

# Cross-sectional analysis of chemsex drug use and gonorrhoea diagnosis among men who have sex with men in the UK

Manik Kohli<sup>A</sup>, Ford Hickson<sup>A,B</sup>, Caroline Free<sup>A</sup>, David Reid<sup>A</sup> and Peter Weatherburn<sup>A</sup>

<sup>A</sup>London School of Hygiene & Tropical Medicine, Keppel Street, London, WC1E 7H, UK.

<sup>B</sup>Corresponding author. Email: [ford.hickson@lshtm.ac.uk](mailto:ford.hickson@lshtm.ac.uk)

**Abstract.** **Background:** Illicit drug use among men who have sex with men (MSM) has been associated with sexual risk and HIV. Less is documented about associations with other sexually transmissible infections (STIs). The aim of the present study was to determine whether the use of drugs commonly associated with chemsex is associated with increased risk of gonorrhoea among MSM. **Methods:** Using data from 16 065 UK-based respondents to the European MSM Internet Survey (2010), we examined associations between a recent diagnosis of gonorrhoea and three chemsex drugs (crystal methamphetamine,  $\gamma$ -hydroxybutyric acid (GHB)/ $\gamma$ -butyrolactone (GBL) and mephedrone). Univariate logistic regression identified determinants of gonorrhoea diagnosis and multivariate logistic regression models calculated adjusted odds ratios (aORs) for independent associations between chemsex drugs and gonorrhoea. **Results:** MSM who reported using crystal methamphetamine and GHB/GBL in the previous year had 1.92- and 2.23-fold higher odds of gonorrhoea respectively over the same period ( $P=0.0001$  and  $P<0.0001$ ;  $n=15\,137$ ) after adjusting for age, recruitment website, HIV status, residence and use of other chemsex drugs. MSM reporting the use of all three chemsex drugs had the highest increased odds (aOR 3.58;  $P<0.0001$ ;  $n=15\,174$ ). Mephedrone alone was not associated with gonorrhoea in multivariate models. **Conclusions:** Use of chemsex drugs is associated with a higher risk of gonorrhoea. The results of this study complement existing research about crystal methamphetamine and indicate a role for GHB/GBL in adverse sexual health outcomes. The use of mephedrone alongside other chemsex drugs may account for its lack of association with gonorrhoea in multivariate models. Future research should use encounter-level data, examine other STIs and attribute pathways through which chemsex leads to infection.

**Additional keywords:** crystal methamphetamine, gay, illicit drugs, MSM, sexually transmissible infection.

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## Introduction

Men who have sex with men (MSM) have been shown to have higher rates of drug use than the general population, including the use of crystal methamphetamine,  $\gamma$ -hydroxybutyric acid (GHB)/ $\gamma$ -butyrolactone (GBL), ketamine, cocaine, cannabis, ecstasy or 3,4-methylenedioxymethamphetamine (MDMA), mephedrone, volatile nitrites (poppers) and sildenafil.<sup>1,2</sup> Traditional ‘club’ drugs, such as ecstasy and cocaine, have made room for the increasingly popular ‘chemsex’ drugs, due in part, to their ability to increase and sustain sexual arousal for extended ‘sessions’. There is variation in the types of drugs used and their prevalence across different countries.<sup>3</sup> One study estimated the prevalence of crystal methamphetamine use among MSM in London to be as high as one in 10.<sup>4</sup> A recent Australian study found 5.4% of gay and bisexual men had used GHB in the past 6 months.<sup>5</sup>

‘Chemsex’ refers to combining sex and illicit drugs (in particular stimulants) among groups of MSM to intensify and extend sexual sessions. In the UK, the most commonly

used chemsex drugs are crystal methamphetamine, GHB/GBL and mephedrone, although other drugs may be used.<sup>2,6,7</sup>

The increasing prevalence and awareness of chemsex poses a public health challenge for health professionals and social scientists attempting to understand the motivations and risks involved. Chemsex is not necessarily commonplace among the general MSM population, but the use of harmful drugs, such as crystal methamphetamine, is high among MSM who do engage in chemsex.<sup>8</sup> Combining sex and drugs, including oral erectile dysfunction medication, has been found to be associated with high-risk sexual behaviours and HIV.<sup>4,9–12</sup>

Existing chemsex research has focused on HIV; there has been little investigation of the relationship between chemsex and other sexually transmissible infections (STIs) such as gonorrhoea. Many studies have used sexual behaviours associated with high transmission of STIs as their main outcome (in particular condom-unprotected anal intercourse (cUAI)), and assumptions are made that this translates into increased transmission of STIs.<sup>4,6,13,14</sup>

