PUBLIC HEALTH

Methamphetamine and sildenafil (Viagra) use are linked to unprotected receptive and insertive anal sex, respectively, in a sample of men who have sex with men

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Sex Transm Infect 2006;**82**:131–134. doi: 10.1136/sti.2005.017129

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Accepted for publication 1 August 2005

Objectives: There is evidence that methamphetamine and sildenafil (Viagra) use are associated with sexual risk behaviour among men who have sex with men (MSM). We investigated the association of methamphetamine, sildenafil, and other substance use with unprotected receptive and insertive anal sex among MSM by conducting an encounter specific analysis.

Methods: Data were from a cross sectional, community based survey of MSM in San Francisco regarding behaviour during their most recent anal sex encounter. Mulitvariate regression analysed independent associations of specific substance use and demographic variables with unprotected anal sex behaviours.

Results: The sample (n = 388) was diverse in race/ethnicity, age, income, education, HIV status, and homosexual/bisexual identification. More than half (53%) reported unprotected anal sex, including insertive (29%) and receptive (37%) during their most recent anal sex encounter; 12% reported unprotected insertive and 17% reported unprotected receptive anal sex with an HIV discordant or unknown partner. Methamphetamine was used by 15% and sildenafil was used by 6% of the men before or during the encounter; 2% used both drugs. In multivariate analysis controlling for demographic factors and other substance use, methamphetamine use was associated with unprotected receptive (odds ratio (OR), 2.03; 95% confidence interval (CI), 1.09 to 3.76) and sildenafil use was associated with unprotected insertive (OR, 6.51; CI, 2.46 to 17.24) anal sex. Effects were stronger with HIV discordant or unknown sex partners specifically.

Conclusion: Encounter specific associations of methamphetamine and sildenafil use with unprotected receptive and insertive anal sex, respectively, indicate the importance of assessment specificity and tailoring risk reduction efforts to address certain drugs and sexual behavioural roles among MSM.

In an era when sexual risk behaviour and STI/HIV diagnoses are on the rise among men who have sex with men (MSM),[1–5] it is necessary to identify factors associated with high risk behaviour and STI/HIV transmission in order to develop risk reduction programmes for these men. Studies have reported that substance use—particularly sildenafil (Viagra) and methamphetamine use—is associated with high risk sex among MSM.[6–16] Although these studies have contributed to our understanding, specificity and clarity have been lacking owing to methodological limitations of the assessments (for example, broad behavioural windows; substance use and sexual risk behaviours not situationally linked; combined behavioural roles of unprotected insertive and receptive anal sex). Given that sildenafil is a medication used to counteract erectile dysfunction, we might expect that sildenafil would be associated more strongly with unprotected insertive than receptive anal sex. And given that methamphetamine can lead to impotence, use of this drug before sex may be associated more strongly with unprotected receptive than insertive anal sex.

In this study, we assessed the use of methamphetamine, sildenafil and other substances (for example, alcohol, MDMA/ecstasy, amyl nitrite/poppers) before or during the most recent anal sex encounter for a diverse group of MSM in San Francisco. With this encounter specific measurement, we are able to identify the manner in which these substances associate with specific anal sex roles.

METHODS

MSM were recruited in the San Francisco Bay Area in the fall of 2001 through outreach at bars, dance clubs, community agencies, and street locations; through passive methods (for example, posters, flyers); and through participant referral. Black, Latino, and HIV positive MSM were oversampled (by identifying and targeting recruitment venues with a relatively large presence of the subgroups) for adequate representation in the analysis. Eligibility requirements included age 18 years or older and either homosexual/bisexual self identification, or oral or anal sex with a man in the past year. Participants provided informed consent, completed a 1 hour audio computer assisted self interview survey, and were reimbursed $25. Participants reported their substance use, sexual behaviour, and HIV status of their most recent anal sex partner in the previous 6 months (to assess recently sexually active men and to reduce recall bias). Substance use before or during any instance of anal sex in the previous 3 months was asked similarly (but not analysed in relation to sexual behaviour). Respondents reported whether or not (yes, no) they engaged in each of eight specific behaviours during their most recent anal sex encounter, including unprotected insertive (''You [had insertive anal sex with] him without a condom?'') and receptive (''You [had receptive anal sex with] him without a condom?'') anal sex. Substance use was defined as ''use before or during anal sex such that you felt the effects while you were having sex?'' Study procedures

Abbreviations: DUA, unprotected anal sex with a discordant/unknown HIV status partner; DUIA, HIV discordant/unknown unprotected insertive anal; DURA, HIV discordant/unknown unprotected receptive anal; HS, high school; MSM, men who have sex with men; UA, unprotected anal sex; UIA, unprotected insertive anal; URA, unprotected receptive anal

and instruments were approved by federal and local institutional review boards.

