International Journal of Drug Policy 68 (2019) 54–61

Contents lists available at ScienceDirect

International Journal of Drug Policy

journal homepage: www.elsevier.com/locate/drugpo

Research Paper

Changes in chemsex and sexual behaviour over time, among a cohort of MSM in London and Brighton: Findings from the AURAH2 study

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ARTICLE INFO

Keywords:
Chemsex
Sexual behaviour
Condomless sex
Men who have sex with men
Sexual health
HIV prevention
Longitudinal
Cohort

ABSTRACT

Background: Recent evidence has suggested that chemsex (the use of mephedrone, crystal methamphetamine and γ -hydroxybutyrate/ γ -butryolactone (GHB/GBL) to enable, enhance and prolong sexual interactions) has increased among men having sex with men (MSM) attending sexual health clinics in large UK cities. To date there has been no data from the UK or Europe that describes changes in chemsex over time within a cohort of MSM.

Methods: The prospective cohort study, Attitudes to and Understanding Risk of Acquisition of HIV over Time (AURAH2), collected online questionnaire data from HIV negative or undiagnosed MSM (at enrolment) from 2015 to 2018, recruited from sexual health clinics. We aim to investigate changes in chemsex, three individual drugs associated with chemsex, frequency of chemsex sessions and measures of sexual behaviour, among the cohort of MSM over the study's 3 year follow-up period.

Results: In total 622 MSM completed at least one online questionnaire for the AURAH2 study, of which 400 (64.3%) were still engaged with the study within the last six months of follow-up. Prevalence of chemsex significantly declined during the follow-up from 31.8% (198/622) at the first online questionnaire, to 11.1% (8/72; $p < 0.001$) at the 9th. This decline was reflected in the proportion of MSM reporting use of two of the three individual chemsex drugs: mephedrone use had significantly declined from 25.2% at the first online questionnaire to 9.7% ($p < 0.001$) at the 9th, GHB/GBL use had also declined from 19.9% to 8.3% ($p = 0.001$). While crystal methamphetamine use declined, but not significantly (11.1%–6.9% [$p = 0.289$]). Most measures of sexual behaviour (any anal sex, group sex, recent HIV test and bacterial STI) also tended to decline over the follow-up period, with the exception of CLAI with more than one and more than two partners.

Conclusions: Chemsex and use of two individual chemsex drugs (mephedrone and GHB/GBL) significantly declined over time among individuals in the study, alongside most measures of sexual behaviour with the exception of those related to CLAI. Focusing health promotion and HIV prevention, such as awareness of post-exposure prophylaxis (PEP) and access to pre-exposure prophylaxis (PrEP), on MSM that report chemsex, and in particular problematic chemsex, would be highly beneficial, potentially only necessary for a relatively short period of time for individuals, and could have long term benefits for HIV and STI prevention.

Introduction

Chemsex, defined in the UK as the use of mephedrone, crystal methamphetamine and γ -hydroxybutyrate/ γ -butryolactone (GHB/GBL) to enable, enhance and prolong sexual interactions (Bourne, Reid, Hickson, Torres Rueda, & Weatherburn, 2014), has been described predominantly among men who have sex with men (MSM) and has potential implications for public health due to its associations with high risk sexual behaviour (Hegazi et al., 2017; McCarty-Caplan, Jantz, & Swartz, 2014; Sewell et al., 2017), sexually transmitted infections (STI) and HIV transmission (Hirshfield, Remien, Walavalkar, & Chiasson, 2004; Macdonald et al., 2008; Ostrow et al., 2009; Pufall et al., 2018; Sewell et al., 2017). Qualitative data have described motivations and values associated with chemsex among MSM which include, enhancing

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https://doi.org/10.1016/j.drugpo.2019.03.021

the quality of sex and increasing the ability to engage in type of sex that is desired (Weatherburn, Hickson, Reid, Torres-Rueda, & Bourne, 2017). However, research has also highlighted issues around sexual consent in the context of drugs, as well as difficulties in negotiating sex, particularly in group sex environments (Bourne et al., 2015). Whilst not all chemsex is problematic in nature, recent evidence has demonstrated that MSM attending sexual health clinics who disclosed chemsex participation had a five-fold increase in the odds of being newly diagnosed with HIV-infection (Pakianathan et al., 2018). For this reason, chemsex is currently a key area of focus for Public Health England (PHE) with the aim of improving the health and wellbeing of MSM (PHE action plan, 2015-*16 Promoting the health and wellbeing of gay, bisexual and other men who have sex with men*, 2015), as well as to develop best practice in terms of specialist support services.

Although, there is some evidence that drug use and chemsex is more common among HIV positive MSM (Pakianathan et al., 2018; Stuart, 2013), cross-sectional data from 2013/14 and 2015/16 indicated an increase in the proportion of HIV negative or undiagnosed MSM attending large, urban, sexual health services reporting use of drugs typically associated with chemsex (Sewell et al., 2018), and recent research has shown that chemsex is widespread across the UK (Wiggins et al., 2018), and not confined to urban areas, where the majority of data have been collected (Edmundson et al., 2018). Most previous cross-sectional studies from the UK have collected information on use of chemsex drugs among MSM, but not the context of use (whether these drugs were used just prior to or during sexual activity) (Edmundson et al., 2018), despite evidence that drugs associated with chemsex, in particular mephedrone and GHB/GBL, are used in a range of other settings outside of a sexual context (Frankis, Flowers, McDaid, & Bourne, 2018; Melendez-Torres et al., 2018). Furthermore, as yet, there have been no longitudinal studies from the UK or Europe, able to detect changes in frequency of chemsex at an individual level over time, which would help contextualise cross-sectional prevalence data. Although strong associations between chemsex and measures of sexual risk behaviour have been reported (Sewell et al., 2017), there is a lack of data that places chemsex patterns in the context of other sexual behaviour patterns within the same period of time. In this paper we present data from the prospective cohort study, Attitudes to and Understanding Risk of Acquisition of HIV over time (AURAH2), which recruited HIV negative or undiagnosed MSM from sexual health clinics in London and Brighton (Sewell et al., 2016). We report changes in chemsex, and use of individual chemsex drugs, in the cohort over the time of the study, and describe changes in sexual behaviour over the same time period. We further investigate factors associated with chemsex and the individual chemsex drugs, among AURAH2 participants.

