

**Population-level sexual mixing by HIV status and pre-exposure prophylaxis use among men who have sex with men in Montreal, Canada: implications for HIV prevention**

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3 **Population-Level Sexual Mixing By HIV Status and Pre-exposure Prophylaxis Use**  
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5 **Among Men Who Have Sex with Men in Montreal, Canada: Implications for HIV**  
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7 **Prevention**  
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Running head: Sexual Mixing By HIV Status and PrEP Use Among MSM

## Abstract

There are limited data on population-level mixing patterns by HIV status or pre-exposure prophylaxis (PrEP) use. Using cross-sectional survey data (*Engage*, 2017-2018) of 1137 men who have sex with men  $\geq 16$  year-old in Montreal, we compared observed seroconcordance in the past-6-month sexual partnerships to what would have been observed by chance if zero individuals serosort. Of 5 recent partnerships where both individuals were HIV-negative, we compared observed concordance in PrEP use to the counterfactual if zero individuals selected partners based on PrEP use. We estimated the concordance by chance using a balancing-partnerships approach assuming proportionate-mixing. HIV-positive respondents had a higher proportion of HIV-positive partners (66.4% (95% confidence interval: 64.0%-68.6%)) than by chance (23.9%(23.1%-24.7%)). HIV-negative respondents (both on and not on PrEP) had higher proportions of HIV-negative partners (82.9%(81.1%-84.7%), and 90.7%(89.6%-91.7%), respectively) compared with by chance (76.1%(75.3%-76.9%)); but those on PrEP had a higher proportion of HIV-positive partners than those not on PrEP (17.1%(15.3%-18.9%) vs. 9.3%(8.3%-10.4%)). Those on PrEP also had a higher proportion of partners on PrEP among their HIV-negative partners (50.6%(42.5%-58.8%)) than by chance (28.5%(27.5%-29.4%)). The relationship between PrEP and sexual-mixing patterns demonstrated by less population-level serosorting among those on PrEP and PrEP-matching warrants consideration during PrEP roll-out.

**Key words:** HIV; sexual mixing patterns; serosorting; PrEP; MSM; PrEP-matching

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3 **Abbreviations:** PrEP: pre-exposure prophylaxis; MSM: men who have sex with men;  
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5 RDS: respondent-driven sampling  
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For Peer Review

## Main text

Gay, bisexual, and other men who have sex with men (MSM) are disproportionately at risk of HIV acquisition.(1) In several epidemic contexts including Canada, seroadaptive practices are adopted by some MSM as a strategy to reduce HIV risk.(2-6) Seroadaptive practices consider one's own and a partner's HIV status in deciding with whom to have sex, such as choosing sexual partners of the same HIV status (individual-level serosorting), alongside sexual positioning and/or condom use.(2-6)

With the scale-up of HIV pre-exposure prophylaxis (PrEP) and antiretroviral treatment for HIV-positive individuals leading to viral suppression, serosorting and related patterns of 'who has sex with whom' may be changing.(7-9) Qualitative evidence suggests that PrEP may reduce stigma and anxiety around sex within serodiscordant partnerships and lead to less serosorting.(10) Conversely, PrEP use may be associated with increased stigma if those on PrEP are perceived to have multiple sexual partners, and/or by equating PrEP use with condomless anal sex, thus leading to preferential partner selection by PrEP use.(10) There is also emerging evidence of 'biomed-matching', which refers to preferentially selecting sexual partners who are using the same biomedical prevention strategy as oneself, such as individual-level PrEP-matching wherein both partners are using PrEP.(7, 9)

Preferential partner selection by any attribute at the individual-level can influence the population-level sexual mixing patterns, which in turn influence HIV transmission.(11, 12) Individual-level serosorting may be the most effective among partnerships in which

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3 both partners are certain about HIV status. Individuals may be unaware/uncertain about  
4 their own and/or partners' HIV status, thus limiting serosorting effectiveness.(13) At the  
5 population-level, individuals' serosorting may result in fewer serodiscordant  
6 partnerships. For instance, in settings with low levels of undiagnosed HIV, this could  
7 mean fewer onward HIV transmissions in the context of condomless sex within  
8 seroconcordant partnerships.(11) Consequently, population-level mixing patterns can  
9 further influence the impact of HIV prevention strategies at the population-level.(14)  
10 Moqueet *et al.* found that assumptions of no serosorting could underestimate the  
11 population-level impact of PrEP on HIV incidence reduction compared with  
12 incorporating serosorting in the HIV transmission model.(14)  
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28 Despite compelling evidence of individual-level serosorting, there is no empirical  
29 estimate that quantifies population-level sexual mixing by HIV status nor its relationship  
30 with PrEP use. Existing studies often measured individual-level serosorting, by  
31 examining the proportions of MSM who only had seroconcordant partners or who  
32 intended to serosort.(2-5, 15-24) A few studies measured the proportion of  
33 seroconcordant partnerships in the sexual-network.(5, 19, 23) However, to quantify the  
34 extent to which the observed partnership distribution reflects preferential partner  
35 selection, the observed patterns must be compared with what would have been  
36 observed in the absence of individuals' preferential mixing - by chance alone.(25)  
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51 Using cross-sectional survey data of MSM in Montreal, Canada, we aimed to i) quantify  
52 population-level serosorting by comparing observed partnership distribution by HIV  
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3 status to that expected by chance; ii) quantify population-level serosorting among HIV-  
4 negative MSM stratified by PrEP use; and iii) quantify population-level PrEP-matching  
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6 by comparing observed partnership distribution by PrEP use to that expected by  
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## METHODS

### Study design and subjects

We obtained data (Feb 7<sup>th</sup> 2017 to June 15<sup>th</sup> 2018 (n=1179)) from *Engage-Montreal*, a cross-sectional survey of MSM in Montreal. Cisgender and transgender men aged  $\geq 16$  years who had sex with another man in the past 6 months were recruited using respondent-driven sampling (RDS).(26, 27) RDS is an adapted form of chain referral method of recruiting study participants.(26, 27) Details on the recruitment procedures for *Engage-Montreal* have been documented elsewhere.(28) Participants completed a computer-assisted self-interview, which included questions on sexual behaviours in the past 6 months. We included respondents who reported  $\geq 1$  anal or oral male sex partners in the past 6 months in our analyses, and excluded respondents who only had vaginal/frontal sex with another man in the past 6 months (n=4). We excluded respondents who did not report (different from reporting 'unaware') HIV status for all of their sexual partners (n=38).

### Measures

As per terminology for social/sexual-network data, we hereafter refer to respondents as egos, and their sexual partners as alters.(29) Egos' HIV status was determined by self-report of their most recent HIV test results prior to the current study, and was classified as positive, negative, and unknown (never tested/did not receive or were unsure about results/preferred not answering).

