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The relationship between methamphetamine use and heterosexual behaviour: Evidence from a prospective longitudinal study

Running title: Methamphetamine use and sexual behaviour

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Aims: To estimate the extent to which specific sexual behaviours (being sexually active, having multiple sex partners, casual sex, condomless casual sex, anal sex, and condomless anal sex) change during periods of methamphetamine use.

Design: Within-person estimates for the relationship between methamphetamine use and sexual behaviour were derived from longitudinal panel data from the MATES cohort (2006 to

2010). **Setting:** Sydney and Brisbane, Australia. **Participants:** Participants (N = 319) were recruited through treatment and other health services, self-identified as heterosexual, were aged 17 to 51 years, 75% were male and all were dependent on methamphetamine on study entry. **Measurements:** Days of methamphetamine use in the past month, and sexual

behaviour in the past month, were both assessed using the Opiate Treatment Index. **Findings:**

When using methamphetamine, participants had double the odds of being sexually active compared with when they were not using, after adjustment for demographics and other substance use (Adjusted Odds Ratio [AOR] = 1.9, $p = .010$). When participants were sexually active, they were more likely to have multiple sex partners (AOR = 3.3, $p = .001$), casual sex partners (AOR 3.9, $p < .001$), and condomless casual sex (AOR = 2.6, $p .012$) when using methamphetamine than when they were not using. During months when participants had a casual sex partner, there was no significant reduction in their likelihood of condom use when they were using methamphetamine. There was no significant change in the likelihood of having anal sex or condomless anal sex during months of methamphetamine use.

Conclusions: Methamphetamine use is associated with a dose-related increase in being sexually active, having multiple sex partners and casual sex partners, and having condomless sex with casual partners, but it is not associated with a change in condom use per se.

INTRODUCTION

Methamphetamine is now a global public health concern, being consumed by an estimated 14-53 million people world-wide in 2015 [1]. A potential implication of methamphetamine use is for the transmission of HIV and other sexually transmitted infections (STIs) [2, 3]. Methamphetamine is associated with potentially high-risk sexual behaviours (e.g., multiple sex partners, condomless anal sex) [5], and with an elevated prevalence and incidence of HIV [4], although a causal association has not been confirmed [3].

Previous research has focused very specifically on men who have sex with men (MSM) as a high risk population for HIV transmission [2, 5-11]. Comparatively few studies have been conducted in heterosexual populations [12]. This leaves a substantial gap in our understanding of how methamphetamine use might impact on HIV and other STI transmission at a population level. Although the risk of HIV transmission may be lower with heterosexual behaviour [13], the larger number of people affected may amount to a significant public health impact. This is a particularly important consideration in countries where heterosexual HIV transmission is dominant, and where there has been concern about the potential impact of increasing methamphetamine use on HIV rates [14-16].

The handful of studies that have examined the relationship between methamphetamine use and heterosexual behaviour suggest that methamphetamine use is associated with enhanced libido, increased sexual activity, prolonged sexual activity, sexual disinhibition, increased sexual confidence [17-19], more sex partners[20], casual sex partners[21], anal sex [21] and trading sex for drugs or money [22]. Condomless sex is less consistently observed [19, 22,

23]. This literature is almost exclusively comprised of cross-sectional studies. It is therefore is not clear to what extent potentially risky sexual behaviour is due to the pre-existing characteristics of people who use methamphetamine (e.g., an appetite for risky behaviour which leads to both potentially high risk sexual behaviour and illicit drug use [24]).

One way to remove confounding by premorbid factors is to examine the within-person association between methamphetamine use and sexual behaviour. The presence of within-person effects are used in economics research (where they are referred to as “fixed effects”) [25], and more recently in public health research [26-29], because they discount the influence of premorbid variables (e.g. personality and historical factors that may lead to potentially risky sexual behaviour), provided that these variables are stable across the observation period.

We used longitudinal panel data from a cohort of heterosexual people dependent on methamphetamine to estimate within-person effects for the probability of specific sexual behaviours (being sexually active; having multiple sex partners, having casual sex partners; having condomless sex with casual partners; having anal sex and having condomless anal sex) occurring during periods of methamphetamine use relative to periods when people were not using the drug. We disaggregated overall effects to assess whether methamphetamine increased the likelihood of (a) being sexually active, (b) engaging in particular types of sexual acts, if people were sexually active (e.g., having multiple sex partners or casual sex partners, having anal sex), and (c) having condomless sex if people were engaged in potentially high risk sexual behaviours (e.g., sex with casual partners, anal sex). Analyses adjusted for concurrent use of other substances and changes in health and demographic factors.

METHOD

Design

Four non-contiguous one-month panels of data from a prospective longitudinal cohort study were used to examine the relationship between methamphetamine use and sexual behaviour. We first documented the relationship between methamphetamine use and all sexual behaviour outcomes across all participants. However, these relationships represent a composite risk of being sexually active, engaging in sex with multiple/casual partners, and condom use. To understand the relationship between methamphetamine use and each of these specific sexual behaviours we stratified the sample into those participants who were at risk for each behaviour. Specifically, we first assessed whether methamphetamine was related to being sexually active. We then tested whether methamphetamine use was associated with a change in the type of sexual activity (e.g., having multiple sex partners, having sex with a casual partner, having condomless casual sex, anal sex, having condomless anal sex) during months when participants were sexually active. Third, to understand whether methamphetamine use was related to condom use per se, we examined whether methamphetamine was associated with having condomless sex for months when individuals were engaged in potentially risky behaviour (i.e., during months when participants had a casual partner and during months when they had anal sex).

