Recreational drug use, polydrug use, and sexual behaviour in HIV-diagnosed men who have sex with men in the UK: results from the cross-sectional ASTRA study

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Summary

Background Recreational drug use in men who have sex with men (MSM) is of concern because it might be linked to the transmission of HIV and other sexually transmitted infections. Evidence about drug use in HIV-diagnosed MSM in the UK is limited by representativeness of the study populations. We describe patterns of drug use and associations with sexual behaviours in HIV-diagnosed MSM in the UK.

Methods We used data from the cross-sectional ASTRA study, which recruited participants aged 18 years or older with HIV from eight HIV outpatient clinics in the UK between Feb 1, 2011, and Dec 31, 2012. We examined data for MSM, assessing the prevalence of recreational drug use and polydrug use in the previous 3 months and associations with sociodemographic and HIV-related factors. We examined the association of polydrug use with measures of condomless sex in the previous 3 months and with other sexual behaviours.

Findings Our analysis included data for 2248 MSM: 2136 (95%) were gay, 1973 (89%) were white, 1904 (85%) were on antiretroviral treatment (ART), and 1682 (76%) had a viral load of 50 copies per mL or lower. 1138 (51%) used recreational drugs in the previous 3 months; 608 (27%) used nitrites, 477 (21%) used cannabis, 460 (21%) used erectile dysfunction drugs, 453 (20%) used cocaine, 280 (13%) used ketamine, 258 (12%) used 3,4-methylenedioxy-N-methylamphetamine (MDMA), 221 (10%) used gamma-hydroxybutyrate or gamma-butyrolactone, 175 (8%) used methamphetamine, and 162 (7%) used mephedrone. In the 1138 individuals who used drugs, 529 (47%) used three or more drugs and 241 (21%) used five or more. Prevalence of injection drug use was 3% (n=68). Drug use was independently associated with younger age ($p<0·0001$), not being religious ($p=0·001$), having an HIV-positive stable partner ($p=0·0008$), HIV-serostatus disclosure ($p=0·009$), smoking ($p<0·0001$), evidence of harmful alcohol drinking ($p=0·0001$), and ART non-adherence ($p<0·0001$). Increasing polydrug use was associated with increasing prevalence of condomless sex (prevalence range from no drug use to use of five or more drugs was 24% to 78%), condomless sex with HIV-seroconcordant partners (17% to 69%), condomless sex with HIV-serodiscordant partners (10% to 25%), and higher-HIV-risk condomless sex after taking viral load into account (4% to 16%; $p\leq0·005$ for all). Associations were similar after adjustment for sociodemographic and HIV-related factors. Methamphetamine was more strongly associated with higher-HIV-risk condomless sex than were other commonly used drugs.

Interpretation Polydrug use is prevalent in HIV-diagnosed MSM and is strongly associated with condomless sex. Specialist support services for MSM with HIV who use recreational drugs might be beneficial in the reduction of harm and prevention of ongoing transmission of HIV and other sexually transmitted infections.

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Introduction

Recreational drug use is an important public health concern in men who have sex with men (MSM) in the UK.[1,2] Findings from studies done in Europe and the USA show that drug use is more prevalent in MSM compared with the general population.[3–5] Drugs that are usually taken in nightclubs and in unlicensed dance parties are collectively known as club drugs and encompass controlled and non-controlled substances including 3,4-methylenedioxy-N-methylamphetamine (MDMA, or ecstasy), methamphetamine (crystal meth), gamma-hydroxybutyrate (GHB), gamma-butyrolactone (GBL), mephedrone, and ketamine.[6,7] Although findings from many studies in the past 15 years have shown the high prevalence of drug use in MSM,[4–6] club drug use might have increased in this group possibly becoming normalised within sexual contexts.[1,8] One London club drug clinic (a free health service for adult clubbers and lesbian, gay, bisexual, and transgender people), for which data have been collected since 2005, reports increasing use of methamphetamine, mephedrone, and GHB, solely in facilitating sex (known as chemsex) in MSM attending

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the clinic,[2] and it has been suggested that the practice of injecting recreational drugs at sex parties might be increasing in MSM.[9,10]

A possible changing culture of recreational drug use in MSM in the UK might be linked to increased sexual risk behaviours.[1] This increase could in turn lead to an increase in new sexually transmitted infections (STIs) including HIV, the transmission of which is high in MSM in the UK (3250 new diagnoses in 2012).[11] Findings from many online and gay-venue-based studies in MSM in Europe, Australia, and North America have associated use of some drugs (such as methamphetamine and erectile dysfunction drugs) with sex without a condom (herein referred to as condomless sex), including with HIV-serodiscordant status partners.[5,12–16] Findings from several studies have shown HIV-diagnosed MSM to be more likely to use almost all types of recreational drugs compared with MSM who are HIV-negative or undiagnosed.[4,14,17,18] Polydrug use (use of more than one drug at the same time or within the same time period) might indicate a more severe substance abuse problem. Findings from some studies from the UK and USA suggest that polydrug use is particularly prevalent in HIV-positive MSM.[4,19] Additionally, polydrug use was linked to condomless sex with casual partners in a US study of HIV-diagnosed MSM surveyed in bars and sex clubs.[20] However, findings relating to HIV-diagnosed MSM from online and venue-based studies might have restricted generalisability. UK researchers[21] reported the prevalence of methamphetamine and other recreational drug use in a sample of HIV-diagnosed MSM from a London HIV clinic between 2002 and 2003.[21] Since then, few studies have assessed patterns of recreational drug use and the extent of polydrug use from representative samples of HIV-diagnosed MSM in the UK.

We describe the prevalence of recreational drug use and polydrug use, their association to socio-demographic, lifestyle, and HIV-related factors, and their relation with condomless sex and other sexual behaviours in HIV-diagnosed MSM in the UK from the ASTRA (Antiretrovirals, Sexual Transmission Risk and Attitudes) study.

