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

Manik Kohli

Ford Hickson

Caroline Free

David Reid

Peter Weatherburn

London School of Hygiene & Tropical Medicine, Keppel Street, London, United Kingdom, WC1E 7H

**Corresponding author**

Ford Hickson

ford.hickson@lshtm.ac.uk

15-17 Tavistock Place, London, United Kingdom, WC1H 9SH

020 7927 2791

## Conflicts of interest

The authors declare no conflicts of interest.

***Word count: 3664***

# Abstract

## Objectives

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 transmitted infections (STIs)*.* The aim of this study is to determine whether 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, GHB/GBL and mephedrone). Univariate logistic regression identified determinants of gonorrhoea diagnosis and multivariate logistic regression models calculated adjusted odds ratios for independent associations between chemsex drugs and gonorrhoea.

## Results

MSM who reported use of crystal methamphetamine and GHB/GBL in the previous year had respectively 1.92 and 2.23 times higher odds of gonorrhoea over the same period (p=0.0001 and p<0.0001, n=15,137); adjusting for age, recruitment website, HIV status, residence, and use of other chemsex drugs. MSM reporting use of all three chemsex drugs had the highest increased odds (adj. OR 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 complement existing research about crystal methamphetamine and indicates a role for GHB/GBL in adverse sexual health outcomes. Use of mephedrone alongside other chemsex drugs may account 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.

***Word Count 250***

# Introduction

MSM have been shown to have higher rates of drug use compared to the general population, including use of crystal methamphetamine, GHB/GBL, ketamine, cocaine, cannabis, ecstasy/MDMA, mephedrone, volatile nitrites (poppers), and sildenafil (Viagra) ([1](#_ENREF_1), [2](#_ENREF_2)). Traditional ‘club’ drugs – such as ecstasy and cocaine – have made room for the increasingly popular ‘chemsex’ drugs, in part due to their ability to increase and sustain sexual arousal for extended ‘sessions’. There is variation in types of drugs used and prevalence across different countries ([3](#_ENREF_3)). One study estimated the prevalence of crystal methamphetamine use among MSM in London to be as high as one in ten ([4](#_ENREF_4)). A recent Australian study found 5.4% of gay and bisexual men had used GHB in the past 6 months ([5](#_ENREF_5)).

‘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, gamma-hydroxybutyric acid (GHB)/gamma-butyrolactone (GBL) and mephedrone; although other drugs may be used ([2](#_ENREF_2), [6](#_ENREF_6), [7](#_ENREF_7)).

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, however use of harmful drugs – such as crystal methamphetamine – is high among MSM who do engage in chemsex ([8](#_ENREF_8)). Combining sex and drugs, including oral erectile dysfunction medication, has been found to be associated with high-risk sexual behaviours and human immunodeficiency virus (HIV) ([4](#_ENREF_4), [9-12](#_ENREF_9)).

Existing chemsex research has focussed on HIV; there has been little investigation of its relationship to other sexually transmitted 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, or cUAI), and assumptions are made that this translates into increased transmission of STIs ([4](#_ENREF_4), [6](#_ENREF_6), [13](#_ENREF_13), [14](#_ENREF_14)).

Crystal methamphetamine has been shown to be associated with engagement in cUAI, cUAI between HIV serodiscordant partners, higher numbers of sexual partners, and multi-partner encounters – all of which are risk factors for HIV transmission ([4](#_ENREF_4), [9](#_ENREF_9), [10](#_ENREF_10), [15](#_ENREF_15), [16](#_ENREF_16)). 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 multi-partner encounters, is less consistent ([2](#_ENREF_2), [6](#_ENREF_6), [16](#_ENREF_16), [17](#_ENREF_17)). Multi-partner encounters and condomless anal intercourse has been associated with GHB use in the previous 6 months ([5](#_ENREF_5)).

While 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 ([11](#_ENREF_11), [14](#_ENREF_14), [15](#_ENREF_15), [18](#_ENREF_18)). A systematic review and meta-analysis of 35 different studies, across 3 different pooled estimates, found amphetamine-like substances were significantly associated with between 1.8 to 3.5 times increased odds, prevalence rate, or hazard of HIV infection ([11](#_ENREF_11)).

