Internet-based partner selection and risk for unprotected anal intercourse in sexual encounters among men who have sex with men: a meta-analysis of observational studies

Joseph A Lewnard,1,2 Lea Berrang-Ford2

ABSTRACT
Introduction Men who have sex with men (MSM) who identify sex partners over the internet are more likely than other MSM to report having unprotected anal intercourse (UAI). It is unclear whether the internet facilitates pursuit of high-risk sex or whether MSM seeking sex online are a higher-risk population than other MSM. To summarise evidence as to whether internet-based partner selection predisposes MSM to high-risk behaviour, we conducted a meta-analysis of observational studies comparing MSM’s UAI risk in online-initiated encounters to their UAI risk in offline-initiated encounters.

Methods We systematically searched published, peer-reviewed literature to identify studies reporting MSM participants’ engagement in UAI with online-identified and offline-identified male partners. We calculated pooled odds ratios for any UAI and for serodiscordant UAI practices with partners identified online relative to partners identified offline. Results We included 11 studies representing 39,602 sexual encounters. Odds for any UAI, seroconcordant UAI and serodiscordant UAI with strategic positioning were higher in online-initiated than offline-initiated encounters. Odds for UAI in group sex were higher in online-initiated encounters only among HIV-positive MSM. Effect sizes for all outcomes were greater among MSM who were HIV-negative than HIV-positive MSM. Effect sizes were greatest when bathhouses, saunas and sex resorts were treated as offline comparison venues. Conclusions Encounters initiated online have elevated odds for entailing UAI and seroadaptive UAI practices. Online-delivered behavioural interventions should address insufficiency of risk-reducing practices involving UAI relative to consistent condom use and promote frequent HIV testing among MSM seeking UAI partners online.

INTRODUCTION
Internet-based platforms are increasingly prominent interfaces for sexual networking among men who have sex with men (MSM).1 Early in the HIV epidemic, bars, bathhouses, and cruising grounds were key venues for MSM to find sex partners.2 3 In contrast, by 2005 nearly half of MSM in the USA and UK had initiated sexual encounters online.4 Incidence rates of sexually transmitted infections (STIs) including HIV rose among MSM concurrently with emergence of online partner selection (OPS) venues.5–6 Popularisation of OPS additionally coincided with increasing prevalence of unprotected anal intercourse (UAI) among MSM, and notably among HIV-positive MSM.7–8 MSM who seek sex online are more likely to report engaging in UAI, to have HIV and to seroconvert than MSM who do not seek sex online.9–9 These factors may suggest OPS has mediated STI and HIV resurgence among MSM by facilitating UAI partnership formation.5–9

MSM are more likely to discuss HIV status and sexual preferences with prospective partners when meeting online than offline.10–14 These online interactions may guide MSM in identifying UAI partners.4 12 15 Intentional UAI pursuit is of public health concern as MSM increasingly adopt behavioural risk-reduction strategies that do not incorporate consistent condom use, and as incidence rates for STIs including HIV rise concurrently.16–20 Here we define selective UAI practices that MSM perceive to be risk-reducing as HIV-seroadaptive behaviours.20–22 ‘Serosorting’ is prominent among these and involves pursuing UAI exclusively with partners reporting HIV-seroconcordant status. Serosorting is imperfect for preventing HIV transmission because MSM who serosort may acquire HIV and transmit it to uninfected partners prior to receiving a positive test outcome.19 23–26 Among HIV-positive MSM, serosorting elevates probability for acquiring bacterial STIs or multivariant HIV infection.27 Strategic positioning in HIV-serodiscordant UAI (SDUAI) encounters additionally represents high-risk seroadaptive behaviour and involves HIV-negative MSM engaging selectively in insertive (penile/‘top’ role) UAI with receptive (anal/ ‘bottom’ role) HIV-positive partners to reduce risk for HIV transmission.17 18 Collectively, seroadaptive behaviours including these are more prevalent than consistent condom use among MSM.19 20

Elevated prevalence of UAI in MSM’s online-initiated encounters may signal that OPS accentuates sexual risk-taking.4 To address whether such accentuation occurs, numerous studies have evaluated MSM’s relative odds for UAI with internet-identified and offline-identified partners. To summarise evidence for risk accentuation in online-initiated encounters, and to characterise shortcomings across studies to inform research priorities, we sought to synthesise current outcomes quantitatively. Specifically, our objective was to determine whether MSM have elevated odds for UAI and seroadaptive UAI practices in online-initiated encounters.

