Methamphetamine ("tik") use, sexual risk, aggression and mental health among school going adolescents in Cape Town

By

Andreas Plüddemann

Thesis presented for the degree of

Doctor of Philosophy

in the Department of Psychiatry and Mental Health

University of Cape Town

November 2010

This thesis is dedicated to the late Professor Alan J. Flisher, truly a man for all seasons and a great tree that fell all too soon.

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Supervisors: Prof. Alan J. Flisher, Prof. Charles DH Parry, Dr Rebecca McKetin & A/Prof. Crick Lund

This thesis is presented in fulfilment of the requirements for the degree of Doctor of Philosophy (PhD) in the Department of Psychiatry and Mental Health, Faculty of Health Sciences, University of Cape Town. The work on which the thesis is based is original research and has not, in whole or in part, been submitted for another degree at this or any other university. The contents of the thesis are entirely the work of the candidate, and in the case of multi-authored published papers, constitutes work for which the candidate was the lead author. The contribution of the candidate to included multi-authored papers is further outlined in the preface to the thesis and in the introduction to each included paper where appropriate.

Andreas Plüddemann November 2010

ABSTRACT

Methamphetamine use has become a growing problem in many regions of the world. Cape Town has shown a particularly sharp increase in use over the past six years. The aim of this thesis is to establish the extent of methamphetamine use among adolescents in Cape Town, and to investigate mental health problems and sexual risk behaviour related to methamphetamine use among adolescents. In addition the study aimed to establish whether methamphetamine use is associated with not continuing to attend high school. The results of the thesis are presented through five journal articles, which address the above aims. The articles are based on two quantitative high school surveys and an ongoing surveillance of substance abuse counselling and rehabilitation centres in Cape Town.

Findings in the first paper in Chapter 3 indicate that the proportion of individuals seeking substance abuse treatment for methamphetamine related problems increased steadily from 2004 to 2006 and that in 2006 73% of adolescents in treatment for substance abuse reported methamphetamine as their primary or secondary drug. Findings of the high school surveys in Chapters 4-7 indicated that between 9% and 12% of high school students (mean age = 15) reported life-time use of methamphetamine. The second and fourth papers in Chapters 4 and 6 indicated associations between methamphetamine use and sexual risk behaviour, particularly for students who reported recent use of methamphetamine. The third paper in Chapter 5 indicated associations between methamphetamine use in the past year and mental health problems among adolescents, including aggressive behaviour, depression and higher scores on a composite measure of

mental health. The fifth paper in Chapter 7 showed that life-time methamphetamine use in addition to other substances was significantly associated with high school non-attendance when other non-substance use factors (repeating a year at school and being older than the norm for current grade) were taken into account.

This thesis clearly demonstrates that methamphetamine use is a significant problem in Cape Town, and that developing strategies to curb and address this problem should be given priority. The thesis presents among the first and most comprehensive studies on adolescent methamphetamine use and associated problems internationally, and to our knowledge the first publications on this problem among adolescents in Africa. For South Africa, and Cape Town in particular, the greatest concern remains the associations between methamphetamine use and sexual risk behaviour, leading to an increased exposure to HIV. Further prevention efforts targeting both methamphetamine use and sexual risk behaviour should be a high priority for government and community based prevention efforts.

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- My supervisors: (1) The late Alan Flisher who travelled this long journey with me, until his tragic passing in April 2010, and was always supportive, available, pragmatic and encouraging – a truly remarkable man who will be sadly missed. (2) Charles Parry who started this journey into the field of substance abuse with me, walking many a road together, and who always had ideas, ready for new challenges. My gratitude also for his support and taking over Alan's responsibilities. (3) Rebecca McKetin who was such a great source of encouragement and practical support throughout this thesis, even from the distance of Sydney, Australia. Without you this journey would have been so much harder! Also Prof. Crick Lund for taking over Alan's duties at the University of Cape Town.
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PREFACE

This thesis includes published papers, as per general provision 6.7 in the General Rules for the Degree of Doctor of Philosophy (PhD) of the University of Cape Town, and with the approval of the University Doctoral Degrees Board. The following five papers are formally included as part of the thesis:

1. Plüddemann, A., Myers, B.J., & Parry, C.D. (2008). Surge in treatment admissions related to methamphetamine use in Cape Town, South Africa: implications for public health. *Drug & Alcohol Review,* 27(2), 185-189.

2. Plüddemann, A., Flisher, A.J., Mathews, C., Carney, T., & Lombard, C. (2008). Adolescent methamphetamine use and sexual risk behaviour in secondary school students in Cape Town, South Africa. *Drug & Alcohol Review*, 27(6), 687-692.

3. Plüddemann, A., Flisher, A.J., McKetin, R., Parry, C., & Lombard, C. (2010). Methamphetamine use, aggressive behavior and other mental health issues among high-school students in Cape Town, South Africa. *Drug & Alcohol Dependence*, 109(1-3), 14-19.

4. Plüddemann, A., Flisher, A.J., McKetin, R., Parry, C., & Lombard, C. (in press). Methamphetamine use and sexual risk behavior among high school students in Cape Town, South Africa. *Journal of Child & Adolescent Substance Abuse.*

5. Plüddemann, A., Flisher, A.J., McKetin, R., Parry, C., & Lombard, C. (2010). A prospective study of methamphetamine use as a predictor of high school non-attendance in Cape Town, South Africa. *Substance Abuse Treatment, Prevention & Policy*, 5(1), 25.

The contribution of the candidate is presented before each of the papers (Chapters 3-7). In summary, the candidate is the lead and corresponding author for all the included papers. All first-authored papers were drafted and revised by the candidate. All co-authors critically reviewed and approved the submitted manuscripts and any comments were assessed by and where appropriate integrated by the candidate.

References are provided at the end of each Chapter or paper. For the papers, the referencing systems required by the respective journals are used, while the remaining Chapters use the APA style of referencing. Tables and figures are numbered per Chapter (or article) and not continuously.

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.1 What is methamphetamine?

Methamphetamine is a powerful psychoactive stimulant which provides users with a sense of euphoria and energy through facilitating the release of large amounts of the neurotransmitters dopamine, norephinephrine and ephenephrine from the nucleus accumbens (McCann & Ricaurte, 2004). It is derived mostly from ephedrine and pseudoephedrine. As these chemicals are used in the manufacture of other licit substances, they are readily available for illicit manufacture. In South Africa the drug is mostly smoked in crystalline form, hence its street name "ice" or "crystal" in the US. In South Africa it has become known as "tik" on the street. The name is thought to have evolved from the sound the drug makes when heated (i.e. a ticking or clicking/crackling sound). In other countries the drug is often injected.

1.2. The history of methamphetamine

Methamphetamine was discovered in Japan in 1919. Methamphetamine was widely prescribed in the 1950s and 1960s as a medication for depression and obesity, reaching a peak of 31 million prescriptions in the United States in 1967. The drug was reputed to

have been used non-medically by students, truck drivers and athletes during this decade. In 1970 the US Controlled Substances Act severely restricted its use. It is however still legally produced in the US under the name Desoxyn (Anglin, Burke, Perrochet, Stamper, & Dawud-Noursi, 2000). In South Africa the first methamphetamine manufacturing laboratory was discovered by police in 1998, however very few seizures of the drug transpired until 2001. First reports of use of methamphetamine under the name of "tik" were documented with qualitative research in 2003 (Leggett, 2003).

1.3 Effects and consequences of methamphetamine use

1.3.1 Short-term effects/consequences

Methamphetamine triggers release of epinephrine, norepinephrine and dopamine in the sympathetic nervous system. Common effects of intoxication are euphoria, increased energy and self-confidence, insomnia, restlessness, irritability, heightened sense of sexuality, and tremors. Respiratory effects include increased respirations, pulmonary edema, pulmonary hypertension and decreased lung capacity. Cardiovascular effects include increased heart rate and blood pressure, tachycardia (abnormally rapid heart beat) and/or arrhythmias. Users run the risk of overdose characterised by dehydration, hyperthermia, convulsions, renal failure, stroke and myocardial infarction (Anglin et al., 2000). For most users the effects of methamphetamine last 2-4 hours, commencing immediately after ingestion (by smoking). The elimination half-life is approximately 10-12 hours although some users experience effects (e.g. insomnia) for days after a single

dose. As the mood enhancing effects of methamphetamine wear off, users begin "tweaking", a term describing a dangerous combination of restless anxiety, irritability, fatigue, and dysphoria (Lineberry & Bostwick, 2006). Further use of methamphetamine temporarily improves the symptoms and further reinforces the addiction. Eventually, after days of sleeplessness, users "crash" into a non-restful sleep.

1.3.2 Long-term effects

1.3.2.1 Summary

Despite the short-term perceived positive effects, in the long-term methamphetamine acts as a neurotoxin, with regular users showing a loss of dopamine nerve terminals in the caudate and putamen, an early reduction in the density of cortical white matter, reduced glucose metabolism in the thalamus, caudate and putamen, and increased glucose metabolism in the parietal cortex (McCann & Ricaurte, 2004). These structural brain changes are associated with acute and chronic cognitive impairments (specifically recall and recognition) and emotional deficits (such as lasting depression, negative symptoms of psychosis, anxiety and uncontrollable anger) which only partially improve with abstinence (Brecht, O'Brien, von Mayrhauser, & Anglin, 2004; Cretzmeyer, Sarrazin, Huber, Block, & Hall., 2003). Other long term side effects include severe dermatological and dental problems, malnutrition and weight loss, and the risk of overdose and death (Brecht et al., 2004). Researchers in Australia have noted that the crystalline form of methamphetamine (most commonly used in South Africa) is an especially potent form of

methamphetamine, associated with harms in a number of domains (Topp, Degenhardt, Kaye, & Darke, 2002). This form of methamphetamine use was also found to be more likely to result in dependence than other forms of methamphetamine use

Research also indicates that the use of methamphetamine by pregnant women can cause growth retardation, premature birth, and developmental disorders in neonates and enduring cognitive deficits in children (Anglin et al., 2000; Eriksson & Zetterstrom, 1994).

1.3.2.2 Physiological effects and consequences

Methamphetamine has a number of physiological effects and consequences. These will be briefly summarised below.

(1) Cardiovascular effects

A number of studies have indicated cardiovascular effects from smoking methamphetamine including unstable angina, chest pain, tachycardia, hypertension and mycocardial infarction. Although not as common as cocaine related heart attacks, and in some of the cases reviewed underlying coronary artery was present, this is nevertheless a potential (and possibly life-threatening) consequence. In addition, coronary artery disease, myocardial ischemia, acute pulmonary edema, endocarditis, acute aortic dissection and ischemic stroke have also been linked to amphetamine-type stimulants.

Cardiomyopathy has also been linked to methamphetamine use (Swalwell & Davis, 1999; Wijetunga, Bhan, Lindsay, & Karch, 2004; Wijetunga, Seto, Lindsay, & Schatz, 2003). There is also an indication that concurrent methamphetamine and alcohol use leads to increased cardiac work, which could produce more adverse cardiovascular effects than either drug taken alone (Mendelson, Jones, Upton, & Jacob, 1995).

(2) Other effects

One study indicated a predictive association between methamphetamine and/or cocaine use and giant gastric ulcer formation from a sample of 220 patients (Pecha et al., 1996). Stroke has also been associated with the use of methamphetamine (Yen et al., 1994). A number of studies have indicated dental health deterioration linked to the use of methamphetamine (Assael, 2005; Klasser & Epstein, 2005; McGrath & Chan, 2005). This is primarily induced by a reduction in saliva production, fostering rapid cariogenic bacterial growth and due to users often consuming large of amounts of carbonated drinks because of a constantly dry mouth (Shaner, Kimmes, Saini, & Edwards, 2006).

(3) Overdose

Although fatal overdose due to methamphetamine ingestion is uncommon, it is a possibility. Fatal overdose usually occurs as a result of multiple organ failure, heart attack or stroke (Karch, Stephens, & Ho, 1999; Lan, Lin, Yu, Lin, & Chu, 1998). A study in Australia showed that over a 5-year period, 371 deaths were related to methamphetamine use, with 68% found to be related to methamphetamine toxicity (Kaye, Darke, Duflou & McKetin, 2008).

(4) Methamphetamine withdrawal

While methamphetamine does not result in withdrawal symptoms as experienced during alcohol or heroin withdrawal (physical dependence symptoms such as joint and muscle pain, nausea, or even the risk of death in the case of alcohol), a withdrawal syndrome has been identified. This is characterised by increased sleeping and eating, a cluster of depression-related symptoms, and anxiety and craving-related symptoms. Acute withdrawal lasts about 7-10 days, with a sub-acute phase lasting at least a further two weeks (McGregor et al., 2005).

1.3.2.3 Neurological/cognitive consequences

Methamphetamine use also has a number of effects on the brain and brain functioning, which are collectively described as neurological or cognitive consequences.

(1) Cognitive deficits

A number of studies have found impairment in cognitive performance or functioning associated with methamphetamine use. Memory and concentration seem to be most affected. The studies examined cognitive performance in either currently using or recently abstinent methamphetamine or amphetamine users. One study showed that the severity of dependence was associated with poorer performance on both memory and attention/concentration indices of the Wechsler Memory Scale-Revised (McKetin &

Mattick, 1997). Another study comparing current methamphetamine users with non-users on a battery of cognitive tests found that methamphetamine users were significantly more impaired on recall tasks, digit symbol tasks (a measure of psychomotor speed and manipulation of information), a Trail Making test (which taps attention, sequencing, psychomotor speed and mental flexibility), and the Stroop Colour Word Interference Test. This test measures selective attention and the ability to ignore irrelevant information by measuring the ease with which a person can conform to changing demands by suppressing a habitual response in favour of an unusual one (Simon et al., 2000). Another study confirmed the reduced cognitive inhibition or attention difficulties, comparing methamphetamine users with non-users (Salo et al., 2002). A recent literature review on cognitive effects of methamphetamine use confirmed that memory impairment, attention deficits or distractibility, as well as impairment in abstract reasoning, planning and behavioural flexibility were some of the most common problems users experienced (Barr et al., 2006).

1.3.2.4 Mental health and behavioural consequences

Methamphetamine use has also been associated with a number of detrimental effects on mental health, briefly described below.

(1) Psychosis

One of the most prominent effects of methamphetamine abuse is drug-related psychosis. This manifests mostly in the form of auditory and visual hallucinations, persecutory

delusions, delusions of reference, thought reading, and strange or unusual beliefs (Chen et al., 2003; Srisurapanont et al., 2003). Aside from the sudden psychosis-inducing effects of high doses of methamphetamine, prior exposure to methamphetamine, following metabolism and excretion of the drug, can also lead to an enduring form of psychosis. Studies conducted in Japan report that between 36% and 64% of methamphetamine users who have experienced psychotic symptoms continue to present with these symptoms for more than 10 days after cessation of methamphetamine use, even though methamphetamine is eliminated from the blood stream in less than 5 days. Another study of a group of female methamphetamine users in Japan observed that 21% of those having experienced methamphetamine psychosis remained in a psychotic state for more than 6 months, whereas 49% returned to their pre-morbid state but experienced "flashbacks" (i.e., spontaneous recurrence of psychotic symptoms that would fit criteria for a paranoid-schizophrenia psychotic relapse). Japanese studies have also shown that methamphetamine users with methamphetamine psychosis are much more likely to experience psychotic symptoms again if they use methamphetamine and are also more likely to have a psychotic relapse when confronted with stressful situations, even years after cessation of methamphetamine use (Barr et al., 2006); (Sato, 1992). Another study showed that methamphetamine users who started using at a younger age and in larger doses were more likely to develop psychosis (Chen et al., 2003).

An Australian study investigating the prevalence of psychotic symptoms among methamphetamine users found that of 309 methamphetamine users 13% screened positive for psychosis, while 23% had experienced a clinically significant symptom of

suspiciousness, unusual thought content or hallucinations in the past year. Dependent methamphetamine users were three times more likely to have experienced psychotic symptoms than their non-dependent counterparts. The prevalence of psychosis in this sample was found to be 11 times higher than in the general population of Australia (McKetin, McLaren, Lubman, & Hides, 2006).

2) Depression

Symptoms of depression seem to be a common side effect of methamphetamine use and dependence. A study by Kalechstein et al. (2000) found that participants who screened positive for methamphetamine dependence were significantly more likely to have experienced depressive symptoms as well as suicidal ideation in the 12 months prior to the interview (Kalechstein et al., 2000). Another study of 182 adult methamphetamine users found a significant correlation between intensity of methamphetamine use and Beck Depression Inventory (BDI) scores. The study also showed that women compared with men, older participants compared with younger ones, and unmarried compared with married participants had higher levels of depressive symptoms. Overall 38% of the 182 participants met the BDI criteria for moderate to severe depression (Semple, Patterson, & Grant, 2005). A study of methamphetamine users who had recently been arrested confirmed this with methamphetamine users being significantly more likely than non-users to have depressive symptoms (identified by the BDI and the Brief Symptom Inventory). Again women scored significantly higher on the BDI than men. In addition methamphetamine users who reported injecting the drug had significantly higher BDI scores than non-injectors and they also reported significantly more suicide attempts and

suicidal thoughts in their lifetimes and during the past 30 days. Frequency of use (in the past 30 days) was also associated with higher BDI scores (Zweben et al., 2004). A study attempting to identify brain abnormalities in methamphetamine users found that methamphetamine users provided higher self-rating scores of depression and anxiety than control subjects. They also found that methamphetamine users had abnormalities in brain regions associated with mood disorders (London et al., 2004). A study following 500 methamphetamine users up 2-5 years post treatment found that depression was reported at similar rates at follow up as had been reported at treatment admission, suggesting that these symptoms may be permanent, even after abstinence or significantly reduced use of methamphetamine (Rawson et al., 2002).

3) Anxiety and paranoia

A third common side effect of methamphetamine use is anxiety and paranoia. An Australian study found that amphetamine users experienced more psychological symptoms subsequent to their initiation of amphetamines, with 76% reporting anxiety and 52% paranoia. Injectors were also more likely than non-injectors to experience paranoia (Hall, Hando, Darke, & Ross, 1996). The association between methamphetamine use and paranoia or anxiety was confirmed by London et al. (2001), Zweben et al. (2004), and Sommers, Baskin & Baskin-Sommers (2006). London et al. found that methamphetamine users self-reported higher levels of anxiety than control subjects and Zweben et al. found high levels of anxiety, paranoid ideation, and phobic anxiety among methamphetamine users. Frequency of use in the 30 days prior to the interview also correlated these symptoms. Sommers et al. (2006) found that the most

frequent form of paranoia was fear of others and feeling that people wished harm to or threatened the respondent.

4) Aggression and violence

The studies reported above (Hall et al., Zweben et al., and Sommers et al.) all found high levels of violent behaviour among methamphetamine users. Frequency and route of administration were again associated with increased reports of violent behaviour. Between 35% and 44% of the participants in these three studies reported problems with controlling violent behaviour. Zweben et al. (2004) also found a significant number of violence related criminal charges (assault and weapons charges) against methamphetamine users, with again a significantly higher number among those who injected. A relationship between violent behaviour and methamphetamine use was confirmed by a number of other studies (Brecht et al., 2004); (Cartier, Farabee, & Prendergast, 2006). It is hypothesised that the violent behaviour associated with methamphetamine use may partly stem from the paranoia induced by methamphetamine, particularly fear of harm from others. It has been found that where a person feels threatened by others, interpersonal violence becomes more likely (Sommers et al., 2005).

1.3.3 Sexual risk behaviour

The vast majority of studies investigating the link between sexual risk behaviour and methamphetamine use have been conducted amongst men who have sex with men. The next most commonly investigated sub-population are injecting drug users. Relatively few

studies have investigated the link between methamphetamine use and sexual risk behaviour/HIV infection in heterosexual populations. These studies will be reviewed systematically in Chapter 2.

Importantly, only one previous study has been conducted in a community sample in Cape Town, South Africa. The study examined methamphetamine use in relation to HIV risks in a racially mixed township. Street intercept recruitment was used and 441 men and 521 women were interviewed. Of the men 18% and of the women 12% had used methamphetamine in the preceding six months. Methamphetamine use was closely associated with other drug use. Methamphetamine use was associated with being male, engaging in unprotected sex, and having multiple sex partners in the preceding six months. Although methamphetamine users were more likely to use condoms than non-users, less than half of all their intercourse occasions were condom protected (Simbayi et al., 2006).

1.4 Aim and objectives of the present study

As illustrated above there are a number of health and mental health problems associated with methamphetamine use. However relatively few studies have investigated these problems in adolescent populations and only one previous study, relating to methamphetamine use and sexual risk behaviour, had been published in South Africa (Simbayi et al., 2006).

The cluster of effects and consequences of methamphetamine use are particularly relevant to adolescents, as they face other life-stage challenges including education, identity formation, and sexual experimentation. The various effects of methamphetamine use are potentially detrimental to adolescent development in all of these domains.

Thus the aim of the present study was to establish the extent of methamphetamine use among adolescents in Cape Town, and to investigate mental health problems and sexual risk behaviour related to methamphetamine use among adolescents. In addition the study aimed to establish whether methamphetamine use is associated with not continuing to attend high school.

The study had the following objectives:

1) To establish the proportion of alcohol and other drug treatment admissions related to methamphetamine and the proportion who were adolescents.
2) To assess the prevalence and nature of methamphetamine use among school-going adolescents in a defined geographical area in Cape Town.
3) To investigate the association between methamphetamine use and sexual risk behaviour among school-going adolescents.
4) To investigate the association between methamphetamine use and mental health problems (including aggression and depression) among school-going adolescents.
5) To investigate prospectively whether methamphetamine use predicts non-attendance at school after a 12 month period.

Thus this study aims to contribute to a still limited body of knowledge globally on adolescent methamphetamine use and key associated problems. It also represents one of the first investigations of methamphetamine use among adolescents in a developing country setting and the first investigation of methamphetamine use among adolescents in Africa that the author is aware of.

1.5 Outline of the thesis

The aim and objectives of this thesis are addressed through five articles following the literature review in Chapter 2. The first of these articles relates to objective 1, the second article relates to objectives 2 and 3, the third article relates to objectives 2 and 4, the fourth article relates to objective 3, and the fifth article relates to objective 5.

Articles 2 and 4 address similar issues, however, both articles have been included as they refer to different studies and samples and assessed sexual risk behaviour in different ways. While Article 2 assessed sexual risk behaviour through answers to individual questions, Article 4 assessed sexual risk behaviour by categorising students into 'levels of sexual risk' based on answers to a number of questions. Thus the findings of these two articles are complimentary in addressing objective 3. In a country with a high HIV prevalence, investigating factors which could contribute to the spread of the virus is also of particular importance.

The fifth article is followed by a conclusion chapter, synthesising the findings in the various articles and discussing recommendations for policy and future research.

References

Anglin, M.D., Burke, C., Perrochet, B., Stamper, E., & Dawud-Noursi, S. (2000). History of the methamphetamine problem. *Journal of Psychoactive Drugs*, 32(2), 137-141.

Assael, L.A. (2005). Methamphetamine: an epidemic of oral health neglect, loss of access to care, abuse, and violence. *Journal of Oral and Maxillofacial Surgery*, 63(9), 1253-1254.

Barr, A.M., Panenka, W.J., MacEwan, W., Thorton, A.E., Lang, D.J., Honer, W.G., & Lecomte, T. (2006). The need for speed: an update on methamphetamine addiction. *Journal of Psychiatry & Neuroscience*, 31(5), 301-313.

Brecht, M. L., O'Brien, A., von Mayrhauser, C., & Anglin, M.D. (2004). Methamphetamine use behaviors and gender differences. *Addictive Behaviors*, 29(1), 89-106.

Cartier, J., Farabee, D., & Prendergast, M.L. (2006). Methamphetamine use, self-reported violent crime, and recidivism among offenders in California who abuse substances . *Journal of Interpersonal Violence*, 21(4), 435-445.

Chen, C.K., Lin, S.K., Sham, P.C., Ball, D., Loh, E.W., Hsiao, C.C., Chiang, Y.L., Ree, S.C., Lee, C.H., & Murray, R.M. (2003). Pre-morbid characteristics and co-morbidity of methamphetamine users with and without psychosis. *Psychological Medicine*, 33(8), 1407-1414.

Cretzmeyer, M., Sarrazin, M.V., Huber, D.L., Block, R.I., & Hall, J.A. (2003). Treatment of methamphetamine abuse: research findings and clinical directions. *Journal of Substance Abuse Treatment*, 24(3), 267-277.

Eriksson, M., & Zetterstrom, R. (1994). Amphetamine addiction during pregnancy: 10-year follow-up. *Acta Paediatrica* Suppl, 404 , 27-31.

Hall, W., Hando, J., Darke, S., & Ross, J. (1996). Psychological morbidity and route of administration among amphetamine users in Sydney, Australia. *Addiction*, 91(1), 81-87.

Kalechstein, A.D., Newton, T.F., Longshore, D., Anglin, M.D., van Gorp, W.G., & Gawin, F.H. (2000). Psychiatric comorbidity of methamphetamine dependence in a forensic sample. *Journal of Neuropsychiatry & Clinical Neurosciences*, 12(4), 480-484.

Karch, S.B., Stephens, B.G., & Ho, C.H. (1999). Methamphetamine-related deaths in San Francisco: demographic, pathologic, and toxicologic profiles. *Journal of Forensic Science*, 44(2), 359-368.

Kaye, S., Darke, S., Duflou, J., & McKetin, R. (2008). Methamphetamine-related fatalities in Australia: demographics, circumstances, toxicology and major organ pathology. *Addiction*, 103(8), 1353-1360.

Klasser, G.D., & Epstein, J. (2005). Methamphetamine and its impact on dental care. *Journal of the Canadian Dental Association*, 71(10), 759-762.

Lan, K.C., Lin, Y.F., Yu, F.C., Lin, C.S., & Chu, P. (1998). Clinical manifestations and prognostic features of acute methamphetamine intoxication. *Journal of the Formosan Medical Association*, 97(8), 528-533.

Leggett, T. (2003). On the tuk-tuk express: Has methamphetamine hit the Cape Flats. *SA Crime Quarterly*, 6, 33-35

Lineberry, T.W., & Bostwick, J.M. (2006). Methamphetamine abuse: A perfect storm of complications. *Mayo Clinical Practice*, 81 (1), 77-84.

London, E.D., Simon, S.L., Berman, S.M., Mandelkern, M.A., Lichtman, A.M., Bramen, J., Shinn, A.K., Miotto, K., Learn, J., Dong, Y., Matochik, J.A., Kurina, V., Newton, T., Woods, R., Rawson, R., & Ling, W. (2004). Mood disturbances and regional cerebral metabolic abnormalities in recently abstinent methamphetamine abusers. *Archives of General Psychiatry*, 61(1), 73-84.

McCann, U.D. & Ricaurte, G.A. (2004). Amphetamine neurotoxicity: accomplishments and remaining challenges. *Neuroscience & Biobehavioral Reviews*, 27(8), 821-826.

McGrath, C. & Chan, B. (2005). Oral health sensations associated with illicit drug abuse. *British Dental Journal*, 198(3), 159-62

McGregor, C., Srisurapanont, M., Jittiwutikarn, J., Laobhripatr, S., Wongtan, T., & White, J. M. (2005). The nature, time course and severity of methamphetamine withdrawal. *Addiction*, 100(9), 1320-1329.

McKetin, R. &. Mattick, R.P. (1997). Attention and memory in illicit amphetamine users. *Drug & Alcohol Dependence*, 48(3), 235-242.

McKetin, R., McLaren, J., Lubman, D.I., & Hides, L. (2006). The prevalence of psychotic symptoms among methamphetamine users. *Addiction*, 101(10), 1473-1478.

Mendelson, J., Jones, R.T., Upton, R., & Jacob, P. (1995). Methamphetamine and ethanol interactions in humans. *Clinical Pharmacology & Therapeutics*, 57(5), 559-568.

Pecha, R.E., Prindiville, T., Pecha, B.S., Camp, R., Carroll, M., & Trudeau, W. (1996). Association of cocaine and methamphetamine use with giant gastroduodenal ulcers. The *American Journal of Gastroenterology*, 91(12), 2523-2527.

Rawson, R.A., Huber, A., Brethen, P., Obert, J., Gulati, V., Shoptaw, S., & Ling, W. (2002). Status of methamphetamine users 2-5 years after outpatient treatment. *Journal of Addictive Diseases*, 21(1), 107-119.

Salo, R., Nordahl, T.E., Possin, K., Leamon, M., Gibson, D.R., Galloway, G.P., Flynn, N.M., Henik, A., Pfefferbaum, A., & Sullivan, E.V. (2002). Preliminary evidence of reduced cognitive inhibition in methamphetamine-dependent individuals. *Psychiatry Research*, 111 (1), 65-74.

Sato, M. (1992). A lasting vulnerability to psychosis in patients with previous methamphetamine psychosis. *Annals of the New York Academy of Sciences*, 654, 160-170.

Semple, S.J., Patterson, T.L., & Grant, I. (2005). Methamphetamine use and depressive symptoms among heterosexual men and women. *Journal of Substance Use*, 10(1), 31-47.

Shaner, J.W., Kimmes, N., Saini, T., & Edwards, P. (2006). "Meth mouth": Rampant caries in methamphetamine abusers. *AIDS Patient Care and STDs*, 20(3), 146-150.

Simbayi, L.C., Kalichman, S., Cain, D., Cherry, C., Henda, N., & Cloete, A. (2006). Methamphetamine use and sexual risks for HIV infection in Cape Town, South Africa. *Journal of Substance Use*, 11(4), 291-300.

Simon, S.L., Domier, C., Carnell, J., Brethen, P., Rawson, R., & Ling, W. (2000). Cognitive impairment in individuals using methamphetamine. *American Journal on Addictions*, 9, 222-231.

Sommers, I., Baskin, D., & Baskin-Sommers, A. (2005). Methamphetamine use among young adults: Health and social consequences. *Addictive Behaviors*, 31(8), 1469-1476.

Srisurapanont, M., Ali, R., Marsden, J., Sunga, A., Wada, K., & Monteiro, M. (2003). Psychotic symptoms in methamphetamine psychotic in-patients. *International Journal of Neuropsychopharmacology*, 6(4), 347-352.

Swalwell, C.I., & Davis, G.G. (1999). Methamphetamine as a risk factor for acute aortic dissection. *Journal of Forensic Sciences*, 44(1), 23-26.

Topp, L., Degenhardt, L., Kaye, S., & Darke, S. (2002). The emergence of potent forms of methamphetamine in Sydney, Australia: a case study of the IDRS as a strategic early warning system. *Drug & Alcohol Review*, 21, 341-348.

Wijetunga, M., Bhan, R., Lindsay, J., & Karch, S. (2004). Acute coronary syndrome and crystal methamphetamine use: a case series. *Hawaii Medical Journal*, 63(1), 8-13.

Wijetunga, M., Seto, T., Lindsay, J., & Schatz, I. (2003). Crystal methamphetamine-associated cardiomyopathy: Tip of the iceberg. *Journal of Toxicology*, 41(7), 981-986.

Yen, D.J., Wang, S.J., Ju, T.H., Chen, C.C., Liao, K.K., Fuh, J.L., & Hu, H.H. (1994). Stroke associated with methamphetamine inhalation. *European Neurology,* 34(1), 16-22.

Zweben, J.E., Cohen, J.B., Christian, D., Galloway, G.P., Salinardi, M., Parent, D., & Iguchi, M. (2004). Psychiatric symptoms in methamphetamine users. *The American Journal on Addictions*, 13, 181-190.

CHAPTER 2

Systematic Literature Review

2.1 Introduction

This literature review focuses on the key themes investigated in this study (see Chapters 4-6), to establish the current state of evidence on the links between methamphetamine use and mental health problems and methamphetamine use and sexual risk behaviour. It is divided into four sub-topics, which were investigated empirically in the present study:

1) methamphetamine and aggression,
2) methamphetamine and mental health,
3) methamphetamine and depression, and
4) methamphetamine and sexual risk behaviour.

These four issues have emerged as the major consequences of methamphetamine use and have not together been the subject of a systematic review. It is likely that they also represent some of the key risk issues in terms of adolescent development and therefore deserve a particular focus for this population. Although depression and aggression could be considered to fall under the 'umbrella' of 'mental health', it was decided to divide the review in this way to identify articles which specifically focussed on aggression or violence and methamphetamine use, and depression and methamphetamine use. The primary reason for this was to align the literature review with the empirical measures

used in the study in the next chapter. These measures yielded indicators of 'mental health', a composite measure of a broad range of potential mental health problems, a measure focussing on aggressive behaviour, and a measure indicating symptoms of depression. Thus the aim was to identify studies that referred to mental health and methamphetamine use broadly, studies that specifically reported on aggression or violence and methamphetamine use, and studies reporting on depression and methamphetamine use. The fourth part of the review was focussed on identifying studies on methamphetamine use and sexual risk behaviour in primarily heterosexual populations.

Mental health problems affect a significant proportion of adolescents world wide. A national study in Germany found that 15% of children and adolescents aged 7-17 had some form of mental health problem (Ravens-Sieberer et al., 2008). A study in Brazil indicated a prevalence of mental health problems of 25% among children and adolescents (Paula, Duarte, & Bordin, 2007). In the Western Cape province in South Africa, researchers estimated the prevalence of mental disorders among children and adolescents to be 17%, with generalized anxiety disorder and major depressive disorder being among the most common disorders in this group (Kleintjies et al., 2006). Thus a review establishing methamphetamine's role in contributing to mental health problems was considered important for this population.

A systematic review on substance use and high-school dropout had also recently been conducted by Townsend et al. (2007). Methamphetamine was not specifically mentioned

in the studies reviewed and no subsequent literature on the topic of methamphetamine use and high-school dropout (or non-attendance) could be identified. Therefore this topic was not reviewed.