One study (in New York) found evidence of an association between crystal methamphetamine and incident non-HIV STI diagnosis, almost half of which were gonorrhoea ([13](#_ENREF_13)).

Sexual health services in the UK face growing challenges from bacterial STIs, which have reached record levels among MSM. While chlamydia is the most common bacterial STI in the total adult population, among MSM gonorrhoea has more annual incident diagnoses ([19](#_ENREF_19), [20](#_ENREF_20)). In England between 2008 and 2012, gonorrhoea diagnoses in MSM approximately trebled ([19](#_ENREF_19)). Drug-resistant gonorrhoea is increasing, with the first known case of treatment failure internationally being reported in the UK in 2015 ([21](#_ENREF_21)).

Among MSM, determinants of gonorrhoea infection include frequent partner change and cUAI. Studies have also identified use of recreational drugs and HIV seropositivity, as well as younger age and lower socioeconomic status ([22-26](#_ENREF_22)). 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 programme 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 this study was to examine associations between gonorrhoea and use of chemsex drugs using data collected as part of the 2010 European Men-who-have-sex-with-men Internet Survey (EMIS) ([27](#_ENREF_27), [28](#_ENREF_28)).

# Methods

We used data from UK-based respondents to the first European MSM Internet Survey (EMIS) 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. ([29](#_ENREF_29))). Analysis was carried out in STATA v14. Ethical approval for the original study was granted by University of Portsmouth, and ethical approval obtained for this analysis from the LSHTM MSc Research Ethics Committee. Written consent from participants was included in the survey.

We identified potential confounders and devised a conceptual framework to illustrate the distal and proximal determinants of gonorrhoea, directions of associations and theoretical relationships (see Figure 1).

The UK dataset consisted of 18,234 cases. Of these, 2,169 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/visit in the previous 12 months.

We first described the sample using counts and percentages. Univariate logistic regression examined the association between potential risk factors and gonorrhoea; and also between the potential risk factors and each chemsex drug. Chi-squared test-for-trend was done where a potential trend in odds was observed. When comparing odds ratios between two strata within a variable a Wald test was used.

Age group and recruitment website were identified *a priori* for the multivariate models. Mantel-Haenszel 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, odds ratio was reviewed for meaningful changes and, if present, likelihood-ratio test (LRT) used to determine if 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 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 odds ratios 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.

# Results

## Sample description

The total number of MSM in the analysis was 16,065. The majority of UK respondents were recruited from 4 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 use of all three drugs in the previous year missing=215. Of variables included in the analysis complete data existed only for age, gender identity and number of casual partners; and the variables with the most missing data were cUAI at last sex (missing=1,132), condom use (missing=6,247), and number of casual cUAI partners (missing=6,360). There was significant ‘missing data’ for frequency of condom use and number of casual cUAI partners, however 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.

The vast majority identified as men (99.8%) with only 27 respondents identifying as trans men or trans women. Nearly all (94.6%) identified as gay or bisexual; 4.4% of survey respondents selected ‘I don’t usually use a term’ with regards to sexual orientation. Mean age was 37.2 years and the majority (81.0%) were educated beyond secondary level. Most (72.4%) lived in settings with populations over 100,000 and 39.0% in cities with populations over 1 million. Of respondents living in England, just over one third lived in London. 28.6% were born outside the UK and the majority of foreign-born respondents in England lived in London (60.0%). Table 1 provides further description of the sample.

A fifth (20.4%) reported ever being diagnosed with gonorrhoea and 3.4% (543 men) in the past year (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 had used mephedrone in the previous year as ever used (11.1% and 11.6% respectively), indicating its recent introduction to the UK at the time of the survey (2010). Lower proportions had used crystal methamphetamine and GHB/GBL in the last year compared with ever. Only 2.4% of respondents reported having used all three chemsex drugs in the previous year.