Methods

Study design

The ASTRA study has been described elsewhere.[22] Briefly, ASTRA recruited men and women aged 18 years or older with HIV who were attending eight HIV outpatient clinics in the UK between Feb 1, 2011, and Dec 31, 2012.[22] Participants completed a confidential, self-administered questionnaire that sought information about socio-demographic factors (age, ethnic origin, education, employment, housing, financial hardship, religion, HIV-status, and their stable partner's HIV status), HIV-related factors (date of HIV diagnosis, antiretroviral treatment [ART] history, and adherence to ART), lifestyle factors (cigarette smoking, evidence of harmful alcohol consumption according to the modified World Health Organization's [WHO] AUDIT-C questionnaire,[23] and recreational drug use), and sexual behaviour measures. Consent to participate included permission to collect latest CD4 count and HIV plasma viral load. Men who identified as being gay or bisexual, or who reported sex with men in the previous 3 months, were classified as MSM. The study was approved by the North West London REC 2 research ethics committee (ref 10/H0720/70).

Procedures

Participants were asked if they had used recreational drugs in the past 3 months and if so which ones. Recreational drugs included the following: acid, lysergic acid diethylamide (LSD), or magic mushrooms (all grouped as psychedelics); anabolic steroids; cannabis (marijuana); cocaine (coke); crack; codeine; crystal meth (methamphetamine); ecstasy (E); GHB (liquid ecstasy); heroin, ketamine (K); khat (chat); mephedrone; morphine; opium; poppers (amyl nitrites); speed (amphetamine); and erectile dysfunction drugs sildenafil and tadalafil. Other drugs were coded to the above categories according to slang names.[24] Polydrug use was assessed by the number of different drugs used during the previous 3 months. Club drugs were defined as MDMA, GHB (liquid ecstasy) or GBL, ketamine, and mephedrone. We did not include methamphetamine in the definition for club drugs because reports suggest it might be more commonly used in private sex parties.[1,10,25] Participants were asked about injecting recreational drugs and needle sharing in the past 3 months.

We defined ten sexual behaviour measures in the previous 3 months (unless otherwise stated): any anal or vaginal sex, condomless sex (anal or vaginal sex without a condom), condomless sex with a seroconcordant (HIV-diagnosed) partner, condomless sex with a serodiscordant partner (of unknown or HIV-negative status), higher-HIV-risk condomless sex with a serodiscordant partner (if the participant was either not on ART, had latest HIV viral load greater than 50 copies per mL, or had a new STI diagnosis in the previous 3 months), new STI diagnosis (syphilis, gonorrhoea, chlamydia, lymphogranuloma venereum, new hepatitis B and C, genital herpes, genital warts, trichomonas, non-specific urethritis, non-gonoccocal urethritis), group sex (with more than one person on the same occasion), used the internet to find sexual partners, agreement to the statement "I am less likely to use a condom with a casual partner (no recall period)", and number of new sexual partners in the previous year.

Statistical analysis

Our analysis includes HIV-diagnosed MSM only. First, we assessed prevalence of any recreational drug use, and use of one, two, three, four, or five or more types of drug in the past 3 months, and examined patterns of drug use according to number of drugs used. Second,

we examined the association of sociodemographic, HIV-related, and lifestyle factors with any recreational drug use (dependent variable); in recreational drug users, we assessed factors associated with use of four or more drugs versus one to three drugs. We examined crude associations with χ^2 tests, and used modified Poisson regression models with robust error variances[26] to produce prevalence ratios (PRs) with 95% CIs. Factors with $p<0{\cdot}15$ in univariable analysis were considered in multivariable models; factors with $p<0{\cdot}05$ were retained in the final model. Third, we examined associations of recreational drug use and polydrug use (none, one, two, three, four, or five or more drugs) with each of the ten measures of sexual behaviour (dependent variables). We assessed unadjusted associations with χ^2 tests and adjusted (for significant sociodemographic and HIV-related factors) associations with modified Poisson regression.

Because some recreational drugs are reported to be used solely in a sexual context,[9,10] the analysis of associations between polydrug use and measures of condomless sex was repeated in the subgroup of MSM who reported any anal or vaginal sex in the past 3 months. Within this subgroup, we further examined the adjusted association of specific drugs and club drugs with higher-HIV-risk condomless sex with a serodiscordant partner with multivariable modified Poisson models. For each drug, the reference category was no recreational drug use, and the remaining two categories were use of the specific drug and use of any other recreational drug. We adjusted all multivariable Poisson models for clinic centre. We used Stata SE (version 12.0) for all statistical analyses.

Role of the funding source

The sponsor of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

During the study period 5112 HIV-diagnosed men and women were invited to participate, of whom 4200 (82%) consented to take part. 3258 patients completed the questionnaire (response rate 64% of the 5112 individuals approached). 2248 (69%) of these patients were MSM, 2136 (95%) of whom identified as gay and 112 (5%) identified as bisexual. 1973 (89%) identified as white, 983 (45%) were educated to university degree, and 1357 (62%) were employed. Median age was 46 years (IQR 39–51) and median time since HIV diagnosis was 10 years (5–16). Overall, 1904 (85%) were on antiretroviral treatment, of whom 1654 (88%) had undetectable viral load (≤50 copies per mL) at their most recent test.

1435 men who identified as MSM had anal or vaginal sex in the previous 3 months; 1402 (98%) had anal sex with men only, 12 (<1%) had anal or vaginal sex with women only, and 21 (2%) had both anal sex with men and anal or vaginal sex with women.

1138 MSM (50·6%, 95% CI 48·6–52·7) reported recreational drug use in the previous 3 months. The most commonly used drugs were nitrites, cannabis, erectile dysfunction drugs, cocaine, ketamine, MDMA, GHB or GBL, methamphetamine, and mephedrone (figure 1). The prevalence of use of club drugs was 22% (n=503), and including methamphetamine the prevalence was 24% (n=540). When excluding nitrites, the overall prevalence of recreational drug use was 44% (1000 of 2248 individuals).