2.2 Review methodology

Articles published in English in peer reviewed academic journals were considered for inclusion. Abstracts published at any time in the last century and up to the end of May 2010 were considered for inclusion. A database search for relevant articles was conducted on three major databases in the medical and social sciences literature, namely PubMed, EBSCO's Academic Search Premier and PsychINFO. (During the course of the study the PsychINFO database was incorporated with EBSCO). Search terms were *methamphetamine and aggression, methamphetamine and violence, methamphetamine and mental health, methamphetamine and depression,* and *methamphetamine and sexual risk.* Studies on animals were excluded. For *methamphetamine and mental health* studies focusing on more specific neurological or psychiatric disorders (e.g. psychosis or schizophrenia) were excluded, as the aim of the review was to identify literature on the issues investigated empirically in Chapter 5 of this thesis. For *methamphetamine and sexual risk* studies among men who have sex with men populations (MSM) were excluded, as the population in the present study was considered primarily heterosexual. Review articles were also excluded from this review. However the reference lists of these articles as well as the retrieved articles were scanned for further relevant articles. The author's own articles presented

later in this thesis were also not included in this review. All retrieved full text articles were evaluated for inclusion and articles without sufficient findings relating to the topics were excluded. A total of 103 studies were reviewed.

Of the 103 studies, some contained findings on more than one of the sub-topics and were thus included in the respective summaries below. These overlaps were as follows:

- Aggression – 18 articles
- Mental health – 20 articles
- Depression – 22 articles
- Sexual risk – 33 articles
- Aggression and mental health – 1 article
- Aggression, mental health and depression – 1 article
- Aggression and sexual risk – 3 articles
- Aggression and depression – 2 articles
- Mental health and sexual risk – 1 article
- Mental health and depression – 2 article

Total: 103 articles

2.3 Results

2.3.1 Methamphetamine use and aggression

A total of 25 articles were included in the review of methamphetamine and aggression or methamphetamine and violence (Table 1, pages 40-48). Most of the identified studies

were quantitative, although one qualitative study was included (Sexton, Carlson, Leukefeld, & Booth, 2009) and one study with mixed quantitative and qualitative methods (Sommers, Baskin, & Baskin-Sommers, 2005). Most of the studies were conducted among adult populations, with only one study focusing on adolescents in high school (Pinhey & Wells, 2007). Population types included general populations, trauma patients, patients in treatment for methamphetamine and methamphetamine-related deaths. Most studies were cross-sectional in nature or compared methamphetamine users and non-users. Aggression was mostly assessed through a series of questions relating to aggressive or violent behaviour (e.g. fighting with strangers, assaults with or without a weapon or domestic violence). Other methods of assessing aggression or violence included incarceration for homicide or suffering violence related injuries. Methamphetamine use was also mostly assessed through a series of questions, while fewer studies used biological testing to assess methamphetamine use. The majority of studies were conducted in the USA or Australia (n = 23) with one study in Canada and one study in Guam.

Most of the studies showed associations between methamphetamine use and aggression or methamphetamine use and violence, however one study found no association between daily use of methamphetamine and perpetrating violence among street-based youth (Martin et al., 2009). Another study showed that impulsivity and positive symptoms of psychosis mediated the relationship methamphetamine use and hostility (Lapworth et al., 2009). The association between past year methamphetamine use and past year violent behaviour also diminished when other substances were adjusted for in a regression model

(Iritani, Hallfors, & Bauer, 2007). The type of violent behaviours investigated ranged from child abuse (Grella, Hser, & Huang, 2006) to homicide (Stretesky, 2009). The latter study contained the findings highlighting the strongest link between methamphetamine use and violence. From an analysis of over 200,000 subjects it showed that individuals who used methamphetamine in the past month were 10 times more likely to commit homicide. Another study reported on the experience of violence, finding that 80% of female methamphetamine patients had experienced partner violence (Cohen et al., 2003).

In summary, the studies highlighted in this section of the review generally indicated associations between methamphetamine use and aggression and methamphetamine use and violence. A qualitative study described how methamphetamine use often seemed to increase the stakes in everyday interactions, transforming non-challenging verbal interactions into 'character contests' whose resolution often involved violence (Sommers et al., 2005). A second qualitative study provided further insight into the context of violence, indicating that violence was often associated with disputes over methamphetamine or its use, paranoia and hallucinations during methamphetamine binges (Sexton et al., 2009).

The review indicated that studies focussing on adolescent populations were very limited, with only one study among high school students, and only one study was conducted in a developing state (Guam), indicating the need for further studies among adolescents as well as in developing societies or emerging economies. Further research is also required on the pathways and 'mechanisms' through which methamphetamine use leads to

aggression and/or violence. While there are a number of studies indicating associations between methamphetamine use and aggression or violence, the 'why' and 'how' methamphetamine use leads to aggression and violence remains an area for further research.

2.3.2 Methamphetamine use and mental health

As for methamphetamine and aggression, 25 articles met the inclusion criteria for *methamphetamine and mental health* (Table 2, pages 49-64). Five studies investigated adolescent populations. Most studies were conducted in the USA and Australia (n = 22), with two studies in Taiwan and one study in Japan. All the studies identified were quantitative and tended to be cross-sectional and/or comparative in nature. Mental health was mostly assessed using a range of standardized scales, questionnaires or indexes, or by participants meeting DSM-IV diagnostic criteria. One study used mental health service utilization as their measure of mental health problems (Herman-Stahl, Krebs, Kroutil, & Heller, 2006). Methamphetamine use was mostly assessed through a series of questions, while fewer studies used biological testing to assess methamphetamine use. Some studies used the fact that patients were admitted for treatment for methamphetamine-related mental health problems as their indicator of methamphetamine use.

All the studies showed associations between methamphetamine use and mental health problems, and a few went further to suggest that higher frequency or quantity of

methamphetamine use was primarily associated with mental health problems (Gonzales et al., 2009; Vincent, Shoobridge, Ask, Allsop, & Ali, 1998). The most common mental health problems reported were mood and anxiety disorders. Among the mood disorders, depression was particularly common (Baker et al., 2004; Copeland & Sorensen, 2001; Eisinger, Wodarski, & Ferguson, 2009; Grant et al., 2007; Kim & Jackson, 2008; Maxwell & Spence, 2005; McKetin et al., 2008; Toles, Jiang, Goebert, & Lettich, 2006; Yen & Su, 2006). Some studies compared methamphetamine and cocaine users and found that methamphetamine users were more likely to have a psychiatric diagnosis (Copeland & Sorensen, 2001; Leamon, Gibson, Canning, & Benjamin, 2002). For example, Copeland and Sorensen (2001) found that 49% of methamphetamine users had a psychiatric diagnosis versus 28% of cocaine users ($p<0.001$).

Baker et al. (2004) were able to show that two thirds of amphetamine users in their study experienced their mental health problem after commencing amphetamine use. Psychosis was also reported as a common problem, with one study showing that rural methamphetamine users were more likely to experience psychosis (45%) than urban residents (29%). An Australian study found a somewhat lower prevalence of past year psychosis among methamphetamine users (13%) (McKetin et al., 2006). A study in Taiwan found that female methamphetamine users were more likely than males to have suffered from psychiatric problems (43% versus 31%) and to have reported suicidal behaviour (36% versus 6%) (Shih-Ku Lin et al., 2004), and a large, national survey of US adolescents in 2002 found that adolescents who reported past year mental health treatment utilization were 1.66 times ($p<0.01$) more likely to report past year

methamphetamine use (Herman-Stahl et al., 2006). Other disorders associated with methamphetamine use in another study in Taiwan were conduct disorder and attention deficit disorder (Yen & Su, 2006).

In summary, studies clearly indicate associations between methamphetamine use and mental health problems. The most common problem identified appears to be depression, followed by anxiety related problems and psychosis or hallucinations. A number of studies showed that mental health problems are greater in methamphetamine users than other (stimulant) drug users. Follow-up studies were able to show that reduction or cessation of methamphetamine use also positively impacted on reported mental health problems (Gonzales et al., 2009).

While a few studies (five) were conducted among adolescents none were conducted in developing countries or emerging economies. The impact of methamphetamine use on the mental health of adolescents in developing countries is thus an important area for further research, as well as the impacts of mental health problems related to methamphetamine use by adolescents on their functioning at school and in their relationships with peers and family. In the context of considering education as a corner stone of poverty alleviation, potential negative contributors to scholastic performance are a key area for identification and intervention in developing countries.

2.3.3 Methamphetamine use and depression

For methamphetamine and depression 27 articles were included (see Table 3 on pages 65-74), although three overlapped with articles included for methamphetamine and mental health. While a number of articles in the methamphetamine and mental health section referred to depression, the goal in this section was to specifically focus on methamphetamine and depression associations. To some extent it can be considered an extension of the section above.

Again, most studies were conducted in the USA or Australia (n = 23), with two studies in Thailand and two in Taiwan. Most were conducted among mainly adult populations although two studies were conducted in adolescent populations. Two of the studies used qualitative methods. Depression was mostly assessed through standardized scales or questionnaires, the most common being the Beck Depression Inventory (BDI) (Beck & Steer, 1987). One study scanned medical files of patients for previous diagnoses of depression or prescription of anti-depressants (Dyer & Cruickshank, 2005). Methamphetamine use was also mostly assessed through a series of questions, while fewer studies used biological testing to assess methamphetamine use and some used DSM-IV diagnostic criteria for methamphetamine dependence.

All the studies, except one (Nakama et al., 2008), showed some associations between methamphetamine use and depression, with a number showing improvements in depression symptoms with treatment for methamphetamine dependence (Glasner-

Edwards et al., 2009; Jaffe, Shoptaw, Stein, Reback, & Rotheram-Fuller, 2007) or abstinence (McGregor et al., 2005; Newton, Kalechstein, Duran, Vansluis, & Ling, 2004). Newton et al. (2004) investigated non-treatment seeking methamphetamine users and found that BDI symptoms decreased significantly after only three days of abstinence. However, a study by Rawson et al. (2002) found that reported depression remained unchanged in a treatment follow-up sample although most had not used methamphetamine in the past 30 days (83%) and 54% reported periods of abstinence of 24 months or more from treatment admission to follow-up.

One study found that methamphetamine users with psychosis had significantly higher rates of methamphetamine-related depression (29%) than methamphetamine users without experience of psychosis (5%). Methamphetamine users with psychosis were also more likely to have major depression (8%) than those without experience of psychotic symptoms (4%) (Chen et al., 2003). Different findings emerged with regard to gender, with one study finding depression to be more likely in male methamphetamine users compared with non-users (OR=2.2, $p<0.01$) but not in female methamphetamine users (Embry, Hankins, Biglan, & Boles, 2009). In contrast Zweben et al. (2004) found that female methamphetamine outpatients scored significantly higher on the BDI than men ($p<0.001$). A study comparing different groups of stimulant drug users in treatment found that users of both cocaine and methamphetamine (or amphetamine) and users of methamphetamine (or amphetamines) only, were significantly more likely to report depression symptoms than those who only used cocaine (Riehman, Iguchi, & Anglin, 2002). This difference however disappeared when controlling for (previous) life-time

depressive episode, but did remain for individuals who had been abstinent since treatment.

A qualitative study of HIV positive men who have sex with men who used methamphetamine indicated that almost all the participants spoke of chronic depression following methamphetamine use (Mimiaga et al., 2008). A qualitative study of general practitioners in Sydney supported the finding of an association between methamphetamine and depression from the general practitioners' experiences with methamphetamine using patients (Saltman, Newman, Mao, Kippax, & Kidd, 2008).

In summary, most of the studies showed associations between methamphetamine use and depression. A number of studies indicated that symptoms of depression would improve with abstinence, although one study found an absence of improvement. This leaves some questions as to whether methamphetamine use may be related to permanent problems with depression, although the majority of studies appear to indicate improvement with abstinence. More clarity is still required to what extent methamphetamine use physiologically causes depression as opposed to circumstances associated with the use of the drug (e.g. family or relationship problems). Further studies in adolescent populations and developing societies are also required, with mainly two studies in Thailand investigating depression in methamphetamine users in these young and potentially even more vulnerable populations.

2.3.4 Methamphetamine use and sexual risk behaviour

For *methamphetamine and sexual risk* 37 studies were included focussing on heterosexual populations (Table 4, pages 75-96). The majority of studies were conducted in the USA (n = 25), six studies in Thailand, and one each in Australia, China, Guam, Mexico, South Africa and Taiwan. Five studies focussed on adolescents or high school students and a further eight focussed on young adults between 18-25 years. Only two studies used qualitative methodologies. Sexual risk behaviour was mostly assessed through a series of questions about number of sexual partners in a defined period, condom use, anal sex, casual sex partners, age of sexual debut, presence or history of STIs, having sex for money or drugs and having sex with sex workers. Some studies asked about HIV status specifically and one study tested for HIV status (Patterson et al., 2009). Methamphetamine use was also mostly assessed through a series of questions, while fewer studies used biological testing to assess methamphetamine use and some used patients admitted for methamphetamine-related problems in their studies.

All the studies found associations between methamphetamine use and sexual risk behaviour or sexually transmitted infections (STIs). Some of the most common types of sexual risk behaviours associated with methamphetamine use included:

- Inconsistent or no condom use (Baskin-Sommers & Sommers, 2006; Bogart et al., 2005; Dew, Elifson, & Sterk, 2007; Gleghorn, Marx, Vittinghoff, & Katz, 1998; Iritani et al,, 2007; MacMaster, Tripp, & Argo, 2008; McKetin et al., 2008; Molitor et al., 1999; Nemoto, Operario, & Soma, 2002; Semple, Grant, &

Patterson, 2004; Semple, Patterson, & Grant, 2004; Sherman et al., 2008; Simbayi et al., 2006; Yen, 2004; Zule, Costenbader, Meyer, & Wechsberg, 2007).

- Multiple sexual partners or a higher average number of partners in a defined period than non-methamphetamine users (Bogart et al., 2005; Centers for Disease Control, 2006; Cheng et al., 2010; Gleghorn et al., 1998; Lorvick, Martinez, Gee, & Kral, 2006; MacMaster et al., 2008; Marquez, Mitchell, Hare, John, & Klausner, 2009; McKetin et al., 2008; Molitor et al., 1999; Molitor, Truax, Ruiz, & Sun, 1998; Pinhey & Wells, 2007; Semple, Grant, & Patterson, 2005; Semple, Grant, & Patterson, 2004; Semple, Patterson, & Grant., 2004; Springer, Peters, Shegog, White, & Kelder, 2007; Simbayi et al., 2006; Yen, 2004; Zapata, Hillis, Marchbanks, Curtis, & Lowry, 2008).
- Anal intercourse (Bogart et al., 2005; Centers for Disease Control, 2006; Lorvick et al., 2006; Molitor et al., 1999; Molitor et al., 1998; Semple, Patterson, & Grant, 2004; Zule et al., 2007).

Other sexual risk behaviours mentioned in a few studies were a greater likelihood of sex with a sex worker (Beyrer et al., 2004) and engaging in 'marathon sex' (Centers for Disease Control, 2006; Cheng et al., 2009; Semple, Patterson, & Grant, 2004).

To provide an indication of the 'degree of risk' some studies were able to find, a good example was a study by Baskin-Sommers & Sommers (2006), who found that in a university student population the adjusted odds of not using a condom was 15.9 for methamphetamine users. Another survey conducted in U.S. high schools found that

students who had used methamphetamine at least once were 11 times more likely to have experienced sexual debut than those who had never used methamphetamine (Springer et al., 2007).

An increased risk for sexually transmitted infections (STIs) was also documented in some studies. Celentano et al. (2008) found that 38% of their sample of 18-25 year-old methamphetamine users had at least one STI and high frequency methamphetamine use among women was associated with prevalent bacterial STIs and herpes simplex virus 2 (HSV-2). Patterson et al. (2009) recently found that among men who had recently had sex with a sex worker, life-time methamphetamine use was significantly related to being HIV positive (OR = 4.34, 95% CI: 1.31-14.36). A study in China similarly found that amphetamine-type stimulant use showed a strong positive association with sexual transmission of HIV (Zhongwei et al., 2010).

One qualitative study found different experiences among methamphetamine users. Some reported that methamphetamine enhanced their libido, while others reported not 'thinking about sex at all' while high on methamphetamine. Some males also reported difficulty with achieving erections after using methamphetamine (Sherman et al., 2008).

The five studies among adolescents indicated that risky sex was significantly more likely among life-time methamphetamine users, that life-time methamphetamine use was associated with earlier initiation of intercourse and having had two or more partners in the past three months, that higher frequency methamphetamine users were more likely to

have had sex before age 13, and that unprotected sex increased in frequency with frequency of methamphetamine use (Embry, Hankins, Biglan, & Boles, 2009; Pinhey & Wells, 2007; Springer et al., 2007; Yen, 2004; Zapata et al., 2008).

In summary, studies generally found associations between methamphetamine use and sexual risk behaviour in (primarily) heterosexual populations. Findings of particular relevance to the present study were that even adolescent or high school based populations showed associations between methamphetamine use and increased sexual risk behaviour, although these studies were few in number. Risk behaviour seemed to mostly manifest by a greater number of sexual partners, inconsistent condom use and anal sex. Only two studies were conducted among adolescents in developing countries or states (Thailand and Guam), indicating a need for further research in these settings, particularly in those countries with a high prevalence of STIs.

2.4 Conclusion

Published literature reviewed in this review generally supported associations between methamphetamine use and (i) mental health problems (including depression), (ii) aggression and violence, and (iii) sexual risk behaviour. In adolescent populations these are likely to translate into negative consequences, such as problems with school work (mental health and depression), problems with relationships with friends and family (aggression and mental health), possible conflict with the law (aggression/violence), and an increased risk of contracting STIs including HIV.

Most studies tended to be cross-sectional in nature, leaving a further need for longitudinal studies to assess the causal relationship between methamphetamine use and mental health problems (including depression, aggression and violence) and sexual risk behaviour. More studies may also be required to assess what proportion of mental health problems, aggressive and violent acts, and STIs could be directly ascribed to non-injection methamphetamine use.

Table 1: Summary of studies on aggression or violence and methamphetamine (MA)

Authors	Sample demographics				Country/city/ state of study	Methods			Key findings relating to MA and aggression/violence
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was aggression/violence assessed?	How was MA use assessed?	Statistics used	
Austin, 2004	88	Majority women	41/ 15-90	1. General 2. Random distribution of questionnaires by community college and community informant	Hawaii (native Hawaiians in a rural community)	35-item questionnaire based on the US National Household Survey on Alcohol and Other Drug Use	35-item questionnaire based on the US National Household Survey on Alcohol and Other Drug Use	Correlation	Age at first perpetration of violence was positively correlated with age of first use of MA, frequency of use during past 30 days and age at which person became a regular user.
Baskin-Sommers & Sommers, 2006	249	49	21.4/ 18-25	1. University students aged 18-24 2. Randomly recruited through flyers	Los Angeles, USA	Frequency of carrying a weapon (gun or knife), fighting with a stranger, and intimate partner violence during prior 6 months.	Ever used MA in past 6 months & frequency, i.e. < 6 times, 6-12 times, 13-18 times or >18 times	Correlation	Significant correlation between MA use and partner violence
Brecht, O'Brien, von Mayrhauser, & Anglin, 2004	350	56	Not listed	1. Former MA patients 2. Random sample of admissions, stratified by gender, ethnicity and treatment modality.	LA County, USA	Natural History Interview (NHI)	NHI + frequency and route of use	Frequency	57% of sample reported violent behaviour
Bunting et al., 2007	449 (100 MA	67% of MA users	Not listed/ MA users 26-30	1. Patients presenting to an emergency	Sydney, Australia	Medical staff recorded behaviour in the emergency	Patients self-reported drug use (related to	Chi-square tests, t-tests	MA-related presentations were significantly more

Authors	Sample demographics				Country/city/ state of study	Methods			Key findings relating to MA and aggression/violence
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was aggression/violence assessed?	How was MA use assessed?	Statistics used	
	users)			department as a result of illicit drug use. 2. All patients clinically determined to have been admitted as a result of illicit drug use between 1 October and 31 December 2006.		department at admission	their reason for presenting to the emergency department)		aggressive (18%) than other drug-related presentations (2%), ($p< 0.001$).
Cartier, Farabee, & Prendergast, 2006	641	100	36.2/ Not listed	1. Prison parolees who had in-prison treatment for substance abuse and controls who had no treatment 2. 12-month follow-up of cases and controls	California, USA	Self-reported violent criminal behaviour; return to prison for a violent offense	Self-reported use in 30 days prior to interview	Ordinary least squares regression	MA use was significantly predictive of self-reported violent criminal behaviour and general recidivism ($p<0.001$).
Cohen et al., 2003	1016	45	Not listed/ ≥ 18	1. MA dependent outpatients (18 or older) 2. Recruited at intake from 8 outpatient treatment programmes	California, Montana & Hawaii USA	Abuse and Violence history section of Women's Interagency health Study Assessment	DSM-IV MA dependence	Frequency	80% of women reported experiencing partner violence; 58% of women reported sexual abuse.
Darke, Torok, Kaye, Ross, &	400	70	35.4/ 18-75	1. Adult MA and opiate users. 2. Convenience sample of at least	Sydney, Australia	Violent offending was assessed by questions relating to assault, armed	Questions on drug use were asked.	Odds ratios	MA users were more likely than heroin users to have committed a

Authors	Sample demographics				Country/city/ state of study	Methods			Key findings relating to MA and aggression/violence
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was aggression/violence assessed?	How was MA use assessed?	Statistics used	
McKetin, 2010				weekly MA/opiate users in past year.		robbery, sexual assault and homicide.			violent crime in the past 12 months (OR=1.94, CI: 1.19-3.15).
Eisinger et al., 2009	32	60% of MA users. 0% of non-MA users	32.9 (MA users) 23.7 (non-MA users)/ Range not listed	1. 15 past-year MA users compared with 17 non-MA users. 2. MA users recruited from treatment programmes and non-MA users were undergraduate students recruited through flyers.	Knox County, Tennessee, USA	The Multi-Problem Screening Inventory (MPSI) was used, which includes assessment of aggression.	A MA use questionnaire was used.	Means, t-tests	MA users had significantly higher scores on aggression and also had 'clinically significant' scores on aggression.
Ernst, Weiss, Enright-Smith, Hilton, & Byrd, 2008	1712	8	Not listed	1. Victims of intimate partner violence (IPV). 2. Retrospective cohort study of data collected by Victims Assistance Unit from January to November 2006.	Albuquerque, New Mexico, USA	Participants were victims of IPV	Victims were asked about their and their perpetrators' MA use.	Chi-square tests and Relative Risks	According to victim report, perpetrators were 11 times more likely to use MA than victims (0.8% vs. 8.9%, RR = 10.9, 95% CI: 6.4-18.8).
Grella et al., 2006	4156	0	33/ Not listed	1. Women in treatment for substance abuse who had children younger than 18 years	California, USA	Questions on involvement with child welfare	Addiction Severity Index (ASI)	Frequency	47% of women who had been involved with child welfare had MA as their primary substance of abuse

Authors	Sample demographics				Country/city/ state of study	Methods			Key findings relating to MA and aggression/violence
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was aggression/violence assessed?	How was MA use assessed?	Statistics used	
				2. California counties who volunteered to participate selected treatment programmes in their counties.					vs. 37% of women who had not been involved with child welfare
Hall, Hando, Darke, & Ross, 1996	301	53	25/ Not listed	1.Amphetamine users 2. Recruited through advertisements in various appropriate mediums (e.g. rock magazines, local newspapers, radio) and by word of mouth	Australia	General Health Questionnaire, which included questions on violent behaviour	Amphetamine use history & Opiate Treatment Index (OTI)	Frequency, McNemar Chi-square Multivariate logistic regression	44% of subjects reported violent behaviour after first use, a significant increase compared to before first use. Multivariate logistic regression also showed that violent behaviour was predicted by injecting the drug.
Iritani et al., 2007	14108	50.7	21.8/ 19-24	1. Young adults 2. Prospective cohort of nationally representative US adolescents followed into young adulthood.	USA	Questions on violence/weapon related behaviours in past 12 months	Asked whether they had used MA in past 12 months and number of times they used in past 30 days	Odds ratios, logistic regression	Past year MA use was significantly associated with past year violent behaviour in a bivariate model, but diminished when other substances were adjusted for.
Lapworth et al., 2009	237	71.3	27.7/ ≥ 18	1&2. MA injectors recruited from a Needle and Syringe	Brisbane, Australia	The Brief Psychiatric Rating Scale was used to assess hostility in	Severity of MA dependence was assessed	Hierarchical regression	Higher levels of MA dependence were associated with increased

Authors	Sample demographics				Country/city/ state of study	Methods			Key findings relating to MA and aggression/violence
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was aggression/violence assessed?	How was MA use assessed?	Statistics used	
				Exchange programme in Brisbane. .		the previous month.	using the 5-item Severity of Dependence Scale		hostility. However, this relationship was mediated by both impulsivity and positive symptoms of psychosis.
Logan, Fligner, & Haddix, 1998	92	Not listed	Not listed	1. MA related deaths 2. Review of deaths in which MA was detected	Seattle, USA	Cause of death	Toxicology screen	Frequency	Homicide was cause of death in 27% of cases
Martin et al., 2009	478	72.4	21.9/ 14-26	1. Drug-using street youth 2. Snowball sampling	Vancouver, Canada	Participants were asked if they had been a victim of or perpetrated violence in the 6 months prior to the interview.	Questions on daily or more frequent MA use in past 6 months	Logistic regression	Daily use of MA was not significantly associated with perpetrating violence.
Pinhey & Wells, 2007	1386	Not listed	Grade 9-11 students	1. Grade 9-11 high school students 2. Random selection of classes from all seven high schools in Guam	Guam	Respondents were asked: '*During the past 12 months, how many times were you in a physical fight?*'	Question on number of times used MA in life-time (coded as binary – used or not used)	Ordinary least squares multiple regression and Logistic regression	Males who had used MA appeared to be particularly belligerent (b = 1.226, p < .01). Females indicating that they had used MA were also exceptionally aggressive (b = 1.675, p < .001)

Authors	Sample demographics				Country/city/ state of study	Methods			Key findings relating to MA and aggression/violence
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was aggression/violence assessed?	How was MA use assessed?	Statistics used	
Richards et al., 1999	461	64	34.9/ Not listed	1. Trauma patients with positive MA toxicology screens 2. Reviewed all patients presenting over a six-month period for positive MA toxicology screens	California, USA	Patients who had physical trauma	Toxicology screen	Frequency/Chi-square	37% of MA patients had injuries from trauma, significantly more than non-MA patients (21%).
Sexton et al., 2009	39	56.4	Not listed/ 18-55	1&2. Qualitative study of rural MA users	Arkansas and Kentucky, USA	Participants were asked about fights, sexual assault or 'bad' arguments linked to MA use.	Self-reported MA use in past 30 days	Qualitative analysis	Violence was associated with disputes over MA or its use, paranoia, ill tempers and hallucinations during MA binges.
Sommers et al., 2005	106	59.4	21.6/ 18-25	1. MA users 2. MA users in a treatment programme (55) and 51 recruited from the community.	LA County, USA	Questions on violence toward others	Participants must have used MA for a minimum of 3 months	Frequencies & qualitative	35% of the sample had committed violence under the influence of MA, of whom 46% had never committed violent crime prior to the MA-related event. MA use often increased the stakes in everyday interactions, transforming non-

Authors	Sample demographics				Country/city/ state of study	Methods			Key findings relating to MA and aggression/violence
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was aggression/violence assessed?	How was MA use assessed?	Statistics used	
									challenging verbal interactions into 'character contests' whose resolution often involved violence. Respondents also described their behaviour under the influence of MA as 'being out of control', 'blowing up' or having an 'outburst of rage'.
Sommers & Baskin, 2006	205	67.4 – treatment group 50.5 – community group	26 (median)/ 18-46	1. MA users 2. MA users in a treatment programme (98) and 107 recruited from the community through advertising and snowball sampling.	LA County, USA	Asked whether they had ever been violent under the influence of MA	Participants must have used MA for a minimum of 3 months	Frequencies, logistic regression	27% of the respondents reported violent acts under the influence of MA, including domestic violence, drug and gang related violence, and random violence. Exposure to family deviance (arrests and child abuse), previous substance-related violence, social functioning problems, age of onset of MA use,

Authors	Sample demographics				Country/city/ state of study	Methods			Key findings relating to MA and aggression/violence
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was aggression/violence assessed?	How was MA use assessed?	Statistics used	
									and childhood fighting significantly increased the odds of engaging in MA-related violence.
Stretesky, 2009	222,335	48.2	Not listed/ ≥ 18	1. Homicide offenders and non-homicide offenders. 2. Data from homicide offenders and general adult population surveys were pooled.	USA	Incarceration for a homicide-type crime	Questions on MA use history (life-time and past month)	Rare events logistic regression	Adjusted for a number of demographic variables, individuals who used MA in the past month were 10 times more likely to commit homicide (AOR=9.87, CI: 5.25-18.36).
Swanson et al., 2007	4932	73	32.7 (MA +) 38.1 (MA -)/ Not listed	1 &2. Retrospective review of trauma patients' records from 2003-2005.	San Diego, California, USA	Patient records were examined for violence related injuries	Urine toxicology screening	Chi-square	MA-positive patients were twice as likely as MA-negative patients to have a violent mechanism of injury ($p< 0.001$).
Szuster, 1990 *Full text not available*	Un-known	Unknow n	Unknown	1&2. Patients with MA-induced organic mental disorders seen in a psychiatric emergency service	Ewa Beach, Hawaii	History of aggression toward others	MA-induced organic mental disorder	Frequency	43% of the group had clear histories of aggression towards others

Authors	Sample demographics				Country/city/ state of study	Methods			Key findings relating to MA and aggression/violence
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was aggression/violence assessed?	How was MA use assessed?	Statistics used	
Tominaga, Garcia, Dzierba, & Wong, 2004	212	74.1	30.9/ 18-55	1. Trauma patients with toxicology screens 2. All trauma patients admitted at a Honolulu trauma centre in 2002 with toxicology screens	Honululu, Hawaii	Type of injury sustained	Toxicology screens positive for amphetamine or MA	Frequency/Chi-square	The amphetamine or MA positive group were more likely to have intentional injury (37% vs 22%, $p < 0.05$)
Zweben et al., 2004	1016	44.7	Not listed/ ≥ 18	1. MA users in outpatient treatment programmes 2. MA dependent patients (DSM-IV) from 8 outpatient programmes in California, Montana and Hawaii	California, Montana and Hawaii	Addiction Severity Index (ASI) – self-reports of assault/weapons charges and self-assessment of difficulty controlling violent behaviour or anger.	DSM IV criteria for MA dependence	Frequencies	43% of the sample reported having problems controlling their violent behaviour.

Table 2: Summary of studies on mental health and methamphetamine (MA)

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and mental health
	N	% Male	Mean age/ range	1. Population type & 2. Sampling strategy		How was mental health assessed?	How was MA use assessed?	Statistics used	
Baker et al., 2004	214	62.6	30.2/ Not listed	1. Regular amphetamines users (i.e. at least weekly) 2. Participants were recruited between October 2001 and September 2002 via notices placed within various agencies and treatment centres, media releases and via word of mouth. (Exclusion criteria were suicidality or acute psychosis, acquired cognitive impairment and current involvement in treatment for amphetamine use.)	Newcastle and Brisbane, Australia	1. Brief Symptom Inventory (BSI) 2. BDI-II 3. International Personality Disorder Examination Questionnaire (IPDEQ)	Amphetamine abuse or dependence during the 6 and 12 months preceding the interview was determined using the Non-Alcohol Psychoative Substance Use Disorders sections of the Structured Clinical Interview for DSM-IV Axis 1 Disorders – Research Version	Frequencies, t-test	49% of the sample had been diagnosed or treated for a mental health problem. The average age of first diagnosis/treatment was approximately 2 years after the mean age of onset of amphetamine use. Almost two thirds of people who had been diagnosed with a mental health problem reported that they experienced the problem after commencing regular amphetamine use. A t-test revealed that the mean overall IPDEQ score for regular amphetamine users differed significantly from that for the

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and mental health
	N	% Male	Mean age/ range	1. Population type & 2. Sampling strategy		How was mental health assessed?	How was MA use assessed?	Statistics used	
									Australian community (0.47 vs 0.19) [t=24.92, p<0.001] 71% of the sample scored in the moderately to severely depressed range on the BDI-II.
Booth, Leukefeld, Falck, Wang, & Carlson, 2006	706	62	32.6/ ≥ 18	1. Rural stimulant (cocaine and/or MA) users 2. Respondent Driven Sampling (RDS) was used to identify participants in nine rural counties (three each in eastern Arkansas, western Kentucky, and western Ohio)	Arkansas, Kentucky, and Ohio, USA	Brief Symptom Inventory (BSI) – a 53 item scale assessing psychological distress in the past week.	A 'drug matrix' developed by the authors for lifetime and recent use of a range of substances was used to assess MA, cocaine and other drug use	MANOVA, multiple linear regression, adjusted means	MA only users, cocaine only users and cocaine & MA users were compared. All three groups had higher mean BSI scores than the general population. Those who used both MA and cocaine had the highest mean BSI scores, with paranoid ideation and psychoticism having the highest means. Significant differences were found on 9/10 of the BSI subscales between the MA only group and the

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and mental health
	N	% Male	Mean age/ range	1. Population type & 2. Sampling strategy		How was mental health assessed?	How was MA use assessed?	Statistics used	
									MA & cocaine group
Booth et al., 2010	710	61	32.6/ ≥ 18	See Booth et al. (2006)	Arkansas, Kentucky, and Ohio, USA	Brief Symptom Inventory (BSI) and its summary score for psychological distress, the Global Severity Index (GSI)	A 'drug matrix' developed by the authors for lifetime and recent use of a range of substances was used to assess MA, cocaine and other drug use	Multivariate generalized estimating equations	MA use in the past 6 months was significantly associated with higher GSI scores ($p<0.01$). However, further analysis showed that only using MA on 15 or more days in the past 30 days was associated with higher GSI scores ($p<0.01$).
Bunting, Fulde, & Forster, 2007	449 (100 MA users)	67% of MA users	Not listed/ 26-30 most common for MA related incidents	1. Patients presenting to an emergency department as a result of illicit drug use. 2. All patients clinically determined to have been admitted as a result of illicit drug use between 1 October and 31 December 2006.	Sydney, Australia	Medical staff recorded behaviour in the emergency department at admission, and patients self-reported their psychiatric history which was confirmed by cross-checking.	Patients self-reported drug use (related to their reason for presenting to the emergency department)	Chi-square tests	A significantly higher proportion of patients with MA-related presentations had to be scheduled under the *Mental Health Act* (i.e. they were considered a danger to themselves) compared to other toxicology related presentations (39% vs. 19%, $p<0.001$).