The analytic sample (n = 388) consisted of self reported HIV negative (n = 233) and positive (n = 155) men who provided data on their substance use and sexual behaviours during their most recent anal sex encounter. χ^2 tests were used to examine bivariate associations. A series of multivariate logistic regressions examined dichotomous dependent measures of unprotected anal sex (insertive, receptive). The regression equation included the following independent variables: sildenafil and methamphetamine use, use of other substances (alcohol, marijuana, cocaine, crack, LSD/mushrooms, heroin, ecstasy/MDMA, ketamine, GHB, amyl nitrite/poppers), race/ethnicity (white versus others), income (ordinal variable), education (ordinal variable), age (continuous variable), participant HIV status (positive versus negative), and homosexual versus bisexual identification.

In the regressions, use of other substances was modelled as a dichotomous score (used one or more other substance versus not) because no substances other than methamphetamine and sildenafil were consistently associated with anal sex either when those other substances were examined as individual dichotomous measures or as a sum score of other drugs used. Finally, we conducted regressions to examine correlates of methamphetamine and sildenafil use analysed as dependent variables.

RESULTS

The sample was demographically diverse: 31% black, 26% Latino, 31% white, and 11% other/mixed race; 15% identified as bisexual. Twenty per cent were under 25 years of age, 32% were 25–34, 36% were 35–44, and 12% were 45 or older. More than a third (35%) had a high school degree or less, 32% had some college or post-high school training, and 33% had a college degree or higher; 25% had an annual income of less than $10 000 and 16% earned $50 000 or more.

Overall, 6% reported using sildenafil and 15% used methamphetamine before or during their most recent anal sex encounter (table 1), of which 2% reported using both drugs during the encounter. Further, 12% of the sample reported using sildenafil (9% for HIV negative versus 16% for HIV positive men, $p<0.05$) and 17% reported using methamphetamine (15% for HIV negative and 19% for HIV positive men, $p>0.05$) before or during anal sex at any time in the previous 3 months. Nearly half (45%) of the men reported using any other substance during the most recent anal sex encounter, including alcohol (23%), marijuana (20%), amylnitrite/poppers (8%), crack (8%), cocaine (3%), MDMA/ecstasy (2%), GHB (2%), ketamine (1%), LSD/mushrooms (1%), heroin (1%), or another substance (2%).

More than half (53%) of the men reported having unprotected anal (UA) sex during the most recent anal encounter, which included unprotected insertive (UIA, 29%) and unprotected receptive anal (URA, 37%) sex. Twenty four per cent reported UA with a partner whose HIV status was different from theirs or unknown (DUA), including 12% insertive (DUIA) and 17% receptive (DURA). HIV positive (versus negative) men were more likely to report URA (47% versus 30%, $p<0.01$) and DURA (27% versus 10%, $p<0.01$); there was no difference by HIV status for UIA and DUIA ($p>0.05$).

In bivariate analysis, UA prevalence in the most recent anal encounter was higher among men who used sildenafil compared to those who did not (74% versus 52%, $p<0.05$); this pattern was also observed for DUA (52% versus 22%, $p<0.01$). Methamphetamine use (versus non-use) was associated with UA (66% versus 51%, $p<0.05$) but not DUA ($p>0.05$).

Further analysis indicated that sildenafil use was associated with unprotected insertive anal sex, including UIA and DUIA (table 1), but not with unprotected receptive anal sex (URA or DURA). Alternatively, methamphetamine use was associated with unprotected receptive anal sex, including URA and DURA, but not UIA or DUIA. These patterns were the same for HIV positive and negative participants. There was no consistent pattern of association of any other substance with unprotected insertive or receptive anal sex separately.

In multivariate analysis, sildenafil use was not associated with general UA ($p>0.05$) but not DUA (adjusted odds ratio (OR), 4.35; 95% confidence interval (CI), 1.63 to 11.59). Sildenafil use was strongly associated with unprotected insertive anal sex (table 2), including UIA and DUIA. Men of white race and more education were less likely to report DUIA.

