

1 **Understanding continuing high HIV incidence: trends in sexual behaviours, HIV testing and**
2 **the proportion of men at risk of transmitting and acquiring HIV in London 2000-2013. A serial**
3 **cross-sectional study.**

4

5 **Abstract**

6 Background: HIV incidence among men who have sex with men (MSM) in the UK has remained unchanged
7 over the last decade despite increases in HIV testing and antiretroviral (ARV) coverage. Here we examine
8 trends in sexual behaviours and HIV testing among MSM, and explore risk of transmitting and acquiring
9 HIV.

10 Methods: Ten cross-sectional surveys between 2000 and 2013 using self-administered questionnaires and
11 oral HIV antibody testing among MSM in London gay social venues.

12

13 Findings: Of 11,876 MSM recruited, 12.7% (n=1512) were HIV positive with no significant trend over time.
14 Of these, 35.3% (531/1505) had undiagnosed infection which over time declined from 34.4% (45/131) to
15 23.6% (25/106) (p=0.01) as recent HIV testing (in the last 12 months) increased from 26.4% (263/997) to
16 60.1% (467/777) (p<0.001). The increase in recent testing among the undiagnosed (from 28.6% to 66.7%,
17 p<0.001) and negative (from 26.2% to 61.7%, p<0.001) suggests undiagnosed infection may be
18 increasingly recently acquired infection.

19 Over the study period, the proportion reporting unprotected anal intercourse (UAI) during the previous
20 year increased from 43.2% (513/1187) to 52.6% (394/749) (p<0.001) and serosorting (exclusively)
21 increased from 18.3% (207/1132) to 27.7% (177/6369) (p<0.001). Overall, one in 43 (2.3%, 268/11570)
22 had undiagnosed infection and reported UAI and were therefore at risk of transmitting HIV. A further one
23 in 45 (2.2%, 259/11570) had diagnosed infection and reported UAI and not exclusively serosorting in the
24 previous year. Whilst we did not collect data on ARV or viral load, surveillance data suggest that a small
25 proportion of the latter group will have detectable viral load and hence be at risk of transmitting HIV. One
26 in four HIV negative men (25.4%, 2633/10364) were at higher risk of acquiring HIV (defined as HIV
27 negative MSM either reporting ≥ 1 casual UAI partner(s) in the previous year or not exclusively
28 serosorting). The proportions of men at risk of transmission or acquisition changed little over time.
29 Undiagnosed men reporting UAI and diagnosed men not exclusively serosorting had consistently higher
30 partner numbers than other MSM over the period.

31

32 Interpretation: Undiagnosed HIV may be increasingly recently acquired infection, during which persons
33 are most infectious. This coupled with the high partner numbers of a core group of MSM at risk of
34 transmitting HIV, and the lack of decline in the proportion of men at higher risk of acquiring the infection,
35 may explain the sustained HIV incidence.

36

37 Funding: Public Health England

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39

40 **Introduction**

41 Men who have sex with men (MSM) continue to be at highest risk of acquiring HIV in the UK. Since 2000,
42 the annual number of new HIV diagnoses among MSM has increased from 1,830 to 3,270 in 2013.^{1;2} Two
43 studies have shown estimated HIV incidence over this period to have remained stable (increasing slightly),
44 and is currently at a level similar to the annual number of new HIV diagnoses (in 2013, 2800 new infections
45 estimated).^{3;4} One of these studies uses a back-calculation approach based on CD4 cell count at diagnosis³;
46 the second is a dynamic model of sexual behaviours⁴. Given the greatly increased uptake of HIV testing
47 and antiretroviral (ARV) treatment in the last decade, which, by reducing viral load should reduce
48 transmission, the sustained level of HIV incidence supports the notion that risk behaviours must have
49 increased over this period.^{5;6} Studies suggest, since the introduction of ARVs in the mid 1990's, the
50 prevalence of high risk sexual behaviours among MSM is increasing (at least partly) due to 'treatment
51 optimism', relating both to the dramatically reduced morbidity and mortality associated with the
52 infection, and the reduced risk of transmission from a positive partner (the latter discovered in later
53 years).⁷⁻¹⁰ Few behavioural studies are able to explore trends in sexual behaviours in detail in particular
54 examining seroadaptive behaviours in relation to a confirmed versus perceived HIV status. Current
55 guidelines are for MSM to test annually and at least every three months if having UAI with new or casual
56 partners.^{1;11;12} Here we examine trends in both sexual risk and HIV testing behaviours against a
57 background of targeted prevention and testing initiatives among MSM recruited from community venues
58 in London over the last 14 years. With half of all new HIV diagnoses in the UK occurring in London, these
59 trends can be used to understand the role of behaviour change and testing in driving continued HIV
60 transmission.

61

62 **Methods**

63 **Study population and data collection**

64 The Gay Men's Sexual Health Survey is a regular community-based survey conducted since 1996. The
65 survey methods have been described in detail elsewhere.¹³⁻¹⁵ Briefly, from 2000 to 2013, for each survey,
66 fieldworkers visited 38-58 bars, clubs and saunas across London over a three month period inviting MSM
67 to self-complete a short, anonymous questionnaire on demographic and sexual behaviour characteristics,
68 and provide oral fluid specimen for HIV antibody testing (OraSure Technologies, Inc., Bethlehem,
69 Pennsylvania, USA). Recruitment was conducted between October and January for all survey years up to
70 2008; for 2011 and 2013 it was conducted between February and August. A barcode linked specimens to
71 the corresponding questionnaire. Fieldworkers explained to participants that the specimens would be
72 tested for research purposes only and results not returned to them. All participants were advised to
73 attend a healthcare setting for a named HIV test if they wanted to know their status. All men aged 16 and

74 above in the study venues were eligible to take part and fieldworkers attempted to approach all and
75 recorded refusal rates. Ethical approval was granted each year by the UCL research ethics committee
76 (00/0158). Verbal consent for anonymous saliva samples and self-completion of questionnaires was
77 obtained to ensure anonymity of all participants.

78

79 **Statistical analysis**

80 We defined undiagnosed infection when a participant had a positive Orasure specimen and reported
81 either that they (i) had never had an HIV test, (ii) perceived themselves to be negative or didn't know, (iii)
82 the result of their last test was negative. We defined a casual partner as a partner with whom unprotected
83 (condomless) anal intercourse (UAI) was reported once only and a regular partner if more than once in
84 the last year. Exclusively serosorting was defined as having UAI only with partners of presumed same HIV
85 status in the last year. We refer to it as 'presumed' as the HIV status of partners was self-reported by
86 respondents. This was established using the question '*In the past year, how many men that you had*
87 *active/passive anal intercourse without a condom did you know had the same HIV status as you.*'

88

89 MSM potentially at risk of transmitting HIV were defined as either those with undiagnosed HIV reporting
90 UAI in the previous year or with diagnosed HIV reporting UAI and not exclusively serosorting in the
91 previous year. Among the latter group, most may have had undetectable viral load due to ARV treatment
92 and may therefore not have been at risk of transmitting, but information on ARV treatment and viral load
93 were not collected in this study. The implications of this for the interpretation of our findings are
94 discussed later. MSM at higher risk of acquiring HIV were HIV negative who reported in the previous year
95 either ≥ 1 casual UAI partner(s) or not exclusively serosorting.