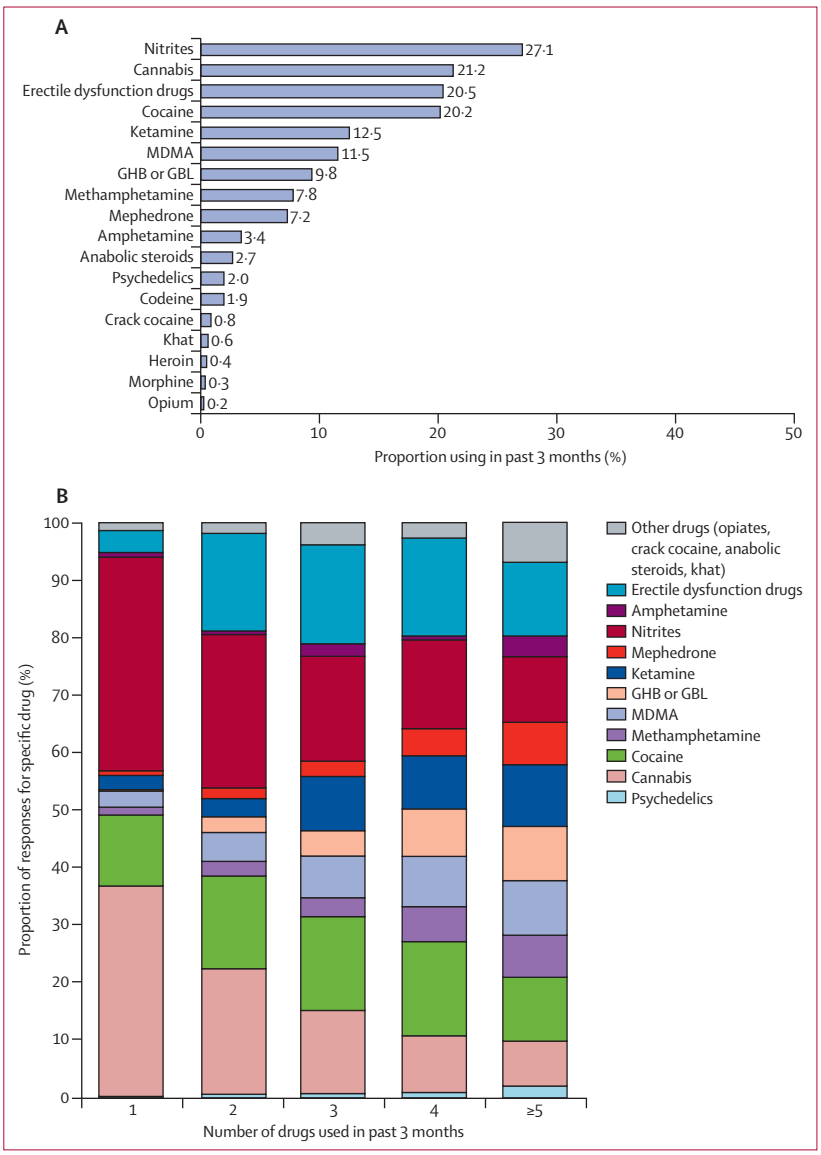

Figure 1: **Recreational drug use in the past 3 months in HIV-diagnosed men who have sex with men**
(A) Prevalence of recreational drug use in 2248 individuals. (B) Type of drug according to number of drugs used in 1138 individuals who used at least one drug. GHB=gamma-hydroxybutyrate. GBL=gamma-butyrolactone. MDMA=3,4-methylenedioxy-N-methylamphetamine.

	Recreational drug use in 2248 HIV-diagnosed men who have sex with men				Use of four or more recreational drugs in 1138 HIV-diagnosed men who have sex with men who used at least one drug			
	n/N (%)	Univariate p value	Adjusted prevalence ratio* (95% CI; n/N=1138/2248)	Final model p value†	n/N (%)	Univariate p value	Adjusted prevalence ratio* (95% CI; n/N=353/1138)	Final model p value†
Age at recruitment, years		<0·0001†				0·0018†		
<30	67/107 (63%)	..	1·7 (1·3–2·3)	..	34/67 (51%)		1·7 (1·0–3·0)	..
30–39	306/496 (62%)	..	1·7 (1·3–2·1)	..	106/306 (35%)		1·2 (0·7–2·0)	..
40–49	485/935 (52%)	..	1·5 (1·1–1·9)	..	144/485 (30%)		1·1 (0·6–1·8)	..
50–59	208/504 (41%)	..	1·2 (0·9–1·5)	..	49/208 (24%)		0·8 (0·5–1·4)	..
≥60	44/150 (29%)		1·00	<0·0001†	12/44 (27%)		1·00	0·002†
Ethnic origin		0·201				0·598		
White	1006/1973 (51%)		..	..	309/1006 (31%)		..	..
Black African	7/23 (30%)		..	..	1/7 (14%)		..	..
Black Other	29/53 (55%)		..	..	11/29 (38%)		..	..
All other	77/160 (48)		..	..	26/77 (34%)		..	..
Education		0·622				0·009		
University degree or above	494/983 (50%)		..	..	174/494 (35%)		1·2 (1·0–1·6)	..
No qualifications or up to A levels (or equivalent)	627/1222 (51%)		..	..	175/627 (28%)		1·00	0·009
Employment		0·0001				0·016		
Employed	721/1357 (53%)		..	..	247/721 (34%)		..	..
Unemployed	166/320 (52%)		..	..	45/166 (27%)		..	..
Other (retired, carer, disabled, student)	227/520 (44%)		..	..	57/227 (25%)		..	..
Housing		0·003				0·740		
Owner	430/913 (47%)		..	..	131/430 (31%)		..	..
Renting	612/1127 (54%)		..	..	195/612 (32%)		..	..
Other (homeless, staying with friends, work accommodation)	82/174 (47%)		..	..	23/82 (28%)		..	..
Money for basic needs (financial hardship)		0·326				0·159		
Always	579/1151 (50%)		..	..	195/579 (34%)		..	..
Mostly or sometimes	446/886 (50%)		..	..	127/446 (28%)		..	..
Never	100/178 (56%)		..	..	28/100 (28%)		..	..
Religious‡		<0·0001				0·055		
Yes	425/947 (45%)		1·00	..	118/425 (28%)		1·00	..
No	695/1264 (55%)		1·2 (1·1–1·3)	<0·0001	231/695 (33%)		1·2 (1·1–1·3)	0·040
Partner's HIV status		<0·0001				0·0031		
HIV-positive	303/522 (58%)		1·00	..	117/303 (39%)		1·00	..
HIV-negative or status unknown	321/711 (45%)		0·8 (0·7–0·9)	..	81/321 (25%)		0·7 (0·5–0·9)	..
No stable partner	514/11015 (51%)		0·9 (0·8–1·0)	0·0008	155/514 (30%)		0·8 (0·6–1·0)	0·003
HIV-status disclosure to friends, family, or partners		0·0001				0·590		
Disclosed to at least one person	1098/2127 (52%)		1·5 (1·1–1·9)	..	340/1098 (31%)		..	..
Not disclosed to anyone	37/113 (33%)		1·00	0·009	13/37 (35%)		..	..
Evidence of alcohol dependency (modified WHO AUDIT-C)§		<0·0001				0·416		
No	328/785 (42%)		1·00	..	96/328 (29%)		..	..
Yes	810/1463 (55)		1·2 (1·1–1·3)	0·0001	257/810 (32%)		..	..
Smoking status		<0·0001				0·555		
Current smoker	519/823 (63%)		1·4 (1·3–1·6)	..	167/519 (32%)		..	..
Ex-smoker	335/718 (47%)		1·1 (1·0–1·3)	..	104/335 (31%)		..	..
Never smoked	281/687 (41%)		1·00	<0·0001	80/281 (28%)		..	..