Crystal methamphetamine has been shown to be associated with engagement in cUAI, cUAI between HIV serodiscordant partners, higher numbers of sexual partners and multipartner encounters, all of which are risk factors for HIV transmission.<sup>4,9,10,15,16</sup> Crystal methamphetamine has been the primary focus for research; published research demonstrating associations of GHB/GBL and mephedrone with high-risk behaviours, such as UAI and multipartner encounters, is less consistent.<sup>2,6,16,17</sup> Multipartner encounters and cUAI have been associated with GHB use in the previous 6 months.<sup>5</sup>

Although several studies have found evidence of an association between crystal methamphetamine and HIV among MSM, differing study designs, samples sizes and methods of data collection and analysis have led to inconsistent results.<sup>11,14,15,18</sup> A systematic review and meta-analysis of 35 different studies, across three different pooled estimates, found amphetamine-like substances were significantly associated with HIV infection, with between 1.8- and 3.5-fold increased odds, prevalence rate or hazard of infection.<sup>11</sup>

One study (in New York) found evidence of an association between crystal methamphetamine and incident non-HIV STI diagnoses, almost half of which were gonorrhoea.<sup>13</sup>

Sexual health services in the UK face growing challenges from bacterial STIs, which have reached record levels among MSM. Although chlamydia is the most common bacterial STI in the total adult population, among MSM gonorrhoea has more annual incident diagnoses.<sup>19,20</sup> In England between 2008 and 2012, gonorrhoea diagnoses in MSM approximately trebled.<sup>19</sup> Drug-resistant gonorrhoea is increasing, with the first known case of treatment failure internationally being reported in the UK in 2015.<sup>21</sup>

Among MSM, determinants of gonorrhoea infection include frequent partner change and cUAI. Studies have also identified the use of recreational drugs and HIV seropositivity, as well as younger age and lower socioeconomic status, as determinants of gonorrhoea infection.<sup>22–26</sup> Public health responses to gonorrhoea and other STIs require a multidisciplinary approach, transmission prevention strategies, screening and diagnostics and new antibiotics. Interventions to prevent transmission require targeting high-risk groups, such as MSM. To increase program effectiveness, we need to identify key determinants for gonorrhoea infection among MSM and have a good understanding of the circumstances that lead to transmission.

The objective of the present study was to examine associations between gonorrhoea and the use of chemsex drugs, using data collected as part of the 2010 European Men-who-have-sex-with-men Internet Survey (EMIS).<sup>27,28</sup>

## Methods

Data from UK-based respondents to the first EMIS were used to examine associations between gonorrhoea diagnosis and the three main UK chemsex drugs (crystal methamphetamine, GHB/GBL and mephedrone). EMIS was an online self-completion survey recruited in 2010, predominantly on gay dating websites (for detailed study design and methodology, see Weatherburn *et al.*<sup>29</sup>). Analyses were conducted in STATA v14 (StataCorp, College Station, TX, USA). Ethics approval

for the original study was granted by the University of Portsmouth, and ethics approval for this analysis was obtained from the London School of Hygiene and Tropical Medicine MSc Research Ethics Committee. Written consent from participants was included in the survey.

Potential confounders were identified and a conceptual framework was devised to illustrate the distal and proximal determinants of gonorrhoea, directions of associations and theoretical relationships (see Fig. 1).

The UK dataset consisted of 18 234 cases. Of these, 2169 contained discrepant responses across HIV testing history and/or sexual behaviour and were dropped before further analysis.

