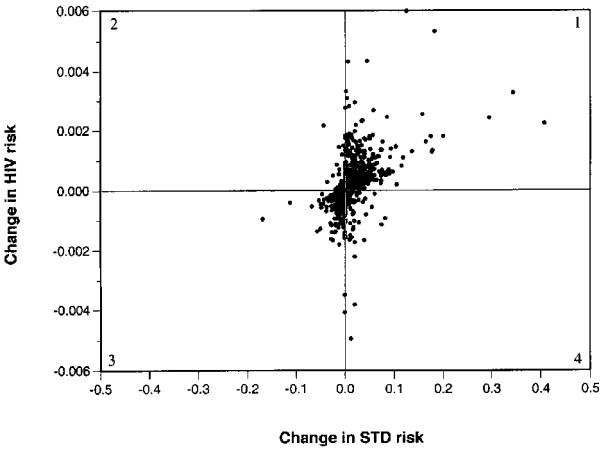

Figure 1. Absolute changes in HIV and STD risk for men and women in the Project Light intervention trial

The remainder of the analysis concerns participants' proportionate risk change (which is always positive, by definition), rather than their absolute risk change (which could be positive or negative). As explained in the Methods section, for the present purposes increases and decreases in risk can be considered to be equivalent. Therefore, to simplify the presentation of the results, we will use the terms 'risk change' or 'risk reduction' rather than the more awkward 'proportionate risk change,' with the understanding that the change is the proportion by which the participant's risk has changed from baseline to follow-up (or *vice versa*), rather than the absolute amount by which it has changed. The joint distribution of (proportionate) changes in HIV and STD risk for participants in the main sample is illustrated in Figure 2.

We conducted separate ANOVAs to compare the impact of changing condom use or number of partners on participants' HIV and STD risk. The results indicate that participants who changed their number of partners experienced a statistically significantly greater reduction in STD risk than did participants whose number of partners remained the same ($F_{1, 2332} = 231.98$, $P < 0.001$). In contrast, the two groups experienced similar changes in HIV risk ($F_{1, 2332} = 1.86$, ns). In short, changing the number of partners affected STD risk but not HIV risk. In contrast, condom use affected both HIV and STD risk. Specifically, participants who changed their condom use reduced both their HIV risk ($F_{1, 2332} = 129.17$, $P < 0.001$) and their STD risk ($F_{1, 2332} = 75.80$, $P < 0.001$) relative to participants whose condom use remained the same.

Of the 2336 participants in the main sample, 1039 (44.5%) changed both condom use and number of partners, 783 (33.5%) changed only condom use, 207 (8.9%) changed only the number of partners,

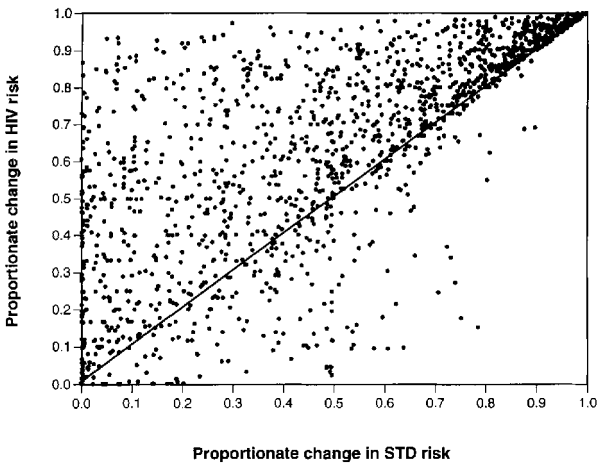

Figure 2. Proportionate changes in HIV and STD risk for Project Light intervention trial participants

and 307 (13.1%) changed neither. For participants who changed their condom use but not their number of partners, or *vice versa*, we examined whether these changes resulted in a greater reduction in HIV risk or STD risk (this analysis excluded six participants whose reductions in HIV and STD risk were equal). A 2×2 contingency table analysis (see Table 2) revealed a statistically significant difference ($P < 0.001$) between participants who changed only their condom use and those who changed only the number of sex partners. Among participants who only changed condom use, 96.3% experienced a greater reduction in their risk for HIV than for STD. In contrast, only 65.2% of the participants who changed only the number of partners experienced a greater reduction in HIV risk than in STD risk. Overall, 1971 of 2330 (84.6%) of participants who changed either condom use, number of partners, or both experienced a greater reduction in their HIV risk than in their STD risk (see Figure 2).