Participants and procedure

Participants were selected from a larger study, the Methamphetamine Treatment Evaluation Study (MATES) cohort, which is detailed elsewhere [21]. In brief, the MATES cohort included 400 people entering community-based drug treatment services in Sydney and Brisbane, Australia, for methamphetamine use, and 101 methamphetamine users from Sydney

who were not in treatment but who screened positive for dependence on methamphetamine (i.e, total sample of 501). Recruitment of the cohort took place in 2006 and 2007, while follow-up interviews spanned the period from 2006 to 2010. A structured interview schedule was administered at baseline, 3 months, 1 year and 3 years later. The current study used data on the past month at each of these four time points. Interviews were conducted face-to-face or by telephone. All participants provided informed consent, were volunteers, and were reimbursed for their time and travel expenses (up to AU\$40 per interview).

Selection of the cohort for this analysis

From the MATES cohort, 17 participants were excluded because they did not meet DSM-IV criteria for methamphetamine dependence on recruitment. Sexual identity was assessed at the 12 month interview by asking participants “Do you identify as being gay, lesbian or bisexual?”, with response options of: no, gay, lesbian, bisexual, other. Individuals who responded no to this question were assumed to self-identify as heterosexual. Only 2 individuals nominated ‘other’ and both were transgender. For heterosexual participants who were sexually active in the past month, their last sexual partner was same-sex in 1% of cases. Participants were excluded from the current analysis if they did not participate in the 12-month follow-up interview when sexual identity was assessed, or if they declined to provide this information (n = 3). Of the remaining 364 participants, 319 identified as heterosexual (excluded were 6 gay women, 18 bisexual women, 15 gay men, 4 bisexual men and 2 transgender individuals). All were interviewed at 12 months, 92% (n = 295) were interviewed at 3 months, and 80% (n = 256) at 3 years. Three participants declined to answer questions on sexual behaviour at one of their interviews, and 7 months of data were censored from the data

because sex work was the main source of income, resulting in 1,179 months of data for all of the participants combined.

Measures

Sexual behaviour: Sexual behaviour in the past month was assessed at each time point using the HIV Risk-taking Behaviour Scale of the Opiate Treatment Index [30, 31]. From the responses to these questions we derived data for the past month for (a) any penetrative sex, (b) multiple sex partners, (c) sex with a casual partner, (d) any condomless sex with a casual partner, (e) anal sex, and (f) any condomless anal sex. Condomless sex was assessed using the question “How many different people did you have unprotected sex with in the last month? (i.e., no use of condoms, dams or gloves)”. Self-reports of unprotected sex obtained using this question have been validated against partner reports (kappa 0.88) [30].

Drug use: Days of use in the past four weeks for methamphetamine and other major drug classes was measured at each time point using the Drug Use Scale of the Opiate Treatment Index [30, 31]. Self-reported abstinence from methamphetamine use was confirmed in a subsample of the entire MATES cohort (n = 83) using hair toxicology, with false reporting of abstinence occurring in 6% of cases (detailed elsewhere [32]).

Other measures: Other measures at each time point were: current employment status (currently unemployed vs. casual/part-time, full-time, student or home duties), net legal income in the past fortnight (< AU\$400, \$400-499, \$500-799, \$800), accommodation in the past month (private dwelling, public housing, parents’ house, residential rehabilitation, homeless or temporary accommodation), living with a partner in the past month, and poor

physical or mental health in the past month (> 1 standard deviation below the normative mean on the Physical and Mental Component Scales of the Short Form 12 respectively [33]).

Additional demographics collected at baseline were age, not completing high school (< 10 years schooling), tertiary education (none, trade qualification, university degree), and whether or not the participant was recruited from a treatment setting.

Statistical analysis

Data were analyzed using Stata SE version 14.0 [29]. All tests were two-sided with significance set at $p < 0.05$. A series of multi-level regression models was used to determine the relationship between methamphetamine use and each sexual behaviour across the four panels of data. A random intercept was included in the model to allow for clustering of variance on individuals across panels. The outcome measure was the time-varying sexual behaviour being examined, the predictor was time-varying methamphetamine use in the past month (any use versus no use). Both between- and within-person effect estimators for past month methamphetamine use were included in each model. The between-person effect estimators were calculated as the mean methamphetamine use score across all observed time points. The within-person estimator was calculated for each time point as the difference between the observed score at that time point and that participant's mean score across all time-points (i.e. the deviation from their mean score). Time-varying covariates included past month cannabis use (no use, 1-15 days, 16+ days), past month alcohol use (no use, 1-15 days, 16+ days), the number of other substances used in that month (heroin, other opioids, benzodiazepines, cocaine, ecstasy, hallucinogens, inhalants, tobacco), unemployment, income, accommodation, living with a partner, physical and mental health disability. Time invariant covariates included age at baseline, gender, incomplete schooling ($< \text{year } 10$),

tertiary education and whether the participant was recruited from a treatment setting. Poisson models were used for anal sex and condomless anal sex because of the low prevalence of these behaviours (anal sex, mean 0.076, variance 0.070; condomless anal sex, mean 0.058, variance 0.054). Logit models were used for all other outcomes because these were binary. A Hausman test was used to compare model fit. Including a random intercept for recruitment site did not significantly alter model fit (difference in coefficients 0.01 – 0.08, $p > 0.05$). Dose-relationships were estimated by extracting the marginal effects for days of methamphetamine use in the past month (0, 1–15 days, 16+ days) from the adjusted random effects model. These categories were based on the median days of methamphetamine use at baseline (see Table 1) and to match our previous studies [28, 29].