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and mental health
	N	% Male	Mean age/ range	1. Population type & 2. Sampling strategy		How was mental health assessed?	How was MA use assessed?	Statistics used	
Copeland & Sorensen, 2001	345	MA: 82% Coc.: 60%	MA: 34.8 Cocaine: 36.4/ not listed	1. MA or cocaine dependent outpatients 2. Consecutive admissions to the Stimulant Treatment Outpatient Program at San Francisco General Hospital during 1995-1997	San Francisco, USA	A retrospective chart review was conducted which included psychiatric diagnostic information and psychiatric history	Admitted to Outpatient Programme for MA dependence	Frequency, Chi-Square	MA user were more likely to have a psychiatric diagnosis than cocaine users (49% vs 28%, $p<0.001$). Among the MA users mood disorders accounted for 71% of the psychiatric diagnoses (major depression 57% and Bipolar I Disorder 27%). PTSD and Generalized Anxiety Disorder accounted for a further 27% of diagnoses.
Domier, Simon, Rawson, Huber, & Ling, 2000	427	Not listed	Not listed	1. Men and women entering an outpatient treatment centre 2. Injecting (n=55) and non-injecting (n=372) MA users who entered the programme between 1988 and 1995.	Rancho Cucamonga, California, USA	Matrix Admissions Questionnaire, a six-page self-administered questionnaire which includes questions on psychological histories.	Matrix Admissions Questionnaire, a six-page self-administered questionnaire which includes questions on drug use	Frequencies, chi-square	MA injectors were more likely to have a history of psychological problems (39%) than noninjectors (25%). Injectors were more likely to feel depressed at time of admission (80% vs. 64%), had more suicidal

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and mental health
	N	% Male	Mean age/ range	1. Population type & 2. Sampling strategy		How was mental health assessed?	How was MA use assessed?	Statistics used	
									ideation (33% vs. 19%) and reported a higher incidence of hallucinations (46% vs. 32%). All these differences were significant at the 5% level ($p<0.05$).
Eisinger et al., 2009	32	60% of MA users. 0% of non-MA users	32.9 (MA users) 23.7 (non-MA users)/ ≥ 18	1. Fifteen past-year MA users were compared with 17 non-MA users. 2. MA users were recruited from treatment programmes and non-MA users were undergraduate students recruited through flyers.	Knox County, Tennessee, USA	The Multi-Problem Screening Inventory (MPSI) was used, which includes assessment of depression, self-esteem, personal stress, phobias, etc.	A MA use questionnaire was used.	Means, t-tests	MA users had significantly higher scores on depression, fearfulness and phobias and also had 'clinically significant' scores on depression and phobias.
Gonzales et al., 2009	723	48.5	31.4/ 18-60	1. MA dependent individuals 2. Participants were recruited from 8 outpatient programmes participating in the MA Treatment Project between 1999 and 2001.	California, Montana and Hawaii, USA	The Short-Form Health Survey (SF-36) and the Addiction Severity Index (ASI) were used. Both contain questions relating to mental health.	Participants had to meet DSM-IV criteria for MA dependence and used MA in the past month.	Hierarchical linear modelling	Designed as a treatment follow-up survey over a 12 month period, at 3-monthly intervals, this study found that mental health scores generally improved, although higher frequency

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and mental health
	N	% Male	Mean age/ range	1. Population type & 2. Sampling strategy		How was mental health assessed?	How was MA use assessed?	Statistics used	
									MA use negatively impacted this improvement.
Grant et al., 2007	172	60.5	34.3/ ≥ 18	1. MA users in treatment programmes (divided into urban and rural residents) 2. Volunteer patients diagnosed with MA abuse or dependence, admitted to five treatment centres between July 2004 and June 2005.	Nebraska, USA	Portions of the Mini-International Neuropsychiatric Interview (MINI) for depression, anxiety, psychosis, anorexia and bulimia were administered.	DSM-IV MA abuse or dependence diagnosis and questions on MA use patterns.	Frequencies, chi-square, t-tests	MA-related psychosis was experienced by 36% of the sample, with rural residents being more likely to report this (45%) than urban residents (29%) [$p<0.05$]. Almost half (48%) reported a major depressive episode in remission, and a further 36% reported a recurring major depressive episode.
Hendrickson, Cloutier, & McConnell, 2008	353	61%	36.6/ Not listed	1&2. MA-related emergency department visits were identified between February and July 2006 at a Oregon hospital	Portland, Oregon, USA	ICD-9 coding was used to link and identify psychiatric and other medical conditions.	Clinicians were asked to assess if 1) the ED visit was related to MA, and 2) if the patient was a confirmed user of MA in the past 3 months.	Frequencies, chi-square tests	Psychiatric disorders were more prevalent in MA using patients (19%) than non-MA using patients (4%) ($p<0.001$).
Herman-Stahl et al.,	17,709	51	Not listed/ 12-17	1&2. Adolescents sampled in the 2002	USA	Adolescents were asked whether they	Questions on use of MA in past	Multivariate logistic	Adolescents who reported past-year

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and mental health
	N	% Male	Mean age/ range	1. Population type & 2. Sampling strategy		How was mental health assessed?	How was MA use assessed?	Statistics used	
2006				US National Survey of Drug Use and Health		had received in- or outpatient services or assistance from a private therapist, paediatrician or school counsellor (excluding treatment for substance abuse)	year	regression	mental health treatment utilization were 1.66 times more than adolescents who did not seek mental health treatment to report past-year MA use. [$p<0.01$]
Kim & Jackson, 2008	250	68.4	15.8/ 13-18	1 & 2. An adolescent inpatient treatment programme provided outcome data on 250 youth admitted to the programme between 2002 and 2006.	Hawaii, USA	An Internal Mental Distress Index (IMDI) was used, including measures of depression, anxiety, suicidal ideation and traumatic stress. Secondly a Behavioral Complexity Index was used, including measures of ADHD and Conduct Disorder.	A Substance Problems Index was used.	Chi-squares and MANOVA	MA users scored significantly higher on the IMDI than non-MA users ($\chi^2=21.05$, df=2, $p<0.001$), as well as on its sub-indices for depressive symptoms, anxiety, traumatic stress and homicidal/ suicidal ideation. MA users also scored significantly higher than non-MA users on the Behavioral Complexity Index ($\chi^2=25.89$, df=2, $p<0.001$).
Leamon et al., 2002	2357	61	Not listed/ 18-48+	1. Patients admitted to a psychiatric	Sacramento County,	DSM-III-R or DSM-IV diagnoses	Chart review (substance abuse	Chi-square	Patients with amphetamine-

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and mental health
	N	% Male	Mean age/ range	1. Population type & 2. Sampling strategy		How was mental health assessed?	How was MA use assessed?	Statistics used	
				crisis unit with amphetamine or cocaine related disorders 2. All admissions meeting above criteria from July 1993 through June 1997	CA, USA		diagnoses) & urine test for amphetamine		related disorders were more likely to be transferred to an inpatient ward (35%) than patients with cocaine-related disorders (27%).
Lin et al., 2004	325	55.4	26.8/ ≥18	1. MA users in a detention centre 2. Participants were recruited on a first available basis, while waiting for an addiction severity assessment.	Taipei, Taiwan	Selected sections from the Chinese version of the Diagnostic Interview for Genetic Studies which includes detailed assessment of psychotic and mood symptoms	MA related disorders according to DSM-IV had to be present. Questions on frequency/amount of consumption.	Frequency, chi-square	Women were more likely than men to have suffered from psychiatric problems (43% vs. 31%, $p<0.05$) MA-induced psychosis had been experienced by 22% of the participants. Suicidal behaviour was reported by 36% of the women (vs. 6% of the men).
Maxwell & Spence, 2005	35,095	60	28/ Not listed	1. Club drug users admitted to treatment programmes 2. Clients admitted to publicly funded treatment programmes for	Texas, USA	Addiction Severity Index (ASI) DSM-IV diagnoses	Clients who reported MA as a primary or secondary drug problem	Frequency, t-tests	MA users had a significantly higher mean number of ASI psychological problem days at admission than any other club drug users ($p<0.05$)

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and mental health
	N	% Male	Mean age/ range	1. Population type & 2. Sampling strategy		How was mental health assessed?	How was MA use assessed?	Statistics used	
				club drug related problems from January 1988 – December 2003					Of those clients who received DSM-IV evaluation, 6% of the MA users had a depressive disorder at admission and 4% had Biploar I or II disorder.
McKetin, McLaren, Lubman, & Hides, 2006	309	59	28 (median)/ 16-60	1. MA users in the community 2. Recruited through ads in news papers, websites, needle and syringe programmes and word of mouth.	Sydney, Australia	Questions on whether participants had ever been diagnosed with schizophrenia, mania or bipolar disorder, or any other psychotic disorder. Participants were screened for psychosis with a 7 item instrument based on Composite International Diagnostic Interview Schizophrenia module. The Brief Psychiatric Rating Scale subscales of suspiciousness, unusual thoughts	Questions on life-time, past year and past month drug use, as well as current frequency. The Severity of Dependence Scale was used to assess MA dependence.	Frequencies, logistic regression (Odds ratios)	13% screened positive for psychosis in the past year and 23% had experienced clinically significant suspiciousness, unusual thoughts or hallucinations during this period. Dependent MA users were 3x more likely than non-dependent MA users to experience a clinically significant symptom of psychosis in the past year, even after adjusting for a self-reported diagnosis of

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and mental health
	N	% Male	Mean age/ range	1. Population type & 2. Sampling strategy		How was mental health assessed?	How was MA use assessed?	Statistics used	
						and hallucinations were used to assess severity of symptoms.			schizophrenia and other psychotic disorders (27% vs. 8%).
McKetin et al., 2008	358	75	30.6/ 16-54	1. Drug treatment entrants who reported MA or amphetamines as a primary or secondary drug of concern. 2. Participants were recruited through the MA Treatment Evaluation Study (MATES) in 2006 and 2007.	Sydney and Brisbane, Australia	Short Form 12 (SF-12), Kessler Psychological Distress Scale (K10), Brief Psychiatric Rating Scale (BPRS).	The composite International Diagnostic Interview (CIDI) to assess abuse or dependence, the Severity of Dependence Scale (SDS), and the Opiate Treatment Index (OTI) for frequency of use.	Frequencies, t-tests, chi-squares	Depression and anxiety were the most common mental health problems among both MA injectors and smokers. MA injectors were significantly more likely to report depression (65%) than smokers (51%) ($p<0.05$). MA smokers and injectors had similar mean scores on the SF-12, K10 and BPRS, although smokers scored higher on suspiciousness on the BPRS ($p<0.05$).
Miura, Fujiki, Shibata, & Ishikawa, 2006	1362	86	17/ Not listed	1&2. Adolescents admitted to a Juvenile Classification Home between April 2003	Nagoya, Japan	Participants were questioned on psychiatric treatment history by doctors on	MA use was identified by doctors on admission through questions	Logistic regression	MA users were more likely than non-MA users to have a history of psychiatric

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and mental health
	N	% Male	Mean age/ range	1. Population type & 2. Sampling strategy		How was mental health assessed?	How was MA use assessed?	Statistics used	
				and March 2004. Of these, 93 were MA users and 1296 served as control group.		admission and most of the MA users (n=79) were interviewed by a psychiatrist about psychiatric conditions related to MA use and diagnosed according to DSM-IV criteria.	on drug use.		treatment (16% vs. 3%, adjusted OR=8.7)
Rawson et al., 2000	500 MA users 224 cocaine users	MA users: 60% Cocaine users: 69%	MA users: 29 Cocaine users: 32/ Range not listed	1&2. MA and cocaine users enrolled in an outpatient programme between 1989 and 1995.	California, USA	Participants completed a self-administered questionnaire which included questions on psychiatric status and the Problem Severity Index (PSI) which categorises the severity of substance-related problems.	Participants completed a self-administered questionnaire which included questions on drug use	Frequencies, chi-square, t-tests	MA user were significantly more likely than cocaine users to feel depressed a lot (19% vs. 12%), have had suicidal thoughts (7% vs. 3%) and to have had hallucinations (35% vs. 25%) [$p<0.05$]
Rawson, Gonzalez, Obert, McCann, & Brethen, 2005	305	70	16/ 13-18	1&2. Adolescents who entered outpatient treatment at two clinics from 1999 to 2003.	Southern California, USA	Self-administered questionnaire including questions on psychological history (developed by the Matrix Institute on Addictions). This included questions on current psychological	Questions on drug of choice, including current use patterns.	Frequencies, chi-square	MA users had significantly more psychological symptoms than non-MA users, including auditory hallucinations ($p<0.01$) and depression ($p<0.05$)

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and mental health
	N	% Male	Mean age/ range	1. Population type & 2. Sampling strategy		How was mental health assessed?	How was MA use assessed?	Statistics used	
						functioning, including hallucinations, depression and suicidality.			
Stoops et al., 2007	225	57	31.2 (MA users) 35.7 (other stimulant users)/ Range not listed	1. Rural illegal stimulant users 2. RDS was used to recruit adult stimulant users who had not been in treatment in the past 30 days.	Ohio, Arkansas, Kentucky, USA.	Measure relating to key results was whether individuals had received mental health treatment in the past 3 years	Addiction Severity Index	Chi-square tests	Rural MA users were more likely than other stimulant users to have received mental health treatment in the past 3 years (27% vs 11%, $p < 0.05$).
Toles et al., 2006	904	59	38.5/ Not listed	1. Patients admitted to a psychiatric emergency department. 2. Record review of all patients admitted between March and May 2002.	Hawaii, USA	Diagnoses according to DSM-IV criteria	MA-related diagnoses according to DSM-IV	Frequencies, chi-square, multiple logistic regression	18% of the 904 patients had a MA-related diagnosis. MA patients were more likely to present with suicidality than non-MA patients (47% vs. 32%, $p<0.001$). This remained significant in a multiple logistic regression model (OR = 1.55, $p<0.05$). Dual diagnosis was more commom

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and mental health
	N	% Male	Mean age/ range	1. Population type & 2. Sampling strategy		How was mental health assessed?	How was MA use assessed?	Statistics used	
									among MA patients (37% vs. 17%, p<0.001; OR=2.71, p<0.001). Schizophrenia (15%), major depression (11%) and bipolar disorder (8%) were the most common co-morbid diagnoses.
Vincent et al., 1998	100	58	24 (median)/ 16-47	1. Amphetamine users in the community 2. Participants were recruited through flyers, referrals from known ex or current drug users, and key informants between November 1995 and March 1996.	Adelaide, Australia	Questions on psychological health and the SF36 Health Status Questionnaire, which includes a mental health dimension	Questions on drug use history and current use patterns, as well as severity of dependence on amphetamines.	Frequencies, multiple linear regression	A quarter of participants had experienced depression, 23% anxiety and 23% panic attacks only since using amphetamines. Regression analysis showed that increased severity of dependence, quantity of use, and previous mental health problems significantly contributed to the prediction of the

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and mental health
	N	% Male	Mean age/ range	1. Population type & 2. Sampling strategy		How was mental health assessed?	How was MA use assessed?	Statistics used	
									number of mental health problems.
Wallace, Galloway, McKetin, Kelly, & Leary, 2009	140	63	36 (median)/ Not listed	1. Regular MA users. 2. Participants had to have used MA at least monthly in the past 6 months, be at least 16 years old, and reside in the North Coast Area Health Service region in Australia. They were recruited through flyers, word of mouth, newspaper ads, NSPs and direct approach.	New South Wales, Australia	Mental health status in the previous month was assessed with the Short-Form 12 (SF-12) and by self-reported history of mental disorders.	Questions on MA use history were asked and MA dependence was assessed with the Severity of Dependence Scale (SDS).	Frequencies, Chi-squares, Kruskal Wallis tests, and logistic regression.	Dependent MA users were significantly more likely to score 'mental disability' (80%) on the SF-12 compared to non-dependent MA users (43%) ($p<0.01$). Depression and anxiety disorders were the most common mental health problems among all the MA users. Those that were dependent were more than 4 times more likely to report moderate to severely impaired mental health in an adjusted multiple logistic regression model (OR=4.7, 95% CI: 2.0-11.2, $p< 0.001$).

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and mental health
	N	% Male	Mean age/ range	1. Population type & 2. Sampling strategy		How was mental health assessed?	How was MA use assessed?	Statistics used	
Yen & Su, 2006	299	64.5	17/ Not listed	1&2. Adolescent MA users were recruited from two juvenile detention centres from September 1998 to March 2002. MA users were divided into two groups: an 'early onset' group (started using MA at 15 years or younger) and a 'late onset' group (started using MA at 16 or older)	Kaohsiung and Taipei, Taiwan	Kiddie Schedule for Affective Disorders and Schizophrenia (K-SADS-E) administered by a child psychiatrist. Diagnosis for psychiatric comorbidity based on DSM-IV criteria.	Questions on drug use, urine tests, substance use disorder diagnoses	Frequencies, chi-square	Among male adolescents conduct disorder (50% for the 'early onset' group and 48% for the 'late onset' group), ADHD (22% for the 'early onset' and 29% for the 'late onset' groups), and anxiety disorder (26% for the 'early onset' and 24% for the 'late onset' groups) were the most common. There were no significant differences on these variables between the 'early onset' and 'late onset' groups. For the females conduct disorder (45% for the 'early onset' group and 18% for the 'late onset' group), anxiety disorder (25% for the 'early

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and mental health
	N	% Male	Mean age/ range	1. Population type & 2. Sampling strategy		How was mental health assessed?	How was MA use assessed?	Statistics used	
									onset' group and 37% for the 'late onset' group) and specific phobia (20% for the 'early onset' group and 18% for the 'late onset' group) were the most common. For conduct disorder the difference between the two groups was significant ($p<0.01$). Depressive disorder was identified in a high proportion of the 'early onset' females (27%).

Table 3: Summary of studies on depression and methamphetamine (MA)

Authors	Sample demographics				Country/city/state of study	Methods			Key findings relating to MA and depression
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was depression assessed?	How was MA use assessed?	Statistics used	
Chen et al., 2003	445	63.7	27/ 18-37 (91%)	1. Amphetamine users recruited from a psychiatric hospital and a detention centre 2. Consecutive admissions for MA detoxification to the psychiatric hospital. In the detention centre MA users waiting for an addiction severity evaluation were approached on a 'first available' basis.	Taipei, Taiwan	Chinese version of the Diagnostic Interview for Genetic Studies which includes detailed assessment of mood symptoms	MA related disorders according to DSM-IV had to be present	Logistic regression/ odds ratios	MA users with psychosis had significantly higher rates of MA-related depression (29%) than MA users without experience of psychotic symptoms (5%). [OR=7.4, P <0.001] MA users with psychosis were also more likely to have major depression (8%) than MA users without experience of psychotic symptoms (4%) [OR=4.3, P < 0.05]
Dyer & Cruickshank, 2005	Study 1: 218 Study 2: 367 (two studies described)	Study 1: 60.4 Study 2: 62	Study 1: 26.5 18-46 Study 2: 33.7/ 18-53	Study 1: Consecutive amphetamine or MA related admissions to a detoxification unit between 1995 and 2003. Study 2: Participants in an outpatient	Perth, Australia	Study 1: Medical files scanned for psychiatric diagnosis of depression and prescription of antidepressants	Study 1: Preadmission assessments asking questions on duration and frequency of amphetamine use.	Frequency Chi-square	Study 1: 35% were diagnosed with depressive disorders. Study 2: The mean BDI score was in the moderate range, similar to

Authors	Sample demographics				Country/city/state of study	Methods			Key findings relating to MA and depression
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was depression assessed?	How was MA use assessed?	Statistics used	
				programme who were heroin or amphetamine dependent during 2002-2003.		Study 2: Beck Depression Inventory (BDI)-II	Study 2: Participants asked about their drug use.		psychiatric outpatients with clinical depression. Differences between heroin, amphetamine and heroin + amphetamine users were not significant on these mean scores.
Eisinger et al., 2009	See Table on mental health								
Embry et al., 2009	1213	49	Grade 11 students	1. 11th Grade high school students 2. 88 schools sampled from all high schools in Oregon between 2001-2003	Oregon, USA	4-item Centre for Epidemiological Studies Depression Scale (CES-D)	Life-time use of MA used for analysis	Logistic Regression	Depression more likely in male MA users (OR=2.2, $p < 0.01$), but not in female MA users
Glasner-Edwards et al., 2008	526	40	36.2/ ≥18	1 &2. MA dependent individuals recruited at outpatient clinics for randomized control trial	California, Montana and Hawaii, USA	BDI-II	Addiction Severity Index (ASI)	Multiple logistic regression	3 years post treatment, Major Depressive Disorder was predicted by a BDI score >20 (OR=2.2, CI:1.2-4.0)
Glasner-Edwards et al., 2009	526	40	33.4/ ≥18	1 &2. MA dependent individuals recruited at outpatient clinics for randomized control trial followed up after 3 years.	California, Montana and Hawaii, USA	BDI and the Mini-International Neuropsychiatric Interview (MINI)	ASI	t-tests, multiple logistic regression	Depressive symptoms declined significantly during treatment, an effect which

Authors	Sample demographics				Country/city/state of study	Methods			Key findings relating to MA and depression
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was depression assessed?	How was MA use assessed?	Statistics used	
									was greatest among MA abstainers.
Jaffe et al., 2007	162	100	37/ 19-57	1&2. Gay and bisexual men seeking treatment for MA and diagnosed as MA dependent.	Los Angeles, USA	BDI	Questions on drug use + DSM-IV MA dependence	Structural equation modeling	BDI scores reduced significantly after 1 month of treatment.
Kalechstein et al., 2000	1580	76.1	(66% were 25-44 years)	1. Male & female arrestees. 2. Sampled from the 14 most populous county jails in California	California, USA	Participants were asked if they felt seriously depressed, and lost interest or pleasure in things they usually cared about in the past 12 months.	Participants were classified as (MA) dependent if, during the 12 months prior to the interview, they had 1) used the drug, 2) unsuccessfully tried to decrease their use of the drug, and 3) felt addicted	Chi-square, Odds ratios, hierarchical logistic regression	MA dependent arrestees (n=170) were significantly more likely to have had depressive symptoms (57%) in the past year than those who were not MA dependent (32%). [OR = 2.85, p =0.001] Remained significant after controlling for demographic profile and other substance dependence. [OR = 1.91, p=0.001]
London et al., 2004	17 MA abusers and 18 controls	MA abusers: 65% Controls: 56%	MA abusers: 34.7 Controls: 32.3/	1&2. Inpatient MA abusers and matched controls	Los Angeles, CA, USA	BDI	DSM-IV MA dependence	t-test	MA abusers had higher BDI scores than control subjects [t=-3.88, p=.001]

Authors	Sample demographics				Country/city/state of study	Methods			Key findings relating to MA and depression
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was depression assessed?	How was MA use assessed?	Statistics used	
			Ranges not listed						
Looby & Earleywine, 2007	6673	64	27.4 for MA users (18-62) and 31.2 for non-MA users (18-88)	1. Internet survey advertised via three drug policy organizations' mailing lists 2. Respondents divided into non-MA users and having used MA in the past year. (Those who had used MA, but not in the past year, were excluded)	USA (95% of participants were US residents)	CES-D	Questions on MA use in life-time and previous year	ANCOVA	ANCOVA revealed that MA use accounted for significant variance in depression, apathy, happiness and satisfaction with life. (MA users had higher mean scores on depression). Results remained significant after controlling for the effects of age, gender and other drug and alcohol use.
McGregor et al., 2005	21	95	21.4/ 18-28	1&2. MA patients admitted to a single facility	Chiang Mai, Thailand	BDI	Drug use history	ANOVA	BDI scores reduced significantly within the first 3 weeks of abstinence ($p<0.01$).
Mimiaga et al., 2008	20	100	38.2/ 21-58	1&2. Qualitative study of HIV positive MA using MSM	Massachusetts, USA	Open-ended questions	Questions on MA use	Qualitative	Almost all participants spoke of chronic depression following MA use.

Authors	Sample demographics				Country/city/state of study	Methods			Key findings relating to MA and depression
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was depression assessed?	How was MA use assessed?	Statistics used	
Nakama et al., 2008	77	57	Not listed/ 18-51	1. MA users and controls 2. Recruited through treatment programmes, flyers and word-of-mouth	Hawaii, USA	CES-D	Drug use history (last use, quantity, frequency)	Analysis of variance, correlations	No significant difference in depression scores of MA users and non-users and no correlation between MA use and CES-D scores.
Newton et al., 2004	19	79	33.4 &36.2 (2 study entry groups)/ 26-49	1&2. Non-treatment seeking MA dependent subjects recruited from the community through ads in local newspapers	Los Angeles, CA, USA	BDI	Using at least 0.5 grams of MA per week for six months prior to the study & a positive urine screen for MA	ANOVA	BDI symptoms decreased significantly over a short period of abstinence (3 days), with participants reporting mild to moderate symptoms during the first two days of abstinence and minimal symptoms on the third day. [F(2,16)=6.7, p=0.008]
Peck, Reback, Yang, Rotheram-Fuller, & Shoptaw, 2005	162	100	36.6/ Not listed	1. Gay & bisexual males in treatment programmes, dependent on MA, aged between 18-65 2. Recruited from an outpatient clinic between 1996 and 2001	Hollywood, LA, USA	BDI	Urine samples and 30 day self-report using the Addiction Severity Index	ANCOVA, ANOVA, t-tests and linear mixed regression model	At baseline 73% of participants had at least mild depressive symptoms and 29% had moderate to severe symptoms. Depressive

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	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was depression assessed?	How was MA use assessed?	Statistics used	
									symptoms decreased significantly after one week of treatment. Urine samples documenting recent use of MA predicted future high BDI scores and samples documenting recent prior abstinence predicted future low BDI scores.
Rawson et al., 2002	114	53.5	30.1/ Not listed	1. MA users who were followed up 2-5 years post treatment 2. Convenience sample drawn from an outpatient treatment programme	Los Angeles, USA	Brief Symptom Inventory (BSI): profiles psychiatric symptoms	Urine samples, Addiction Severity Index, question on MA use in past 30 days	Frequency, Chi-square	At baseline 62.9% of the sample reported depression. This remained unchanged at follow-up (62.7%), although 83% reported not having used MA in the 30 days prior to the interview and 54% reported periods of abstinence of 24 months or more from treatment admission to

Authors	Sample demographics				Country/city/state of study	Methods			Key findings relating to MA and depression
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was depression assessed?	How was MA use assessed?	Statistics used	
									follow up.
Riehman et al., 2002	2176	63	33.7/ 18-45+	1. Patients admitted for drug treatment 2. Data was drawn from the Drug Abuse Treatment Outcome Studies (DATOS), a study of 20 major US cities, which included 10,010 individuals admitted to treatment during 1991-1993. 12-month follow-up interviews were conducted and 2176 cocaine or amphetamine (A)/MA users were included in this analysis	20 US cities	1. Series of self-report items measuring depressive symptoms in the 12 months before treatment entry 2. Symptom Check List-90 (SCL-90) – a self-report depression scale	Reported number of times the drug was used per month or per week in the year before treatment entry.	Frequency, Chi-square, t-test Multivariate logistic regression, multivariate linear regression	The cocaine + A/MA and the A/MA groups were also significantly more likely to have had a major lifetime depressive episode (21% and 19% respectively) than the cocaine only group (9%) [$p<0.001$] When controlling for lifetime depressive episode, C+A/MA users were no more likely to report depressive symptoms, whereas the number of substances used significantly increased the odds of depressive symptoms.
Saltman et al., 2008	16	87.5	Not listed	1&2. GPs with high caseloads of gay and HIV+ men recruited Sydney	Sydney, Australia	Semi-structured interviews	Questions about MA use	Qualitative	A number of GPs mentioned associations between problematic MA

Authors	Sample demographics				Country/city/state of study	Methods			Key findings relating to MA and depression
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was depression assessed?	How was MA use assessed?	Statistics used	
									use and depression.
Semple, Zians, Grant, & Patterson, 2005	385	69	36.7/ 18-63	1. HIV negative, heterosexual MA users 2. Recruited from the community through outreach workers, posters, advertisements in local newspapers/magazines and chain referral	San Diego County, CA, USA	BDI	Self-report in number of grams consumed in past 30 days and number of days used in past 30 days	T-test and logistic regression	Respondents were divided into two groups based on an impulsivity score (low & high). Respondents in the high impulsivity group had significantly higher scores (18.0 vs 13.2, $t = 4.7$, $p<0.001$). Logistic regression showed that depression scores also best predicted impulsivity ($p<0.001$), in a model including age, education, amount consumed, no. of sex partners and number of unprotected sex acts.
Semple, Zians, Strathdee, & Patterson, 2007	146	0	35.4/ 18-56	1&2. Heterosexual, HIV- MA using women, volunteering for sexual risk reduction intervention	California, USA	BDI	Quantity and frequency of MA use	Multiple logistic regression	Binge use of MA was positively associated with higher depression symptoms (OR=2.6, CI: 1.2-

Authors	Sample demographics				Country/city/state of study	Methods			Key findings relating to MA and depression
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was depression assessed?	How was MA use assessed?	Statistics used	
									5.8).
Shoptaw, Peck, Reback, & Rotheram-Fuller, 2003	155	100	36/ ≥18	1. Gay and bisexual men enrolled in an outpatient treatment programme for MA dependence. 2. Adult convenience sample	California, USA	Structured Clinical Interview (SCID) for DSM-IV	Questions on drug use	Frequency	Participants only dependent on MA had the highest prevalence of Major Depressive Disorder (53.7%).
Sommers et al., 2005	106	59.4	21.6/ 18-25	1&2. MA users recruited from a treatment programme and the community.	Los Angeles County, USA	Questions on psychological problems	Life history of drug use	Frequency	37% reported depression symptoms.
Sutcliffe et al., 2009a	863	73	Not listed/ 18-25	1&2. MA users part of a randomized trial who returned for at least 3 follow-up visits.	Chiang Mai, Thailand	CES-D	Self-reported use in past 3 months	Paired t-tests, ANOVA, logistic regression	35% reported high levels of depression. Individuals who reduced/ceased MA use had greater decreases in CES-D scores ($p<0.05$).
Vigil et al., 2007	142	59-70	39-43/ not listed	1. MA dependent HCV+, MA dependent HCV-, and non-MA dependent HCV- individuals. 2. Convenience sample of volunteers.	USA	BDI	DSM-IV MA dependence in past 18 months	Chi-squares	MA+ groups had significantly higher non-somatic BDI symptoms than the MA- group. HCV status did not impact on depression.
Wallace et al., 2009	See Wallace et al. (2009) in mental health Table								

Authors	Sample demographics				Country/city/state of study	Methods			Key findings relating to MA and depression
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was depression assessed?	How was MA use assessed?	Statistics used	
Yen & Su, 2006	See Yen & Su (2006) in mental health Table								
Zweben et al., 2004	1016	44.6	Not listed/ ≥18	1&2. A randomized control trial of MA outpatients from 8 clinics	California, Montana and Hawaii, USA	BSI and the BDI-II	Questions on drug use history	Means, frequencies, t-tests	The mean score on the depression sub-scale of the BSI was the highest for all the subscales. Women scored significantly higher on the BDI than men ($p<0.001$).