METHODS
Registration CRD42013004396 (Prospero International Prospective Register of Systematic Reviews; http://crd.york.ac.uk/Prospero).
SEARCH AND SELECTION
In April 2013, we searched [(MSM OR “men who have sex with men”) AND (online* OR Internet*) AND (risk* OR behavior* OR behaviour* OR disclos* OR condom* OR anal or serosort* OR sero-sort* OR unprotected)] in titles, abstracts and keywords of English-language published, peer-reviewed literature in the MEDLINE and Web of Knowledge databases. We identified observational studies comparing UAI prevalence within MSM’s online-initiated and offline-initiated sexual encounters with male partners. We limited our search to studies conducted in the USA, Canada, Great Britain, and Australia and New Zealand; most studies were undertaken in these countries, and these countries have generalisable seroadaptive behaviour and HIV resurgence studies were undertaken in these countries, and these countries
have generalisable seroadaptive behaviour and HIV resurgence studies were undertaken in these countries, and these countries

We assumed all encounters at risk for entailing behaviours under consideration. We defined effect size as the OR for reporting a behaviour in online-initiated relative to offline-initiated encounters. We pooled natural-log transformations of studies’ ORs using weighted random-effects models to ensure conservative precision estimation relative to estimation under fixed-effects assumptions. The weighting procedure is described elsewhere and accounts for study-level variance and heterogeneity across studies. We defined associations as significant if 95% CIs around pooled ORs excluded unity (null effect size) and marginally significant if 90% intervals excluded unity.

To account for heterogeneity, we built subgroup models stratifying outcomes by participants’ reported HIV serostatus. We did not build subgroup models for MSM reporting unknown serostatus because self-reported unknown-status subgroups were prohibitively small within studies, if present. To assess whether associations depended upon offline reference venue, we categorised offline venues as settings where sex typically occurs on-premises or off-premises and built subgroup models considering these venues as reference exposures. We evaluated study designs to assess differences in underlying risk within and across samples potentially contributing bias. We quantified heterogeneity using Q-tests and I² indices. Following convention, we defined I²<25% as low, 25%<I²<75% as moderate and I²>75% as high heterogeneity. We visualised heterogeneity including potential publication bias with funnel plots illustrating effect sizes horizontally and SEs vertically.

For sensitivity analyses, we iteratively re-generated models without one of the k studies for outcomes where k≥5 studies provided effect size estimates. Outcomes were considered stable if re-estimates were within 1 SD of original estimates. We implemented analyses within the R environment (V3.0.1, R Foundation for Statistical Computing, Vienna, 2013) using the metafor package.

RESULTS
Identification and inclusion
We obtained 376 non-duplicate articles for review. Eighteen presented methods allowing OR estimation for behaviours considered, summarising 12 studies (figure 1). Communication with authors identified one additional study with unpublished comparative UAI outcomes. Citation tracking identified no further datasets. We obtained sufficient data to analyse outcomes from 11 studies (n=39 602 encounters). Sample characteristics across included studies are presented in table 1, and designs are detailed in online supplementary appendix I. Study outcomes are presented in tables 2 and 3 along with meta-analysis model summaries. We present larger forest plots illustrating study-level and pooled effect sizes in online supplementary appendix II.

Studies defined sexual encounters as those involving manual, oral or anal genital contact and asked MSM to report on their last 1–3 encounters within recall periods ranging 90 days to 1 year. Including all reported same-sex male encounters from all studies (k=11), we identified elevated odds for UAI in internet-initiated encounters (OR 1.24, 95% CI 1.01 to 1.52). In a subgroup model including HIV-negative respondents (k=8), we identified marginally significant odds elevation for UAI in internet-initiated encounters (OR 1.13, 95% CI 0.99 to 1.29). Although we identified a significant association by leaving out either the MINTS II studies or NHBS II studies, re-estimated ORs were stable, differing from the original estimate by less than 5%. Across these and one additional study, we identified elevated odds for UAI among HIV-positive MSM (OR 1.75, 95% CI 1.26 to 2.43). The full-sample model had high heterogeneity, whereas subgroup models had moderate heterogeneity.