96

97 Data were analysed using STATA version 13.0 (StataCorp, College Station, Texas, USA). Analyses were
98 performed stratified by HIV status. We examined the significance of trends over time using linear, logistic
99 and quantile regression, adjusted for age, with survey year modelled as a linear term. For trends in HIV
100 testing, overall HIV positivity and undiagnosed HIV, we additionally adjusted for education, employment,
101 and ethnicity, and assessed linearity using a likelihood ratio test relative to a model with survey year as a
102 categorical variable. Characteristics of MSM at risk of transmitting and acquiring HIV were explored using
103 a multivariable model controlling for the year of survey as a linear term (odds ratios for year not shown).
104 Factors significant to $p < 0.05$ in univariable analyses were included in the multivariable model.

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106

107 **Laboratory procedures**

108 Oral fluid samples collected with the Orasure kit were tested for HIV antibody at Public Health England
109 (PHE) using GACELISA HIV-1 and 2 (Abbott Laboratories, Maidenhead, UK). All samples were tested for
110 total immunoglobulin (IgG) to check the specimen quality apart from those collected in 2011, when a two-
111 stage approach was used, firstly by screening with a modified enzyme immunoassay, secondly by re-
112 screening positive specimens with an enzyme immunoassay and a western blot (Genelabs HIV blot 2.2).

114 **Role of the funding source**

115 The sponsor contributed to the study design, data collection, data analysis, data interpretation and
116 writing of the report. The corresponding author had full access to all the data in the study and had final
117 responsibility for the decision to submit for publication.

119 **Results**

120 A total of 13,861 questionnaires were collected between 2000 and 2013. Response rates ranged between
121 50% and 70% each year. Venue data were missing for 930 participants (two in 2002, three participants in
122 2008 and all 925 participants in 2013, however where data were available, 82% (n=10,578) were recruited
123 from bars, 13% (n=1,636) from clubs, 6% (n=717) from saunas. We excluded 124 questionnaires from men
124 who completed the survey previously or were heterosexual reporting no anal intercourse in the last year,
125 leaving 13,737. In addition, 1,861 (13%) men were excluded as they did not provide samples for antibody
126 testing leaving 11,876. Men who did and did not give samples were similar in age, education and
127 employment status however differed slightly by ethnicity (5.7% (105/1856) vs. 3.2% (374/11841) black).
128 Among the 11,876 included, the demographic characteristics of participants were similar over each of the
129 ten surveys. Overall, the median age was 33 years and most (87%) were of white ethnicity.

131 When combining the study years, 12.7% (n=1512/11876) were HIV positive ranging between 8.5%
132 (n=82/965) and 17.4% (200/1153) over the period (Table 1). A third of positive MSM (35.3%, n=531/1505,
133 4.5% of the entire sample) were undiagnosed which declined (non-linearly) over the period from 34.4%
134 (45/131) in 2000 to 23.6% (25/106) in 2013 (p=0.01). Over this period, recent HIV testing (in the last 12
135 months) increased from 26.4% (263/997) to 60.1% (467/777) (p<0.001). Recent testing increased among
136 the undiagnosed at a similar level (from 28.6% (10/35) to 66.7% (16/24), p<0.001). The proportion of
137 MSM ever having had an HIV test increased from 63.1% (629/997) in 2000 to 91.3% (709/777) in 2013
138 (p=0.004). HIV positivity varied by recruitment venue type with a similar prevalence among MSM in bars
139 (8.1% (740/9100) diagnosed, 4.3%, (387/9100) undiagnosed) and clubs (6.5% (89/1375) diagnosed, 4.5%,

140 (62/1375) undiagnosed) and highest prevalence in saunas (11.5% (71/617) diagnosed, 9.2%, (57/617)
141 undiagnosed).

142

143 Over the 14 years, there was an increase in the proportion of MSM reporting UAI during the previous year
144 from 43.2% (513/1187) in 2000 to 52.6% (394/749) in 2013 ($p < 0.001$, Table 2, Figure 1.). This increase
145 was significant among both negative and diagnosed MSM increasing from 42.3% (448/1058) to 50.9%
146 (329/647, $p < 0.001$) and 48.8% (41/84) to 63.8% (51/80, $p = 0.002$), respectively. Among undiagnosed
147 MSM, numbers were small and no clear trend was observed, the prevalence fluctuating between 42.9%
148 (18/42) and 63.6% (14/22).

149

150 The proportion of MSM who exclusively serosorted increased overall from 18.3% (207/1132) in 2000 to
151 27.7% (177/639) in 2013; among negative men (with other presumed negative men) this increased, from
152 18.0% (181/1007) to 27.1% (150/554), among diagnosed men from 21.7% (18/83) to 30.4% (21/69) and
153 among undiagnosed men (with presumed negative men) from 19.0% (8/42) to 37.5% (6/16). (To note,
154 among men who perceived themselves to be negative, 2.8% (18/653) had undiagnosed HIV in 2013 with
155 no significant trend overtime.)

156

157 Alongside this increase in men exclusively serosorting, the proportion of men reporting UAI with partners
158 of unknown or discordant status declined from 22.3 % (253/1132) in 2000 to 16.7% (107/639) in 2013
159 ($p < 0.001$) overall, and among negative men from 21.7% (218/1007) to 15.5% (86/554) ($p < 0.001$), from
160 26.5% (22/83) to 27.5% (19/69) $p = 0.433$ among diagnosed men and from 31.0% (13/42) to 12.5% (2/16)
161 ($p = 0.012$) among the undiagnosed, respectively.

162

163 Over the 14 years of study, the mean number of sexual partners in the last year was consistently higher
164 in diagnosed positive MSM and increased significantly in this group from 4.7 (standard deviation (SD)
165 12.8) partners in 2000 to 9.7 (SD 22.5) in 2013 ($p = 0.008$), after a peak of a mean of 13.5 (SD 36.8) in 2006.