RESULTS

Sample characteristics

Participants included in the analysis ($N = 319$) all identified as heterosexual and met DSM-IV criteria for methamphetamine dependence in the year prior to study entry. Most injected methamphetamine. Other substance use consisted primarily of tobacco, cannabis, and alcohol. Participants were aged between 17 and 51, with a mean age of 31 years; most were male, unemployed, single, Australian-born and spoke English (Table 1).

Methamphetamine use occurred during 56% of the observed months, during which participants used the drug on a median of 8 days (IQR 3-18). The majority of participants (89%) were sexually active during at least one month of the study period. Sexual activity was

reported during 62% of the observed months: 36% of these involved a casual partner, and 28% involved more than one partner.

Table 1 about here.

Relationship between methamphetamine use and sexual behaviour

The unadjusted within-person relationship between methamphetamine use and each sexual behaviour is shown in Table 2, including after adjustment for demographic factors and general health (Model 1) and further adjustment for concurrent substance use (Model 2). Between-person effects can be found in Table S1 (see Supporting Information). The large confidence limits around the between-person effects suggested that we only had the statistical power to detect large effects (OR/IRR >3).

Overall effects for sexual behaviour: Unadjusted analyses showed that participants had twice the odds of being sexually active during months of methamphetamine use (Table 1). The overall odds of having multiple sex partners, casual sex partners, and condomless sex with casual partners were also significantly elevated (ORs 4-5) and these effects remained statistically significant after adjustment for substance use and demographics (ORs 2-3).

Changes in sexual behaviour during periods of sexual activity: During months when participants were sexually active, they were four times more likely to have multiple partners when they were using methamphetamine than when they were not; they were six times more likely to have a casual sex partner, and five times more likely to have condomless casual sex (Table 2). Each of these effects was significant for both men and women ($p < .001$; analysis

not shown). These relationships were attenuated (ORs 2-4) after adjustment for demographics, health and the use of other substances in the same month (Models 1 and 2 respectively, Table 2).

Condom use with casual partners: During months when participants had a casual sex partner, they were not significantly more likely to have condomless casual sex when they were using methamphetamine than when they were not (Table 2).

Table 2 about here.

Anal sex: Only 8% of months involved anal sex, but 77% of these months involved condomless anal sex. There was no significant within-person association between methamphetamine use and the likelihood of having anal sex or having condomless anal sex (Table 2). There was also no change in having condomless anal sex use during months of methamphetamine use for participants engaged in anal sex (Incidence Rate Ratio [IRR] = 1.0 [95% CI = 0.5 - 1.9], $p = .988$). However, there was a between-participant effect suggesting that individuals who had higher average methamphetamine use (i.e. had used during more months of the study) were more likely to engage in anal sex (adjusted IRR = 3.6 [95% CI = 1.5 – 8.3], $p = .003$) and to have condomless anal sex (adjusted IRR = 4.3 [95% CI = 1.5- 11.9], $p = .005$). See Model 2 in Table S1, for details. There were no other significant predictors of anal sex, and the only other predictor of condomless anal sex was living with a partner (adjusted IRR = 2.0 [95% CI = 1.1 - 3.5], $p = 0.020$).

Other predictors of sexual behaviour

Other substance use (with the exception of cannabis use) was associated with being sexually active, however, only methamphetamine and alcohol use were associated with casual sex partners, and having multiple sex partners was specifically associated with methamphetamine use (Table 3).

Dose relationship with methamphetamine use

Evidence of a dose relationship with frequency of methamphetamine use was most apparent for having more than one sexual partner in the past month (relative to no use: 1-15 days AOR = 2.5 [95% CI = 1.3 – 4.7], 16+ days AOR = 5.8 [95% CI = 2.6 – 13.2]). Other sexual behaviours showed a less compelling dose-relationship with frequency of methamphetamine use (see Figure 1 and Table S2). A sensitivity analysis using a cut-point of 8 days of use (i.e., no use, 1-7 days, 8+ days) returned similar results (see Table S2).

Tables 3 and Figure 1 about here.

DISCUSSION

In this cohort of dependent methamphetamine users, we found a dose-related increase in the likelihood of people having multiple sex partners, casual sex partners and condomless casual sex when they were using methamphetamine compared to when they were abstinent from the drug. The within-person analysis showed that this increase in risk was net of any premorbid or

historical factors that may have influenced sexual behaviour, and this risk persisted after adjustment for any changes in other substance use, lifestyle factors and general health that occurred concurrently with methamphetamine use. Although the use of other substances was also associated with sexual activity, with alcohol particularly associated with having casual sex, methamphetamine use specifically was associated with having multiple sex partners. This increase in sexual activity was dose-related and translated into an increase in the probability of participants having condomless sex with casual sex partners. However, there was no significant decrease in condom use during periods of methamphetamine use.