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5 Alters' HIV status was classified based on egos' responses to two sets of questions  
6 **(Web Appendix 1)**. One question asked about the aggregate numbers of anal or oral  
7 sex partners in the past 6 months by alters' HIV status (e.g., *'of the men you had oral or*  
8 *anal sex with in the past 6 months, how many were HIV-positive'*), which did not  
9 separate anal sex from oral sex partners. Responses to these questions were used for  
10 our primary analyses on all anal or oral sex partners in the past 6 months. The other  
11 event-level questions asked about each of the up to 5 most recent male sexual partners  
12 in the past 6 months (e.g., *'the most recent time you had sex with the partner named*  
13 *above, did you know what his HIV status was BEFORE you guys had sex'*; respondents  
14 could select if they were certain about their answers **(Web Appendix 1**; frequency of  
15 each response is shown in **Web Appendix 2**)). We classified uncertain as unknown, to  
16 be consistent with the set of questions on the partnerships in the past 6 months **(Web**  
17 **Appendix 1)**. Event-level questions were asked to distinguish the type of sex (anal or  
18 oral or both) within each partnership **(Web Appendix 1)**. For each ego, event-level data  
19 were aggregated to derive total numbers of recent anal or oral sex partners by alters'  
20 HIV status, and separately for recent anal sex partners. These event-level measures  
21 were used in our sensitivity analyses.  
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47 HIV-negative egos' PrEP use in the past 6 months (yes/no) was ascertained based on  
48 self-report of PrEP use anytime in the past 6 months. We also used event-level data to  
49 determine PrEP use at last sex (yes/no/unknown) for both egos and alters (e.g., *'the*  
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3 *most recent time you had sex with the partner named above, were you using PrEP?*  
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5 *Was your partner using PrEP?* (**Web Appendix 1**).

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10 Statistical analysis

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14 We described sociodemographic, sexual behavioural, and health system engagement  
15 characteristics of our study sample. We calculated RDS-adjusted estimates with the  
16 95% empirical likelihood-based confidence intervals, using the *Volz and Heckathorn*  
17 method (RDS-II estimates, calculated using R ‘RDS’ package), by which individuals  
18 were weighted by the inverse of their self-reported network size (survey question in  
19 **Web Appendix 1**).(30)

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31 *Analysis: serosorting.* We first estimated the distribution of partnerships by alters’ HIV  
32 status by chance alone if zero individuals serosort (**Equation 1**). This counterfactual  
33 cannot be observed, and was instead estimated under the proportionate-mixing  
34 assumption using a balancing-partnerships approach commonly used in mathematical  
35 models of HIV.(25) Proportionate-mixing assumes that by chance alone, the distribution  
36 of partnerships ‘available’ by a given attribute depends on the prevalence of this  
37 attribute and the heterogeneity in partner numbers by this attribute.(25) We then  
38 calculated the partnership distribution by alters’ HIV status by chance conditional on  
39 knowing alters’ HIV status.

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54 We calculated the observed past-6-month partnership distributions by alters’ HIV status

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3 for HIV-positive, negative, and egos of unknown-status separately using **equation 2**.  
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5 The observed partnership distributions by alters' HIV status conditional on knowing  
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7 alters' HIV status were also calculated among the subset of alters whose HIV status  
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9 were known.  
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14 We compared the observed partnership distributions conditional on knowing alters' HIV  
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16 status to those expected by chance, using chi-squared tests, for egos with HIV-positive,  
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18 negative, and unknown-status, separately. To quantify the extent of serosorting, we  
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20 calculated the excess fraction of seroconcordance beyond chance by subtracting the  
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22 seroconcordance by chance from the observed seroconcordance and then dividing by  
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24 the observed seroconcordance.  
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31 *Analysis: serosorting stratified by PrEP use.* We calculated the observed partnership  
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33 distributions by alters' HIV status for HIV-negative egos using **equation 2**, stratified by  
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35 egos' past-6-month PrEP use. For HIV-negative egos on PrEP, and those not on PrEP,  
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37 we compared their observed partnership distributions by alters' HIV status to each  
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39 other, and separately, to the partnership distribution by alters' HIV status by chance,  
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41 using chi-squared tests.  
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47 *Analysis: PrEP-matching.* We first estimated the distribution of HIV-negative  
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49 partnerships by alters' PrEP use under proportionate-mixing assumption, using  
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51 **equation 3** (based on egos' past-6-month PrEP use data). We then calculated the  
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53 observed partnership distributions by alters' PrEP use using event-level data, stratified  
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3 by egos' PrEP use, reflecting PrEP use at last sex within recent anal or oral sex  
4 partnerships, in which both partners were HIV-negative (**equation 4**). The observed  
5 partnership distributions by alters' PrEP use conditional on knowing alters' PrEP use  
6 were also calculated by restricting **equation 4** to the subset of alters whose PrEP use  
7 were known.  
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17 We compared the observed partnership distributions conditional on knowing alters'  
18 PrEP use to those expected by chance, using chi-squared tests, for HIV-negative egos  
19 who used PrEP at last sex and those who did not, separately. Finally, we calculated the  
20 excess fraction of concordance in PrEP use beyond by chance.  
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## 28 Sensitivity analyses

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33 Although there are established adjustment methods for RDS sampling to generate  
34 population-representative individual-level estimates,(30) it is unknown how RDS  
35 sampling would influence population-level sexual mixing estimates. Thus, to examine  
36 the sensitivity of our results to the sampling strategy, we repeated our analyses on an  
37 RDS-weighted sample (equivalent size as the original sample). We computed RDS  
38 weights using the *Volz and Heckathorn* method.(30)  
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49 To assess the sensitivity of our results to the differences in how event-level and past-6-  
50 month data were recalled and reported, and to the inclusion of oral sex only partners,  
51 we repeated analyses of aims 1 and 2 using event-level data on recent anal or oral sex  
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3 partners, and separately for recent anal sex partners only to generate the observed  
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5 partnership distributions by alters' HIV status. We also repeated the aim 2 analyses,  
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7 stratifying by egos' PrEP use at last sex, instead of in the past 6 months. Lastly, we  
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9 repeated the aim 3 analysis restricting to recent anal sex partners.  
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14 We used R version 3.5.1 (R Foundation for Statistical Computing, Vienna, Austria) for  
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16 analyses, and calculated confidence intervals (CIs) assuming binomial distributions. All  
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18 statistical significance tests were two sided.  
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## 24 Ethics

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29 The following ethics boards approved the study: Ryerson University, St. Michael's  
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31 Hospital, University of Toronto, University of Windsor, University of British Columbia,  
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33 University of Victoria, the Simon Fraser University, and the Research Institute of the  
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35 McGill University Health Centre.  
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## RESULTS

A total of 1137 respondents were included for analyses. Their median age was 34 years [interquartile range, 27-49 years]. The majority of respondents self-identified as gay (81.5%). Over a third (38.0%) self-identified as 'Non-French/English Canadian' and 0.9% as 'Aboriginal or Indigenous'. Overall, 207 (18.2%) self-reported as HIV-positive, 831 (73.1%) as HIV-negative, and 99 (8.7%) as of unknown-status. Respectively, they reported a median of 5 [3-15], 5 [3-10], and 3 [2-6] anal or oral sex partners in the past 6 months ( $P<0.001$ ). The majority of HIV-positive respondents reported currently using antiretroviral therapy ( $n=190$  (96.4%)), of whom 174 (91.6%) were virally suppressed. A total of 112 HIV-negative respondents (13.5%) reported using PrEP in the past 6 months. **Table 1** shows RDS-adjusted estimates of the study sample characteristics.

