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Chemsex behaviours among men who have sex with men: A systematic review of the literature

Steven Maxwell[a,*], Maryam Shahmanesh[b], Mitzy Gafos[c]

[a] King's College London, James Clerk Maxwell Building, 57 Waterloo Road, London, SE1 9NN, United Kingdom
[b] Institute for Global Health, University College London, Capper Street, London, WC1E 6JB, United Kingdom
[c] Department of Global Health and Development, London School of Hygiene and Tropical Medicine, 15-17 Tavistock Place, London, WC1H 9SN, United Kingdom

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ABSTRACT

Background: 'Chemsex' is the use of drugs before or during planned sexual events to facilitate, enhance, prolong and sustain the experience. Drugs associated with chemsex are methamphetamine, GHB/GBL, mephedrone, cocaine and ketamine. This review syntheses published research on the antecedents, behaviours and consequences associated with chemsex behaviours among men who have sex with men (MSM).

Methods: Papers from high income countries which were published between January 2000 and September 2018 reporting the use of chemsex drugs before or during sex were identified through Medline, Web of Science, CINAHL and Central. Results were synthesised using a narrative approach and conceptualised using a behavioural analysis framework.

Results: The search identified 2492 publications, of which 38 were included in the final synthesis. There were wide variations in chemsex prevalence estimates due to the heterogeneous sampling in the studies. Chemsex participants have expectations that the drugs will positively affect their sexual encounters and HIV positive MSM are more likely to engage in the behaviour than HIV negative MSM. There were wide ranging prevalence estimates on injecting drugs for sexual purposes and the sharing of injecting equipment with some evidence of unsafe injecting practices. Participants were more likely to engage in condomless anal intercourse than men who do not engage in chemsex. This may increase the risk of transmission for HIV and other sexually transmitted infections.

Conclusion: A minority of MSM appear to engage in chemsex behaviours but they are at risk of this negatively impacting on their health and well-being. Further research is required to examine high risk chemsex behaviours, impact of chemsex on psycho-social well-being and if chemsex influences uptake of PrEP, PEP and sexual health screening.

Introduction

Men who have sex with men (MSM) can have significant and multi-faceted relationships with drugs and alcohol. Public Health England (2014) identify an alcohol dependence rate among MSM that is double that of the non-MSM male population. The Office for National Statistics (2014) report gay and bisexual men to be three times more likely to use illicit substances than their heterosexual counterparts. One quarter of a sample of MSM drawn from twenty sexual health clinics in England report using three or more recreational drugs in the previous three months (Sewell et al., 2017). However, sexual health clinic samples are likely to provide over-estimates for substance use behaviours and differences would also be expected between metropolitan samples of MSM and country-wide estimates. However, poly drug use is a recognised concern among MSM particularly those who use drugs before or during sex.

Sexualised drug use (SDU) refers to the use of any illicit drug just before or during sex and a subset term of SDU is referred to as 'chemsex' (Edmundson et al., 2018). Chemsex behaviours are described as the use of specific drugs before or during planned sex to facilitate, initiate, prolong, sustain and intensify the encounter (Public Health England, 2015; Bourne, Reid, Hickson, Torres-Rueda, & Weatherburn, 2015). Certain drugs have been associated with chemsex behaviours including mephedrone, methamphetamine, and GHB/GBL (Gamma hydroxybutyrate/Gamma butyrolactone) (Public Health England, 2015). In a London based study cocaine and ketamine were also linked to the behaviours (Bourne, Reid, Hickson, Torres Rueda, & Weatherburn, 2014). A high-risk behaviour associated with chemsex involves the injecting of

* Corresponding author.
E-mail addresses: steven.maxwell@kcl.ac.uk (S. Maxwell), m.shahmanesh@ucl.ac.uk (M. Shahmanesh), Mitzy.Gafos@lshtm.ac.uk (M. Gafos).

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a drug for sexual purposes (Public Health England, 2015). The concept of 'chemsex' is socially constructed and as such is subject to the preferences of participants and the popularity and availability of specific drugs. Furthermore, these features are likely to vary across countries and among sub-cultures within countries, as well as across time.

There have been growing concerns about the interconnected nature of high risk drug/sexual behaviours and the increased transmission risk of blood borne viruses (BBV) and sexually transmitted infections (STIs) (Public Health England, 2015). In the United Kingdom (UK) MSM account for more than half of all new human immunodeficiency virus (HIV) infections which demonstrates that they are disproportionately affected by the disease in comparison to the general population (Public Health England, 2016). The advent of HIV antiretroviral therapy and pre-exposure prophylaxis (PrEP) provide protection by reducing the risk of onward transmission and acquisition. However, the effectiveness of these medicines is reliant on patient adherence and there is limited evidence on the impact of chemsex behaviours on medication adherence. In addition to the biological risk, there is increasing concerns that chemsex may be associated with psychosocial risks. Tomkins, George, and Kilner, (2018) identified that there is growing evidence which indicates that chemsex is potentially associated with the mental ill health of MSM who engage in the activity. This highlights that there are potentially multiple biopsychosocial risk factors for MSM that engage in chemsex behaviours.

Chemsex has attracted international clinical and research attention from which there is an emerging body of knowledge on different aspects of the behaviour. For example, its prevalence (Heiligenberg et al., 2012), sociodemographic characteristics associated with the behaviour (Ober et al., 2009), patterns of drug use and sexual behaviours (Benotsch, Lance, Nettles, & Koester, 2012), biopsychosocial impact of the behaviour (Hegazi et al., 2017), and associations with HIV (Bourne et al., 2015). In early 2018 two published literature reviews (Edmundson et al., 2018; Tomkins et al., 2018) examined some aspects of chemsex but had a wider focus on MSM sexualised drug use. To date, we are not aware of a literature review that has specifically examined the research related to chemsex drug use before or during sex. As chemsex participants health is potentially at high-risk there is a need to systematically interrogate the literature on chemsex drug use within a sexualised setting. This review will comprehensively analysis the behaviours involved in chemsex activities, including the risks they present to participants. The review will help inform the development of evidence-based risk reduction strategy and provide recommendations on the need for further research.

Methods

The research team anticipated that different methods and means of measurement would characterise the literature in the emerging evidence base on chemsex behaviours. This review was conducted as a narrative review, guided by a conceptual framework and drawing on systematic methodology as far as possible to promote transparency and replicability with results reported according to PRISMA guidelines (Liberati et al., 2009).

Chemsex behaviours are activities for which the antecedent-behaviour-consequence (ABC) framework provides a useful way to map potential variables of interest. Table 1 contains a provisional ABC analysis of chemsex drawn from the literature and from research team discussions. It provides a framework to organise review findings and to specify the review's objectives:

1 To establish prevalence estimates for chemsex behaviour among MSM;
2 To document chemsex behaviour in terms of drugs used, high risk drug use behaviour, sexual risk behaviour and characteristics of the drug use setting;
3 To gauge whether sex sessions that include drugs differ from those that do not in terms of the behaviours and associated risks;
4 To identify factors associated with chemsex behaviour, including HIV status, individual's socio-demographics and expectations of participation;
5 To identify any bio-medical risk reduction interventions used by chemsex participants and whether their use is compromised when drugs are combined with sex;
6 To identify the biopsychosocial impact of chemsex behaviour on participants, including risk of STI/BBV infection and the psychosocial impact.

There are challenges to identifying and reaching representative populations of MSM who engage in chemsex behaviours. Added to this are the challenges of classifying and measuring a varied, uncommon set of human behaviours. The sampling frames of the studies included in this review will by extension be heterogeneous and not representative, making accurate population estimates unrealistic. For example, where studies have recruited samples from sexual health or drug treatment services, prevalence is likely to be over-estimated. The context for each study and its potential effects on prevalence are addressed when estimates are presented in the review.

Eligibility criteria

This review includes studies of chemsex behaviours that involve drug use before or during sex with any one of the following drugs: methamphetamine, mephedrone, GHB/GBL, cocaine and ketamine. To be able to consider HIV risk reduction strategies during chemsex behaviours, alongside other potential biopsychosocial harms and protective mechanisms, studies were included that sampled HIV negative MSM or those whose HIV status was unknown. Studies that exclusively sampled HIV positive MSM were excluded. The review includes studies of primary research from high income countries, as defined by the World Bank, which were published in peer review journals in the English language between 1st of January 2000 and 1st of September 2018.

Information sources and search

Four databases were used for the search; Medline, CINAHL, Web of Science and CENTRAL. The databases were selected to reflect medical, nursing, allied health professionals, sociological and clinical trial journals. Table 2 presents the MESH terms and key words that were used for the search. One reviewer conducted the search using a

Table 1
ABC analysis of chemsex behaviour between MSM.

Antecedent	Behaviour	Consequence
• Sociodemographic characteristics • HIV status • Expectations of the event	• Prevalence • Drugs used • Injecting drug use • Drug use setting • Sexual behaviours • Bio-medical risk reduction interventions	• Physical including HIV/BBV/STI infection • Psychological • Social

Table 2
PIO search terms.