166

167 Between 2000 and 2013, there were 259 diagnosed MSM who reported UAI and were not exclusively
168 serosorting, some of whom may have been at risk of transmitting HIV. There were a further 268
169 undiagnosed HIV positive MSM who reported UAI. Together, they represented 4.6% (527/11570) of MSM
170 overall (Table 3). The overall proportion of MSM potentially at risk of transmitting HIV remained stable
171 over the period, as did the fraction of men in this group that were diagnosed and undiagnosed. Both
172 diagnosed and undiagnosed MSM potentially at risk of transmitting HIV had consistently higher UAI

173 partners numbers compared to all other MSM, while the mean number of partners increased over time
174 for all groups; in 2013 undiagnosed men at risk of transmitting reported a mean of 11.6 (SD 16.1) and
175 median of 2.5 (interquartile range (IQR) 1, 20) UAI partners in the last year; diagnosed MSM, of whom
176 some may be at risk of transmitting, reported a mean of 22.4 (SD 30) and median 10 (IQR 2,28) compared
177 to other MSM with 2.2 (SD 13.1) and 1 (IQR 0, 1), respectively. This demonstrates the skewed distribution
178 of partner numbers, with no increase over time for the majority (medians largely unchanged) but an
179 increase in partners for the fraction in the upper end of the distribution so that the mean is increased.
180 Multivariable analyses revealed that MSM were more likely to be at risk of transmitting HIV (compared
181 to all other MSM) if they were older (Adjusted Odds Ratios (AOR) 35-44 years compared to 16-24 years
182 2.7 (95% confidence interval (C.I.) 1.8-3.9), of black ethnicity (AOR compared to white: 2.6 95% C.I. 1.7-
183 3.9), had a higher number of casual UAI partners in the previous year (>10 compared to <2 AOR 21.8, 95%
184 C.I. 16.2-29.2) or had attended a genitourinary medicine clinic (GUM) clinic during the previous year (AOR
185 1.8, 95% C.I. 1.5-2.3) (Table 4).

186 HIV negative MSM were considered at higher risk of acquiring HIV if they reported UAI with ≥ 1 casual
187 partners or reported not to have exclusively serosorted in the previous year. Overall, this applied to 25.4%
188 (2633/10364) of negative men fluctuating between 23.0% (n=203/883) and 28.8% (n=377/1308) over the
189 ten surveys with no significant trend. The mean and median numbers of UAI partners in the previous year
190 among those at higher risk of acquiring HIV fluctuated between 2.8 and 6.1, and 1 and 2, respectively with
191 no trend. There was a marked increase in HIV testing in the last year among MSM in this group from 33.8%
192 (79/234) to 72.5% (111/153) ($p < 0.001$) (Table 3.). Compared to other HIV negative MSM, those at higher
193 risk of acquiring HIV were more likely to have had a high number of casual UAI partners (>10 compared
194 to <2 AOR 69.8, 95% C.I. 35.3-138.2, $p < 0.001$) or have been diagnosed with a sexually transmitted
195 infection (STI) in the previous year (AOR 1.4, 95% C.I. 1.2-1.7) (Table 4).

196 **Discussion**

197 We have shown in a 14 year time series of large-scale surveys amongst MSM in London that HIV
198 prevalence remains high at around 13%, and that there have been substantial increases in the uptake of
199 HIV testing and the concomitant decline in the fraction of HIV which remains undiagnosed. Despite these
200 changes, which may have been expected, combined with improved uptake of treatment to reduce
201 transmission, HIV incidence remains high and unchanged.^{3,4} Our data show that irrespective of the
202 positive changes in testing uptake, risk behaviour has increased over this period characterised by
203 increased UAI and increasing numbers of sexual partners, particularly among HIV positive men and those
204 who remain at risk of transmission. We have shown that serosorting, which has increased substantially
205 over the last 14 years, is a risky practice, particularly amongst negative men since 3% (in 2013) of those

206 who perceive themselves to be negative are positive and inadvertently putting others at risk. We have
207 identified and characterised a subgroup at risk of transmitting infection, in particular undiagnosed men
208 reporting UAI (one in 43 MSM) and a larger group at risk of acquiring infection (one in five negative MSM)
209 in whom maintenance of the epidemic may be occurring. As not all diagnosed MSM are on treatment
210 (69% in 2000 (personal communication Zheng Yin), 90% in 2013²) and of those on treatment, not all have
211 undetectable viral loads (94% in 2013)², a fraction of those diagnosed reporting UAI and not exclusively
212 serosorting are also likely to be at risk of transmission. Furthermore, increased uptake of recent testing,
213 combined with evidence of undiagnosed HIV positives amongst those who have recently tested negative,
214 suggest that an increasing proportion of the undiagnosed fraction may be recent infections posing high
215 risk of transmission.

216 This study examined long term trends in undiagnosed HIV, testing, UAI, serosorting and partner numbers
217 by HIV status among MSM in London. It sheds light on the changes in behaviours and testing alongside
218 other current available information on testing^{1,16} and ARV treatment uptake^{1,17}. It is known that some HIV
219 positive individuals change their behaviour shortly after diagnosis¹⁸ and here we are able to present
220 differences by HIV infection status and further explore a large group of undiagnosed MSM. In addition,
221 we were able to identify HIV positive (particularly undiagnosed) MSM reporting behaviours conducive to
222 transmission. These data will be of value to modelling studies, as we are able to provide key parameters
223 such as rate of partner change and the proportion of the population at risk.

224

225 A limitation of the study is that for MSM at risk of transmitting HIV, we had no information on the timing
226 of infection in relation to contact with sexual partners, or how many diagnosed individuals were on
227 treatment and had undetectable viral load. Among HIV diagnosed men potentially at risk of transmitting,
228 the proportion diagnosed with an STI in the last year was double that compared to other MSM (39% vs.
229 17%) which may have increased their risk of transmission. Secondly, the increase in recent testing among
230 the undiagnosed is only suggestive of undiagnosed infection being increasingly recently acquired, as we
231 cannot know length of infection among men that did not test.

232

233 Thirdly, the surveys were convenience samples and may lack generalisability and/or comparability over
234 time which may partially explain the lack of some observed trends. Response rates varied between 50%
235 and 70% and we are unable to say how non-responders differed in risk. Among the 13% that refused a
236 test, the demographic characteristics were broadly the same as those that did test, although we are
237 unable to infer differences in HIV status. Also, the self-reported behaviour and testing data may be
238 subject to recall bias. Further, new web- or app-based methods to meet partners have become
239 increasingly popular¹⁹ and MSM who use these may differ from those visiting bars, clubs and saunas; a

240 study comparing MSM recruited to online and offline behavioural surveillance studies showed that those
241 using web-based methods were younger, less gay identified, less likely to use condoms with casual
242 partners and less likely to test for HIV.²⁰ In addition, London-based MSM may not be representative of
243 MSM in the UK; in the capital the estimated HIV prevalence is one in 11 MSM compared to one in 28 in
244 England and Wales outside London.²¹ However, due to the low MSM population prevalence, it is not
245 feasible to obtain a true probability sample. Unlike many convenience samples or internet samples, we
246 did have a clear sampling frame and calculated a response rate. Data from the National Survey of Sexual
247 Attitudes and Lifestyles (NATSAL) show that in 2000, 61.6% (95% CI: 52.8-69.7) of MSM had attended a
248 gay club or bar in the last year and in 2010 this was 55% (95% CI: 44.7-64.9) (personal communication
249 Catherine Mercer). Among gay-identifying MSM, 77.5% (95% C.I. 64.3-86.8) had attended such venues in
250 the last year. Comparison of data from MSM in convenience sample surveys and NATSAL (2010) show
251 that the former are likely to overestimate rates of STI diagnoses and HIV testing but that these differences
252 are smaller among gay-identifying MSM²², suggesting our findings may be generalizable to gay-identifying
253 MSM. By obtaining trends from similar venues over an extended time frame, we were able to make
254 comparisons over time. Lastly, some participants may not have accurately disclosed their status
255 potentially inflating our estimate of the undiagnosed. However, we believe nondisclosure was kept to a
256 minimum as the self-completed survey was entirely anonymous.