Methods

The AURAH2 study was a prospective cohort study that recruited HIV negative or undiagnosed MSM from sexual health clinics in London and Brighton (56 Dean Street clinic, London, Mortimer Market centre, London and Claude Nicol clinic, Brighton) from November 2014 to April 2016. Participants completed a baseline paper questionnaire in clinic, and subsequent four monthly (from online registration) online questionnaires, available from March 2015, for up to three years until March 2018. The four monthly questionnaires captured information on HIV status, HIV testing history, recent sexual behaviour (number of condomless sex partners, group sex, status of partners and whether on anti-retroviral therapy (ART) (if partner(s) were HIV+), health and lifestyle factors including recreational drug use and chemsex, and STI diagnoses (all with a 3 month recall period). Participants were also invited to complete a longer, online, annual questionnaire that collected the same information as the four monthly questionnaire plus additional information on post exposure prophylaxis (PEP) and pre-exposure prophylaxis (PrEP) use (in the past year), relationship status, mental health (using the Patient Health Questionnaire-9 (PHQ-9) (Kroenke, Spitzer, & Williams, 2001) and Generalised Anxiety Disorder-7 (GAD-7)(Spitzer, Kroenke, Williams, & Lowe, 2006)) and alcohol consumption (World Health Organisation alcohol screening tool audit (AUDIT-C score) (Babor, Higgins-Biddle, Saunders, & Monteiro, 2001)). Methodological details for the AURAH2 study have been published elsewhere (Sewell et al., 2016).

Ascertainment of chemsex drug use

At each four monthly online questionnaire, participants were asked to self-report whether they had 'used drugs before or during sex (chemsex)' with a recall period of 'last three months', and if so, to select which chemsex drugs from the following list: mephedrone, GHB/GBL, crystal methamphetamine, other (with space for free text). Participants were then asked 'Approximately how often did you have chemsex in the last 3 months?' with the answer options of, 'Once', 'Monthly' or 'Weekly'.

Sexual risk behaviours, STI diagnoses and HIV testing

Seven measures of sexual risk behaviour and related activities were derived from the four monthly online questionnaires. Anal sex referred to anal sex with men throughout the questionnaires. The first measure was (i) any anal sex within the past three months, subsequent measures of condomless anal intercourse (CLAI) in the past three months were defined as: (ii) CLAI with one or more partners, (iii) CLAI with two or more partners, (iv) CLAI with partners of unknown HIV status. Three additional measures related to sexual behaviour (in the past three months) were defined as: (v) diagnosis with a bacterial STI (Gonorrhoea, Chlamydia, Syphilis, and/or Lymphogranuloma Venereum (LGV)), (vi) group sex, and (vii) recent HIV test.

Online questionnaire completion

Two reminder emails spaced over a two week period were sent to participants when they were due to complete a questionnaire, followed by a text message a week after the second email (if the participant had provided a phone number at enrolment). If a participant missed a questionnaire at any time during follow-up they were still invited to complete subsequent questionnaires and were only withdrawn from the study if they specifically emailed the study manager stating their decision to withdraw. Participants who completed a first online follow-up questionnaire in March 2015 had the option of completing up to 9 online questionnaires, whereas participants who joined the study afterwards only had the option of completing fewer, as the online follow-up finished in March 2018.

Statistical analysis plan

Analyses were based on all MSM that completed an online questionnaire (n = 622), using pooled data from all the online follow-up questionnaires; therefore, multiple responses from individuals were included. Firstly, we examined the associations of sociodemographic, health, lifestyle characteristics and PEP, PrEP, HIV status and calendar year and time in the study with chemsex (binary dependent variable) using univariate generalized estimating equations (GEE) Poisson model with robust variance estimation, with an exchangeable covariance matrix to produce prevalence ratios (PR). In these and subsequent analyses, baseline values of sociodemographic variables were used throughout follow-up, as these were not collected subsequently. For all other variables, information from the relevant follow-up questionnaire was used. Then, in multivariable analysis, using pooled data from the online follow-up questionnaires, we assessed the association between chemsex (binary, dependent variable) and time in the study, adjusting for socio-demographic factors, that could not be influenced by chemsex: age group (< 25, 25–29, 30–34, 35–39, 40–44, ≥45 years), country of

birth and ethnicity (white UK born, non-white UK born, white non-UK born, non-white non-UK born), self-reported sexual identity (gay or bisexual/other), university education (yes or no/missing) and study site (The Mortimer Market Centre, London; 56 Dean Street Clinic, London; The Claude Nicol Centre, Brighton).

