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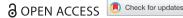
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Disclosure of HIV-serodiscordant relationships and association with viral suppression: results from the Positive Plus One study

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ABSTRACT

Background. Little is known about the effects of disclosure of HIV-serodiscordant relationships on clinical outcomes. We aimed to evaluate the effect of relationship disclosure on HIV viral suppression, and hypothesized that disclosure by HIV-positive and HIV-negative partners would be associated with viral suppression in the HIV-positive partner. Methods. We conducted a Canadian national online and telephone-administered survey of HIV-positive and HIV-negative partners in serodiscordant relationships. The primary outcome was self-reported viral suppression. Multivariable analyses were undertaken using Firth logistic regression. Results. We recruited 540 participants in current serodiscordant relationships (n = 228 HIV-negative; n = 312 HIV-positive). Similar proportions of HIV-positive and HIV-negative partners disclosed their relationship to healthcare professionals (82% v. 76%, $p = 0.13$). Among HIV-positive partners, disclosure of the relationship to healthcare professionals increased the odds of viral suppression (aOR = 4.7; CI: 2.13, 10.51) after adjusting for age, education, and relationship turmoil due to HIV. Increasing age (aOR = 1.28; 95% CI = 1.07, 1.55) and education (aOR = 2.43; 95% CI = 1.15, 5.26) were also associated with viral suppression. Among HIV-negative partners, relationship disclosure was not associated with viral suppression and HIV-negative heterosexual men were less likely to report that their HIV-positive partners were virally suppressed (aOR = 0.24; CI: 0.09, 0.61). Conclusions. Disclosure of HIV-serodiscordant status by HIV-positive participants to healthcare professionals was associated with increased odds of viral suppression. Similar effects were not evident among HIV-negative participants. Future work should explore factors that empower relationship disclosure and incorporate them into supportive services for HIV-serodiscordant relationships.

Introduction

While advances in early testing and initiation of antiretroviral therapy (ART) have facilitated a decline in HIV incidence and mortality (UNAIDS, 2020), the number of HIV-serodiscordant relationships is poised to increase (Eyawo et al., 2010; Smith et al., 2015). The fact that having an undetectable viral load means that a person cannnot transmit HIV (undetectable = untransmittable, U = U) may provide normalcy to individuals engaged in serodiscordant relationships (Rendina et al., 2020). Serostatus disclosure within relationships is an important step for navigating healthy relationships (Armstrong et al., 2018; Loutfy et al., 2016; Mi et al., 2020; Sullivan et al., 2020; Wei et al., 2011); however, the effect on viral suppression requires clarification (Brittain et al., 2019; Daskalopoulou et al., 2017). An extension of serostatus disclosure within the relationship, disclosure of serodiscordant relationships outside of the relationship is not well understood.

Table 1. Socio-demographic characteristics comparing HIV-positive and HIV-negative partners in current relationships (n = 540 partners in current HIV-serodiscordant relationships).

