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BRIEF REPORT

Concordance Between Laboratory Diagnosed Sexually Transmitted Infections and Self-Reported Measures of Risky Sex by Partner Type Among Rural Ugandan Outpatients

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Abstract Numerous HIV risk reduction interventions which show effects on sexual risk behaviors fail to find effects on STIs. We examined the concordance between laboratory diagnosed STIs and sexual risk behavior among Ugandan outpatients (n = 328). We screened for STIs and assessed sexual behavior at baseline and 6 month follow-up. Less risk was associated with an STI at baseline. At follow-up more unprotected sex with casual partners was associated with incident Syphilis, more unprotected sex with primary and secondary regular partners was associated with incident Chlamydia or Gonorrhea. Our results suggest ways to improve concordance between behavioral measures and STIs.

Resumen Numerosas intervenciones para reducir el riesgo de VIH que muestran efectos en los comportamientos sexuales de riesgo no encuentran efectos en las infecciones de transmisión sexual (ITS). Se examinó la concordancia entre las ITS diagnosticados en el laboratorio y el comportamiento sexual de riesgo entre los pacientes ambulatorios de Uganda (n = 328). Se hicieron pruebas de ITS y se evaluó el comportamiento sexual en el inicio del estudio y 6 meses de seguimiento. Menor riesgo de comportamiento sexual se asoció con una ITS al inicio del estudio. En el seguimiento, más sexo sin protección con parejas ocasionales se asoció con sífilis incidente, y más sexo sin protección con parejas habituales (cónyuge/novio(a) u otra pareja sexual concurrente) se asoció con clamidia o gonorrea incidentes. Nuestros resultados sugieren formas de mejorar la concordancia entre las medidas de comportamiento sexual y las ITS.

Keywords Sexual behavior · Africa · Syphilis · Chlamydia · Gonorrhea

Introduction

Many sexual risk reduction behavioral interventions include sexually transmitted infections (STIs) as a biomarker of the effectiveness of the intervention. Yet, numerous interventions which show effects on sexual risk behaviors fail to also find effects on STIs (e.g., [1–3]). Other studies find effects on STIs/HIV yet show little change in sexual risk behaviors (e.g., [4]). This inconsistent concordance may be attributable to a number of factors, as discussed by Aral [5], including the choice of behavioral indicators of sexual risk behavior, the sexual risk behavior measurement time frame relative to the STI screening, as well as epidemiological factors.

Concordance between measures of sexual risk behaviors and STIs in intervention trials could be improved by measuring the risk behaviors that likely resulted in the STI [5]. Intervention studies often ask participants to report on their sexual behavior for the prior 3 or 6 months at baseline and conduct an STI screening at that time, as a basis for measuring change from pre-intervention to post-intervention.

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Follow-up behavioral measures then ask about behavior that occurred after the baseline, or another time point, until the present follow-up date, at which time another STI screening is conducted. This approach may result in a lack of concordance between sexual risk behaviors and STIs because the behaviors that resulted in an STI at baseline could have occurred long before the behavioral measurement time frame.

Another source of imprecision in behavior-STI biomarker concordance is the choice of behavioral measures for the STIs of interest. Behaviors most likely to result in an STI may be different for different pathogens [6]. Furthermore, there is increasing risk of STI acquisition with each additional act of unprotected sexual intercourse, yet many studies measure unprotected sex as a dichotomy of any unprotected sex during a time period or with certain types of partners or as the estimated categorical percentage of times a condom was used during sex (e.g., 5 point scale, always—never).