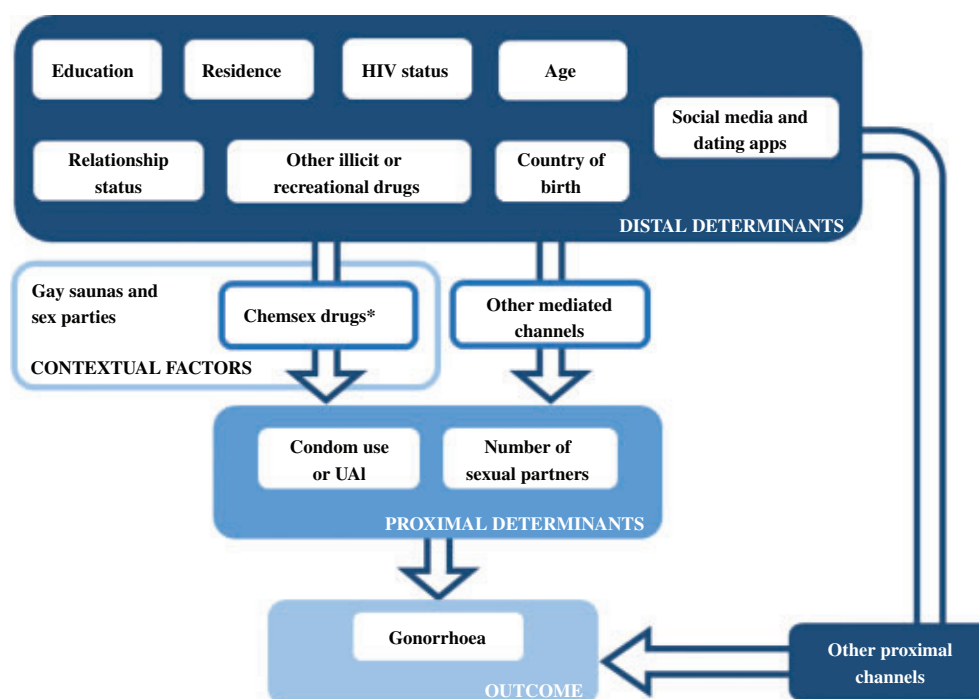
Event-based exposure and outcome variables were recoded as binary, indicating use, diagnosis or visit in the previous 12 months.

The sample was first described using counts and percentages. Univariate logistic regression examined the association between potential risk factors and gonorrhoea, as well as between the potential risk factors and each chemsex drug. A Chi-squared test-for-trend was conducted where a potential trend in odds was observed. When comparing odds ratios (ORs) between two strata within a variable, a Wald test was used.

Age group and recruitment website were identified *a priori* for the multivariate models. The Mantel–Haenszel test was used to look for confounding by potential risk factor of the association between gonorrhoea and drug use. This was repeated to examine confounding of the association between gonorrhoea and each drug by the other two drugs.

Multivariate logistic regression models were built for each of the three drugs. Further variables were added in the same order for each model starting with the *a priori*, then variables determined to be more distal and then proximate to the outcome. Variables considered as on the causal pathway or contextual to the use of drugs were not adjusted for in the final models. As variables were added, ORs were reviewed for meaningful changes and, if present, the likelihood ratio test (LRT) used to determine whether the model had been improved. The variables kept in each model were the same: age group, recruitment website, size of settlement of residence (residence population) and HIV status. The same final logistic regression model was created by adding the two drugs not included to each initial model. Final Model A included gonorrhoea, crystal methamphetamine, GHB/GBL, mephedrone, age group, recruitment website, residence population and HIV status. LRTs were performed for each drug to determine the strength of evidence of any observed association between the drug and gonorrhoea in the fully adjusted multivariate model.

Multivariate logistic regression analysis and LRT were repeated using the combined drug variable. Final Model B included gonorrhoea, the combined drug variable, age group, recruitment website, residence population and HIV status. The number and proportion of observations dropped in each of the two final multivariate models was calculated. Additional crude ORs for the associations between gonorrhoea and crystal methamphetamine, GHB/GBL, mephedrone and all three drugs were calculated using univariate logistic regression including only the populations in each of the final models.



**Fig. 1.** Conceptual framework of determinants of gonorrhoea infection. \*Crystal methamphetamine,  $\gamma$ -hydroxybutyric acid (GHB)/ $\gamma$ -butyrolactone (GBL) and mephedrone. UAI, unprotected anal intercourse.

## Results

### Sample description

The total number of MSM in the analysis was 16 065. The majority of UK respondents were recruited from four sites: GaydarON, Manhunt, GayRomeo and Gaydar. There were missing data in the main outcome of interest (gonorrhoea ever, missing=215; previous year, missing=239) and the three chemsex drugs (crystal methamphetamine missing=149; GHB/GBL missing=160; mephedrone missing=133). For the combined variable recording the use of all three drugs in the previous year, data were missing for 215 MSM. Of variables included in the analysis, complete data existed only for age, gender identity and number of casual partners; the variables with the most missing data were cUAI at last sex (missing=1132), condom use (missing=6247) and number of casual cUAI partners (missing=6360). There was significant 'missing data' for the frequency of condom use and the number of casual cUAI partners, but respondents without casual partners were not asked to answer these two questions. Between 5.5% and 5.8% of observations were excluded from the final multivariate models due to missing data.