Table 4: Summary of studies on sexual risk behaviour and methamphetamine (MA)

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and sexual risk behaviour
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was sexual risk behaviour assessed?	How was MA use assessed?	Statistics used	
Baskin-Sommers & Sommers, 2006	243	49	21.4/ 18-24	1&2. University students (aged 18-24) were recruited through posting of flyers at 3 Universities in Los Angeles	Los Angeles, USA	Participants reported number of times they had sex without a condom outside a long-term monogamous relationship and number of partners in the prior 6 months.	Asked if ever used MA in past six months and frequency of use.	Correlations and logistic regression	MA use was significantly correlated with not using a condom ($r=0.30$, $p<0.001$). Adjusted logistic regression showed that the odds of not using a condom was 15.9 for MA users.
Beyrer et al., 2004	1865	MA users: 93% Opiate users: 87%	MA users: 51% <20 years; Opiate users: 51% 35+	1. MA and opiate users admitted for treatment 2. Patients aged 12 or older admitted to a drug treatment centre between February 1999 and January 2000. Of those eligible, 87% completed the study.	Mae Rim, Thailand	Patients were asked about number of sexual partners, condom use, casual sex partners, and having sold sex.	Patients admitted for MA abuse	Odds ratios, multiple logistic regression	Male MA users were more likely than opiate users to report sex with casual female partners in the last year (OR=3.7) and having visited sex workers in the last year (OR=1.8). MA users had higher rates of chlamydial infection than opiate users (OR=2.1).
Bogart et al., 2005	1445	68	42/ 18-77	1. Injecting drug users 2. Recruited from	California, USA	Participants were asked about numbers of sexual	Participants were asked whether they had used	Descriptive, logistic regression,	Anal intercourse was predicted by amphetamine use

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and sexual risk behaviour
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was sexual risk behaviour assessed?	How was MA use assessed?	Statistics used	
				24 syringe exchange programmes in California from 2000-2003		partners they had, whether they had been paid for sex in the past 6 months, engaging in vaginal, anal and oral sex, and condom use.	amphetamines in the past 30 days (injection or non-injection).	multivariate logistic regression	in men and women. Non-injection amphetamine use increased the odds of having both a steady and multiple partners among males. Men who injected amphetamines had lower odds of consistent condom use than those who did not inject amphetamines.
Brown, Domier, & Rawson, 2005	108 (52 MA users)	65 (MA users)	32.5 (MA users)/ not listed	1. MA and cocaine users (92% heterosexual) admitted to a treatment program in California 2. Participants were sampled from one of seven Matrix Institute on Addictions clinics in Southern California or the Washton Institute in New York.	California and New York , USA	Participants were questioned about sexual thoughts, feelings and behaviours they recollected from the last time they were under the influence of the substance relating to their admitting diagnosis.	Participants met criteria for MA dependence according to DSM-IV criteria.	Frequencies and chi-squares	MA and cocaine users were compared in terms of the substances' perceived effects on sexual drive, performance and pleasure. Overall MA was associated with increased sexual thoughts and activity, whereas cocaine use was significantly more associated with

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and sexual risk behaviour
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was sexual risk behaviour assessed?	How was MA use assessed?	Statistics used	
									reduced interest in sex and negative emotional states. Male MA users tended to report more positive effects than female MA users.
Celentano et al., 2008	658	68	19 (median)/ 18-25	1. MA users aged 18-25 years 2. Recruited by outreach workers from places where MA users were known to congregate. Eligible if they used MA or had sex at least 3 times in the past 3 months.	Chiang Mai, Thailand	Questions on condom use at last sex, age of sexual debut, and number of sex partners in the past 12 months. STI testing.	Frequency of MA use in past 3 months	Frequencies and multiple regression	38% of participants had at least one STI. For women, high frequency MA use was associated with prevalent bacterial STI and HSV-2.
Centers for Disease Control, 2006	968	100	Not listed/ 18-35	1. Heterosexual males aged 18-35 from low-income neighbourhoods in northern California 2. Households in low-income census blocks were enumerated in city blocks, and field workers recruited	5 counties in northern California	Questions were asked to determine the sex and category (i.e., main, casual, or anonymous) of each of up to 10 sex partners (in the previous 6 months) and whether acts included vaginal or anal intercourse	MA use was split into two categories: recent use (any use in past 6 months) and historical use (use but not during the preceding 6 months)	Frequencies, chi-square, regression	Regression analyses determined that recent MA users were more likely than men who had never used MA to be sexually active with a female partner, have multiple female

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and sexual risk behaviour
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was sexual risk behaviour assessed?	How was MA use assessed?	Statistics used	
				participant door-to-door.		with the partner.			partners, have a casual or anonymous female partner, have anal intercourse with a casual or anonymous female partner, or have ever received money or drugs for sex from a male or female partner.
Cheng et al., 2009	452	68	36.6/ Not listed	1. HIV-negative heterosexual adult MA users. 2. Sample consisted of individuals enrolled in the FASTLANE sexual risk reduction study at the University of California, San Diego between June 2001 and August 2004.	California, USA	Participants were asked yes/no questions including having had casual or anonymous partners, whether they had any STI in the last 60 days, and engaging in sex marathons, as well as their total number of sex partners.	Questions on age of initiation of MA use and quantity and frequency of MA use in the past 30 days.	Descriptive statistics, univariate and multivariate logistic regression	Participants reported a mean of 4.7(SD=6.1) sex partners in the past 60 days. Marathon sex while high on MA was commonly reported (64%), although women were less likely to report this (OR=0.43, 95% CI: 0.28-0.64).
Cheng et al., 2010	451	68	36.6/ Not listed	As above	California, USA	As above	As above	Descriptive statistics, univariate and multivariate logistic	A multivariate model showed that binge use of MA was associated with marathon sex

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and sexual risk behaviour
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was sexual risk behaviour assessed?	How was MA use assessed?	Statistics used	
								regression	while high on MA (OR=1.86 CI: 1.21-2.87).
Dew et al., 2007	108	100	27.2/ 18-48	1. Heterosexual (n=69) and non-heterosexual (n=39) male current MA users 2. Snowball community based sampling was used to recruit the participants	Atlanta, Georgia, USA	Participants were asked about number of sexual partners they had in the past year, condom use, having sex for money or drugs, having sex under the influence of drugs and a number of other sexual risk and HIV risk related questions.	Participants had to have used MA at least once in the 30 days prior to the interview and at least six times in the six months prior to the interview.	Frequencies, Fisher's exact tests, ANOVA and Mann-Whitney U tests	38% of heterosexual and 32% of non-heterosexual MA users indicated that they 'were always high' when they had sex. Almost half (44%) of the heterosexual group and a third of the non-heterosexual group had never used condoms in the past year. Non-heterosexuals had a significantly higher mean number of sex partners in the past year (19.1, SD=37.7) than heterosexuals (7.3, SD=14.7).
Embry et al., 2009	1213	49	Grade 11 students/ Not listed	1. 11th Grade high school students 2. 88 schools sampled from all high schools in Oregon between	Oregon, USA	Questions on engaging in sex in past 3 months, condom or birth control use, and having been or	Life-time use of MA used for analysis	Logistic Regression	Risky sex was significantly more likely among life-time MA users (Males: OR = 2.32, p <0.01; Females:

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and sexual risk behaviour
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was sexual risk behaviour assessed?	How was MA use assessed?	Statistics used	
				2001-2003		made someone pregnant			OR = 3.43, p < 0.01)
Farabee, Prendergast, & Cartier, 2002	807	unknown	36/ Not listed	1. Inmates whose official records showed clear evidence of substance abuse 2. Volunteers were recruited into the study by research staff from small groups of potential subjects.	California, USA	Questions on number of partners in the past six months, condom use and casual partners	Current MA users were defined as those who reported any MA use during the past six months	Chi-square, logistic regression	MA users (54%) significantly more likely than non-MA users (35%) to have had unprotected sex during past six months with someone who was not their spouse or partner (p<0.01). MA users (24%) also five times more likely than non-users (5%) to have had unprotected sex with injecting drug user. Logistic regression confirmed MA use as predictor of unprotected sex with a non-spouse/partner in past six months (p<0.0001) and unprotected sex with an injecting drug user in the

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and sexual risk behaviour
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was sexual risk behaviour assessed?	How was MA use assessed?	Statistics used	
									past six months ($p<0.0001$).
German et al., 2008	305	0	Not listed/ 18-25	1. Females who had sex at least 3 times in the past 3 months or used MA at least 3 times in the past 3 months. 2. Outreach workers recruited female index participants who had to enrol at least one member of their drug or sex networks.	Chiang Mai, Thailand	Participants were grouped into those with multiple sex partners (i.e. 2 or more male partners in the past 12 months) and those with only one male partner in the past 12 months.	Participants were asked on how many days in the past week they used MA.	Frequencies, chi-square tests, multinomial logistic regression	Females in the multiple sex partners group were significantly more likely to have used MA at least once a week (73%, $p< 0.001$). Adjusted multinomial regression showed that females with only one partner were significantly less likely to use MA at least once per week (RRR=0.40, 95% CI: 0.21-0.77, $p<0.01$)
Gleghorn et al., 1998	1121	64	62% > 18 years/ Not Listed	1. Homeless youth between 12 and 23 years living on the street 2. Youth were identified through street based sampling methods.	San Francisco, Berkeley, Santa Cruz and Arcata, California, USA	Questions were asked about recent casual sex partners, anal sex during the past month, more than one sex partner during the past month, use of any drug during vaginal sex with main or	Questions on use of various drugs in the past month were asked (including speed (MA), cocaine and heroin).	Frequencies, chi-square, Odds ratios	A majority of combined MA and cocaine users (85%) did not use condoms during last intercourse with a main partner. Combined stimulant and heroin and primary

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and sexual risk behaviour
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was sexual risk behaviour assessed?	How was MA use assessed?	Statistics used	
						casual partner, no condom use during last sex with a main or casual partner, and a history of trading sex for money, food, drugs or shelter.			stimulant users were more likely than primary heroin users and non-users to have had a casual sex partner in the past month, and to have had more than one sex partner in the past month.
Iritani et al., 2007	14 108	50.7	Not listed/ 19-24	1. Young adults 2. National cohort study, original sample from 132 schools in 1994-1995 was followed up in 2001-2002	USA	More than one vaginal sex partner in past 12 months, inconsistent or no condom use during past year, regretted sexual situation, and exchange of sex for money (all dichotomous responses)	Used MA in past year and number of times used in past 30 days	Logistic regression	Among women, MA use related to inconsistent condom use (OR = 2.6, $p < 0.05$) and regretting a sexual situation (OR = 2.0, $p < 0.05$) after controlling for other substance use and novelty seeking.
Liu et al., 2006	1725	52	18.5/ 15-21	1. Students from three vocational schools 2. Equal enrolment quotas were set for males and females, as well as for each of the six grade levels in the	Chiang Mai, Thailand	Students were asked about age of first intercourse, condom use, life-time number of sexual partners, whether they had had steady or casual partners in the past 3 months.	Students were asked if they had ever used MA	Chi-square, Mann-Whitney U tests, Cox regression survival analysis	Males (64%) and females (62%) who had ever used MA were twice as likely than those who had not, to have had sex at least once. Ever having used MA

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and sexual risk behaviour
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was sexual risk behaviour assessed?	How was MA use assessed?	Statistics used	
				schools.					was also associated with earlier initiation of intercourse.
Lorvick et al., 2006	477	0	68% aged 30-49	1. Female injecting drug users 2. Women from five semi-annual cross-sections of street-recruited IDUs conducted from 2003 to 2005 were included in this study.	San Francisco, USA	Questions on vaginal and anal sex, condom use and number of sexual partners in the past six months were asked.	Questions on types of drug use were asked. MA injectors were defined as injecting MA in the past six months	Chi-square/Fisher's exact test, stepwise multivariate logistical regression	The odds of having had more than five sexual partners in the past 6 months were significantly higher among MA injectors in both bivariate and multivariate analysis, after controlling for age, white race, homelessness, daily alcohol use, sex with both men and women and frequency of injection in the past 30 days.
MacMaster et al., 2008	97	55.7	30.8/ Not listed	1. Rural MA users 2. Snowball sampling, including use of a flyer distributed to a few known MA users in the community	Rural Tennessee, USA	Qualitative interviews were conducted, using open questions relating to high-risk sexual practices	Self-identified MA users who had used MA at least once in the past year	Qualitative analysis	Most respondents reported that individuals using MA tended to 'have lots of partners' and/or 'nobody stops to use condoms'. Respondents

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and sexual risk behaviour
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was sexual risk behaviour assessed?	How was MA use assessed?	Statistics used	
									reported that 'all you want to do when you get high is have sex' and 'persons using meth don't mind who or how'.
Marquez, et al., 2009	653	80	44 (median)/ Not listed	1. HIV-infected patients visiting outpatient clinics 2. Patients attending two HIV clinics between January and May 2006 were eligible for the study.	San Francisco, USA	Questions on number of sex partners and HIV status positive	Questions on MA use and mode of use	t-test to compare means	Heterosexual men who used MA in the past 4 weeks had a mean of 2.3 sex partners versus a mean of 0.6 partners among those who did not use MA ($p < 0.01$). Men who had sex with men who used MA in the past 4 weeks had a mean of 3.2 sex partners versus a mean of 1.7 partners among those who did not use MA ($p < 0.005$).
McKetin et al., 2008	358	75	30.6/ 16-54	1. MA or amphetamine treatment entrants who reported these drugs as their primary or	Sydney and Brisbane, Australia	A modified version of the Opiate Treatment Index was used along with questions on number of sex	Participants reported MA as a primary or secondary drug, and also completed	Frequencies, t-tests and logistic regression	Frequent MA use (twice or more per day) was found to be related to having had unprotected sex

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and sexual risk behaviour
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was sexual risk behaviour assessed?	How was MA use assessed?	Statistics used	
				secondary concern. 2. Participants recruited from selected treatment centres in Brisbane and Sydney, aged 16 or older who had not received treatment or been incarcerated in past month.		partners and prevalence of unprotected sex in the prior month.	questions on MA use history and frequency.		with more than one partner in the month before treatment (entering the study) (AOR = 1.9, CI: 1.0-3.5, p< 0.05)..
Molitor et al., 1999	1392	74	37 (median)/ 17-72	1. Out-of-treatment injection drug users 2. IDUs were recruited in three California counties by outreach workers from street sites and other venues known to be frequented by IDUs. Male IDUs who had predominantly had sex with men were excluded from the study.	Sacramento , Fresno and San Diego, California, USA	IDUs were asked about sexual behaviour in the past six months, including number of partners, vaginal and anal sex and exchange of sex for money or drugs. They were also asked about frequency of condom use.	Questions on injection MA use in the past 30 days were asked and life-time use of MA (regardless of mode of use).	Chi-square, t-tests, multivariate logistic regression and discriminant function analyses	Discriminant function analysis showed that anal receptive intercourse and condom use had the strongest correlations with MA use (the discriminant function), and anal insertive intercourse and giving or receiving money or drugs for sex were also significant (p<0.05).
Molitor et al., 1998	258 567	50.8	55% <30 years/	1. Men and women attending	California, USA	Questions on frequency of	Questions on drug use history	Chi-square, t-tests, multiple	MA use during sex was reported by

Authors	Sample demographics				Country/ city/state of study	Methods			Key findings relating to MA and sexual risk behaviour
	N	% Male	Mean age/ range	1. Population type & 2. Sampling/ recruitment strategy		How was sexual risk behaviour assessed?	How was MA use assessed?	Statistics used	
			<19-60<	HIV counselling and testing. 2. Men and women attending 850 HIV counselling and testing sites in California between July 1994 and December 1995. Repeat clients, IDUs, clients with missing gender data, clients who had never had sex, or female clients who had sex with women only were eliminated from the analysis.		vaginal and anal sex, numbers of sexual partners, and frequency of condom use were asked.	(including MA) were asked, including drug use during sex.	logistic regression. (Due to large *N* $p<0.0001$ was used as significance level)	3.8% of participants. These participants had a significantly higher mean number of sex partners in the past 12 months (n=5.3), than participants who had not used MA during sex (n=3.1). Among heterosexual men, MA users were more likely to have participated in anal sex with women than non-users (27% vs. 14%). Similarly, a greater percentage of female MA users (31% vs 16%) engaged in anal receptive intercourse. MA use was the most significant predictor of inconsistent condom use.

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Nemoto et al., 2002	83	83	29/ 18-50+	1. Filipino American MA users 2. Participants were recruited through snowball sampling. They had to identify as Filipino, be at least 18 years old, and have used MA during preceding six months at least 3 days per week on average.	San Francisco, USA	The NIDA Risk Behavior Assessment questionnaire, which includes questions on sexual behaviour under the influence of drugs was used. Additional questions on sexual behaviours and commercial sex activities were also asked.	Participants had to have used MA during preceding six months at least 3 days per week.	Frequencies, multiple regression	45% of the sexually active participants reported never using condoms during the previous six months. Of the 39 participants who engaged in sex in the past 30 days, 80% reported using drugs or alcohol immediately before or during sex, with 69% using MA.
Patterson et al., 2009	400	100	36.6/ 19-68	1. Men who had sex with a female sex worker. 2. Recruited by outreach workers and 'jaladores' (men who 'hook up' clients with sex workers)	Tijuana, Mexico	Questions on sexual risk behaviour and Laboratory HIV test	Questions on illicit drug use	Multivariate logistic regression	After controlling for all other variables, ever using MA was significantly related to being HIV positive (OR 4.34: CI 1.31 – 14.36)
Pinhey & Wells, 2007	1386	unknown	Grade 9-12 students	1. Grade 9-12 high school students 2. Random selection of classes from all seven high schools in Guam	Guam	Question on number of sex partners in life-time (scale from 0 to 6 or more)	Question on number of times used MA in life-time (coded as binary – used or not used)	Ordinary least squares multiple regression and Logistic regression	Males and females who had used MA reported a greater number of sex partners ($p < 0.001$), adjusted for age and ethnicity.

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Rawson, Washton, Domier, & Reiber, 2002	321	65	38/ Not listed	1. Drug dependent patients admitted to one of 8 clinics. 2. Over a 60 day period all patients admitted to one of the 8 clinics were invited to participate in the study	Southern California and New York, USA.	Questions about sexual thoughts, feelings and behaviours that patients recollected from the last time they were under the influence of their 'primary drug'.	DSM-IV criteria for MA dependence on admission	Chi-square tests and Post-hoc tests with Bonferroni corrections for multiple comparisons.	Compared with alcohol, opiate and cocaine users, a greater number of MA users reported their sexual performance and pleasure was enhanced by their drug use ($p<0.001$). Compared with the other groups, more MA users reported that their drug use made them obsessed with sex and/or made their sex drive abnormally high.
Rondinelli et al., 2009	3209	70	23.9/ 15-30	1. Injecting Drug Users (IDUs) 2. IDUs aged 15-30 were recruited in Baltimore, Chicago, Los Angeles, New York and Seattle between May 2002 and January 2004	USA	Questions on number of sex partners, unprotected sex, and same sex activity during the past 3 months. Exchanging sex for money or drugs in life-time	Questions on MA use and injecting drug use	Chi-square tests and multiple logistic regression	HIV positive IDUs were more likely than HIV negative IDUs to inject heroin and MA (34% vs 11%, $p < 0.0001$). IDUs who were HIV positive were more likely to inject MA and heroin than heroin alone in a

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									multivariate adjusted model (AOR = 1.47: CI 1.15 – 9.67)
Semple, Grant, & Patterson, 2004	98	0	35.1/ 18-56	1. HIV-negative, heterosexual, female MA users enrolled in a sexual risk reduction intervention. 2. Participants were recruited into a sexual risk reduction intervention through a poster/media campaign and referrals.	San Diego, CA, USA	Questions on frequency of vaginal, anal and oral sex in the past 2 months as well as questions on condom use were asked.	MA dependence was assessed with the SSAGA and the amount of MA use in the past 30 days was recorded.	Frequencies, means, correlations	On average the participants had 7.8 sexual partners in the past 2 months (SD=10.7) and had engaged in an average of 79.2 sex acts over the past 2 months (SD=58.6). Most of these sex acts were unprotected (89%). A significant positive correlation between intensity of MA use and subjective positive experience of sex was also found ($p<0.05$).
Semple et al., 2005	156	76	39/ 18-59	1. HIV-negative, heterosexual MA using adult males and females 2. Participants were recruited by outreach workers	San Diego, CA, USA	Participants were asked about steady, casual and anonymous partners and frequency of vaginal, anal and oral sex in the	The Semi-Structured Assessment for the Genetics of Alcoholism (SSAGA II), section G was	Chi-square, t-tests, mediation analysis	Participants with high levels of negative self-perceptions had the greatest degree of sexual risk behaviour,

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				into an HIV risks counselling programme (FASTLANE).		preceding two months with these respective partner types. Use of condoms and dental dams was also assessed.	used to determine MA abuse and dependence. Frequency of MA use in the past 30 days was also determined.		including significantly more unprotected vaginal sex and a larger number of sexual partners as compared to individuals with low levels of negative self-perceptions.
Semple, Patterson, & Grant, 2004	139	Majority	38.6/ Not listed	1. HIV-negative, heterosexual, MA users enrolled in a sexual risk reduction intervention. 2. Participants were recruited through a poster/media campaign and referrals.	San Diego, CA, USA	Questions on frequency of vaginal, anal and oral sex in the past 2 months as well as questions on condom use were asked.	MA dependence was assessed with the SSAGA and the amount of MA use in the past 30 days was recorded.	Frequencies, means	The mean number of unprotected vaginal sex acts (in the past 2 months) was 21.5 (SD=26.6). Participants reported using condoms for vaginal sex about one third of the time. Condom use during anal and oral sex was also irregular (25% and 7% of the time respectively). Participants reported an average of 9.4 (SD=22.5) sex

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									partners over the past 2 months. Most of the participants (86%) reported that they had engaged in 'marathon sex' while high on MA.
Sherman et al., 2008	48	> 50%	19 (median)/ Not listed	1. Young MA users 2. A purposive sample for a qualitative study was drawn, including young MA users at various points in their trajectory of MA use.	Chiang Mai, Thailand	Qualitative semi-structured interviews including questions on sexual behaviour were used.	Participants had to have used MA in the past year. Qualitative semi-structured interviews including questions on drug use history were used	Qualitative analysis	Participants reported different experiences, with some reporting that MA enhanced their libido, while others reported not 'thinking about sex at all' while high on MA. Some males also reported difficulty with achieving erections after using MA. Many women reported not using condoms when having sex after MA use.
Simbayi et al., 2006	962	45.8	Not listed ≥18	1. General adult population. 2. Street intercept recruitment at community	Cape Town, South Africa	Asked to estimate number of sex partners in past 6 months, occasions of sex with and	Asked if they had ever tried "tik" (MA).	Adjusted odds ratios, multivariate logistic regression	MA use (compared with other non-alcohol drug use) was related to engaging in

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				venues.		without condoms, exchange of sex for money or goods, and use of drugs before sex.			unprotected intercourse while having multiple partners (AOR = 5.6, CI:2.0 - 15.6)
Springer et al., 2007	15,240	51.4	Grade 9-12 students	1. US high-school students 2. National representative sample of US high school students (2003)	USA	Questions related to: Having had sexual intercourse, having had sexual intercourse before age 13, lifetime sexual intercourse experience with four or more people, no condom use during last sexual intercourse, having been pregnant or gotten someone pregnant, and having used drugs or alcohol before last sexual intercourse.	Students were asked how many times in their life they had used MA.	Weighted descriptive and logistic regression analyses	Lifetime MA use was reported by 7.6% of males and 6.8% of females. MA use was associated with 2-11 times the likelihood of engaging in one of the six sexual risk behaviours examined. Heavy MA users were >4 times more likely to report having had sexual intercourse before age 13, sex with multiple partners, and having gotten someone pregnant compared to those who used MA 1-2 times.
Sutcliffe et al., 2009b	519	67	19 (median)/ 18-25	1. Male and female MA users 2. MA users	Chiang Mai, Thailand	Questions relating to condom use, number of sex	Questions on frequency of MA use	Frequencies (prevalence), Poisson	Overall 12.7% of participants had an STI. Most (61.1%)

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				recruited from street. Eligible if 18-25 years and had used MA and had sex at least 3 times in past 3 months.		partners, sex with a sex worker, and sex while high or drunk. Blood and urine were tested for common STIs.		regression to estimate relative risks.	used MA at least once per week. Almost a third had sex while high on drugs (31.4% of females and 29.1% of males).
Yen, 2004	255	65	17/ 15-9	1. 85 adolescent MA users recruited from a juvenile detention centre and 170 controls (non-MA users). 2. MA users were recruited from September 2001 to March 2002. Controls were recruited from a senior high school and a vocational school.	Taiwan	Questions included: age of first intercourse, number of partners, frequency of intercourse in the most recent month, frequency of unprotected sex, frequency of unplanned sex under the influence of MA or alcohol, previous experience of sex with a partner under the influence of MA or alcohol, and previous experience of sex after MA use.	Adolescents arrested for MA use were considered MA users, confirmed by MA positive urine sample.	Chi-square, Fisher's exact test and Mann-Whitney U tests	More MA users than non-users reported previous sexual experience ($p<0.001$). MA users had a higher mean number of partners (3.7 vs 2.0, $p<0.05$). High-frequency MA users had a higher mean number of sex partners than low-frequency MA users ($p<0.05$).The proportions of respondents who had engaged in unprotected sex were higher in high-frequency users than low frequency users (92% vs 66%, $p<0.01$). The

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									proportions of respondents who had used MA before sex were higher in high-frequency users than low-frequency users (33% vs. 6%, p<0.01).
Zapata et al., 2008	15,214	51.4	Grade 9-12 students	1. US high-school students in grades 9-12 2. Three-stage cluster design for national representative sample	USA	Being sexually active in past 3 months; Having 2 or more sex partners during past 3 months; Ever being or getting someone pregnant	Question: 'During your life, how many times have you used MA?' (6 response options)	Logistic regression	Adjusted logistic regression showed that life-time MA use was associated significantly with being sexually active in the past 3 months (AOR=1.8, 95% CI = 1.5.2.3), having 2 or more sex partners in the past 3 months (AOR=3.0, p5% CI = 2.2-4.2), and ever being pregnant or getting someone pregnant (AOR=2.9, 95% CI = 2.1-3.9). The odds of recent sexual activity and having had 2 or

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									more sex partners also increased as the frequency of MA use increased.
Zhongwei Jia et al., 2010	Not listed	Not listed	Not listed	1. 'New drug users' identified through the Chinese National Institute on Drug Dependence. 2. New drug users from 2003-2007 who had not received clinical detoxification were included.	China	A category of drug users using amphetamine-type stimulants (including MA) was created.	Data on HIV/AIDS cases was obtained from the Centre of HIV/AIDS	Partial Least Squares Regression Model	Amphetamine-type stimulant use showed a strong positive association with sexual transmission of HIV.
Zule et al., 2007	703	74	41/ Not listed	1. Out-of-treatment injecting drug users 2. Outreach workers recruited active drug users from high drug use communities.	Raleigh-Durham, North Carolina, USA	Questions were asked about the participants' last sexual encounter, including type of sex (e.g. vaginal, vaginal and oral, vaginal and anal, etc.)	Participants were asked about drug use and whether they or their partner had used MA before or during the last time they had sex.	Multivariate generalised estimating equations were developed to analyse 1213 sexual encounters reported by the 703 participants.	MA was used in 7% of sexual encounters. MA use by either or both partners was associated with an increased likelihood of anal intercourse (OR=2.41, 95% CI: 1.29-4.53), vaginal and anal intercourse (OR=2.41, 95% CI: 1.22-4.77), and sex with a new

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									partner (OR=1.98, 95% CI: 1.09-3.61). MA use by both partners was also significantly associated with unprotected intercourse with a new partner (OR=5.20, 95% CI: 2.09-12.93) and unprotected anal intercourse (OR=4.63, 95% CI: 1.69-12.70).

References

Austin, A.A. (2004). Alcohol, tobacco, other drug use, and violent behavior among Native Hawaiians: ethnic pride and resilience. *Substance Use and Misuse*, 39(5), 721-46.

Baker, A., Lee, N.K., Claire, M., Lewin, T. J., Grant, T., Pohlman, S., Saunders, J. B., Kay-Lambkin, F., Constable, P., Jenner, L., & Carr, V.J. (2004). Drug use patterns and mental health of regular amphetamine users during a reported 'heroin drought'. *Addiction*, 99, 875-884.

Baskin-Sommers, A., & Sommers, I. (2006). The co-occurence of substance use and high-risk behaviours. *Journal of Adolescent Health*, 38(5), 609-611.

Beck, A.T. & Steer, R.A. (1987). *Beck Depression Inventory Manual*. San Antonio, TX: Psychological Corporation.

Beyrer, C., Razak, M.H., Jittiwutikarn, J., Suriyanon, V., Vongchak, T., Srirak, N., Kawichai, S., Tovanabutra, S., Rungruengthanakit, K., Sawanpanyalert, P., Sripaipan, T., & Celentano, D. D. (2004). Methamphetamine users in northern Thailand: changing demographics and risks for HIV and STD among treatment-seeking substance abusers. *International Journal of STD and AIDS*, 15(10), 697-704.

Bogart, L.M., Kral, A.H., Scott, A., Anderson, R., Flynn, N., Gilbert, M.L., & Bluthenthal, R.N. (2005). Sexual risk among injection drug users recruited from syringe exchange programs in California. *Sexually Transmitted Diseases,* 32(1), 27-34.

Booth, B.M., Curran, G., Han, X., Wright, P., Frith, S., Leukefeld, C., Falck, R., & Carlson, R.G. (2010). Longitudinal relationship between psychological distress and multiple substance use: results from a three-year multisite natural-history study of rural stimulant users. *Journal of Studies on Alcohol and Drugs*, 71(2), 258-67.

Booth, B.M., Leukefeld, C., Falck, R., Wang, J., & Carlson, R. (2006). Correlates of rural methamphetamine and cocaine users: results from a multistate community study. *Journal of Studies on Alcohol*, 67(4), 493-501.

Brecht, M. L., O'Brien, A., von Mayrhauser, C., & Anglin, M.D. (2004). Methamphetamine use behaviors and gender differences. *Addictive Behaviors*, 29(1), 89-106.

Brown, A.H., Domier, C.P., & Rawson, R.A. (2005). *Stimulants, sex, and gender*,12(2-3), 169-180.

Bunting, P.J., Fulde, G.W., & Forster, S.L. (2007). Comparison of crystalline methamphetamine ('ice') users and other patients with toxicology-related

problems presenting to a hospital emergency department. *Medical Journal of Australia*, 187(10), 564-6.

Cartier, J., Farabee, D., & Prendergast, M.L. (2006). Methamphetamine use, self-reported violent crime, and recidivism among offenders in California who abuse substances. *Journal of Interpersonal Violence*, 21(4), 435-445.

Celentano, D.D., Sirirojn, B., Sutcliffe, C.G., Quan, V.M., Thomson, N., Keawvichit, R., Wongworapat, K., Latkin, C., Taechareonkul, S., Sherman, S.G., & Aramrattana, A. (2008). Sexually transmitted infections and sexual and substance use correlates among young adults in Chiang Mai, Thailand. *Sexually Transmitted Diseases*, 35(4), 400-5.

Centers for Disease Control. (2006). Methamphetamine use and HIV risk behaviors among heterosexual men--preliminary results from five northern California counties, December 2001-November 2003. *MMWR Morbidity and Mortality Weekly Report*, 55(10), 273-7.

Chen, C.K., Lin, S.K., Sham, P.C., Ball, D., Loh, E.W., Hsiao, C.C., Chiang, Y.L., Ree, S.C., Lee, C.H., & Murray, R.M. (2003). Pre-morbid characteristics and co-morbidity of methamphetamine users with and without psychosis. *Psychological Medicine*., 33(8), 1407-1414.

Cheng, W.S., Garfein, R.S., Semple, S.J., Strathdee, S.A., Zians, J.K., & Patterson, T.L. (2009). Differences in sexual risk behaviors among male and female HIV-seronegative heterosexual methamphetamine users. *American Journal of Drug and Alcohol Abuse*, 35(5), 295-300.

Cheng, W.S., Garfein, R.S., Semple, S.J., Strathdee, S.A., Zians, J.K., & Patterson, T.L. (2010). Binge use and sex and drug use behaviors among HIV(-), heterosexual methamphetamine users in San Diego. *Substance Use and Misuse*, 45(1-2), 116-33.

Cohen, J.B., Dickow, A., Horner, K., Zweben, J.E., Vandersloot, D., Reiber, C., & Methamphetamine Treatment Project . (2003). Abuse and violence history of men and women in treatment for methamphetamine dependence. *American Journal of Addiction*, 12(5), 377-385.

Copeland, A.L., & Sorensen, J.L. (2001). Differences between methamphetamine users and cocaine users in treatment. *Drug and Alcohol Dependence*, 62(1), 91-5.

Darke, S., Torok, M., Kaye, S., Ross, J., & McKetin, R. (2010). Comparative rates of violent crime among regular methamphetamine and opioid users: offending and victimization. *Addiction,* 105(5), 916-919.

Dew, B.J., Elifson, K.W., & Sterk, C.E. (2007). Differences in HIV sexual risk behaviors between heterosexual and nonheterosexual male users of methamphetamine. *Journal of Drug Issues*, 37(2), 281-298.

Domier, C.P., Simon, S.L., Rawson, R.A., Huber, A., & Ling, W. (2000). A comparison of injecting and noninjecting methamphetamine users. *Journal of Psychoactive Drugs*, 32(2), 229-232.

Dyer, K.R., & Cruickshank, C.C. (2005). Depression and other psychological health problems among methamphetamine dependent patients in treatment: Implications for assessment and treatment outcome. *Australian Psychologist*, 40(2), 96-108.

Eisinger, G.J., Wodarski, J.S., & Ferguson, D. (2009). Psychosocial Correlates of Methamphetamine Use. *Journal of Human Behavior in the Social Environment*, 19(7), 915-931.

Embry, D., Hankins, M., Biglan, A., & Boles, S. (2009). Behavioral and social correlates of methamphetamine use in a population-based sample of early and later adolescents. *Addictive Behaviors*, 34(4), 343-51.

Ernst, A.A., Weiss, S.J., Enright-Smith, S., Hilton, E., & Byrd, E.C. (2008). Perpetrators of intimate partner violence use significantly more methamphetamine, cocaine, and alcohol than victims: a report by victims. *American Journal of Emergency Medicine*, 26(5), 592-596.

Farabee, D., Prendergast, M., & Cartier, J. (2002). Methamphetamine use and HIV risk among substance-abusing offenders in California. *Journal of Psychoactive Drugs*, 34(3), 295-300.

German, D., Sherman, S.G., Latkin, C. A., Sirirojn, B., Thomson, N., Sutcliffe, C.G., Aramrattana, A., & Celentano, D.D. (2008). Young Thai women who use methamphetamine: intersection of sexual partnerships, drug use, and social networks. *International Journal of Drug Policy*, 19(2), 122-9.

Glasner-Edwards, S., Marinelli-Casey, P., Hillhouse, M., Ang, A., Mooney, L.J., & Rawson, R. (2009). Depression among methamphetamine users: association with outcomes from the Methamphetamine Treatment Project at 3-year follow-up. *The Journal of Nervous and Mental Disease*, 197(4), 225-31.

Glasner-Edwards, S., Mooney, L. J., Marinelli-Casey, P., Hillhouse, M., Ang, A., & Rawson, R. (2008). Identifying methamphetamine users at risk for major depressive disorder: findings from the methamphetamine treatment project at three-year follow-up. *The American Journal on Addictions*, 17(2), 99-102.

Gleghorn, A.A., Marx, R., Vittinghoff, E., & Katz, M.H. (1998). Association between drug use patterns and HIV risks among homeless, runaway, and street youth in northern California. *Drug and Alcohol Dependence*, 51 (3), 219-27.

Gonzales, R., Ang, A., Marinelli-Casey, P., Glik, D.C., Iguchi, M.Y., & Rawson, R.A. (2009). Health-related quality of life trajectories of methamphetamine-dependent individuals as a function of treatment completion and continued care over a 1-year period. *Journal of Substance Abuse Treatment*, 37(4), 353-61.

Grant, K.M., Kelley, S.S., Agrawal, S., Meza, J.L., Meyer, J.R., & Romberger, D.J. (2007). Methamphetamine use in rural Midwesterners. *The American Journal on Addictions*, 16(2), 79-84.

Grella, C.E., Hser, Y.I., & Huang, Y.C. (2006). Mothers in substance abuse treatment: differences in characteristics based on involvement with child welfare services. *Child Abuse and Neglect*, 30(1), 55-73.

Hall, W., Hando, J., Darke, S., & Ross, J. (1996). Psychological morbidity and route of administration among amphetamine users in Sydney, Australia. *Addiction*, 91(1), 81-87.

Hendrickson, R.G., Cloutier, R., & McConnell, K.J. (2008). Methamphetamine-related emergency department utilization and cost. *Academic Emergency Medicine*, 15(1), 23-31.

Herman-Stahl, M., Krebs, C.P., Kroutil, L.A., & Heller, D.C. (2006). Risk and protective factors for nonmedical use of prescription stimulants and methamphetamine among adolescents. *Journal of Adolescent Health*, 39(3), 374-380.