### Population-level serosorting

Respondents reported information on 11,883 anal or oral sex partnerships in the past 6 months (**Table 2**). By chance, the partnership distributions with alters of HIV-negative, positive, and unknown-status were 72.1%, 22.7%, and 5.2%, respectively. However, 43.7% of observed partnerships comprised alters' of unknown-status. Conditional on knowing alters' HIV status, the partnership distributions by chance with alters' of HIV-negative and HIV-positive status were 76.1% and 23.9%, respectively (**Table 2**). HIV-positive egos had a higher proportion of HIV-positive alters compared with by chance (66.4% vs. 23.9%,  $P<0.001$ )(**Table 2**). HIV-negative egos and egos with unknown-HIV status both had higher proportions of alters with an HIV-negative status compared with

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3 by chance (87.9% and 92.7%, respectively, vs. 76.1%, both  $P<0.001$ )(**Table 2**). The  
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5 excess fractions of HIV-positive seroconcordance and HIV-negative seroconcordance  
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7 beyond by chance were 64.0% and 13.4%, respectively.  
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#### 10 11 12 Population-level serosorting stratified by PrEP use 13

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17 Among HIV-negative egos, those used PrEP in the past 6 months had a lower  
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19 proportion of alters whose HIV status were unknown to egos, compared with those who  
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21 did not use (30.6% vs. 49.5%,  $P<0.001$ ) (**Table 3**). Conditional on knowing alters' HIV  
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23 status, HIV-negative egos who used PrEP and those who did not use both had lower  
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25 proportions of HIV-positive alters, compared with by chance (17.1% and 9.3%,  
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27 respectively, vs. 23.9%;  $P<0.001$ ); however, the proportion of HIV-positive alters was  
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29 higher among those who used PrEP compared with those who did not use (17.1% vs.  
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31 9.3%;  $P<0.001$ )(**Table 3**). The excess fractions of HIV-negative seroconcordance  
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33 beyond chance were 8.9% and 16.1% for HIV-negative egos on and not on PrEP,  
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35 respectively.  
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#### 42 Population-level PrEP-matching 43

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47 HIV-negative respondents reported information on 1312 recent anal or oral sex  
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49 partnerships with another HIV-negative man (**Table 4**). By chance, the partnership  
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51 distributions with HIV-negative alters who used PrEP and those did not use PrEP were  
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53 28.5%, and 71.5%, respectively (**Table 4**). However, in 10.1% of observed recent HIV-  
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3 negative partnerships, HIV-negative egos did not know about alters' PrEP use status.  
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5 Conditional on knowing alters' PrEP use status, HIV-negative egos on PrEP had a  
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7 higher proportion of HIV-negative alters who used PrEP at last sex compared with by  
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9 chance (50.6% vs. 28.5%,  $P<0.001$ ). Those not on PrEP had a higher proportion of HIV-  
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11 negative alters who did not use PrEP, compared with by chance (80.3% vs. 71.5%,  
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13  $P<0.001$ ) (**Table 4**). The excess fractions of concordance in PrEP use, and in no PrEP  
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15 use, beyond chance were 43.7% and 11.0%, respectively.  
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## 22 Sensitivity analyses

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26 RDS-weighted analyses produced similar results as the un-weighted analyses. The  
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28 RDS-weighted proportion of HIV-negative alters, conditional on knowing alters' HIV  
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30 status, was 81.5% by chance (**Web Appendix 3**) and slightly higher than the un-  
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32 weighted estimate (76.1%). The observed proportions of HIV-negative alters were also  
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34 higher across all subgroups after adjusting for weights (**Web Appendix 3**). Thus, the  
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36 RDS-adjusted excess fractions (vs. un-weighted) of seroconcordance beyond by  
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38 chance were 69.9% (vs. 64.0%), 8.4% (vs. 8.9%), and 10.7% (vs. 16.1%) for individuals  
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40 who were HIV-positive, HIV-negative on PrEP, and HIV-negative not on PrEP,  
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42 respectively. The RDS-adjusted excess fraction (vs. un-weighted) of concordance in  
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44 PrEP use beyond chance was 42.1% (**Web Appendix 3**) (vs. 43.7%). Our results were  
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46 not sensitive to differences in event-level and past-6-month data, nor to the inclusion of  
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48 oral sex partners (**Web Appendix 4**).  
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## DISCUSSION

We found evidence of population-level serosorting among HIV-positive MSM and HIV-negative MSM in Montreal, Canada, including those who used PrEP. However, there was less serosorting among HIV-negative MSM who used PrEP compared with those who did not. We also found evidence of population-level PrEP-matching among HIV-negative MSM. Our empirical estimates of population-level serosorting and PrEP-matching could help in the study of HIV transmission dynamics, and in the population-level evaluation of combination HIV prevention strategies which use HIV transmission models.(11, 12, 14, 31)

Our findings of population-level serosorting are consistent with prior studies which demonstrated serosorting intention or behaviours among MSM in high-income settings.(2-4, 6, 15-18, 20, 21, 23, 24) Our population-level measures complement individual-level measures of sexual mixing by addressing the limitations of measuring individuals' intention to preferentially select partners, a measure shown to have low agreement with individual behaviours;(20, 23, 24) or measuring individuals' sexual partnering behaviours, which does not distinguish intended behaviours from what could be unintentional (by chance).(2, 3, 15-18, 21) Additionally, our estimates of excess fractions of concordance allowed us to quantify the extent of serosorting and PrEP-matching attributable to individuals' preference beyond by chance. Specifically, a strength of our analyses is that we estimated the partnership distribution by chance under proportionate-mixing assumption,(25) which accounted for the heterogeneity in sexual partner numbers by HIV status and PrEP use.(22)