Population	Intervention	Outcome
Men who have sex with men (MSM)	Chemsex	Sexually transmitted infection(s)
Homosexual me(a)n	Party and play	Sexually transmitted disease(s)
Gay me(a)n	Sexualised drug use	HIV
Gay male(s)	Slamming	Hepatitis C
	Substance use disorder(s)	
	Illicit drug use	

predefined protocol which was developed in combination with another two senior researchers. The search was conducted initially in December 2017 and was updated in September 2018.

Study selection

Data retrieved through the search were extracted onto Endnote x8 (Thomson Reuters, New York, USA). At the abstract stage an independent reviewer examined a random sample of abstracts (10% of those excluded and 20% of those included) to ensure the robust application of the inclusion and exclusion criteria. A third researcher was available to resolve any differences through discussion.

Risk of bias assessment in individual studies

A risk of bias assessment was performed for each study by one reviewer. The National Heart, Lung and Blood Institute (NHLBI) tool was used to assess the clarity and rigour of the outcomes/measures, sample recruitment, data collection and statistical analysis process of quantitative studies that were cohort/cross sectional in design. Critical Appraisal Skills Programme (CASP) checklists were used to assess the clarity and rigour of the recruitment strategy, data collection/analysis methodology, ethical considerations and presentation of findings of qualitative studies. The primary strengths and limitations of the methodologies of the papers are summarised in the findings section.

Data collection process and data items collected

Data from the studies included in the analysis were extracted by one reviewer onto a structured data extraction template. The following variables were extracted: authors, title, year published, study aim, data collection period, study design, study location, setting, data collection/analysis methodology and variables of interest as defined in Table 1.

Data analysis

The narrative approach to synthesis uses words and text to 'tell the story' of the findings. Popay et al.'s (2006) four stage framework and techniques are used to increase the transparency and trustworthiness of the narrative synthesis. The literature in this review is used to understand a behavioural event and Table 1 provides an initial theoretical model of that behavioural event. The ABC framework is utilised to organise and compare evidence and was subject to alterations and refinements as synthesis progressed.

Results

Study selection

The number of studies identified, reviewed and selected with reasons for exclusion are summarised in Fig. 1. The initial total number of articles captured from the search was 3438, which after removing duplicates was 2653. On reviewing article titles there were 2362 excluded which left 291 articles for abstract screening. Eighty articles met final inclusion and at full reading there were forty-two excluded, one was not English language, five did not fully published primary research data and 36 were not explicitly on chemsex drug use which is before or during a sexual encounter. Ten articles (*5 UK: two data sets, 2 Canadian: one data set, 3 Australia: one data set)* were based on data from four samples but had been used for different study objectives. A final total of 38 articles were included the review.

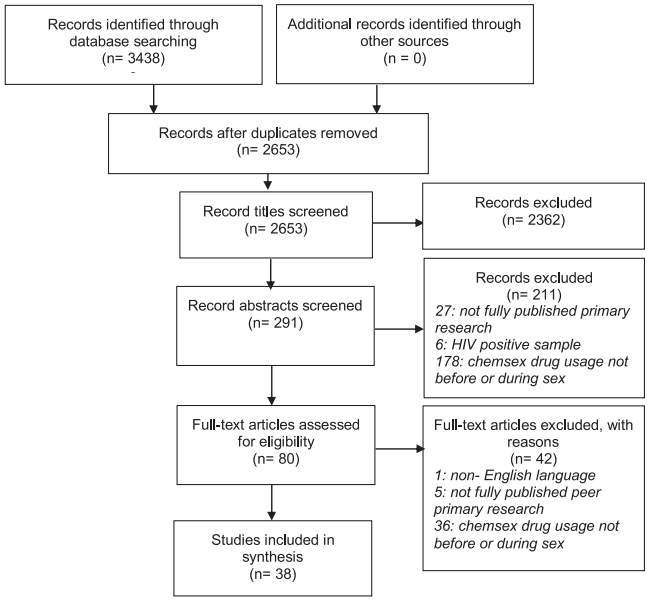

Fig. 1. Study selection process.

Study selection and characteristics

Table 3 provides a summary on the aim, population, country, sample size, year of data collection, study design and ABC key findings of the 38 articles included in the review. The findings section will be presented in the ABC headings but structured as, 1: behavior, 2: antecedents, 3: consequences. Fig.2 provides a summary of the review's main findings which is structured using the ABC framework. The sample size from all the studies ranged from 14 to 6757 participants with data collected from 2001 to 2017. The majority of the studies are from the North Americas (13- USA, 2- Canada) or Europe (10- UK, 1- Republic of Ireland (ROI), 1- European wide, 1- UK and ROI, excluding England, 1- Germany, 3- Netherlands) and only six are from outside these areas, which includes five from Australia and one from Israel. The majority of the studies are quantitative cross-sectional studies (26) or qualitative studies (9) with two retrospective case note reviews and one observational cohort study. Thirty-one studies reported HIV prevalence rates ranging from 1% to 80%. Only four studies exclusively focused on HIV negative MSM and three studies did not report HIV prevalence rates in their sample. The diverse nature of the samples may explain the wide variations in HIV prevalence. Some studies specifically recruited MSM engaged in chemsex whilst others tried to recruit representative samples of MSM. There was also variation in chemsex prevalence estimates, which may be accounted for by the different settings in which studies were conducted. For example, recruitment using multiple digital media platforms and participants recruited from specific clinical services.

Risk of bias assessment in individual studies

The NHLBI tool grades all the quantitative cross-sectional and case

Table 3
Summary of Findings.

Study	Country	Aim	Sample	Data collection	Design	Key Findings
Kurtz (2005)	USA	exploration of the motivations for and consequences of crystal crystal meth use.	15 MSM: crystal meth users via print media recruitment	2003	qualitative	**A:** crystal meth. use motivated by loneliness, apprehensions about self-attractiveness/getting older, and desire to lose sexual inhibitions. **B:** unlikely to use condoms or ask about partner HIV status. **C:** ongoing crystal meth used associated with loss of friends, partners, employment and higher risk of HIV/STIs.
Green and Halkitis (2006)	New York, USA	examination of crystal meth. use and association with social contexts among New York City's gay sexual subculture.	49 MSM: crystal meth users attending gay venues	2001	qualitative	**A:** crystal meth. associated with increased self-esteem, libido and sexual endurance, lowered sexual inhibition and is used to facilitate receptive AI. **B:** used strategically to negotiate casual encounters at sex parties/bath houses.
Koblin et al. (2007)	New York, USA	examination of amphetamine use, in MSM recruited at public venues and associations with sexual risk behaviors.	503 MSM: attendees at 12-16 public venues	2004-2005	cross section	**A:** Among HIV + men, more were likely to use the drug than not use the drug (29.8% versus 16.6%). **B:** 13.8% used crystal meth in the past year, of which 71% was for sexualised use and associated with CAI with casual partners, including receptive CAI.
Kubicek et al. (2007)	Los Angeles, USA	descriptions of attitudes to and perceptions of drugs among young men in Los Angeles.	24 MSM, age:18-24	2006	qualitative	**A**: crystal meth. associated with the prolongation of sex, but an equal amount said it affected the quality. **C:** negative impact on social relationships, body image and deterioration of health.
Mor et al. (2008)	Tel Aviv, Israel	to identify sexual risks and the substance use behaviours associated with them.	2873 MSM: internet based; living in Israel	2005	cross section	**B:** between 1.2% *(ketamine)* and 46% *(alcohol)* used substances during sex. Chemsex related drugs rates are: *EDDs: 4.8%, methamphetamine: 3.9%, cocaine: 2.4%, ketamine: 1.2%.* 23% reported receptive CAI during the last 6 months and substance use was significantly higher among those engaging in receptive CAI.
Ober et al. (2009)	Los Angeles, USA	explore if methamphetamine is associated with ethnicity, age, HIV status, venue and number of sex partners; and if crack use is associated with ethnicity, age, housing status and number of sex partners.	779 MSM & MSMW: via seed recruitment at MSM and/or drug user venues	2005-2008	cross section	**A:** HIV +, and white/hispanic associated with methamphetamine use, and black MSM with crack use. **B:** 33% crack and 22% methamphetamine use during sex. CAI, SPV, HIV + partner, exchanging sex for money/drugs, and a higher number sexual partners all associated with increased odds of methamphetamine use. CAI associated with increased odds of crack use only when sex partners were thought to be HIV- rather or of unknown status. **C:** methamphetamine users are at greater risk of HIV.
Prestage et al. (2009)	Australia	examination of the association between use of drugs and sexual risk behavior.	746 MSM: engaged in GSE: attendees of SPVs and gay commercial websites	2007- 2008	cross section	**A:** frequent methamphetamine use associated with younger age, mixing with other gay men and less education. **B:** 63.0% of the sample used illicit drugs, most commonly amyl 38.6%, EDDs 23.2%, methamphetamines 15.9%, ecstasy 15.8%, cannabis 15%, GHB 7.6%, cocaine 3.8%, ketamine 2.9%. Sero-discordant CAI reported by 22% and meth. associated with CAI among non-HIV sero-concordant partners. Frequent meth. users more likely to engage in esoteric sex acts.
Jerome et al. (2009)	New York, USA	explore motivations for using club drugs and risky sexual behavior.	32 MSM: attendees of gay venues	2002-2004	qualitative	**A:** motivations classified into domains; *Physical:* initiation of sex, increased sensations *Emotional/mental*: enhance feelings, share similar thought process and