## Potential risk factors

10.5% (n=1,685) reported being definitely HIV positive, 5.0% reported that they were not sure or possibly HIV positive, and the remaining 84.5% reported being HIV negative. 44.0% of respondents reported having cUAI at their most recent sex.

A quarter (26.7%) reported no casual sexual partners in the previous year and 4.9% reported more than 50 (the top of the scale offered). Half (49.0%) of all respondents included in the analysis reported having no cUAI with casual partners in the previous year, 29% cUAI with 1 or 2 casual partners, and 9.4% with 7 or more. Of respondents with casual sexual partners, half (48.8%) reported always using a condom for anal sex with a casual partner, 26.3% more than half the time and 13.8% seldom or never. More than half (53.0%) reported ever having visited a gay sauna, with a 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).

## Associations between risk factors and chemsex drugs

Potential risk factors and confounders significantly associated with use of each chemsex drug in the last 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 pGHB/GBL=0.0044; pmephedrone=0.0001; pall3=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 times higher odds of use of a chemsex drug in the previous year than those living in locations with populations less than 10,000 (crude ORcrystalmeth 5.62; 95%CI 3.69, 8.58; pwald<0.001; crude ORGHB/GBL 6.43; 95%CI 4.54, 9.10; pwald<0.001; crude ORmephedrone 5.19; 95%CI 3.98, 6.76; pwald<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 times higher unadjusted odds of gonorrhoea diagnosis compared to 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 partner and casual cUAI partners in the previous year; condom use; visiting sauna; private or public sex party in the previous year; ever having used illicit drugs. Education was not associated with gonorrhoea. See Table 4 for further detail. 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 20s to those aged 30-34 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 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 5 times the odds of gonorrhoea in the previous year than those who identified as HIV negative (pwald<0.001) while those unsure of their HIV status had double the odds (pwald<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 those reporting never using condoms had lower odds than those reporting seldom.

## 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 versus 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 attendances to each of gay saunas, public sex parties and private sex parties. Crystal methamphetamine, GHB/GBL and mephedrone were also each found to confound the other two’s association with gonorrhoea. When stratifying by sexuality, among bisexually identified respondents there were no cases of gonorrhoea and among ‘other term or no term’ between 0 and 2 cases, for those who reported use of crystal methamphetamine, GHB/GBL, mephedrone and all three chemsex drugs. 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 association with gonorrhoea. There was no evidence of an association with mephedrone. Prevalence of gonorrhoea diagnosis in this model was 3.5% (522/15,137). 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). Prevalence of gonorrhoea in this model was also 3.5% (524/15,174).

# Discussion

Our study found very strong evidence that MSM reporting use of crystal methamphetamine, GHB/GBL, and all three chemsex drugs in the previous year had respectively 1.9, 2.2 and 3.6 times higher odds of gonorrhoea in the previous year, compared to 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 and one small study found higher incident cases of STIs with crystal methamphetamine, but a gap in research has existed for looking specifically at STIs other than HIV in detail ([9](#_ENREF_9), [11](#_ENREF_11), [13](#_ENREF_13), [15](#_ENREF_15), [16](#_ENREF_16), [30](#_ENREF_30), [31](#_ENREF_31)). The results of this study are consistent with the research base on high-risk behaviours associated with crystal methamphetamine: a meta-analysis ([11](#_ENREF_11)) placed effect estimates for HIV between 1.8 and 3.5. A single-centre study in London found 2.83 times increased adjusted odds of ‘bacterial STI’ among chemsex participants; again consistent with our own findings ([32](#_ENREF_32)). Limited to a single STI clinic in London, this study 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 sample was lower than other studies, and lower than GHB/GBL and mephedrone despite its prominence in the literature ([4](#_ENREF_4), [7](#_ENREF_7)). This 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 where crystal methamphetamine has ([16](#_ENREF_16)). Our findings demonstrate 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.