While it is impossible to confirm a null effect, our failure to detect a significant relationship between methamphetamine use and a reduced likelihood of condom use in this sample (i.e., ORs 0.4-0.9 of having condomless casual sex when using methamphetamine compared to when not using the drug) stands in contrast to an often discussed view that intoxication with methamphetamine increases the risk of not using condoms (e.g., through impaired judgement) [5]. Rather, our results suggest that methamphetamine is associated with an increased risk of condomless casual sex because it is associated with an increase in sexual activity, particularly sex with multiple/casual partners, an effect that is likely to be driven by well-documented capacity of the drug to enhance libido [17, 19] and sexual disinhibition [19]. The discrepancy between our findings and the results of previous studies is likely to reflect our approach of examining the relationship between methamphetamine use and condom use specifically amongst people who had a casual sex partner.

These findings none-the-less suggest methamphetamine use is a potential vector in the heterosexual transmission of HIV and other STIs. This is important for regions where the

heterosexual transmission of HIV is high (e.g. Sub-Saharan Africa [34]), particularly where high HIV rates coalesce with high rates of methamphetamine use [35], and also in the context of endemic and increasing incidence of STIs (e.g., chlamydia, gonorrhea, syphilis) seen in specific population groups [36-38]. In addition to having their own health consequences (e.g., cervical cancer, infertility [39]), STIs elevate the risk of HIV transmission [40] through various biological mechanisms including ulceration [41].

STI and HIV prevention initiatives targeting heterosexual people who use methamphetamine are currently less well developed than those targeting MSM, and are likely to be challenged by lack of methamphetamine-specific treatment options [24] and the relatively low levels of contact that people who use methamphetamine have with health services [42]. Sexual health messages could be delivered to people who inject methamphetamine in tandem with blood-borne virus prevention efforts (e.g., needle and syringe programs). However, engaging with people who smoke the drug is likely to prove more challenging. The integration of strategies to target sexual health and methamphetamine-related sexual behaviour into mainstream treatment, as has been done for MSM [43], is a further consideration. Although not related to current levels of methamphetamine use, a minority of this heterosexual sample were engaged in condomless anal sex, which conveys a much greater risk of HIV transmission than vaginal sex [44, 45].

Limitations and considerations

The key strength of our findings is that we were able to establish the risk of specific sexual behaviours during periods of methamphetamine use relative to periods when people were not using the drug. This discounts many of the potentially confounding factors in understanding

the relationship between methamphetamine use and sexual behaviour, particularly premorbid personality characteristics that may lead to both potentially risky sexual behaviour and substance use. In addition, we adjusted for a range of time-varying factors that may have co-occurred with methamphetamine use and which might have influenced sexual behaviour (other substance use, relationship status, physical and mental health, living circumstances). However, there may have been other potential confounds that we did not measure, including whether or not people had STIs or were using prophylactics to reduce the risk of contracting HIV.

Unfortunately there were too few participants who did not identify as heterosexual, particularly MSM, to compare effects. However, it was evident that both sexual behaviour, and its relationship with methamphetamine use, differed from that seen amongst the heterosexual participants in our sample, and certainly, some of our findings differ from those arising from longitudinal studies on methamphetamine-using MSM [5]. Understanding the relative within-person risk in both communities would help quantify their relative contribution to overall HIV and STI transmission risk.

The major limitation of our approach is that it does not indicate the direction of the effect between methamphetamine and sexual behaviour. Methamphetamine use and sexual behaviour were both measured in an aggregate fashion across the past month, meaning that we are unable to determine whether sexual behaviour was contemporaneous with methamphetamine use. Although there is abundant evidence that stimulant intoxication increases libido [17, 22, 46], and this is a likely catalyst for potentially risky sexual behaviour, we cannot discount the possibility that methamphetamine use occurs as a consequence of

particular sexual behaviour (e.g., increased exposure to drug-using peers through sex networks), that individuals may undertake sexual favours to obtain the drug, or that individuals who wish to engage in potentially high risk sexual activity take methamphetamine to facilitate this behaviour.

Our data on drug use and sexual behaviour were based on self-report, assessed using a validated scale. Self-reported substance use is typically accurate when confidentiality was assured [47], as it was in our study, and confirmation of abstinence using toxicology (in 94% of cases [32]) supports the validity of the methamphetamine use data. The self-reported sexual behaviour was based on a scale with validity of between 0.88 and 1.00 against partner self-report [30].

The outcomes from this study apply to dependent methamphetamine users in a developed country. The findings should not be generalized to samples of recreational stimulant users, methamphetamine use in to the general population, or methamphetamine use in countries where safe-sex messages and access to condoms are more limited. Methamphetamine use in the context of recreational drug use may be associated with different patterns of sexual behaviour due to the more social nature of use (particularly crystal methamphetamine smoking, which has since become more prevalent in Australia [48]), the younger age of people who use recreationally, and differences in the context of use compared to our sample, who were mostly older adults who injected methamphetamine users and who were recruited largely from a treatment setting. Data also pre-date hepatitis C vaccination and HIV prophylaxis, which may alter on people's willingness to engage in potentially risky sexual behaviour.