Table 2. Contingency table analyses of participants who changed only condom use or only number of partners

	Larger proportionate risk change for	
	HIV	STD
Changed number of partners only	135 (13.7%)	72 (7.3%)
Changed condom use only	748 (76.0%)	29 (2.9%)

$\chi^2 = 179.09$, df = 1, $P < 0.001$

The results of the sensitivity analyses are summarized in Table 3. As shown, the mean proportionate HIV risk change was not particularly sensitive to any of the parameter manipulations, except increasing or decreasing the condom effectiveness parameter, which affected HIV risk in the expected directions (e.g. increasing condom effectiveness increased risk change). The STD risk change measure was more volatile. Besides condom effectiveness, it also was sensitive to increases in the number of acts of intercourse and/or the number of partners. Multiplying the number of acts by four decreased the mean STD risk change. When, in addition to quadrupling the number of acts, the number of partners was doubled—thereby (roughly) extrapolating from three months to 12 months—a small increase in STD risk was observed.

None of the parameter manipulations listed in Table 3 affected the results of the contingency table analysis: as in the base-case, participants who changed only their condom use were more likely than those who only changed their number of partners to experience a greater change in HIV risk than in STD risk. The only manipulation that affected the ANOVA results was the assumption that prevalence increases linearly with number of partners. For all other manipulations, changing condom use reduced both HIV risk and STD risk, but changing the number of partners reduced only STD risk. When prevalence was assumed to increase with number of partners, changing the

Table 3. Sensitivity analyses for participants in main sample

	Mean proportionate HIV risk change	Mean proportionate STD risk change
Base-case	0.657	0.526
Condom effectiveness		
=100%	0.720 (+9.6%[a])	0.613 (+16.5%[a])
=80%	0.622 (−5.2%)	0.480 (−8.7%)
Minimum condom use change[b]		
=20%	0.657 (0.0%)	0.526 (0.0%)
=5%	0.657 (0.0%)	0.526 (0.0%)
Increase number of acts by four	0.654 (−0.3%)	0.409 (−22.3%)
Increase number of acts by four and increase number of partners by two	0.656 (−0.1%)	0.458 (−13.0%)
Prevalence increases with number of partners (see text)	0.673 (+2.5%)	0.538 (+2.3%)

[a]Deviation from base-case results
[b]Minimum change in condom use needed to classify participant as having changed his or her condom use (see text)

number of partners also resulted in a statistically significant reduction in HIV risk ($P < 0.05$).

The above analyses assumed a 2% prevalence of HIV and STD infection among the partners of intervention participants, and particular values for HIV and STD infectivity. We conducted a two-way sensitivity analysis to evaluate how different assumptions about STD infectivity and prevalence mediate the impact of behavioural changes on STD risk. The main outcome measure for this analysis was the mean proportionate STD risk change, which was calculated separately for participants who changed condom use and those who changed their number of partners. As indicated in Figure 3, the change in STD risk is essentially constant for small infectivity values, but drops off as the infectivity increases above approximately 0.01. This is especially true for the subsample of participants who changed their condom use (Figure 3a), but also holds for participants who changed numbers of partners in high STD prevalence conditions (Figure 3b). Comparison of Figure 3a and 3b demonstrates again that, for low-infectivity STDs (such as HIV), participants who changed condom use experienced a greater reduction in STD risk than did participants who changed numbers of partners, but for highly-infectious STDs (e.g. those with infectivities in excess of 0.1), greater reductions in risk were experienced by participants who changed numbers of partners than by those who changed condom use. Figure 3 also suggests that the prevalence of the STD is not a critical mediator of how behavioural changes affect STD risk except when both the infectivity and prevalence are very large.