To examine changes over time in the study in chemsex and individual chemsex drugs, we considered the proportion of those who reported chemsex at each 4 monthly online questionnaire, using the total number who responded to that questionnaire as the denominator. Univariate generalized estimating equations (GEE) Poisson model with robust variance estimation was used to see if the changes in chemsex and individual chemsex drugs over the follow-up period were significant. This method was also used to investigate changes in the seven measures of sexual behaviour over time.

Three sensitivity analyses were conducted to better understand whether results were affected by lost to follow-up over time. The first analysis included only MSM who completed a questionnaire within the final six months of the study follow-up period compared to the main results. The second sensitivity analysis investigated whether chemsex predicted being lost to follow-up. Two variables were created, 'lost to follow-up' (stopped completing online questionnaires and did not resume) and 'missed the next questionnaire' (missed the next questionnaire). The GEE Poisson model used in the main analysis was utilised to explore whether chemsex predicted being 'lost to follow-up' or 'missed the next questionnaire'. For the third sensitivity analysis, the last observation for the chemsex variable was carried forward where online questionnaires were missing and the same adjustment and Poisson model was used as in the main analysis. All analysis was conducted in Stata statistical software V.13.

Results

Characteristics of online participants

Of the 1167 MSM who consented to and completed the AURAH2 study baseline questionnaire in clinic, 622 (53.2%) went on to complete at least one online follow up questionnaire. Of these, 64.3% (400/622) remained engaged with the study throughout (completed a questionnaire within the last 6 months of the study follow-up period). In total, all participants that completed at least one online questionnaire contributed a total of 1423 person-years of follow-up. Table 1 shows sociodemographic, health and lifestyle characteristics, sexual behaviour, PEP, PrEP and HIV testing in the AURAH2 cohort.

Socio-demographic, health and lifestyle characteristics, sexual behaviour, PEP, PrEP and HIV testing, among participants in the AURAH2 study, and those that reported chemsex use at first online questionnaire of online (n = 622)

The median age among participants who completed at least one online questionnaire (n = 622) was 34 (standard deviation [SD]: 11.3) years, 579 (94.5%) identified as gay and 34 (5.5%) identified as bisexual or other, most (511, 83.8%) were of white ethnicity and over three quarters (472 (76.7%)) were educated to university level (see Table 1). The prevalence of chemsex associated drug use at baseline among MSM who did not complete any online questionnaires (n = 545) was comparable (29.4%) to that among MSM that completed at least one online questionnaire (32.3%); as was the prevalence of individual chemsex drugs that were reported among MSM who did not complete an online questionnaire compared to those that did, mephedrone (26.8% vs 28.5%), GHB/GBL (17.4% vs 20.3%) and crystal methamphetamine (9.4% vs 10.0%) (see supplementary material 1, Table 3). Fifteen men self-reported a new HIV diagnosis during the 3-year online follow-up period.

When examining associations with chemsex using pooled data from all the follow-up questionnaires, a number of factors were found to be associated with chemsex. In unadjusted analysis (Table 2). There was a tendency for prevalence of chemsex to be higher among participants not born in the UK and among those not in an ongoing relationship. Clinically significant symptoms of depression (PR 1.47 95%CI: 1.08, 2.00) or anxiety (PR 1.49 95%CI: 1.10, 2.01) (at annual questionnaires) were both associated with chemsex, as was the use of PEP (PR 1.43 95%CI: 1.09, 1.87) or PrEP (PR 1.63 95%CI: 1.28, 2.09). Age and markers of socioeconomic status were not associated with chemsex. Chemsex prevalence significantly decreased as time in the study increased and as calendar year increased (see Table 2.)

Table 1
Socio-demographic, health and lifestyle characteristics, sexual behaviour, PEP, PrEP and HIV testing, among MSM in the AURAH2 study that completed at least one follow-up questionnaire, (n = 622 unless indicated).

Characteristic	Category	n(%)
Age[1] (years) [n = 610]	< 25	132 (21.6%)
	25-29	86 (14.1%)
	30-34	121 (19.8%)
	35-39	89 (14.6%)
	40-44	69 (11.3%)
	45 +	113 (18.5%)
Born in the UK and white ethnicity[1] [n = 610]	Yes, white	317 (52.0%)
	Yes, non-white	29 (4.7%)
	No, white	194 (31.8%)
	No, non-white	70 (11.5%)
Money to cover basic needs[1] [n = 615]	All of the time	509 (82.8%)
	Most of the time	81 (13.2%)
	Sometimes/no	25 (4.1%)
University education[1] [n = 615]	Yes	472 (76.7%)
	No	143 (23.2%)
Employed[1] [n = 615]	Yes	547 (88.9%)
	No	68 (11.1%)
Housing status[1] [n = 606]	Home owner	200 (33.0%)
	Renting	328 (54.1%)
	Unstable/other	78 (12.9%)
Sexual identity[1] [n = 610]	Gay	579 (94.5%)
	Bisexual/other	34 (5.5%)
Ongoing relationship[1] [n = 615]	Yes	257 (41.8%)
	No	358 (58.2%)
Higher risk alcohol consumption (WHO AUDIT-C > = 6) [1] [Missing n = 7]	Yes	80 (12.9%)
	No/missing	542 (87.1%)
Clinically significant depressive symptoms (PHQ-9 score > = 10) [1] [Missing n = 7]	Yes	75 (12.1%)
	No/missing	547 (87.9%)
Clinically significant anxiety symptoms (GAD& score > = 10)[1] [Missing n = 7]	Yes	57 (9.2%)
	No/missing	565 (90.8%)
Any anal sex[2] [missing n = 4]	Yes	562 (90.3%)
	No/missing	60 (9.1%)
CLAI with 1 or more partner(s) [2] [missing n = 4]	Yes	413 (66.4%)
	no/missing	209 (33.6%
CLAI with 2 or more partner(s) [2] [missing n = 4]	Yes	243 (39.1%)
	No/missing	379 (60.9%)
CLAI with partner(s) of unknown status[2] [missing n = 10]	Yes^	210 (33.8%)
	no/missing	412 (66.2%)
Chemsex[2] [missing n = 4]	Yes	198 (32.0%)
	No/missing	424 (68.2%)
Diagnosed with bacterial* STI[2] [missing n = 4]	Yes	164 (26.4%)
	no/missing	458 (73.6%)
Group sex[2] [missing n = 4]	Yes	203 (32.6%)
	no/missing	419 (67.4%)
Recent HIV test[2] [missing n = 10]	Yes	476 (76.5%)
	no/missing	146 (23.5%)