Most respondents identified as men (99.8%), with only 27 identifying as transgender men or transgender women. Nearly all (94.6%) identified as gay or bisexual; 4.4% of survey respondents selected 'I don't usually use a term' with regard to sexual orientation. The mean age of respondents was 37.2 years, and most (81.0%) were

educated beyond secondary level. Most respondents (72.4%) lived in settings with populations over 100 000, and 39.0% lived in cities with populations over 1 million. Of respondents living in England, just over one-third lived in London. Of the respondents, 28.6% were born outside the UK and most foreign-born respondents in England lived in London (60.0%). Table 1 provides a further description of the sample.

One-fifth of respondents (20.4%) and 543 men (3.4%) reported ever being diagnosed with gonorrhoea or being diagnosed in the past year respectively (see Table 2). Just over half (52.2%) disclosed ever having used illicit drugs. Of the three chemsex drugs, GHB/GBL was the most commonly ever used (13.0%), followed by mephedrone (11.6%) and crystal methamphetamine (8.1%). A similar proportion of respondents had used mephedrone in the previous year as had ever used mephedrone (11.1% and 11.6% respectively), indicating its recent introduction to the UK at the time of the survey (2010). Lower proportions of respondents had used crystal methamphetamine and GHB/GBL in the past year compared with ever. Only 2.4% of respondents reported having used all three chemsex drugs in the previous year.

### Potential risk factors

Of the respondents, 10.5% ( $n=1685$ ) reported being definitely HIV positive, 5.0% reported that they were not sure or were possibly HIV positive and the remaining 84.5% reported being HIV negative. In addition, 44.0% of respondents reported having cUAI at their most recent sex.

**Table 1. Descriptive data of the study sample**  
Data are given as *n* (%)

Age (years; <i>n</i> = 16 065)	
<20	646 (4.0)
20–24	2077 (12.9)
25–29	2428 (15.1)
30–34	2240 (13.9)
35–39	2089 (13.0)
40–44	2097 (13.1)
45–49	1777 (11.1)
50–54	1204 (7.5)
≥55	1507 (9.4)
Education <sup>A</sup> ( <i>n</i> = 15 959)	
Primary	454 (2.8)
Lower secondary	1082 (6.8)
Upper secondary	1494 (9.4)
Postsecondary non-tertiary	2700 (16.9)
First-stage tertiary	2692 (16.9)
Second-stage tertiary	7537 (47.2)
Residence population ( <i>n</i> = 15664)	
>1 million	6104 (39.0)
500 000–999 999	1859 (11.9)
100 000–499 999	3380 (21.6)
10 000–99 999	2737 (17.5)
<10 000	1584 (10.1)
Sexuality ( <i>n</i> = 16 031)	
Gay/homosexual	13 337 (83.2)
Bisexual	1827 (11.4)
Straight/heterosexual	85 (0.5)
Other term	75 (0.5)
Does not define	707 (4.4)
Relationship status ( <i>n</i> = 16 017)	
Steady relationship <sup>B</sup>	6761 (42.2)
Single	9256 (57.8)
Born in the UK ( <i>n</i> = 15664)	
Yes	11 179 (71.4)
No	4485 (28.6)

<sup>A</sup>Classified using International Standard Classification of Education (ISCED) 1997 levels of education.<sup>30</sup>

<sup>B</sup>With a male or female partner.

One-quarter of respondents (26.7%) reported no casual sexual partners in the previous year, whereas 4.9% reported more than 50 partners (the top of the scale offered). Approximately half of all respondents (49.0%) included in the analysis reported having no cUAI with casual partners in the previous year, 29% reported cUAI with one or two casual partners and 9.4% reported cUAI with seven or more casual partners. Of respondents with casual sexual partners, approximately half (48.8%) reported always using a condom for anal sex with a casual partner, 26.3% reported using a condom more than half the time and 13.8% reported using a condom seldom or never. More than half the respondents (53.0%) reported ever having visited a gay sauna, with one-third visiting within the previous 12 months. Many respondents also reported attending private sex parties (30.5% ever; 17.0% in the previous year) and public sex parties or other sex-on-premises venues (44.1% ever; 25.6% in the previous year).