(Table 1 continues on next page)

	Recreational drug use in 2248 HIV-diagnosed men who have sex with men				Use of four or more recreational drugs in 1138 HIV-diagnosed men who have sex with men who used at least one drug			
	n/N (%)	Univariate p value	Adjusted prevalence ratio* (95% CI; n/N=1138/2248)	Final model adjusted p value†	n/N (%)	Univariate p value	Adjusted prevalence ratio* (95% CI; n/N=353/1138)	Final model p value†
(Continued from previous page)								
Time since HIV diagnosis		0·071†				0·013†		
≤6 months	48/92 (52%)		..	..	15/48 (31%)		..	..
6 months to 2 years	84/149 (56%)		..	..	31/84 (37%)		..	..
2–5 years	189/341 (55%)		..	..	69/189 (37%)		..	..
5–10 years	270/529 (51%)		..	..	86/270 (32%)		..	..
>10 years	510/1067 (48%)		..	..	138/510 (27%)		..	..
On antiretroviral treatment (ART)		0·071				0·017		
Yes	947/1904 (50%)		..	..	279/947 (30%)		..	..
No	188/333 (57%)		..	..	72/188 (38%)		..	..
CD4 count (clinical record)		0·072				0·111		
>350 cells per μL	956/1859 (51%)		..	..	307/956; (32%)		..	..
≤350 cells per μL	166/359 (46%)		..	..	43/166; (26%)		..	..
Viral load (clinical record)		0·015				0·015		
≤50 copies per mL	828/1682 (49%)		..	..	241/828 (29%)		..	..
>50 copies per mL	294/532 (55%)		..	..	108/294 (37%)		..	..
ART use and adherence		<0·0001				0·007		
On ART and adherent	734/1550 (47%)		1·00		159/588 (27%)		..	..
On ART and non-adherent¶	183/289 (63%)		1·3 (1·2–1·4)		117/352 (33%)		..	..
Not on ART	188/333 (57%)		1·1 (1·0–1·2)	<0·0001	72/188 (38%)		..	..

Data given for those who provided responses on the questionnaire, so differ from total sample size owing to missing data. Adjusted analyses done for men who have sex with men (MSM) who have complete data for all these variable. Unadjusted p values calculated with χ^2 test or χ^2 test for trend. ART=antiretroviral therapy. All factors with p<0·15 in univariable analysis were considered for inclusion in the multivariable model, except for viral load and on ART, because the ART use and adherence variable was included. Factors with p<0·05 were retained in the final model. *Prevalence ratio for multivariable modified Poission regression (includes adjustment for clinic). †Wald test from adjusted model; the four p values relating to age and the two p values relating to time since diagnosis of HIV are test for trend. ‡Identifies as belonging to a religion (Christianity, Judaism, Islam, Buddhism, Sikhism, any other). §Evidence of harmful alcohol consumption (that increases the risk of harmful consequences for the user or others) defined as a score of 8 or greater on the modified AUDIT-C questionnaire. ¶Non-adherence defined as: missed one or more ART dose in the past 2 weeks or missed 2 or more days of ART on one or more occasions in the past 3 months.

Table 1: **Association of sociodemographic, HIV-related, and lifestyle factors with recreational and polydrug use in the past 3 months in HIV-diagnosed men who have sex with men**

Of 1138 MSM who had used recreational drugs, 368 (32%) used one drug, 241 (21%) used two, 176 (16%) used three, 112 (10%) used four, and 241 (21%) used five or more. In the 368 MSM who used only one drug in the past 3 months, 138 (38%) used nitrites, 133 (36%) used cannabis, and 44 (12%) used cocaine (figure 1). 241 MSM used two drugs in the past 3 months; of the 477 responses for use of two drugs, 128 (27%) of responses were for nitrites, 104 (22%) were for cannabis, 81 (17%) were for erectile dysfunction drugs, and 77 (16%) were for cocaine. The proportional use of methamphetamine and club drugs increased with the number of drugs an individual reported to have taken in the past 3 months (figure 1). Injecting drug use in the previous 3 months was reported by 68 individuals (3·0%, 95% CI 2·4–3·8), of whom four (6%) reported sharing injecting equipment with a person of unknown HIV serostatus.

Although prevalence of drug use was high across most demographic groups, in univariable analysis, recreational drug use was associated with younger age, being employed or unemployed (compared with being retired, a carer, sick or disabled, or a student), rented housing (compared with owning a home, living in temporary accommodation, or being homeless), not identifying with a religion, having an HIV-positive stable partner (compared with an HIV-negative or no stable partner), disclosing HIV status to anyone else, cigarette smoking, and evidence of harmful alcohol drinking (table 1). Recreational drug use was significantly associated with having a viral load greater than 50 copies per mL and with ART use and adherence, being higher in men who were not on ART, and those who were on ART and non-adherent, than in those who were on ART and adherent. Drug use was not significantly associated with ethnic origin, education, financial hardship, time since HIV diagnosis, or CD4 cell count (table 1).

Factors independently associated with recreational drug use (p<0·05) were younger age, not identifying with a religion, having an HIV-positive stable partner, having disclosed HIV status to anyone else, evidence of harmful alcohol drinking, current cigarette smoking, not being on ART, and non-adherence to ART (table 1).