Methods

In the present paper we examine the concordance between Syphilis, Chlamydia, and Gonorrhea, and sexual risk behavior measures at baseline and 6 month follow-up using data from a sample of rural Ugandan outpatients. We recruited outpatients receiving provider-initiated HIV testing at a rural Ugandan hospital for a brief HIV sexual risk reduction intervention trial. Recruitment procedures are reported in detail elsewhere [7]. Institutional review boards at Makerere University School of Public Health and Rhode Island Hospital, as well as the Uganda National Council for Science and Technology, approved the study protocol. Participants provided written informed consent. At baseline and 6 month follow-up, participants provided a first catch urine sample for *Chlamydia trachomatis* (CT) and *Neisseria gonorrhoeae* (NG) testing using Roche Amplicor PCR. Remnant plasma from the HIV test specimen was used to test for Syphilis using Rapid Plasma Reagin (RPR) with confirmation by Treponema Pallidum Hemagglutination (TPHA). Those with positive STI results were referred for free treatment for themselves and their partner(s). We collected behavioral measures via computer-assisted interview at baseline and 3 and 6 month follow-up. These measures captured data on the number of times participants had vaginal sexual intercourse and the number of these times a condom was used in the prior 3 months with each partner using timeline follow back techniques, which help reduce recall bias through memory cues. Based on our previous work in this population [7] we classified partner types as: primary or marital partner, non-marital secondary regular partner, and casual partner. Participants also reported symptoms of STIs (e.g., genital discharge or itching, burning or pain during urination) and diagnoses of STIs by a doctor or nurse during the prior 6 months. We excluded one participant who had the same STI at both time points since we are unable to determine if that was an incident case. We used Generalized Linear Modeling to examine the concordance between different measures of sexual risk behavior and STIs at the two time points, as well as comparing the two time points. We controlled for sociodemographics, STI symptoms, reported STI diagnosis, intervention condition, and HIV test results. Separate models were run for Syphilis and for combined CT and NG. CT and NG were combined since they are both often asymptomatic and have some similar symptoms [8]. Behavior reported at 3 and 6 month follow-ups were combined in the models looking at concordance between STI incidence and sexual risk behavior at follow-up.

Results

There were 328 (164 female, 164 male) participants at baseline with unequivocal results on the Syphilis test and 323 (162 female, 161 male) with unequivocal results on NG and CT tests. At follow-up there were 211 (106 female, 105 male) participants and 191 (94 female, 97 male) participants with unequivocal results on the Syphilis and the NG and CT tests respectively. At baseline (n = 328) average age was 33.39, SD 9.90, 86.5 % were married, and 64.1 % had primary schooling or less (≤7th grade). The subsample at follow-up did not differ from the baseline sample on sociodemographic factors.

At baseline 32 (9.8 %) tested HIV positive, 17 (5.2 %) tested positive for Syphilis, and 15 (4.6 %) for NG or CT. At follow-up 5 (2.4 %) had incident Syphilis and 7 (3.7 %) had incident NG or CT. Of the full sample, 11.6 % at baseline and 6.2 % at follow-up, reported being diagnosed with an STI by a doctor or nurse in the prior 6 months and 31.7 % at baseline and 21.3 % at follow-up reported potential symptoms of an STI.

Those who tested HIV positive at baseline were more likely than those who tested HIV negative to have Syphilis at baseline, OR 4.38, 95 % CI (1.44–13.37), X^2 6.74, $p = 0.009$ and women were more likely than men to have Syphilis at baseline, OR 5.01, 95 % CI (1.41–17.78), X^2 6.22, $p = 0.013$. HIV test results, gender, and symptoms of NG or CT were not associated with baseline or follow–up NG or CT results. Diagnosis of an STI by a doctor or nurse was not associated with Syphilis results at either time point. There were no differences by study condition. All participants with Syphilis, NG, or CT at follow–up were HIV negative.

As shown in Table 1, compared to those without Syphilis at baseline, those with Syphilis at baseline reported fewer sex acts in the prior 3 months, X^2 15.37, Exp(β) 0.78 (95 % CI 0.69–0.88) and less unprotected sex: in general, X^2 13.31, Exp(β) 0.80 (95 % CI 0.69–0.90), with a partner of unknown or HIV positive status, X^2 7.33, Exp(β) 0.82 (95 % CI 0.72–0.95), and with a marital/primary partner, X^2 7.81, Exp(β) 0.83 (95 % CI 0.73–0.95). At follow-up those with incident Syphilis reported less unprotected sex in the prior 6 months: in general, X^2 11.29, Exp(β) 0.76 (95 % CI 0.65–0.89), with a marital/primary partner, X^2 58.91, Exp(β) 0.37 (95 % CI 0.29–0.48), and with secondary partners, X^2 5.26, Exp(β) 0.51 (95 % CI 0.29–0.91) but three times more unprotected sex acts with casual partners, X^2 56.28, Exp(β) 3.04 (95 % CI 2.27–4.06). The association between Syphilis and unprotected sex with casual partners was stronger at follow-up than at baseline, X^2 14.22, $p < 0.001$, and the negative association between Syphilis and unprotected sex with primary partners was also stronger at follow-up, X^2 38.71, $p < 0.001$.