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Table 3 (*continued*)

Study	Country	Aim	Sample	Data collection	Design	Key Findings
						escape into the moment. *Social:* drugs act as a shared mechanism to facilitate sex.
Kelly et al. (2012)	New York, USA	assess area of residence and social network influence on sexual risk behaviours.	710 HIV-MSM: attendees at expo events	2005	cross section	**A:** social networks primarily of gay men associated with insertive CAI, 'party and play' and using the internet to find sexual partners. Residence associated with gay-centric networks, but not socialising with other gay men. Association between residence and 'party and play' is mediated by gay- centric networks.
Benotsch et al. (2012)	Denver, USA	investigation of the relationship between methamphetamine use and sexual risk behaviors.	342 MSM: attendees at gay pride event	not specified	cross section	**A:** associated with increased desire for sex (42%) and enhanced sexual pleasure (32%). Non-white men more likely to report recent use. **B:** 27% lifetime methamphetamine use, 7% in the previous 3 months, with a mean use of 10 times. Sexualised users more likely to have more partners for receptive CAI, to trade sex for money and report higher levels of risk behavior.
Heiligenberg et al. (2012)	Amsterdam, Netherlands	assess whether drug usage is associated with STIs after adjusting for demographics and high-risk sexual behavior.	2822: sexual health clinic	2008- 2009	cross section	**A:** HIV + more drugs with sex than HIV- negative. **B:** reported drugs with sex: most commonly cocaine (15.3%) and GHB (16.1%) and less so ketamine (4.2%) and methamphetamine (3.3%) MSM more sexual partners in the previous 6 months than heterosexuals. Sex related drug use associated with high-risk sexual behavior in HIV- but not HIV + MSM. **C:** STIs significantly more common among MSM than heterosexual men and women.
Grov et al. (2013)	USA	categorised participants into three groups based on their most recent GSE and compared groups to understand unique and similar facets of the events.	2063 MSM: online MSM sexual network website	2012	cross section	**A:** HIV + GSE varied: 20.0% threesomes, 31.8% spontaneous group sex, 30.1% organised sex parties. **B:** A significantly larger number of MSM whose last GSE was spontaneous had consumed 5 or more alcoholic drinks, or used cocaine, methamphetamine, MDMA/ ecstasy, or GHB/GBL during that encounter.
McCarty-Caplan et al. (2014)	Chicago, USA	to establish whether drug use groups exist among MSM; and what characteristics related to HIV risk, in addition to drug use patterns, distinguish these groups.	943 MSM: internet survey	2007-2010	cross section	**A:** larger number of SDUs 25 or older and HIV + . **B:** 2 drug groups were identified, poly drug users (PDU) and sexualised drug users (SDU). SDU 10.5% of the sample primarily used poppers, methamphetamine, EDDs, club drugs and cocaine. The SDU group were far more likely to use methamphetamine before sex and had more receptive CAI than the PDU group.
Bourne et al. (2015)	London, UK	explore HIV/STI risk behaviour during the intentional combining of sex with mephedrone, GHB/GBL and crystal methamphetamine.	30 MSM: chemsex users via gay magazines online apps & venues/ services	2013- 2014	qualitative	**A:** enhanced sexual performance and sensation. **B:** casual partners met via geosocial apps or SPVs. Common for group events in private residences, some men attending multiple events over several days. Some HIV + men would not use condoms if partner also HIV + . 1 in 3 had multiple episodes of high risk sexual behavior and reported drugs affecting their judgment of risk. 1 in 4 always use condoms with casual partners.
Rich, Lachowsky, Cui, Sereda, Lal, Birch et al. (2016)	Vancouver, Canada	compare sexual behaviour, substance use, psychosocial factors and prevention strategies of recent GSE attendees with non-attendees	719 MSM: MSM seed recruitment	2012- 2014	cross section	**B:** 21.4% attended at least one GSE in the previous 6 months. All substances associated with GSE. Crystal meth. use associated with EDD use and attendance at GSEs. Crystal meth users more likely to use EDDs/attend GSE compared to lower likelihood of using EDDs/attend a GSE when crystal meth is not used.
	Canada	to assess whether (1) EDD are associated with insertive anal sex (2) poppers are associated with receptive anal	719 MSM: MSM seed recruitment via paper or electronic vouchers	2012- 2014	cross section	**A:** participants more likely to be HIV + . **B:** levels of any substance use consistent across all sexual

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Table 3 (*continued*)

Study	Country	Aim	Sample	Data collection	Design	Key Findings
Rich, Lachowsky, Cui, Sereda, Lal, Moore et al. (2016)		sex (3) poppers & EDD are associated with versatile & reciprocal anal sex (4) crystal meth is associated with all sex roles.				acts. Associations between GSE and crystal meth, GHB in univariate analysis, and with EDDs in multivariate analysis, which is positively associated with insertive sex role. Crystal meth associated with insertive/ receptive roles in univariate analysis but not multivariate.
Hopwood et al. (2015)	Australia	explore the social aspects of hepatitis C among gay and bisexual men and factors associated with sharing injecting equipment.	474 MSM: Facebook, gay websites & MSM organisations	2013	cross section	**B:** 9% ever injected drugs, 86% in the previous 6 months, most commonly crystal meth 85%, IEDM 25%, speed 21%, cocaine 13% and heroin 3%. 15% injected in the previous 6 months and crystal meth (76%) was the most commonly injected. Men who shared injecting equipment in the previous 6 were more likely to have injected crystal meth. 72% of HIV- men had been tested for HIV and 77% HCV- men had been tested for HCV.
Gilbart et al. (2015)	UK	explore the lifestyle and sexual behaviour of MSM diagnosed with S flexneri.	21 MSM diagnosed with S flexneri 3a: via Health Protection Units	2012- 2013	cross section	**A:** HIV + seek condomless sex, GSE and chemsex. **B:** 50% attended or organised a sex party through social networks typically of about 8 casual partners that could last for several days. 38% had injected drugs & were injected by others. Needles were soaked for later use in a shared solution. 43% said drugs effected judgement in risk taking.14% used EDDs. HIV + linked with insertive AI with casual partners, receptive fisting and web apps. for CAI.
Deimel et al. (2016)	Germany	examine reasons for drug use and drug use contexts among MSM.	14 MSM: substance users via LGBT/ HIV services	2015	qualitative	**A:** to lower inhibitions, intensify experiences and increase sexual performance. **B:** amphetamine, cocaine or ecstasy used at events that can last hours to days with multiple partners involving behaviours they would not do. 9 had injected drugs, most commonly crystal meth for its sexual intensification. 80% reported CAI in the previous 12 months.
Melendez-Torres et al. (2016)	UK	describe the relationship between situational characteristics and sexual outcomes.	321 MSM: internet survey via community recruited MSM	2011- 2012	cross section	**B:** drug use in 67.7 % of encounters and partner drug use in 43.3 % of encounters including GHB 9.2 %, crystal meth 8.0 %, and mephedrone 7.3 %. 14.2 % of multi-partner encounters included at least one of these drugs. Locations were SPVs 37.6%, homes 51.6%, cruising locations 10.8%. CAI occurred in 37.7% of the encounters and associated with crystal meth. and EDDs. Encounters involving partners of unknown HIV serostatus were less likely to involve CAI.
Weatherburn et al. (2017)	London, UK	examine factors that men value about sexualised drug use and build a picture of motivations for chemsex.	30 MSM: chemsex users via gay magazines online apps & venues/ services	2013- 2014	qualitative	**A:** motivations include arousal, increased libido, confidence and stamina, heightened orgasm and connections with partners, lower inhibitions, to alter perceptions of partner attractiveness, and to have more diverse sexual experiences with more adventurous acts.
Hegazi et al. (2017)	London, UK	explore associations between chemsex, STI, Hepatitis C and HIV incidence and sexual risk behaviours.	818 MSM: case note review of 2 sexual health clinics	2014- 2015	case note review	**A:** chemsex associated with HIV + but not with ethnicity or place of birth. **B:** 113/655 had engaged in chemsex commonly using mephedrone 69.3%, GBL/GHB 56.4%, crystal meth. 46%, cocaine 15.8% and ketamine 5.9%. Frequency of participation in the previous 3 months varied: 34.18% > once a month, 17.72% 1–3 times and 48.1% less often. Chemsex associated with more than 6 partners in the previous 3 months, transactional sex, group sex,

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Table 3 (*continued*)