Methamphetamine use was not associated ($p>0.05$) with UA or DUA. It was, however, associated with unprotected receptive anal sex (URA and DURA). Men who were HIV positive, homosexual identified, older, and reported less education were more likely to report DURA.

In other multivariate models, methamphetamine use (OR, 4.00; CI, 1.45 to 11.09) and older age (OR, 1.06; CI, 1.01 to

Table 1 Prevalence of sildenafil and methamphetamine use, and high risk sexual behaviour by substance use during the most recent anal sex encounter of men who have sex with men (n = 388)

	Sexual risk behaviour during most recent anal sex encounter			
	UIA	URA	DUIA	DURA
Substance use before or during encounter†	No (%)	No (%)	No (%)	No (%)
Sildenafil (Viagra)				
Yes [24/381 (6%)]	14 (61)*	11 (48)	10 (43)*	7 (30)
No [357/381 (94%)]	93 (26)	128 (36)	32 (9)	58 (16)
Methamphetamine				
Yes [59/381 (15%)]	14 (24)	32 (55)*	5 (9)	17 (29)*
No [322/381 (85%)]	93 (29)	107 (34)	37 (12)	48 (15)
Other substance‡				
Yes [171/381 (45%)]	53 (31)	61 (36)	22 (13)	29 (17)
No [210/381 (55%)]	54 (26)	78 (38)	20 (10)	36 (17)

UIA, unprotected insertive anal; URA, unprotected receptive anal.
DUIA, HIV discordant/unknown unprotected insertive anal; DURA, HIV discordant/unknown unprotected receptive anal.
*$p<0.01$ for 2×2 χ^2 test for each substance use variable within columns.
†Substance used before or during the most recent anal sex encounter such that the respondent felt effects during the encounter.
‡Other substance use included alcohol, marijuana, cocaine, crack, LSD/mushrooms, heroin, ecstasy/MDMA, GHB, ketamine, amyl nitrite/poppers, and other substance.
Note: a few cases are missing from analyses because of incomplete data.

Table 2 Multivariate independent correlates of specific sexual risk behaviours during the most recent anal sex encounter of men who have sex with men (n = 388)

	Sexual risk behaviour during most recent anal sex encounter			
	UIA	URA	DUIA	DURA
	OR (CI)	OR (CI)	OR (CI)	OR (CI)
Sildenafil (Viagra) use*	6.56 (2.47 to 17.40)		29.24 (7.90 to 108.26)	
Methamphetamine use*		2.04 (1.10 to 3.81)		2.15 (1.02 to 4.50)
Other substance use*†				
HIV positive (*v* negative)		1.99 (1.17 to 3.37)		2.30 (1.18 to 4.51)
Age (continuous)				1.04 (1.01 to 1.08)
White (*v* other) race/ethnicity			0.26 (0.08 to 0.86)	
Education level (ordinal)			0.63 (0.45 to 0.90)	0.69 (0.54 to 0.89)
Annual income (ordinal)				
Homosexual (*v* bisexual) self identification				4.71 (1.31 to 16.91)

UIA, unprotected insertive anal; URA, unprotected receptive anal.
DUIA, HIV discordant/unknown unprotected insertive anal; DURA, HIV discordant/unknown unprotected receptive anal.
OR, adjusted odds ratio; CI, 95% confidence interval; blank spaces represent non-significant results ($p>0.05$).
*Substance used before or during the most recent anal sex encounter such that the respondent felt effects during the encounter.
†Other substance use included alcohol, marijuana, cocaine, crack, LSD/mushrooms, heroin, ecstasy/MDMA, GHB, ketamine, amyl nitrite/poppers, and other substance.
Note: a few cases are missing from analyses because of incomplete data.

1.12) were associated with use of sildenafil (dependent variable). Sildenafil use (OR, 3.66; CI, 1.38 to 9.73) and HIV positive serostatus (OR, 2.86; CI, 1.41 to 5.84) were associated with methamphetamine use (dependent variable). Use of any other substance during the encounter was not associated with sildenafil or methamphetamine use.