As shown in Table 2, compared to those without NG or CT at baseline, those with NG or CT at baseline reported less unprotected sex with marital/primary partners in the prior 3 months, X^2 4.90, Exp(β) 0.86 (95 % CI 0.76–0.98) but reported more unprotected sex with secondary regular partners, X^2 31.37, Exp(β) 3.02 (95 % CI 2.05–4.45). At follow–up those with incident NG or CT reported more sex, X^2 4.48, Exp(β) 1.13 (95 % CI 1.01–1.25), and more unprotected sex with: HIV serodiscordant or unknown status partners, X^2 58.86, Exp(β) 1.65 (95 % CI 1.45–1.88), marital/primary partners, X^2 3.91, Exp(β) 1.14 (95 % CI 1.01–1.29), and secondary regular partners, X^2 9.49, Exp(β) 1.78 (95 % CI 1.23–2.56). The positive association between NG or CT and the number of sex acts, X^2 8.23, $p = 0.004$, as well as the number of unprotected sex acts with: all partners, X^2 5.34, $p = 0.021$, HIV serodiscordant or unknown status partners, X^2 28.87, $p < 0.001$, and marital/primary partners, X^2 15.70, $p < 0.001$, was stronger at follow-up than at baseline.

Discussion

In a rural Ugandan sample with low rates of condom use and significant prevalence of sex with secondary regular and casual partners, unprotected vaginal sex was differentially associated with incident Syphilis and NG or CT by partner type. In our data more unprotected sex with casual partners was a key source of risk for acquiring Syphilis. This is consistent with studies from sub-Saharan Africa showing an association between having sex with casual partners and Syphilis infection [9]. More unprotected sex with marital/primary partners, secondary regular partners, and partners of serodiscordant or unknown HIV status was predictive of incident NG or CT. The difference between risk factors for incident Syphilis and NG/CT may be due to differences in per-act transmission rates between these types of STIs and that NG and CT are more often asymptomatic in both men and women than is Syphilis [8, 10–12].

The results also showed that concordance between sexual risk behavior measures and STIs was better at follow-up than at baseline. This is expected because we knew that those positive for an STI at follow-up were STI negative at baseline. Furthermore, we captured the sexual behavior that occurred between the baseline and follow-up STI screenings—thereby ensuring that the behavior resulting in the STI at follow-up occurred between baseline and follow-up. STIs detected at baseline could have been acquired prior to the 3 month behavior measurement window, thereby explaining some of the lack of concordance between risk behavior and STIs.

Our study is limited by its small sample size and generalizability to rural sub-Saharan African settings. We also did not take into account sexual networks in terms of how sexual networks may affect the relationship between individual risk behaviors and STI acquisition. Sexual network characteristics such as size, presence of high prevalence subgroups, the degree of mixing between high prevalence subgroups and lower prevalence groups, spatial movement of individuals within the network, average number of connections between network members, and duration of concurrencies may all influence the risk of STI acquisition posed by unprotected sex with different types of partners [5]. An individual's position within a network (e.g., center, periphery, not connected) also influences STI risk. Those at the center of, as well those having only one partner with the partner being connected to the network, can be at significantly higher risk of STI infection [13]. Without knowing details of individuals' sexual networks we are unable to take into account likelihood of exposure to an infected partner in our estimates of association between sexual behavior and STIs.

Despite the limitations, our findings suggest ways to improve concordance between STI biomarkers and risky sexual behavior outcomes in intervention studies: investigators should examine risk behaviors for specific STIs separately, perform an STI screening and provide treatment to STI-positive participants and their partners prior to a baseline STI screening and prior to the measurement period for risky sexual behavior. This could be done several months prior to collecting baseline data. Furthermore, consistent with Aral's [5] recommendations investigators would be wise to first gain an understanding of the sexual risk behavior dynamics in their study population and the

Table 1 Concordance of potential sexual risk behavior indicators with Syphilis results. Butambala District, Uganda