Conclusion

Previous studies have not had the capacity to undertake detailed within-person analyses to explore more nuanced relationships between methamphetamine and sexual behaviour. In this cohort, we clearly documented that during periods when people were consuming methamphetamine, they were more likely to have multiple sexual partners, and that this was associated with an increase in condomless sex with casual sex partners. However, we failed to find a significant reduction in condom use. This stands in contrast to the view that methamphetamine intoxication reduces condom use. Targeted campaigns among people who use methamphetamine need to reinforce the need for safety during periods of riskier or more extensive sexual activity.

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REFERENCES

- 1 United Nations Office on Drugs and Crime. World Drug Report 2016. New York: United Nations; 2016.
- 2 Shoptaw S., Reback C. J. Methamphetamine use and infectious disease-related behaviors in men who have sex with men: implications for interventions. *Addiction* 2007; 102 Suppl 1: 130-135
- 3 Degenhardt L., Mathers B., Guarinieri M., Panda S., Phillips B., Strathdee S. A. *et al.* Meth/amphetamine use and associated HIV: Implications for global policy and public health. *Int J Drug Policy* 2010; 21: 347-358
- 4 Plankey M. W., Ostrow D. G., Stall R., Cox C., Li X., Peck J. A. *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
- 5 Halkitis P. N., Mukherjee P. P., Palamar J. J. Longitudinal modeling of methamphetamine use and sexual risk behaviors in gay and bisexual men. *Aids Behav* 2009; 13: 783-791
- 6 Menza T. W., Jameson D. R., Hughes J. P., Colfax G. N., Shoptaw S., Golden M. R. Contingency management to reduce methamphetamine use and sexual risk among men who have sex with men: A randomized controlled trial. *BMC Public Health* 2010; 10:
- 7 Reback C. J., Fletcher J. B., Shoptaw S., Grella C. E. Methamphetamine and other substance use trends among street-recruited men who have sex with men, from 2008 to 2011. *Drug Alcohol Depend* 2013; 133: 262-265
- 8 Reback C. J., Veniegas R., Shoptaw S. Getting Off: Development of a Model Program for Gay and Bisexual Male Methamphetamine Users. *J Homosexuality* 2014; 61: 540-553
- 9 Shoptaw S., Reback C. J., Larkins S., Wang P.-C., Rotheram-Fuller E., Dang J. *et al.* Outcomes using two tailored behavioral treatments for substance abuse in urban gay and bisexual men. *J Subst Abuse Treat* 2008; 35: 285-293
- 10 Frosch D., Shoptaw S., Huber A., Rawson R. A., Ling W. Sexual HIV risk among gay and bisexual male methamphetamine abusers. *J Subst Abuse Treat* 1996; 13: 483-486
- 11 Mansergh G., Purcell D. W., Stall R., McFarlane M., Semaan S., Valentine J. *et al.* CDC Consultation on Methamphetamine Use and Sexual Risk Behavior for HIV/STD Infection: Summary and Suggestions. *Public Health Rep* 2006; 121: 127-132
- 12 Hittner J. B. Meta-analysis of the association between methamphetamine use and high-risk sexual behavior among heterosexuals. *Psych Addict Beh* 2016; 30: 147-157
- 13 Boily M.-C., Baggaley R. F., Wang L., Masse B., White R. G., Hayes R. J. *et al.* Heterosexual risk of HIV-1 infection per sexual act: systematic review and meta-analysis of observational studies. *Lancet Infect Dis*; 9: 118-129
- 14 Simbayi L. C., Kalichman S. C., Cain D., Cherry C., Henda N., Cloete A. Methamphetamine use and sexual risks for HIV infection in Cape Town, South Africa. *J Subst Use* 2006; 11: 291-300
- 15 Plüddemann A., Flisher A. J., McKetin R., Parry C. D., Lombard C. J. Methamphetamine Use and Sexual Risk Behavior among High School Students in Cape Town, South Africa. *J Child Adolesc Subst Abuse* 2012; 21: 181-191