Study	Country	Aim	Sample	Data collection	Design	Key Findings
						fisting, sharing sex toys, injecting drug use, higher alcohol consumption and use of 'bareback' social networking apps. Participants more likely to report sex with a discordant HIV or HCV- infected partner. **C:** any STI and PEP use. 52% reported consequences: time off work (14.1%), accidental overdose (4.8%), hospitalisation (7.7%), impact on mental health (15.1%).
Ahmed et al. (2017)	London, UK	describe the nature and operation of social norms relating to chemsex and identify public health implications.	30 MSM interviews: 12 MSM groups: via gay magazines online apps & venues/ services	2013- 2014	exploratory	**B:** chemsex viewed as mainstream, only a few men thought it was a minority behaviour. 1 in 3 interviewees had injected, one quarter were wary of or disliked IDU. One-sixth thought slamming had become more commonplace. Some sexual acts were more acceptable during chemsex because the drug effects justified actions, particularly high risk/esoteric acts. Chemsex in private settings linked to mobile apps. Private settings (homes/hotels) reported as secure places to participate in chemsex.
Melendez-Torres et al. (2017)	England, UK	to test associations between drug use and unprotected anal intercourse.	2142 MSM: online via dating websites	2011-2012	cross section	**B:** CAI associated with use of EDDs, crystal meth, GHB and occurred in 30.9% of encounters. Sexual encounters without drugs decreased odds of CAI as did encounters with casual and steady partners and with people who were HIV- sero-discordant or of unknown HIV status.
Rusow et al. (2017)	USA	participant racial/ethnic, sexual identities, socio-demographics, would be associated with differential choice of venue, and choice of venue would be associated with different risk behaviors during that sexual encounter.	1298 MSM: used any substance in the 12 months via outreach in substance using MSM venues	2005- 2012	cross section	**A:** Gay, White and HIV + associated with methamphetamine use during last sexual encounter. **B:** 39.7% report methamphetamine use during sex which is most likely to occur during SPV (49.0%). SPV significantly more likely to involve multiple sex partners (19.1%) and/or sex with anonymous partners (82.3%) than PSE or private locations. SPV more likely to be with HIV- sero-discordant partners (85%) than PSE (60.5%) or private locations (52%).
Bowden-Jones et al. (2017)	London, UK	describe patterns of HIV risk-related drug use and sexual activity in an MSM population presenting for drug treatment.	407 MSM: attendees of a specialist drug service	2011- 2014	cross section	**A:** HIV + MSM associated with chemsex and IDU. **B:** 73% used drugs to facilitate sex including methamphetamine, cocaine and ketamine. Methamphetamine use associated with a four-fold increase in the risk of being HIV + . 50% had ever injected drugs (data for n 1/4 399 men), a third had injected in the last 28 days and 11.8% had shared injecting equipment for chemsex. These injecting behaviours more likely in primary problem methamphetamine users.
Ottaway et al. (2017)	Brighton, UK	hypothesise that MSM sexualised drug usage is contributing to current STI and HIV transmission.	260 MSM: (130 cases and 130 controls): sexual health clinic	2015	observatio-nal cohort	**B:** Chemsex significantly greater in cases than controls. Mephedrone used most frequently, followed by GHB/ GBL. More sexual partners and significantly more CAI among cases than controls. **C:** associations between STIs and HIV, number of sexual partners, increased CAI and chemsex.
Bui et al. (2018)	Australia	investigate the prevalence & correlates of recent injecting using baseline data from a large prospective observational study.	1995 MSM: MSM specific websites and apps	2014-2015	cross section	**A:** HIV+ & HCV + MSM more likely to inject, Reasons for injecting crystal meth: facilitate AI, sustain sex for longer % reduce inhibitions. **B:** 4.7% recently injected and 91% was for sexual purposes. The most commonly injected drug is crystal meth & 1 in 10 had shared injecting equipment.

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Table 3 (*continued*)

Study	Country	Aim	Sample	Data collection	Design	Key Findings
						Associated with recent injecting is multiple partners & group sex.
Frankis et al. (2018)	Scotland, Wales, Ireland	examine the prevalence of MSM chemsex drug usage, including sexual context and determine the associated behaviours.	3217 MSM: MSM specific websites and apps	2016	cross section	**A:** HIV + MSM and HIV test in previous 3 months **B:** 6.1% engaged in chemsex and 1.3% injected for sexual purposes. Chemsex drug use rates in the last year: crystal methamphetamine 2.5%; mephedrone 4.5%; GHB/ GBL 4.9%; ketamine 3.8%. Chemsex in the last year associated with CAI, fisting sand transactional sex.
Rosinska et al. (2018)	Thirteen European Cities	examine the prevalence and predictors of drug use during a sexual encounter amongst MSM.	4266 MSM: community field workers	2013-2014	cross section	**A:** HIV + MSM, younger age and university education **B:** 3.4% engaged in chemsex, range 0%-14% across the different cities. Chemsex associated with injecting & more than one partner. 23% used EDDs and is associated with more than 1 partner. **C:** STI diagnosis
Hammoud, Vaccher et al. (2018)	Australia	describe the prevalence of concurrent use of methamphetamine, PrEP & EDDs, and methamphetamine and EDDs, without PrEP.	1831 HIV-MSM: social media, including MSM specific	2014-2017	cross section	**B:** 2017: 14.5% used methamphetamine and 28.3% EDDs. Concurrent use of meth, PrEP and EDDs in 2014: 1.9% & 2017: 6%. 13.4% engaged in chemsex. Overall, PrEP use in 2014:1% & 2017: 28%. PrEP use (n = 205) in previous 6 months for chemsex participation: 81.5% never used, 2.4% used once.
Druckler et al. (2018)	Netherlands	examine the proportion of STI clinic clients engaging in chemsex and identify if chemsex is a risk factor for STI diagnosis.	6757 MSM: sexual health clinic & online survey via MSM app	2016	cross section	**B:** STI clinic (n = 4925): 18% engaged in chemsex, Online survey (n = 1832): 29% engaged in chemsex. Most used: GHB/GBL 93%, methamphetamine 22%, mephedrone 16%. 6% injected for sexual purposes in previous 6 months. Chemsex participants had more partners, CAI & more often on PrEP than non-participants. **C:** STI diagnosis
Pakianathan et al. (2018)	UK	hypothesis that a new HIV diagnosis is positively associated with chemsex participation.	1840 MSM: case note review of 2 sexual health clinics	2014-2015	case note review	**A:** HIV + MSM **B:** 17% engaging in chemsex, drugs most common: mephedrone 78.6%, GHB/GBL 62%, methamphetamine 50%, cocaine 28%, ketamine 13%. Chemsex participants more likely to engage in group sex, inject drugs & engage in esoteric acts, have sex with a sero-discordant HIV and HCV + partner **C:** HIV & STI diagnosis, accessing PEP
Hammoud, Bourne et al. (2018)	Australia	examine factors associated with the use of GHB, its relationship to sexual risk behaviour,	3190 MSM: social media, including MSM specific	2014-2017	cross section	**A:** HIV + MSM & sexual enhancement a primary reason for GHB use **B:** 80% never used GHB, 19.5% had ever used it & 5% used it in the previous 6 months. Primary reason for GHB use was sexual. GHB associated with a greater number of partners, casual partners, CAI and group sex. **C:** risk of overdose, accidental injury & loss of friends
Horeenborg et al. (2018)	Netherlands	examine for changes in sexual behaviour after the initiations of PrEP among MSM and transgender women.	330 HIV-MSM/TGW: sexual health clinic	2015	cross section	**B:** 99% are MSM. 75% chose daily PrEP and 25% episodic PrEP. 41% engaged in chemsex. Older age, PEP use, engaging in chemsex with casual partners and daily PrEP regimen are factors associated with increased CAI with casual partners at 6 months compared with baseline. Overall, no evidence of increase in partners. Median number of CAI with casual partners increased from 2 at baseline, to 4 at 6 months.
Glynn et al. (2018)	Republic of Ireland	examine the prevalence of chemsex use & the relationship between chemsex and other sexual risk behaviours.	486 MSM: sexual health clinic	2016	cross section	**B:** 27% engaged in chemsex and 9% had injected drugs for sexual purposes. Drugs most commonly used: GHB/ GBL 57%, cocaine 46%, ketamine 30%,

(*continued on next page*)

Table 3 (*continued*)

Study	Country	Aim	Sample	Data collection	Design	Key Findings
						methamphetamine 21%, mephedrone 16%. Chemsex participants are more likely to have more partners and CAI than non-participants.
Reback et al. (2018)	USA	examine the associations between users' socio-demographics, substance use before or during sex & sexual behaviours.	286 MSM: methamphetamine user via MSM venues, online media	2014-2016	cross section	**B:** Participants had more than 1 episode of sex in the previous 30 days with cocaine & methamphetamine. Higher level of cocaine use is associated with engaging in more CAI, not significant in partner type. Higher level of methamphetamine use is associated with engaging in more CAI, significant across partner types.
Closson et al. (2018)	USA	explore strategies for PrEP adherence and dosing preferences in the context of sexualised drug use.	40 MSM: chemsex users via MSM venues & primary care clinics	2012-2013	qualitative	**B:** participants believe it may be an issue to remember and take PrEP while under the influence of methamphetamine, crack, powder cocaine, & GHB. All believe it is viable to take PrEP while not under the influence of drugs. Daily PrEP was the preferred regimen for those who more regularly use drugs and episodic PrEP use was preferred by those who only frequently use drugs.