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 use of other drugs ([16](#_ENREF_16)). 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 ([17](#_ENREF_17)). Mephedrone was the most widely reported chemsex drug in this study sample although 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 association between mephedrone and gonorrhoea in the adjusted model. Additionally, while mephedrone is 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 condomless anal sex, higher numbers of sexual partners, illicit drugs use, use of sex-on-premises venues and living in larger settlements ([33-35](#_ENREF_33)). This 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 to other sexual identities. Increasingly populous place of residence was associated with increasing odds of gonorrhoea, and also increasing use chemsex drugs. We also saw this same dynamic when comparing London to the rest of England. This also correlated to 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. Additionally, those identifying as gay may engage more in the ‘gay community’ than those choosing not to identify as gay.

The combined variable for use of all three drugs had the strongest association and highest odds of gonorrhoea in the previous year. This is potentially the sub-population most engaged in chemsex; as opposed to a population who 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 these are 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 multi-partner encounters) and whether visiting gay saunas, private or public sex parties is an independent risk factor for STIs.

Restricting gonorrhoea diagnosis and 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 is various sexual behaviours over a defined overlapping period.

Limitations of the study include all measures were self-reported and online non-probability sampling. Gonorrhoea diagnosis data would ideally be diagnostically confirmed, and there is potential for recall bias. 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 to 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. The study was limited to gonorrhoea as the most prevalent bacterial STI among MSM; and similar research for chlamydia and syphilis is necessary. Additionally, this 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 focussing 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.

# Acknowledgements

The EMIS project was funded by: Executive Agency for Health and Consumers, EU Health Programme 2008–2013 (funding period: 14.3.2009 - 13.9.2011); CEEISCat -Centre d’Estudis Epidemiològics sobre les ITS/HIV/SIDA de Catalunya (2009–2012); Terrence Higgins Trust (CHAPS) for Department of Health for England (2009–2012); Maastricht University (2009–2012); Regione del Veneto (2009–2012); Robert Koch Institute (2009–2012). Scientific co-ordination: Robert Koch Institute (Germany). Administrative co-ordination: GIZ–Gesellschaft für Internationale Zusammenarbeit (Germany). Technical Implementation: Sigma Research, London School of Hygiene & Tropical Medicine (UK). Questionnaire drafting: University College, Maastricht (The Netherlands). EMIS was promoted in United Kingdom by: Terrence Higgins Trust and the CHAPS partnership including GMFA, The Eddystone Trust, Healthy Gay Life, The Lesbian and Gay Foundation, The Metro Centre London, NAM, Trade Sexual Health, and Yorkshire MESMAC; City University London, Department for Public Health.

# References

1. Hunter LJ, Dargan PI, Benzie A, White JA, Wood DM. Recreational drug use in men who have sex with men (MSM) attending UK sexual health services is significantly higher than in non-MSM. Postgraduate Medical Journal. 2014.

2. Melendez-Torres GJ, Bourne A. Illicit drug use and its association with sexual risk behaviour among MSM: more questions than answers? Curr Opin Infect Dis. 2016;29(1):58-63.

3. Schmidt AJ, Bourne A, Weatherburn P, Reid D, Marcus U, Hickson F. Illicit drug use among gay and bisexual men in 44 cities: Findings from the European MSM Internet Survey (EMIS). International Journal of Drug Policy. 2016;38:4-12.

4. Bolding G, Hart G, Sherr L, Elford J. Use of crystal methamphetamine among gay men in London. Addiction. 2006;101(11):1622-30.

5. Hammoud MA, Bourne A, Maher L, Jin F, Haire B, Lea T, et al. Intensive sex partying with gamma-hydroxybutyrate: factors associated with using gamma-hydroxybutyrate for chemsex among Australian gay and bisexual men – results from the Flux Study %J Sexual Health. 2018;15(2):123-34.

6. Kirby T, Thornber-Dunwell M. High-risk drug practices tighten grip on London gay scene. The Lancet. 2013;381(9861):101-2.

7. Bourne A, Reid DS, Hickson F, Torres Rueda S, Weatherburn P. The Chemsex Study: drug use in sexual settings among gay and bisexual men in Lambeth, Southwark & Lewisham. Sigma Research, London School of Hygiene & Tropical Medicine; 2014.