Factor	HIV-positive N (%)	HIV-negative N (%)	p-value
All	312	228	
Age, median years (IQR)	43 (34, 52)	42 (32, 52.2)	p = 0.703[a]
Relationship duration, median years (IQR)	4.5 (2, 11.6)	5 (2, 13)	p = 0.637[a]
Study dyad (both partners in study)	153 (49%)	153 (67.1%)	p <0.001
Gender			
Male	215 (68.9)	177 (77.6)	p = 0.0579[b]
Female	89 (28.5)	47 (20.6)	
Other (includes 1 missing value)	8 (2.6)	4 (1.8)	
Gender / sexual orientation			
Men who have sex with men	144 (46.2)	116 (50.9)	p = 0.0439
Heterosexual female	70 (22.4)	39 (17.1)	
Heterosexual male	48 (15.4)	49 (21.5)	
Other	50 (16)	24 (10.5)	
Race / ethnicity			
White	189 (62)	164 (72.6)	p = 0.0249
Black	23 (7.5)	20 (8.8)	
Hispanic	30 (9.8)	10 (4.4)	
Aboriginal/Indigenous	31 (10.2)	13 (5.8)	
Other	32 (10.5)	19 (8.4)	
Not stated	7 (2.2)	2 (0.9)	
Education			
Less than secondary school diploma	42 (13.5)	17 (7.5)	p = 0.0591
Secondary school diploma	65 (21)	44 (19.4)	
Beyond secondary school	203 (65.5)	166 (73.1)	
Not stated	2 (0.6)	1 (0.4)	
Income			
< $20,000	131 (43.1)	62 (27.8)	p <0.0001
$20,000 – $50,000	102 (33.6)	71 (31.8)	
>$50,000	71 (23.4)	90 (40.4)	
Not stated	8 (2.5)	5 (2.2)	
Region			
Ontario	179 (57.7)	130 (57.3)	p = 0.8549
British Columbia	35 (11.3)	30 (13.2)	
Prairie Provinces (Saskatchewan, Manitoba, Alberta)	40 (12.9)	32 (14.1)	
Quebec	35 (11.3)	20 (8.8)	
Atlantic Provinces (New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador)	21 (6.8)	15 (6.6)	
Not stated	2 (0.6)	1 (0.4)	
Reside in large city (>500,000 population)	193 (61.9)	148 (64.9)	p = 0.5247
Married or cohabiting	235 (75.8)	176 (77.9)	p = 0.6483
Relationship satisfaction (Range 1–5), mean (SD)	4.2 (0.8)	4.3 (0.7)	p = 0.3327[a]
HIV diagnosis relative to relationship			
Diagnosis before relationship start	209 (67)	34 (14.9)	p <0.0001
Diagnosis at same time of relationship start	24 (7.7)	124 (54.4)	
Diagnosis after relationship start	79 (25.3)	70 (30.7)	
Disclosed relationship to own friends or family‡ (children, parents, siblings, other)	249 (83.3)	160 (72.4)	p = 0.0039
Disclosed relationship to healthcare professional‡ (healthcare providers e.g., doctors/nurses, therapists, counselors, or other support services)	244 (81.9)	165 (76)	p = 0.1313
Other sexual partners during current relationship	136 (44.4)	85 (37.8)	p = 0.1468
Sexual agreement (re. consensual non-monogamy)‡‡	218 (69.9)	146 (64)	p = 0.1815
Discussed HIV testing with partner	227 (73.2)	185 (81.9)	p = 0.0021
Relationship power dynamic relative to partner on condom use			
More say	49 (19.4)	32 (17.4)	p = 0.1016
Equal say	44 (17.4)	19 (10.3)	
Less say	160 (63.2)	133 (72.3)	
NA/DK/Not stated	59 (18.9)	44 (19.3)	
Relationship power dynamic‡‡‡			
More say	0 (0)	1 (0.4)	p = 0.484[a]
Equal say	269 (86.2)	193 (84.6)	
Less say	43 (13.8)	34 (14.9)	
Relationship turmoil because of HIV	64 (20.8)	46 (20.4)	p = 0.9906

Values are numbers and proportions unless otherwise stated; IQR = interquartile range.
p-values are Pearson's chi-square tests unless otherwise stated; [a] T-test; [b] Fisher's exact test.
‡ Disclosure of serodiscordant status was assessed by asking: "Below is a list of different groups of people. How many people in each group know, or have you told, that you are in a serodiscordant relationship?" Response options included "none," "some," or "all" ("some" and "all" were grouped for analysis).
‡‡ Constructed from three questions: (i) any agreements allowing sex with people outside of the relationship, (ii) discussions about making such agreements, and (iii) a list of specific sexual agreements permitting/proscribing certain activities.
‡‡‡ "More say" or "less say" was coded if each topic area were answered the same way. Topic areas included: whose friends to go out with; decision to have sex; decision on general activities done together; timing of serious discussions; decision to use condoms; choice of sexual behaviors; financial decisions; and overall assessment. "Equal say" was coded for all other response combinations.