DISCUSSION

This study identified associations of methamphetamine and sildenafil use with unprotected receptive and insertive anal sex during a recent anal sex encounter for a diverse sample of MSM in San Francisco. The focused nature of our findings potentially offers a more refined understanding of situational links of substance use and specific high risk sexual behaviours. The study overcomes the methodological limitations of previous findings, which include: (a) assessment of unconnected substance use and sexual behaviour in broad windows of time (for example, 3 month, 12 month)[7 9 10 12–14]; (b) analysis of unprotected insertive and receptive anal sex combined[6–8 10–14 16]; (c) failure to assess sexual risk behaviour with HIV discordant/ unknown partners[7–10 16]; (d) bivariate analyses only or multivariate models that do not control for other substance use in predicting sexual behaviour[7 12 14 15]; and (e) combining substances in analysis.[6 16] Thus, our findings are not directly comparable to other studies. None the less, our results confirm a consistent finding that methamphetamine and sildenafil use are associated with unprotected anal sex among MSM. We further found distinct links to unprotected receptive and insertive behaviours. That we did not find other substances to be associated with unprotected anal sex could possibly be attributed to a number of reasons, including methodological limitations (above), low power, and different sampling strategies, to name a few. More research is needed on other samples of MSM that focuses specifically on substance use before or during sex, and for insertive and receptive roles separately.

Using sildenafil before or during sex was associated with a substantially increased likelihood of unprotected insertive (but not receptive) anal sex, the riskiest sexual behaviour for transmitting HIV to another person. The link between sildenafil use and insertive sex is not surprising because the drug is used to promote or maintain an erection; however, it was curious to find an association with unprotected insertive anal sex (especially with an HIV discordant/unknown partner). A different picture emerged for methamphetamine use. Using this drug before or during sex was associated with an increased likelihood of unprotected receptive anal sex, the riskiest sexual activity for contracting HIV.[17] Interestingly, there was no evidence in this study that methamphetamine use was associated with unprotected insertive anal sex. One explanation of the linkage of methamphetamine use with receptive but not insertive sex, is that its use may cause erectile dysfunction in some men.[18] Others[18 19] have anecdotally or qualitatively suggested a link between methamphetamine use and receptive anal sex, owing to increased sexual desire and decreased sexual inhibitions from use of the drug. Only 2% of our sample reported using sildenafil and methamphetamine in combination. Our measure of substance use during sex (that is, ''use before or during anal sex such that you felt the effects while you were having sex'') may be limited by subjective assessment and report.

We found that one out of approximately eight men in this study used sildenafil before or during sex in the previous 3 months, and 6% used the drug in their most recent anal sex encounter. Our survey was conducted when sildenafil was the only erectile dysfunction medication available. Additional studies are needed on a wider geographical basis to examine prevalence of both sildenafil and methamphetamine use and to monitor whether use among MSM changes over time, including use of newer generations of erectile dysfunction medications (for example, tadalafil (Cialis), which has a longer effectiveness window than sildenafil).

In multivariate analysis, HIV positive MSM were more likely than their HIV negative counterparts to engage in unprotected receptive anal sex with HIV discordant/unknown partners. This difference may reflect HIV negative men's avoidance of high risk sexual activities or inaccuracies in perceived or reported serostatus of partners. It may also reflect ''strategic positioning'' on the part of some HIV positive men to reduce the likelihood of infecting a sex partner (for example, receptive rather than insertive role).[20] Less education, older age, non-white ethnicity, and homosexual (versus bisexual) identification were associated with unprotected insertive and receptive anal sex. These demographic subgroups should be targeted to reduce risk behaviour.

Our findings suggest that public health programmes for MSM should incorporate strategies to reduce methamphetamine use and sexual risk behaviour in this population, especially given the relatively high prevalence (17%) of

Key messages

In this encounter specific analysis that controls for other substance use and demographic factors:

- methamphetmine use before or during sex was associated with unprotected receptive anal sex (but not unprotected insertive anal sex)
- sildenafil use before or during sex was associated with unprotected insertive anal sex (but not unprotected receptive anal sex)
- other substance use was not associated with unprotected anal sex

methamphetamine use during anal sex within the previous 3 months. These efforts are particularly important for HIV positive MSM, as they were more likely than HIV negative MSM to use this drug. It is also important that MSM who use erectile dysfunction medications (whether prescribed or not) receive messages about the risk of unsafe sex that may occur after taking those medications, and healthcare providers (including internet sites) should reinforce these messages with patients. Concerted prevention efforts are needed to combat use of substances that promote sexual behaviours that put MSM at risk for STI/HIV transmission.