- 16 Parry C. D., Pluddemann A., Myers B., Wechsberg W. M., Flisher A. J.
Methamphetamine use and sexual risk behaviour in Cape Town, South Africa: a
review of data from 8 studies conducted between 2004 and 2007. *Afr J Psychiatry*
2011; 14: 372-376
- 17 Rawson R. A., Washton A., Domier C. P., Reiber C. Drugs and sexual effects: role of
drug type and gender. *J Subst Abuse Treat* 2002; 22: 103-108
- 18 Cheng W. S., Garfein R. S., Semple S. J., Strathdee S. A., Zians J. K., Patterson T. L.
Differences in Sexual Risk Behaviors among Male and Female HIV-Seronegative
Heterosexual Methamphetamine Users. *Am J Drug Alcohol Abuse* 2009; 35: 295-300
- 19 Lorvick J., Bourgois P., Wenger L. D., Arreola S. G., Lutnick A., Wechsberg W. M.
et al. Sexual Pleasure and Sexual Risk among Women who Use Methamphetamine:
A Mixed Methods Study. *Int J Drug Policy* 2012; 23: 385-392
- 20 Zapata L. B., Hillis S. D., Marchbanks P. A., Curtis K. M., Lowry R.
Methamphetamine use is independently associated with recent risky sexual behaviors
and adolescent pregnancy. *J Sch Health* 2008; 78: 641-648
- 21 Zule W. A., Costenbader E. C., Meyer W. J., Jr., Wechsberg W. M.
Methamphetamine use and risky sexual behaviors during heterosexual encounters.
Sex Transm Dis 2007; 34: 689-694
- 22 Molitor F., Ruiz J. D., Flynn N., Mikanda J. N., Sun R. K., Anderson R.
Methamphetamine use and sexual and injection risk behaviors among out-of-
treatment injection drug users. *Am J Drug Alcohol Abuse* 1999; 25: 475-493
- 23 Wechsberg W. M., Jones H. E., Zule W. A., Myers B. J., Browne F. A., Kaufman M.
R. *et al.* Methamphetamine ("tik") use and its association with condom use among
out-of-school females in Cape Town, South Africa. *Am J Drug Alcohol Abuse* 2010;
36: 208-213
- 24 Colfax G., Santos G.-M., Chu P., Vittinghoff E., Pluddemann A., Kumar S. *et al.*
Amphetamine-group substances and HIV. *Lancet* 2010; 376: 458-474
- 25 Greene W. Econometric analysis (6th ed.). Upper Saddle River, NJ: Prentice Hall;
2008
- 26 Livingston M. A longitudinal analysis of alcohol outlet density and domestic
violence. *Addiction* 2011; 106: 919-925
- 27 Fergusson D. M., Swain-Campbell N. R., Horwood L. J. Deviant peer affiliations,
crime and substance use: a fixed effects regression analysis. *J Abnorm Child Psychol*
2002; 30: 419-430
- 28 McKetin R., Lubman D. I., Najman J. M., Dawe S., Butterworth P., Baker A. L. Does
methamphetamine use increase violent behaviour? Evidence from a prospective
longitudinal study. *Addiction* 2014; 109: 798-806
- 29 McKetin R., Lubman D. I., Baker A. L., Dawe S., Ali R. L. Dose-related psychotic
symptoms in chronic methamphetamine users: Evidence from a prospective
longitudinal study. *JAMA Psychiatry* 2013; 70: 319-324
- 30 Darke S., Hall W., Wodak A., Heather N., Ward J. Development and validation of a
multi-dimensional instrument for assessing outcome of treatment among opiate users:
the Opiate Treatment Index. *Br J Addict* 1992; 87: 733-742
- 31 Darke S., Ward J., Hall W., Heather N., Wodak A. The Opiate Treatment Index (OTI)
Manual. Sydney, Australia.: National Drug and Alcohol Research Centre 1991.
- 32 McKetin R., Najman J., Baker A., Lubman D., Dawe S., Ali R. *et al.* Evaluating the
impact of community-based treatment options on methamphetamine use: findings

- from the Methamphetamine Treatment Evaluation Study (MATES). *Addiction* 2012; 107: 1998-2008
- 33 Ware J. E., Kosinski M., Keller S. D. How to score the SF-12 Physical and Mental Health Summary Scales (2nd Edition). Boston, MA: The Health Institute, New England Medical Centre; 1995.
- 34 Fetting J., Swaminathan M., Murrill C. S., Kaplan J. E. Global Epidemiology of HIV. *Infectious disease clinics of North America* 2014; 28: 323-337
- 35 Wechsberg W. M., Luseno W. K., Karg R. S., Young S., Rodman N., Myers B. *et al.* Alcohol, cannabis, and methamphetamine use and other risk behaviours among Black and Coloured South African women: a small randomized trial in the Western Cape. *Int J Drug Policy* 2008; 19: 130-139
- 36 Ward J. S., Guy R. J., Akre S. P., Middleton M. G., Giele C. M., Su J. Y. *et al.* Epidemiology of syphilis in Australia: moving toward elimination of infectious syphilis from remote Aboriginal and Torres Strait Islander communities? *Med J Aust* 2011; 194: 525-529
- 37 Martí-Pastor M., García de Olalla P., Barberá M.-J., Manzardo C., Ocaña I., Knobel H. *et al.* Epidemiology of infections by HIV, Syphilis, Gonorrhea and Lymphogranuloma Venereum in Barcelona City: a population-based incidence study. *BMC Public Health* 2015; 15: 1015
- 38 Aral S. O., Fenton K. A., Holmes K. K. Sexually transmitted diseases in the USA: temporal trends. *Sex Trans Inf* 2007; 83: 257-266
- 39 Institute of Medicine Committee on Prevention, Control of Sexually Transmitted Diseases. In: Eng TR, Butler WT, editors. The Hidden Epidemic: Confronting Sexually Transmitted Diseases: Summary. Washington (DC): National Academies Press, 1997.
- 40 Chesson H. W., Pinkerton S. D. Sexually transmitted diseases and the increased risk for HIV transmission: implications for cost-effectiveness analyses of sexually transmitted disease prevention interventions. *J Acquir Immune Defic Syndr* 2000; 24: 48-56
- 41 Fleming D. T., Wasserheit J. N. From epidemiological synergy to public health policy and practice: the contribution of other sexually transmitted diseases to sexual transmission of HIV infection. *Sexually transmitted infections* 1999; 75: 3-17
- 42 Quinn B., Stoové M., Dietze P. Factors associated with professional support access among a prospective cohort of methamphetamine users. *J Subst Abuse Treat*; 45: 235-241
- 43 Reback C. J., Shoptaw S. Development of an evidence-based, gay-specific cognitive behavioral therapy intervention for methamphetamine-abusing gay and bisexual men. *Addict Behav* 2014; 39: 1286-1291
- 44 Baggaley R. F., White R. G., Boily M. C. HIV transmission risk through anal intercourse: systematic review, meta-analysis and implications for HIV prevention. *Int J Epidemiology* 2010; 39: 1048-1063
- 45 Boily M. C., Baggaley R. F., Wang L., Masse B., White R. G., Hayes R. J. *et al.* Heterosexual risk of HIV-1 infection per sexual act: systematic review and meta-analysis of observational studies. *Lancet Infect Dis* 2009; 9: 118-129
- 46 Volkow N. D., Wang G.-J., Fowler J. S., Telang F., Jayne M., Wong C. Stimulant-induced enhanced sexual desire as a potential contributing factor in HIV transmission. *Am J Psychiatry* 2007; 164: 157-160