257

258 To our knowledge, few UK studies exist which examine trends in sexual behaviours among MSM in the
259 community by HIV status and none that have reported trends in MSM partner numbers in detail by HIV
260 transmission risk. Most are cross-sectional data from earlier rounds of surveys included in this
261 study.^{14;15;23;24} A study by Lattimore et al. which examined the sexual behaviour of gay men in London
262 using gyms between 1998 and 2008 found a lower proportion of MSM reporting UAI than in our study
263 (36.6% vs. 50% in our study in 2008) but also an increase in UAI with partners of the same status
264 particularly among HIV negative MSM from 12.4% in 1998 to 21.1% in 2008.²⁵ A study by McDaid et al. on
265 both serosorting and strategic positioning during UAI among MSM in Scotland found that, although these
266 were occurring (among 11% of HIV positive and 13% of negative MSM in 2008), they were performed
267 inconsistently.²⁶ Both of these studies also found increased HIV testing (ever and recent) among MSM.
268 Continuing high levels of undiagnosed infection among MSM in the community has been reported also in
269 Scotland (25.4% in 2011).²⁷ To note is that HIV epidemics among MSM in numerous other countries are
270 similar to that in the UK. For example, reports show that in France and the United States, also despite
271 increases in ARV coverage and testing, transmission is sustained at a high level,^{28;29} likely due to increased
272 risk behaviours similar to those shown here.

273 This study emphasises the importance of core groups in the epidemiology and control of HIV infection
274 among the UK MSM community. The data show changes in sexual risk behaviours of MSM in London over
275 the last 14 years with more reporting UAI and using serosorting as a risk reduction strategy. As may be
276 expected, there are distinct differences in risk behaviours of MSM by HIV status with positive men
277 describing the highest risk. A subgroup of these are infectious, particularly the undiagnosed and, coupled
278 with high partner numbers, and the one in five negative men at risk of acquisition, they are likely to
279 disproportionately be the drivers of the sustained incidence over the last decade. The benefits of
280 serosorting may be outweighed by increased partner numbers, inconsistent practice and incorrect
281 perceived serostatus as demonstrated by the high proportion of undiagnosed men who incorrectly
282 perceive their status as negative. In addition, the rise in testing rates among the undiagnosed suggests
283 these infections are increasingly recently acquired, when persons may be most infectious.

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285 Modelling studies have shown that reducing the number of undiagnosed infections and subsequently
286 treating them will have the greatest impact on HIV incidence.^{30;31} There is a high level of undiagnosed HIV
287 infection in the community, particularly in saunas where nearly one in 10 men were undiagnosed.
288 Community-level interventions in settings such as bars, clubs and saunas have been shown to be
289 successful³² and not to deter clientele³³. Further, self-sampling and self-testing is acceptable to MSM³⁴
290 and now available in the UK, which could promote testing at more regular intervals, and would be
291 important in earlier detection of infection to reduce transmission, in particular among those less likely to
292 frequent sexual health clinics. Anecdotal evidence suggests the recent increase in new diagnoses and
293 infections in London¹ may also partly be attributable to other behaviours not studied here such as an
294 increase in recreational drug use.³⁵ As Kirby et al report, MSM attending the central London CODE clinic
295 (a clinic which specialises in sexual health for men who use drugs for sex referred to as chemsex) prefer
296 to use internet sites which specialise in 'barebacking' (UAI) to find partners, with an average of five
297 partners per episode reported.³⁵ Further work is needed to design interventions which also reach the
298 users of these sites.

299

300 Whilst HIV testing is increasing¹, and the coverage of ARV is high among people diagnosed, the prevalence
301 of high risk behaviours among MSM visiting gay social venues remains high. It has been demonstrated
302 that treatment as prevention strategies are unlikely to have a significant impact on HIV incidence in the
303 UK, due to transmission from men with primary infection and undiagnosed cases.³⁶ We have shown here
304 that a large fraction of undiagnosed infection is now recently acquired infection and a proportion of these
305 are likely primary infections. In addition, modelling studies have found the epidemiological effect of
306 earlier diagnosis and treatment to be offset by increases in risk behaviours.^{37;38} Pre-exposure prophylaxis

307 (PreP) may help prevent outbreaks among those with early infection, however it relies on MSM perceiving
308 themselves at risk and choosing to test; in our study a third of undiagnosed MSM had not tested within
309 the last year. Finally, it must be emphasised that serosorting, where the status of the partner is presumed,
310 is unsafe due incorrect perception of serostatus. Thus, there is an urgent need for public health authorities
311 to put more focus on behaviour change interventions alongside other possible biomedical interventions
312 currently being evaluated, such as test and treat and PreP programmes, targeting in particular the core
313 group of ‘potential transmitters’, as well as those negative with behavioural patterns putting themselves
314 at high-risk of acquisition. The social and cultural mixing between these groups will need to be considered
315 as part of the design of risk reduction strategies, e.g. targeting in particular younger MSM who may be
316 less aware of the risks and/or less able to protect themselves. These findings are an important
317 contribution to the growing evidence that testing and treat strategies alone are not sufficient to reduce
318 HIV incidence at population level. Combination prevention working closely with affected communities, to
319 reduce communitywide risk by both behavioural and biological interventions, is critical if we are to move
320 towards eradication of HIV.

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322 Catherine Mercer for providing the NATSAL statistics, Zheng Yin for providing data on proportion of
323 diagnosed men on ARV with detectable viral load in 2000, and all participants for their valuable
324 contributions.

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327 **Contributors:** All authors contributed to the design of the study. AA and SW analysed the data and drafted
328 the manuscript. All authors commented on drafts of the manuscript and approved the final version.