CONTRIBUTORS

GM was the lead writer, assisted with analysis, and was the project officer on this study; LS was the lead analyst and a writer on this study; GM assisted with writing and was the co-project officer on this study; SB and GC edited earlier versions of the manuscript and were principal investigators on the study; RG and MR edited earlier versions of the manuscript and were project coordinators on the study.

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Study sponsorship: This study was funded by a Cooperative Agreement from the US Center for Disease Control and Prevention (CDC).

Competing interest: All authors declare no competing interests.

Ethics approval: The study protocol was reviewed and approved for scientific and ethical considerations by institutional review boards at CDC and the San Francisco Department of Public Health.

REFERENCES

1 **US Centers for Disease Control and Prevention**. Increases in unsafe sex and rectal gonorrhea among men who have sex with men—San Francisco, California, 1994–1997. *MMWR* 1999;**48**:45–58.
2 **US Centers for Disease Control and Prevention**. Outbreak of syphilis among men who have sex with men—Southern California, 2000. *MMWR* 2001;**50**:117–20.
3 **US Centers for Disease Control and Prevention**. Primary and secondary syphilis among men who have sex with men—New York City, 2001. *MMWR* 2002;**51**:853–6.
4 **US Centers for Disease Control and Prevention**. Primary and secondary syphilis—United States, 2002. *MMWR* 2003;**52**:1117–20.
5 **US Centers for Disease Control and Prevention**. Increases in HIV diagnoses—29 states, 1999–2000. *MMWR* 2003;**52**:1145–8.
6 **Colfax GN**, Vittinghoff E, Husnik MJ, *et al*. Substance use and sexual risk: a participant and episode-level analysis among a cohort of men who have sex with men. *Am J Epidemiol* 2004;**159**:1002–12.
7 **Paul J**, Stall R, Davis F. Sexual risk for HIV transmission among gay/bisexual men in substance-abuse treatment. *AIDS Educ Prev* 1992;**5**:11–24.
8 **Moliter F**, Traux SR, Ruiz JD, *et al*. Association of methamphetamine use during sex with risky sexual behaviors and HIV infection among non-injection drug users. *West J Med* 1998;**168**:93–7.
9 **Stone E**, Haegerty P, Vittinghoff E, *et al*. Correlated of condom failure in a sexually active cohort of men who have sex with men. *J AIDS* 1999;**20**:495–501.
10 **Reback CJ**, Grella CE. HIV risk behaviors of gay and bisexual male methamphetamine users contacted through street outreach. *J Drug Issues* 1999;**29**:155–66.
11 **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 AIDS* 2001;**28**:373–9.
12 **Sherr L**, Bolding G, Maguire M, *et al*. Viagra use and sexual risk behaviour among gay men in London. *AIDS* 2000;**14**:2051.
13 **Kim AA**, Kent CK, Klausner JD. Increased risk of HIV and sexually transmitted disease transmission among gay an bisexual men who use Viagra, San Francisco 2000–2001. *AIDS* 2002;**16**:1425–8.
14 **Chu PL**, McFarland W, Gibson S, *et al*. Viagra use in a community-recruited sample of men who have sex with men, San Francisco. *J AIDS* 2003;**33**:191–3.
15 **Purcell D**, Wolitski RJ, Hoff CC, *et al*. Predictors of the use of Viagra, testosterone, and antidepressants among HIV-seropositive gay and bisexual men. *AIDS* 2005;**19**(suppl. 1):S57–S66.
16 **Hirschfield S**, Remien RH, Humberstone M, *et al*. Substance use and high-risk sex among men who have sex with men: a national online study in the USA. *AIDS Care* 2004;**16**:1036–47.
17 **Vittinghoff E**, Douglas J, Judson F, *et al*. Per-contact risk of human immunodeficiency virus transmission between male sexual partners. *Am J Epidemiol* 1999;**150**:306–11.
18 **Halkitis PN**, Parsons JT, Stirratt MJ. A double epidemeic: crystal methamphetamine drug use in relation to HIV transmission among gay men. *J Homosexuality* 2001;**41**:17–35.
19 **Semple SJ**, Patterson TL, Grant I. Motivations associated with methamphetamine use among HIV+ men who have sex with men. *J Substance Abuse Treatment* 2002;**22**:149–56.
20 **Wolitski RJ**, Parsons JT, Gomez CA. Prevention with HIV-seropositive men who have sex with men: lessons from the Seropositive Urban Men's Study (SUMS) and the Seropositive Urban Men's Intervention Trial (SUMIT). *J AIDS* 2004;**37**:S101–9.