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5 We found less population-level serosorting among those who used PrEP. This finding  
6 aligns with individual-level measure data in Canada, which found MSM on PrEP  
7 reported a higher proportion of HIV-diagnosed partners after starting PrEP.(32)  
8 Moreover, we found evidence of population-level PrEP-matching, suggesting potential  
9 partner preference by PrEP use. Similarly, Grov *et al.* found that compared with HIV-  
10 negative MSM not on PrEP, those on PrEP reported a larger proportion of partners on  
11 PrEP, and a smaller proportion of partners not on PrEP (41% vs. 22%, 28% vs. 44%,  
12 respectively).(7) Martinez *et al.* found HIV-negative MSM on PrEP expressed  
13 preference toward PrEP users over non-PrEP users while looking for sexual partners  
14 online.(8) Nevertheless, we cannot deduce the PrEP use was a causal factor in partner  
15 selection, as PrEP-matching may reflect individuals' preferential partner selection by  
16 factors other than PrEP which are associated with PrEP use (e.g., health literacy, HIV  
17 risk behaviours, insurance-status).(33, 34)  
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38 We found that at the population-level, awareness of partners' HIV status was higher  
39 among MSM who used PrEP compared with those who did not use. This finding  
40 contrasts some qualitative evidence which suggests that individuals were less likely to  
41 discuss HIV status with partners after initiating PrEP.(10) However, our results may  
42 reflect an early adopter effect in our sample. As PrEP scale-up began in Montreal in  
43 2016 following the approval of 'Truvada' as PrEP by Health Canada, MSM who used  
44 PrEP in our study represent early adopters of PrEP, who may have been more  
45 empowered around discussion of HIV status, potentially through prior engagement in  
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3 HIV prevention services and strategies.(33) With PrEP roll-out, the patterns of  
4 population-level sexual mixing are likely to be evolving over time and warrant  
5 monitoring, as communities re-assemble biomedical evidence and apply it to HIV risk  
6 management.(35)  
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14 Population-level patterns of PrEP-matching and less serosorting while on PrEP could  
15 potentially lead to disparities in HIV prevention benefits between HIV-negative MSM  
16 who use PrEP and those who do not. This is because MSM not on PrEP do not directly  
17 benefit from the decreased HIV acquisition risk through taking PrEP; and they may be  
18 less likely to benefit from partners' PrEP use if they are less likely to have a partner on  
19 PrEP due to population-level PrEP-matching. Moreover, their sexual-network reflects a  
20 greater extent of serosorting than HIV-negative MSM on PrEP. In a setting where  
21 undiagnosed HIV may be high,(11) if serosorting is associated with more condomless  
22 sex,(23) HIV-negative MSM not on PrEP may face an even higher HIV acquisition  
23 risk.(11) Thus, with potential changes in sexual mixing because of PrEP, it is even more  
24 important to ensure high or increased HIV testing to reduce the fraction or person-years  
25 of undiagnosed HIV in the population.  
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44 Finally, our findings have important implications for the transmission of sexually  
45 transmitted bacteria and other viruses. For example, bacterial sexually-transmitted  
46 infections such as syphilis and viral infections such as hepatitis C are disproportionately  
47 higher among HIV-positive MSM,(36, 37) which could partly be due to population-level  
48 serosorting.(38) Our observed patterns of sexual mixing related to PrEP could  
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3 potentially modify the difference in rates of sexually-transmitted infections by HIV  
4 status.(38)  
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10 Our study has several limitations. First, measures of the number and characteristics of  
11 sexual partners were subject to recall and reporting bias, especially when respondents  
12 were asked to recall information over the period of half a year. However, similar results  
13 from event-level and past-6-month data suggest minimal influence of recall bias on the  
14 results. Second, population-level PrEP-matching was restricted to recent partnerships  
15 and might not reflect the mixing pattern among all past-6-month partnerships. This was  
16 restricted by lack of data on all partners' PrEP use status in the past 6 months. Third,  
17 we did not simultaneously consider the influence of viral suppression on sexual mixing  
18 as only 33 HIV-positive MSM were not virally suppressed in our study, which limited the  
19 analytic power. Fourth, although our results suggest individuals' preferential partner  
20 selection by HIV status and PrEP use, we cannot infer which subset of MSM intended to  
21 do so. For example, even if only HIV-positive MSM intended to serosort, and HIV-  
22 negative MSM did not, we would still observe serosorting at the population-level for both  
23 subgroups as a result of partnership-balancing. Therefore, population-level measures of  
24 sexual mixing complement but cannot replace individual-level measures of preferential  
25 partner selection. Fifth, our approach is limited by the extent to which it subsumes  
26 layers of heterogeneity that could be associated with differences in preferential partner  
27 selection, including race, age, and socioeconomic-status.(39) Future studies can apply  
28 the same approach to examine sexual mixing by these attributes. Sixth, we cannot  
29 ascertain the temporality in the relationship we observed due to the cross-sectional  
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3 study design. For example, we cannot distinguish whether being part of a certain  
4 sexual-network before PrEP uptake influenced the likelihood of PrEP initiation, or  
5 whether starting PrEP influenced individuals' sexual-network. Future studies using  
6 longitudinal data can be used to examine potential reasons underlying PrEP-matching.  
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8 Finally, our results from the RDS-weighted analyses are subject to limitations of the  
9 RDS recruitment and statistical adjustment methods.(40) For instance, there may be  
10 measurement error in respondents' self-reported social network size, which was used to  
11 produce weights in RDS-adjusted analysis to account for selection bias.(40)  
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24 Our findings demonstrate population-level serosorting among both HIV-negative and  
25 HIV-positive MSM, in a setting where the majority of HIV-positive MSM are virally  
26 suppressed. Our findings also suggest potential influence of PrEP on sexual mixing  
27 patterns as evidenced by less population-level serosorting among those on PrEP and  
28 PrEP-matching. These data reinforce the importance of monitoring changes in sexual  
29 mixing patterns among MSM to inform PrEP implementation and impact evaluation.  
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For Peer Review

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**Table 1. Crude and RDS-adjusted Estimates of Characteristics of Gay, Bisexual and Other Men Who Have Sex With Men in the 2017-2018 *Engage-Montreal* Study (n=1131).**

Characteristics	No. of respondents	Crude %	RDS-adjusted <sup>a</sup>	
			%	95% confidence intervals
			34 (27, 49) <sup>h</sup>	
			37.9 (36.6, 39.2) <sup>i</sup>	
Age, years				
Non, French Canadian or English Canadian	427	38.0	46.4	41.2, 51.6
Aboriginal or Indigenous	10	0.9	1.2	0.0, 2.6
Sexual orientation				
Bisexual	91	8.0	12.6	9.1, 16.0
Gay	927	81.5	77.0	72.4, 81.5
Straight	5	0.4	1.7	0.0, 4.1
Other <sup>b</sup>	114	10.0	8.7	5.8, 11.6
Single	820	72.1	73.7	69.1, 78.4
Have a main partner <sup>c</sup>	492	43.3	44.7	39.6, 49.9
Completed university or higher degree	738	64.9	58.8	53.8, 63.7
Employed, current	767	67.5	56.2	51.1, 61.3
Annual income, \$CAD				
0, <10k	168	14.8	23.4	18.6, 28.1
10, <30k	482	42.4	42.4	37.3, 47.5
30, <60K	353	31	26.1	21.9, 30.3
60K+	134	11.8	8.1	5.5, 10.7
Anal/oral sex partners, past 6 months				5 (3, 10) <sup>h</sup>
				3 (1,7) <sup>h</sup>
				7.2 (5.4, 8.9) <sup>i</sup>
Anal sex partners, past 6 months				4.9 (3.2, 6.7) <sup>i</sup>
Self, reported HIV status <sup>d</sup>				
Negative	831	73.1	73.4	68.9, 77.8
Positive	207	18.2	13.9	10.5, 17.3
Unknown	99	8.7	12.8	9.4, 16.1
Tested HIV positive by the <i>Engage</i> study	208	18.5	14.0	10.5, 17.5
Used PrEP, past 6 months <sup>e</sup>	112	13.5	8.9	5.2, 12.6
Current on ART <sup>f</sup>	190	96.4	97.7	95.2, 100
Virally suppressed <sup>g</sup>	174	91.6	89.7	81.9, 97.3

Abbreviations: RDS, respondent, driven sampling; PrEP, pre-exposure prophylaxis; ART: antiretroviral treatment for HIV, positive individuals.

<sup>a</sup> RDS-II estimator and empirical likelihood-based confidence intervals calculated using R 'RDS' package.

<sup>b</sup> Such as queer, questioning, asexual, pansexual, two, spirit etc.

<sup>c</sup> Person with whom the respondents are in a relationship with and feel most committed to (even if you are in a polyamorous/open/non, monogamous relationship).

<sup>d</sup> Self-report of the most recent HIV test results, where unknown was defined as those who never tested for HIV, ever tested but never received the most recent test results, or were unsure or preferred not to answer.

<sup>e</sup> Among self-reported HIV-negative individuals.

<sup>f</sup> Among self-reported HIV-positive individuals.

<sup>g</sup> Among individuals who self-reported being currently on ART.

<sup>h</sup> Values are expressed as median (interquartile range).

<sup>i</sup> Values are expressed as RDS adjusted mean and 95% empirical likelihood-based confidence interval.