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330 **Panel: Research in context**

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332 **Evidence before this study**

333 We conducted a systematic review searching PubMed for articles published in English up until 14th June
334 2015 using the terms: “sexual behaviour”, “MSM”, “homosexuality or male” “trends”, “HIV”, “HIV
335 infections” or “HIV antibodies” or “HIV seropositivity” or “saliva” or “incidence” or “prevalence,” “UK”,
336 “Great Britain”. There has only been one other study examining trends in sexual behaviours among UK
337 MSM (recruited from gyms across London) between 1998-2008, which found lower rates of MSM
338 reporting unprotected anal intercourse (UAI) overall, but also an increase in the proportion of men
339 reporting UAI and to serosort. There are no studies showing trends in sexual behaviours in the UK in more
340 recent years and none showing trends in numbers of sexual partners in this population. One recent cross-
341 sectional study among HIV positive MSM recruited from HIV clinics between 2011 and 2012 showed a
342 lower prevalence of UAI (38%) and serosorting (28%). Another cross-sectional study in 2008 also found a
343 lower prevalence of serosorting and strategic positioning during UAI among MSM in Scotland with 11%
344 among HIV positive and 13% among negative MSM. Three modelling studies which used multiple national
345 surveillance databases show trends in undiagnosed HIV infection to not have declined and HIV testing to

346 have increased. In addition, similar patterns were found in community-based surveys conducted in
347 Scotland, and England.

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350 **Added value of this study**

351 Our data indicate changes in sexual risk behaviours with increasing rates of UAI and serosorting, the latter
352 considered to be a risk reduction strategy. Our findings emphasise the importance of core groups in the
353 epidemiology and control of HIV infection in MSM in the UK, with one in 20 identified as being potentially
354 at risk of transmitting and one in four at risk of acquiring HIV. Undiagnosed HIV infection may be
355 increasingly recently acquired infection, during which persons are most infectious. This coupled with the
356 high partner numbers of a core group of MSM potentially at risk of transmitting HIV, and the lack of
357 decline in the proportion at men at risk of acquiring the infection, may explain the sustained HIV incidence
358 in the UK, despite increases in HIV testing and ARV coverage.

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360 **Implications of all the available evidence**

361 There is growing evidence that test and treat interventions alone are not sufficient to reduce HIV
362 incidence at population level. Combination prevention interventions will be critical for countries with
363 similar epidemics among MSM.

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375**Table 1 Trends in HIV positivity and HIV testing among MSM in London^{a,d}, 2001-2013**

		Year											
		Total % (n)	2000 % (n)	2001 % (n)	2002 % (n)	2003 % (n)	2004 % (n)	2005 % (n)	2006 % (n)	2008 % (n)	2011 % (n)	2013 % (n)	p-value ^b
% HIV positive	All MSM	12.7 (1512/11876)	11.0 (132/1206)	11.5 (150/1309)	12.1 (126/1043)	12.2 (177/1432)	12.8 (177/1377)	12.9 (195/1503)	17.4 (200/1153)	15.0 (167/1106)	8.5 (82/965)	13.6 (106/782)	p<0.001 ^c
% undiagnosed	HIV + MSM	35.3 (531/1505)	34.4 (45/131)	49.3 (74/150)	33.9 (42/126)	44.1 (78/177)	41.2 (73/177)	29.0 (56/193)	34.9 (68/197)	28.1 (46/166)	29.3 (24/82)	23.6 (25/106)	p=0.01 ^c
% ever tested for HIV	All MSM	79.4 (9184/11568)	63.1 (629/997)	69.3 (900/1297)	75.9 (788/1035)	78.0 (112/1240)	78.1 (1065/1363)	80.4 (1195/1487)	83.4 (952/1142)	89.1 (972/1092)	89.9 (862/958)	91.3 (709/777)	p<0.004
	HIV-	77.6 (7886/10161)	61.6 (567/920)	66.9 (770/1150)	74.9 (683/912)	76.5 (955/1288)	76.0 (904/1189)	78.6 (1024/1303)	81.1 (770/950)	87.5 (818/935)	89.4 (787/880)	90.1 (608/674)	p<0.001
	HIV + undiag	78.9 (408/517)	57.1 (20/35)	77.0 (57/74)	57.1 (24/42)	80.3 (61/76)	82.1 (60/73)	76.8 (43/56)	85.3 (58/68)	93.3 (42/45)	87.5 (21/24)	91.7 (22/24)	p<0.001
% tested for HIV in the past year	All MSM	42.3 (4891/11568)	26.4 (263/997)	32.4 (421/1297)	36.2 (375/1035)	38.6 (550/1420)	42.3 (576/1363)	43.1 (634/1487)	44.0 (504/1142)	51.4 (560/1092)	55.5 (532/958)	60.1 (467/777)	p<0.001
	HIV-	42.2 (4312/10161)	26.2 (241/920)	32.1 (370/1150)	36.6 (334/912)	38.6 (482/1248)	41.58 (498/1198)	43.2 (563/1303)	44.4 (422/950)	51.9 (485/935)	56.9 (501/880)	61.7 (416/674)	p<0.001
	HIV + undiag	43.3 (224/517)	28.6 (10/35)	29.7 (22/74)	21.4 (9/42)	46.1 (35/76)	49.3 (36/73)	39.3 (22/56)	55.1 (38/68)	53.3 (24/45)	50.0 (12/24)	66.7 (16/24)	p<0.001

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379^a Determined by Orasure oral fluid specimen^b Adjusted for age, education, ethnicity and employment^c p-value for association between outcome and survey year (categorical) as data showed evidence of departure from linearity^d Denominators vary due to incomplete data on all variables

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384 **Table 2 Trends in sexual behaviours among MSM by HIV status ^{a,c}, 2000-2013**