	Any anal or vaginal sex		Condomless sex		Condomless sex with a seroconcordant partner		Condomless sex with a serodiscordant partner		Higher-HIV-risk condomless sex with a serodiscordant partner*		Diagnosed with a sexually transmitted infection		Participated group sex		Used internet to find sexual partners		"Less likely to use a condom with a casual partner"†		Had ten or more new sexual partners in past year	
	n/N	% or p value	n/N	% or p value	n/N	% or p value	n/N	% or p value	n/N	% or p value	n/N	% or p value	n/N	% or p value	n/N	% or p value	n/N	% or p value	n/N	% or p value
Recreational drug use		<0·0001		<0·0001		<0·0001		<0·0001		<0·0001		<0·0001		<0·0001		<0·0001		<0·0001		<0·0001
No	542/1110	49%	268/1110	24%	184/1110	17%	108/1110	10%	39/1110	4%	79/1094	7%	105/1082	10%	268/1083	25%	136/1058	13%	130/1110	12%
Yes	893/1138	79%	591/1138	52%	452/1138	40%	231/1138	20%	117/1138	10%	173/1123	15%	361/1114	32%	548/1118	49%	225/1118	20%	389/1138	34%
Polydrug use (n=1138)		<0·0001		0·002		<0·0001		0·004		0·005		<0·0001		<0·0001		<0·0001		<0·0001		<0·0001
1	237/368	64%	121/368	33%	81/368	22%	53/368	14%	24/368	7%	33/360	9%	63/357	18%	107/359	30%	57/361	16%	71/368	19%
2	194/241	81%	114/241	47%	76/241	32%	49/241	20%	23/241	10%	34/239	14%	60/236	25%	113/236	48%	38/236	16%	75/241	31%
3	140/176	80%	94/176	53%	72/176	41%	37/176	21%	19/176	11%	29/174	17%	51/176	29%	84/176	48%	33/174	19%	59/176	34%
4	100/112	89%	74/112	66%	57/112	51%	31/112	28%	12/112	11%	19/111	17%	51/110	46%	79/111	71%	27/111	24%	54/112	48%
≥5	222/241	92%	188/241	78%	166/241	69%	61/241	25%	39/241	16%	58/239	24%	136/235	58%	165/236	70%	70/236	30%	130/241	54%

Data given for those who provided responses on the questionnaire, so differ from total sample size owing to missing data. Adjusted analyses done for men who have sex with men (MSM) who have complete data for all these variable. p values calculated with χ^2 test and, for polydrug use, χ^2 test for trend. *Condomless sex with a serodiscordant partner and not on antiretroviral therapy, viral load greater than 50 copies per mL, or diagnosed with a sexually transmitted infection in the previous 3 months. †Strongly agrees or tends to agree versus undecided, tends to agree, or strongly disagrees (no recall period).

Table 2: **Association of recreational drug use or polydrug use in the past 3 months with measures of sexual behaviour in the past 3 months in 2248 HIV-diagnosed men who have sex with men**

In univariable analysis in 1138 MSM who used at least one drug, use of four or more drugs versus one to three drugs in the past 3 months was associated with: younger age, university education, current employment, not identifying with a religion, having an HIV-positive stable partner, more recent HIV diagnosis, viral load greater than 50 copies per mL, not being on ART, and ART non-adherence (table 1). In multivariable analysis, younger age, university education, not identifying with a religion, and having an HIV-positive stable partner were still significantly associated with use of four or more drugs compared with use of one to three drugs (table 1).

In the previous 3 months, 1435 (64%) of the 2248 individuals had anal or vaginal sex, 859 (38%) had condomless sex, 339 (15%) had such sex with a serodiscordant partner, and 156 (7%) had higher-HIV-risk condomless sex with a serodiscordant partner.

Compared with MSM who did not use drugs in the previous 3 months, those who used drugs were more likely to report any anal or vaginal sex, condomless sex, new STI diagnoses, group sex, searching for sexual partners on the internet in the past 3 months, having ten or more new sexual partners in the past year, and being less likely to use a condom with a casual partner (table 2)

With increasing number of recreational drugs used we noted striking increases in the prevalence of condomless sex and all other sexual behaviour outcomes (table 2). These associations were not greatly attenuated after adjustment for statistically significant sociodemographic and HIV-related factors (figure 2). We detected a strong association between increasing polydrug use and higher prevalence of all types of condomless sex for the subgroup of 1435 MSM who reported any anal or vaginal sex in the past 3 months (appendix).

We assessed the adjusted association between individual drugs and higher-HIV-risk condomless serodiscordant sex in MSM who reported any anal or vaginal sex in the past 3 months (figure 3). Compared with MSM who used no drugs, MSM who used methamphetamine had the highest prevalence ratio of higher-HIV-risk condomless serodiscordant sex, followed by the prevalence ratios for club drugs, erectile dysfunction drugs, nitrites, and cocaine, which were all of a similar magnitude.

Discussion

Our findings show that half of the 2248 HIV-diagnosed MSM surveyed had used recreational drugs in the past 3 months and that about a quarter had used at least three types of drugs during that time period. Drug use and polydrug use were independently associated with younger age, not identifying as religious, and having an HIV-positive stable partner. Drug use was also associated with disclosure of HIV serostatus, harmful alcohol drinking, cigarette smoking, not being on ART,