8. Hickson F, Reid D, Hammond G, Weatherburn P. State of Play: findings from the England Gay Men’s Sex Survey 2014. London: Sigma Research, London School of Hygeine and Tropical Medicine; 2016.

9. Bonell CP, Hickson FC, Weatherburn P, Reid DS. Methamphetamine use among gay men across the UK. Int J Drug Policy. 2010;21(3):244-6.

10. Li J, McDaid LM. Alcohol and drug use during unprotected anal intercourse among gay and bisexual men in Scotland: what are the implications for HIV prevention? Sex Transm Infect. 2014;90(2):125-32.

11. Vu NT, Maher L, Zablotska I. Amphetamine-type stimulants and HIV infection among men who have sex with men: implications on HIV research and prevention from a systematic review and meta-analysis. J Int AIDS Soc. 2015;18:19273.

12. Prestage G, Jin F, Kippax S, Zablotska I, Imrie J, Grulich A. Use of illicit drugs and erectile dysfunction medications and subsequent HIV infection among gay men in Sydney, Australia. J Sex Med. 2009;6(8):2311-20.

13. Hirshfield S, Remien R, Walavalkar I, Chiasson MA. Crystal methamphetamine use predicts incident STD infection among men who have sex with men recruited online: a nested case-control study. Journal of Medical Internet Research. 2004;6(4):e41.

14. Schwarcz S, Scheer S, McFarland W, Katz M, Valleroy L, Chen S, et al. Prevalence of HIV Infection and Predictors of High-Transmission Sexual Risk Behaviors Among Men Who Have Sex With Men. American Journal of Public Health. 2007;97(6):1067-75.

15. Prestage G, Grierson J, Bradley J, Hurley M, Hudson J. The role of drugs during group sex among gay men in Australia. Sex Health. 2009;6(4):310-7.

16. Melendez-Torres GJ, Hickson F, Reid D, Weatherburn P, Bonell C. Nested Event-Level Case–Control Study of Drug Use and Sexual Outcomes in Multipartner Encounters Reported by Men Who Have Sex with Men. AIDS and Behavior. 2016;20(3):646-54.

17. Vosburgh HW, Mansergh G, Sullivan PS, Purcell DW. A review of the literature on event-level substance use and sexual risk behavior among men who have sex with men. AIDS Behav. 2012;16(6):1394-410.

18. Gilbart VL, Simms I, Jenkins C, Furegato M, Gobin M, Oliver I, et al. Sex, drugs and smart phone applications: findings from semistructured interviews with men who have sex with men diagnosed with Shigella flexneri 3a in England and Wales. Sex Transm Infect. 2015;91(8):598-602.

19. Kirby T. Record highs of sexually transmitted infections in UK's MSM. Lancet Infect Dis. 2014;14(1):16-7.

20. Mohammed H, Mitchell H, Sile B, Duffell S, Nardone A, Hughes G. Increase in Sexually Transmitted Infections among Men Who Have Sex with Men, England, 2014. Emerg Infect Dis. 2016;22(1):88-91.

21. Fifer H, Natarajan U, Jones L, Alexander S, Hughes G, Golparian D, et al. Failure of Dual Antimicrobial Therapy in Treatment of Gonorrhea. New England Journal of Medicine. 2016;374(25):2504-6.

22. Grewal R, Allen VG, Gardner S, Moravan V, Tan DHS, Raboud J, et al. Serosorting and recreational drug use are risk factors for diagnosis of genital infection with chlamydia and gonorrhoea among HIV-positive men who have sex with men: results from a clinical cohort in Ontario, Canada. Sexually Transmitted Infections. 2017;93(1):71-5.

23. Jin F, Prestage GP, Mao L, Kippax SC, Pell CM, Donovan B, et al. Incidence and risk factors for urethral and anal gonorrhoea and chlamydia in a cohort of HIV-negative homosexual men: the Health in Men Study. Sexually Transmitted Infections. 2007;83(2):113-9.

24. Bjekić M, Vlajinac H, Sipetić S, Marinković J. Risk factors for gonorrhoea: case-control study. Genitourinary Medicine. 1997;73(6):518-21.