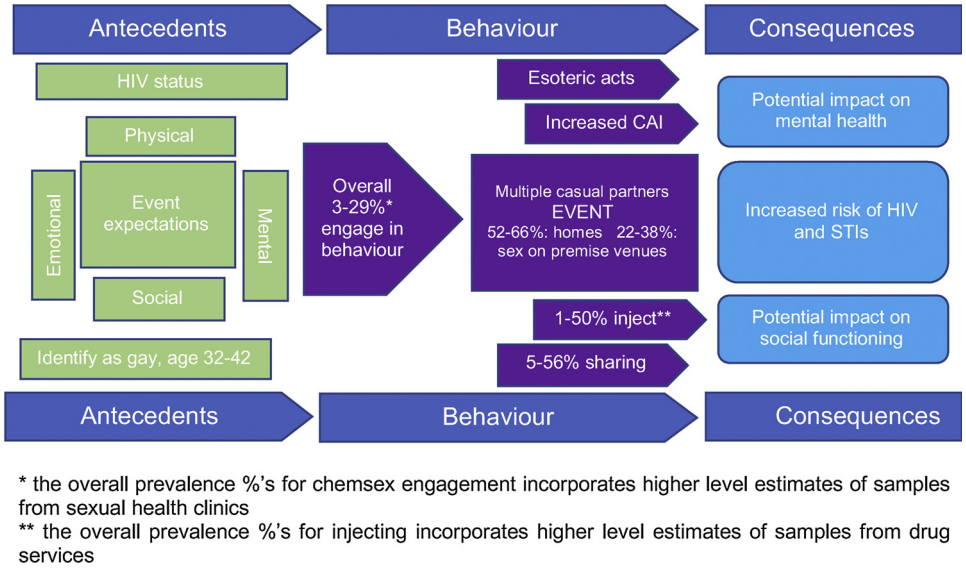

Fig. 2. ABC Summary of Findings.
* the overall prevalence %'s for chemsex engagement incorporates higher level estimates of samples from sexual health clinics.
** the overall prevalence %'s for injecting incorporates higher level estimates of samples from drug Services.

note review studies as 'fair' in terms of their quality. All these studies were rated at this level due to limitations in this design which only provided a 'snapshot' at one point in time. Most of these studies did not provide a sample size justification, only measured the exposures once and it is unclear if the researchers were blinded to the status of the sample. The primary strengths in most of these studies were the clear objectives, a defined sample being recruited, defined exposures/outcomes and appropriate methodology for data analysis. The majority of the qualitative studies provided a clear recruitment strategy, justified the data collection methods, secured ethics approval, described a rigorous analysis methodology and provided the findings in a clearly structured format. Although the studies briefly discussed key ethics considerations, most of them did not critically examine the role between the researcher or sample. There was limited discussion of the wider ethics issues raised in or from the study.

Prevalence and type of non-injecting drugs

Ten articles examined the prevalence of chemsex drugs within general MSM samples and most of the articles are from the USA and Western Europe (Benotsch et al., 2012; Frankis, Flowers, McDaid, & Bourne, 2018; Hammoud, Bourne et al., 2018; Hammoud, Vaccher et al., 2018; Heiligenberg et al., 2012; Koblin et al., 2007; McCarty-Caplan, Jantz, & Swartz, 2014; Mor, Davidovich, McFarlane, Feldshtein, & Chemtob, 2008; Prestage, Grierson, Bradley, Hurley, & Hudson, 2009; Rosinska et al., 2018). The majority of the studies each examined numerous sex related drugs but two from the USA specifically focused on two stimulants *(methamphetamine and cocaine)* (Benotsch et al., 2012; Koblin et al., 2007).

Eight studies provided an overall prevalence for chemsex related behaviour which incorporates various drugs, this ranges from 3%–29% (Druckler, van Rooijen, & de Vries, 2018; Frankis et al., 2018; Glynn et al., 2018; Hammoud, Vaccher et al., 2018; Hegazi et al., 2017; McCarty-Caplan et al., 2014; Pakianathan et al., 2018; Rosinska et al., 2018). Prevalence estimates which range from 17%–27% were all of MSM attending sexual health clinics and the 29% estimate is from an online survey which only used one MSM geo-social dating app to recruit the sample (Druckler et al., 2018; Glynn et al., 2018; Hammoud, Vaccher et al., 2018; Hegazi et al., 2017; Pakianathan et al., 2018). The four other studies provided estimates between 3%–13% but they used a wider selection of online platforms to recruit MSM samples (Frankis et al., 2018; Hammoud, Vaccher et al., 2018; McCarty-Caplan et al., 2014; Rosinska et al., 2018). Rosinska et al. (2018) conducted an online survey of MSM across thirteen different European cities which provided a prevalence range of between 0%–14%. Chemsex prevalence varies widely across different countries but the evidence is limited with most of samples being recruited from cities or sexual health clinics.

Six studies provided use rates for the three drugs primarily connected to chemsex *(methamphetamine, mephedrone, GHB/GBL)* (Druckler et al., 2018; Frankis et al., 2018; Glynn et al., 2018; Hegazi et al., 2017; Pakianathan et al., 2018; Melendez-Torres, Hickson, Reid, Weatherburn, & Bonell, 2016). All studies were from Western Europe and the majority recruited MSM samples from sexual health clinics. Mephedrone was the most commonly used in two UK studies and the least used in three other three studies from the UK, ROI and the Netherlands (Pakianathan et al., 2018; Frankis et al., 2018; Druckler et al., 2018; Hegazi et al., 2017; Melendez-Torres et al., 2016; Glynn et al., 2018). Seven studies specifically examined rates of GHB/GBL use. In five studies GHB/GBL was the most commonly used chemsex drug but in two other studies it was the second mostly commonly used (Druckler et al., 2018; Frankis et al., 2018; Glynn et al., 2018; Hegazi et al., 2017; Heiligenberg et al., 2012; Melendez-Torres et al., 2016; Pakianathan et al., 2018). A study from Australia which only examined the use of GHB/GBL reported that 5% of the MSM sample had used the drug in the previous 6 months (Hammoud, Bourne et al., 2018). With the exception of this study, all the other studies that examined GHB/GBL were from Western Europe. The five studies which suggested that GHB/GBL was the most commonly used drug originate from the Netherlands, UK and Ireland and most of the samples were recruited from sexual health clinics.

Eight studies examined the use of methamphetamines, in which five provided prevalence estimates ranging from 3%–22%. From these studies the three USA (2007-12) stimulant focused articles reported a prevalence range of 9%–22% (Benotsch et al., 2012; Heiligenberg et al., 2012; Koblin et al., 2007; Mor et al., 2008; Ober, Shoptaw, Wang, Gorbach, & Weiss, 2009). The highest rate of 22% was from the study by Ober et al. (2009), which consists of MSM with a low income and high rates of previous homelessness. With the exemption of this study, the methamphetamine prevalence range was from 3%–10%. McCarty-Caplan et al. (2014) in the Chicago study reported an overall chemsex related behaviour prevalence rate of 10% which is comparable to the prevalence results of the two USA methamphetamine studies of

9%–10%. (Benotsch et al., 2012; Koblin et al., 2007). Six of eight studies that examined the use of various substances all identified that methamphetamine was among the highest three most commonly used chemsex drugs (Druckler et al., 2018; Frankis et al., 2018; Hegazi et al., 2017; Heiligenberg et al., 2012; Melendez-Torres et al., 2016; Mor et al., 2008; Pakianathan et al., 2018;).

The use of cocaine was examined in seven studies and ketamine within six studies. Three of the studies related to cocaine provided prevalence estimates ranging from 2%–33% (Heiligenberg et al., 2012; Mor et al., 2008; Ober et al., 2009). The highest rate of 33% was from the Ober et al study and with the exception of this study the cocaine estimates range from 2%–15%. Four of the studies which examined the use of varying chemsex drugs indicated that cocaine was one of the least used drugs (Hegazi et al., 2017; Melendez-Torres et al., 2016; Mor et al., 2008; Pakianathan et al., 2018). Two of the studies related to ketamine reported a prevalence ranging from 1%–4% and four studies ranked ketamine as one of the least used chemsex drugs (Frankis et al., 2018; Hegazi et al., 2017; Heiligenberg et al., 2012; Mor et al., 2008; Pakianathan et al., 2018). Only two studies from the Netherlands and ROI found ketamine was used more frequently than methamphetamine (Glynn et al., 2018; Heiligenberg et al., 2012).

Prevalence and type of injecting drugs

Nine of the studies examined MSM injecting drug use for sexual purposes which provided prevalence estimates ranging from 1%–50% (Gilbart et al., 2015; Hopwood, Lea, & Aggleton, 2015; Bowden-Jones et al., 2017; Hegazi et al., 2017; Ahmed et al., 2017; Bui et al., 2018; Frankis et al., 2018; Druckler et al., 2018; Glynn et al., 2018). Five studies which examined this in large MSM samples reported a prevalence range of 1%–9% and within three of the studies methamphetamine was the most commonly injected drug (Bui et al., 2018; Druckler et al., 2018; Frankis et al., 2018; Glynn et al., 2018; Hopwood et al., 2015). The remaining four studies targeted specific MSM populations or had small MSM samples which reported a prevalence range of 25%–50%. These studies may have reported higher rates of injecting because two-focused on chemsex users, one was a small sample diagnosed with shigella and another was a small sample from sexual health clinics. Only one of these studies specified drug types, which indicates that most chemsex injectors primarily use methamphetamine (Bowden-Jones et al., 2017).