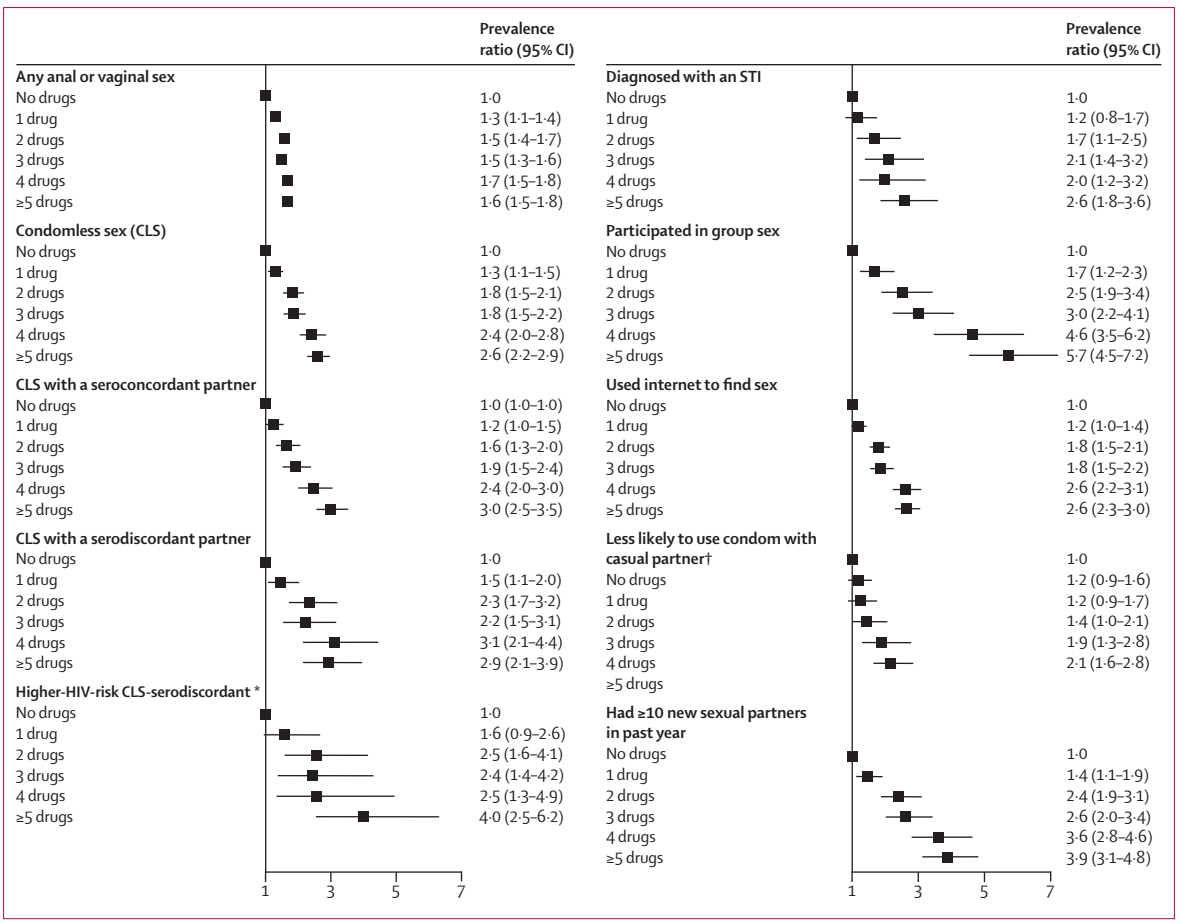

Figure 2: **Adjusted prevalence ratios for the association of polydrug use in the past 3 months with measures of sexual behaviour in 2248 HIV-diagnosed men who have sex with men**

Ratios are adjusted for age group, education, religion, stable partner's HIV status, antiretroviral treatment use and adherence, and clinic. Sexual behaviour measures have 3-month recall period unless otherwise specified. *Condomless sex with a HIV-serodiscordant partner, and not on antiretroviral treatment or viral load greater than 50 copies per mL, or diagnosed with a sexually transmitted infection in the previous 3 months. †No recall period. STI=sexually transmitted infection.

See Online for appendix

and non-adherence to ART. We saw strong and consistent associations between increasing numbers of drugs used and increasing prevalence of all indicators of condomless sex (including high HIV-transmission risk condomless sex), group sex, and having multiple new sexual partners. However, the overall prevalence of higher-HIV-risk serodiscordant condomless sex was low (7%).

To the best of our knowledge, ASTRA is the largest questionnaire study of HIV-diagnosed individuals in the UK to date. We think our study population is representative of HIV-diagnosed MSM in the UK because the UK has universal access to health care and 95% of HIV-diagnosed people access specialist services.[11] The response rate (64%) was satisfactory with no significant differences in viral load or CD4 cell count between responders and those who did not respond to the questionnaire but who consented to participate.[22] A further strength of the study is the comprehensive information obtained about self-reported polydrug use and recent sexual behaviour. Nevertheless, under-reporting of drug use and specific sexual behaviours is possible and could have led to underestimation of prevalence.

Previous comparable data for recreational drug use in HIV-diagnosed MSM in the UK derive predominantly from a 2002–03 study that surveyed HIV-negative and HIV-positive MSM at gyms and outpatient clinics in London;[21] prevalence of recreational drug use in the previous year in the HIV-diagnosed outpatient sample (n=388) was 54%.[21] When comparing use of specific drugs in the previous 3 months in participants from London clinics in the ASTRA study (N=1527) to drug use that occurred at least once or twice a month in the 2002–03 London HIV outpatient sample, we detected evidence of higher use of methamphetamine (10% *vs* 4%), cocaine (23% *vs* 14%), and injecting drug use (4% *vs* 1%), similar prevalence for use of ketamine (12% *vs* 13%) and amphetamine (3% *vs* 2%), and lower prevalence for use

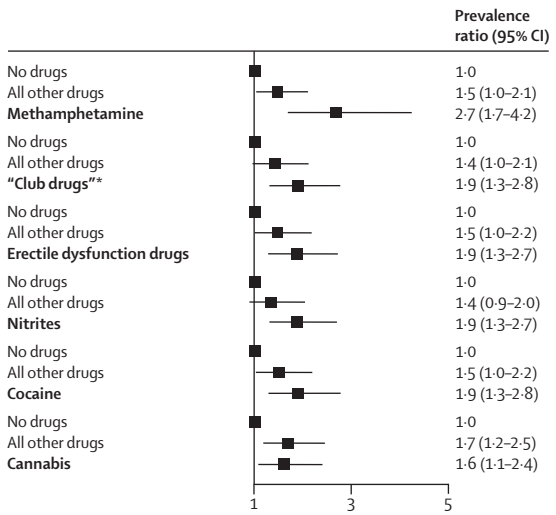

Figure 3: **Adjusted prevalence ratios for the association of use of specific drugs in the past 3 months with higher-HIV-risk condomless sex with a serodiscordant partner**

Data from 1435 HIV-diagnosed men who have sex with men who reported any anal or vaginal sex in the past 3 months. Adjusted for age group, religion, antiretroviral treatment use and adherence, and clinic. Higher-HIV-risk sex is defined as condomless sex plus: not on antiretroviral treatment, latest viral load greater than 50 copies per mL, or new diagnosis of a sexually transmitted infection in the previous 3 months. *Ecstasy, ketamine, mephedrone, and gamma-hydroxybutyrate or gamma-butyrolactone.