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**Table 2. Seroconcordance Among Anal or Oral Sex Partnerships in the Past 6 Months As Expected By Chance Under Proportionate Mixing Versus Observed Patterns in the 2017-2018 Engage-Montreal Study (No. of Respondents=1137, No. of Partnerships Reported By Respondents=11,883).**

Egos' characteristics			Comparison	Alters' HIV status as perceived by egos						
				Unaware/Unsure		Conditional on awareness of alters' HIV status				P-value <sup>a</sup>
HIV status <sup>b</sup>	No. of respondents	No. of partnerships		%	95% CI	%	95% CI	%	95% CI	
N/A	N/A	N/A	Chance <sup>c</sup>	5.2	4.8, 5.6	76.1	75.3, 76.9	23.9	23.1, 24.7	Reference
Negative	831	8573	Observed	44.2	43.1, 45.2	87.9	87.0, 88.8	12.1	11.2, 13.0	<0.001
Positive	207	2695	Observed	39.1	37.3, 41.0	33.6	31.4, 36.0	66.4	64.0, 68.6	<0.001
Unknown	99	615	Observed	57.9	53.9, 61.8	92.7	88.8, 95.5	7.3	4.5, 11.2	<0.001

Abbreviations: CI: confidence intervals.

<sup>a</sup> Three chi-squared tests were performed independently stratified by egos' HIV status, to compare observed seroconcordance to expected seroconcordance, conditional on egos' awareness of alters' HIV status.

<sup>b</sup> Self-report of the most recent HIV test results; unknown was defined as those who never tested for HIV, ever tested but never received the most recent test results, or were unsure or preferred not to answer.

<sup>c</sup> Reflects the 'total number of anal or oral sex partnerships available by HIV status' under proportionate mixing assumption, which accounts for the number of individuals by HIV status, and different numbers of sexual partners they have.

**Table 3. Variability in Seroconcordance Among Anal or Oral Sex Partnerships in the Past 6 Months By Whether or Not an HIV-Negative Respondent Uses PrEP in the Past 6 Months (2017-2018 *Engage-Montreal* Study, No. of HIV-Negative Respondents=831, No. of Partnerships Reported By HIV-Negative Respondents=8573).**

Egos' characteristics			Alters' HIV status perceived by egos								
			Comparison	Conditional on awareness of alters' HIV status						P-value <sup>a</sup>	P-value <sup>b</sup>
				Unaware/Unsure		Negative		Positive			
PrEP, past 6 months <sup>c</sup>	No. of HIV-Negative respondents	No. of partnerships		%	95% CI	%	95% CI	%	95% CI		
N/A	N/A	N/A	Chance <sup>d</sup>	5.2	4.8, 5.6	76.1	75.3, 76.9	23.9	23.1, 24.7	Reference	N/A
No	719	6132	Observed	49.5	48.3, 50.8	90.7	89.6, 91.7	9.3	8.3, 10.4	<0.001	Reference
Yes	112	2441	Observed	30.6	28.8, 32.5	82.9	81.1, 84.7	17.1	15.3, 18.9	<0.001	<0.001

Abbreviations: CI: confidence intervals; PrEP: Pre-exposure Prophylaxis.

<sup>a</sup> Two chi-squared tests were performed independently stratified by respondent's PrEP use to compare observed seroconcordance to expected seroconcordance, conditional on awareness of alters' HIV status.

<sup>b</sup> A chi-squared test was performed to compare the difference in the two observed seroconcordance by PrEP use conditional on awareness of alters' HIV status.

<sup>c</sup> Base on whether the self-reported date of PrEP use at the most recent time was within the past 6 months.

<sup>d</sup> Reflects the 'total number of anal or oral sex partnerships available by HIV status' under proportionate mixing assumption, which accounts for the number of individuals by HIV status, and different numbers of sexual partners they have.

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**Table 4. Concordance in PrEP Use between HIV-Negative Egos and HIV-Negative Alters As Expected With Proportionate Mixing Versus Observed Patterns Among Recent Sexual Partnerships (2017-2018 Engage-Montreal Study, No. of HIV-Negative Respondents=859, No. of HIV-Negative Recent Anal or Oral Sex Partners Reported by HIV-Negative Respondents=1312).**

Egos' characteristics			Alters' PrEP use, last sex <sup>b</sup> as perceived by egos								
			Comparison	Conditional on awareness of alters' PrEP use						P-value <sup>a</sup>	P-value <sup>b</sup>
PrEP, last sex <sup>c</sup>	No. of HIV-negative respondents	No. of partnerships		Unaware/Unsure		No		Yes			
			%	95% CI	%	95% CI	%	95% CI			
N/A	N/A	N/A	Chance <sup>d</sup>	0.0	0.0, 0.0	71.5	70.6, 72.5	28.5	27.5, 29.4	Reference	N/A
No	765	1136	Observed	9.8	8.1, 11.6	80.3	77.7, 82.7	19.7	17.3, 22.3	<0.001	Reference
Yes	94	176	Observed	12.5	8.0, 18.3	49.4	41.2, 57.5	50.6	42.5, 58.8	<0.001	<0.001

Abbreviations: CI: confidence intervals; PrEP: Pre-exposure Prophylaxis.

<sup>a</sup> Two chi-squared tests were performed independently to compare observed concordance in PrEP use to expected concordance, conditional on awareness of alters' PrEP use.

<sup>b</sup> A chi-squared test was performed to compare the difference in the proportions of partners who use PrEP by respondent's PrEP use conditional on awareness of partner's PrEP use status.

<sup>c</sup> Self-reported PrEP use at the time of the most recent sex with each partner.

<sup>d</sup> Reflects the 'total number of HIV-negative anal or oral sex partnerships available by PrEP use' under proportionate mixing assumption, which accounts for the number of individuals by PrEP use, and different numbers of sexual partners they have.

**Main text box 1. Equations to Calculate the Expected By Chance and Observed Distributions of Partnerships By HIV Status and PrEP Use (2017-2018 Engage-Montreal Study).**

$$P_{h,expected} = \frac{\sum_i^{n_k} c_{i,k}}{\sum_k \sum_i c_{i,k}} \quad (1)$$

where  $P_{h,expected}$  is the expected probability of having an alter with HIV status  $h$  ( $h=1$ , positive;  $h=2$ , negative;  $h=3$ , unknown);  $n_k$  reflects the number of egos by egos' HIV status  $k$  ( $k=1$ , positive;  $k=2$ , negative;  $k=3$ , unknown);  $c_{i,k}$  is the number of anal or oral sex partners in the past 6 months, for ego  $i$  whose HIV status is  $k$ . Given partnership balancing, if an HIV-positive individual  $i$  has  $c_i$  number of sexual partners, he provides  $c_i$  number of HIV-positive partnerships to the sexual-network. Therefore,  $k$  always takes the value of  $h$  in equation (1).

$$P_{h,k,observed} = \frac{\sum_i c_{i,h,k}}{\sum_h \sum_i c_{i,h,k}} \quad (2)$$

where  $P_{h,k,observed}$  is the observed probability of having an alter with HIV status  $h$  for ego whose HIV status is  $k$ ;  $c_{i,h,k}$  is the number of anal or oral sex partners with HIV status  $h$  in the past 6 months, for ego  $i$  whose HIV status is  $k$ .  $c_{i,h,k}$  can be derived directly from the past 6 months responses as defined in *Measures*.