Karney and colleagues (2010) proposed that relationships exist on a continuum of "dyadic coordination", from casual to primary, where coordination within the relationship is defined as a process through which individual partners act to achieve a specific goal. Disclosure of one's relationship to key networks, such as healthcare professionals, could have an important effect on health by facilitating access to information and supportive services. We hypothesized that in primary relationships, there would be similar levels of relationship disclosure by each partner to healthcare professionals, and that relationship disclosure would be associated with viral suppression.

Methods

Study design

In this cross-sectional study, participants were recruited sequentially from 143 AIDS Serivce and other non-governmental organizations (ASOs and NGOs) and 35 clinics (12/2015–6/2018) in Canada, and through digital and partner-referral methods, to complete a 30-minute online or telephone-administered survey. Individuals were eligible if they were ≥18 years old, spoke English or French, were in a primary serodiscordant relationship (currently or in the past two years) that lasted ≥3 months, and if HIV-status was disclosed within the relationship. Participants were considered to have met the study definition of being an HIV-serodiscordant relatonship if the initial partner enrolled in the study (i.e., index participant) described their relationship with a primary sexual partner as being in "a couple," "together" or "dating". Ethical approvals were received from the University of Toronto and from six other Canadian institutions. All other recruitment partners accepted these approvals through coordinated processes.

Data sources

A structured questionnaire offered in English or French was used to collect data on sociodemographic characteristics, relationship disclosure, and viral suppression measured by self-report (primary outcome). Unknown viral load status was coded as detectable. Composite categories of personal and healthcare professional networks were used to classify to whom the serodiscordant relationship status had been disclosed (Table 1).

Statistical Methods

Differences between groups were assessed using t-tests for means and Pearson χ^2 or Fisher's exact tests for proportions. Testing was two-sided and used a significance level of α = 0.05. Cohen's Kappa was used to assess agreement on viral suppression. Multivariable modeling was completed independently on HIV-positive and HIV-negative partners using the Firth logistic regression R package logistf (Heinze et al., 2020). Models were constructed using blocked regression with backward elimination where covariates with $p < 0.20$ were consigned to the full model, and $p < 0.05$ determined final model specification (R Core Team, 2020). Likelihood ratio tests were used to assess models. Odds ratios (OR) and 95% confidence intervals (CI) were reported.

Results

Sociodemographic and relationship factors

We recruited 613 participants who were currently, or had been (within two years) engaged in a primary HIV-serodiscordant relationship. Analyses focused on 540 participants in current relationships (Table 1), 58% of whom were HIV-positive. The partners of half of HIV-positive participants and two-thirds of HIV-negative participants were also enrolled in the study (n = 153 study dyads). No differences were found between HIV-positive and HIV-negative participants in age, education, or marital/cohabitation status; however, HIV-positive participants reported lower incomes (43% v. 28%, $p < 0.0001$). A larger proportion of HIV-negative participants reported having discussed HIV testing with their partner (82% v. 73%, $p = 0.0021$). Similar proportions of each group had disclosed their serodiscordant relationship status to healthcare professionals (82% v. 76%; $p < 0.1313$). Both groups reported similar levels of input into relationship functioning and one-fifth of participants in each group reported having experienced relationship turmoil because of HIV.

Self-reported viral suppression and correlates

High proportions of HIV-positive and HIV-negative participants reported viral suppression (87% v. 85%, p

Table 2. Reported viral suppression by HIV-positive and HIV-negative partners (n = 529‡).

Group	Total, n (100%)	Self-reported viral suppression‡‡, n (%)	χ^2 p-value
HIV-positive	303	263 (86.8)	p = 0.738
HIV-negative	226	193 (85.4)	
All	529	456 (86.2)	

‡ Nine HIV-positive and two HIV-negative participants with incomplete data were excluded; responses of "don't know" (12 HIV+ and 14 HIV-) were included in "unsuppressed".

‡‡ Response options consisted of <40 copies/mL (undetectable); 40–10,000 copies/mL (detectable); >10,000 copies/mL (detectable); and detectable but don't know copies/mL.