Four studies reported a wide variation in the levels of sharing injecting equipment which ranges from 5%–56%, although the three most recent studies reported a range of 5%–12% (Bowden-Jones et al., 2017; Bui et al., 2018; Hegazi et al., 2017; Hopwood et al., 2015). Gilbart et al. (2015) highlighted that their study sample had a low level of knowledge related to the risks of BBV transmission. Only one study from Australia identified that the injecting of drugs was associated with multiple partners and group sex (Bui et al., 2018). From the evidence it appears methamphetamine is the most commonly injected drug and there are variations in the extent to which users adopt safe injecting practices. However, there are limitations in determining injecting prevalence and associated risk behaviours due to the heterogeneous nature of the samples in the studies.

Drug use setting

Thirteen of the studies examined elements of the environments and related drug use patterns linked to chemsex related behaviors (Bourne et al., 2015; Grov, Rendina, Ventuneac, & Parsons, 2013; Ober et al., 2009; Prestage et al., 2009; Rich, Lachowsky, Cui, Sereda, Lal, Birch et al., 2016, 2016b; Gilbart et al., 2015; Deimel et al., 2016; Melendez-Torres et al., 2016; Ahmed et al., 2017; Melendez-Torres, Hickson, Reid, Weatherburn, & Bonell, 2017; Rusow, Fletcher, & Reback, 2017; Bowden-Jones et al., 2017). Most of these studies involved specific samples of MSM; five focused on varying elements of drug using MSM and three on MSM who engaged in group sex or multi-partner sexual encounters. All the studies indicated that there was a complex two-way interface between MSM using specific drug types to facilitate multi-partner sexual events, within which the venue plays an integral role.

Five studies showed that chemsex related activities primarily occured in sex on premise venues (SPV) (bath houses/saunas) or private homes (Ahmed et al., 2017; Bourne et al., 2015; Ober et al., 2009; Rusow et al., 2017; Melendez-Torres et al., 2016). Two studies highlighted that between 22%–38% of encounters took place in SPVs and 52%–66% within private homes (Melendez-Torres et al., 2016; Ober et al., 2009). Two UK studies highlighted that with the growth in MSM using geo-social networking platforms, there is potentially a change in chemsex being more likely to occur in private homes (Ahmed et al., 2017; Bourne et al., 2015). Three studies from Western Europe reported that chemsex based sex parties mostly involved multiple casual partners and can last from a few hours to several days (Bourne et al., 2015; Deimel et al., 2016; Gilbart et al., 2015).

Prestage et al. (2009) reported that 63% of an MSM group sex attendee sample had consumed illicit drugs at a group sex event in the previous six months. In comparison, a more recent study from a UK club drug clinic highlighted that 75% of the MSM sample had used the primary chemsex related drugs (mephedrone, methamphetamine, GHB/GBL) to facilitate sex (Bowden-Jones et al., 2017). Three studies indicated that consumption of varying stimulants occured at group sex events, which could include methamphetamine, GHB/GBL, mephedrone, ecstacy, cocaine and ketamine (Grov et al., 2013; Prestage et al., 2009; Rich, Lachowsky, Cui, Sereda, Lal, Birch et al., 2016). Three studies reported that between 14%–26% of MSM attending sex parties consumed erectile disorder drugs (EDDs) and within two studies EDDs were more likely to be associated with methamphetamine use (Gilbart et al., 2015; Melendez-Torres et al., 2016; Prestage et al., 2009). Gilbart et al. (2015) found MSM chemsex participants were more likely to use EDDs to counteract the physiological effect of methamphetamine.

Sexual behaviour

Seventeen studies identified that there can be an increased risk of condomless anal intercourse (CAI) when chemsex drugs were combined with sex (Benotsch et al., 2012; Koblin et al., 2007; Ober et al., 2009; Prestage et al., 2009; McCarty-Caplan et al., 2014; Melendez-Torres et al., 2016; Ottaway et al., 2017; Melendez-Torres et al., 2017; Gilbart et al., 2015; Bourne et al., 2015; McCarty-Caplan et al., 2014; Ahmed et al., 2017; Reback, Fletcher, & Swendeman, 2018; Glynn et al., 2018; Druckler et al., 2018, Horeenborg et al., 2018; Frankis et al., 2018). Only three studies, with specific and limited samples, provided rates of CAI which are explicitly when chemsex drugs are combined with sex, which ranges from 30%–38% (Bourne et al., 2015; Melendez-Torres et al., 2016; Ober et al., 2009). Five UK studies identified that when the sexual encounter involved chemsex dugs there was a higher likelihood of men performing esoteric sex acts *(for example: fisting)* (Ahmed et al., 2017; Hegazi et al., 2017; Gilbart et al., 2015; Frankis et al., 2018; Pakianathan et al., 2018). Two of these studies had high rates of HIV positive men in the sample and one study had a small sample of men diagnosed with shigella.

Six of the studies examined the associations between specific drug types and the likelihood of engaging in high risk sexual activity. All of these studies found that methamphetamine use with sex was associated with CAI but only one study found this was distinctly with HIV negative sex partners (Benotsch et al., 2012; Koblin et al., 2007; Melendez-Torres et al., 2016; Ober et al., 2009; Prestage et al., 2009; Reback et al., 2018). One of these studies found there was an interconnection between the use of methamphetamine and EDDs with sex, which increased levels of CAI (Melendez-Torres et al., 2016). Evidence for other specific drugs was limited but this may be due to studies focusing on methamphetamine use.

Bio-medical risk reduction interventions

Ten studies examined elements of STI/BBV testing, post-exposure prophylaxis (PEP), PrEP and injecting equipment provision (IEP) services (Frankis et al., 2018; Gilbart et al., 2015; Hegazi et al., 2017; Hopwood et al., 2015; Pakianathan et al., 2018; Prestage et al., 2009; Druckler et al., 2018; Hammoud, Bourne et al., 2018, 2018b; Closson, Mitty, Malone, Mayer, & Mimiaga, 2018). One Australian study highlighted that 89% of the sample had ever had an HIV test and a more recent UK study identified that 94% of the sample had ever attended sexual health services (Gilbart et al., 2015; Prestage et al., 2009). However, the UK study is unlikely to be representative as 63% of the sample were HIV positive. Hopwood et al. (2015) identified that in the previous 12 months 72% of the HIV negative men had tested for HIV and 77% of the HCV negative men had tested for HCV. A recent study from Western Europe identified that the likelihood of engaging in chemsex is greater if MSM have had an HIV test in the previous 3 months (Frankis et al., 2018).

Two studies identified that chemsex participants were more likely to access PEP than non-chemsex participants. (Hegazi et al., 2017; Pakianathan et al., 2018). An Australian study reported that 80% of the PrEP users had not engaged in chemsex in the previous 6 months, although this was a relatively small sample and 16% did not answer the chemsex question (Hammoud, Vaccher et al., 2018). However, a Netherlands study highlighted that MSM who engaged in chemsex were more likely to be on PrEP than MSM who did not participate in the activity (Druckler et al., 2018). A study which explored MSM chemsex participants' views of PrEP highlighted that more regular drug users would prefer daily dosing and less frequent drug users would opt for episodic dosing (Closson et al., 2018). Gilbart et al. (2015) identified that most MSM who injected chemsex drugs were generally unaware of injecting equipment service provision and safer injecting practices. However, this study had a small sample diagnosed with shigella. Based on this evidence it is difficult to conclude how MSM chemsex participants utilise bio-medical interventions.

Socio-demographics of participants

Thirteen studies examined elements of key socio-demographics of MSM samples that used chemsex related drugs before or during sex and the majority of the studies are from the USA and UK. Eight studies provided a mean or median age for chemsex participants, ranging from 32 to 42 (Green, Halkitis, Green, & Halkitis, 2006; Weatherburn, Hickson, Reid, Torres-Rueda, & Bourne, 2017; Hegazi et al., 2017; Benotsch et al., 2012; Reback et al., 2018; Druckler et al., 2018; Rosinska et al., 2018; Closson et al., 2018) and one study into chemsex injectors reported a median age of 42 (Hopwood et al., 2015). Frankis et al. (2018) identified that MSM between the ages of 36–45 were more likely to engage in chemsex. In the six studies that reported sexual identity, the majority of the sample identify as gay (Green et al., 2006; Benotsch et al., 2012; Hopwood et al., 2015; Weatherburn et al., 2017; Reback et al., 2018; Closson et al., 2018) and in six of the seven studies that reported ethnicity, most of the sample identified as white (Green et al., 2006; Benotsch et al., 2012; Weatherburn et al., 2017; McCarty-Caplan et al., 2014; Druckler et al., 2018; Closson et al., 2018).

Rusow et al. (2017) found in a USA study that MSM who combined methamphetamine with sex were significantly more likely to be white and identify as being gay. In another USA study, methamphetamine had higher rates of use in white and Hispanic populations', but they were less likely to use cocaine when compared to black MSM (Ober et al., 2009). In comparison, a USA study reported that white MSM used less cocaine with sex compared to ethnic groups (Reback et al., 2018), but this study may be limited by the small number of white MSM in the sample. From this limited evidence it is not clear if ethnicity is a determining factor for engaging in chemsex. Two studies identified that chemsex participants spend most of their time with other gay men but does not necessarily mean that most of their social network consists of friends who were gay men (Hopwood et al., 2015; Kelly, Carpiano, Easterbrook, & Parsons, 2012). It appears from the overall evidence that chemsex participants were more likely to be a gay man and participation peaks between the mid-thirties to early forties but is evident at all ages.