Panel: Research in context

Systematic review

We searched PubMed and Embase for articles published in English (Jan 1, 1996, to July 31, 2014) using the following MeSH headings in any fields: "recreational drugs" or "street drugs" or "illicit drugs" or "designer drugs" or "controlled substances" or "counterfeit drugs" and "men who have sex with men" or "gay" and "sexual behaviour" and "HIV". We identified cross-sectional studies based on venue-based, online, and clinic-based samples, of recreational drug use in men who have sex with men (MSM) in the USA, Australia, Canada, and Europe, and longitudinal cohort studies of recreational drug use and occurrence of HIV in MSM from the USA.[5,16,30] We identified two small qualitative studies of MSM in the UK who use recreational drugs in a sexual context, irrespective of HIV-serostatus.[9,10] One cross-sectional HIV clinic-based study was done in 2002–03 in HIV-diagnosed individuals in the UK that examined associations with sexual behaviours, such as condomless sex with casual partners and looking for sex on the internet.[21]

Interpretation

To the best of our knowledge, ASTRA is the largest questionnaire study of HIV-diagnosed individuals in the UK, accounting for about 5% of all HIV-diagnosed MSM in the UK. Our study includes comprehensive information about the extent of polydrug use, which has not been reported before in the UK. We measured condomless sex with HIV-seroconcordant, HIV-serodiscordant or unknown status partners, and condomless sex with serodiscordant partners accounting for viral load, which has not previously been examined. Our findings show that recreational drug use and polydrug use are prevalent, and strongly associated with condomless sex and multiple new sexual partners among HIV-diagnosed MSM. These findings draw attention to the importance of tailored harm reduction support for MSM who use recreational drugs and to the need to address the prevention of HIV and sexually transmitted infection in this group.

of MDMA (11% *vs* 17%).[21] This comparison suggests changing patterns of drug use in HIV-diagnosed MSM, with possible increases in methamphetamine and injection drug use. However, comparisons are not straightforward because of the different recall periods for drug use, potential confounding factors in the comparison, and the shortage of data from other comparable studies in the UK.

There have been few studies of polydrug use in representative samples of HIV-diagnosed MSM in the UK (panel). Findings from the London 2002–03 study showed that more than 90% of the 49 HIV-diagnosed MSM who used methamphetamine during the previous year had used at least one other drug during this time period. Similarly, more than 80% of the 162 cocaine users had used other drugs in the previous year.[21] In our study the high prevalence of polydrug use in the previous 3 months (46% of drug users using three or more drugs and 21% using five or more) is concerning, especially in view of potential drug-drug interactions, such as possible cardiovascular harms from simultaneous use of erectile dysfunction drugs and nitrites,[27] intensification of the toxic effects of GHB when consumed with alcohol,[28] and the potential for polydrug use to interfere with the effectiveness of antiretroviral drugs.[28] Although we saw that recreational drug use was associated with non-adherence to ART and lower prevalence of suppressed viral load, 87% of HIV-diagnosed MSM on ART who used recreational drugs, and 83% of those on ART who used five or more drugs, had suppressed viral load, showing that recreational drug use is not incompatible with good ART adherence.

In our study, recreational drug use and polydrug use were associated with being sexually active, and more strongly associated with all measures of condomless sex. Although a minority (15%) of HIV-diagnosed MSM reported serodiscordant condomless sex, and fewer (7%) fulfilled our criteria for higher-HIV-risk serodiscordant condomless sex, it was evident that increasing polydrug use was associated with increases in prevalence of serodiscordant condomless sex, and specifically higher-HIV-risk condomless sex. In men who reported anal or vaginal sex in the past 3 months, methamphetamine had the strongest association with higher-HIV-risk serodiscordant condomless sex. Findings from previous cross-sectional and longitudinal studies have shown associations between use of methamphetamine and serodiscordant condomless sex in HIV-diagnosed MSM,[6,21] although none has incorporated measures of viral load.[30] Additionally, results from a US cohort of MSM showed that use of methamphetamine was independently associated with HIV-seroconversion during follow-up.[29]Risk of HIV transmission is low when the HIV-positive partner is adherent to ART with undetectable viral load in the absence of STIs,[31] in line with available data for the risk

of transmission during anal sex in MSM.[32] However, such condomless sex, as well as condomless sex with partners known to be HIV-positive, does present a risk of transmission of other STIs including hepatitis C infection, syphilis, and gonorrhoea. Additionally, since 2004, the UK has an ongoing lymphogranuloma venereum epidemic in MSM, of which most cases are in HIV-diagnosed MSM, among whom reported levels of drug use (particularly methamphetamine and mephedrone use) are high.[33]

The difficulties in attributing a causal relation to the associations between recreational drug use and higher-risk sexual behaviours in cross-sectional studies have been well documented.[34] However, irrespective of causal attributions, our findings show that polydrug use and condomless sex are inextricably linked in HIV-diagnosed MSM in the UK, and that polydrug users are likely to be a group at especially high risk for transmission of HIV and other STIs. A need exists for longitudinal, episode-level studies focusing on drug use during episodes of condomless sex in the same individual, which could provide important information about temporality and causality.

Improved understanding of the underlying drivers of polydrug use in HIV-diagnosed MSM is needed in order to reduce health harms. Cross-agency collaboration between HIV treatment and substance misuse services might be beneficial in providing tailored, judgment-free harm reduction advice and support to HIV-diagnosed MSM who use recreational drugs, and in addressing HIV and STI prevention issues in this group. Peer-led interventions might also be productive in outreach services for HIV-diagnosed men who are polydrug users and have multiple sexual partners. National STI and HIV prevention strategies should address recreational drug use.

Contributions

FCL, ANP, AR, AS, LS, SC, JE, AMJ, GH, AM, AHMG, WJB, RG, MAJ, MF, EW, and JA had the idea for and designed the study. AS, FCL, AR, MAJ, RG, MF, EW, JA, JM, JE, NP, RO, ML, and MJ collected the data. MD, AS, and FCL managed the data. MD and FCL did the data analysis. MD, FCL, AR, LS, and ANP wrote the first draft of the paper. All authors contributed to writing and revision of the paper.

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Declaration of interests

We declare no competing interests.