- 47 Darke S. Self-report among injecting drug users: a review. *Drug Alc Dependence*
1998; 51: 253-263.
- 48 Degenhardt L., Sara G., McKetin R., Roxburgh A., Dobbins T., Farrell M. *et al.*
Crystalline methamphetamine use and methamphetamine-related harms in Australia.
Drug Alcohol Rev 2017; 36: 160-170

Table 1. Characteristics of the participants at baseline (N = 319)

	Total sample (N = 319)
Past month drug use	
Methamphetamine use, median days (IQR)	16 (8-21)
Cannabis use, n (%)	
No use	66 (21)
1-15 days	96 (30)
16+ days	157 (49)
Alcohol use, n (%)	
No use (ref)	88 (28)
1-15 days	160 (50)
16+ days	71 (22)
Heroin, n (%)	74 (23)
Cocaine, n (%)	86 (27)
Ecstasy, n (%)	83 (26)
Hallucinogens, n (%)	17 (5)
Inhalants, n (%)	21 (7)
Demographics	
Age, mean (SD)	31.4 (7.9)
Male, n (%)	237 (74)
Incomplete schooling, n (%)	99 (31)
Unemployed, n (%)	256 (80)
Tertiary education, n (%)	
None	163 (51)
Trade/technical	37 (43)
University/college	19 (6)
Income (past fortnight), n (%)	
< \$400	79 (25)
\$400-499	93 (29)
\$500-799	79 (25)
800+	68 (21)
Living with partner, n (%)	68 (21)
Accommodation, n (%)	
Private housing	133 (42)
Public housing	44 (14)
Parent's house	68 (21)
Unstable housing	72 (23)
Residential rehabilitation	0 (0)
Health, n (%)	
Poor physical health	80 (25)
Poor mental health	265 (83)

Notes: Data were for the month prior to treatment for participants recruited on entry to treatment. Although no participants were in residential rehabilitation in the month prior to their baseline interview, 8% of follow-up interviews involved participants who were living in residential rehabilitation.

Table 2. The within-person relationship between past month methamphetamine use and past month sexual behaviour (n = 1,179 months)

	Number (%) of months	Methamphetamine use (No. (%) of months)		Unadjusted univariate effects		Model 1 ^a		Model 2 ^b	
		No	Yes	OR/IRR (95% CI)	P value	OR/IRR (95% CI)	P value	OR/IRR (95% CI)	P value
Sexually active	732 (62)	286 (55)	446 (68)	2.3 (1.6-3.3)	< .001	2.5 (1.6-3.8)	< .001	1.8 (1.1-2.9)	.013
> 1 sex partner	201 (17)	51 (10)	150 (23)	4.3 (2.6-7.0)	< .001	4.0 (2.3-7.0)	< .001	3.1 (1.7-5.7)	< .001
Casual sex partner	263 (22)	69 (13)	194 (30)	5.2 (3.3-8.1)	< .001	4.8 (2.9– 8.0)	< .001	3.5 (2.0 – 6.1)	< .001
Condomless sex with a casual sex partner	159 (13)	40 (8)	119 (18)	5.0 (2.9-8.5)	< .001	3.8 (2.1 – 6.9)	< .001	2.9 (1.5 – 5.4)	.001
Anal sex	88 (8)	27 (5)	61 (9)	1.4 (0.8-2.4)	.256	1.3 (0.7-2.4)	.369	1.3 (0.7-2.4)	.481
Condomless anal sex	68 (6)	20 (4)	48 (7)	1.4 (0.7-2.6)	.329	1.3 (0.6-2.5)	.496	1.2 (0.6-2.6)	.558
During months of sexual activity (n = 732 months)									
> 1 sex partner	201 (27)	51 (18)	150 (34)	4.1 (2.3 – 7.4)	< 0.001	3.7 (2.0- 7.0)	< .001	3.3 (1.7 – 6.4)	.001
Casual sex partner	263 (36)	69 (24)	194 (44)	6.4 (3.5-11.4)	< 0.001	4.9 (2.6-9.3)	< .001	3.9 (2.0-7.6)	< .001
Condomless sex with a casual sex partner	159 (22)	40 (14)	119 (27)	5.1 (2.7-9.6)	< 0.001	3.3 (1.6-6.5)	.001	2.6 (1.2-5.4)	.012
Anal sex	88 (8)	27 (5)	61 (9)	1.1 (0.6-1.9)	.706	1.1 (0.6-1.9)	.854	1.1 (0.6-2.0)	.868
Condomless anal sex	68 (6)	20 (4)	48 (7)	1.1 (0.6 -2.1)	.750	1.1 (0.5-2.1)	.896	1.1 (0.5-2.3)	.838
Condomless casual sex during months with a casual partner (n = 263 months)	159 (60)	40 (58)	119 (61)	0.9 (0.3-2.9)	.873	0.4 (0.1-2.2)	.319	0.4 (0.1-2.2)	.289

Note. Incident Rate Ratios (IRRs) are presented for anal sex and Odds Ratios (ORs) are presented for all other outcomes. Between subject effects can be found in Table S1. Other significant correlates of sexual behaviour (from Model 2) are reported in Table 2.