Three studies provided data comparing UAI in group-sex encounters where at least one partner was identified online to group-sex encounters where all partners were identified offline. Across full samples and HIV-negative subgroups, we identified no

Statistical analysis
We examined proportions of internet-initiated UAI and non-UAI encounters with male partners, with seroconcordant male partners, and with potentially serodiscordant male partners reported by HIV-positive, HIV-negative and unknown-status MSM. When counts were unavailable, we extracted effect sizes and error measures. We defined ‘potential’ SDUAI encounters as those where the participant did not know his and/or his partner’s HIV serostatus, or reported these to differ. Within known SDUAI encounters, we identified strategic positioning if HIV-negative partners reported insertive UAI without receptive UAI or HIV-positive partners reported receptive UAI without insertive UAI. We defined partners met via websites or mobile phone-based applications as internet partners. Where available, we recorded specific partner identification venue and differentiated group-sex encounters from single-partner encounters.

Data extraction
We extracted numbers of internet-initiated and offline-initiated UAI and non-UAI encounters with male partners, with seroconcordant male partners, and with potentially serodiscordant male partners reported by HIV-positive, HIV-negative and unknown-status MSM. When counts were unavailable, we extracted effect sizes and error measures. We defined ‘potential’ SDUAI encounters as those where the participant did not know his and/or his partner’s HIV serostatus, or reported these to differ. Within known SDUAI encounters, we identified strategic positioning if HIV-negative partners reported insertive UAI without receptive UAI or HIV-positive partners reported receptive UAI without insertive UAI. We defined partners met via websites or mobile phone-based applications as internet partners. Where available, we recorded specific partner identification venue and differentiated group-sex encounters from single-partner encounters.

Downloaded from http://sti.bmj.com/ on September 24, 2016 - Published by group.bmj.com
elevation in odds for UAI in group-sex encounters involving internet partners (OR_{tot} 1.14, 95% CI 0.57 to 2.28; OR_{HIV} 1.11, 95% CI 0.50 to 2.48). Both models had high heterogeneity. For HIV-positive subgroups, we identified elevated odds for UAI in group-sex encounters with at least one internet partner (OR 1.87, 95% CI 1.03 to 3.38), with low heterogeneity.

Three studies\(^{14,38,40}\) assessed UAI risk with partners from the internet and bathhouses, saunas and sex resorts, where sex presumably occurred on-premises (table 3). We identified elevated odds (OR 1.64, 95% CI 1.52 to 1.78) for UAI with internet partners relative to partners from these venues. Estimates had low heterogeneity. Five studies\(^{14,36-40}\) distinguished partners from bars and dance clubs, with whom sex presumably occurred off-premises. These studies indicated marginally significant odds elevation for UAI with internet partners relative to partners from such venues (OR 1.14, 95% CI 0.98 to 1.33) with high heterogeneity. Precision improved if we left out the NHBS II\(^{40}\) study (OR 1.22, 95% CI 1.07 to 1.39), which did not include HIV-positive MSM, however the effect size remained smaller than the estimate involving sex-on-premises reference venues.

We identified elevated odds for UAI serosorting in internet-initiated relative to offline-initiated encounters (OR 1.01, 95% CI 0.89 to 1.11) with moderate heterogeneity.

---

**Table 1** Characteristics of included studies and participants

<table>
<thead>
<tr>
<th>Study</th>
<th>Year(s)</th>
<th>Encounters (n)</th>
<th>Recruitment</th>
<th>HIV+ (%)</th>
<th>White (%)</th>
<th>Black (%)</th>
<th>Hispanic (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chiasson et al(^{38})</td>
<td>2003–2004</td>
<td>1662</td>
<td>Online</td>
<td>8</td>
<td>78</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Grov et al(^{14})</td>
<td>2004–2005</td>
<td>2796</td>
<td>Online</td>
<td>16</td>
<td>80</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Menza et al(^{41})</td>
<td>2003–2006</td>
<td>846</td>
<td>Offline</td>
<td>19</td>
<td>86</td>
<td>&lt;5(^*)</td>
<td>3</td>
</tr>
<tr>
<td>MINTS II(^{42,43})</td>
<td>2005</td>
<td>4547</td>
<td>Online</td>
<td>45</td>
<td>27</td>
<td>16</td>
<td>25</td>
</tr>
<tr>
<td>Mustanski(^{49})</td>
<td>2004</td>
<td>530</td>
<td>Online</td>
<td>4</td>
<td>96</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>NHBS p(^{19})</td>
<td>2003–2005</td>
<td>3177</td>
<td>Offline</td>
<td>20</td>
<td>45</td>
<td>17</td>
<td>27</td>
</tr>
<tr>
<td>NHBS II(^{40})</td>
<td>2008</td>
<td>13 665</td>
<td>Offline</td>
<td>0(^\dagger)</td>
<td>44</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>SILAS W4(^{46,47})</td>
<td>2008</td>
<td>11 221</td>
<td>Online</td>
<td>12</td>
<td>80</td>
<td>&lt;8(^*)</td>
<td>15</td>
</tr>
<tr>
<td>Smith et al(^{46})</td>
<td>2002–2005</td>
<td>572</td>
<td>Offline</td>
<td>100(^\dagger) (53)(^*)</td>
<td>70</td>
<td>&lt;31(^*)</td>
<td>&lt;31(^*)</td>
</tr>
<tr>
<td>Tieu et al(^{47})</td>
<td>2008–2009</td>
<td>328</td>
<td>Mixed</td>
<td>63</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Wilson et al(^{48})</td>
<td>2007</td>
<td>258</td>
<td>Offline</td>
<td>100(^\dagger)</td>
<td>22</td>
<td>53</td>
<td>25</td>
</tr>
</tbody>
</table>