[1]from baseline questionnaire data;[2]from first 4 monthly questionnaire data.
CLAI: Condomless anal intercourse.
^It means they report not knowing the status of some or none of their partners; *bacterial STI (Gonorrhoea, Chlamydia, Syphilis, and/or Lymphogranuloma Venereum (LGV).

Associations of chemsex and individual chemsex drugs with time (calendar year) over the AURAH2 follow-up period

In unadjusted analysis we found a strong negative association

Table 2
Unadjusted associations of sociodemographic and lifestyle characteristics, PEP, PrEP, HIV status, calendar year and time in the study, with chemsex during follow-up in the AURAH2 study. Analysis using pooled data from all available follow-up questionnaires.

Factor (number of observations)		Prevalence Ratio (95%CI)
Age* (years) (observations 3239)	< 25	1
	25-29	0.83 (0.66, 1.05)
	30-34	0.95 (0.73, 1.26)
	35-39	1.03 (0.76, 1.40)
	40-44	1.00 (0.70, 1.44)
	45+	0.76 (0.54, 1.08)
		p = 0.298*
		p = 0.278**
Born in the UK and white ethnicity[1] (observations 3239)	Yes, white	1
	Yes, non-white	0.90 (0.50, 1.64)
	No, white	1.25 (0.97, 1.61)
	No, non-white	1.46 (1.06, 2.00)
		p = 0.066*
Money to cover basic needs[1] (observations 3257)	All of the time	1
	Most of the time	1.05 (0.77, 1.45)
	Sometimes/no	1.06 (0.63, 1.77)
		p = 0.931*
		p = 0.716**
University education [1] (observations 3257)	No	1
	Yes	0.96 (0.74, 1.23)
		p = 0.546*
Employed [1] (observations 3257)	No	1
	Yes	1.12 (0.77, 1.63)
		p = 0.510*
Housing status[1] (observations 3211)	Home owner	1
	Renting	0.96 (0.74, 1.23)
	Unstable/other	1.02 (0.73, 1.44)
		p = 0.902*
		p = 0.828**
Sexual identity[1] (observations 3247)	Bisexual/other	1
	Gay	1.13 (0.69, 1.84)
		p = 0.628*
Ongoing relationship[2] (observations 937)	No	1
	Yes	0.79 (0.62, 1.02)
		p = 0.068*
Higher risk alcohol consumption[2] (modified WHO AUDIT-C > = 6) (observations 942)	No/missing	1
	Yes	0.94 (0.65, 1.38)
		p = 0.768*
Clinically significant depressive symptoms[2] (PHQ-9 score > = 10) (observations 942)	No/missing	1
	Yes	1.47 (1.08, 2.00)
		p = 0.014*
Clinically significant anxiety symptoms[2] (GAD& score > = 10) (observations 942)	No/missing	1
	Yes	1.49 (1.10, 2.01)
		p = 0.008*
PEP use[2] (observations 942)	No/missing	1
	Yes	1.43 (1.09, 1.86)
		p = 0.009*
PrEP use[2] (observations 942)	No/missing	1
	Yes	1.63 (1.28, 2.09)
		p < 0.001*
HIV status (observations 3277)	Negative	1
	Positive	0.87 (0.55, 1.38)
	Don't know/ missing	1.01(0.83, 1.23)
		P = 0.8383*
Year (observations 3262)	2015	1
	2016	0.82 (0.74, 0.90)
	2017	0.77 (0.69, 0.86)
	2018	0.73 (0.62, 0.87)
		p < 0.001*
		p < 0.001**
Time in the study (since 1st online questionnaire) (observations 3277)	0 months	1
	4 months	0.90 (0.81, 1.00)
	8 months	0.79 (0.69, 0.89)
	12 months	0.83 (0.73, 0.95)
	16 months	0.71 (0.61, 0.83)
	20 months	0.78 (0.68, 0.89)
	24 months	0.77 (0.67, 0.89)
	28 months	0.68 (0.56, 0.81)
	32 months	0.54 (0.41, 0.70)

Table 2 (*continued*)

Factor (number of observations)	Prevalence Ratio (95%CI)
	p < 0.001*
	p < 0.001*

[1]from baseline questionnaire data; [2]from annual questionnaire data; *p value from Poisson GEE model;**p value from Poisson GEE model including the predictors as continuous variable.

Table 3
Associations of time since first online questionnaire with chemsex, and individual chemsex drugs, during follow-up in the AURAH2 study. Analysis using pooled data from all available follow-up questionnaires.