Role of HIV status

Eleven studies identified that HIV positive MSM were more likely to use chemsex drugs with sex, when compared to MSM of non-HIV positive status (Ober et al., 2009; McCarty-Caplan et al., 2014; Rich, Lachowsky, Cui, Sereda, Lal, Moore et al., 2016; Gilbart et al., 2015; Hegazi et al., 2017; Bowden-Jones et al., 2017; Rusow et al., 2017; Frankis et al., 2018; Rosinska et al., 2018; Hammoud, Bourne et al., 2018; Pakianathan et al., 2018). Only one study provided an analysis on the role of HIV status in injecting drug use, which found HIV positive status was associated with recent injecting and sharing of injecting equipment (Bowden-Jones et al., 2017). In comparison, a study on injecting drug use reported recent injectors were significantly more likely to be HIV positive when compared to other study participants (Bui et al., 2018). Due to the limited evidence it is not possible to substantively conclude what role HIV plays in the injection of drugs for sexual purposes.

Four studies reported that within chemsex related behaviour HIV positive MSM were more likely to sero-sort and engage in CAI with HIV positive partners (Bourne et al., 2015; Gilbart et al., 2015; Melendez-Torres et al., 2016; Rich, Lachowsky, Cui, Sereda, Lal, Birch et al., 2016). One study found that there was less incidence of CAI at sexual encounters when partner HIV status was sero-discordant or unknown (Melendez-Torres et al., 2017). The evidence indicates HIV status is potentially an important factor in determining if men that engage in chemsex use condoms.

Expectations of the event

Twelve articles indicated that MSM who engage in chemsex related behaviors may have perceptions and expectations that the desired physiological effects of a drug will alter a sexual event (Kurtz, 2005; Green et al., 2006; Kubicek et al., 2007; Jerome, Halkitis, & Siconolfi, 2009; Benotsch et al., 2012; Bourne et al., 2015; Deimel et al., 2016; Weatherburn et al., 2017; Ahmed et al., 2017; Prestage et al., 2009; Bui et al., 2018; Hammoud, Bourne et al., 2018). These studies were primarily qualitative and from the UK and USA. There were variable and multi-faceted effects when chemsex drugs were combined with sex, but these can be categorised into primary domains. The findings from the articles can be themed into physical, mental, emotional and social domains. Fig. 3. provides a summary of drug effects and the potential desired outcomes that alter the sexual event.

Most of the studies found that a key effect is the ability to increase stamina and arousal levels, so an individual can engage in sex for sustained periods and facilitate easier receptive anal intercourse/sex acts (Kurtz, 2005; Green et al., 2006; Kubicek et al., 2007; Jerome et al., 2009; Bourne et al., 2015; Deimel et al., 2016; Ahmed et al., 2017; Weatherburn et al., 2017; Prestage et al., 2009; Bui et al., 2018; Hammoud, Bourne et al., 2018). Some of the studies reported that the reduction in cognitive inhibition allowed the men to overcome under confidence and enhanced their ability to engage more meaningfully with sex partners (Green et al., 2006; Jerome et al., 2009; Weatherburn et al., 2017). The lowering of inhibitions may be important in establishing more immediate and sustained interaction with sex partners, providing a more meaningful shared sexual experience. Some of the studies identified that the increase in awareness and intensity of feeling was important for men to enhance their emotional connection with partners during sex (Green et al., 2006; Jerome et al., 2009; Weatherburn et al., 2017). There are interactions between all these

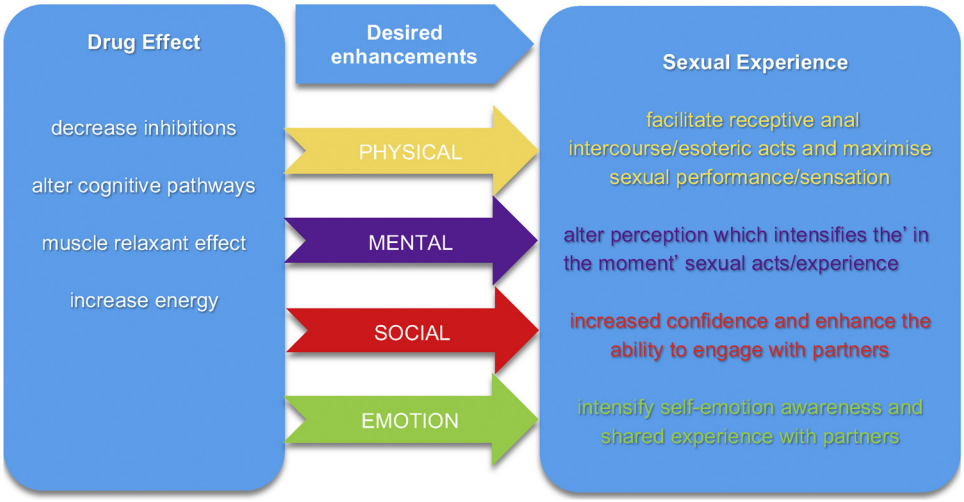

Fig. 3. Expected drug effects on the sexual event.

domains with an overarching theme being to maximise the intensity of a sexual event.

Biological impact

As indicated earlier, HIV positive men are potentially more likely to engage in high risk chemsex related behaviours. However, it is important to recognise that a significant number of HIV negative MSM may engage in chemsex and be at risk of HIV. Seven studies that had a majority of drug users in their samples, reported an assumed HIV negative prevalence range of 20%–59% (Kurtz, 2005; Green et al., 2006; Bourne et al., 2015; Hopwood et al., 2015; Bowden-Jones et al., 2017; Deimel et al., 2016; Reback et al., 2018). From the earlier evidence, it is apparent that when drugs are combined with sex that there is an increased risk of men engaging in CAI. An important variable for rates of CAI is the effect of drugs. A few studies identified that drugs effect decision making during sex, which can influence a participant's choice to engage in high risk sexual practices (Bourne et al., 2015; Gilbart et al., 2015; Ahmed et al., 2017; Deimel et al., 2016). These interconnected factors demonstrate that HIV negative MSM who engage in chemsex related behaviours are potentially at increased risk of disease transmission.

Four studies examined levels of HCV in chemsex related behaviour which identified a prevalence range of 6%–30% and two of these studies report an HIV/HCV co-infection prevalence range of 9%–21% (Hopwood et al., 2015; Bowden-Jones et al., 2017; Deimel et al., 2016; Bui et al., 2018). The highest rate of 30% was from a study with a small sample size of which approximately 80% were HIV positive. Three of the studies with the highest prevalence rates had samples which primarily consisted of men who injected drugs. Bui et al. (2018) identified that recent injectors were more likely to be HCV positive compared to non-recent injectors. There was limited evidence to indicate HCV infection rates among MSM who inject chemsex drugs.

All seven studies that examined components of STIs identified that MSM who engage in chemsex related behaviours have had issues with previous infections (Druckler et al., 2018; Gilbart et al., 2015; Glynn et al., 2018; Hegazi et al., 2017; Kurtz, 2005; Ottaway et al., 2017; Rosinska et al., 2018). One of the studies identified that MSM diagnosed with STIs were more likely to engage in chemsex (Ottaway et al., 2017). In comparison, four studies identified that chemsex participation was associated with the diagnosis or treatment of an STI (Hegazi et al., 2017; Rosinska et al., 2018; Druckler et al., 2018; Glynn et al., 2018). Ottaway et al. (2017) identified that those diagnosed with an STI were more likely to engage in chemsex, were more likely to be HIV positive and have higher rates of CAI. The studies indicated that MSM who engage in chemsex are potentially at a high risk of STI transmission.

Psycho-social impact

Six studies examined aspects on the perceived and actual psychological and social consequences of chemsex related behaviours. A recent study highlighted that 25% of the MSM sample reported that chemsex had a negative effect on their lives (Glynn et al., 2018). Two USA studies highlighted that there is a perception that methamphetamine will have negative consequence on social networks, with the loss of friends & partners (Kubicek et al., 2007; Kurtz, 2005). A USA study highlighted that methamphetamine users reported that sustained use of the drug reduced their ability to fulfil daily functioning (Closson et al., 2018). In comparison, an Australian study identified that the higher the use of GHB reported by the sample, the greater the impact on the drug user's social networks (Hammoud, Bourne et al., 2018). Two studies identified that chemsex drug use can have an impact upon employment, within one study some men had lost their jobs and in the other study 14% of the men had taken time off work (Hegazi et al., 2017; Kurtz, 2005). One UK study identified that 15% of the sample reported chemsex participation had a negative impact on their mental health and a USA study identified some methamphetamine users experience issues with paranoia (Hegazi et al., 2017; Kurtz, 2005). In comparison, another study reported that poly drug users were more likely to experience psychological distress when compared to sexualised drug users, but this did not attain statistical significance (McCarty-Caplan et al., 2014). A study on GHB did not find that the drug use was associated with depression or anxiety (Hammoud, Bourne et al., 2018). There is limited evidence that fully explores the psycho-social impact, although some of the men in the studies had experienced negative consequences directly due to chemsex related behaviours.