Table 3. Agreement on reported viral suppression within dyads (n = 149‡).

Viral suppression	HIV-negative partner	
HIV-positive partner	Suppressed	Unsuppressed (including DK)
Suppressed	124	8
Unsuppressed (including "do not know")	6	11
Cohen's Kappa measuring agreement	K = 0.558	
McNemar's test for direction of difference	*p* = 0.7893	

‡ 3 HIV-positive and 1 HIV-negative participant with incomplete data were excluded.

= 0.74) (see Table 2). There were moderate levels of agreement within relationships where both partners were enrolled in the study on whether viral suppression has been attained by the HIV-positive partner (Cohen's Kappa K = 0.56) (Table 3).

Among HIV-positive participants (Tables 4 and 5), disclosure of relationships to healthcare professionals was associated with a fivefold increase in the odds of viral suppression (aOR = 4.7; 95% CI = 2.13, 10.51). Increasing age (aOR = 1.28; 95% CI = 1.07, 1.55) and

education (aOR = 2.43; 95% CI = 1.15, 5.26) were also associated with viral suppression. Those reporting relationship turmoil due to HIV had lower odds of viral suppression (aOR = 0.35; CI = 0.15, 0.81). Among HIV-negative participants (Table 5), the partners of heterosexual men were less likely to be virally suppressed (aOR = 0.24, CI = 0.09, 0.61).

Discussion

We hypothesized that similar proportions of HIV-positive and HIV-negative partners in primary serodiscordant relationships would disclose their relationships to healthcare professionals due to the strong coordination capacities that exist in primary relationships. We found that disclosure of serodiscordant status by HIV-positive partners increased the odds of viral suppression compared with those who had not disclosed their relationship status. We hypothesized that the association between disclosure and viral suppression would hold for HIV-negative

Table 4. Multivariable models estimating association of factors with self-reported viral suppression by HIV-**positive** partners in current HIV-serodiscordant relationships in Canada (n = 303[‡]).

Factor	Viral suppression N (%)	Crude odds ratio (95% CI)	*p*-value	Adjusted odds ratio (95% CI)[b]	*p*-value
BLOCK 1					
Age (in 5 years, centered)[a]		1.37 (1.16, 1.63)	0.0001	1.28 (1.07, 1.55)	0.0051
Gender / sexual orientation					
MSM	139 (93.5)	1	0.0098		
Heterosexual female	70 (82.9)	0.34 (0.14, 0.830)			
Heterosexual male	46 (78.3)	0.25 (0.1, 0.66)			
Other	48 (81.2)	0.3 (0.11, 0.8)			
Education					
Up to secondary school	105 (78.1)	1	0.0016	1	0.0206
Beyond secondary school	197 (91.4)	2.94 (1.51, 5.82)		2.43 (1.15, 5.26)	
BLOCK 2					
Disclosed relationship to healthcare professional (healthcare providers e.g., doctors/nurses, therapists, counselors, or other support services)					
No	52 (65.4)	1	<0.0001		0.0002
Yes	238 (91.2)	5.42 (2.64, 11.16)		4.71 (2.13, 10.51)	
Other sexual partners during current relationship					
No	167 (83.8)	1			
Yes	131 (90.1)	1.72 (0.87, 3.54)	0.1199		
Relationship power dynamic ("More or equal say" about 100% of statements answered)					
No	171 (83)	1			
Yes	130 (92.3)	2.38 (1.16, 5.22)	0.0172		
Relationship turmoil because of HIV					
No	240 (89.6)	1		1	0.0146
Yes	61 (75.4)	0.35 (0.18, 0.73)	0.0055	0.35 (0.15, 0.81)	
BLOCK 3					
Income					
< $20,000	127 (80.3)	1	0.0072		
≥ $20,000	170 (91.2)	2.5 (1.28, 5.01)			
Region					
Ontario	176 (89.8)	1	0.0062		
British Columbia	34 (94.1)	1.52 (0.45, 7.86)			
Prairies	39 (69.2)	0.26 (0.11, 0.59)			
Quebec	34 (91.2)	1.05 (0.35, 4.16)			
Atlantic Provinces	19 (73.7)	0.31 (0.11, 0.99)			

p-values are log likelihood ratio tests; CI = confidence interval.
[‡]Nine participants with incomplete data were excluded; 12 participants who responded "do not know" to current viral load were coded as unsuppressed.
[a]Factor modeled as a linear effect; *p*(tr) = *p*(trend).