**Table 2. Number of respondents (%) reporting gonorrhoea and use of each chemsex drug in the sample**  
GHB/GBL,  $\gamma$ -hydroxybutyric acid/ $\gamma$ -butyrolactone

Gonorrhoea ever ( <i>n</i> = 15 850)	
Yes	3235 (20.4)
No	12 615 (79.6)
Gonorrhoea in the previous year ( <i>n</i> = 15 826)	
Yes	543 (3.4)
No	15 283 (96.6)
Crystal methamphetamine ever ( <i>n</i> = 15 916)	
Yes	1296 (8.1)
No	14 620 (91.9)
Crystal methamphetamine in the previous year ( <i>n</i> = 15 916)	
Yes	671 (4.2)
No	15 245 (95.8)
GHB/GBL ever ( <i>n</i> = 15 905)	
Yes	2086 (13.0)
No	13 837 (87.0)
GHB/GBL in the previous year ( <i>n</i> = 15 905)	
Yes	1125 (7.1)
No	14 780 (92.9)
Mephedrone ever ( <i>n</i> = 15 932)	
Yes	1846 (11.6)
No	14 086 (88.4)
Mephedrone in the previous year ( <i>n</i> = 15 932)	
Yes	1773 (11.1)
No	14 159 (88.9)
All three chemsex drugs ever ( <i>n</i> = 15 810)	
Yes	635 (4.0)
No	15 175 (96.0)
All three chemsex drugs in the previous year ( <i>n</i> = 15 850)	
Yes	382 (2.4)
No	15 468 (97.6)

### Associations between risk factors and chemsex drugs

Potential risk factors and confounders significantly associated with use of each chemsex drug in the past year were age group, larger residence population, gay identity, believing being HIV positive or unknown status, higher numbers of casual partners and casual cUAI partners, less condom use, being single, born outside the UK, visiting a gay sauna, public sex party or private sex party in the previous year, and website of recruitment to the study.

Use of GHB/GBL, mephedrone and all three chemsex drugs was associated with higher education levels (Chi-squared test-for-trend  $P_{\text{GHB/GBL}} = 0.0044$ ,  $P_{\text{mephedrone}} = 0.0001$ ,  $P_{\text{all3}} = 0.0007$ ), but education was not associated with crystal methamphetamine use.

As population of residence increased, the odds of drug use also increased (crystal methamphetamine, GHB/GBL, mephedrone, all three: Chi-squared tests-for-trend  $P < 0.0001$ ). Those living in cities with populations over 1 million had between 5.6- and 8.6-fold higher odds of use of a chemsex drug in the previous year than those living in locations with populations less than 10 000 (crude  $\text{OR}_{\text{crystalmeth}} = 5.62$  (95% confidence interval (CI) 3.69–8.58;  $P_{\text{wald}} < 0.001$ ); crude

**Table 3. Univariate analysis of survey responses for associations between gonorrhoea in the previous year and chemsex drugs in the previous year**CI, confidence interval; GHB/GBL,  $\gamma$ -hydroxybutyric acid/ $\gamma$ -butyrolactone; OR, odds ratio

Drug	No. respondents	No. cases (%)	Crude OR <sup>A</sup>	95% CI	P-value <sup>B</sup>
Crystal methamphetamine ( <i>n</i> = 15 697)					
No	15 038	426 (2.8)	1		
Yes	659	112 (17.0)	7.02	5.61–8.79	<0.0001
GHB/GBL ( <i>n</i> = 15 686)					
No	14 578	379 (2.6)	1		
Yes	1108	158 (14.3)	6.23	5.11–7.59	<0.0001
Mephedrone ( <i>n</i> = 15 712)					
No	13 967	374 (2.7)	1		
Yes	1745	163 (9.3)	3.74	3.09–4.53	<0.0001
All three chemsex drugs ( <i>n</i> = 15 632)					
No	15 260	460 (3.01)	1		
Yes	372	76 (20.43)	8.26	6.32–10.81	<0.0001

<sup>A</sup>Calculated from logistic regression.<sup>B</sup>Likelihood ratio test.

OR<sub>GHB/GBL</sub> 6.43 (95% CI 4.54–9.10;  $P_{\text{wald}} < 0.001$ ); crude OR<sub>mephedrone</sub> 5.19 (95% CI 3.98–6.76;  $P_{\text{wald}} < 0.001$ ).

#### Univariate analysis of associations with gonorrhoea

MSM who reported use of a chemsex drug in the previous year had between 3.7- and 8.3-fold higher unadjusted odds of gonorrhoea diagnosis than MSM who did not. Use of all three chemsex drugs was associated with the highest odds of gonorrhoea (see Table 3).

Univariate analysis found each of the following variables to be strongly associated with gonorrhoea: age; residence; sexuality; relationship status; born in the UK; HIV status; number of casual partners and casual cUAI partners in the previous year; condom use; visiting a sauna; private or public sex party in the previous year; and ever having used illicit drugs. Education was not associated with gonorrhoea. For further details, see Table 4. Among the 27 MSM who identified as transgender, there were no cases of gonorrhoea.