25. Castor D, Jolly PE, Furlonge C, Rao A, Brown A, Camara B, et al. Determinants of gonorrhoea infection among STD clinic attenders in Trinidad--II: sexual behavioural factors. Int J STD AIDS. 2002;13(1):46-51.

26. Benn PD, Rooney G, Carder C, Brown M, Stevenson SR, Copas A, et al. Chlamydia trachomatis and Neisseria gonorrhoeae infection and the sexual behaviour of men who have sex with men. Sexually Transmitted Infections. 2007;83(2):106-12.

27. EMIS. The European MSM Internet Survey 2010 [updated 31/10/2015. Available from: <http://www.emis-project.eu/>.

28. The EMIS Network. EMIS 2010: The European Men-Who-Have-Sex-With-Men Internet Survey. Findings from 38 countries. Stockholm: European Centre for Disease Prevention and Control; 2013.

29. Weatherburn P, Schmidt AJ, Hickson F, Reid D, Berg RC, Hospers HJ, et al. The European Men-Who-Have-Sex-With-Men Internet Survey (EMIS): Design and Methods. Sexuality Research and Social Policy. 2013;10(4):243-57.

30. Boone MR, Cook SH, Wilson P. Substance use and sexual risk behavior in HIV-positive men who have sex with men: an episode-level analysis. AIDS Behav. 2013;17(5):1883-7.

31. Bourne A, Reid D, Hickson F, Torres-Rueda S, Weatherburn P. Illicit drug use in sexual settings (‘chemsex’) and HIV/STI transmission risk behaviour among gay men in South London: findings from a qualitative study. Sexually Transmitted Infections. 2015.

32. Hegazi A, Lee M, Whittaker W, Green S, Simms R, Cutts R, et al. Chemsex and the city: sexualised substance use in gay bisexual and other men who have sex with men attending sexual health clinics. International journal of STD & AIDS. 2017;28(4):362-6.

33. Koblin BA, Husnik MJ, Colfax G, Huang Y, Madison M, Mayer K, et al. Risk factors for HIV infection among men who have sex with men. AIDS. 2006;20(5):731-9.

34. Mimiaga MJ, Reisner SL, Bland SE, Driscoll MA, Cranston K, Isenberg D, et al. Sex Parties among Urban MSM: An Emerging Culture and HIV Risk Environment. AIDS and Behavior. 2011;15(2):305-18.

35. Lau JTF, Zhao J-K, Wu X-B, Gu J, Hao C. Gay Saunas and the Risks of HIV and Syphilis Transmissions in China—Results of a Meta‐Analysis. The Journal of Sexual Medicine. 2013;10(3):642-52.

****

Figure 1 Conceptual framework of determinants of gonorrhoea infection.

**Table 1** Descriptive data of the study sample.

|  |  |
| --- | --- |
|  | No of individuals (%) |
| **Age** (n=16,065) |  |
| <20 | 646 (4.0) |
| 20-24 | 2,077 (12.9) |
| 25-29 | 2,428 (15.1) |
| 30-34 | 2,240 (13.9) |
| 35-39 | 2,089 (13.0) |
| 40-44 | 2,097 (13.1) |
| 45-49 | 1,777 (11.1) |
| 50-54 | 1,204 (7.5) |
| 55+ | 1,507 (9.4) |
| **Education** (n=15,959) |  |
| Primary | 454 (2.8) |
| Lower secondary | 1,082 (6.8) |
| Upper secondary | 1,494 (9.4) |
| Post-secondary non-tertiary | 2,700 (16.9) |
| 1st stage tertiary | 2,692 (16.9) |
| 2nd stage tertiary | 7,537 (47.2) |
| **Residence population** (n=15,664) |  |
| > 1 million | 6,104 (39.0) |
| 500,000 – 999,999 | 1,859 (11.9) |
| 100,000 – 499,999 | 3,380 (21.6) |
| 10,000 – 99,999 | 2,737 (17.5) |
| < 10,000 | 1,584 (10.1) |
| **Sexuality** (n=16,031) |  |
| Gay/homosexual | 13,337 (83.2) |
| Bisexual | 1,827 (11.4) |
| Straight/heterosexual | 85 (0.5) |
| Other term | 75 (0.5) |
| Does not define | 707 (4.4) |
| **Relationship status** (n=16,017) |  |
| Steady relationship† | 6,761 (42.2) |
| Single | 9,256 (57.8) |
| **Born in the UK** (n=15,664) |  |
| Yes | 11,179 (71.4) |
| No | 4,485 (28.6) |