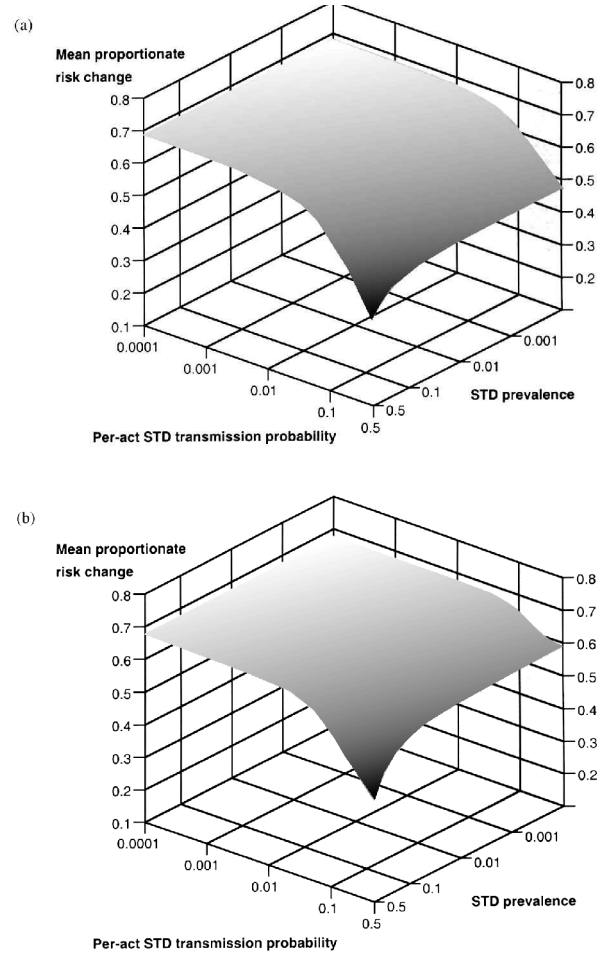

Figure 3. Mean proportionate STD risk change for participants in the main sample who changed their condom use (part a) or number of partners (part b), as a function of the per-act transmission probability for receptive vaginal intercourse and the prevalence of STD infection among their sex partners

The above analyses could not be conducted for the 146 women and 79 men who decreased one risk while increasing the other (quadrants 2 and 4 in Figure 1) because a consistent definition of the proportionate risk change was not possible for these participants. For example, participants in quadrant 2 decreased their HIV risk but increased their STD risk; therefore, the denominator of the proportionate HIV risk change $((H_0 - H_{12})/H_0)$ was calculated from the baseline data, whereas the denominator of the proportionate STD risk change $((S_{12} - S_0)/S_{12})$ was obtained from the 12-month follow-up data. Thus, comparing HIV and STD risk changes would be inappropriate for this group. Nevertheless, an examination of the direction of risk changes revealed a consistent pattern: decreasing the number of partners (whether from baseline to follow-up, or *vice versa*) resulted in a decrease in STD risk and an increase in HIV risk (data not shown). For these individuals, the increased HIV risk was a consequence of concomitant increases in the number of acts of intercourse. These results highlight the relatively greater impact of the changes in the number of partners on STD risk, relative to HIV risk. In particular, for the STD but not for HIV, decreasing the number of partners was sufficient to counter the increased risk caused by the greater number of sex acts. These results also point to the importance of the number of acts of intercourse as a determinant of HIV/STD risks.

Discussion

All STDs are not created equal, and neither are all behavioural risk reduction strategies. According to our modelling results, limiting the number of sex partners is a more effective strategy for reducing transmission risks for highly infectious STDs than for reducing HIV risk. In contrast, condoms can be very effective at reducing cumulative transmission risk for low infectivity pathogens, such as HIV, but are somewhat less effective against highly infectious STDs, such as gonorrhoea.