$$P_{p,expected} = \frac{\sum_i^{n_q} c_{i,q}}{\sum_q \sum_i c_{i,q}} \quad (3)$$

where  $P_{p,expected}$  is the expected probability of having an HIV-negative alter with past 6 months PrEP use status  $p$  ( $p=1$ , yes;  $p=2$ , no);  $n_q$  reflects the number of HIV-negative egos by egos' PrEP use in the past 6 months status  $q$  ( $q=1$ , yes;  $q=2$ , no);  $c_{i,q}$  is the number of anal or oral sex partners in the past 6 months, for HIV-negative respondent  $i$  whose past 6 months PrEP use status is  $q$ . Given partnership balancing, if an HIV-negative individual  $i$  who used PrEP in the past 6 months has  $c_i$  number of sexual partners, he provides  $c_i$  number of HIV-negative on PrEP partnerships to the sexual-network. Therefore,  $q$  always takes the value of  $p$  in equation (3).

$$P_{r,s,observed} = \frac{\sum_i c_{i,r,s}}{\sum_h \sum_i c_{i,r,s}} \quad (4)$$

where  $P_{r,s,observed}$  is the observed probability of having an HIV-negative alter with last sex PrEP use status is  $r$  ( $r=1$ , yes;  $r=2$ , no;  $r=3$ , unknown) for HIV-negative egos whose last sex PrEP use status is  $s$  ( $s=1$ , yes;  $s=2$ , no;  $s=3$ , unknown);  $c_{i,r,s}$  is the number of recent anal or oral sex partners with last sex PrEP use status  $r$ , for HIV-negative ego  $i$  whose last sex PrEP use status is  $s$ .

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18 Joseph Cox, Nathan J. Lachowsky, Syed W. Noor, Heather L. Armstrong, Darrell H. S.  
19 Tan, Ann N. Burchell, Huiting Ma, Herak Apelian, Jesse Knight, Marc Messier-Peet,  
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**Web Appendix 1. Relevant Survey Questions of the 2017-2018 Engage-Montreal Study Used for Generating Measures in Our Analyses.**

**1. Measures: HIV status**

**1.1 Egos' HIV status**

3.91 Have you ever been tested to find out if you have HIV?

Yes

No

Don't know / don't remember

3.92 What was the result of your last HIV test?

I did not receive the result

I was HIV negative, I did not have the virus

I was HIV positive, I have the virus

(9996) Never tested for HIV

(9995) Unsure if tested for HIV

**1.2 Alters' HIV status: past 6 months (past 6 months) question**

5.7 Of the *[insert response from Error! Reference source not found.]* men you had any kind of sex with in the past 6 months, how many of them did you have oral or anal sex with?

\_\_\_\_\_ men

5.8 Of the *[insert response from 0]* men you had oral or anal sex with in the past 6 months:

How many men were HIV positive?

How many men were HIV negative?

How many were men whose HIV status you did not know (or were unsure about)?

**1.3 Alters' HIV status: event-level question**

5.91 The most recent time you had sex with the partner named above, did you know what his HIV status was BEFORE you guys had sex?

No, I did not know his HIV status

Yes, I was certain he was HIV-negative

Yes, I think he was HIV-negative, but I'm not certain

Yes, I was certain he was HIV-positive

Yes, I think he was HIV-positive, but I'm not certain

**2. Measures: PrEP use**

**2.1 Egos' PrEP use in the past 6 months**

3.121 Have you ever taken PrEP yourself?

No

Yes

(9994) HIV + and never heard of PrEP

(9993) HIV - and never heard of PrEP

3.123 When did you last take PrEP?

*<Month dropdown> <Year dropdown>*

*I am currently taking PrEP*

(9994) HIV + and never heard of PrEP

(9993) HIV- and never heard of PrEP

(9992) HIV+ and never taken PrEP

(9991) HIV- and never taken PrEP

(9990) HIV+ and taken PrEP

## 2.2 Egos' and alters' PrEP use at the event-level

5.94 The most recent time you had sex with the partner named above, were you using PrEP (pre-exposure prophylaxis)?

No

Yes

Don't know / don't remember

(9977) HIV pos

5.95 The most recent time you had sex with the partner named above, was your partner using PrEP?

No

Yes

Don't know / don't remember

(9976) Unknown or known/suspected HIV pos partner

### 3. Measures: event-level data to whether the recent partner is an anal or oral sex partner

5.77 Did you do any of the following sexual activities with the partner named above the most recent time you had sex? (Check all that apply.)

	Yes	No
He fucked me in the ass	<input type="radio"/>	<input type="radio"/>
I fucked him in the ass	<input type="radio"/>	<input type="radio"/>
He gave me oral sex (he used his mouth or tongue on my cock/frontal genitals)	<input type="radio"/>	<input type="radio"/>
I gave him oral sex (I used my mouth or tongue on his cock/frontal genitals)	<input type="radio"/>	<input type="radio"/>

### 4. Measures: network size

1.4 How many men who have sex with men aged 16 years or older, including trans men, do you know who live or work in the [Metro Vancouver/Greater Toronto/Metro Montreal depending on site] area (whether they identify as gay or otherwise)? This includes gay/bi guys you see or speak to regularly; e.g., close friends, boyfriends, spouses, regular sex partners, roommates, relatives, people you regularly hang out with, etc.

**Web Appendix 2: Details on Numbers and Proportions of Recent Sexual Partners By Alters' HIV Status (2017-2018 Engage-Montreal Study).**

Web Table 1. Numbers and Proportions of Recent Anal or Oral Sex Partners in the Past 6 Months By Alters' HIV Status, Stratified By Egos' Self-reported HIV Status and PrEP Use.

Egos' characteristics	Alters' HIV status as perceived by egos									
	Positive and certain		Positive but not certain		Negative and certain		Negative but not certain		Unaware	
	N	%	N	%	N	%	N	%	N	%
HIV-positive	216	30.9	11	1.6	200	28.6	32	4.6	240	34.3
HIV-negative	141	4.6	13	0.4	1257	41.0	594	19.4	1062	34.6
Used PrEP, past 6 months	42	8.4	4	0.8	232	46.6	68	13.7	152	30.5
Did not use PrEP, past 6 months	99	3.9	9	0.4	1025	39.9	526	20.5	910	35.4
HIV status-unknown	6	2.0	0	0.0	103	34.2	47	15.6	145	48.2

Abbreviations: PrEP: Pre-exposure Prophylaxis.

Web Table 2. Numbers and Proportions of Recent Anal Sex Partners in the Past 6 Months By Alters' HIV Status, Stratified By Egos' Self-reported HIV Status and PrEP Use.

Egos' characteristics	Alters' HIV status as perceived by egos									
	Positive and certain		Positive but not certain		Negative and certain		Negative but not certain		Unaware	
	N	%	N	%	N	%	N	%	N	%
HIV-positive	185	33.6	9	1.6	162	29.4	28	5.1	167	30.3
HIV-negative	108	5.2	9	0.4	948	45.9	410	19.9	589	28.5
Used PrEP, past 6 months	39	9.5	4	1.0	202	49.1	58	14.1	108	26.3
Did not use PrEP, past 6 months	69	4.2	5	0.3	746	45.1	352	21.3	481	29.1
HIV status-unknown	5	2.5	0	0.0	70	34.7	34	16.8	93	46.0

Abbreviations: PrEP: Pre-exposure Prophylaxis.