Iritani, B.J., Hallfors, D.D., & Bauer, D.J. (2007b). Crystal methamphetamine use among young adults in the USA. *Addiction*, 102(7), 1102-1113.

Jaffe, A., Shoptaw, S., Stein, J., Reback, C.J., & Rotheram-Fuller, E. (2007). Depression ratings, reported sexual risk behaviors, and methamphetamine use: latent growth curve models of positive change among gay and bisexual men in an outpatient treatment program. *Experimental & Clinical Psychopharmacology*, 15(3), 301-7.

Kalechstein, A.D., Newton, T.F., Longshore, D., Anglin, M.D., van Gorp, W.G., & Gawin, F.H. (2000). Psychiatric comorbidity of methamphetamine dependence in a forensic sample. *The Journal of Neuropsychiatry & Clinical Neurosciences*, 12(4), 480-484.

Kim, R. J., & Jackson, D. S. (2008). A comparison of adolescent methamphetamine and other substance users in Hawai'i. *Hawaii Medical Journal*, 67(11), 294-300, 302.

Kleintjies, S., Flisher, A.J., Fick, M., Railoun, A., Lund, C., Molteno, C., & Robertson, B.A. (2006). The prevalence of mental disorders among children, adolescents and adults in the western Cape, South Africa. *South African Psychiatry Review*, 9, 157-160.

Lapworth, K., Dawe, S., Davis, P., Kavanagh, D., Young, R., & Saunders, J. (2009). Impulsivity and positive psychotic symptoms influence hostility in methamphetamine users. *Addictive Behaviors*, 34(4), 380-385.

Leamon, M.H., Gibson, D.R., Canning, R.D., & Benjamin, L. (2002). Hospitalization of patients with cocaine and amphetamine use disorders from a psychiatric emergency service. *Psychiatric Services*, 53(11), 1461-1466.

Lin, S.-K., Ball, D., Hsiao, C.-C., Chiang, Y.-L., Ree, A.-C., & Chen, C.-K. (2004). Psychiatric comorbidity and gender differences of persons incarcerated for methamphetamine abuse in Taiwan. *Psychiatry and Clinical Neurosciences*, 58, 206-212.

Liu, A., Kilmarx, P., Jenkins, R. A., Manopaiboon, C., Mock, P. A., Jeeyapunt, S., Uthaivoravit, W., & van Griensven, F. (2006). Sexual initiation, substance use, and sexual behavior and knowledge among vocational students in northern Thailand. *International Family Planning Perspectives*, 32(3), 126-35.

Logan, B.K., Fligner, C.L., & Haddix, T. (1998). Cause and manner of death in fatalities involving methamphetamine. *Journal of Forensic Sciences*, 43(1), 28-34.

London, E.D., Simon, S.L., Berman, S.M., Mandelkern, M.A., Lichtman, A.M., Bramen, J., Shinn, A.K., Miotto, K., Learn, J., Dong, Y., Matochik, J.A., Kurina, V., Newton, T., Woods, R., Rawson, R., & Ling, W. (2004). Mood disturbances and regional cerebral metabolic abnormalities in recently abstinent methamphetamine abusers. *Archives of General Psychiatry*, 61(1), 73-84.

Looby, A., & Earleywine, M. (2007). The impact of methamphetamine use on subjective well-being in an Internet survey: preliminary findings. *Human Psychopharmacology: Clinical & Experimental*, 22(3), 167-172.

Lorvick, J., Martinez, A., Gee, L., & Kral, A.H. (2006). Sexual and injection risk among women who inject methamphetamine in San Francisco. *Journal of Urban Health*, 83(3), 497-505.

MacMaster, S. A., Tripp, K., & Argo, S. (2008). Perceptions of HIV risk behaviors and service needs among methamphetamine users in rural Appalachian Tennessee. *Journal of Ethnicity in Substance Abuse*, 7(1), 115-30.

Marquez, C., Mitchell, S.J., Hare, C.B., John, M., & Klausner, J.D. (2009a). Methamphetamine use, sexual activity, patient-provider communication, and medication adherence among HIV-infected patients in care, San Francisco 2004-2006. *AIDS Care*, 21(5), 575-82.

Martin, I., Palepu, A., Wood, E., Li, K., Montaner, J., & Kerr, T. (2009). Violence among Street-Involved Youth: The Role of Methamphetamine. *European Addiction Research*, 15(1), 32-38.

Maxwell, J.C., & Spence, R.T. (2005). Profiles of Club Drug Users in Treatment. *Substance Use & Misuse*, 40(9-10), 1409-1426.

McGregor, C., Srisurapanont, M., Jittiwutikarn, J., Laobhripatr, S., Wongtan, T., & White, J. M. (2005). The nature, time course and severity of methamphetamine withdrawal. *Addiction*, 100, 1320-1329.

McKetin, R., McLaren, J., Lubman, D. I., & Hides, L. (2006). The prevalence of

psychotic symptoms among methamphetamine users. *Addiction*, 101(10), 1473-1478.

McKetin, R., Ross, J., Kelly, E., Baker, A., Lee, N., Lubman, D.I., & Mattick, R. (2008). Characteristics and harms associated with injecting versus smoking methamphetamine among methamphetamine treatment entrants. *Drug & Alcohol Review*, 27(3), 277-285.

Mimiaga, M. J., Fair, A. D., Mayer, K. H., Koenen, K., Gortmaker, S., Tetu, A. M., Hobson, J., & Safren, S. A. (2008). Experiences and sexual behaviors of HIV-infected MSM who acquired HIV in the context of crystal methamphetamine use. *AIDS Education and Prevention*, 20(1), 30-41.

Miura, H., Fujiki, M., Shibata, A., & Ishikawa, K. (2006). Prevalence and profile of methamphetamine users in adolescents at a juvenile classification home. *Psychiatry and Clinical Neurosciences*, 60(3), 352-7.

Molitor, F., Ruiz, J. D., Flynn, N., Mikanda, J. N., Sun, R. K., & Anderson, R. (1999). Methamphetamine use and sexual and injection risk behaviors among out-of-treatment injection drug users. *American Journal of Drug and Alcohol Abuse*, 25(3), 475-493.

Molitor, F., Truax, S. R., Ruiz, J. D., & Sun, R. K. (1998). Association of methamphetamine use during sex with risky sexual behaviors and HIV infection among no-injection drug users. *The Western Journal of Medicine*, 168(2), 93-97.

Nakama, H., Chang, L., Cloak, C., Jiang, C., Alicata, D., & Haning, W. (2008). Association between psychiatric symptoms and craving in methamphetamine users. The American *Journal on Addictions*, 17(5), 441-446.

Nemoto, T., Operario, D., & Soma, T. (2002). Risk behaviors of Filipino methamphetamine users in San Francisco: implications for prevention and treatment of drug use and HIV. *Public Health Reports*, 117 Suppl 1, S30-38.

Newton, T. F., Kalechstein, A. D., Duran, S., Vansluis, N., & Ling, W. (2004). Methamphetamine abstinence syndrome: preliminary findings. *The American Journal on Addictions*, 13(3), 248-255.

Paula, C.S., Duarte, C.S., & Bordin, I.A. (2007). Prevalence of mental health problems in children and adolescents from the outskirts of Sao Paulo City: treatment needs and service capacity evaluation. *Revista Brasileira de Psiquiatria* 29(1), 11-17.

Patterson, T. L., Goldenberg, S., Gallardo, M., Lozada, R., Semple, S. J., Orozovich, P., Abramovitz, D., & Strathdee, S. A. (2009). Correlates of HIV, sexually transmitted infections, and associated high-risk behaviors among male clients of female sex workers in Tijuana, Mexico. *AIDS*, 23(13), 1765-1771.

Peck, J. A., Reback, C. J., Yang, X., Rotheram-Fuller, E., & Shoptaw, S. (2005).

Sustained reductions in drug use and depression symptoms from treatment for drug abuse in methamphetamine-dependent gay and bisexual men. *Journal of Urban Health*, 82(1 Suppl 1), i100-108.

Pinhey, T. K., & Wells, N. R. (2007). Asian-Pacific Islander adolescent methamphetamine use: does ice increase aggression and sexual risks? Substance Use & Misuse, 42(11), 1801-9.

Ravens-Sieberer, U., Wille, N., Erhart, M., Bettge, S., Wittchen, H.U., Rothenberger, A., Herpertz-Dahlmann, B., Resch, F., Holling, H., Bullinger, M., Barkmann, C., Schulte-Markwort, M., & Dopfner, M. (2008). Prevalence of mental health problems among children and adolescents in Germany: results of the BELLA study within the National Health Interview and Examination Survey. *European Child & Adolescent Psychiatry*, 17 Suppl 1, 22-33.

Rawson, R., Huber, A., Brethen, P., Obert, J., Gulati, V., Shoptaw, S., & Ling, W. (2000). Methamphetamine and cocaine users: differences in characteristics and treatment retention. *Journal of Psychoactive Drugs*, 32(2), 233-8.

Rawson, R.A., Gonzalez, R., Obert, J.L., McCann, M.J., & Brethen, P. (2005). Methamphetamine use among treatment-seeking adolescents in Southern California: participant characteristics and treatment response. *Journal of Substance Abuse Treatment*, 29(2), 67-74.

Rawson, R. A., Huber, A., Brethen, P., Obert, J., Gulati, V., Shoptaw, S., & Ling, W. (2002). Status of methamphetamine users 2-5 years after outpatient treatment. *Journal of Addictive Diseases*, 21(1), 107-119.

Rawson, R.A., Washton, A., Domier, C.P., & Reiber, C. (2002). Drugs and sexual effects: role of drug type and gender. *Journal of Substance Abuse Treatment*, 22(2), 103-108.

Richards, J.R., Bretz, S.W., Johnson, E.B., Turnipseed, S.D., Brofeldt, B.T., & Derlet, R.W. (1999). Methamphetamine abuse and emergency department utilization. *Western Journal of Medicine*, 170(4), 198-202.

Riehman, K.S., Iguchi, M.Y., & Anglin, M.D. (2002). Depressive symptoms among amphetamine and cocaine users before and after substance abuse treatment. *Psychology of Addictive Behaviors*, 16(4), 333-337.

Rondinelli, A.J., Ouellet, L.J., Strathdee, S.A., Latka, M. H., Hudson, S.M., Hagan, H., & Garfein, R.S. (2009). Young adult injection drug users in the United States continue to practice HIV risk behaviors. *Drug & Alcohol Dependence*, 104(1-2), 167-74.

Saltman, D.C., Newman, C.E., Mao, L., Kippax, S.C., & Kidd, M.R. (2008). Experiences in managing problematic crystal methamphetamine use and associated depression in gay men and HIV positive men: in-depth interviews with general practitioners

in Sydney, Australia. *BMC Family Practice*, 9, 45.

Semple, S.J., Grant, I., & Patterson, T.L. (2004). Female methamphetamine users: social characteristics and sexual risk behaviour. *Women & Health*, 40(3), 35-50.

Semple, S. J., Grant, I., & Patterson, T. L. (2005). Negative self-perceptions and sexual risk behavior among heterosexual methamphetamine users. *Substance Use & Misuse*, 40(12), 1797-810.

Semple, S. J., Patterson, T. L., & Grant, I. (2004b). The context of sexual risk behavior among heterosexual methamphetamine users. *Addictive Behaviors*, 29(4), 807-810.

Semple, S.J., Zians, J., Grant, I., & Patterson, T.L. (2005). Impulsivity and methamphetamine use. *Journal of Substance Abuse Treatment*, 29(2), 85-93.

Semple, S.J., Zians, J., Strathdee, S.A., & Patterson, T.L. (2007). Psychosocial and behavioral correlates of depressed mood among female methamphetamine users. *Journal of Psychoactive Drugs*, Suppl 4, 353-366.

Sexton, R. L., Carlson, R. G., Leukefeld, C. G., & Booth, B. M. (2009). An Ethnographic Exploration of Self-Reported Violence Among Rural Methamphetamine Users. *Journal of Ethnicity in Substance Abuse*, 8(1), 35-53.

Sherman, S.G., Gann, D., German, D., Sirirojn, B., Thompson, N., Aramrattana, A., & Celentano, D. (2008). A qualitative study of sexual behaviours among methamphetamine users in Chiang Mai, Thailand: a typology of risk. *Drug & Alcohol Review*, 27(3), 263-269.

Shih-Ku Lin, T., Ball, D., Cheng-Cheng Hsiao, D. , Yuan-Lin Chiang, D., Shao-Chun Ree, D., & Chih-Ken Chen, D. (2004). Regular Article Psychiatric comorbidity and gender differences of persons incarcerated for methamphetamine abuse in Taiwan. *Psychiatry & Clinical Neurosciences*, 58(2), 206-212.

Shoptaw, S., Peck, J., Reback, C. J., & Rotheram-Fuller, E. (2003). Psychiatric and substance dependence comorbidities, sexually transmitted diseases, and risk behaviors among methamphetamine-dependent gay and bisexual men seeking outpatient drug abuse treatment. *Journal of Psychoactive Drugs*, 35 Suppl 1, 161-8.

Simbayi, L.C., Kalichman, S.C., Cain, D., Cherry, C., Henda, N., & Cloete, A. (2006). Methamphetamine use and sexual risks for HIV infection in Cape Town, South Africa. *Journal of Substance Use*, 11(4), 291-300.

Sommers, I., Baskin, D., & Baskin-Sommers, A. (2005). Methamphetamine use among young adults: Health and social consequences. *Addictive Behaviors*, 31(8), 1469-1476.

Sommers, I., & Baskin, D. (2006). Mehtamphetamine use and violence. *Journal of Drug Issues*, 36(1), 77-96.

Springer, A., Peters, R., Shegog, R., White, D., & Kelder, S. (2007a). Methamphetamine Use and Sexual Risk Behaviors in U.S. High School Students: Findings from a National Risk Behavior Survey. *Prevention Science*, 8(2), 103-113.

Stoops, W.W., Tindall, M.S., Havens, J.R., Oser, C.B., Webster, J.M., Mateyoke-Scrivner, A., Wright, P.B., Booth, B.M., & Leukefeld, C.G. (2007). Kentucky rural stimulant use: a comparison of methamphetamine and other stimulant users. *Journal of Psychoactive Drugs*, Suppl 4, 407-17.

Stretesky, P.B. (2009). National Case-Control Study of Homicide Offending and Methamphetamine Use. *Journal of Interpersonal Violence*, 24(6), 911-924.

Sutcliffe, C. G., German, D., Sirirojn, B., Latkin, C., Aramrattana, A., Sherman, S. G., & Celentano, D. D. (2009a). Patterns of methamphetamine use and symptoms of depression among young adults in northern Thailand. *Drug and Alcohol Dependence*, 101(3), 146-151.

Sutcliffe, C.G., Aramrattana, A., Sherman, S.G., Sirirojn, B., German, D., Wongworapat, K., Vu Minh Quan, Keawvichit, R., & Celentano, D.D. (2009b). Incidence of HIV and Sexually Transmitted infections and risk Factors for acquisition among young methamphetamine users in Northern Thailand. *Sexually Transmitted Diseases*, 36(5), 284-280.

Swanson, S. M., Sise, C. B., Sise, M. J., Sack, D. I., Holbrook, T. L., & Paci, G. M. (2007). The scourge of methamphetamine: impact on a level I trauma center. *Journal of Trauma* , 63(3), 531-7.

Szuster, R. R. (1990). Methamphetamine in psychiatric emergencies. *Hawaii Medical Journal*, 49(10), 389-91.

Toles, M., Jiang, C. S., Goebert, D., & Lettich, L. (2006). Methamphetamine in emergency psychiatry. *Addictive Disorders and Their Treatment*, 5(4), 191-199.

Tominaga, G. T., Garcia, G., Dzierba, A., & Wong, J. (2004). Toll of methamphetamine on the trauma system. *Archives of Surgery*, 139(8), 844-847.

Townsend, L., Flisher, A.J., & King, G. A systematic review of the relationship between high school dropout and substance use. *Clinical Child and Family Psychology*, 10(4), 295-317.

Vigil, O., Woods, S. P., Moran, L. M., Letendre, S. L., Young-Casey, C., Grant, I., & Atkinson, J. H. (2007). Is hepatitis C infection associated with increased risk of depression in persons with methamphetamine dependence? *The American Journal on Addictions*, 16(5), 418-423.

Vincent, N., Shoobridge, J., Ask, A., Allsop, S., & Ali, R. (1998). Physical and mental health problems in amphetamine users from metropolitan Adelaide, Australia. *Drug & Alcohol Review*, 17(2), 187-195.

Wallace, C., Galloway, T., McKetin, R., Kelly, E., & Leary, J. (2009). Methamphetamine use, dependence and treatment access in rural and regional North Coast of New South Wales, Australia. *Drug & Alcohol Review*, 28(6), 592-9.

Yen, C.F. (2004). Relationship between methamphetamine use and risky sexual behavior in adolescents. *Kaohsiung Journal of Medical Science* , 20(4), 160-165.

Yen, C.F., & Su, Y.C. (2006). The associations of early-onset methamphetamine use with psychiatric morbidity among Taiwanese adolescents. *Substance Use & Misuse*, 41(1), 35-44.

Zapata, L.B., Hillis, S.D., Marchbanks, P.A., Curtis, K.M., & Lowry, R. (2008). Methamphetamine use is independently associated with recent risky sexual behaviors and adolescent pregnancy. *Journal of School Health*, 78(12), 641-8.

Zhongwei Jia, Wei Wang, Dye, C., Yanping Bao, Zhimin Liu, & Lin Lu. (2010). Exploratory Analysis of the Association between New-Type Drug Use and Sexual Transmission of HIV in China. *American Journal of Drug & Alcohol Abuse*, 36(2), 130-133.

Zule, W.A., Costenbader, E.C., Meyer, W.J.Jr , & Wechsberg, W.M. (2007). Methamphetamine use and risky sexual behaviors during heterosexual encounters. *Sexually Transmitted Diseases*, 34(9), 689-94.

Zweben, J.E., Cohen, J.B., Christian, D., Galloway, G.P., Salinardi, M., Parent, D., & Iguchi, M. (2004). Psychiatric symptoms in methamphetamine users. *The American Journal on Addictions*, 13, 181-190.

CHAPTER 3

Surge in treatment admissions related to methamphetamine use in Cape Town, South Africa: Implications for public health

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Abstract

Introduction and aims: In the past decade, methamphetamine has increasingly become a drug of concern globally. The purpose of this study is to describe the changing trends in treatment admissions for methamphetamine abuse in Cape Town, South Africa and to highlight the implications of these changes for policy, practice and research. **Design and methods:** Data were collected on admissions for drug abuse treatment through a regular monitoring system involving drug treatment centres and programmes in Cape Town every six months as part of the South African Community Epidemiology Network on Drug Use (SACENDU). A one-page form was completed by treatment centre personnel to obtain demographic data, the patients' primary and secondary substances of abuse, the mode, frequency and age of first use of substance, and information on prior treatment. **Results:** The results indicate that between 2004 and 2006 a dramatic increase in treatment admissions for methamphetamine abuse occurred, a large proportion of the methamphetamine patients are adolescents and that the drug is almost exclusively smoked. **Discussion and conclusions:** The rapid increase in admissions for methamphetamine abuse is of great concern, particularly as the drug has a number of serious, often chronic side effects, and that a large proportion of the patients are adolescents. The implications for public health are discussed.

Introduction

In the last decade increases in methamphetamine use have been documented in a number of countries, including Australia, Japan, New Zealand, Thailand and some parts of the United States [1-7]. Traditionally, levels of methamphetamine and other amphetamine use have been low in Africa [8, 9].

South Africa has experienced a considerable increase in drug trafficking and use of heroin, cocaine and amphetamine-type stimulants (ATS) since its first democratic election in 1994 and subsequent re-entry into the global economy. The country's geographic location, lax border controls, weak criminal justice system, modern telecommunications and banking systems and international trade links with South America, North America, Europe, and Asia have resulted in South Africa becoming a desirable zone for the transshipment of drugs. Heroin (from Asia) and cocaine (from South America) are both imported into South Africa and also exported to Europe, North America and even Australia [8, 9]. Over the past 10 years urban centres such as Cape Town, Johannesburg and Pretoria have witnessed a marked increase in the use of drugs like heroin and cocaine [10]. However very little use of methamphetamine had been noted until data collected from drug treatment centres in Cape Town began to show significant numbers of patients reporting the use of this drug in 2004.

The purpose of this paper is to (i) describe changes in treatment admissions for methamphetamine-related problems in Cape Town, South Africa from 2004 to 2006; and (ii) outline the implications these findings have for policy, practice, and research.

Methods

Established in 1996, the South African Community Epidemiology Network on Drug Use (SACENDU) is a network of researchers, practitioners and policy makers from six sentinel sites who meet bi-annually to provide community-level public health surveillance information about alcohol and other drug (AOD)-related trends. All AOD treatment centres are requested to join the network, although participation within the network is voluntary. SACENDU collects data from more than 80% of treatment centres in Cape Town and includes both state-funded, private non-profit, and private for-profit facilities in its network and data are therefore representative of treatment centres in the region. The focus of this paper is on data obtained from 27 specialist substance abuse treatment centres. All these centres have participated in the project since 2004 and 22 of the 27 since 2002. The five centres added between 2002 and 2006 were small programmes, serving a small number of clients and collectively contributing less than 5% of the total number of patients treated every six months.

For the purpose of monitoring, a standardised one-page form is completed for each person treated by a given centre during a particular six-month period. The form records responses about the source of referral for treatment, biographical information, the type of treatment received (inpatient and/or outpatient), the primary and secondary substances of abuse (including alcohol, over-the-counter and prescription medicines, and illicit drugs), the mode(s) of use, frequency of use, age of first use and whether the person had received treatment prior to the current episode. It is based on the instrument developed by the

Pompidou Group in Europe and more recently on the Treatment Demand Indicators (TDI) used by the European Monitoring Centre for Drugs and Drug Addiction. To ensure data quality treatment centre personnel regularly receive training in data collection procedures and completed forms are checked for missing information and possible mis-codes. Forms are completed by treatment centre personnel upon admission or shortly thereafter. Ethical approval for this study was provided by the South African Medical Research Council's Ethics Committee.

Results

Figure 1 indicates that the proportion of persons seeking treatment with methamphetamine as their primary substance of abuse has increased steadily from 0.3% in the first half of 2002 (N = 4/1608) to 42.3% in the second half of 2006 (N = 1184/2798) (Figure 1). The Cochran-Armitage Trend test showed this increase as significant ($z = 50.174$, $p < 0.0001$). During the same time period, the proportion of patients reporting methamphetamine as their primary or secondary substance of abuse increased significantly from 0.7% in the first half of 2002 to 51.9% in the second half of 2006 ($z = 59.443$, $p < 0.0001$).

For each data collection period, smoking is the most frequently reported mode of primary drug use (90%-99%), with only one to six percent of respondents reporting snorting as their mode of ingestion. Table 1 presents data from the six most recent six-monthly data collection periods. Over all six data collection periods, only nine out of 4243 patients reported injecting methamphetamine. The majority of patients reported frequent use of

methamphetamine, with the proportion of patients reporting daily methamphetamine use ranging from 39% to 58%, and the proportion of respondents reporting methamphetamine use several times per week ranging from 28% to 35%. The proportion of patients reporting daily use of methamphetamine has increased steadily and significantly, according to the Cochran-Armitage Trend test ($z = 8.838$, $p < 0.0001$), over the past four reporting periods (Table 1).

Throughout these periods, the majority of persons accessing treatment for methamphetamine-related problems were male, with the proportion of females accessing treatment ranging from 24% to 29% (Table 1). During the same time period, Coloured South Africans were more likely to access treatment for methamphetamine-related problems than patients from other race groups (with the proportion of Coloureds ranging from 81% to 92%).[1] The mean age of patients reporting methamphetamine-related problems ranged from 19.7 years (SD = 5.07) in the first half of 2004 to 22.3 years (SD = 6.21) in the second half of 2006. The mean age of patients reporting methamphetamine-related problems has increased over time and an ANOVA indicated this increase to be significant ($F = 94.21$, $df = 1$, $p < 0.0001$).

The age of patients with methamphetamine-related problems ranged from 11 to 53 years. The proportion of adolescent patients (i.e. patients younger than 20 years) reporting methamphetamine as their primary substance of abuse fluctuated between 38% and 59%

[1] The terms “white", "black", and "Coloured”, originate from the apartheid era. They refer to demographic markers and do not signify inherent characteristics. They refer to people of European, African and mixed (African, European and/or Asian) ancestry, respectively. These markers were chosen for their historical significance. Their continued use in South Africa is important for monitoring improvements in health and socio-economic disparities, identifying vulnerable sections of the population, and planning effective prevention and intervention programmes

over the six reported periods (Table 1). Similarly, Figure 2 presents that the proportion of adolescents receiving treatment for methamphetamine as a primary or secondary drug of abuse ranged between 59% and 73% of all adolescent patients in substance abuse treatment.

Between 2004 and 2006, 85% to 88% of patients with methamphetamine-related problems were first-time admissions. Over the six reporting periods, the mean time to treatment from first use of methamphetamine ranged between 1.5 and 2.7 years (SD = 1.37 to 2.46). This was shorter than that for other drugs, with time to treatment for heroin ranging from 2.4 to 3.0 years (SD = 2.02 to 2.73), and time to treatment for crack/cocaine ranging from 5.0 to 5.4 years (SD = 4.14 to 6.0). In addition, an ANOVA revealed that the mean time to treatment for methamphetamine-related problems has increased significantly over the six reporting periods ($F = 140.00$, $df = 1$, $p < 0.0001$).

Discussion

The increase in treatment admissions for methamphetamine related problems in Cape Town represents the most rapid increase in admissions for a particular drug ever noted in the country. Increases in admissions for other drugs such as heroin have been more gradual [10]. Of particular concern is the use of this drug amongst poor Coloured and Black communities where there are high levels of violence and HIV, given the potential methamphetamine has to fuel both violence and risky sexual behaviour. The association between methamphetamine use and sexual risk behaviour [1,7] is also disconcerting, given the already high prevalence of HIV infection in South Africa. Although the

prevalence rate of HIV among pregnant women in the province surrounding Cape Town (the Western Cape) is still the lowest in the country (according to antenatal clinic attendee data) at 16% for 2005, the province has recently seen the highest increase in the incidence of HIV in the country [11]. Although methamphetamine is almost exclusively smoked in Cape Town currently, there is also the potential for injection methamphetamine use to increase, further adding to the HIV risk nexus. The concern therefore is that methamphetamine use among a young sexually active population could further fuel the already high incidence of HIV/AIDS in this part of South Africa.

Another concern is the large number of adolescent users presenting for treatment and the dramatic increase in their admissions for treatment compared to older users. This appears to differ from the United States and Australia, where the majority of patients are above 25 years [12, 13], and is only partially explained in terms of any structural changes in treatment services or service marketing practices. While the proportion of adolescent methamphetamine patients did decline from 53% in the first half of 2004 to 34% in the second half of 2006 and the mean age of methamphetamine patients in treatment also increased from 19.7 to 22.3 years, it is difficult to say whether this is reflective of a decline in use among adolescents in the community. The increase in mean age of methamphetamine patients and the increase in mean time from first use to first treatment could possibly indicate that the youngest users of methamphetamine were the first to present for treatment, while those who were slightly older have taken more time to reach the point of entering treatment, shifting the mean age of patients in treatment and the time to first treatment upward.

As the size of the treatment system in Cape Town did not change significantly between 2004 and 2006, an increase in availability of treatment places is unlikely to have been a significant factor contributing to the increase in methamphetamine-related admissions, although these patients may have pushed others out of treatment due to their young age and (possibly) more severe symptoms. There is a lack of additional indicator data tracking changes in drug use, although the police forensic science laboratory in Cape Town has reported an increase in amphetamine-related cases during 2004 to 2006. A community survey of 962 adults conducted in one of Cape Town's suburbs in 2006 found that 18% of men and 12% of women had tried methamphetamine at least once [14]. No other survey data on methamphetamine use in Cape Town have been published to date.

Alongside the increase in the proportion of methamphetamine patients a decrease in the proportion of patients presenting with mandrax (methaqualone) as their primary substance has been noted from 2002 to 2006, decreasing from 21% in the first half of 2002 to 3% in the second half of 2006. It is widely believed that methamphetamine has replaced mandrax in Cape Town, with organised crime changing their focus from the sale of mandrax to methamphetamine, possibly due to higher profit margins and the apparent greater popularity of the drug. There has also been a steady decrease in the proportion of patients coming to treatment centres in Cape Town with cocaine as their primary drug of abuse, from 9.7% in the first half of 2004 to 4.8% in the second half of 2006, suggesting that stimulant users have also shifted to methamphetamine use.

These findings suggest that researchers and policymakers should be extremely concerned about the use of methamphetamine among adolescents in Cape Town; especially because

the detrimental cognitive effects of methamphetamine may be particularly salient in adolescents who are still developing neurologically, may be school-going and need to "perform" cognitively (e.g. learn new, sometimes complex information almost daily) on a regular basis [15]. Whether methamphetamine use may be especially detrimental to adolescent cognitive development has yet to be determined as few studies of methamphetamine users have looked at adolescents specifically.

The explosion of methamphetamine use in Cape Town has caught many health service providers unawares, particularly those in the low cost outpatient substance abuse treatment settings who have to deal with the bulk of methamphetamine patients. Most staff in these facilities feel ill equipped to cope with the psychiatric manifestations that methamphetamine patients experience, particularly the symptoms of psychosis. There is an urgent need to train drug treatment staff in how to assess and manage patients presenting with drug-related psychoses and to expand existing mental health services. In addition, there is a need to expand drug treatment services for which availability is limited; particularly in the poorer suburbs of Cape Town that are most affected by methamphetamine use.

A limitation of this study is the reliance on a single data source, namely treatment admissions. Other kinds of community-based studies (e.g. school or household surveys, key informant interviews, or user interviews) are required to assess the use of the drug in populations that might not have access to specialist drug treatment services or that might be accessing other services such as private mental health professionals, general practitioners and other kinds of support services. The lack of these additional data sources

makes quantification and verification of the extent of methamphetamine use difficult and the available data presented here is only one indication of the extent of methamphetamine use in the general population.

Further research is required to determine the possible reasons why the use of methamphetamine has escalated quite so rapidly among young people in Cape Town, particularly in the Coloured community. The "usual suspects" (including gangsterism and organised crime, increased/aggressive marketing and availability, low price, peer pressure, unemployment, and poverty) would seem to be inadequate in explaining such a rapid progression, and further qualitative research is needed to investigate this phenomenon. Levels of methamphetamine use are substantially higher in Cape Town than in other parts of the country with SACENDU data for the second half of 2006 identifying less than two dozen patients reporting methamphetamine as their primary substance in the five other sites monitored by the project. Ongoing monitoring of the use of this drug in Cape Town and the possible spread to other parts of the country is also required to inform the government and civil society and ensure that intervention resources are adequately deployed.

References

[1] Gibson DR, Leamon, MH, Flynn, N. Epidemiology and public health consequences of methamphetamine use in California's Central Valley. J Psychoactive Drugs 2002; 34(3): 313-319.

[2] Topp L, Degenhardt L, Kaye S, Darke S. The emergence of potent forms of methamphetamine in Sydney, Australia: a case study of the IDRS as a strategic early warning system. Drug Alcohol Rev 2002; 21: 341-348.

[3] Beyrer C, Razak MH, Jittiwutikarn J, Suriyanon V, Vongchak T, Srirak N, Kawichai S, Tovanabutra S, Rungruengthanakit K, Sawanpanyalert P, Sripaipan T, Celentano DD. Methamphetamine users in northern Thailand: changing demographics and risks for HIV and STD among treatment-seeking substance abusers. Int J STD AIDS 2004; 15(10): 697-704.

[4] United Nations Office on Drugs and Crime World Drug Report. Vienna: United Nations Office on Drugs and Crime, 2006.

[5] Wijetunga M, Bhan R, Lindsay J, Karch S. Acute coronary syndrome and crystal methamphetamine use: a case series. Hawaii Med J 2004; 63(1): 8-13.

[6] Wilkins C, Pledger M, Bhatta K, Casswell S. Patterns of amphetamine use in New Zealand: findings from the 2001 National Drug Survey. N Z Med J 2004; 117(1190): 790.

[7] Yen CF. Relationship between methamphetamine use and risky sexual behavior in adolescents. Kaohsiung J Med Sci 2004; 20(4): 160-165.

[8] Bureau for International Narcotics and Law Enforcement Affairs (2006). International Narcotics Control Strategy Report. (http://www.state.gov/p/inl/rls/nrcrpt/2006/vol1/html/62112.htm)

[9] United Nations Office on Drugs and Crime. World Drug Report. Vienna: United Nations Office on Drugs and Crime, 2004.

[10] Parry, CDH, Plüddemann, A, Myers, BJ. Heroin treatment demand in South Africa: Trends from two large metropolitan sites (January 1997-December 2003). Drug Alcohol Rev. 2005; 24: 419-423.

[11] Department of Health. National HIV and Syphilis Antenatal Sero-prevalence Survey in South Africa 2005. South Africa: Department of Health, 2006.