^a Adjusted for demographic variables at baseline (age, gender, schooling, qualifications, recruitment from treatment) and time-varying demographics (unemployment, income, living with a partner, accommodation) and time-varying health (mental health disability, physical health disability).

^b Adjusted for demographic variables, health (as per Model 1) and time-varying use of other substances (alcohol use, cannabis use, number of other drug classes used)

Table 3. Adjusted odds ratios (AOR) for methamphetamine and other variables included in Model 2 (Table 2) for selected sexual behaviours

	Sexually active	During months of sexual activity	
		> 1 partner	Casual sex partner
	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Methamphetamine use			
Within-person	1.8 (1.1 – 2.9)*	3.3 (1.7 – 6.4)**	3.9 (2.0 – 7.6)***
Between-person	2.6 (1.0 – 6.7)*	2.2 (0.8 – 6.4)	1.3 (0.5 – 3.4)
Cannabis use			
No use (ref)			
1-15 days	0.9 (0.5 – 1.4)	1.1 (0.6 – 2.0)	1.1 (0.6 – 2.0)
16+ days	1.1 (0.7 – 1.9)	0.7 (0.3 – 1.3)	1.0 (0.5 – 1.8)
Past month alcohol use			
No use (ref)			
1-15 days	1.4 (0.9 – 2.2)	1.6 (0.9 – 2.9)	1.9 (1.1 – 3.3)*
16+ days	2.1 (1.1 – 3.9)*	1.6 (0.7 – 3.4)	2.2 (1.1 – 4.6)*
No. other drugs used	1.4 (1.1 – 1.6)**	1.2 (0.9 – 1.5)	1.2 (0.9 – 1.5)
Age	1.0 (0.9 – 1.0)	0.9 (0.9 – 1.0)**	1.0 (0.9 – 1.0)
Male	0.6 (0.3 – 1.0)	1.9 (1.0 – 3.8)	2.2 (1.2 – 4.3)*
Incomplete schooling	1.4 (0.8 – 2.3)	1.1 (0.6 – 2.1)	1.2 (0.7 – 2.1)
Unemployed	1.2 (0.8 – 2.0)	0.6 (0.3 – 1.1)	0.6 (0.3 – 1.2)
Tertiary education			
None (ref)			
Trade/technical	1.2 (0.7 – 1.9)	0.9 (0.5 – 1.6)	0.8 (0.4 – 1.4)
University/college	1.2 (0.4 – 3.6)	2.4 (0.7 – 8.7)	1.3 (0.4 – 4.3)
Income (past fortnight)			
< \$400 (ref)			
\$400-499	0.9 (0.5 – 1.5)	1.0 (0.5 – 2.0)	0.9 (0.5 – 1.8)
\$500-799	0.9 (0.5 – 1.6)	1.1 (0.5 – 2.4)	1.0 (0.5 – 2.1)
800+	1.0 (0.5 – 1.9)	0.7 (0.3 – 1.6)	0.9 (0.4 – 2.0)
Living with partner	11.0 (5.9 – 20.5)***	0.1 (0.1 – 0.3) ***	0.1 (0.0 – 0.1) ***
Accommodation			
Private housing (ref)			
Public housing	0.9 (0.5 – 1.6)	1.1 (0.5 – 2.3)	0.6 (0.3 – 1.4)
Parent's house	1.0 (0.6 – 1.8)	1.1 (0.6 – 2.1)	0.9 (0.5 – 1.6)
Unstable housing	0.6 (0.4 – 1.0)	1.3 (0.6 – 2.5)	1.7 (0.8 – 3.2)
Residential rehabilitation	0.4 (0.2 – 0.8)*	0.6 (0.2 – 2.1)	0.8 (0.3 – 2.7)
Poor mental health	0.6 (0.4 – 0.9)*	1.0 (0.6 – 1.6)	1.1 (0.7 – 1.9)
Poor physical health	1.2 (0.8 – 1.9)	1.5 (0.8 – 2.8)	1.6 (0.9 – 2.9)
Recruited from treatment	1.7 (1.1 – 2.9)*	1.2 (0.1-2.8)	1.6 (0.7-3.8)

Note. Drug use measures are for the past month. Reference category (ref); adjusted odds ratio (AOR); confidence interval (CI). Odds ratios adjusted for demographic variables at baseline (age, gender, schooling, qualifications, recruitment from a treatment setting), time-varying demographics (unemployment, income, living with a partner, accommodation), time-varying health (mental health disability, physical health disability), and time-varying use of other substances (alcohol use, cannabis use, number of other drug classes used).

Figure 1. Predicted probability of sexual behaviour in the past month by past month methamphetamine use.

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