\*classified using ISCED 1997 Levels of Education ([32](#_ENREF_32))

†with a male or female partner

|  |  |
| --- | --- |
|  | **No of individuals (%)** |
| **Gonorrhoea ever** (n=15,850) |  |
| Yes | 3,235 (20.4) |
| No | 12,615 (79.6) |
| **Gonorrhoea in previous year**(n=15,826) |
| Yes | 543 (3.4) |
| No | 15,283 (96.6) |
| **Crystal methamphetamine ever** (n=15,916) |
| Yes | 1,296 (8.1) |
| No | 14,620 (91.9) |
| **Crystal methamphetamine in previous year** (n=15,916) |
| Yes | 671 (4.2) |
| No | 15,245 (95.8) |
| **GHB/GBL ever** (n=15,905) |  |
| Yes  | 2,086 (13.0) |
| No | 13,837 (87.0) |
| **GHB/GBL in previous year** (n=15,905) |
| Yes | 1,125 (7.1) |
| No | 14,780 (92.9) |
| **Mephedrone ever** (n=15,932) |  |
| Yes | 1,846 (11.6) |
| No | 14,086 (88.4) |
| **Mephedrone in previous year** (n=15,932) |  |
| Yes | 1,773 (11.1) |
| No | 14,159 (88.9) |
| **All three chemsex drugs ever** (n=15,810) |  |
| Yes | 635 (4.0) |
| No | 15,175 (96.0) |
| **All three chemsex drugs in previous year** (n=15,850) |
| Yes | 382 (2.4) |
| No | 15,468 (97.6) |

 **Table 2** Numbers reporting gonorrhoea and use of each chemsex drug in the sample.

**Table 3** Univariate analysis of survey responses for associations between gonorrhoea in the previous year and chemsex drugs in the previous year.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Drug | n | Cases (%) | Crude OR\* | 95%CI | P-Value† |
| **Crystal methamphetamine** (n=15,697) |  |  |  |  |
| No | 15,038 | 426 (2.8) | 1.0 |  |  |
| Yes | 659 | 112 (17.0) | 7.02 | 5.61, 8.79 | <0.0001 |
| **GHB/GBL** (n=15,686) |  |  |  |  |  |
| No | 14,578 | 379 (2.6) | 1.0 |  |  |
| Yes | 1,108 | 158 (14.3) | 6.23 | 5.11, 7.59 | <0.0001 |
| **Mephedrone** (n=15,712) |  |  |  |  |  |
| No | 13,967 | 374 (2.7) | 1.0 |  |  |
| Yes | 1,745 | 163 (9.3) | 3.74 | 3.09, 4.53 | <0.0001 |
| **All three chemsex drugs** (n=15,632) |  |  |  |  |
| No | 15,260 | 460 (3.01) | 1.0 |  |  |
| Yes | 372 | 76 (20.43) | 8.26 | 6.32, 10.81 | <0.0001 |

\*Calculated from logistic regression;

†Likelihood ratio test;

CI Confidence Interval

OR Odds Ratio

**Table 4** Univariate analysis of study sample for associations between potential risk factors and odds of gonorrhoea in the previous year.