\(^{*}\)Specific proportion not available.
\(^{\dagger}\)Authors excluded persons of HIV-positive or HIV-negative serostatus from sample.
\(^{*}\)53.3% of encounters occurred after HIV diagnosis and are represented in the HIV+ subgroup UAI model; prediagnosis outcomes were not included in subgroup models because perceived serostatus in prediagnosis encounters was unavailable.

NHBS, National HIV Behavioral Surveillance; UAI, unprotected anal intercourse.
Table 2  Effect sizes from included studies and meta-analysis model summaries

<table>
<thead>
<tr>
<th>Unprotected anal intercourse (UAI)</th>
<th>OR (95% CI)</th>
<th>Weight (%)</th>
<th>OR (95% CI)</th>
<th>Weight (%)</th>
<th>OR (95% CI)</th>
<th>Weight (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full samples</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIV-negative subgroups</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model summary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I^2=88%; Q^0=46.1 (p&lt;0.0001)*</td>
<td>I^2=70%; Q^0=22.5 (p=0.0004)</td>
<td>I^2=73%; Q^0=25.7 (p=0.0012)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIV-positive subgroups</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model summary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I^2=71%; Q^0=24.4 (p=0.0004)</td>
<td>I^2=86%; Q^0=27.8 (p=0.0002)</td>
<td>I^2=79%; Q^0=27.2 (p=0.0003)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potential serodiscordant UAI (SDUAI)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model summary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I^2=73%; Q^0=27.2 (p=0.0003)</td>
<td>I^2=71%; Q^0=24.4 (p=0.0004)</td>
<td>I^2=86%; Q^0=27.8 (p=0.0002)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SDUAI with strategic positioning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chiasson et al18</td>
<td>0.89 (0.67 to 1.19)</td>
<td>14.9</td>
<td>0.78 (0.52 to 1.17)</td>
<td>13.9</td>
<td>1.53 (0.72 to 3.28)</td>
<td>11.5</td>
</tr>
<tr>
<td>Grow et al14</td>
<td>1.01 (0.81 to 1.26)</td>
<td>17.3</td>
<td>0.95 (0.71 to 1.26)</td>
<td>17.6</td>
<td>1.03 (0.66 to 1.60)</td>
<td>14.3</td>
</tr>
<tr>
<td>Menza et al41</td>
<td>0.89 (0.70 to 1.13)</td>
<td>16.8</td>
<td>0.99 (0.72 to 1.37)</td>
<td>16.4</td>
<td>0.63 (0.40 to 1.02)</td>
<td>14.0</td>
</tr>
<tr>
<td>MINTS II42 43</td>
<td>0.90 (0.55 to 1.46)</td>
<td>9.6</td>
<td>1.31 (0.73 to 2.37)</td>
<td>9.4</td>
<td>0.38 (0.14 to 0.92)</td>
<td>9.6</td>
</tr>
<tr>
<td>NHBS I9</td>
<td>1.34 (0.93 to 1.94)</td>
<td>12.5</td>
<td>1.50 (1.10 to 2.05)</td>
<td>16.8</td>
<td>0.90 (0.50 to 1.62)</td>
<td>13.0</td>
</tr>
<tr>
<td>SILAS IV</td>
<td>0.76 (0.70 to 0.83)</td>
<td>21.0</td>
<td>0.72 (0.65 to 0.81)</td>
<td>22.8</td>
<td>0.86 (0.73 to 1.00)</td>
<td>16.0</td>
</tr>
<tr>
<td>Tieu et al47</td>
<td>2.37 (0.94 to 5.98)</td>
<td>3.8</td>
<td>0.73 (0.22 to 2.42)</td>
<td>3.2</td>
<td>4.02 (1.80 to 8.98)</td>
<td>8.3</td>
</tr>
<tr>
<td>Wilson et al48</td>
<td>2.90 (1.20 to 7.01)</td>
<td>4.1</td>
<td></td>
<td></td>
<td>2.90 (1.20 to 7.01)</td>
<td>10.4</td>
</tr>
<tr>
<td>Model summary</td>
<td>I^2=73%; Q^0=27.2 (p=0.0003)</td>
<td>I^2=71%; Q^0=24.4 (p=0.0004)</td>
<td>I^2=86%; Q^0=27.8 (p=0.0002)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIV-negative subgroups</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model summary</td>
<td>I^2=71%; Q^0=24.4 (p=0.0004)</td>
<td>I^2=86%; Q^0=27.8 (p=0.0002)</td>
<td>I^2=79%; Q^0=27.2 (p=0.0003)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIV-positive subgroups</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model summary</td>
<td>I^2=71%; Q^0=24.4 (p=0.0004)</td>
<td>I^2=86%; Q^0=27.8 (p=0.0002)</td>
<td>I^2=79%; Q^0=27.2 (p=0.0003)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Q_0 denotes the value of the test statistic for k−1=10° of freedom; p denotes the type II error for rejecting the null hypothesis that the pooled estimate is without heterogeneity.