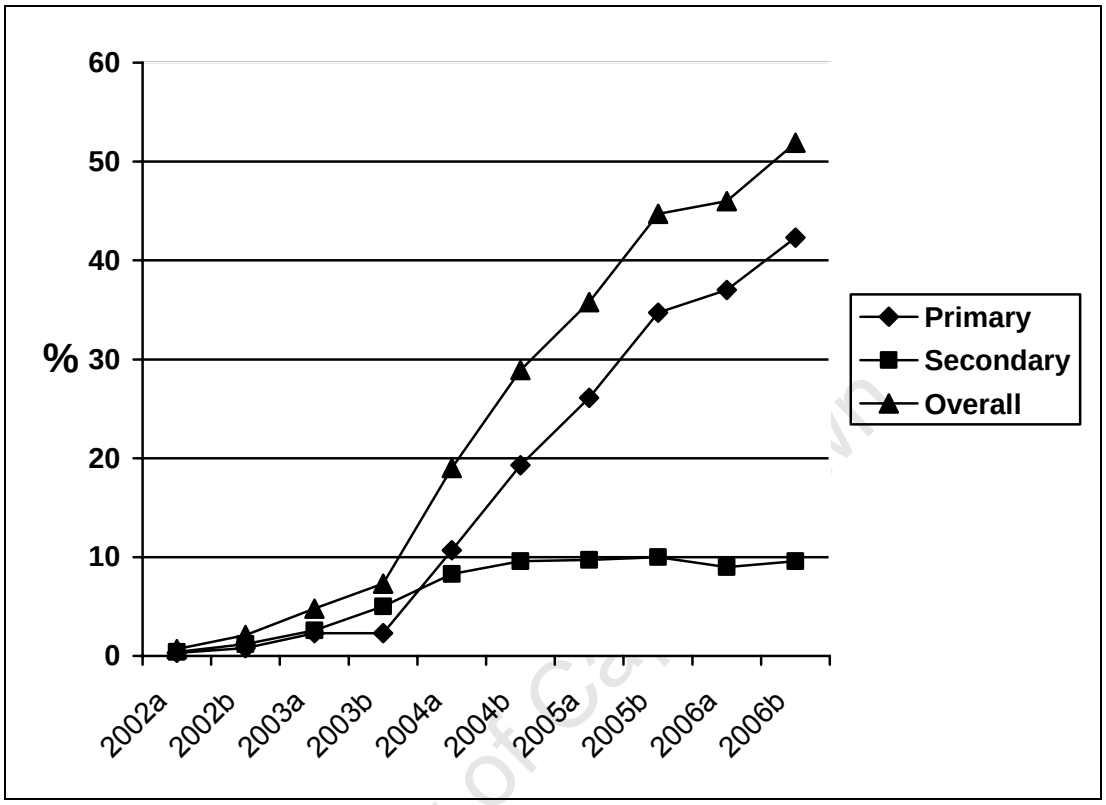
[12] Department of Health & Human Services. Treatment Episodes Data Set (TEDS) 1994-2004: National Admissions to Substance Abuse Treatment Services. Rockville, Maryland: Office of Applied Studies, Substance Abuse and Mental Health Services Administration, 2006.

[13] Copeland J, Indig D. Patterns and correlates of treatment: findings of the 2000-2001 NSW minimum dataset of clients of alcohol and other drug treatment services. Drug Alcohol Rev 2004; 23(2): 185-194.

[14] Simbayi LC, Kalichman S, Cain D, Cherry C, Henda N, Cloete A. Methamphetamine use and sexual risks for HIV infection in Cape Town, South Africa. Journal of Substance Use 2006; 11(4):291-300.

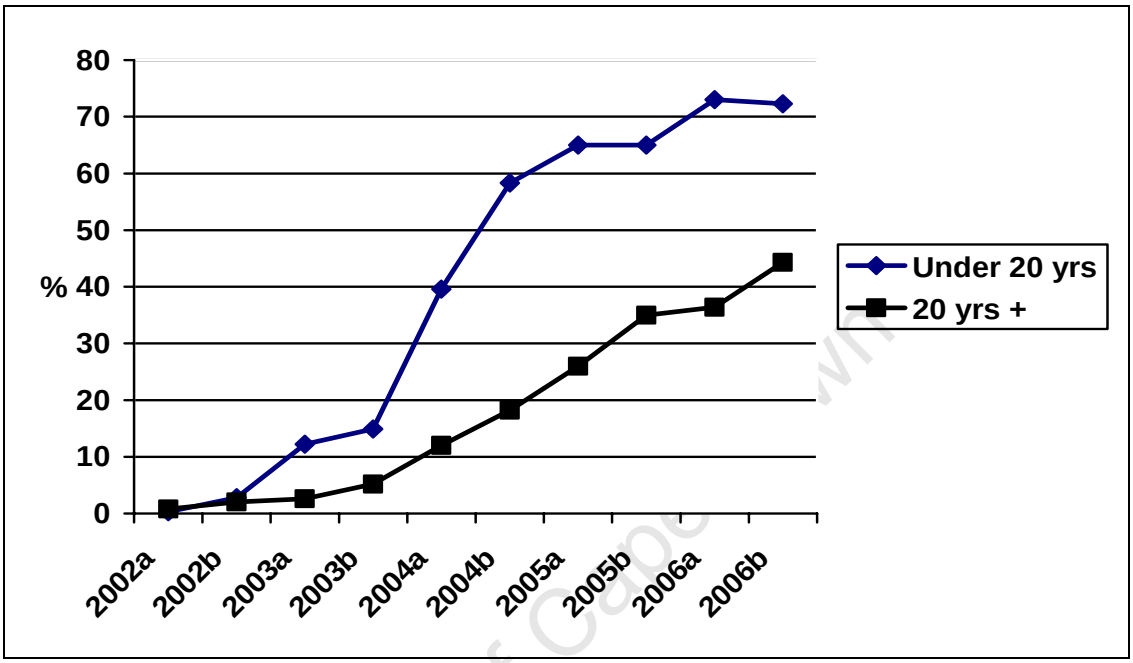
[15] Nordahl TE, Salo R, Leamon M. Neuropsychological effects of chronic methamphetamine use on neurotransmitters and cognition: A review. J Neuropsychiatry Clin Neurosci 2003; 15(3): 317-325.

Figure 1. Proportion of patients with methamphetamine as their primary, secondary or overall (primary or secondary) substance of abuse



Note: 2002a = January – June 2002, 2002b = July – December 2002 etc.

Figure 2. Proportions of patients reporting methamphetamine as either a primary or secondary substance of abuse (patients aged 19 and younger vs. patients aged 20 and older)



Note: 2002a = January – June 2002, 2002b = July –December 2002 etc.

Table 1. Demographic and other characteristics of patients with methamphetamine as their primary substance of abuse (2004 - 2006)*

	Jan-Jun 2004	Jul-Dec 2004	Jan-Jun 2005	Jul-Dec 2005	Jan-Jun 2006	Jul-Dec 2006
	N = 241	N = 442	N = 640	N = 738	N = 989	N = 1184
	%	%	%	%	%	%
Gender						
Male	73.0	71.9	76.3	71.5	72.6	71.7
Female	27.0	28.1	23.7	28.5	27.4	28.3
Race						
African	0.4	0.9	0.5	0.8	0.6	1.0
Coloured	80.9	88.6	91.7	91.6	91.6	89.6
Indian/Asian	3.3	0.7	0.5	1.2	0.4	1.3
White	15.4	9.8	7.4	6.4	7.4	8.1
Age categories						
10-14 years	5.4	6.7	6.7	4.5	3.3	3.4
15-19 years	53.5	51.7	41.3	43.8	40.8	34.3
20-24 years	28.6	27.2	31.2	29.1	31.7	35.6
25-29 years	7.1	9.0	12.6	13.0	14.6	13.6
30-34 years	3.7	4.0	5.3	6.8	6.1	7.5
35+ years	1.6	1.3	3.0	2.9	3.4	5.6
Frequency of use						
Daily	40.9	39.4	44.3	49.2	58.1	57.8
2-6 days/week	34.7	34.3	28.1	28.5	28.9	33.9
Once/week or less	14.5	13.5	12.4	8.3	5.7	4.9
Not used in past month	8.9	12.8	14.3	14.0	7.3	3.4
First admission	85.5	86.0	85.2	87.9	86.1	84.4

	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Years from first use to first treatment	1.6	1.36	1.5	1.70	1.9	1.74	2.1	2.06	2.5	2.30	2.7	2.46
Mean age of patients	19.7	5.07	19.8	4.92	20.9	5.59	21.0	5.62	21.5	5.84	22.3	6.21

* Demographic data for previous reporting periods are not presented due to the low number of methamphetamine patients seen in treatment prior to 2004

CHAPTER 4

Adolescent methamphetamine use and sexual risk behaviour in secondary school students in Cape Town, South Africa

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Andreas Plüddemann was lead author for this article and primarily responsible for drafting all sections of the manuscript, including conducting the data analysis, in consultation with Prof. Carl Lombard, Director of Biostatistics at the Medical Research Council.

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ABSTRACT

Introduction and aims: This study investigated involvement in substance use and sexual activities among adolescents in Cape Town, and specifically the associations between methampethamine use and sexual risk behaviours.

Design and methods: Data were collected from 15 randomly selected and 15 matched schools in Cape Town via quantitative questionnaires. Students used hand-held computers (PDAs) to answer the questions. A total of 4605 Grade 9 students were sampled.

Results: Male and female students were almost equally likely to have used methamphetamine at least once (13% versus 12%). Students who had used methamphetamine in the past 30 days were significantly more likely to have had vaginal, anal or oral sex than students who had never used it, to have been pregnant/been responsible for a pregnancy, and to have been diagnosed with a sexually transmitted infection. Logistic regression analysis indicated significant associations between methamphetamine use in the past 12 months and engaging in vaginal and anal sex.

Discussion and conclusions: Drug abuse and STI prevention services should incorporate the link between drugs and STI into their prevention and education strategies, especially those aimed at school-going adolescents.

Introduction

A serious concern related to methamphetamine use is its possible association with sexually transmitted infections (STIs), including HIV/AIDS. Use of this drug has been associated with sexual behaviour as it enhances sexual desire.[1,2] It has also been linked to high levels of sexual risk behaviour such as multiple partners and engaging in unprotected sex for both men and women.[1,3] A compilation of key literature relating to methamphetamine revealed that the vast majority of studies investigating the link between sexual risk behaviour/HIV and methamphetamine use have been conducted amongst men who have sex with men or injecting drug users.[4] A recent review of studies demonstrating associations between STI risk and club drug use among men who have sex with men, found that methamphetamine use came closest to being identified as a causal risk factor for STIs in this population.[5] Relatively few studies have investigated the link between methamphetamine use and sexual risk behaviour/HIV infection in heterosexual adult populations. Even fewer have investigated heterosexual adolescent populations, but one study found that those adolescents who used methamphetamine were more likely to have unsafe, unplanned sex.[6]

Methamphetamine use has become increasingly widespread in Cape Town, South Africa. There has been a steady increase in the use of the drug since 2002. Only 0.3% of all patients admitted to drug counseling or rehabilitation centres in Cape Town had methamphetamine as their primary or secondary drug of abuse in the first half of 2002, in comparison to 46% in the first half of 2006. Even more concerning is that this figure rose to 73% for patients who were under 20 years of

age.[7] In Cape Town, methamphetamine is mostly smoked in crystalline form and referred to as "tik" due to the sound the drug makes when heated (a ticking or clicking/crackling sound). When in this crystallized form, methamphetamine is seen as especially potent and associated with harm in a number of domains. It is more likely to result in dependence than other forms of methamphetamine use.[8]

South Africa also has one of the highest HIV prevalence figures in the world.[9] Although the prevalence rate of HIV in the province surrounding Cape Town (the Western Cape) is still the lowest in the country (according to antenatal clinic attendee data) at 16% for 2005, the province has recently seen the highest increase in the incidence of HIV in the country.[10] Most cases of HIV are sexually transmitted, which partly explains the governments' focus on pregnant women and adolescents, and especially promoting safe sex.[11]

In South Africa, to date only one recent study has examined methamphetamine use in relation to HIV risks. The study related to an adult community sample in Cape Town. Findings indicated that methamphetamine use was associated with being male, engaging in unprotected sex, and having multiple sex partners in the preceding six months.[12]

This study is part of a broader study on adolescent sexual risk behaviour in Cape Town, South Africa, and this paper investigates some of the links between sexual risk behaviour and methamphetamine use among school-attending adolescents. The data presented was drawn from a set of questions that formed part of an extensive investigation into the issues of sexual risk behaviour and attitudes and beliefs with regard to HIV and AIDS.

Methods

This study was part of a larger multi-site prospective panel study, the SATZ project, which has been described elswhere.[13] In each of three sites, Cape Town, Mankweng and Dar es Salaam, we conducted a cluster randomised controlled trial to investigate the effect of school-based HIV prevention programmes among Grade 8 students. This grade was chosen to include students in the age range 12-14 years at baseline. The research took place over a 14-month period (March 2004 to May 2005). This article focuses on the third data collection period (March/April 2005) in Cape Town, which was the only survey where data on methamphetamine use were collected.

Sample

The study population included all grade 8 students attending public schools in Cape Town during 2004. Schools were the primary sampling unit. We employed a multi-stage sampling strategy. All high schools in the Cape Town Metropole were stratified by postal (zip) code groupings. Each postal code grouping contains areas that are relatively homogenous in terms of key demographic factors such as socio-economic level, race and culture. Following this, 39 schools were randomly selected so that the proportion of the selected schools in a stratum was directly proportional to the number of students in that stratum. The probability of a school being selected was proportional to the number of students in that school. Using a random numbers table, fifteen schools were randomly selected from the 39 schools, so that the probability of selection was proportional to the size of the school. These schools were then matched in pairs to 15 other schools on a range of demographic characteristics (student population size, "race" of students, language of instruction, geographical area in which the school was located and the

amount of school fees paid as a proxy for the socio-economic status). For each pair, one school was randomly assigned to the intervention arm of the trial and the other to the control arm. All Grade 8 students in the included schools were invited to participate in the study. The analyses reported here are based on the cohort of both groups of students.

Measurement and variables

The second follow-up survey (analysed in this article) was conducted in March-April 2005, with most students now in grade 9. A self-completed anonymous electronic questionnaire was administered to students, who were given a choice of a combination of two of the three languages spoken in Cape Town (English and Afrikaans, or English and Xhosa), using handheld computers. The instrument was subjected to a test-retest reliability study during 2003 and the internal consistency and test-retest correlations of the scales were adequate (submitted for publication). The reliability of the electronic questionnaires was compared with paper questionnaires and it was found that the intra-scale reliability and the test-retest correlations of the scales for each data collection method were adequate, and similar.[14]

Procedure

A letter describing the study was sent to parents at all participating schools and parents objecting their children's participation were invited to contact the school principals or to complete a declination form and return it to the evaluation coordinators. The students signed an assent form agreeing to participate. Ethical clearance was provided by the

Western Norway Regional Committee for Medical Research Ethics and the Research Ethics Committee of the Faculty of Health Sciences, University of Cape Town.

Analysis

The sampling strategy of schools as clusters was taken into account for estimating the 95% confidence intervals (CI) of the risk behaviour prevalences. For comparing the crude prevalence of the various drug using and sexual risk behaviours, one can use the reported 95% CIs. If the CIs do not overlap, there is a significant difference ($p < 0.05$) between the groups. If they overlap to the extent that the point estimate of one group is contained within the CI of the other group, the two estimates are not significantly different ($p > 0.05$). Furthermore, a number of logistic and multiple logistic regression analyses were also performed. As chi-square tests indicated no significant differences between the intervention and control groups on the methamphetamine use and sexual risk behaviour variables, we opted for a combined analysis of both groups. Evaluation of the project also (unfortunately) found no significant positive effect of the intervention, a second reason for our combined analysis. Statistical analysis was conducted using SPSS 14.0 and STATA version 9.

Results

A total of 4605 grade 9 students completed the questionnaire of whom 46% were male and 54% female. The mean age of the students was 15.3 years (SD = 1.16). In terms of socio-economic status, over 90% of students reported that they had electricity and tap

water in their homes. Almost 75% reported living in a brick house or apartment, while 14% reported living in a 'shack'. Twenty percent of students said that 'they do not have enough money for food' in their homes, 17% had 'enough money for food but not other basic items such as clothes', 34% had 'enough money for food and clothing but not other basic items', 10% had 'the most important things but few luxury items', and 20% had 'money for luxury goods and extra things'.

Substance use

One third of male students and a quarter of female students had smoked a cigarette in the past 30 days. Similar proportions were noted for alcohol use in the past 30 days (Table 1). Twenty-one percent of male students and 9% of female students had smoked cannabis in the past 30 days. Males (33%) were significantly more like likely than females (26%) to have smoked cigarettes in the last month. Thirteen percent of male students and 12% of female students had tried methamphetamine at least once in their life. Of those who had tried it, 63% of males and 45% of females had used the drug in the past 12 months. Sixty percent of females and 61% of males who had used in the past 12 months had also used in the past 30 days (Table 1).

Sexual risk behaviour

A quarter of all students had vaginal sex at least once, 16% had oral sex and 15% had anal sex. Differences between male and female sexual risk behaviour were significant for all questions. A significantly greater proportion of male students reported sexual debut (38%) compared to female students (15%). Male students also appeared to be significantly more likely to engage in oral (26%) and anal sex (23%) than females (8%

and 7% respectively (Table 2). Five percent of the male students reported that they had made a girl pregnant and two percent of female students had been pregnant (Table 2). Twelve percent of all students indicated that they had been told by a health worker that they had an STI. Of those students who had sex at least once, 37% had never used a condom. The mean age at which students had first had sex was 13.3 years (SD = 1.85).

Methamphetamine use and sexual risk behaviour

Table 3 shows the students divided into four groups, depending on reported methamphetamine use (Group 1: Students who have never used methamphetamine, Group 2: Students who have tried methamphetamine at least once, but not in the past 12 months, Group 3: Students who have used methamphetamine in the past 12 months but not in the past 30 days, and Group 4: Students who have used methamphetamine in the past 30 days). The table shows that students who had used methamphetamine in the last 30 days were significantly more likely than those who had never tried methamphetamine to have had vaginal (57%), oral (43%), and anal sex (41%). They were also significantly more likely than students who had never tried methamphetamine to have been/made a girl pregnant (18%) or had an STI (31%). Additionally there was also a significant difference between lifetime use (Group 2) and use in the last 30 days (Group 4) on all items except for students being told that they had a STI. Students who engaged in methamphetamine use in the last 30 days were also significantly more likely to have had vaginal sex; oral sex and anal sex than those who had used in the past 12 months. Differences between those who had never used methamphetamine and those who had engaged in lifetime use (Group 2) were not significant for any items. Likewise, those students who had engaged in methamphetamine use over the last 12 months were not significantly more likely to

participate in sexual risk behaviours than those who had never used the drug, with the exception of vaginal sex. Students who had used in the last 12 months were more likely to have had vaginal sex (44%) in comparison with those who had never used the drug (23%).

For the purposes of further analysis we created a binary variable, whereby methamphetamine use in the past 12 months was used as defining a methamphetamine user (yes/no). In a multiple logistic regression model adjusted for gender, age and smoking tobacco and the clustering within schools, ever having had vaginal sex and ever having had anal sex were significantly associated ($p<0.01$) with having used methamphetamine in the past 12 months (OR = 2.1, 95%CI: 1.5 to 3.0 and OR = 1.6 5% CI: 1.1 to 2.2 respectively).

Discussion

The associations found between the use of methamphetamine and these HIV risk behaviours indicate that the use of methamphetamine may escalate the risk for contracting HIV, and confirm the findings of Yen[5] and more recently those of Springer et al.[15] The proportion of students who engaged in sexual risk behaviours were significantly higher for those students who had used methamphetamine recently (in the last 12 months, and especially the last 30 days) than those who had not used it or who had only used the drug once. Almost 60% of students who had used methamphetamine in the past 30 days had also had vaginal sex at least once, compared to about one in four of those who had never used methamphetamine. Students who had used methamphetamine in the past 30

days were significantly more likely to have engaged in sexual risk behaviours than those who had not used the drug and those who did not report use in the past 12 months. The proportions of those who engaged in the above sexual risk behaviours increased for students who reported more recent methamphetamine use, indicating that continued use of the drug seems to coincide with increased sexual risk behaviour. The fact that almost a third of students who had used methamphetamine in the past 30 days had been informed by a health care worker that they have an STI supports this contention. Further compounding this risk behaviour is the fact that it has been found that early sexual debut, defined by WHO in 2006 as 15 years of age or younger, has been shown to be a risk factor for multiple sexual partners and HIV infection.[16]

While the logistic regression analysis did not yield significant associations for all the sexual risk behaviours, associations between vaginal and anal sex and methamphetamine use remained significant.

The findings of this study add to the limited body of research showing that methamphetamine use is not only a serious risk factor for HIV transmission and infection among men who have sex with men, but also in adolescent, school-attending, predominantly heterosexual populations.

The limitations of this study include that students were not asked about the use of other hard illicit drugs such as cocaine or heroin for example. Although not used as commonly by adolescents in Cape Town as methamphetamine,[17] it is possible that these drugs may have similar associations with sexual risk behaviour, possibly confounding the ability to

attribute a direct association between the use of methamphetamine specifically and sexual risk behaviour. A direct causal link between methamphetamine use and sexual risk behaviour could therefore not be established from our study, with the use of other drugs possibly confounding the relationships. The study was unable to exclude the possibility that students may be engaging in a pattern of risk behaviours, resulting in the associations found in this study. It is also possible that although the intended intervention that formed part of this study did not appear to have its desired effect, the intervention may have had an effect on the associations between methamphetamine use and sexual risk behaviours.

In conclusion, the findings in this survey of grade 9 students certainly warrant cause for concern. A number of associations between using methamphetamine and engaging in sexual risk behaviour were found, indicating that methamphetamine us by adolescents may impact on sexual risk behaviour in this population. School-based prevention and education programmes particularly need to incorporate these issues, both programmes focussing on STI prevention and those focussing on drug abuse prevention. Further research is needed to investigate whether and how methamphetamine use may be impacting on sexual risk behaviour directly and whether methamphetamine may be a particular 'culprit' in increasing the risk of engaging in sexual risk behaviour, as opposed to other illicit drugs (particularly other 'hard' stimulant drugs like cocaine or crack cocaine).

Acknowledgements

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References

1. Semple SJ, Patterson TL, Grant I. The context of sexual risk behaviour among heterosexual methamphetamine users. Addict Behav 2004; 29: 807-810.

2. Rawson R A, Washton A, Domier CP, Reiber C. Drugs and sexual effects: role of drug type and gender. J Subst Abuse Treat 2002; 22: 103-108.

3. Baskin-Sommers A, Sommers I. The co-occurence of substance use and high-risk behaviours. J Adolesc Health 2006; 38: 609-611.

4. Hammer MR. A Key to Methamphetamine-Related Literature. Division of HIV Prevention, AIDS Institute, New York State Department of Health, 2007.

5. 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: 1551-1561.

6. Yen CF. Relationship between methamphetamine use and risky sexual behaviour in adolescents. Kaohsiung Journal of Medical Science 2004; 20: 160-165.

7. Plüddemann A, Myers BJ, Parry CDH. Surge in treatment admissions related to methamphetamine use in Cape Town, South Africa: Implications for public health. Drug Alcohol Rev in press.

8. Topp L, Degenhardt L, Kaye S, Darke S. The emergence of potent forms of methamphetamine in Sydney, Australia: a case study of the IDRS as a strategic early warning system. Drug & Alcohol Review 2002; 21: 341-348.

9. UNAIDS. Report on the global AIDS epidemic 2006. www.unaids.org, 2006.

10. Department of Health. National HIV and Syphilis Antenatal Sero-prevalence Survey in South Africa 2005. Department of Health, South Africa, 2006.

11. Morojele NK, Brook JS, Moshia KM. Sexual behaviour among South African adolescents as it relates to drug use, exposure to drug use and access to drugs. Tygerberg: Medical Research Council, South Africa 2002.

12. Simbayi LC, Kalichman S, Cain D, Cherry C, Henda N, Cloete A. Methamphetamine use and sexual risks for HIV infection in Cape Town, South Africa. Journal of Substance Use 2006; 11: 291-300.

13. Aarø LE, Flisher AJ, Kaaya S, Onya H, Fuglesang M, Klepp K-I, Schaalma, H. Promoting sexual- and reproductive health in early adolescence in South Africa and Tanzania: Development of a theory- and evidence-based intervention programme. Scand J Public Health 2006; 30: 148-160.

14. Mukoma W, Mathews C, Flisher AJ et al. Use of electronic questionnaires on handheld devices to evaluate the effects of a school-based HIV prevention programme on adolescent sexual behaviour. XV International AIDS Conference, Bangkok. 11-16 July 2004.

15. Springer AE, Peters RJ, Shegog R, White DL, Kelder SH. Methamphetamine use and sexual risk behvaviors in U.S. high school students: findings from a national risk behavior survey. Prev Sci. 2007; 8: 103-113.

16. Pettifor AE, Measham DM, Rees HV, Padian NS. Sexual power and HIV risk, South Africa. Emerg Infect Dis 2004; 10: 1996-2004.

17. Plüddemann A, Parry CDH, Bhana A, Harker N, Potgieter H. Gerber W. Monitoring Alcohol and Drug Abuse Trends in South Africa (July 1996 – June 2006). SACENDU Research Brief, 9(2). Medical Research Council, South Africa, 2007.

Table 1: Proportion of males and females who reported using various substances

	Males (N = 1967) % (95% CI)	**Females** (N = 2384) % (95% CI)
Did you smoke a whole cigarette in the past 30 days?	33.1 (29.5 – 36.8)	25.8 (24.0 – 27.6)
Did you drink alcohol (other than a few sips) in the past 30 days?	32.1 (28.3 – 35.8)	24.5 (19.8 – 29.2)
Did you smoke cannabis in the past 30 days?	21.1 (17.3 – 24.9)	8.7 (7.1 – 10.4)
Have you ever used methamphetamine?	13.3 (10.8 – 15.7)	11.9 (9.9 – 13.9)
Have you used methamphetamine in the past 12 months? (Of those who have used)	62.8 (55.1 – 70.5)	44.8 (31.1 – 58.5)
Did you use methamphetamine in the past 30 days? (of those who have used in the past 12 months)	61.0 (51.6 – 70.5)	59.7 (50.9 – 68.4)

Table 2: Proportion of all students who answered 'yes' to sexual behaviour questions

	All (N=4474) % (95% CI)	**Male** (N=2041) % (95% CI)	**Female** (N=2433) % (95% CI)
Have you ever had vaginal sex?	25.3 (20.0 – 31.4)	37.8 (30.8 – 45.3)	14.8 (10.8 – 20.1)
Have you ever had oral sex?	16.3 (13.8 - 19.3)	26.2 (22.3 – 30.5)	8.1 (6.5 – 10.0)
Have you ever had anal sex?	14.5 (10.9 – 19.0)	23.3 (18.6 – 28.6)	7.1 (4.5 – 11.1)
Have you ever made a girl pregnant/been pregnant?	3.2 (2.3 – 4.4)	5.1 (3.9 – 6.7)	1.6 (0.9 – 2.8)
Have you ever been told by a health care worker that you had a sexually transmitted disease?	12.3 (8.6 – 17.2)	16.0 (12.0 – 21.1)	9.1 (5.8 – 13.9)

Table 3: Proportions of all students who answered 'yes' to sexual risk behaviour questions by methamphetamine use

	Group 1 ***n*** **%** (95% CI)	**Group 2** ***n*** **%** (95% CI)	**Group 3** ***n*** **%** (95% CI)	**Group 4** ***n*** **%** (95% CI)
Had vaginal sex (life-time)	875 22.8 (17.3 – 29.4)	75 29.4 (22.5 – 37.5)	50 43.5 (34.0 – 53.4)	98 56.7 (48.0 – 64.9)
Had oral sex (life-time)	562 14.6 (12.1 – 17.6)	48 19.1 (13.3 – 26.5)	25 21.6 (15.2 – 29.7)	75 43.1 (34.5 – 52.2)
Had anal sex (life-time)	495 12.9 (9.3 – 17.7)	39 15.3 (10.8 – 21.2)	23 20.0 (12.8 – 29.8)	70 40.7 (32.5 – 49.5)
Have you ever made a girl pregnant/been pregnant?	97 2.5 (1.7 – 3.5)	9 3.5 (1.4 – 8.2)	4 3.4 (0.8 – 13.5)	32 17.6 (11.6 – 25.7)
Told by a health care worker that you had a sexually transmitted disease	407 10.7 (7.4 – 15.2)	48 19.1 (12.9 – 27.3)	14 12.2 (6.7 – 21.1)	53 30.5 (20.0 – 43.4)

Group 1: Students who have never used methamphetamine
Group 2: Students who have tried methamphetamine at least once, but not in the past 12 months
Group 3: Students who have used methamphetamine in the past 12 months but not in the past 30 days
Group 4: Students who have used methamphetamine in the past 30 days

CHAPTER 5

Methamphetamine use, aggressive behavior and other mental health issues among high school students in Cape Town, South Africa

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Description of contribution of candidate

Author 1 (AP) was the principal investigator of the study, conceptualising the study in consultation with authors 2, 3 and 4. AP took primary responsibility for data collection (with assistance from fieldworkers), processing, entry and cleaning of the data. AP was also primarily responsible for the drafting all sections of the manuscript, including conducting the data analysis.

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Abstract

Objective: Methamphetamine use has become a growing problem in a number of countries over the past two decades, but has only recently emerged in South Africa. This study investigated the prevalence of methamphetamine use among high-school students in Cape Town and whether students reporting methamphetamine use were more likely to be at risk for mental health and aggressive behavior problems. **Method**: A cross-sectional survey of 15 randomly selected high-schools in Cape Town, of 1561 male and female grade 8-10 students (mean age 14.9), was conducted using the Problem Oriented Screening Instrument for Teenagers (POSIT) and the Beck Depression Inventory (BDI). **Results**: Findings indicated that 9% of the students had tried methamphetamine at least once. Ordinal logistic regression analyses showed that methamphetamine use in the past year was significantly associated with higher aggressive behavior scores (OR = 1.81, 95% CI: 1.04 – 3.15, $p < 0.05$), mental health risk scores (OR = 2.04, 95% CI: 1.26 – 3.31, $p < 0.01$) and depression scores (OR = 2.65, 95% CI: 1.64 – 4.28, $p < 0.001$). **Conclusions**: Methamphetamine use has become a serious problem in Cape Town, particularly among adolescents. Screening adolescents in school settings for methamphetamine use and behavior problems may be useful in identifying youth at risk for substance misuse, providing an opportunity for early intervention. These findings have implications for other parts of the world where methamphetamine use may be occurring at younger ages and highlight the importance of looking at co-morbid issues related to methamphetamine use.

Key words: Adolescents, methamphetamine use, aggression, mental health, South Africa

1. Introduction

Methamphetamine use has been documented as a serious cause for concern in a number of countries, including the Czech Republic, Australia, Japan, New Zealand, Thailand and some parts of the United States. Traditionally, levels of methamphetamine (and other amphetamine) use have been low in Africa (United Nations Office on Drugs & Crime, 2008). However, data collected from drug treatment centers in Cape Town began to show significant numbers of patients reporting methamphetamine use in 2004. This grew exponentially in subsequent years, reaching a peak in 2006, when 72% of adolescent patients admitted for substance abuse or dependence counseling in Cape Town reported methamphetamine as a primary or secondary drug problem (Pluddemann et al., 2008a).

The identification of an emerging methamphetamine problem among adolescents in Cape Town, based on drug treatment data, prompted the need for population-based surveys to determine both the extent of this problem as well as to begin to investigate associated health consequences. Use mostly involved smoking crystalline methamphetamine. Smoking crystalline methamphetamine has been associated with high levels of harm (Topp et al., 2002). The most salient harms associated with methamphetamine use are mental health problems, including psychosis, depression, anxiety and violent behaviors (Darke, Kaye, McKetin, & Duflou, 2008). Few studies have reported on these problems in adolescent populations. A study among male and female adolescents in the pacific islands found that those who used methamphetamine were significantly more likely to participate in aggressive behaviors (Pinhey & Wells, 2007). Another study among a general population of adolescents was from the 2002 US National Survey on Drug Use

and Health, which found that adolescents who reported past-year mental health treatment utilization were 1.66 times more likely than adolescents who did not seek mental health treatment to report past-year MA use (Herman-Stahl, Krebs, Kroutil, & Heller, 2006).

The aim of the present study was to examine the relationship between methamphetamine use and mental health and aggression among adolescents. Furthermore, the present study aimed to expand on a still fairly limited body of research globally on the effects and consequences of methamphetamine use by adolescents. To our knowledge, it is also the first study investigating methamphetamine use and mental health problems and aggressive behavior in Africa. The authors feel it is very important to establish the above mentioned associations in 'new and different' contexts, particularly in contexts already affected by extreme poverty and other 'social stressors'. The authors propose that the cohort in the present study is in fact unique, in terms of age (i.e. the high prevalence of methamphetamine use in 15 year-olds on average) and socio-political climate (i.e. young persons growing up in a rapidly changing society fairly recently coming out of a repressive historical past).

2. METHODS

2.1 Design and sampling strategy

The school population was all high schools (N=54) in the South Educational District, one of four education management districts in the city of Cape Town. Fifteen schools were randomly selected from this population, such that the probability of selection was directly proportional to the number of students in the school. This district was believed to be the most affected by methamphetamine use, based on treatment demand data and newspaper

and other anecdotal reports. Subsequently one class of approximately 30 students was randomly selected from each of grades 8 (majority aged 12-14), 9 (majority aged 14-15 and 10 (majority aged 15-17). Data were collected in July and August 2006.

2.2 Procedures

Questionnaires were administered by trained staff in a standardized way in a classroom setting without the presence of school staff. Students were seated in such a way as to preserve confidentiality. Personal Digital Assistants (PDAs) were used to administer the questionnaires and students were able to choose from one of three major local languages (English, Afrikaans and isiXhosa). PDAs have been used in a number of local studies and have been found to be very effective (Jaspan et al., 2007; Seebregts et al., 2009).

Each student provided informed assent. Parents were informed of the study by letter and given the opportunity to withdraw their child from the study. Very few parents withdrew their children from the study and very few students refused to participate. Of over 1600 students approached to participate, only 50 refused or were withdrawn from the study. Ethical clearance for the study was obtained from the University of Cape Town's Faculty of Health Sciences Research Ethics Committee.

2.3 Measures

The questionnaire included basic demographics, substance use history, the Problem Oriented Screening Instrument for Teenagers (POSIT) and the Beck Depression Inventory (BDI). In order to obtain an impression of the socio-economic status (SES) of the learners, a question asking learners to describe their 'living circumstances' by

selecting one of five categories was used. The options were: 'We don't have enough money for food', 'We have enough money for food, but not clothes', 'We have enough money for food and clothes, but are short of other things', 'We have the most important things, but few luxuries', and 'We have money for luxury goods and extra things'. A question relating to what type of home/dwelling they lived in was also asked. Substance use measures covered tobacco, alcohol, cannabis, methaqualone, cocaine, heroin, ecstasy and methamphetamine. For each of these substances students were asked whether they had ever tried them, and whether they had used them in the past 12 months, past 30 days, and past seven days.