### Web Appendix 3. Results of Weighted Analyses Corresponding to Study Aims 1 to 3 After Respondent-Driven Sampling Adjustment.

Web Table 3. Seroconcordance Among Anal or Oral Sex Partnerships in the Past 6 Months as Expected with Proportionate Mixing Versus Observed Patterns in the 2017-2018 Engage-Montreal Study (n=1137, N=8144) <sup>a</sup>.

Egos' characteristics		Alters' HIV status as perceived by egos								
		Conditional on awareness of alters' HIV status								
		Unaware/Unsure		Negative		Positive		<i>P</i> -value*		
		% (95% CI)		% (95% CI)		% (95% CI)				
HIV status <sup>b</sup>	n	N								
			Chance <sup>c</sup>	8.7	8.1, 9.3	81.5	80.6, 82.4	18.5	17.6, 19.4	Reference
Negative	834	6061	Observed	39.3	38.1, 40.5	90.5	89.5, 91.4	9.5	8.6, 10.5	<0.001
Positive	158	1374	Observed	40.8	38.1, 43.4	38.5	35.1, 41.9	61.4	58.0, 64.8	<0.001
Unknown	145	709	Observed	63.5	59.8, 67.0	93.1	89.2, 95.8	6.9	4.2, 10.8	<0.001

Abbreviations: CI: confidence intervals.

\*Three chi-squared tests were performed independently stratified by ego's HIV status, to compare observed seroconcordance to expected seroconcordance, conditional on ego's awareness of alter's HIV status.

<sup>a</sup> n denotes number of participants; N denotes number of partnerships.

<sup>b</sup> Self-report of the most recent HIV test results; unknown was defined as those who never tested for HIV, ever tested but never received the most recent test results, or were unsure or preferred not to answer.

<sup>c</sup> Reflects the 'total number of anal or oral sex partnerships available by HIV status' under proportionate mixing assumption, which accounts for the number of individuals by HIV status, and different numbers of sexual partners they have.

Web Table 4. Variability in Seroconcordance Among Anal or Oral Sex Partnerships in the Past 6 Months By Whether or Not an HIV-Negative Participant Uses PrEP in the Past 6 Months (2017-2018 Engage-Montreal Study, n=834, N=6061) <sup>a</sup>.

Egos' characteristics		Alters' HIV status perceived by egos									
		Conditional on awareness of alters' HIV status									
		Unaware/Unsure		Negative		Positive		<i>P</i> -value*		<i>P</i> -value**	
%		%		%							
PrEP, past 6 months <sup>b</sup>	n	N	% (95% CI)		% (95% CI)		% (95% CI)		<i>P</i> -value*	<i>P</i> -value**	
			Chance <sup>c</sup>	8.7	8.1, 9.3	81.5	80.6, 82.4	18.5	17.6, 19.4	Reference	N/A
No	760	4228	Observed	43.6	42.1, 45.1	91.3	90.1, 92.4	8.7	7.6, 9.9	<0.001	Reference
Yes	74	1833	Observed	29.4	27.3, 31.5	89.0	87.1, 90.6	11.0	9.4, 12.9	<0.001	0.02

Abbreviations: CI: confidence intervals; PrEP: Pre-exposure Prophylaxis.

\*Two chi-squared tests were performed independently stratified by participant's PrEP use to compare observed seroconcordance to expected seroconcordance, conditional on awareness of alter's HIV status.

\*\*Chi-squared test was performed to compare the difference in the two observed seroconcordance by PrEP use conditional on awareness of alter's HIV status.

<sup>a</sup> n denotes number of HIV-negative participants; N denotes number of anal or oral sex partnerships of n.

<sup>b</sup> Base on whether the self-reported date of PrEP use at the most recent time was within the past 6 months.

<sup>c</sup> Reflects the 'total number of anal or oral sex partnerships available by HIV status' under proportionate mixing assumption, which accounts for the number of individuals by HIV status, and different numbers of sexual partners they have.

Web Table 5. Concordance in PrEP Use Between HIV-Negative Egos and HIV-Negative Alters as Expected with Proportionate Mixing Versus Observed Patterns Among Recent Sexual Partnerships (2017-2018 *Engage-Montreal* Study, n=838, N=1123) <sup>a</sup>.

Egos' characteristics		Alters' PrEP use, last sex <sup>b</sup> as perceived by egos									
		Conditional on awareness of alters' PrEP use									
		Unaware/Unsure		No		Yes		<i>P</i> -value*	<i>P</i> -value**		
%		%		%							
PrEP, last sex <sup>b</sup>	n	N	% (95% CI)		% (95% CI)		% (95% CI)				
			Chance <sup>c</sup>	0.0	0.0, 0.0	69.8	68.6, 70.9	30.2	29.1, 31.4	Reference	N/A
No	776	1015	Observed	11.9	10.0, 14.1	83.7	81.1, 86.0	16.3	14.0, 18.9	<0.001	Reference
Yes	62	108	Observed	16.7	10.2, 25.1	47.8	37.1, 58.6	52.2	41.4, 62.9	<0.001	<0.001

Abbreviations: CI: confidence intervals; PrEP: Pre-exposure Prophylaxis.

\*Two chi-squared tests were performed independently to compare observed concordance in PrEP use to expected concordance, conditional on awareness of alter's PrEP use.

\*\*Chi-squared test was performed to compare the difference in the proportions of partners who use PrEP by participant's PrEP use conditional on awareness of partner's PrEP use status.

<sup>a</sup> n denotes number of HIV-negative participants; N denotes number of HIV-negative recent anal or oral sex partners of n; recent is defined as among participant's up to 5 most recent male partners in the past 6 months.

<sup>b</sup> Self-reported PrEP use at the time of the most recent sex with each partner.

<sup>c</sup> Reflects the 'total number of HIV-negative anal or oral sex partnerships available by PrEP use' under proportionate mixing assumption, which accounts for the number of individuals by PrEP use, and different numbers of sexual partners they have.

### Web Appendix 4: Results of Sensitivity Analyses Corresponding to Study Aims 1 to 3.

Web Table 6. Proportions of Recent Sexual Partnerships in the Past 6 Months By HIV Status as Expected with Proportionate Mixing Versus Observed Patterns in the 2017-2018 *Engage-Montreal* Study<sup>a</sup>.

Egos' characteristics		n		N		Alters' HIV status as perceived by egos					
						Conditional on awareness of alters' HIV status				P-value*	
				Unaware/Unsure	Negative		Positive				
				% (95% CI)	% (95% CI)		% (95% CI)				
Among recent anal or oral sex partnerships (N <sup>e</sup> =4067)											
HIV status <sup>b</sup>				Chance <sup>c</sup>	5.2	4.8, 5.6	76.1	75.3, 76.9	23.9	23.1, 24.7	Reference
Negative	827	3067	Observed	54.4	52.6, 56.2	89.9	88.2, 91.4	10.1	8.6, 11.8	<0.001	
Positive	205	699	Observed	40.5	36.8, 44.2	48.1	43.2, 53.0	51.9	47.0, 56.8	<0.001	
Unknown	98	301	Observed	63.8	58.1, 69.2	94.5	88.4, 98.0	5.5	2.0, 11.6	<0.001	
Among recent anal sex partnerships (N <sup>f</sup> =2817)											
			Chance <sup>c</sup>	5.1	4.7, 5.6	74.0	73.0, 75.0	26.0	25.0, 27.0	Reference	
Negative	736	2064	Observed	48.8	46.7, 51.0	89.8	87.8, 91.5	10.2	8.5, 12.2	<0.001	
Positive	180	551	Observed	37.0	33.0, 41.2	46.7	41.3, 52.1	53.3	47.9, 58.7	<0.001	
Unknown	82	202	Observed	62.9	55.8, 69.5	93.3	85.1, 97.8	6.7	2.2, 14.9	<0.001	

Abbreviations: CI: confidence intervals.