Dependent variable	Unadjusted* PR for visit (95%CI)	p value	Adjusted* PR for visit (95%CI)	p value
Chemsex	0.95 (0.93, 0.97)	< 0.001	0.95 (0.93, 0.97)	< 0.001
Mephedrone	0.89 (0.86, 0.92)	< 0.001	0.89 (0.86, 0.92)	< 0.001
GHB/GBL	0.96 (0.93, 0.98)	0.001	0.96 (0.93, 0.99)	0.003
Crystal Meth**	1.02 (0.98, 1.06)	0.289	1.01 (0.97, 1.05)	0.564

CI: confidence interval; PR: prevalence ratio.
*observations in each model: Unadjusted = 3277, Adjusted = 3229.
**Methamphetamine No missing data for question on chemsex at any online questionnaire among respondents.
Adjusted: sociodemographic characteristics that could not be influenced by chemsex :time-updated age (< 25, 25–29, 30–34, 35–39, 40–44, ≥45 years), country of birth and ethnicity (white UK born, non-white UK born, white non-UK born, non-white non-UK born), self-reported sexual identity (gay or bisexual/other), university education (yes or no/missing) and study site (The Mortimer Market Centre, London; 56 Dean Street Clinic, London; The Claude Nicol Centre, Brighton).

between time spent in the study and chemsex, and use of mephedrone and GHB/GBL, but not crystal methamphetamine (see Table 3). After adjusting for age, country of birth and ethnicity, sexual identity, university education and study site, we found the strength of this association remained for chemsex, and the individual drugs mephedrone and GHB/GBL, with crystal methamphetamine use remaining not significantly associated.

Changes in prevalence of chemsex over time in the study

Overall, chemsex and the use of two (mephedrone and GHB/GBL) of the three individual chemsex drugs significantly declined over the follow up period of the study (see Fig. 1). The prevalence of chemsex at the first online questionnaire was 31.8% (198/622), which steadily and significantly declined over time to 11.1% (8/72; p < 0.001) among MSM who completed the 9th questionnaire of follow-up. This decline was reflected in the proportion of MSM reporting use of two individual chemsex drugs: mephedrone use significantly declined from 25.2%–9.7% (p < 0.001), GHB/GBL also significantly declined from 19.9% to 8.3% (p = 0.001). However, crystal methamphetamine use marginally decreased, but not significantly, 11.1% at the first online questionnaire and 6.9% at the 9th online questionnaire (p = 0.2893).

These results remained similar in the first sensitivity analysis that only included MSM who had completed a questionnaire within the final six months of the study follow-up period (supplementary material 2, Figure 4).

In the second sensitivity analysis, we explored whether there was a selective loss over time of MSM engaging in chemsex. There was no association of chemsex with loss to follow-up (stopped and did not resume online questionnaires) (PR 1.04 (95%CI: 0.89, 1.24) or with missing the next online questionnaire (PR 1.02 (95%CI: 0.90, 1.16) (supplementary material 3, Table 4). In the third sensitivity analysis, in which the last observation for the chemsex variable was carried forward

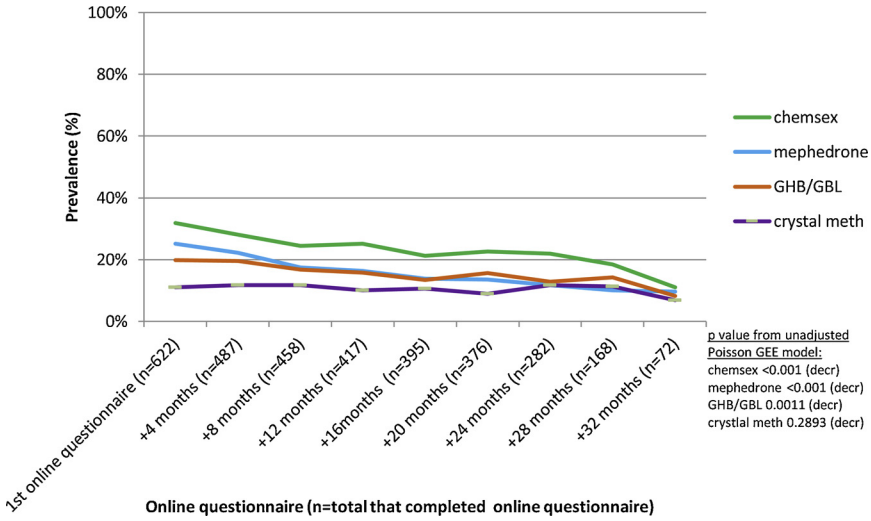

Fig. 1. Prevalence of chemsex, and individual chemsex drugs over time in the study, among MSM in the AURAH2 study (n = 3277 questionnaires)*.
*No missing data for question on chemsex at any online questionnaire among respondents
Decr: decreasing;

to fill in missing data, in adjusted analyses the decline over calendar year in chemsex remained (data not shown).

Within-person changes in frequency of chemsex over time in the study

Fig. 2 shows the frequency of chemsex reported over the follow-up period according to frequency of chemsex reported at the first online questionnaire. There was some variation in levels of chemsex use within individuals over time in the study, and a general tendency for use to decline over time. At the first online questionnaire, around two thirds of MSM (68.3%; 425/622) reported no chemsex (in the past 3 months), 70 out of 622 11.3%) reported chemsex 'Once', 95 MSM (15.3%) reported chemsex 'Monthly' and 32 (5.1%) reported chemsex 'Weekly'. At each questionnaire(time-point) over 65% had reported no chemsex at first online questionnaire and continued to report no chemsex. In total, of the 72 MSM who replied to the 9th questionnaire 90.3% (65/72) reported 'No chemsex' at the 9th questionnaire, 1 (1.4%) reported it 'Once' and 6 (8.3%) reported it 'Monthly', none reported it 'Weekly' at the 9th questionnaire covering the most recent 3 month period(Fig. 2).