1.61, 95% CI 1.18 to 2.19) in a model pooling studies where partnership seroconcordance data were obtainable (k=6).12 14 16 39 41–43 47 48 Providing data on UAI with serodiscordant or unknown-status partners indicated null effects for OPS (OR 1.01, 95% CI 0.83 to 1.23). This was consistent in HIV-negative and HIV-positive subgroup models from the same studies (OR_{HIV−} 0.97, 95% CI 0.77 to 1.22; OR_{HIV+} 1.13, 95% CI 0.70 to 1.82). The full-samples model and HIV-positive subgroup model had high heterogeneity, and the HIV-negative subgroup model had moderate heterogeneity. In
contrast, odds for SDUAI with strategic positioning estimated from four studies were elevated in online-initiated encounters (OR 2.10, 95% CI 1.43 to 3.10), and the model had low heterogeneity.

### Risk of bias

**Within studies**

Eight studies intercepted participants in multiple online or offline venues, while two relied on one venue only and one did not conduct venue-based recruitment. Sexually explicit nature of recruitment venues varied within and across studies, as indicated in online supplementary appendix I. No studies assessed differences in outcomes or demographics among participants according to recruitment venue.

Within all studies, ‘internet’ exposure was defined only as partner identification via internet-based networking platforms; no studies identified website used for initiating each reported online encounter. In contrast, studies defined ‘offline’ exposure either as initiation via any non-internet venue or distinguished offline-initiated encounters involving bars, clubs, bathhouses, gyms, saunas or other venues; two assessed outcome differences across offline exposures.

Most studies collected outcomes representing multiple encounters per participant (see online supplementary appendix I). Of these, two studies were designed to allow matching between participants’ online and offline-initiated encounters, gathering comparative data for each participant’s last online-initiated and last offline-initiated encounter. Fewer than half of studies published outcomes stratified by participant and partner HIV status; we obtained most data for subgroup analyses and for serosorting and SDUAI via communication with authors. Although most studies collected participant age, race, viremia, and/or gay identity as well as HIV status, none stratified analyses by these factors.

### Across studies

We constructed funnel plots to visualise heterogeneity and potential publication bias (see online supplementary appendix III). Plots centred at the pooled OR indicated that although most models identified significant heterogeneity across studies, estimates generally fell within 95% confidence bounds of pooled effect size estimates and lacked clear asymmetry indicative of publication bias. Plots centred at the null effect size illustrated that many studies identified non-significant effect sizes for outcomes other than serosorting.