Table 5. Multivariable model estimating association of factors with self-reported viral suppression by HIV-**negative** partners in current HIV-serodiscordant relationships in Canada (n = 226‡).

Factor	Viral suppression N (%)	Crude odds ratio (95% CI)	p-value	Adjusted odds ratio (95% CI)[b]	p-value
Block 1					
Gender / sexual orientation					
MSM	115 (91.3)	1	0.0049	1	0.0139
Heterosexual female	39 (79.5)	0.37 (0.14, 1.01)		0.42 (0.15, 1.19)	
Heterosexual male	49 (71.4)	0.24 (0.1, 0.58)		0.24 (0.09, 0.61)	
Other	23 (95.7)	1.49 (0.32, 14.32)		1.2 (0.23, 12.19)	
Block 2					
Disclosed relationship to healthcare professional (healthcare providers e.g., doctors/nurses, therapists, counselors, or other support services)		3.08 (1.41, 6.69)	0.0054		
No	51 (72.5)				
Yes	165 (89.1)				
HIV diagnosis relative to relationship					
Diagnosis before relationship start	34 (88.2)	1	0.0238		
Diagnosis at same time of relationship start	123 (90.2)	1.32 (0.37, 3.93)			
Diagnosis after relationship start	69 (75.4)	0.44 (0.13, 1.28)			
Relationship turmoil because of HIV					
No	180 (87.8)	1	0.0429		
Yes	45 (75.6)	0.43 (0.19, 0.97)			
Block 3					
Income					
< $20,000	61 (78.7)	1	0.0983		
≥ $20,000	161 (87.6)	1.92 (0.88, 4.08)			
Reside in city >500 K inhabitants					
No	79 (77.2)	1	0.0123		
Yes	147 (89.8)	2.57 (1.23, 5.45)			
Region					
Ontario	130 (87.7)	1	0.0005	1	0.0013
British Columbia	30 (96.7)	2.83 (0.66, 26.43)		2.69 (0.61, 25.55)	
Prairies	31 (67.7)	0.3 (0.12, 0.74)		0.29 (0.11, 0.75)	
Quebec	20 (100)	5.91 (0.74, 764)		4.61 (0.56, 600.62)	
Atlantic Provinces	15 (60)	0.21 (0.07, 0.67)		0.21 (0.06, 0.69)	

p-values are log likelihood ratio tests; CI = confidence interval.
‡Two participants with incomplete data were excluded; 14 participants responded "do not know" to current viral load of their HIV-positive partner and the response was categorized as unsuppressed.
aFactor modeled as a linear effect; p(tr) = p(trend).

partners given U = U and support for the HIV-positive partner's retention in care but this was not supported by the data.

Consistent with prior findings, younger HIV-positive partners were less likely to report viral suppression (Palmer et al., 2018). Consistent with the TLC-Plus study that did not find a link between social support and viral suppression among women, we did not find an independent association between gender/sexual orientation and viral suppression (Maragh-Bass et al., 2021). Although an association between relationship disclosure to healthcare professionals and viral suppression among HIV-negative partners was not detected overall HIV-negative heterosexual men were less likely to report that their partner was virally suppressed. For HIV-negative partners, not disclosing the relationship to healthcare providers could lead to avoidable delays in HIV testing and improvements in linkage to care, ART initiation, and clinical outcomes (Sharma et al., 2015; Wu et al., 2017). The impact of relationship disclosure on access to pre-exposure prophylaxis (PrEP) and access to supportive services merits further study.