		Year											
		Total % (n)	2000 % (n)	2001 % (n)	2002 % (n)	2003 % (n)	2004 % (n)	2005 % (n)	2006 % (n)	2008 % (n)	2011 % (n)	2013 % (n)	p-value ^b
% had UAI in the last year	HIV -	45.9 (4651/10139)	42.3 (448/1058)	44.8 (510/1138)	41.7 (378/907)	45.9 (567/1235)	42.8 (502/1173)	49.0 (633/1291)	46.5 (431/927)	46.7 (430/920)	50.2 (423/843)	50.9 (329/647)	p<0.001
	HIV+ diag	59.5 (556/934)	48.8 (41/84)	47.3 (35/74)	58.2 (46/79)	61.7 (58/94)	66.3 (65/98)	54.3 (70/129)	65.6 (82/125)	63.8 (74/116)	61.8 (34/55)	63.8 (51/80)	p=0.002
	HIV + undiag	53.9 (268/497)	53.3 (24/45)	59.2 (42/71)	53.8 (21/39)	44.0 (33/75)	56.7 (38/67)	61.5 (32/52)	55.6 (35/63)	42.9 (18/42)	52.4 (11/21)	63.6 (14/22)	p=0.93
	All	47.3 (5475/11570)	43.2 (513/1187)	45.8 (587/1283)	43.4 (445/1025)	46.9 (658/1404)	45.2 (605/1338)	49.9 (735/1472)	49.2 (548/1115)	48.4 (522/1078)	50.9 (468/919)	52.6 (394/749)	p<0.001
% exclusively serosorted in the last year	HIV -	21.2 (1942/9166)	18.0 (181/1007)	17.5 (178/1015)	16.9 (143/844)	21.2 (242/1144)	18.6 (198/1067)	23.5 (271/1155)	22.8 (186/817)	23.9 (200/838)	26.6 (193/725)	27.1 (150/554)	p<0.001
	HIV+ diag	26.1 (225/862)	21.7 (18/83)	19.1 (13/68)	20.8 (15/72)	29.5 (26/88)	30.4 (28/92)	24.2 (30/124)	27.2 (31/114)	30.5 (32/105)	23.4 (11/47)	30.4 (21/69)	p=0.06
	HIV + undiag	14.6 (64/438)	19.0 (8/42)	9.4 (6/64)	8.8 (3/34)	11.9 (8/67)	10.0 (6/60)	19.6 (9/46)	13.2 (7/53)	20.5 (8/39)	17.7 (3/17)	37.5 (6/16)	p=0.033
	All	21.3 (2231/10466)	18.3 (207/1132)	17.2 (197/1147)	17.0 (161/950)	20.6 (267/1299)	19.0 (232/1219)	23.4 (310/1325)	22.7 (224/984)	24.4 (240/982)	26.4 (207/789)	27.7 (177/639)	p<0.001
% reported UAI with partners of unknown/discordant HIV status in the last year	HIV -	19.1 (1748/9166)	21.7 (218/1007)	20.8 (211/1015)	20.5 (173/844)	20.5 (235/1114)	18.7 (200/1067)	19.8 (229/1155)	16.7 (136/817)	17.7 (148/838)	15.5 (112/725)	15.5 (86/554)	p<0.001
	HIV+ diag	30.1 (259/862)	26.5 (22/83)	23.5 (16/68)	33.3 (24/72)	29.6 (26/88)	33.7 (31/92)	28.2 (35/124)	35.1 (40/114)	29.5 (31/105)	31.9 (15/47)	27.5 (19/69)	p=0.433
	HIV + undiag	33.3 (146/438)	31.0 (13/42)	45.3 (29/64)	38.0 (13/34)	25.4 (17/67)	43.3 (26/60)	37.0 (17/46)	34.0 (18/53)	18.0 (7/39)	23.5 (4/17)	12.5 (2/16)	p=0.012
	All	20.6 (2153/10466)	22.3 (253/1132)	22.3 (256/1147)	22.1 (210/950)	21.4 (278/1299)	21.1 (257/1219)	21.2 (281/1325)	19.7 (194/984)	18.9 (186/982)	16.6 (131/789)	16.7 (107/639)	p<0.001
Number of UAI partners in the last year mean (SD); median(IQR)	HIV -	1.4 (6.8) 0 (0,1)	0.9 (3.2); 0 (0,1)	1.6 (5.9); 0 (0,1)	1.2 (5.0); 0 (0,1)	1.4 (4.9); 0 (0,1)	1.3 (7.1); 0 (0,1)	1.7 (11); 0 (0,1)	1.3 (4.3); 0 (0,1)	1.3 (4.6); 0 (0,1)	1.4 (3.6); 0 (0,1)	1.9 (12.5); 0 (0,1)	p=0.073
	HIV+ diag	9.2 (30.7) 1 (0,5)	4.7 (12.8); 0 (0,2)	4.6 (14.7); 0 (0,2)	8.3 (24.9); 1 (0,7)	7.9 (22.5); 1 (0,4)	7.1 (15.6); 2 (0,5)	9.3 (45.0); 1 (0,5)	13.5 (36.8); 1 (0,5)	11.8 (42.1); 1 (0,5)	12.6 (31.8); 1 (0,11)	9.7 (22.5); 1 (0,10)	p=0.008
	HIV + undiag	4.1 (17.5) 1 (0,2)	1.6 (3.5); 1 (0,1)	3.8 (6.5); 1 (0,3)	2.9 (8.4); 1 (0,1)	5.3 (34.6); 0 (0,2)	6.5 (22.4); 1 (0,2)	4.5 (7.8); 1 (0,4.5)	4.0 (13.9); 1,(0,2)	1.5 (3.3); 0,(0,2)	1.2 (2.2); 1(0,1)	7.4 (13.9) 1(0,5)	p=0.77
	All	2.1 (11.6) 0 (0,1)	1.2 (4.7); 0 (0,1)	1.9 (6.9); 0 (0,1)	1.8 (8.7); 0 (0,1)	2.0 (11.0); 0 (0,1)	2.0 (9.5); 0 (0,1)	2.5 (17.0); 0 (0,1)	2.8 (13.8); 0 (0,1)	2.4 (14.8); 0 (0,1)	2.0 (8.9); 1(0,1)	2.9 (14.2); 1(0,1)	p=0.001

^a Determined by Orasure oral fluid specimen
^b Adjusted for age
^c Denominators vary due to incomplete data on all variables

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390 **Table 3 Trends in the proportion of MSM potentially at risk of transmitting and acquiring HIV, their number of UAI partners in the previous year and**
 391 **recent testing among those at risk of acquiring HIV 2000-2013^{a, b}**