### DISCUSSION

Internet-initiated encounters had elevated odds for involving UAI, serosorting and SDUAI with strategic positioning. These findings are consistent with the view that OPS may facilitate selective HIV diagnosis, presently a dominant HIV-serodaptive behaviour among MSM. We identified significant internet effects on odds for UAI in group-sex encounters only among HIV-positive MSM. We identified greater effect sizes in HIV-positive than HIV-negative subgroups for all outcomes. We did not find OPS to be protective against any UAI practices.

Recent interventions have sought to increase public health agencies’ presence in OPS venues, and safer-sex messaging. OPS venues appear acceptable to MSM seeking sex online. Encouraging frequent HIV testing among HIV-negative MSM using OPS to identify UAI partners likewise represents an important objective; frequent testing may reduce probability for unknown HIV infection among MSM who through serosorting engage in UAI with HIV-negative partners.

Our findings suggest OPS facilitates UAI partner identification particularly among HIV-positive MSM. HIV diagnosis generally compels individuals to alter sexual behaviour to reduce risk for onward transmission, and serodaptive UAI behaviours may constitute a majority of risk-reduction practices following seroconversion among MSM; longitudinal studies and behavioural intervention trials indicate HIV-positive MSM have greater success maintaining serosorting and strategic positioning practices than consistent condom use as risk-reducing strategies. The internet may appeal to HIV-positive MSM wishing to initiate UAI encounters by providing an anonymous interface for disclosing HIV-positive serostatus. Searchable user profiles indicating prospective partners’ HIV statuses and behaviour preferences are moreover suggested to make UAI pursuit more efficient online than offline, and this may make it easier for HIV-positive MSM to network within HIV-positive and ‘poz-friendly’ HIV-negative MSM populations.

Excess internet-associated UAI risk was most apparent when comparing internet-initiated encounters to encounters initiated in venues where sex occurs on-premises. This supports the notion that risk differs across non-internet venues as well as between online versus offline venues. Offline risk heterogeneity may be associated with venue characteristics; condoms, HIV testing and informational resources are often available at venues where sex occurs on-premises and may deter high-risk behaviour at such venues. Such resources are not necessarily available at bars and dance clubs, and in private homes where sex occurs with partners from these venues. Additionally, sex under the influence of alcohol is more likely to occur in encounters initiated in bars and dance clubs; this may contribute to low effect sizes for OPS compared with bars and dance clubs.

Because we pooled estimates across studies rather than analysing individual-level data, we could not adjust for within-respondent clustering, and our estimates included within-respondent and across-respondent comparisons. Pooled analyses also prevented us from assessing how individual-level non-HIV factors contributed to

### Table 3 Effect sizes for UAI by offline comparison venue

<table>
<thead>
<tr>
<th>Offline comparison venue</th>
<th>OR (95% CI)</th>
<th>Weight (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHBS I39</td>
<td>1.12 (0.80 to 1.56)</td>
<td>11.9</td>
</tr>
<tr>
<td>NHBS II40</td>
<td>1.12 (0.80 to 1.56)</td>
<td>11.9</td>
</tr>
<tr>
<td>NHBS</td>
<td>1.69 (1.53 to 1.86)</td>
<td>65.0</td>
</tr>
<tr>
<td>Model summary</td>
<td>1.64 (1.52 to 1.78)</td>
<td>65.0</td>
</tr>
</tbody>
</table>

**NHBS, National HIV Behavioral Surveillance; UAI, unprotected anal intercourse.**

Take-home messages

- Internet-initiated encounters are associated with elevated odds for involving UAI, serosorting and SDUAI with strategic positioning.
- Our findings suggest OPS facilitates UAI partner identification particularly among HIV-positive MSM.
- Excess internet-associated UAI risk was most apparent when comparing internet-initiated encounters to encounters initiated in venues where sex occurs on-premises.
- Results suggest that risk differs across non-internet venues as well as between online versus offline venues.
- Offline risk heterogeneity may be associated with venue characteristics; condoms, HIV testing and informational resources are often available at venues where sex occurs on-premises and may deter high-risk behaviour at such venues.
underlying risk for UAI, potentially confounding associations between OPS and behaviour. Race and age are potential factors of interest because HIV disproportionately affects young black and Hispanic MSM.²⁷ Our assessment of bias within studies indicated that non-HIV factors potentially driving underlying heterogeneity in risk among MSM remain underexplored within included studies.