Those aged over 55 years had lowest odds of gonorrhoea. Using this group as the baseline, odds and prevalence of gonorrhoea increased with age from under 20 years of age to those aged 30–34 years before beginning to decrease (Chi-squared test-for-trend  $P < 0.0001$ ). Increasing odds and prevalence of gonorrhoea were noted as the population of place of residence increased (Chi-squared test-for-trend  $P = 0.0001$ ).

There was very strong evidence that as the number of casual partners and number of casual cUAI partners increased, the odds of gonorrhoea infection in the previous year also increased (both Chi-squared tests-for-trend  $P < 0.0001$ ). MSM who believed they were HIV positive had over fivefold higher odds of gonorrhoea in the previous year than those who identified as HIV negative ( $P_{\text{wald}} < 0.001$ ), whereas those unsure of their HIV status had double the odds ( $P_{\text{wald}} < 0.001$ ).

Respondents reporting always using condoms for anal sex with casual partners had the lowest odds of gonorrhoea. Odds of gonorrhoea increased as reported condom use with casual

partners use fell, except that those reporting never using condoms had lower odds than those reporting seldom using condoms.

#### Multivariate models

There was evidence of confounding of the association between chemsex drugs and gonorrhoea when stratifying by age group, residence (residence population, and London vs the rest of England), sexual identity, HIV status, number of casual partners, number of casual cUAI partners, cUAI at last sex, frequency of condom use and attendance of each of gay saunas, public sex parties and private sex parties. Crystal methamphetamine, GHB/GBL and mephedrone were each found to confound the association of the other two drugs with gonorrhoea. When stratifying by sexuality, among bisexually identified respondents who reported use of crystal methamphetamine, GHB/GBL, mephedrone and all three chemsex drugs, there were no cases of gonorrhoea; among those identifying as 'other term or no term', there were between zero and two cases. Reported condom use, number of casual partners and number of casual cUAI partners all exhibited collinearity with each other in multivariate models.

In multivariate models, only GHB/GBL and crystal methamphetamine continued to show evidence of an association with gonorrhoea. There was no evidence of an association between gonorrhoea and mephedrone. The prevalence of gonorrhoea diagnosis in this model was 3.4% (522/15137). Looking specifically at MSM who had used all three chemsex drugs in the previous year, there was very strong evidence of increased odds of gonorrhoea (see Table 5). The prevalence of gonorrhoea in this model was also 3.5% (524/15174).

#### Discussion

This study found very strong evidence that MSM reporting use of crystal methamphetamine, GHB/GBL and all three chemsex drugs in the previous year had 1.9-, 2.2- and 3.6-fold higher odds of gonorrhoea in the previous year respectively, compared



**Table 4. Univariate analysis of the study sample for associations between potential risk factors and odds of gonorrhoea in the previous year**  
CI, confidence interval; cUAI, condom unprotected anal intercourse; OR, odds ratio

	No. respondents	No. cases (%)	Crude OR <sup>A</sup>	95% CI	P-Value <sup>B</sup>
Residence population ( <i>n</i> = 15 432)					
<10 000	1558	27 (1.73)	1		<0.0001
10 000–99 999	2699	45 (1.67)	0.96	0.59–1.56	
100 000–499 999	3334	96 (2.88)	1.68	1.09–2.59	
500 000–999 999	1823	59 (3.24)	1.9	1.20–3.01	
>1 million	6018	305 (5.07)	3.03	2.03–4.51	
Residence location ( <i>n</i> = 12 356)					
Rest of England	7858	227 (2.89)	1		<0.0001
London	4498	232 (5.16)	1.83	1.52–2.20	
Sexuality ( <i>n</i> = 15 795)					
Gay or homosexual	12 643	497 (3.78)	1		<0.0001
Bisexual	1799	26 (1.45)	0.37	0.25–0.56	
Other	856	17 (1.99)	0.52	0.32–0.84	
Relationship status ( <i>n</i> = 15 781)					
Steady relationship <sup>C</sup>	6657	195 (2.93)	1		0.003
Single	9124	346 (3.79)	1.31	1.09–1.56	
Born in the UK ( <i>n</i> = 15 436)					
Yes	11 019	354 (3.21)	1		0.005
No	4417	183 (4.14)	1.3	1.09–1.56	
HIV status ( <i>n</i> = 15 767)					
Negative	13 342	322 (2.41)	1		<0.0001
Positive	1660	184 (11.08)	5.04	4.17–6.09	
Unknown	765	36 (4.71)	2	1.40–2.84	
cUAI at last sex ( <i>n</i> = 14 733)					
No	8017	244 (2.95)	1		<0.0001
Yes	6176	296 (4.57)	1.57	1.32–1.87	
Reported condom use for anal sex with casual partners ( <i>n</i> = 9689)					
Always	4728	109 (2.31)	1		<0.0001
Mostly	2561	186 (7.26)	3.32	2.61–4.23	
Sometimes	1067	65 (6.09)	2.75	2.01–3.77	
Seldom	673	80 (11.89)	5.72	4.23–7.72	
Never	660	37 (5.61)	2.52	1.72–3.69	
Attended gay sauna in previous year ( <i>n</i> = 15 627)					
No	10 429	217 (2.08)	1		<0.0001
Yes	5198	318 (6.12)	3.07	2.57–3.66	
Attended public sex party in previous year ( <i>n</i> = 15 702)					
No	11 684	247 (2.11)	1		<0.0001
Yes	4018	293 (7.29)	3.64	6.06–4.33	
Attended private sex party in previous year ( <i>n</i> = 15 686)					
No	13 021	352 (2.5)	1		<0.0001
Yes	2665	214 (8.03)	3.41	2.85–4.07	
Ever used illicit/recreational drugs ( <i>n</i> = 15 766)					
No	7520	164 (2.18)	1		<0.0001
Yes	8246	377 (4.57)	2.15	1.78–2.59	