		Total %(n)	Year										p-value ^c	
			2000 % (n)	2001 % (n)	2002 % (n)	2003 % (n)	2004 % (n)	2005 % (n)	2006 % (n)	2008 % (n)	2011 % (n)	2013 % (n)		
Potentially at risk of transmitting HIV ^d	Undiagnosed MSM reporting UAI in the previous year	As a % of all MSM	2.3 (268/11570)	2.0 (24/1187)	3.3 (42/1283)	2.1 (21/1025)	2.4 (33/1404)	2.8 (38/1338)	2.2 (32/1472)	3.1 (35/1115)	1.7 (18/1078)	1.2 (11/919)	1.9 (14/749)	0.09
		As a % of MSM having UAI	4.9 (568/5475)	4.7 (24/513)	7.2 (42/587)	4.7 (21/445)	5.0 (33/658)	6.3 (38/605)	4.4 (32/735)	6.4 (35/548)	3.5 (18/522)	2.4 (11/468)	3.6 (14/394)	0.005
		Mean (SD) number of UAI partners ^g	7.6 (23.2)	3 (4.4)	6.5 (10.2)	5.5 (11.0)	12 (51.8)	11.4 (28.9)	7.4 (8.9)	7.1 (18.2)	3.5 (4.4)	2.4 (2.7)	11.6 (16.1)	0.62
		Median (IQR) of n UAI partners ^g	2 (1,5)	1 (1,2)	3 (1,10)	1 (1,5)	2 (1,4)	2 (1,3)	3 (1,10)	2 (1,4)	2 (1,4)	1 (1,3)	2.5 (1,20)	1.0
	Diagnosed MSM reporting UAI and not exclusively serosorting in the previous year ^e	As a % of all MSM	2.2 (259/11570)	1.9 (22/1187)	1.3 (16/1283)	2.3 (24/1025)	1.9 (26/1404)	2.3 (31/1338)	2.4 (35/1472)	3.6 (40/1115)	2.9 (31/1078)	1.6 (15/919)	2.5 (19/749)	0.07
		As a % of MSM having UAI	4.7 (259/5475)	4.3 (22/513)	2.7 (16/587)	5.4 (24/445)	4.0 (26/658)	5.1 (31/605)	4.8 (35/735)	7.3 (40/548)	5.9 (31/522)	3.2 (15/468)	4.8 (19/394)	0.47
		Mean (SD) number of UAI partners ^g	17.8 (39.5)	13.4 (21.3)	16.1 (27.6)	13.8 (17.4)	13.9 (23.4)	12 (23.0)	9.5 (11.5)	28.8 (56.0)	24.0 (71.5)	22.7 (51.6)	22.4 (30.0)	0.05
		Median (IQR) of n UAI partners ^g	5 (2,15)	7 (2,15)	4 (1,14)	7 (3,16)	3.5 (2,8)	4 (2,15)	5 (2,10)	5 (2,16)	5 (2,15)	2 (1,20)	10 (2, 28)	0.45
	Total	As a % of all MSM	4.6 (527/11570)	3.9 (46/1187)	4.5 (58/1283)	4.4 (45/1025)	4.2 (59/1404)	5.2 (69/1338)	4.6 (67/1472)	6.7 (75/1115)	4.6 (49/1078)	2.8 (26/919)	4.4 (33/749)	0.96
	Not reporting risk of transmitting HIV ^f	As a % of all MSM	95.5 (11,043/11570)	96.1 (1141/1187)	95.5 (1225/1283)	95.6 (980/1025)	95.8 (1345/1404)	94.8 (1269/1338)	95.5 (1405/1472)	93.3 (1040/1115)	95.5 (1029/1078)	97.2 (893/919)	95.6 (716/749)	0.96
As a % of MSM having UAI		90.4 (4948/5475)	91.0 (467/513)	90.1 (529/587)	89.9 (400/445)	91.0 (599/658)	88.6 (536/605)	90.9 (668/735)	86.3 (473/548)	90.6 (473/522)	94.4 (442/468)	91.6 (361/394)	0.13	
Mean (SD) number of UAI partners ^g		1.6 (9.2)	1.0 (3.3)	1.5 (5.8)	1.4 (8.1)	1.5 (6.9)	1.5 (7.3)	2.2 (17.2)	1.7 (7.0)	1.7 (8.1)	1.7 (5.6)	2.2 (13.1)	0.004	
Median (IQR) of n UAI partners ^g		0 (0,1)	0 (0,1)	0 (0,1)	0 (0,1)	0 (0,1)	0 (0,1)	0 (0,1)	0 (0,1)	0 (0,1)	0 (0,1)	1 (0,1)	1.0	
At higher risk of acquiring HIV ^{gh}	As a % of all MSM	22.8 (2633/11570)	23.6 (280/1187)	23.3 (299/1283)	23.0 (236/1025)	24.3 (341/1404)	21.5 (288/1338)	25.6 (377/1472)	19.5 (217/1115)	22.1 (238/1078)	22.1 (203/919)	20.6 (154/749)	0.275	
	As a % of all HIV negative MSM	25.4 (2633/10364)	26.1 (280/1074)	25.8 (299/1159)	25.7 (236/917)	27.2 (341/1255)	24.0 (288/1200)	28.8 (377/1308)	22.8 (217/953)	25.4 (238/939)	23.0 (203/883)	22.8 (154/676)	0.16	
	Mean (SD) of n UAI partners ^g	4.2 (12.8)	2.8 (5.7)	5.1 (10.8)	3.4 (9.0)	3.8 (8.2)	4.5 (13.9)	4.8 (20.0)	4.2 (8.1)	3.7 (8.4)	3.8 (6.0)	6.1 (25.2)	0.252	
	Median (IQR) of n UAI ^g	2 (1,3)	1.5 (1,2)	2 (1,4)	1 (1,3)	1 (1,3)	2 (1,3)	2 (1,4)	2 (1,3)	2 (1,3)	2 (1,3)	2 (1,4)	1.0	

	% tested for HIV in the last year	50.1 (1288/2573)	33*8 (79/234)	36*4 (108/297)	43*6 (102/234)	46*6 (157/337)	49*7 (141/284)	52*9 (199/376)	50*7 (110/217)	58*0 (138/238)	70*4 (143/203)	72*5 (111/153)	<0*001
392	^a Determined by Orasure oral fluid specimen												
393	^b Denominators vary due to incomplete data on all variables												
394	^c Adjusted for age												
395	^d MSM with undiagnosed HIV who reported UAI in the previous year or MSM with diagnosed HIV who reported UAI and to not have exclusively serosorted.												
396	^e no ART or VL data available so we were unable to ascertain if men in this group were on treatment and had undetectable viral loads and therefore not at risk of transmitting HIV.												
397	^f all MSM not included in ^d who provided information on number of UAI partners												
398	^g In the last year												
399	^h HIV- MSM reporting ≥ 1 casual UAI partner or not exclusively serosorting in the last year												
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413 **Table 4 Factors associated with potential risk of transmitting and higher risk of acquiring HIV in MSM, 2000-2013 combined**