Changes in sexual risk behaviours, STI diagnoses and HIV testing, over time

Overall the measures of sexual behaviour and associated behaviours, tended to decline over time among the cohort (see Fig. 3), with only those related to CLAI slightly increasing (CLAI with 1 or more partner and CLAI with 2 or more partners). Any anal sex declined from 90.9% at the 1 st questionnaire to 86.5% at the 9th questionnaire, while CLAI with one or more partners increased from 66.4%–70.8% at the 9th

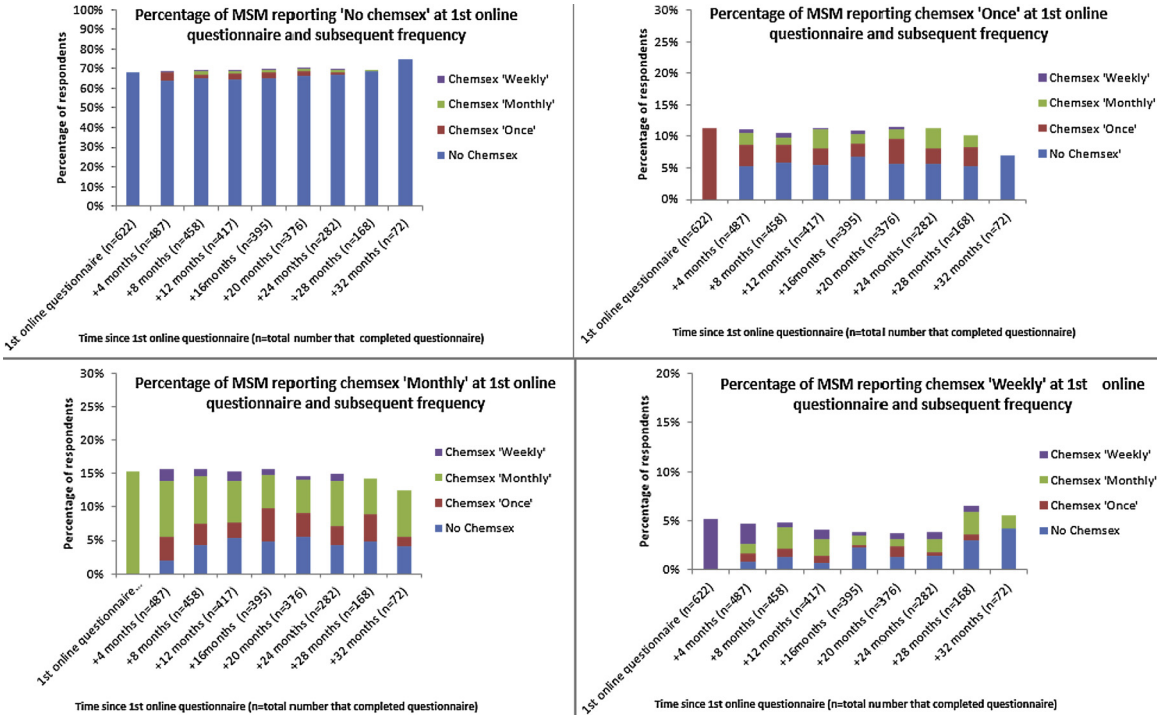

Fig. 2. Within-person changes in frequency of chemsex over time in the study among MSM in the AURAH2 study (n = 3277 questionnaires).

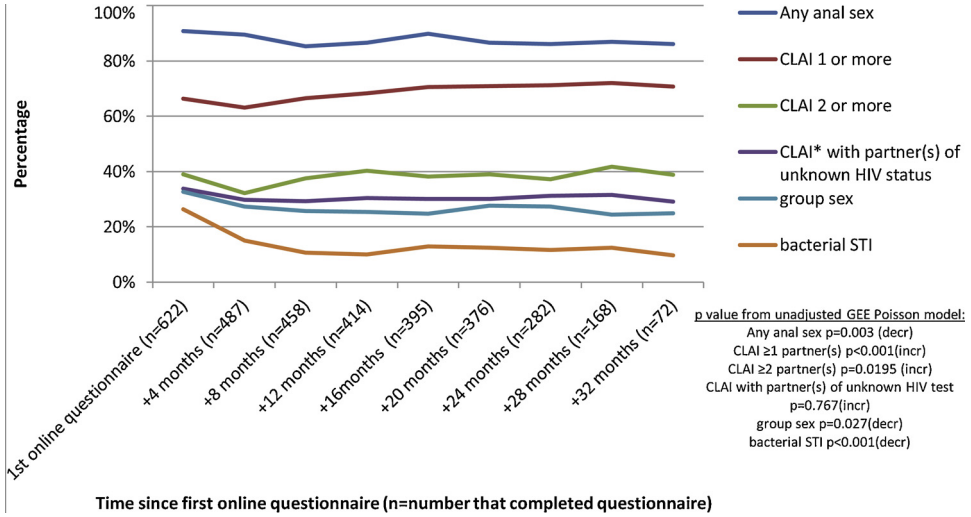

Fig. 3. Prevalence of measures of sexual behaviour[1] over time in the study among MSM in the AURAH2 study (n = 3277 questionnaires).
*CLAI = condomless anal intercourse and Missing data were treated as no, the number of missing data was limited (see missing data for visit 1 in Table 1)

questionnaire and group sex decreased from 32.6%–25.5%. Reporting a bacterial STI had significantly decreased from 26.4%–9.7% over the follow up period ($p < 0.001$). Reporting a recent HIV test (within the past 3 months) had also significantly declined, although the high prevalence of HIV testing at the first online questionnaire (76.5%) could be a reflection of the study process whereby participants were invited (via email) to complete their first online questionnaire within 3 months of recruitment to the study in-clinic, where it is likely they were offered an HIV test.