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References

1 Kirby T, Thornber-Dunwell M. High-risk drug practices tighten grip on London gay scene. *Lancet* 2013; **381:** 101–02.
2 Stuart D. Sexualised drug use by MSM: background, current status and response. *HIV Nurs* 2013; **13:** 1–5.
3 Hunter LJ, Dargan PI, Benzie A, White JA, Wood DM. Recreational drug use in men who have sex with men (MSM) attending UK sexual health services is significantly higher than in non-MSM. *Postgrad Med J* 2014; **90:** 133–38.
4 Hickson F, Bonell C, Weatherburn P, Reid D. Illicit drug use among men who have sex with men in England and Wales. *Addict Res Theory* 2010; **18:** 14–22.
5 Heiligenberg M, Wermeling PR, van Rooijen MS, et al. Recreational drug use during sex and sexually transmitted infections among clients of a city sexually transmitted infections clinic in Amsterdam, the Netherlands. *Sex Transm Dis* 2012; **39:** 518–27.
6 Colfax G, Guzman R. Club drugs and HIV infection: a review. *Clin Infect Dis* 2006; **42:** 1463–69.
7 Cochran SD, Ackerman D, Mays VM, Ross MW. Prevalence of non-medical drug use and dependence among homosexually active men and women in the US population. *Addiction* 2004; **99:** 989–98.
8 Ruf M, Lovitt C, Imrie J. Recreational drug use and sexual risk practice among men who have sex with men in the United Kingdom. *Sex Transm Infect* 2006; **82:** 95–97.
9 Gilbart V, Simms I, Gobin M, Jenkins C, Oliver I, Hughes G. High-risk drug practices associated with Shigella flexneri 3a infections among MSM in England and Wales: findings from in-depth interviews. *HIV Med* 2014; **15:** 14.
10 Bourne A, Reid D, Hickson F, Torres Rueda SWP. The Chemsex study: drug use in sexual settings among gay & bisexual men in Lambeth, Southwark & Lewisham. London: Sigma Research, 2014.
11 Aghaizu A, Brown A, Nardone A, et al. HIV in the United Kingdom 2013 report: data to end 2012. London: Public Health England, 2013.
12 The EMIS Network. EMIS 2010: The European men-who-have-sex-with-men internet survey. findings from 38 countries. Stockholm: European Centre for Disease Prevention and Control, 2013.
13 Sherr L, Bolding G, Maguire M, Elford J. Viagra use and sexual risk behaviour among gay men in London. *AIDS* 2000; **14:** 2051–53.
14 Keogh P, Reid P, Bourne A, et al. Wasted opportunities: problematic alcohol and drug use among gay men and bisexual men. London: Sigma, 2009.
15 Colfax GN, Mansergh G, Guzman R, et al. Drug use and sexual risk behavior among gay and bisexual men who attend circuit parties: a venue-based comparison. *J Acquir Immune Defic Syndr* 2001; **28:** 373–79.
16 Rawstorne P, Digiusto E, Worth H, Zablotska I. Associations between crystal methamphetamine use and potentially unsafe sexual activity among gay men in Australia. *Arch Sex Behav* 2007; **36:** 646–54.
17 Li J, McDaid LM. Alcohol and drug use during unprotected anal intercourse among gay and bisexual men in Scotland: what are the implications for HIV prevention? *Sex Transm Infect* 2014; **90:** 125–32.
18 De Ryck I, Van Laeken D, Noestlinger C, Platteau T, Colebunders R. The use of erection enhancing medication and party drugs among men living with HIV in Europe. *AIDS Care* 2013; **25:** 1062–66.

19 Grov C, Kelly BC, Parsons JT. Polydrug use among club-going young adults recruited through time-space sampling. *Subst Use Misuse* 2009; **44:** 848–64.

20 Purcell DW, Parsons JT, Halkitis PN, Mizuno Y, Woods WJ. Substance use and sexual transmission risk behavior of HIV-positive men who have sex with men. *J Subst Abuse* 2001; **13:** 185–200.

21 Bolding G, Hart G, Sherr L, Elford J. Use of crystal methamphetamine among gay men in London. *Addiction* 2006; **101:** 1622–30.

22 Speakman A, Rodger A, Phillips AN, et al. The "antiretrovirals, sexual transmission risk and attitudes" (ASTRA) study. design, methods and participant characteristics. *PLoS One* 2013; **8:** e77230.

23 Babor TF, Higgins-Biddle JC, Saunders JB, Monteiro MG. The alcohol use disorders identification test. Geneva: World Health Organization, 2001.

24 National Institute on Drug Abuse. Commonly abused drugs. Rockville, MA: National Institutes of Health, US Department of Health and Human Services, 2012.

25 Wood DM, Nicolaou M, Dargan PI. Epidemiology of recreational drug toxicity in a nightclub environment. *Subst Use Misuse* 2009; **44:** 1495–502.

26 Zou G. A modified Poisson regression approach to prospective studies with binary data. *Am J Epidemiol* 2004; **159:** 702–06.

27 Romanelli F, Smith KM. Recreational use of sildenafil by HIV-positive and -negative homosexual/bisexual males. *Ann Pharmacother* 2004; **38:** 1024–30.

28 Antoniou T, Tseng AL-I. Interactions between recreational drugs and antiretroviral agents. *Ann Pharmacother* 2002; **36:** 1598–613.

29 Plankey MW, Ostrow DG, Stall R, et al. The relationship between methamphetamine and popper use and risk of HIV seroconversion in the multicenter AIDS cohort study. *J Acquir Immune Defic Syndr* 2007; **45:** 85–92.

30 Boone MR, Cook SH, Wilson P. Substance use and sexual risk behavior in HIV-positive men who have sex with men: an episode-level analysis. *AIDS Behav* 2013; **17:** 1883–87.

31 Vernazza P, Hirschel B, Bernasconi E, Flepp M. HIV transmission under highly active antiretroviral therapy. *Lancet* 2008; **372:** 1806–07.

32 Rodger A, Bruun T, Cambiano V, et al. HIV transmission risk through condomless sex if HIV+ partner on suppressive ART: PARTNER study. Conference on Retroviruses and Opportunistic Infections (CROI 2014); Boston, MA, USA; March 3–6, 2014. Abstract 153LB

33 Macdonald N, Sullivan AK, French P, et al. Risk factors for rectal lymphogranuloma venereum in gay men: results of a multicentre case-control study in the UK. *Sex Transm Infect* 2014; **90:** 262–68.

34 Drumright LN, Patterson TL, Strathdee SA. Club drugs as causal risk factors for HIV acquisition among men who have sex with men: a review. *Subst Use Misuse* 2006; **41:** 1551–601.