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Characteristic	% (n/N) ^c	MSM potentially at risk of transmitting HIV ^a				MSM at higher risk of acquiring HIV ^b				
		OR (95% C.I.) ^d	p-value	AOR (95% C.I.) ^e	p-value	% (n/N)	OR (95% C.I.) ^d	p-value	AOR (95% C.I.) ^e	p-value
Total	4.6 (527/11570)	N/A		N/A		25.4 (2633/10364)	N/A		N/A	
Age										
16-24	2.5 (40/1583)	1.0		1.0		30.2 (469/1554)	1.0		1.0	
25-34	4.6 (217/4735)	1.85 (1.32-2.60)		2.11 (1.45-3.08)		26.6 (1146/4317)	0.84 (0.74-0.95)		0.94 (0.79-1.12)	
35-44	5.4 (195/3635)	2.19 (1.55-3.09)	0.0002	2.67 (1.82-3.92)	<0.0001	24.1 (745/3090)	0.74 (0.64-0.85)	<0.0001	0.83 (0.69-1.00)	0.003
45-64	4.8 (70/1455)	1.94 (1.31-2.89)		2.55 (1.64-3.97)		20.1 (250/1245)	0.59 (0.49-0.70)		0.62 (0.49-0.80)	
65+	1.2 (1/82)	0.48 (0.06-3.50)		0.89 (0.11-7.21)		11.3 (9/80)	0.30 (0.14-0.66)		0.39 (0.15-1.04)	
Ethnicity										
White	4.4 (434/9973)	1.0		1.0		25.5 (2269/8912)	1.0		--	
Black	11.5 (41/356)	2.86 (2.04-4.01)		2.60 (1.73-3.90)		26.5 (76/287)	1.06 (0.81-1.38)		--	
Asian	3.2 (10/314)	0.72 (0.38-1.37)	<0.0001	0.83 (0.43-1.64)	0.0001	23.6 (73/310)	0.90 (0.69-1.18)	0.14	--	--
South East Asian	2.5 (5/204)	0.55 (0.23-1.35)		0.71 (0.28-1.81)		18.3 (36/197)	0.65 (0.45-0.94)		--	
Mixed/other	5.2 (36/689)	1.21 (0.85-1.71)		1.21 (0.82-1.79)		26.8 (168/628)	1.09 (0.90-1.31)		--	
Years education post age 16										
None	5.2 (69/1325)	1.0		1.0		28.1 (314/1116)	1.0		1.0	
Up to 2 years	6.3 (119/1888)	1.22 (0.90-1.66)		1.32 (0.94-1.85)		27.9 (459/1648)	0.99 (0.84-1.17)		0.91 (0.72-1.13)	
3 years or more	4.1 (306/7459)	0.77 (0.59-1.01)	0.0002	0.91 (0.68-1.23)	0.03	24.3 (1637/6741)	0.83 (0.72-0.95)	0.003	0.82 (0.68-0.99)	0.18
Still in full time education	3.7 (30/820)	0.69 (0.44-1.06)		0.99 (0.60-1.63)		27.3 (213/779)	0.97 (0.79-1.19)		0.85 (0.64-1.14)	
Employed										
No	5.8 (87/1508)	1.0		1.0		27.4 (342/1247)	1.0		1.0	0.96
Yes	4.4 (437/10021)	0.75 (0.59-0.95)	0.011	0.97 (0.74-1.27)	0.81	25.2 (2289/9091)	0.89 (0.78-1.02)	0.09	1.02 (0.84-1.24)	
Age of first AI <16 years										
No	4.4 (410/9393)	1.0		1.0		25.8 (2176/8429)	1.0		1.0	0.42
Yes	7.5 (110/1463)	1.78 (1.43-2.22)	<0.0001	1.27 (1.00-1.63)	0.054	33.3 (406/1218)	1.44 (1.26-1.64)	<0.0001	1.11 (0.94-1.33)	
Casual UAI partners in the last year										
<2	1.8 (168/9264)	1.0		1.0		14.6 (1227/8380)	--		1.0	
2-5	11.0 (180/1633)	6.73 (5.42-8.37)	<0.0001	5.50 (4.37-6.91)	<0.0001	76.9 (1046/1360)	19.7 (17.1-22.7)	<0.0001	17.9 (15.4-20.9)	<0.0001
6-10	18.7 (64/343)	12.5 (9.15-17.06)		9.83 (7.08-13.64)		89.9 (218/245)	48.0 (32.0-71.9)		54.4 (33.3-88.8)	
>10	34.9 (115/330)	29.3 (22.3-38.51)		21.77 (16.23-29.19)		92.2 (142/154)	70.2 (38.8-127.0)		69.8 (35.3-138.2)	
STD in the last year										
No	3.4 (321/9391)	1.0		1.0		22.5 (1938/8610)	1.0		1.0	<0.001
Yes	9.7 (202/2083)	3.05 (2.54-3.67)	<0.0001	1.24 (0.99-1.55)	0.058	40.4 (671/1661)	2.32 (2.08-2.59)	<0.0001	1.43 (1.22-1.68)	<0.001
Attended a GUM clinic in the last year										
No	2.5 (154/6199)	1.0		1.0		21.5 (1275/5537)	1.0		1.0	
Yes	7.0 (367/5256)	2.97(2.45-3.60)	<0.0001	1.81 (1.45-2.26)	<0.0001	30.7 (1330/4327)	1.65 (1.50-1.80)	<0.0001	1.10 (0.97-1.25)	0.12

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^a includes MSM with undiagnosed HIV who report UAI in the previous year and MSM with diagnosed HIV who report UAI and not to have exclusively serosorted in the last year; compared to all other MSM

^b includes HIV negative MSM who either report 1+UAI casual partner or not exclusively serosorting in the last year; compared to all other HIV negative MSM

^c denominators vary due to incomplete data on all variables

^d adjusted for age and year of survey

^e multivariable model includes variables that were p<0.05 in^d

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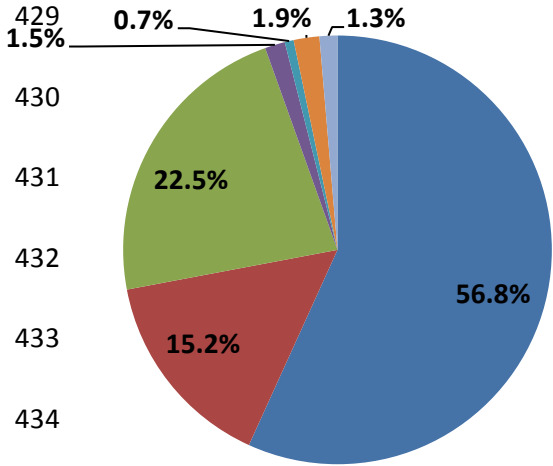
425

426 **Figure 1 Prevalence of serosorting by HIV status among MSM in London in 2000 and 2013**

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2000



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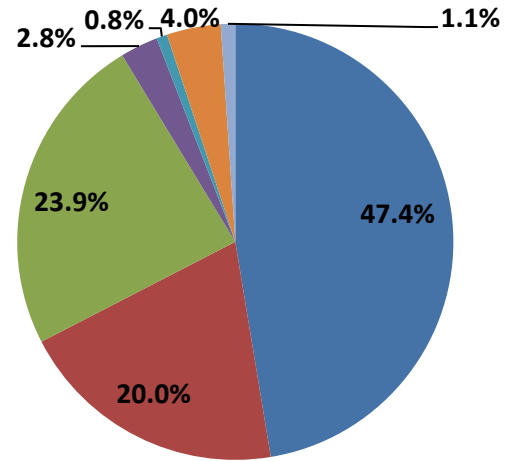
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- No UAI
- HIV - exclusively serosorting
- HIV - not exclusively serosorting
- Diagnosed exclusively serosorting
- Undiagnosed exclusively serosorting with presumed negative partners
- Diagnosed not exclusively serosorting

2013



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