Discussion

This paper provides the first longitudinal analysis of chemsex among a cohort of MSM in Europe and is provided in the context of changes in sexual behaviour over the same time period. Our results suggest a decline in prevalence of chemsex, and chemsex specific drugs such as mephedrone and GHB/GBL, over time among MSM in the study; even when we restrict to those who remained engaged with the study over the 3-year follow-up period. Despite some selective drop-out of MSM who reported chemsex in the study, we found no association between chemsex and being lost to follow-up or missing the next study questionnaire. This decline is reflected in the patterns of reported frequency of chemsex at each online follow-up ('No chemsex, 'Once', 'Monthly', 'Weekly' [past 3 months]) over the same period which showed an increase in MSM reporting 'No chemsex' from the first online questionnaire to the last. Although it is difficult to attribute a direct cause for this decline, one explanation could be found in the clinics that AURAH2 recruited from, which are specialist centres for chemsex support where interventions are specifically tailored to MSM reporting chemsex (Sewell et al., 2018). As such our results may be a reflection on the effectiveness of these services at providing valuable support and interventions to reduce chemsex among a specific group of MSM. Furthermore, engagement with questionnaires that encourage reflection on behaviour may play a factor in study participants becoming more conscious of the consequences of their choices, which could have led to behaviour change (McCambridge & Kypri, 2011); and may partly explain the decline in chemsex and individual chemsex drug use witnessed in this cohort. Another potential explanation for the decline in chemsex in the cohort over time in the study is regression to the mean. In other words, men may have been recruited to the study at a time of particularly high risk behaviour, risk which would then tend to decline with time. It appears that men were more likely to have condomless sex with more than one and more than two partners as the study progressed, but it became less likely that this sex involved a partner of unknown HIV status, group sex and chemsex drugs.

The number of self-reported new HIV diagnoses (15 sero-conversions) among our cohort over the three-year follow-up period is low, even when considered in the context of the steep fall in HIV diagnoses reported by both 56 Dean Street and Mortimer Market clinic (Brown et al., 2017) during the same time period as the study follow-up. Differently from (Pakianathan et al., 2018), we did not find an association between reporting chemsex and becoming newly diagnosed with HIV in unadjusted analysis, despite a strong association with PEP and PrEP use. Similarly to what we reported for the AURAH study (cross-sectional) on use of chemsex drugs (Sewell et al., 2017), we found here a significant association between depression and anxiety and chemsex. It has been suggested that use of recreational drugs among MSM could be part of a behaviour to cope with a feeling of being part of a minority and other stressors (Meyer, 1995; Wolitski, Stall, & Valdiserri, 2008).

The estimated prevalence of chemsex at the start of online follow up in the AURAH2 study (32.0%) is similar to that estimated in the cross-sectional analysis of the larger sample (n = 1031) of MSM who completed a baseline paper questionnaire in-clinic in 2015/2016 during recruitment to the study (32.3%) (Sewell et al., 2018), and is substantially higher than the prevalence of chemsex drug use observed in the cross-sectional AURAH study conducted in 2013/2014 (prevalence among MSM attending 20 sexual health clinics across England: 21.8%, prevalence among MSM attending the same three sexual health clinics included in the AURAH2 study: 24.2%) (Sewell et al., 2017, 2018). Compared to other clinic based studies, the prevalence of chemsex at the start of online follow-up in the AURAH2 study is higher than that reported by a recent retrospective case note review from 2014/2015 among MSM (n = 1734) attending sexual health services in a different area of London (16.5%) (Pakianathan et al., 2018), and similar to that reported among HIV positive MSM in-patients admitted to an HIV unit in 2014/2015 (31%, n = 42) also in London (Elliot, Singh, Tyebally, Gedela, & Nelson, 2017). This high prevalence of chemsex at the start of online follow-up in the AURAH2 study could also be related to the location of the clinics (London and Brighton), that the study population were recruited from. Both cities were in the top three among 44 cities in Europe where use of 4-chems was reported highest among MSM in the 2010 European MSM Internet Survey, 2010 (Schmidt et al., 2016). Furthermore, two of the clinics from which participants were recruited from (56 Dean Street and Mortimer Market) are renowned for their chemsex support services in London, which may have resulted in a larger number of MSM who engage in chemsex, opting to attend them. However, the declining trend in chemsex in this longitudinal analysis, from 31.8%–11.1%, over the 3 year follow-up period of the AURAH2

study, indicates that MSM attending sexual health clinics who report chemsex, would appear to do so for specific, relatively short periods of time, during which regular attendance at sexual health clinics for STI monitoring, HIV testing and access to PEP and PrEP would be highly beneficial due to the high risk sexual behaviours (Hegazi et al., 2017; Sewell et al., 2017). Due to the relatively short follow-up period of the online study (3 years) and the loss to follow-up, it is not known whether MSM who stopped reporting chemsex during the course of the AURAH2 online follow-up period have remained abstinent from chemsex or have since reinitiated. Further longitudinal studies with extended follow-up periods would help elucidate this information and qualitative data on stopping and re-initiating chemsex would be beneficial to contextualise our results.