<sup>A</sup>Calculated from logistic regression.<sup>B</sup>Likelihood ratio test.<sup>C</sup>With male or female partner.

with MSM reporting no use, after adjusting for age, recruitment website, residence, HIV status and use of other chemsex drugs. In a multivariate model, mephedrone use was not found to be associated with gonorrhoea.

This analysis is the first strong evidence of an association between chemsex drug use and diagnosis of gonorrhoea.

Chemsex drugs have previously been shown to be associated with HIV and high-risk sexual behaviours,<sup>9,11,15,16,31,32</sup> and one small study found higher incident cases of STIs with crystal methamphetamine,<sup>13</sup> but a gap in research has existed for looking specifically at STIs other than HIV in detail. The results of the present study are consistent with the research

**Table 5. Crude and final adjusted odds ratios (ORs) from multivariate models for association between chemsex drugs and gonorrhoea in the previous year**CI, confidence interval; GHB/GBL,  $\gamma$ -hydroxybutyric acid/ $\gamma$ -butyrolactone

	Crude OR <sup>A,B</sup>	Adjusted OR <sup>A,C</sup> (95% CI)	P-value <sup>D</sup>
Final Model A ( <i>n</i> = 15 137)			
Crystal methamphetamine	7.24	1.92 (1.40–2.63)	0.0001
GHB/GBL	6.37	2.23 (1.64–3.04)	<0.0001
Mephedrone	3.85	1.18 (0.90–1.55)	0.241
Final Model B ( <i>n</i> = 15 174)			
All three chemsex drugs	8.46	3.58 (2.65–4.84)	<0.0001

<sup>A</sup>Calculated from logistic regression.<sup>B</sup>For respondents included in corresponding multivariate model.<sup>C</sup>Adjusted for the use of the other two chemsex drugs (Model A only), age, recruitment website, residence population, HIV status.<sup>D</sup>Likelihood ratio test.

base on high-risk behaviours associated with crystal methamphetamine: a meta-analysis placed effect estimates for HIV between 1.8 and 3.5.<sup>11</sup> A single-centre study in London found 2.83-fold increased adjusted odds of 'bacterial STI' among chemsex participants,<sup>33</sup> again consistent with the findings of the present study. Limited to a single STI clinic in London, the study of Hegazi *et al.*<sup>33</sup> was able to use laboratory diagnostic data; however, our analysis gains strength from including a wider geographic population. Reported use of crystal methamphetamine in this study sample was lower than in other studies, and lower than GHB/GBL and mephedrone use, despite its prominence in the literature.<sup>4,7</sup> The present analysis helps expand the body of evidence for GHB/GBL. When GHB/GBL features in some studies, it has not consistently demonstrated associations with high-risk sexual behaviours, whereas crystal methamphetamine has.<sup>16</sup> The findings of the present study demonstrate a slightly greater risk of gonorrhoea with GHB/GBL than crystal methamphetamine, although with largely overlapping confidence intervals. Other studies may have been underpowered to detect associations for GHB/GBL; our sample size and the prevalence GHB/GBL use enables this association to be detected.