These findings suggest that behavioural change interventions need to be carefully tailored to address specific STD-related behavioural risks. Most HIV behavioural risk reduction interventions focus on increasing participants' use of condoms,

with less emphasis on reducing partnership formation rates. The analysis presented here indicates that this is an appropriate strategy for combating the spread of HIV among heterosexuals, whereas an emphasis on the number of partners may be more appropriate for programmes designed to prevent transmission of highly infectious STDs[21]. Moreover, because the infectivity of HIV is much higher for receptive anal intercourse, different prevention strategies may be needed in populations in which this practice is common, such as among men who have sex with men.

A further implication of these results concerns the use of non-HIV STDs—particularly highly infectious ones—as surrogate markers for HIV infection. A behavioural change intervention that indices significant increases in participants' condom use could be very effective at reducing HIV risk without substantially affecting STD risk[22]. Consequently, HIV prevention programmes should not necessarily be expected to have measurable effects on STD transmission rates, especially for highly infectious STDs[23,24]. Indeed, the literature provides several examples of interventions that produced changes in participants' sexual behaviours, but not in STD incidence[25–27]. The ideal surrogate for heterosexually-transmitted HIV would be an STD that, like HIV, is not easily transmitted[22]. In light of this, gonorrhoea appears to be a particularly poor choice to serve as a marker for HIV.

Although the HIV transmission model used in this analysis has a number of advantages, several limitations have also been noted[9,28,29]. On the one hand, this simple model is easily described and manipulated, requires few parameters, has high biological plausibility, and has been empirically verified in an HIV seroconversion study in Africa[30,31]. On the other, it omits important STD transmission dynamics, including non-random mixing patterns, selective condom use (e.g. with new partners, but not with steady partners), sexual contact network characteristics, and concurrent partnerships[32–37]. Non-random, assortative sexual mixing patterns would tend to reduce the probability of an uninfected person selecting an infected partner. However, the results of the main analysis were little affected by changes in the assumed prevalence of infection, and by inference, to different assumptions of sexual mixing patterns or sexual network characteristics.

Partnership concurrency tends to amplify STD epidemics by facilitating rapid transmission throughout sexual networks[36,38] and is therefore an important population-level determinant of STD spread[39]. In contrast, an individual's risk of acquiring an STD is a function only of the total number of partners—it does not depend on whether they are concurrent or sequential. Finally, some people may preferentially use condoms with casual partners or partners they otherwise perceive as 'risky,' while foregoing condoms in committed or long-term relationships[37,40,41]. The present model assumed uniform condom use, regardless of partner type, which may have resulted in an underestimation of the cumulative effectiveness of condoms against HIV and other STDs.

It is important to note that HIV/STD infectivity can vary over the course of disease and may exhibit person-to-person variation. For example, HIV infectivity is believed to be substantially higher just after infection, at which time it is best considered a highly infectious STD. HIV infectivity also may increase in the later stages of HIV disease, after the immune system has been compromised. Nevertheless, during the long, relatively symptom-free period which constitutes the bulk of the infectious period, the infectivity of HIV is very small compared to that of other STDs. The impact of brief periods of high HIV infectivity are not considered here[42,43].

The main outcome considered here is a relative measure of risk change, calculated on a participant-by-participant basis. This outcome reflects both the ease with which the pathogen is transmitted, as well as the participant's baseline risk level. Although increasing condom use or decreasing the number of sex partners results in a greater absolute reduction in risk for easily transmitted pathogens (e.g. gonorrhoea) than for less rapidly transmitted ones (e.g. HIV), we observed greater proportionate changes in the risk for HIV than for STD, especially among participants who changed condom use. A relative measure was used here to permit comparisons across pathogens and to reflect the individual-level orientation of behavioural change interventions such as Project Light, the goal of which was to help participants reduce their risk of becoming infected. In contrast, an absolute measure of overall risk reduction, such as change in STD incidence, is needed to assess the epidemiological impact of the intervention on the community as a whole[44]. The results of the present study might not apply to this broader epidemiological context[45].

Further research is needed to explore the relationship between changes in behaviours and reductions in HIV and STD risk, and to examine the myriad factors that affect transmission rates of different STDs, including HIV. Studies such as the one described here are a first step toward gaining a better understanding of these complex relationships. Our results suggest caution in extrapolating from one STD to another, or from one behavioural risk reduction strategy to another.

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