There is limited longitudinal data on chemsex patterns and trajectories among MSM at national or international level with which to compare our results to. The Australian, *Following Lives Undergoing Change* (Flux) Study, is an online prospective cohort study (n = 1710) that commenced in 2014/2015 and collects biannual data on licit and illicit drug use among Australian MSM recruited online through social media, gay community websites and gay sexual networking websites (Hammoud et al., 2017). Recent results from the Flux study described an increase over calendar time in concurrent use of methamphetamines, Viagra™ and other erectile dysfunction medications, and Truvada™ as PrEP (Hammoud et al., 2018), however no results on chemsex have yet been published. Furthermore, the major difference in study samples (Flux used an online convenience sample whilst AURAH2 recruited from clinics) and the drugs included in each analysis (Flux: methamphetamine, Viagra™ and Truvada™, AURAH2: mephedrone, crystal methamphetamine and GHB/GBL) make it difficult to draw comparisons.

A major strength of this study is the large sample size and regular recall period that was used to capture event-level data on chemsex. This allowed us to investigate trends in patterns and frequency of chemsex and individual chemsex drugs. The online retention of participants that registered and completed an online questionnaire, was not optimal, however 64.3% of participants completed an online questionnaire within the last six months of the study follow-up period, and there were no significant differences in the main analyses when restricting to people who had completed a questionnaire in the last 6 months of follow-up. Additionally, collecting sensitive and personal information on drug use and sexual behaviour online may have reduced potential social desirability bias (DiClemente, Swartzendruber, & Brown, 2013). As with any study collecting self-reported data, results may be influenced by recall bias, despite the time frame for chemsex and the sexual behaviour measures being within the past 3 months, the maximum period of recall recommended to obtain accurate self-reports (Napper, Fisher, Reynolds, & Johnson, 2010). Potentially both a strength and limitation of the study was the recruitment of participants attending sexual health clinics renowned for their focus on integrating substance use services with sexual health services, and the location of these clinics being in large, urban centres, noted for their gay communities, London and Brighton. Whilst understanding trends in chemsex and sexual behaviour among clinic attendees in these clinics may elucidate patterns in similar high-density areas populated by MSM, it limits the generalisability of our results to include smaller towns and cities and rural areas where service provision is required but often not supplied in the same capacity (Wiggins et al., 2018). Additionally, our highly educated, economically stable cohort may not be representative of the wider MSM community, thus limiting the generalisability of our results further. Furthermore, we recognise that our results may not reflect trends in chemsex trajectories and patterns among MSM who are not engaged with sexual health services, where potential for problematic harms associated with chemsex may be greater, despite the risk group being the potential smaller (Melendez-Torres et al., 2018).

Conclusions and implications

This is the first study from the UK and Europe to describe changes in patterns of chemsex, frequency of chemsex and sexual behaviour over time among MSM. Chemsex and use of two individual chemsex drugs (mephedrone and GHB/BGL) significantly declined over time among individuals in the study, as did most of the measures of sexual behaviour except for CLAI with one or more and two or more partners. Whilst the majority of MSM in the study did not report chemsex, there is a clear need for integrated drug and sexual health services, with a focus on health promotion and HIV prevention, such as PEP and PrEP access, aimed at MSM who report chemsex, and in particular problematic chemsex. Such targeted interventions would be highly beneficial, potentially only necessary for relatively short periods of time for individuals, and could have long term benefits as well as wider HIV and STI prevention.

Author contributions

Design and data collection: JS, AS, AP, FL, DS, RG, DA, NN, AC, AR.
Analysis and interpretation: JS, VC, AR.
Drafting the manuscript: JS, VC, FL, AS, AP, AR.

Funding

The AURAH2 study was funded by the NIHR under its Programme Grants for Applied Research Programme (RP-PG-1212-20006). The AURAH2 Study Group acknowledges the support of the NIHR, through the Comprehensive Clinical Research Network. The views expressed this paper are those of the authors and not necessarily those of the NHS, the NIHR, or the Department of Health.

Ethics approval and participant consent

The AURAH2 study was approved by the designated research ethics committee, NRES committee London-Hampstead, ref: 14/LO/1881 in November 2014.

Based on these documents, the studies subsequently received permission for clinical research at the three participating National Health Service sites; Chelsea and Westminster NHS Foundation Trust, Central and North West London NHS Foundation Trust and the Brighton and Sussex University Hospitals NHS Trust. All participants provided written, informed consent before taking part.

Declarations of interest

None.

Study sponsor

The AURAH2 study was sponsored by the Joint Research Office, UCL. The sponsor and funder were not involved in the study design, collection, analysis, and interpretation of data or in the writing of the report; or the decision to submit the article for publication.

Acknowledgements

We would like to thank all the study participants for their time and effort. We gratefully acknowledge the 3 participating sites and the contributions and efforts of the following at each site:

The Mortimer Market Centre, London: Ana Milinkovic, Fabienne Styles, Rosanna Laverick, Marzena Orzol, Emmi Suonpera.

56 Dean Street Clinic, London: Ali Ogilvy.

The Claude Nicol Centre, Brighton: Celia Richardson, Elaney Youssef, Sarah Kirk, Marion Campbell, Lisa Barbour.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.drugpo.2019.03.021.

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