It has been suggested elsewhere that elevated UAI prevalence in online-initiated encounters may implicate OPS as a cause for high-risk behaviour among MSM.¹² ¹⁴ ¹⁸ ³⁹ ⁴¹ ⁴² ⁴³ ⁴⁴ ⁴⁵ We caution, however, that our findings merit interpretation in the context of several limitations. Studies were generally cross-sectional and relied upon self-reported personal and partner HIV status and retrospective, self-reported behaviour. Studies did not consistently evaluate outcome differences according to viremia, or receipt of and adherence to antiretroviral therapy, among respondents or their partners if HIV-infected. These factors may contribute to perceived risk and UAI decisions in serodiscordant encounters.¹⁸ ¹⁹ Studies additionally did not investigate whether effect sizes differed across OPS websites where partners were identified; websites serving the bareback community and other MSM intentionally seeking UAI may facilitate proportionally more UAI encounter formation than sites with broader audiences.⁵⁸ Disclosure options in user profiles and options for filtering prospective partners by HIV status and behaviour preferences additionally differ across websites; implications of these tools for risk behaviour remain insufficiently understood. Although publication bias is problematic in many meta-analyses,³⁴ we did not identify egregious asymmetry in funnel plots or suppression of null findings for outcomes except sero_sorting. Publication bias was unlikely to account for the significant sero_sorting findings, as estimates for this outcome had not been published and were obtained directly from investigators in all but one case.¹⁹

In addition to contributing heterogeneity, observed differences in recruitment outcomes may have implications for public health interventions. Generally, studies recruiting participants offline identified proportionally more HIV-positive and minority-race MSM than other studies. Over-representation of HIV-positive MSM in offline-recruited samples likely owed to recruitment of offline samples from clinical settings serving the gay community (see online supplementary appendix I). However, under-representation of racial minority groups in internet samples is consistent with OPS user demographics.³⁹ ⁶⁰ This may suggest continuing need for offline as well as online delivery of safer-sex messaging and other public health interventions for MSM. Although online outreach may efficiently target mostly white MSM populations at risk for UAI, online delivery may be suboptimal for interventions targeting racial-minority MSM among whom HIV resurgence is especially pronounced, and whose participation in OPS is relatively low.

Key messages

- Encounters initiated online had elevated odds for involving any unprotected anal intercourse (UAI), sero_sorting and serodiscordant UAI with strategic positioning
- Effect sizes for online partner identification were higher in HIV-positive than HIV-negative subgroups.
- Future research should address factors other than HIV status affecting associations between internet partner identification and UAI risk.

Handling editor Jackie A Cassell

Acknowledgements We thank the reviewers for helpful suggestions. We also thank Simon Rossier, Timothy Menza and Sabina Hirshfield for providing data.

Contributors JAL designed and conducted the literature search and meta-analysis, corresponded with investigators and drafted the manuscript. LB-F advised study design and interpretation and edited the manuscript.

Competing interests None.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement Readers may request data included in the published analyses from JAL, corresponding author, via email. Readers must request raw data from authors of included studies.

REFERENCES

27 Blackard JT, Mayer KH. HIV superinfection in the era of increased sexual risk-taking.


29 Hedges LV, Vevea JL. Fixed- and random-effects models in meta-analysis.


35 Viechtbauer W. Conducting meta-analyses in R with the metafor package.


50 Sanchez T. Internet-based methods may reach higher-risk men who have sex with men not reached through venue-based sampling. Open AIDS 2012;6:83–9.


Internet-based partner selection and risk for unprotected anal intercourse in sexual encounters among men who have sex with men: a meta-analysis of observational studies

Joseph A Lewnard and Lea Berrang-Ford

Sex Transm Infect 2014 90: 290-296 originally published online February 11, 2014
doi: 10.1136/sextrans-2013-051332

Updated information and services can be found at:
http://sti.bmj.com/content/90/4/290

These include:

Supplementary material can be found at:
http://sti.bmj.com/content/suppl/2014/02/12/sextrans-2013-051332.DC1.html

References
This article cites 59 articles, 7 of which you can access for free at:
http://sti.bmj.com/content/90/4/290#BIBL

Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Topics on similar topics can be found in the following collections

Drugs: infectious diseases (3159)
HIV/AIDS (2491)
HIV infections (2491)
HIV/AIDS (2491)
Condoms (756)
Reproductive medicine (1350)

Notes

To request permissions go to:
http://group.bmj.com/group/rights-licensing/permissions

To order reprints go to:
http://journals.bmj.com/cgi/reprintform

To subscribe to BMJ go to:
http://group.bmj.com/subscribe/