Discussion

To our knowledge, this is the first systematic review on chemsex behaviour to exclusively incorporate and examine research on chemsex drug use before or during sex. Two literature reviews (Edmundson et al., 2018: UK research; Tomkins et al., 2018: research from every country) have examined the wider issue of sexualised drug usage among MSM; but did not provide an in-depth analysis of the behaviours involved in the sexualised setting of chemsex drug use. In early 2018 two special journal editions on chemsex were published but the two previous literature reviews did not fully incorporate this research. As such, this is the first comprehensive up to date review of chemsex behaviour which examines participants socio-demographics, expectations

of the event, prevalence estimates, high risk behaviours and the biopsychosocial consequences.

This review used the ABC framework as a model to structure the results and conceptualise the behavioural processes involved in chemsex. The key advantage of this approach was the ability to process a complex array of research into an understandable three stage behavioural event. Expectations of the event are a fundamental antecedent that influences MSM who engage in chemsex. MSM that engage in chemsex behaviour expect that drugs may trigger multiple effects on the body that will facilitate, enhance, prolong and sustain a sexual event. Participants may seek a drug's desirable effects, but the disinhibiting effects may increase the level of risk taking behaviour which subsequently may produce undesirable consequences. HIV is a key influencer through the whole ABC process as HV status can influence the likelihood of engagement in chemsex, effect the event behaviour and HIV transmission can be a potential consequence.

In the wider literature there are large variations in the prevalence estimates for chemsex. The review published by Tomkins et al. (2018) identified a prevalence range from 4%–94%, but it incorporates research that does not fit within the PHE definition of chemsex. Edmundson et al. (2018) identified that chemsex drugs were also used outside of sexual events and the inter-changeable use of sexualised drug usage and chemsex can cause ambiguity in estimating prevalence levels. Edmundson et al. (2018) identified one study with an overall prevalence of 17% and the review identified a range of 3%–29%. However, the majority of prevalence estimates in this review above 15% are based on samples from sexual health clinics. The overall research indicates that the prevalence of chemsex varies in different countries but also varies within different regions/cities within one country.

It is evident from the findings that there are varying types of drugs used in chemsex behaviours, which can vary by geographical location. The prevalence estimates for methamphetamine were published over a longer-time frame and includes research from different continents (Europe, North America, Australia). This may be explained by the MSM population having a longer history of using this drug. Research examining mephedrone and GHB/GBL was primarily from Western Europe, with the exception of one recent study on GHB/GBL from Australia. It is not possible to evidence specific changes in drug trend's, although type of drug use varies across different high-income regions/countries. As chemsex is a socially constructed phenomenon the use of specific drugs will vary across different cultures and MSM sub-populations. This limits the generalisability of findings which is reflected in the different studies consisting of greatly varied types of sample. The social constructed nature of chemsex accounts for the variation in prevalence estimates and types of drug used across the different geographical areas.

This review highlights that MSM who combine chemsex drugs with sex are engaging in high risk sexual behaviours, including CAI and esoteric acts. There is a lack of knowledge on the specific rates of CAI that occur during chemsex, but it is evident that behaviour is mediated by participants HIV status. There is substantive evidence in this review to demonstrate that some HIV negative MSM who participate in chemsex will engage in CAI. The Edmundson et al. (2018) review concluded that engagement in sexualised drug use can lead to CAI. This correlates with the review's findings which suggests that MSM who combine drugs with sex are more likely to engage in high risk sexual practices when compared to MSM who do not combine drugs with sex.

The studies from Western Europe and Australia which analysed the injection of drugs provided varied prevalence estimates for injecting drugs (1%–50%) for sexual purposes and for the sharing of injecting equipment (5%–56%). This may be accounted for by some studies using general samples and others recruiting smaller samples from high risk groups. A longitudinal analysis of MSM injecting drug use in Australia reported that between 5%–6% of the sample had injected in the previous 6 months (Lea et al., 2013). Edmundson et al. (2018) identified that over a 15-year period the number of MSM attending UK drug services reporting injecting drug use had nearly doubled (4% to 8%) and there was a growth in the use of stimulants. However, it is important to highlight that the data within these publications did not exclusively focus on injecting for sexual purposes. The evidence shows that a small minority of the wider MSM population inject drugs but there is a lack of research examining MSM sexualised injecting of drugs.

This review indicates that high risk chemsex behaviours puts participants at increased risk of acquiring STIs/HIV and there is limited evidence that suggests there are psycho-social consequences. However, the majority of the evidence base regarding the risk of STIs and HIV is associative. There is also a lack of research which exclusively focused on the behaviour of HIV negative MSM and the associated consequences. The findings in this review supports work by Tomkins et al. (2018) who reported that chemsex behaviour has a negative impact on some participants social functioning and mental well-being. However, Prestage et al. (2018) identified that drug use during sexual activity was not associated with depression. The study did identify that illicit drug use is associated with depression and anxiety when the use becomes problematic or dependent (Prestage et al., 2018). The earlier findings in the review indicates that between 14%–25% of chemsex participants have experienced a negative impact on their psycho-social functioning. The wider literature provides evidence which demonstrates that the higher the frequency of the drug use, the more detrimental the impact is on psycho-social well-being of the user, particularly if they engage in poly-drug use (Ives & Ghelan, 2009; European Monitoring Centre for Drugs & Drug Addiction, 2009). There is also the biological risk for poly-drug users who use different substances which can create highly toxic and dangerous reactions in the body. However, evidence for the impact of chemsex behaviours on psycho-social well-being is weak although it is anticipated that the potential consequences for frequent poly-drug users are significant.

The studies in the review that examined the use of STI/BBV screening, PEP and PrEP use did not provide substantive answers on how commonly chemsex participants use these interventions. The limited evidence indicates that a majority may either access screening or attend sexual health services but does not provide a clear understanding on frequency and type of testing. However, the recent publication from Frankis et al. (2018) indicated that chemsex engagement is associated with men who had an HIV test in the previous three months. There is very limited evidence which suggests chemsex participants are more likely to access PEP and PrEP compared to MSM who do not engage in chemsex. However, it is possible that greater access to PrEP/PEP by chemsex participants is influenced by service providers. Sewell et al. (2017) identified in a study of MSM chemsex drug users that the level of PEP use was 14% and PrEP use was 4.5%.

A clinical trial of PrEP reported that in the previous three months approximately 44% of the MSM sample had used methamphetamine, GHB/GBL or mephedrone (Dolling et al., 2016). In comparison, a recent study from Australia highlighted that the concurrent use of methamphetamine, EDDs and PrEP in 2014 was 1.9% but this increased to 6% in 2017 (Hammoud, Vaccher et al., 2018). However, the paper by Hammoud, Vaccher et al. (2018) does not directly link the chemsex drug use episodes to PrEP use (Gafos, Chas, & Pialoux, 2018). The overall evidence indicates that PrEP is being used by some MSM who use chemsex drugs, but the majority of previous research does not identify if the drug usage is within a sexual setting. As PrEP is a relatively new innovation it is important to understand how chemsex participants use the range of bio-medical interventions. This remains an important research question as the introduction of PrEP could potentially influence how chemsex participants use other interventions and chemsex behaviours may influence the participants PrEP adherence.

This review adopted a precise and clear systematic methodology to address it's objectives. A strength is the explicit inclusion/exclusion criteria which focused on the use of chemsex drugs before or during sex. However, is not able to determine if the sexual activity was planned.

The review is limited by the absence of clear sampling frames in the published studies and the resulting heterogeneity of predominantly purposive samples across the studies. The review may also be limited by its exclusion of research from low to medium income countries and by including only English language articles.

To enable improved future research into chemsex it may be beneficial to develop standardised questioning that identifies if chemsex drug use is before or during planned sexual activity. The review has identified some key research gaps and recommends future research in the following areas: i) research exclusively on HIV negative MSM chemsex behaviours; ii) explore and examine the prevalence and risk behaviours of MSM who inject chemsex drugs for sexual purposes; iii) examine MSM chemsex participants use of bio-medical interventions, specifically the use of PEP and PrEP; and iv) in-depth exploration on the psycho-social impact on MSM who engage in chemsex. These research recommendations reflect components in Fig. 2 and relationships between them. The ABC model was a useful conceptual framework in the synthesis of the evidence and it's use would be worth considering to inform future work. Research in these areas could improve the efficiency and targeting of risk reduction interventions that reduce the biopsychosocial impact of chemsex behaviours.

Conclusion

It appears a minority of MSM engage in chemsex behaviour, but there are inter-connected high-risk behaviours associated with the activity. The examination of chemsex is limited due to the challenge in defining the activity and there are limitations in comparing prevalence estimates due to the use of different sampling frameworks. However, there are potentially multiple consequences associated with chemsex behaviour although this remains an under researched area. With the increasing availability of PrEP, it is important to understand how biomedical interventions can be effectively used to reduce the potential impact of high risk chemsex behaviours among this population.

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The authors whose names are listed immediately below certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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