In the present study, mephedrone was not associated with increased odds of gonorrhoea after adjusting for crystal methamphetamine and GHB/GBL. This is consistent with other findings: a 2016 encounter-level study looking at cUAI found no increased odds of cUAI with mephedrone use, after controlling for the use of other drugs.<sup>16</sup> Mephedrone has been largely ignored in quantitative chemsex studies; one systematic review of 23 studies looking at encounter-level data and high-risk behaviours among MSM included no reference to mephedrone.<sup>17</sup> Mephedrone was the most widely reported chemsex drug in the present study sample, although it had the lowest strength association with gonorrhoea in initial models. Mephedrone was also found to be significantly associated with all the same risk factors and behaviours as crystal methamphetamine and GHB/GBL in univariate analysis. The use of multiple chemsex drugs simultaneously (particularly mephedrone with one of the other two) may account for the disappearance of an association between mephedrone and

gonorrhoea in the adjusted model. In addition, although mephedrone was the most widely reported chemsex drug in this survey, it may not always be used as part of sexual encounters or contexts related to chemsex, thus not theoretically conferring any increased risk of gonorrhoea.

Several behavioural and non-behavioural risk factors for gonorrhoea have been identified, including many known determinants of HIV acquisition, such as cUAI, higher numbers of sexual partners, illicit drugs use, use of sex-on-premises venues and living in larger settlements.<sup>34–36</sup> The present analysis has also highlighted other risk factors for gonorrhoea among MSM less well established in published research, such as being born abroad and identifying as gay compared with other sexual identities. Increasingly populous place of residence was associated with increasing odds of gonorrhoea, and increasing use of chemsex drugs. We also saw this same dynamic when comparing London to the rest of England. This also correlated with the higher immigrant MSM populations in London, and easier access to sex-on-premises venues. Larger and more diverse sexual networks, as well as proximity to venues hosting sex parties in larger cities, may contribute to this increased conferred risk of gonorrhoea. In addition, those identifying as gay may engage more in the 'gay community' than those choosing not to identify as gay.

The combined variable for the use of all three drugs had the strongest association and highest odds of gonorrhoea in the previous year. This is potentially the subpopulation most engaged in chemsex, as opposed to a population that may use a chemsex drug in a different context. This reaffirms the current understanding about these three drugs being used by a specific group of MSM, those believed to be engaging in chemsex, and that this is a group most at risk of adverse outcomes. Contextual factors for chemsex, such as gay saunas and sex parties, were also associated with gonorrhoea in univariate analysis. It is as yet to be determined how much of this association is mediated through chemsex or other channels (e.g. cUAI, number of partners and multipartner encounters) and whether visiting gay saunas or private or public sex parties are independent risk factors for STIs.

Restricting gonorrhoea diagnosis and the use of chemsex drugs to the previous year for univariate risk factor and multivariate analyses minimised bias. An additional advantage of this approach is that respondents were reporting exposure and outcome events as well as engagement in various sexual behaviours over a defined overlapping period.

Limitations of the study include the fact that all measures were self-reported and online non-probability sampling. Gonorrhoea diagnosis data would ideally be confirmed diagnostically, and there is potential for recall bias. The findings are not necessary generalisable to the whole UK MSM population. MSM frequenting sites used for recruitment (particularly dating sites) may differ with regard to drug use, STI risk or other potential confounders compared with MSM not included in the survey. Recruitment website was included as an *a priori* factor in the multivariate models to adjust for potential differences in exposure–outcome association. This study was limited to gonorrhoea as the most prevalent bacterial STI among MSM, and similar research for chlamydia and syphilis is necessary. In addition, the present study

analysed data from EMIS 2010; sexual behaviours and trends in drugs use are subject to constant evolution.

Future research could investigate causal pathways to better understand the relationships between chemsex drug use and other determinants of gonorrhoea identified in this analysis, and to establish how much gonorrhoea is attributable to each determinant (e.g. geospatial networking apps, cUAI, number of sexual partners, gay saunas and sex parties). Encounter-level studies are necessary to look into the association between chemsex, high-risk sexual behaviours and STIs.

As well as whole gay population education, targeted interventions are needed focusing on MSM at highest risk. MSM engaging in chemsex are not the same population as MSM frequenting gay bars and clubs. Sex-on-premises venues are sometimes inaccessible, and the rise of privately hosted sex parties makes outreach more difficult. Social media and mobile apps are therefore useful platforms to promote sexual health services and disseminate information about sexual risks.

### Conflicts of interest

The authors declare that they have no conflicts of interest.

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