\*6 chi-squared tests were performed independently to compare observed seroconcordance to expected seroconcordance, conditional on awareness of partner's HIV status.

<sup>a</sup> Recent sexual partnerships were measured using event-level data, which included anal or oral sex partners in the past 6 months, who were among respondent's up to 5 most recent male partners.

<sup>b</sup> Self-report of the most recent HIV test results; unknown was defined as those who never tested for HIV, ever tested but never received the most recent test results, or were unsure or preferred not to answer.

<sup>c</sup> Reflects the 'total number of anal or oral sex partnerships available by HIV status' under proportionate mixing assumption, which accounts for the number of individuals by HIV status, and different numbers of sexual partners they have.

<sup>d</sup> Reflects the 'total number of anal sex partnerships available by HIV status' under proportionate mixing assumption.

<sup>e</sup> Number of observed recent anal or oral sex partnerships in the past 6 months.

<sup>f</sup> Number of observed recent anal sex partnerships in the past 6 months.

Web Table 7. Variability in Serosorting Among Recent Sexual Partnerships in the Past 6 Months By Whether or Not an HIV-Negative Respondent Uses PrEP <sup>a</sup> (2017-2018 *Engage-Montreal* Study).

		Alters' HIV status perceived by egos										
		Conditional on awareness of alters' HIV status										
		Unaware/Unsure		Negative		Positive		<i>P</i> -value*		<i>P</i> -value**		
Egos' characteristics		% (95% CI)		% (95% CI)		% (95% CI)						
Among recent anal or oral sex partnerships (N <sup>f</sup> =3067)												
		Chance <sup>d</sup>	5.2	4.8, 5.6	76.1	75.3, 76.9	23.9	23.1, 24.7	Reference	N/A		
PrEP, past 6 months <sup>b</sup>	n	N										
No	715	2569	Observed	56.2	54.3, 58.2	91.2	89.4, 92.8	8.8	7.2, 10.6	<0.001	Reference	
Yes	112	498	Observed	45.0	40.6, 49.5	84.7	79.9, 88.7	15.3	11.3, 20.1	0.001	0.002	
PrEP, last sex <sup>c</sup>												
No	765	2716	Observed	54.2	52.3, 56.1	91.3	89.6, 92.8	8.7	7.2, 10.4	<0.001	Reference	
Yes	94	351	Observed	40.5	35.3, 45.8	84.2	78.5, 88.9	15.8	11.1, 21.5	0.006	0.002	
Among recent anal sex partnerships (N <sup>g</sup> =2064)												
		Chance <sup>e</sup>	5.1	4.7, 5.6	74.0	73.0, 75.0	26.0	25.0, 27.0	Reference	N/A		
PrEP, past 6 months <sup>b</sup>	n	N										
No	625	1653	Observed	50.7	48.3, 53.1	91.5	89.4, 93.4	8.5	6.6, 10.6	<0.001	Reference	
Yes	111	411	Observed	41.4	36.6, 46.3	83.8	78.5, 88.2	16.2	11.8, 21.5	<0.001	<0.001	
PrEP, last sex <sup>c</sup>												
No	671	1761	Observed	48.5	46.1, 50.9	91.5	89.5, 93.2	8.5	6.8, 10.5	<0.001	Reference	
Yes	93	303	Observed	36.0	30.6, 41.7	84.0	78.1, 88.9	16.0	11.1, 21.9	0.001	0.002	

Abbreviations: CI: confidence intervals; PrEP: Pre-exposure Prophylaxis.

\*Eight chi-squared tests were performed independently to compare observed concordance in PrEP use to expected concordance, conditional on awareness of alters' PrEP use among recent sexual.

\*\*Four chi-squared test were performed to compare the difference in the proportions of partners who use PrEP by respondent's PrEP use conditional on awareness of partner's PrEP use status.

<sup>a</sup> Recent sexual partnerships were included anal or oral sex partners in the past 6 months, who were from each respondent's up to 5 most recent male partners.

<sup>b</sup> Based on whether the self-reported date of PrEP use at the most recent time was within the past 6 months.

<sup>c</sup> Self-reported PrEP use at the time of the most recent sex with each partner.

<sup>d</sup> Reflects the 'total number of anal or oral sex partnerships available by HIV status' under a proportionate mixing assumption, which accounts for the number of individuals by HIV status, and different numbers of



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3 sexual partners they have.

4 <sup>e</sup> Reflects the 'total number of anal sex partnerships available by HIV status' under proportionate mixing  
5 assumption.

6 <sup>f</sup> Number of observed recent anal or oral sex partnerships in the past 6 months for HIV-negative  
7 respondents.

8 <sup>g</sup> Number of observed recent anal sex partnerships in the past 6 months for HIV-negative respondents.  
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For Peer Review

Web Table 8. Concordance in PrEP Use Between HIV-Negative Egos and HIV-Negative Alters as Expected with Proportionate Mixing Versus Observed Patterns Among Recent Anal Sex Partnerships (2017-2018 *Engage-Montreal* Study, n=764, N=993) <sup>a</sup>.

Egos' characteristics		Alters' PrEP use, last sex <sup>b</sup> as perceived by egos									
		Unaware/Unsure		Conditional on awareness of alters' PrEP use						<i>P</i> -value* <i>P</i> -value**	
				No		Yes					
PrEP, last sex <sup>b</sup>	n	N	% (95% CI)		% (95% CI)		% (95% CI)				
			Chance <sup>c</sup>	0.0	0.0, 0.0	64.1	62.9, 65.4	35.9	34.6, 37.1	Reference	N/A
No	671	830	Observed	8.0	6.2, 10.0	77.7	74.6, 80.7	22.3	19.3, 25.4	<0.001	Reference
Yes	93	163	Observed	11.7	7.2, 17.6	48.6	40.2, 57.1	51.4	42.9, 59.8	<0.001	<0.001

Abbreviations: CI: confidence intervals; PrEP: Pre-exposure Prophylaxis.

\*Two chi-squared tests were performed independently to compare observed concordance in PrEP use to expected concordance, conditional on awareness of alters' PrEP use.

\*\*Chi-squared test was performed to compare the difference in the proportions of partners who use PrEP by respondent's PrEP use conditional on awareness of partner's PrEP use status.

<sup>a</sup> n denotes number of HIV-negative respondents; N denotes number of HIV-negative recent anal sex partners of n; recent is defined as among respondent's up to 5 most recent male partners in the past 6 months.

<sup>b</sup> Self-reported PrEP use at the time of the most recent sex with each partner.

<sup>c</sup> Reflects the 'total number of HIV-negative anal sex partnerships available by PrEP use' under proportionate mixing assumption, which accounts for the number of individuals by PrEP use, and different numbers of sexual partners they have.