	Baseline Syphilis screening prior 3 months behavior			Follow up Syphilis screening behavior since baseline screening[a]			Difference between baseline and follow-up association between behavior and Syphilis
	Syphilis n = 17	No Syphilis n = 311	Exp(β) (95 % CI), p value	Syphilis n = 5	No Syphilis n = 206	Exp(β) (95 % CI), p value	
Number of sex acts	16.63 (1.07)	21.33 (0.42)	**0.78 (0.69–0.88) p < 0.001**	32.72 (2.45)	37.17 (1.13)	0.88 (0.77–1.01) p = .072	X^2 0.21, p = 0.65
Mean number of unprotected sex acts	14.86 (0.99)	18.85 (0.40)	**0.80 (0.69–0.90) p < 0.001**	20.13 (1.76)	26.46 (0.97)	**0.76 (0.65–0.89) p = 0.001**	X^2 2.06, p = 0.15
Mean number of unprotected sex acts with HIV serodiscordant/positive or unknown status partners	12.84 (0.93)	15.59 (0.36)	**0.82 (0.72–0.95) p = 0.007**	15.38 (1.70)	18.14 (0.78)	0.85 (0.69–1.04) p = 0.12	X^2 0.06, p = 0.81
Mean number of unprotected sex events with marital/primary partner	14.09 (0.95)	16.94 (0.38)	**0.83 (0.73–0.95) p = 0.005**	7.95 (1.06)	21.24 (0.89)	**0.37 (0.29–0.48) p < 0.001**	**X^2 38.71, p < 0.001**
Mean number of unprotected sex acts with secondary regular partners	0	0.98 (0.07)	[b]	2.20 (0.23)	2.81 (0.15)	**0.51 (0.29–0.91) p = 0.02**	[b]
Mean number of unprotected sex acts with casual partners	0.24 (0.12)	0.73 (0.09)	**0.32 (0.12–0.87) p = 0.025**	9.06 (1.44)	2.98 (0.28)	**3.04 (2.27–4.06) p < 0.001**	**X^2 14.22, p < 0.001**

Bold values indicate statistical significance of $p < 0.05$

All estimates control for sociodemographics, HIV test results, study condition, and reported STI diagnoses by a doctor or nurse

Exp (β) Exponentiated Beta. *CI* Confidence interval

[a] Behavior since baseline screening was an approximately 6 month follow up which on average was 6.4 months

[b] Model cannot be run because one group has no variability in the outcome

Table 2 Concordance of potential sexual risk behavior indicators with *Chlamydia trachomatis* or *Neisseria gonorrhoeae* results. Butambala District, Uganda

	Baseline STI screening, Prior 3 months behavior			Follow up STI screening, Incident STIs, Behavior since baseline STI screening[a]			Difference between baseline and follow–up association between behavior and NG or CT
	NG or CT n = 15	No NG or CT n = 308	Exp(β) (95 % CI), p value	NG or CT n = 7	No NG or CT n = 84	Exp(β) (95 % CI), p value	
Number of sex acts	19.93 (1.15)	20.84 (0.29)	0.96 (0.86–1.07) p = 0.45	40.91 (2.40)	36.41 (0.94)	**1.13 (1.01–1.25) p = 0.034**	**X^2 8.23, p = 0.004**
Mean number of unprotected sex acts	17.82 (1.08)	19.27 (0.28)	0.93 (0.82–1.04) p = 0.21	29.43 (1.95)	27.76 (0.86)	1.06 (0.94–1.20) p = 0.34	**X^2 5.34, p = 0.021**
Mean number of unprotected sex acts with HIV serodiscordant or unknown status partners	17.15 (1.07)	15.25 (0.25)	1.13 (0.99–1.27) p = 0.065	31.96 (2.26)	19.32 (0.68)	**1.65 (1.45–1.88) p < 0.001**	**X^2 28.87, p < 0.001**
Mean number of unprotected sex events with marital/primary partner	14.89 (0.97)	17.23 (0.27)	**0.86 (0.76–0.98) p = 0.027**	24.47 (1.76)	21.51 (0.78)	**1.14 (1.01–1.29) p = 0.048**	**X^2 15.70, p < 0.001**
Mean number of unprotected sex acts with secondary regular partners	1.22 (0.25)	0.41 (0.05)	**3.02 (2.05–4.45) p < 0.001**	2.69 (0.56)	1.51 (0.16)	**1.78 (1.23–2.56) p = 0.002**	X^2 3.05, p = 0.081
Mean number of unprotected sex acts with casual partners	0.48 (0.18)	0.75 (0.06)	0.63 (0.30–1.34) p = 0.23	0	3.20 (0.26)	[b]	[b]

Bold values indicate statistical significance of $p < 0.05$

All estimates control for sociodemographics, HIV test results, study condition, and reported symptoms of NG or CT

Exp (β) Exponentiated Beta. *CI* Confidence interval

[a] Behavior since baseline screening was an approximately 6 month follow up which on average was 6.4 months

[b] Model cannot be run because one group has no variability in the outcome

concordance between different indicators of sexual risk behaviors and specific STIs before deciding on the optimal sexual risk behavior indicators.

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Compliance with Ethical Standards

Conflict of Interest The authors declare no conflicts of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional (Makerere University School of Public Health and Rhode Island Hospital) and national research committee (Uganda National Council for Science and Technology) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. All participants provided written informed consent. This article does not contain any studies with animals performed by any of the authors.

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