The POSIT (Rahdert, 1991) consists of 139 yes/no questions which are sub-divided into 10 sub-scales. The current study used data from the mental health scale (22 items) and the aggressive behavior/delinquency scale (16 items). A few minor linguistic adjustments were made to the POSIT questions in accordance with South African English and the questions were piloted with students, and then translated and back translated into both Afrikaans and isiXhosa (the two common local languages). Reliability analysis on data collected in the present study showed good Cronbach's alpha values (above 0.7) for both the mental health scale (0.80) and the aggressive behavior/delinquency scale (0.75). These sub-scales are scored in terms of three categories: low risk, middle risk and high risk, indicating potential risk for problems in these domains.

The Beck Depression Inventory (BDI) was used to screen for symptoms of depression (Beck et al., 1996). The BDI has been used and found to be reliable in a number of international contexts, including in local studies (Kagee, 2008). Kagee found an internal

reliability of 0.85 as measured by Cronbach's alpha. A second study by Ward et al. on the reliability of the BDI found good test-retest reliability using Cohen's kappa and a Cronbach's alpha of 0.86 (Ward et al., 2003). The present study's data indicated a Cronbach's alpha of 0.91.

2.4 Data analysis

Data was analysed using SPSS 16.0 and STATA 10. For the calculation of the substance use prevalence confidence intervals we took the study design (clustering at school level) into account in STATA's survey analysis settings. Chi-square tests were used for basic comparisons. As a tool to try to address the issue around the use of multiple substances by participants, we used Multiple Correspondence Analysis. In correspondence analysis (Greenacre, 2007) an attempt is made to find a low dimensional graphical representation of the association between the rows and columns of a contingency table. It is an exploratory multivariate technique that converts frequency table data into graphical displays in which rows and columns are depicted as points. Much of the value of correspondence analysis relates to its multivariate treatment of data through the simultaneous consideration of multiple categorical variables. The multivariate nature of correspondence analysis can reveal relationships that would not be detected in a series of pair wise comparisons of variables. Correspondence analysis also helps to show how variables are related, not merely that a relationship exists. The graphical display can help in detecting structural relationships among variable categories. A relationship is generally indicated between variables that appear in the same region of space. However points on the plot clustered around the origin remain unresolved in the analysis. While recognizing the relative rarity, and perhaps therefore unfamiliarity of multiple correspondence

analysis to a number of readers, the authors have nevertheless decided to include it in this manuscript, as we feel Multiple Correspondence Analysis (MCA) is one of few robust techniques which can assist in analysis of this type of categorical data, which is very common in social sciences research.

Ordinal logistic regression was performed to establish the size and significance of the association between methamphetamine use and mental health indices, after adjusting for confounders. The outcome variables in these regressions were risk categories on the POSIT mental health and aggressive behavior/delinquency scales (low risk, middle risk, high risk) and the BDI risk categories (none, medium and high). Methamphetamine use (past year use) was the main predictor variable in these analyses, and adjustment was made for factors that were shown to be related to both methamphetamine use and mental health indices in the correspondence analysis and where tests of association were significant ($p < 0.05$). We also tested our models for the assumption of proportional odds using generalized ordinal logistic models (gologit in STATA) and all p-values were greater than 0.05.

3. RESULTS

3.1 Demographics

The final sample comprised 1561 students, with slightly more females (53%) than males. The majority identified themselves as 'Coloured'(76%), with 43% reporting Afrikaans as their home language and 38% English. [Note: The terms "white", "black", and "Coloured", became entrenched in the apartheid era. They refer to demographic markers and do not signify inherent characteristics. They refer to people of European, African and mixed (African, European and/or Asian) ancestry, respectively. These markers were

chosen for their historical significance. Their continued use in South Africa is important for monitoring improvements in health and socio-economic disparities, identifying vulnerable sections of the population, and planning effective prevention and intervention programs.] The mean age of the students was 14.9 years (SD = 1.36). The ages ranged from 12 to 20 years. Based on the SES, almost 75% of the students came from lower to middle income households (i.e. they chose one of the first four options of the SES question). Most however lived in a brick house or apartment (69%), while 10% lived in a "shack" (a roughly constructed dwelling, sometimes from wood, corrugated iron or other 'waste' or scrap building material), and 12% lived in a "Wendy house" (a small home made from wood, often built in the yard of another (brick) home, sometimes used for sub-letting).

3.2 Substance use

Table 1 shows the proportions of students reporting the use of various substances, from 'life-time use' ("Have you ever tried *substance*?") to use of the substance in the past seven days. The Table shows that tobacco use was most common, followed by alcohol and cannabis. Almost 9% of the students had tried methamphetamine at least once, while 3% or less had tried Mandrax (methaqualone), cocaine, Ecstasy or heroin. Reported substance use in the past seven days was generally low, except for tobacco. Tobacco and alcohol use proportions were very similar for male and female students. Male students were, however, more likely to have tried cannabis (29.3%) than female students (20.8%). These differences also held for more recent cannabis use. Males were also slightly more likely to have tried Mandrax, cocaine or crack, Ecstasy or heroin than females. Ten percent of the male students had tried methamphetamine at least once compared with 8%

of the female students. However the proportion of males who had tried methamphetamine in the past 12 months (6.4%) was almost twice the proportion for the females (3.3%).

INSERT TABLE 1

3.3 Methamphetamine and POSIT scores

Table 2 compares three groups of students on the two subscales of the POSIT: students who have never used methamphetamine, students who have used methamphetamine, but not in the past 12 months, and students who have used methamphetamine in the past 12 months. Students who reported having used methamphetamine in the past 12 months had the highest proportions in the 'high risk' categories. Chi-square tests for the POSIT subscales were significant across columns at $p < 0.001$, indicating significant differences.

INSERT TABLE 2

The Multiple Correspondence Analysis (for included variables see Figure 1) indicated an association between methamphetamine use and both aggression and poor mental health. Methamphetamine use was also closely associated with cannabis use, and the use of both substances was associated with 'high risk' scores on the POSIT aggressive behavior scale and the Mental Health Scale. The use of tobacco and alcohol in the past 12 months also appeared to be associated with these variables (all appeared in a proximal region of space on the MCA graph, especially on Dimension 1, indicating an association: Figure 1), as did being older (16 or older). On dimension 1 (which accounted for 73% of the Chi-square information in the analysis), life-time use of cannabis and methamphetamine also

appeared to be associated with high risk scores on the aggression and mental health scales.

INSERT FIGURE 1

In order to confirm the significance of these associations, and estimate the size of these effects after adjusting for potential confounders, an ordinal logistic regression was undertaken. Using the risk categories on the aggressive behavior/delinquency scale as the outcome variable (low, middle and high), we tested whether methamphetamine use was associated with aggression, adjusting for cannabis, alcohol and tobacco use in the past 12 months. In this model, past year methamphetamine use almost doubled the odds of being in a higher risk category for aggression (adjusted OR = 1.81, 95% CI: 1.04 – 3.15, $p < 0.05$). (Age and gender were also considered as possible confounders of aggression but were not found to be related to the POSIT aggression scale.) In a similar model, methamphetamine use in the past year was a significantly associated with being in a higher mental health risk category (adjusted OR = 2.04, 95% CI: 1.26 – 3.31, $p < 0.01$). In this model we adjusted for age (in four categories: 12-14 years, 15 years, 16 years and 17+ years) and gender, in addition to cannabis, alcohol and tobacco use in the past 12 months, as these variables were found to be related to both methamphetamine use and mental health risk scores.

3.4 Methamphetamine use and depression

Table 3 compares students' scores on the Beck Depression Inventory (BDI) categories. The table shows that higher proportions of students who had tried methamphetamine had scores in the 'borderline clinical depression' to 'severe depression' categories compared

with those who had never tried methamphetamine. Comparing the 'raw scores' on the BDI of students who had never tried methamphetamine with students who had tried methamphetamine with a Mann-Whitney U test showed significant differences ($Z = -3.364$, $p < 0.01$), with methamphetamine users more likely to have high BDI scores.

INSERT TABLE 3

In order to simplify the categories of the BDI, the seven categories of the BDI were collapsed into three groups: students in the 'none' or 'normal ups and downs' range (none), students with 'mild mood disturbance' or 'borderline clinical depression' (medium), and students who scored from 'moderate depression' to 'extreme depression' (high). Students were also grouped into three categories of methamphetamine use: 1) never used, 2) used methamphetamine but not in the past 12 months, and 3) used methamphetamine in the past 12 months. Table 3 shows that students who had used methamphetamine in the past year were more likely to be in the 'high' BDI category than the other two groups of students. A Chi-square test comparing 'life-time' and 'past year' users showed a significant difference between these groups ($\chi 2 = 10.22$, $df = 2$, $p < 0.01$). A comparison, using a Chi-square, test between those who had never used and 'life-time' users was not significant.

As a Multiple Correspondence Analysis plot using the three BDI categories was less clear to interpret (graph not shown), we again used ordinal logistic regression. An ordinal logistic regression model, using the newly created three categories for the BDI indicated methamphetamine use in the past year as a significant indicator of being in a higher

depression category (OR = 2.65, 95% CI: 1.64 – 4.28, $p < 0.001$), adjusting for cannabis use in the past 12 months and age category (based on Chi-square tests for associations). Alcohol and tobacco use in the past year and gender were not found to be associated with BDI scores and were hence not included as covariates.

4. Discussion

The findings of this study indicate substantial use of methamphetamine among students in Cape Town high schools. The life-time prevalence of 9% found in this study is cause for concern and supports data collected from substance abuse treatment centres in the city. The prevalence was slightly higher than the life-time prevalence of 8% found in a 2003 U.S. national high-school survey (Springer et al., 2007). However the prevalence was slightly lower than was found in a study conducted among high school students in Cape Town a year earlier (12%) (Pluddemann et al., 2008b). The sample in that study was drawn from all schools in the city, perhaps indicating the problem to be more wide-spread than was thought to be the case, but also indicating the possibility of a reduction in use from 2005 to 2006. The past year prevalence found in the present study of 4.7% was comparable to the 4.2% (past year amphetamine use for 12-17 year-olds) found in a national survey of schools in Australia in 2005 (White & Hayman, 2006), a country with one of the highest reported methamphetamine prevalence figures in the world (UNODC, 2008).

Our findings indicated some significant associations between recent methamphetamine use and certain mental health problems (including depression) and aggressive behavior.

Students who have used methamphetamine recently (or more regularly) appear to be at greatest risk for potential mental health problems and higher levels of aggressive behavior.

The findings regarding the association between aggressive behavior and methamphetamine use support those of other studies, although most previous studies refer specifically to 'violent behavior' and were conducted in adult samples (Baskin-Sommers & Sommers, 2006; Hall et al., 1996; Iritani et al., 2007). While the finding does indicate an association, it also raises questions similar to those posed by Tyner and Fremouw, in a critical review of the relationship between methamphetamine use and violence (Tyner & Fremouw, 2008). These questions relate to whether methamphetamine is a direct cause of aggression and violence, or whether certain circumstances around the use of the drug may lead to aggression or violence. Some of these circumstances are discussed in a review by Dawe et al. (in press), and include, for example, the role sleep deprivation (commonly induced by methamphetamine use) may play in increased aggression. Another point made in this review is that amphetamine use is associated with increased positive symptoms of psychosis, particularly paranoia, that contribute to a perception of the environment as a hostile, threatening place, another potential catalyst for aggression.

Findings regarding the association between methamphetamine use and mental health problems also support those of a number of previous studies, although many of these studies have recruited samples in drug treatment settings, where underlying co-morbidity may be more prevalent, perhaps complicating the interpretation of some of these findings (Baker et al., 2004; Grant et al., 2007; Rawson et al., 2005). One of the few other studies

among a general population of adolescents was from the 2002 US National Survey on Drug Use and Health, which found that adolescents who reported past-year mental health treatment utilization were 1.66 times more than adolescents who did not seek mental health treatment to report past-year methamphetamine use (Herman-Stahl et al., 2006). While the Mental Health risk scale of the POSIT consists of a fairly broad range of questions relating to various mental health issues, it provides a useful indication of potential mental health problems.

Methamphetamine use in the past year was also a significant indicator of a higher depression score on the BDI, again confirming previous findings on the association between methamphetamine use and depression (London et al., 2004; Looby & Earleywine, 2007; Newton et al., 2004). Again, the samples in these studies mostly represented older individuals (over 25 years) or individuals in drug treatment settings. The present findings indicate associations between methamphetamine use and depression in a fairly 'early stage of use' and among a relatively young age group – certainly an issue of concern given the critical stage of development adolescents are in.

The limitations of the present study include that it was cross-sectional, with no mental health and behavior histories of the participants forming part of the analyses. Larger cohort studies are necessary to determine the causal pathways of methamphetamine use on mental health and aggressive behavior more clearly. A number of the other POSIT sub-scales did not yield good reliability scores in our setting and may need to be revised for use outside the U.S. The Mental Health and Aggressive Behavior scales however showed encouraging reliability in our setting. Future studies may benefit from utilizing

more differential data on frequency of methamphetamine use, although sample sizes may need to be increased along with this to enable analysis by frequency of use. The data collected on SES also did not follow expected patterns, when correlated with methamphetamine use, and was therefore not included in the analysis models. (Students in a higher SES group appeared slightly more likely to have used methamphetamine in the past year, although a Chi-square test did not show this as significant). While the authors believe that SES was not a key factor in the investigated associations, a more detailed approach to ascertain participants SES may have been beneficial.

The findings of the present study indicate high levels of methamphetamine use among school-attending adolescents in Cape Town, and indicate potential mental health and aggressive behavior problems among those who report recent use. The study is, to our knowledge, the first to confirm these associations in a context of extreme poverty and strenuous social circumstances. Many of the adolescents surveyed live in areas with high levels of unemployment (over 30%), overcrowded housing, and particularly crime (including violent crime, such as murder, rape and child abuse). We therefore feel that this study has made a unique contribution by indicating that even in contexts where adolescents may already be severely 'disadvantaged', methamphetamine appears to contribute significantly to even poorer prospects for the adolescents that use it regularly (or recently). The authors contend that the cohort in the present study was unique, in terms of age (i.e. the high prevalence of methamphetamine use in 15 year-olds on average) and socio-political climate (i.e. young persons growing up in a rapidly changing society fairly recently coming out of a repressive historical past).

Screening adolescents in school settings for these mental health and behavior problems may be useful in identifying youth at risk for substance misuse, providing an opportunity for early intervention. These findings also have implications for other parts of the world where methamphetamine use may be occurring at younger ages and highlight the importance of looking at co-morbid issues related to methamphetamine use. The findings also indicate that in South Africa (and other countries including the USA), the policy of education authorities to reduce the psychological services support available to high-schools may need to be revised, as a need for these is clearly indicated, perhaps particularly with a drug like methamphetamine. This recommendation may well also apply to education policies in many other countries and the critical examination of these policies may serve in improving the prevention of drug abuse among high-school students.

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References

Baker, A., Lee, N.K., Claire, M., Lewin, T.J., Grant, T., Pohlman, S., Saunders, J.B., Kay-Lambkin, F., Constable, P., Jenner, L., and Carr, V.J., 2004. Drug use patterns and mental health of regular amphetamine users during a reported 'heroin drought'. *Addiction*, 99, 875-884.

Baskin-Sommers, A. and Sommers, I. Methamphetamine use and violence among young adults., 2006. *Journal of Criminal Justice*, 34, 661-674.

Beck, A., Steer, R., and Brown, G., 1996. BDI-II manual. San Antonio: The Psychological Corporation.

Darke, S., Kaye, S., McKetin, R., and Duflou, J., 2008. Major physical and psychological harms of methamphetamine use. *Drug and Alcohol Review*, 27, 253-62.

Dawe, S., Davis, P., Lapworth, K., and McKetin, R., 2009. Mechanisms underlying aggressive and hostile behavior in amphetamine users. *Current Opinion in Psychiatry*, 22, 269-273.

Grant, K.M., Kelley, S,S., Agrawal, S., Meza, J.L., Meyer, J.R., and Romberger, D.J., 2007. Methamphetamine use in rural Midwesterners. *American Journal on Addictions*, 16, 79-84.

Greenacre, M. (2007). Interdisciplinary Statistics: *Correspondence Analysis in Practice*. Chapman & Hall/CRC: Boca Raton, FL.

Hall, W., Hando, J., Darke, S., and Ross, J., 1996. Psychological morbidity and route of administration among amphetamine users in Sydney, Australia. *Addiction* 91, 81-87.

Herman-Stahl, M., Krebs, C.P., Kroutil, L.A., and Heller, D.C., 2006. Risk and protective factors for nonmedical use of prescription stimulants and methamphetamine among adolescents. *Journal of Adolescent Health*, 39, 374-380.

Iritani, B.J., Hallfors, D.D., and Bauer, D.J., 2007. Crystal methamphetamine use among young adults in the USA. *Addiction*, 102, 1102-1113.

Jaspan, H., Flisher, A.J., Mathews, C., Seebregts, C., Berwick, J.R., Wood, R., and Bekker, L-G., 2007. Methods for collecting sexual behavior information from South African adolescents - a comparison of paper versus personal digital assistant questionnaires. *Journal of Adolescence,* 30**,** 353-359.

Kagee, A., 2008. Symptoms of depression and anxiety among a sample of South African patients living with a chronic illness. *Journal of Health Psychology*, 13, 547-555.

London, E.D., Simon, S.L., Berman, S.M., Mandelkern, M.A., Lichtman, A.M., Bramen, J., Shinn, A.K., Miotto, K., Learn, J., Dong, Y., Matochik, J.A., Kurina, V., Newton, T., Woods, R., Rawson, R., and Ling, W., 2004. Mood disturbances and regional cerebral metabolic abnormalities in recently abstinent methamphetamine abusers. *Archives of General Psychiatry*, 61, 73-84.

Looby, A. and Earleywine, M., 2007. The impact of methamphetamine use on subjective well-being in an Internet survey: preliminary findings. *Human Psychopharmacology*, 22,167-172.

Newton, T.F., Kalechstein, A.D., Duran, S., Vansluis, N., and Ling, W.

Methamphetamine abstinence syndrome: preliminary findings., 2004. *American Journal on Addictions*, 13, 248-255.

Pinhey, T.K. and Wells, N.R., 2007. Asian-Pacific islander adolescent methamphetamine use: Does 'Ice' increase aggression and sexual risk? *Substance Use & Misuse*, 42, 1801-1809.

Pluddemann, A., Flisher, A.J., Mathews, C., Carney, T., and Lombard, C., 2008b. Adolescent methamphetamine use and sexual risk behavior in secondary school students in Cape Town, South Africa. *Drug and Alcohol Review*, 27, 687-692.

Pluddemann, A., Myers, B.J., and Parry, C.D., 2008a. Surge in treatment admissions related to methamphetamine use in Cape Town, South Africa: implications for public health. *Drug and Alcohol Review*, 27,185-189.

Rahdert, E.R., 1991.*The Adolescent Assessment/Referral System Manual*. Rockville, MD. Department of Health and Human Services, Alcohol, Drug Abuse, and Mental Health Administration.

Rawson, R.A, Gonzalez, R., Obert, J.L., McCann, M.J., and Brethen, P. Methamphetamine use among treatment-seeking adolescents in Southern California: participant characteristics and treatment response., 2005. *Journal of Substance Abuse Treatment*, 29, 67-74.

Seebregts, C. J., Zwarenstein, M., Mathews, C., Fairall, L., Flisher, A.J., Seebregts, C., Mukoma, W., and Klepp, K. I., 2009. Handheld computers for survey and

trial data collection in resource-poor settings: Development and evaluation of PDACT, a Palmtrade mark Pilot interviewing system. *International Journal of Medical Informatics*, Jan. 19.

Springer, A., Peters, R., Shegog, R., White, D., and Kelder, S., 2007. Methamphetamine use and sexual risk behaviors in U.S. high school students: Findings from a national risk behavior survey. *Prevention Science*, 8, 103-113.

Topp, L., Degenhardt, L., Kaye, S., and Darke S., 2002. The emergence of potent forms of methamphetamine in Sydney, Australia: a case study of the IDRS as a strategic early warning system. *Drug and Alcohol Review*, 21, 341-348.

Tyner, E.A. and Fremouw, W.J., 2008. The relation of methamphetamine use and violence: A critical review. *Aggression and Violent Behavior*, 13, 285-297.

United Nations Office on Drugs and Crime., 2008. *World Drug Report*. Vienna: United Nations Office on Drugs and Crime.

Ward, C.L., Flisher, A.J., Zissis, C., Muller, M., Lombard, C., 2003. Reliability of the Beck Depression Inventory and the Self-Rating Anxiety Scale in a sample of South African adolescents. *Journal of Child and Adolescent Mental Health*, 15, 73-75.

White, V. and Hayman, J., 2006. *Australian secondary school students' use of over-the-counter and illicit substances in 2005*. Australian Government. http://www.nationaldrugstrategy.gov.au/internet/drugstrategy/publishing.nsf/Content/mono60 Accessed 19 March 2009.

Table 1: Self-reported drug use (N = 1561)

	Lifetime	Past 12 months	Past 30 days	Past 7 days
	% 95% CI	% 95% CI	% 95% CI	% 95% CI
Tobacco	60.2 (53.2 – 67.1)	33.0 (27.2 – 38.8)	27.2 (21.6 – 32.8)	25.4 (20.6 – 30.2)
Alcohol	54.1 (48.8 – 59.3)	22.0 (15.3 – 28.7)	12.5 (9.0 – 16.0)	7.1 (5.0 – 9.2)
Cannabis	24.8 (20.9 – 28.7)	12.9 (10.3 – 15.4)	7.7 (6.1 – 9.3)	6.4 (4.9 – 7.9)
Methamphetamine	8.8 (6.2 – 11.4)	4.7 (3.1 – 6.4)	2.8 (1.6 – 3.9)	1.8 (1.0 – 2.6)
Mandrax (methaqualone)	2.6 (1.8 – 3.3)	1.1 (0.4 – 1.7)	0.6 (0.1 – 1.0)	0.3 (0.0 – 0.7)
Cocaine/crack	2.5 (1.5 – 3.5)	1.3 (0.6 – 2.0)	0.5 (0.1 – 0.9)	0.6 (0.1 – 1.0)
Ecstasy	3.2 (2.2 – 4.2)	1.2 (0.7 – 1.7)	0.6 (0.2 – 1.0)	0.5 (0.1 – 0.9)
Heroin	2.2 1.6 – 2.9	1.0 0.6 – 1.5	0.6 0.2 – 1.0	0.4 0.1 – 0.8

Table 2: POSIT subscale category scores for various groups of students by methamphetamine use (%)

	Non-meth. users (n=1424)	Life-time meth. users (n=63)	Past year meth. users (n=74)	Chi-square[a]
Mental health				
Low risk	39.4	27.0	14.9	28.6
Middle risk	41.7	44.4	47.3	df = 4
High risk	18.9	28.6	37.8	$p < 0.001$
Aggressive behavior/delinquency				
Low risk	28.3	12.7	6.8	56.6
Middle risk	64.1	69.8	64.9	df = 4
High risk	7.6	17.5	28.4	$p < 0.001$

[a] For comparison across the categories of methamphetamine use/non-use

Note: This Table compares three groups of students on the two subscales of the POSIT: students who have never used methamphetamine, students who have used methamphetamine, but not in the past 12 months, and students who have used methamphetamine in the past 12 months.

Table 3: Beck Depression Inventory categories for students who have tried methamphetamine versus students who have not.

	Never tried meth (n=1424) %	Life-time meth users (n=137) %
None	9.5	7.3
Normal ups/downs	47.3	33.6
Mild mood disturbance	14.0	15.3
Borderline clinical depression	6.4	10.9
Moderate depression	12.6	18.2
Severe depression	7.1	10.9
Extreme depression	3.1	3.6

Methamphetamine use by collapsed BDI categories

		Life-time meth use (n=63)[a]	Past year use (n=74)
None	56.8	54.0	29.7
Medium	20.4	25.4	27.0
High	22.8	20.6	43.2

[a] Used methamphetamine, but not in past 12 months

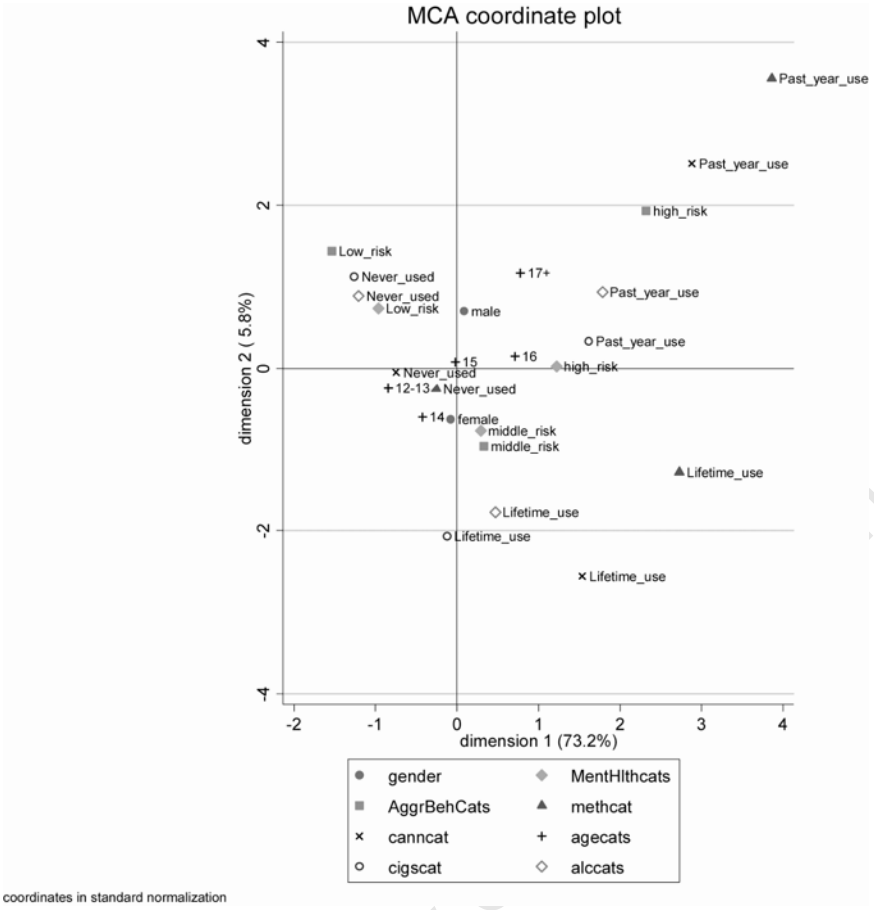

Figure 1: Multiple correspondence analysis co-ordinate plot for selected variables (N=1536) [Note: Some co-ordinates have been graphically shifted slightly to enhance legibility]

Key:

cigscat = Tobacco use categories (Life-time use = not used in the past year)
alccats = Alcohol use categories
canncat = Cannabis use categories
methcat = Methamphetamine use categories
MentHlthcats = mental health risk scale categories
AggrBehcats = aggressive behavior risk scale categories
Agecats = age categories (i.e. 12-13, 14, 15, 16, 17+)

CHAPTER 6

Methamphetamine use and sexual risk behavior among high school students in Cape Town, South Africa

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Description of contribution of candidate

Author 1 (AP) was the principal investigator of the study, conceptualising the study in consultation with authors 2, 3 and 4. AP took primary responsibility for data collection (with assistance from fieldworkers), processing, entry and cleaning of the data. AP was also primarily responsible for the drafting all sections of this manuscript, and conducting the data analysis.

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Abstract

Objective: To investigate whether methamphetamine use is associated with sexual risk behavior among adolescents. **Method**: A cross-sectional survey of 1561 male and female high-school students in Cape Town (mean age 14.9 years), was conducted using items from the Problem Oriented Screening Instrument for Teenagers (POSIT) HIV Risk Scale. **Results**: Nine percent of the students had tried methamphetamine and 30% of male and 17% of female students reported sexual debut. Multinomial logistic regression analyses showed that methamphetamine use in the past year was significantly associated with being in a higher HIV/STI risk category (RRR = 2.1, 95% CI: 1.10 – 4.03, $p < 0.05$). **Conclusions**: Methamphetamine use coupled with a high HIV prevalence in South Africa, raise serious cause for concern about the potential for methamphetamine to further exacerbate the prevalence and spread of HIV in Cape Town.

Introduction

According to the UNAIDS 2008 global report on the AIDS epidemic, young people aged 15-24 account for an estimated 45% of new HIV infections worldwide. In 2007, an estimated 270 000 HIV-infected children younger than 15 years died because of AIDS – more than 90% of them in sub-Saharan Africa (UNAIDS, 2008). UNAIDS estimated the national adult HIV prevalence for South Africa for 2007 to be over 15%, translating to an estimated 5.7 million people living with HIV, making this the largest HIV epidemic in the world. In South Africa methamphetamine use by adolescents began to emerge as an issue in 2004, increasing rapidly in subsequent years particularly in Cape Town. For example, only 0.3% of all patients admitted to drug counseling or rehabilitation centers in Cape Town had methamphetamine as their primary or secondary drug of abuse in the first half of 2002, in comparison to 46% in the first half of 2006. Even more concerning, this figure rose to 73% for patients who were under 20 years of age (Plüddemann, Myers, & Parry, 2008).

A number of studies have found associations between the use of methamphetamine and sexual risk behavior increasing the chances of exposure to HIV. However the majority of these studies have been conducted among men who have sex with men, as indicated by a comprehensive compilation of methamphetamine-related literature (Hammer, 2007). Relatively fewer studies have been conducted in predominantly heterosexual populations, and even fewer among heterosexual adolescent populations. One of the first studies specifically reporting associations between methamphetamine and sexual risk behavior in an adolescent population was conducted by Yen (2004). Yen's study indicated that

adolescent methamphetamine users had a higher mean number of sexual partners, and high frequency methamphetamine users also had a higher mean number of sexual partners than low frequency methamphetamine users. High frequency methamphetamine users were also more likely to report having had unprotected sex. The first survey of 4605 Cape Town high-school students' methamphetamine use, conducted in 2005, found that 13% of male and 12% of female grade 9 students had tried methamphetamine at least once (Plüddemann, Flisher, Mathews, Carney, & Lombard, 2008). This study also provided the first indication of an association between methamphetamine use and sexual risk behavior among Cape Town high-school students, finding that methamphetamine use in the past 12 months was associated with being sexually active. The 2003 US Youth Risk Behavior Survey also found associations between methamphetamine use and sexual risk behaviors, with heavy methamphetamine users being more than four times more likely to report having had sexual intercourse before the age of 13 years, being more likely to have sex with multiple partners, and having been/gotten someone pregnant compared to those who used methamphetamine on one or two occasions (Springer, Peters, Shegog, White, & Kelder, 2007).

The purpose of the present study was to further investigate the association between methamphetamine use and sexual risk behavior among adolescents in Cape Town. We sought to replicate the previously observed association between methamphetamine use and being sexually active, and to additionally explore the level of sexual risk behavior among sexually active teens. We also examined whether the relationship between methamphetamine use and sexual risk behavior could be better accounted for by the concurrent use of other substances or sociodemographic factors. This was done by

examining level of sexual risk behavior (no sexual activity, sexual activity, risky sexual activity) among a large sample of 1561 students from Cape Town and comparing sexual risk level by past year methamphetamine use. A correspondence analysis was used to examine correlates of sexual risk behavior and a multinomial regression was used to adjust for other substance use and demographic factors that were potentially confounding the relationship between methamphetamine use and sexual risk behaviour.

METHODS

Design and sampling strategy

The school population was all public high schools (N=54) in the South Educational District, one of four education management districts in the city of Cape Town. Fifteen schools were randomly selected from this population, such that the probability of selection was directly proportional to the number of students in the school. This district was believed to be the most affected by methamphetamine use, based on treatment demand data and newspaper and other anecdotal reports. Subsequently one class of approximately 35 students was randomly selected from each of grades 8, 9 and 10. Data were collected in July and August 2006.

Procedures

Questionnaires were administered by trained staff in a standardized way in a classroom setting without the presence of school staff. Students were seated in such a way as to preserve confidentiality, with as much space between students as possible. Personal Digital Assistants (PDAs) were used to administer the questionnaires and students were

able to choose from one of three major local languages (English, Afrikaans and isiXhosa). PDAs have been used in a number of local studies and have been found to be very effective (Jaspan et al., 2007; Seebregts et al., 2009). The PDAs also enhanced confidentiality as screens are very difficult to read from an angle.

Each student provided informed assent. Parents were informed of the study by letter and given the opportunity to withdraw their child from the study. Very few parents withdrew their children from the study and very few students refused to participate (n = 50). Ethical clearance for the study was obtained from the University of Cape Town's Faculty of Health Sciences Research Ethics Committee.

Measures

The questionnaire included basic demographic characteristics, substance use history, and a 13-item HIV/STI Risk Screen, based on the Problem Oriented Screening Instrument for Teenagers (POSIT) HIV Risk Scale (Rahdert, 1991). In order to document the socio-economic status (SES) of the learners, a question asking learners to describe their 'living circumstances' by selecting one of five categories was used. The options were: 'We don't have enough money for food', 'We have enough money for food, but not clothes', 'We have enough money for food and clothes, but are short of other things', 'We have the most important things, but few luxuries', and 'We have money for luxury goods and extra things'. Substance use measures covered tobacco, alcohol, cannabis, methaqualone, cocaine, heroin, ecstasy and methamphetamine. For each of these substances students were asked whether they had ever tried them, and whether they had used them in the past 12 months, past 30 days, and past seven days.