|  | n | Cases (%) | Crude OR\* | 95%CI | P-Value† |
| --- | --- | --- | --- | --- | --- |
| **Residence population** (n=15,432) |  |
| < 10,000 | 1,558 | 27 (1.73) | 1.0 |  | <0.0001 |
| 10,000 – 99,999 | 2,699 | 45 (1.67) | 0.96 | 0.59, 1.56 |
| 100,000 – 499,999 | 3,334 | 96 (2.88) | 1.68 | 1.09, 2.59 |
| 500,000 – 999,999 | 1,823 | 59 (3.24) | 1.90 | 1.20, 3.01 |
| > 1 million | 6,018 | 305 (5.07) | 3.03 | 2.03, 4.51 |
| **Residence location** (n=12,356) |  |  |  |  |
| Rest of England | 7,858 | 227 (2.89) | 1.0 |  | <0.0001 |
| London | 4,498 | 232 (5.16) | 1.83 | 1.52, 2.20 |
| **Sexuality** (n=15,795) |  |  |  |  |  |
| Gay or homosexual | 12,643 | 497 (3.78) | 1.0 |  | <0.0001 |
| Bisexual | 1,799 | 26 (1.45) | 0.37 | 0.25, 0.56 |
| Other | 856 | 17 (1.99) | 0.52 | 0.32, 0.84 |
| **Relationship status** (n=15,781) |  |  |  |  |
| Steady relationship‡ | 6,657 | 195 (2.93) | 1.0 |  | 0.003 |
| Single | 9,124 | 346 (3.79) | 1.31 | 1.09, 1.56 |
| **Born in the UK** (n=15,436) |  |  |  |  |
| Yes | 11,019 | 354 (3.21) | 1.0 |  | 0.005 |
| No | 4,417 | 183 (4.14) | 1.30 | 1.09, 1.56 |
| **HIV status** (n=15,767) |  |  |  |  |
| Negative | 13,342 | 322 (2.41) | 1.0 |  | <0.0001 |
| Positive | 1,660 | 184 (11.08) | 5.04 | 4.17, 6.09 |
| Unknown | 765 | 36 (4.71) | 2.00 | 1.40, 2.84 |
| **Condom unprotected anal intercourse at last sex** (n=14,733) |  |  |
| No | 8,017 | 244 (2.95) | 1.0 |  | <0.0001 |
| Yes | 6,176 | 296 (4.57) | 1.57 | 1.32, 1.87 |
| **Reported condom use for anal sex with casual partners** (n=9,689) |  |
| Always | 4,728 | 109 (2.31) | 1.0 |  | <0.0001 |
| Mostly | 2,561 | 186 (7.26) | 3.32 | 2.61, 4.23 |
| Sometimes | 1,067 | 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** (n=15,627) |  |  |  |
| No | 10,429 | 217 (2.08) | 1.0 |  | <0.0001 |
| Yes | 5,198 | 318 (6.12) | 3.07 | 2.57, 3.66 |
| **Attended public sex party in previous year** (n=15,702) |  |  |
| No | 11,684 | 247 (2.11) | 1.0 |  | <0.0001 |
| Yes | 4,018 | 293 (7.29) | 3.64 | 6.06, 4.33 |
| **Attended private sex party in previous year** (n=15,686) |  |  |
| No | 13,021 | 352 (2.5) | 1.0 |  | <0.0001 |
| Yes | 2,665 | 214 (8.03) | 3.41 | 2.85, 4.07 |
| **Ever used illicit/recreational drugs** (15,766) |  |  |  |
| No | 7,520 | 164 (2.18) | 1.0 |  | <0.0001 |
| Yes | 8,246 | 377 (4.57) | 2.15 | 1.78, 2.59 |

\*Calculated from logistic regression

†Likelihood ratio test

‡with male or female partner

CI Confidence Interval; OR Odds Ratio

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Crude OR\*∆ | Adjusted OR\*‡ | Adj. OR 95%CI | P-Value† |
| **Final model A** (n=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 | 0.2410 |
| **Final model B** (n=15,174) |  |  |  |  |
| All three chemsex drugs | 8.46 | 3.58 | 2.65, 4.84 | <0.0001 |

Table 5 Crude and final adjusted odds ratios from multivariate models for association between chemsex drugs and gonorrhoea in the previous year.

\*Calculated from logistic regression

∆for respondents included in corresponding multivariate model

‡Adjusted for use of other two chemsex drugs (Model A only), age, recruitment website, residence population, HIV status

†Likelihood ratio test;

CI confidence interval; OR odds ratio