Viral suppression among HIV-positive partners was less likely in the midst of relationship turmoil, which suggested that HIV-specific relationship counseling could be helpful for sustaining partner support and motivation to sustain viral suppression. HIV-positive partners take on key roles in managing transmission risk given their access to HIV supportive services. The importance of access to targeted advice from healthcare professionals is consistent with the finding that HIV-positive individuals are more likely to understand U = U as accurate when compared with HIV-negative partners or partners of unknown serostatus (Rendina et al., 2020).

What are the barriers to relationship disclosure? Evangeli and Wroe (2017) found that fear of stigmatizing responses was a major reason for serostatus non-disclosure and that disclosure anxiety was associated with general anxiety, depression, and stigma. Enacted individual-level stigma was found to mediate anticipated relationship stigma, which was associated with drug use prior to condomless sex and diagnosis of other sexually transmitted infections (Castro et al., 2019; Gamarel et al., 2020). Interventions focused on promoting safe

environments for relationship disclosure and helping people manage relationship stigma where it occurs will be important for realizing the potential benefits to health and wellbeing that relationship disclosure may facilitate.

Limitations of this study included selection bias as those already engaged in care through clinics, ASOs, and NGOs could have been overrepresented in the study sample. To counter the possibility that self-reported viral suppression was overestimated in online/telephone survey formats, we coded unknown viral suppression status as unsuppressed. Criminalization of HIV status non-disclosure in Canada could have introduced social desirability bias, especially among HIV-positive partners. The cross-sectional design served as a limitation on the interpretability of associations. The association of relationship turmoil and viral suppression could also mean that unsuppressed viral loads are the cause of the turmoil. We suggested that relationship disclosure may sustain viral suppression by encouraging relationship stability and engagement with healthcare; however, it is also possible that people in stable relationships and engaged with healthcare are more likely to disclose their relationship and attain viral suppression. As we are unaware of prior investigations that have studied serodiscordant relationship disclosure, a strength of the study was its novelty. Moreover, the HIV-positive sample tracked national surveillance data by gender, age, sexual orientation, and had similar levels of viral suppression (Haddad et al., 2019; Public Health Agency of Canada, 2020).

Future work should include cohort studies that may help to shed light on the interplay of disclosure and viral suppression over time. Qualitative work is needed to identify the specific support needs of HIV-negative partners, younger HIV-positive partners, and those who have not completed a secondary education. An analysis of response concordance among dyads would help to inform couple-focused interventions. Partners in serodiscordant relationships deserve an environment where they may disclose their relationship without the fear of stigma, and benefit from the positive effects of disclosure. Interventions that target relationship stigma and empower relationship disclosure are needed to improve the health and wellbeing of HIV-serodiscordant relationships.

List of abbreviations (In order of appearance in text)

ART Antiretroviral therapy.
    IQR Interquartile range.
    CI Confidence Interval.
    OR Odds ratio.

aOR Adjusted odds ratio.

Authors contributions

JBM co-designed the study, consulted on data collection and statistical analyses, interpreted results, and wrote the first draft of the manuscript. LC, SB and JI co-designed the study, co-developed survey instruments, managed data collection, oversaw ethics, consulted on analysis, interpreted results, and commented on the draft manuscript. DHST, BL, ML, BC recruited participants, assisted with interpretation of results, and commented on the draft manuscript. AB, ANB and AD assisted with interpretation of results and commented on the draft manuscript. VM completed statistical analyses. All authors read, commented on, and approved the final manuscript.

Ethics approval and consent to participate

Ethical approvals were received from the University of Toronto (RIS Protocol 31855), McGill University (16-035 MUHC), University of Saskatchewan (BEH-15-399), St. Michael's Hospital (16–343), Toronto Public Health (2016–02), Nova Scotia Health Authority (NS1602), and Prince Albert Parkland Health Region. All other recruitment entities accepted pre-existing approvals through coordinated processes.

Disclosure statement

No potential conflict of interest was reported by the author(s).

of the study; collection, management, analysis, and interpretation of the data; preparation, review, and approval of the manuscript; and decision to submit the manuscript for publication.

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