The HIV/STI Risk Screen was developed by Jaramara et al. (unpublished manuscript) to create a HIV/STI risk screen for South African adolescents. In a series of reliability and validity analyses, Jaramara et al. refined the 28 item POSIT HIV/STI Risk Scale by Rahdert to a 13 item HIV/STI Risk Screen. The refined scale was internally consistent (alpha=.80 for the entire sample and alphas ranging from .77 to .83 across languages) and stable over 6-10 days (r=.84 for the entire sample and coefficients ranging from .79 to .91 across languages). Associations with conceptually-related measures provided evidence for convergent and divergent validity. For the purposes of analysis for our study, however, we created three HIV/STI risk categories from this scale, utilizing eight items as follows: 1) Low risk – students who had never had sexual intercourse; 2) medium risk – students who affirmed the question 'Have you ever had sexual intercourse?' and affirmed up to two of sex risk items (items 2-8) in Table 1; and 3) high risk - students who affirmed the question 'Have you ever had sexual intercourse?' and affirmed three or more of subsequent sexual risk items in Table 1. The authors conferred on the categorization based on their extensive collective expertise in the field of adolescent risk behavior. These categories were primarily created for analysis purposes for the Multiple Correspondence Analysis and the comparisons in Table 4. There were no pre-existing categories for this scale.

Data analysis

Data was analyzed using SPSS 16.0 and STATA 10. For the calculation of the substance use and sexual risk behavior prevalence confidence intervals we took the study design (clustering at school level) into account in STATA's survey analysis settings. Chi-square

tests were used for basic comparisons. As a tool to try to address the issue around the use of multiple substances by participants, we used Multiple Correspondence Analysis. In correspondence analysis (Greenacre, 2007) an attempt is made to find a low dimensional graphical representation of the association between the rows and columns of a contingency table. It is an exploratory multivariate technique that converts frequency table data into graphical displays in which rows and columns are depicted as points. Much of the value of correspondence analysis relates to its multivariate treatment of data through the simultaneous consideration of multiple categorical variables. The multivariate nature of correspondence analysis can reveal relationships that would not be detected in a series of pair wise comparisons of variables. Correspondence analysis also helps to show how variables are related, not merely that a relationship exists. The graphical display can help in detecting structural relationships among variable categories. A relationship is generally indicated between variables that appear in the same region of space. However points on the plot clustered around the origin remain unresolved in the analysis (Greenacre, 2007).

Multinomial logistic regression was performed to establish the size and significance of the association between methamphetamine use and various sexual risk behaviors, after adjusting for confounders. The outcome variables in these regressions were the sexual risk categories described in the methods section above. Methamphetamine use (past year) was the main predictor variable in these analyses, and adjustment was made for factors that were shown to be related to both methamphetamine use and sexual risk behavior indices in the correspondence analysis and where tests of association were significant ($p < 0.05$).

RESULTS

Demographics

The final sample comprised 1561 students, with slightly more females (53%) than males. The majority identified themselves as 'Coloured'(76%), with 43% and 38% reporting Afrikaans and English respectively as their home language. [Note: The terms "white", "black", and "Coloured", became entrenched in the apartheid era. They refer to demographic markers and do not signify inherent characteristics. They refer to people of European, African and mixed (African, European and/or Asian) ancestry, respectively. These markers were chosen for their historical significance. Their continued use in South Africa is important for monitoring improvements in health and socio-economic disparities, identifying vulnerable sections of the population, and planning effective prevention and intervention programs.] The mean age of the students was 14.9 years (SD = 1.36). The ages ranged from 12 to 20 years. Based on the SES, almost 75% of the students came from lower to middle income households (i.e. they chose one of the first four options of the SES question).

Sexual risk behavior

Table 2 shows the proportions of male and female students who engaged in various sexual risk behaviors. Almost a third of the male students reported that they had had sexual intercourse, roughly double that of the female students. Of the sexually active students, male students were also significantly more likely to have had sex before their 15th birthday, had anal sex, and to have had sex with two or more people in the past 3 months. However similar proportions of males and females affirmed other sexual risk

questions, including having been sexually involved with someone more than five years older than them, having thought they or their partner might be pregnant, and having had sex without a condom. A higher proportion of the male students who reported sexual debut, admitted to having been high on alcohol or drugs while having sex compared with the female students, but this difference was not statistically significant. Older age also appeared to be related to sexual risk behavior, with the proportion of students in the 'high risk category increasing in increments of approximately 5% for each of the four age groups (12-14 years, 15 years, 16 years and 17 years +) from 5% for the 12-14 years group to 19.4% for the 17 or older group. There was no significant association between SES and sexual risk behavior categories, with between 8% and 12% of students classified in the 'high risk' category across the SES categories.

Substance use

Table 3 shows the proportions of students reporting the use of various substances, from 'life-time use' ("Have you ever tried *substance*?") to use of the substance in the past seven days. The table shows that tobacco use was most common, followed by alcohol and cannabis. Almost 9% of the students had tried methamphetamine at least once, while 3% or less had tried Mandrax (methaqualone), cocaine, Ecstasy or heroin. Reported substance use in the past seven days was generally low, except for tobacco. Tobacco and alcohol use proportions were very similar for male and female students. Male students were, however, more likely to have tried cannabis (29.3%) than female students (20.8%). Ten percent of the male students had tried methamphetamine at least once compared with 8% of the female students. However the proportion of males who had tried methamphetamine

in the past 12 months (6.4%) was almost twice the proportion for the females (3.3%). Older students were more likely to report past year use of methamphetamine, with 10% of students in the 17 or older age category reporting past year use compared to 2% in the 12-14 years age category, 5% of 15 year-olds and 8% of 16 year-olds. SES was not significantly related to methamphetamine use, although a slightly higher proportion of students in the highest SES category reported past year methamphetamine use (7%) compared to the lowest SES category (4%).

Methamphetamine use and sexual risk behavior

Comparing students in three methamphetamine use categories and three HIV/STI risk categories (Table 4) indicated that students who had used methamphetamine in the past year were significantly more likely to be in the 'high HIV/STI risk' category (35.1%) than students who had never used methamphetamine (8.5%).

The Multiple Correspondence Analysis (MCA) (for included variables see Figure 1) indicated an association between methamphetamine use in the past year and being in the 'HIV/STI high risk' category. Methamphetamine use in the past year was also closely associated with cannabis and alcohol use in the past year, and the use of both substances was associated with 'HIV/STI high risk' scores, and to some extent with 'HIV/STI medium risk' scores (all appeared in a proximal region of space on the MCA graph, especially on Dimension 1, indicating an association: Figure 1). Being older (17 or older) and male also seemed to be a factor. On dimension 1 (which accounted for 75% of the Chi-square information in the analysis), life-time use of cannabis and methamphetamine also appeared to be associated with 'HIV/STI high risk' scores.

In order to further clarify the significance of the above associations, we conducted multinomial logistic regression analysis, with the HIV/STI risk categories as outcome variable and methamphetamine use category as the main predictor variable. In our model we added gender, cannabis use in the past 12 months, alcohol use in the past 12 months, tobacco use in the past 12 months and age categories as covariates, judged to be the strongest possible confounders from the MCA and chi-square tests. (SES was not found to be related to HIV/STI risk or methamphetamine use, and therefore not included in the analysis/model.) In this model, only methamphetamine use in the past 12 months (not 'life-time methamphetamine use') was significantly associated with being in a higher HIV/STI risk category (RRR = 2.1, 95% CI: 1.10 – 4.03, $p < 0.05$).

Discussion

The findings of this study clearly indicate a strong association between methamphetamine use and engaging in certain sexual risk behaviors. Even after adjusting for a number of potential confounders, methamphetamine use was still implicated as a significant factor. This research supports other studies such as (Yen, 2004) among adolescents specifically, but also further confirms that methamphetamine use is not only a risk factor among men who have sex with men (MSM) populations. The vast majority of studies on this issue have been conducted among this group, as is clearly indicated in an index to PubMed indexed literature on methamphetamine, including all methamphetamine related studies up to January 2007 (Hammer, 2007). A number of emerging studies have also shown these associations in heterosexual populations, although most have been in adult populations. Previous studies among adolescents in other countries (including the USA,

Taiwan and Thailand) have indicated that risky sex was significantly more likely among life-time methamphetamine users, that life-time methamphetamine use was associated with earlier initiation of intercourse and having had two or more partners in the past three months, that higher frequency methamphetamine users were more likely to have had sex before age 13, and that unprotected sex increased in frequency with frequency of methamphetamine use (Embry, Hankins, Biglan, & Boles, 2009; Pinhey & Wells, 2007; Springer et al., 2007; Yen, 2004; Zapata, Hillis, Marchbanks, Curtis, & Lowry, 2008). The present study further supports the findings in an earlier study by (Plüddemann et al., 2008), which was able to show some 'peripheral' associations between methamphetamine use and sexual risk behaviors, however without the benefit of the potential confounding variables we have been able to examine in the present study.

Important to note, however, is also that the MCA (a rarely used technique in the public health and social sciences) clearly seemed to indicate a 'cluster of associations' between various 'risk behaviors', including methamphetamine use, cannabis use, tobacco and alcohol use. This MCA may provide some support to the theory (Mpofu, Bility, Flisher, Onya, & Lombard, 2005; Mpofu et al., 2006) that certain adolescents may be prone to 'risk behaviors' in general, thereby engaging in these risky health behaviors, which may include sexual risk behavior, substance use or abuse and other risk behaviors. Nevertheless it would still appear that methamphetamine in particular makes an additional significant contribution to sexual risk behaviors among adolescents, likely more so than any other substances, as indicated by the regression analysis.

An important issue for further investigation, however, remains whether methamphetamine use contributes more significantly to sexual risk behavior than other substances. A previous study among South African adolescents found associations between alcohol and cannabis use and sexual risk behavior (Palen, Smith, Flisher, Caldwell, & Mpofu, 2006) and cocaine use has also been associated with sexual risk behavior among adults (Hayaki, Anderson & Stein, 2006). It is possible that in South Africa and particularly Cape Town, the extent of methamphetamine use poses the greatest threat to increasing sexual risk behavior among adolescents, compounding risks already posed by alcohol and cannabis use.

The limitations of the present study include that it was cross-sectional, with no opportunity to follow up the adolescents' behavior patterns. We also did not have access to previous behavior or other health and mental health measures on the adolescents surveyed, which would have provided better longer term 'risk behavior profiles' of the adolescents surveyed. We were therefore also unable to formulate direct predictive models and therefore not able to determine definitively the exact extent of the contribution of methamphetamine use to these sexual risk behaviors.

In conclusion, the present study is one of still relatively few which have investigated the association between methamphetamine use and sexual risk behavior in high-school attending adolescents aged 15 on average. In the context of South Africa's HIV prevalence and being the country with the second highest number of HIV infected individuals in the world, the potential for methamphetamine to further exacerbate this epidemic is extremely concerning. Local and national government authorities should

urgently address methamphetamine use in Cape Town and the rest of South Africa, through intensifying both prevention messaging and treatment and aftercare support services for those with methamphetamine dependence. International drug control bodies, including the United Nations Office on Drugs and Crime (UNODC), the International Narcotics Control Board (INCB) and others should further attempt to sharpen laws governing the sale, importation and perhaps even production of precursor chemicals used to manufacture methamphetamine. Further efforts targeting HIV prevention and treatment are also paramount in South Africa and many other countries, including perhaps particularly those affected by methamphetamine use.

References

Embry, D., Hankins, M., Biglan, A., & Boles, S. (2009). Behavioral and social correlates of methamphetamine use in a population-based sample of early and later adolescents. *Addictive Behaviors*, *34*(4), 343-351.

Greenacre, M. (2007). *Interdisciplinary Statistics: Correspondence Analysis in Practice.* Boca Raton, FL: Chapman & Hall/CRC.

Hammer, M.R. (2007). *A Key to Methamphetamine-Related Literature*. Division of HIV Prevention, AIDS Institute, New York State Department of Health.

Hayaki, J., Anderson, B., & Stein, M. (2006). Sexual risk behaviors among substance users: relationship to impulsivity. *Psychology of Addictive Behaviors, 20*(3), 328-332.

Jaramara, S.L., Parillo, K.M., Townsend, L., Mathews, C., Rahdert, E., Flisher, A.J., Young, P.A., Stultz, N.A., & Snyder, F.R. (Unpublished manuscript).An HIV/STI risk screen for South African Adolescents.

Jaspan, H., Flisher, A.J., Mathews, C., Seebregts, C., Berwick, J.R., Wood, R., & Bekker, L-G. (2007). Methods for collecting sexual behavior information from South African adolescents - a comparison of paper versus personal digital assistant questionnaires. *Journal of Adolescence, 30*(2)**,** 353-359.

Mpofu, E., Bility, K., Flisher, A. J., Onya, H., & Lombard, C. (2005). Correlates of drug use in rural Africa: drug/substance use and sexual behaviour in Mankweng District, South Africa. *Journal of Psychology in Africa, 15*(1), 11-15.

Mpofu, E., Caldwell, L., Smith, E., Flisher, A. J., Mathews, C., & Vergnani, T. (2006). Rasch modeling of the structure of health risk behavior in South African adolescents. *Journal of Applied Measurement, 7*(3), 323-334.

Palen, L. A., Smith, E. A., Flisher, A. J., Caldwell, L. L. , & Mpofu, E. (2006). Substance use and sexual risk behavior among South African eighth grade students. *Journal of Adolescent Health , 39*(5), 761-763.

Pinhey, T. K., & Wells, N. R. (2007). Asian-Pacific Islander adolescent methamphetamine use: does ice increase aggression and sexual risks? *Substance Use & Misuse, 42*(11), 1801-1809.

Plüddemann, A., Flisher, A. J., Mathews, C., Carney, T., & Lombard, C. (2008). Adolescent methamphetamine use and sexual risk behaviour in secondary school students in Cape Town, South Africa. *Drug & Alcohol Review, 27*(6), 687-92.

Plüddemann, A., Myers, B. J., & Parry, C. D. (2008). Surge in treatment admissions related to methamphetamine use in Cape Town, South Africa: implications for public health. *Drug & Alcohol Review, 27*(2), 185-9.

Rahdert, E.R. (1991). *The Adolescent Assessment/Referral System Manual*. Department of Health and Human Services, Alcohol, Drug Abuse, and Mental Health Administration. Rockville, MD.

Seebregts, C. J., Zwarenstein, M., Mathews, C., Fairall, L., Flisher, A. J., Seebregts, C., Mukoma, W., & Klepp, K. I. (2009). Handheld computers for survey and

trial data collection in resource-poor settings: Development and evaluation of PDACT, a Palmtrade mark Pilot interviewing system. International *Journal of Medical Informatics, 78*(11), 721-731.

Springer, A., Peters, R., Shegog, R., White, D., & Kelder, S. (2007). Methamphetamine Use and Sexual Risk Behaviors in U.S. High School Students: Findings from a National Risk Behavior Survey. *Prevention Science, 8*(2), 103-113.

UNAIDS. (2008). *2008 Report on the Global AIDS Epidemic*. UNAIDS 2008.

Yen, C. F. (2004). Relationship between methamphetamine use and risky sexual behavior in adolescents. *Kaohsiung Journal of Medical Science, 20*(4), 160-165.

Zapata, L.B., Hillis, S.D., Marchbanks, P.A., Curtis, K.M., & Lowry, R. (2008). Methamphetamine use is independently associated with recent risky sexual behaviors and adolescent pregnancy. *Journal of School Health, 78*(12), 641-648.

Table 1: HIV/STI Risk Screen items used to assess sexual risk behavior

1. Have you ever had sexual intercourse?
2. Did you have sexual intercourse before your 15th birthday?
3. Have you ever been high on drugs or alcohol when you had sex with someone?
4. Have you had sex with two or more people in the past 3 months?
5. Have you ever had anal intercourse (sex in your butt)?
6. Have you ever been sexually involved with someone more than 5 years older than you?
7. Have you ever thought you or your partner might be pregnant?
8. Have you ever had sexual intercourse without using a condom?

Table 2: Proportions and confidence intervals of male and female students who affirmed selected sexual risk questions

Sexual risk questions	Males % (n = 731) (95% Confidence interval (CI))	Females % (n = 822) (95% CI)	Chi-square p-value
Ever had sexual intercourse?	30.2 (21.5 – 39.0)	16.5 (10.4 – 22.6)	40.9 $p < 0.001$
Proportions of students who affirmed the above question follow below			
	n = 221	n = 136	
Sex before your 15th birthday?	62.9 (58.1 – 67.7)	36.0 (27.2 – 44.9)	24.4 $p < 0.001$
Ever been high on drugs or alcohol when you had sex with someone?	32.1 (25.1 – 39.2)	22.1 (11.9 – 32.2)	4.2 $p > 0.05$
Had sex with two or more people in the past 3 months?	28.5 (20.7 – 36.4)	11.8 (4.2 – 19.3)	13.7 $p < 0.01$
Ever had anal intercourse (sex in your butt)?	29.4 (23.3 – 35.5)	14.7 (5.2 – 24.2)	10.0 $p < 0.05$
Ever been sexually involved with someone more than 5 years older than you?	34.4 (29.2 – 39.6)	30.2 (22.0 – 38.3)	0.7 $p > 0.05$
Ever thought you or your partner might be pregnant?	34.8 (27.6 – 42.1)	37.5 (27.7 – 47.3)	0.3 $p > 0.05$
Ever had sexual intercourse without using a condom?	57.5 (48.2 – 66.8)	57.4 (46.8 – 67.9)	0.0004 $p > 0.05$

Note: 95% CIs and Chi-squares calculated taking design of study into account

Table 3: Self-reported drug use (N = 1561)

	Lifetime % (95% CI)	Past 12 months % (95% CI)	Past 30 days % (95% CI	Past 7 days % (95% CI)
Tobacco	60.2	33.0	27.2	25.4
	(53.2 – 67.1)	(27.2 – 38.8)	(21.6 – 32.8)	(20.6 – 30.2)
Alcohol	54.1	22.0	12.5	7.1
	(48.8 – 59.3)	(15.3 – 28.7)	(9.0 – 16.0)	(5.0 – 9.2)
Cannabis	24.8	12.9	7.7	6.4
	(20.9 – 28.7)	(10.3 – 15.4)	(6.1 – 9.3)	(4.9 – 7.9)
Methamphetamine	8.8	4.7	2.8	1.8
	(6.2 – 11.4)	(3.1 – 6.4)	(1.6 – 3.9)	(1.0 – 2.6)
Mandrax (methaqualone)	2.6	1.1	0.6	0.3
	(1.8 – 3.3)	(0.4 – 1.7)	(0.1 – 1.0)	(0.0 – 0.7)
Cocaine/crack	2.5	1.3	0.5	0.6
	(1.5 – 3.5)	(0.6 – 2.0)	(0.1 – 0.9)	(0.1 – 1.0)
Ecstasy	3.2	1.2	0.6	0.5
	(2.2 – 4.2)	(0.7 – 1.7)	(0.2 – 1.0)	(0.1 – 0.9)
Heroin	2.2	1.0	0.6	0.4
	1.6 – 2.9	0.6 – 1.5	0.2 – 1.0	0.1 – 0.8

Note: 95% CIs calculated taking design of study into account

Table 4: Methamphetamine use categories by HIV/STI risk categories

	Never used meth n % (95% CI)[1]	Lifetime meth. use[2] n % (95% CI)	Past year meth. use n % (95% CI)
HIV/STI risk low	1129 79.3 (70.4 – 86.0)	39 61.9 (49.1 – 73.2)	36 48.7 (32.0 – 65.6)
HIV/STI risk medium	174 12.2 (8.0 – 18.2)	12 19.1 (12.6 – 27.8)	12 16.2 (7.7 – 31.0)
HIV/STI risk high	121 8.5 (5.9 – 12.0)	12 19.1 (10.5 – 32.2)	26 35.1 (21.9 – 51.2)

Notes: 1) 95% CIs calculated taking design of study into account

2) Lifetime methamphetamine use = used methamphetamine, but not in past 12 months

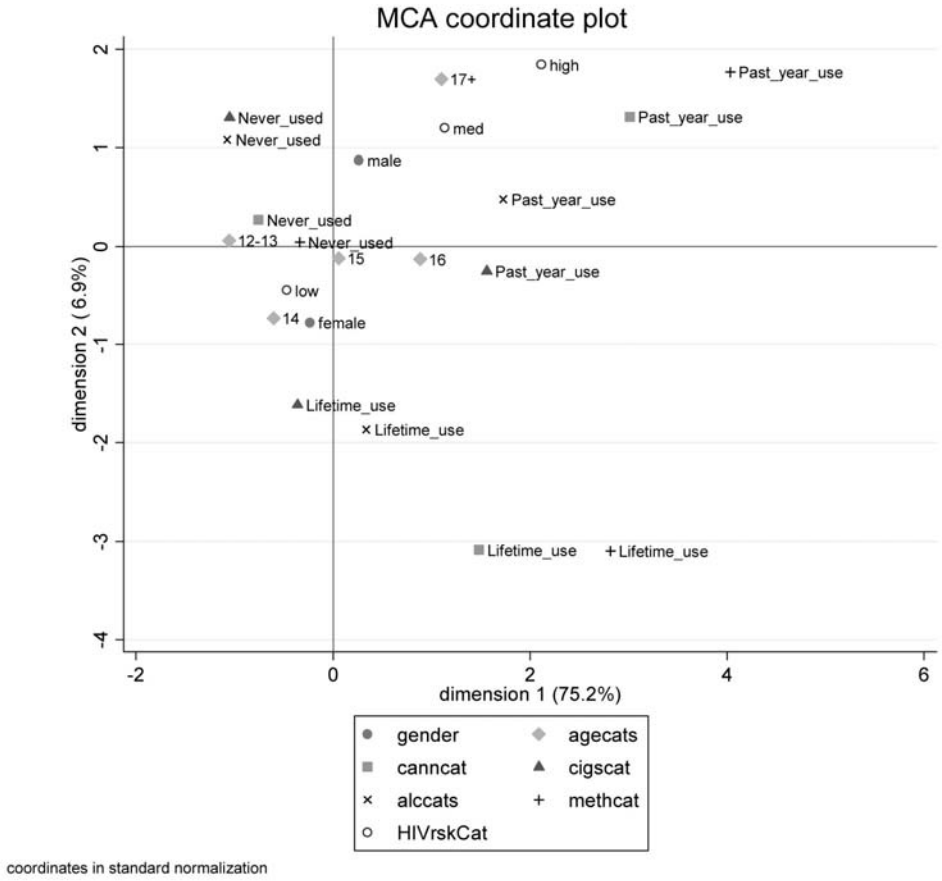

Figure 1: Multiple correspondence analysis co-ordinate plot for selected variables (N=1536)

Key:

cigscat = Tobacco use categories (Life-time use = not used in the past year)
alccats = Alcohol use categories
canncat = Cannabis use categories
methcat = Methamphetamine use categories
HIVrskCat = HIV/STI risk categories
Agecats = age categories (i.e. 12-13, 14, 15, 16, 17+)

CHAPTER 7

A prospective study of methamphetamine use as a predictor of high school non-attendance in Cape Town, South Africa

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5- Director: Biostatistics Unit, Medical Research Council, South Africa

Description of contribution of candidate

Author 1 (AP) was the principal investigator of the study and was primarily responsible for the drafting of the manuscript, including data analysis. AP also managed the data collection process, and was responsible for data entry, cleaning and analysis. Authors 2, 3 and 4 were involved in the design of the study, and contributed to the drafting and revising of the manuscript, and were involved in supervision of the study throughout. Authors 3 and 5 provided advice on methods of statistical analysis.

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ABSTRACT

Background: This prospective study investigated the association between life-long methamphetamine and other drug use and high school non-attendance, in a sample of high school students in Cape Town, South Africa.

Methods: A random sample of 1535 high school students completed a baseline questionnaire in 2006, and were asked to complete a follow-up questionnaire 12 months later. The questionnaire included questions on substance use, including tobacco, alcohol, methamphetamine and cannabis use, demographic factors, and questions relating to school attendance and performance. **Results**: Forty-three percent of the students surveyed at baseline did not complete a follow-up questionnaire after 12 months. Compared with students who were not using selected substances, an adjusted logistic regression model showed that life-time methamphetamine use in addition to other substances was significantly associated with non-attendance (OR = 2.58, 95% CI: 1.24 – 5.36) when other non-substance use factors (repeating a year at school and being older than the norm for current grade) were taken into account. **Conclusions**: Early identification of students with methamphetamine and other substance use problems, and a supportive rather than punitive school policy, may be valuable in improving high school completion and student retention rates.

Key words: methamphetamine, adolescents, high school, non-attendance, South Africa

Background

Over the past six years South Africa, particularly the city of Cape Town, has experienced a sharp increase in the use of methamphetamine.[1] This was initially noted informally by anecdotal reports in the media and then more formally by increases in admissions for methamphetamine related substance use disorders to specialist substance abuse treatment centres in Cape Town, and later confirmed by high school surveys.[2-5] By 2006 over 40% of individuals admitted to various substance abuse treatment facilities in Cape Town reported methamphetamine as their primary substance of abuse. Within two years, methamphetamine had become the most common primary substance of abuse for those admitted for substance abuse treatment in the city, surpassing the previous dominance of alcohol. Admissions were concentrated among adolescents, over 60% of whom reported using methamphetamine as a primary substance of abuse.[2] High school surveys confirmed high levels of methamphetamine use among adolescents, with a life-time prevalence estimate of 12% in a survey of 4605 students, and 9% in a survey of 1561 students in 2006.[3,4] Methamphetamine is almost exclusively smoked in Cape Town, particularly among adolescents. While very little data exists, police sources have indicated that the drug is mostly manufactured in the country currently on a relatively large scale. Most of these methamphetamine labs have been identified by police in the province of Gauteng, which includes Johannesburg and Pretoria. The trade of the drug appears to be mostly controlled by highly organized criminal gangs who have their 'home base' and largest membership in Cape Town. These gangs also have a long history of drug trafficking and dealing.

Evidence is increasingly implicating methamphetamine as one of the most harmful illicit drugs. It can affect mental health, causing depression, anxiety and psychoses, as well as have prominent behavioural effects, including aggression and impulsivity.[6] Studies of methamphetamine users have also indicated cognitive impairment, including memory loss and concentration problems, and irreversible neuronal damage.[7] These potential side effects are perhaps of particular relevance to school-going adolescents, who are required to engage in cognitive tasks and conform to a certain convention of behaviour while attending school. Moreover, the negative impact of substance use on school performance has a carry-over effect into adulthood, impeding opportunities for tertiary education and being associated with lower income, unemployment and lower life satisfaction.[8]

The potential impact of methamphetamine use on high school non-attendance is therefore an important issue for investigation. School attrition rates are a particular challenge in many developing countries, with the South African government estimating a number of years ago that up to 60% of children enrolled in primary schools, drop out before completing high school.[9] A longitudinal survey conducted in Cape Town high schools confirmed high dropout rates, finding a dropout rate of 55% from grade 8 to the final follow-up survey in grade 12.[10] This study found that school dropout was significantly predicted by absenteeism, poverty, and past month cigarette use, but not by past month alcohol use and life-time illicit drug (mostly cannabis) use. The study adjusted for a range of confounders, including gender, age and repeating a grade at school. At the time that this study was conducted (1997-2001), there was no indication or evidence of methamphetamine use in Cape Town. Another previous cross-sectional study of high

school students in Cape Town by Flisher et al. had also shown absenteeism to be related to the use of cigarettes, alcohol and cannabis in the past month.[11] This study suggested that interventions aimed at improving school attendance should comprise a substance abuse prevention component.

For the purposes of our study "non-attendance" is a collective term for students who are either absent from school (absenteeism) for any reason or have dropped out of school (meaning they no longer attend school).

The aim of the present study was to investigate whether the emergence of methamphetamine use would play a significant role in predicting high school non-attendance, further investigating the findings in Flisher et al.'s study which indicated that illicit drug use did not predict high school dropout, while past month cigarette use did predict dropout.[10] A number of studies, identified in a systematic review, have implicated substance use in predicting high school dropout.[12] In terms of illicit drugs, these previous studies have mostly reported on associations between dropout or absenteeism and cannabis use, with some referring to 'other illicit drugs', 'hard drugs' or 'injecting drug use'. To our knowledge, none have investigated methamphetamine use specifically in relation to high school non-attendance. The current study examined whether methamphetamine use among high-school students in school predicted non-attendance at school 12 months later, and whether this effect was beyond that observed with cannabis or tobacco use.

METHODS

Design and sampling strategy

The school population was all high schools (N=54) in the South Educational District, one of four education management districts in the city of Cape Town. This district was believed to be the most affected by methamphetamine use at the time the study was designed, based on treatment demand data.[2] The district encompasses some of the poorest suburbs of Cape Town and is the district most affected by criminal gangs. However, analysis from another random survey of all schools in Cape Town later showed relatively small differences in life-time prevalence of methamphetamine use across school districts.[3] Fifteen schools were randomly selected from this population, such that the probability of selection was directly proportional to the number of students in the school. One class of approximately 35 students was randomly selected from each of grades 8 (majority aged 13-14 years), 9 (majority aged 14-15 years) and 10 (majority aged 15-17 years). The initial data were collected in July and August 2006 (Time 1), and a follow-up survey with the same students was attempted approximately one year later during July and August 2007 (Time 2). Most schools were surveyed within a two week period of being exactly one year later, with only one school being surveyed one year and three weeks later.

Procedures

Questionnaires were administered by trained staff in a standardized way in a classroom setting without the presence of school staff. Students were seated in such a way as to preserve confidentiality. Personal Digital Assistants (PDAs) were used to administer the

questionnaires and students were able to choose from one of three major local languages (English, Afrikaans and isiXhosa). Brief instructions on how to use the PDAs were provided as well as a few 'practice questions'. Students were provided with a sealable envelope containing a unique number. Students were asked to enter the number in the requested field on the PDA, and to write their name, the name of their school, their grade and the date on the front of the envelope. They were then asked to seal the envelope, and sign across the sealed flap, thereby ensuring their data remained anonymous. These sealed envelopes were collected and returned to the students during the follow-up survey. They were asked to open the envelopes and transfer the number onto their new questionnaire on the PDA. In this way, data were linked while preserving anonymity.

Each student provided informed assent. Parents were informed of the study by letter and given the opportunity to withdraw their child from the study. Of all students approached to participate in the initial survey, only 50 refused or were withdrawn from the study. Ethical clearance for the study was obtained from the University of Cape Town's Faculty of Health Sciences Research Ethics Committee.

Measures

This study formed part of a broader investigation into methamphetamine use and various health issues. The complete set of measures used in this broader investigation are described elsewhere.[4] The main outcome measure for the present study was non-attendance at school, as indicated by the student not being present for the one-year follow-up interview. This measure of non-attendance reflects both school drop-out and absenteeism. As our survey was anonymous and we were hence unable to link the reason

for absenteeism or drop-out to individual students, we decided to combine these students as one group. While we were not able to establish reliable information for all students we were able to determine that approximately 50% of those classified as 'non-attenders' had left their school. A previous study of high school drop out in Cape Town had also found no discernable difference between students who were absent and students who had dropped out, and had also combined these students for analysis purposes. [10] For the purposes of the present study, we focused on a number of demographic and substance use variables, and variables related to the potential for school dropout, including failing a year at school and being older than the normal age for the grade they were currently in. Students' age and gender were recorded. Socio-economic status (SES) was assessed by asking students to describe their 'living circumstances' against the following five categories: 'We don't have enough money for food', 'We have enough money for food, but not clothes', 'We have enough money for food and clothes, but are short of other things', 'We have the most important things, but few luxuries', and 'We have money for luxury goods and extra things'. Substance use measures covered tobacco, alcohol, cannabis, methaqualone, cocaine, heroin, ecstasy and methamphetamine. For each of these substances students were asked whether they had ever tried them, and whether they had used them in the past 12 months, past 30 days, and past seven days. The prevalence of methaqualone, cocaine, heroin and ecstasy use was very low (life-time use equalled 3% or less) and thus these substances were not considered for analysis. Students were also asked whether they had ever repeated a year at school due to failing examinations. For the purposes of the present study, we also judged whether students were the appropriate normal age for their grade at the first survey. Students whose age was at least one year older than the normal age for their grade were categorized as 'age greater than

normal for grade', thereby creating a binary variable for being in an age appropriate grade. Above normal age for grade 8 was considered 15 years or older, grade 9 16 years or older and grade 10 17 years or older.

Data analysis

Data were analysed using SPSS 16.0 and STATA 10. For the calculation of the substance use prevalence and other proportions' confidence intervals we took the study design (clustering at school level) into account in STATA's survey analysis settings. A logistic regression model, adjusted for the study design only, was performed to establish the association between non-attendance and methamphetamine use and various other variables (see Table 2). The outcome variable in these regressions was non-attendance (versus 'in school'). In an attempt to establish whether methamphetamine specifically contributed to non-attendance in a combined adjusted model, four categories of substance use were created for contrasting purposes based on data collected at Time 1: (1) students who did not report smoking cigarettes currently (in the past 7 days), and had never tried cannabis or methamphetamine, (2) students who reported smoking cigarettes currently but had never tried cannabis or methamphetamine, (3) students who reported smoking cigarettes currently and had tried cannabis at least once, and (4) students who reported smoking cigarettes currently and had tried both cannabis and methamphetamine. This categorization was used to try to factor in the use of multiple substances into our analysis. To avoid confounding, students who had tried cocaine, heroin, ecstasy or methaqualone together with any other drugs in the categories above were excluded from this analysis. The covariates included in this model were 'repeating a year at school' and 'age greater than norm for grade'. These were identified as confounders because they were

significantly related to both the outcome and main predictor variables. The regression models were developed using a backward stepwise selection procedure. SES and gender were considered as confounding variables but were not found to be related to our main predictor and outcome variables used in the logistic regression model. Age was not included as a confounder as it correlated with 'age greater than norm for grade'. Therefore only one of these two variables could be used and it was decided that the latter variable would be more important to include. A measure of mental health was also considered as a covariate but it did not significantly improve the model fit ($p < 0.05$) and was therefore excluded.

RESULTS

A total of 1561 students completed the initial questionnaire in 2006. At the 12-month follow-up survey, 26 students completed questionnaires but did not enter their survey identification number correctly in the first survey, making it impossible to match their data from the follow-up survey. These students were excluded from the analysis, leaving a sample of 1535 students. Of these 874 (56.9%) completed the follow-up survey and the remaining 661 (43.1%) students were absent for the follow-up survey or had left the school and were thus considered to be non-attenders.

The final sample comprised slightly more females (53%) than males. The majority identified themselves as 'Coloured'(77%), followed by Black African (17%) and White (3%). [Note: The terms "white", "black", and "Coloured", became entrenched in the apartheid era. They refer to demographic markers and do not signify inherent

characteristics. They refer to people of European, African and mixed (African, European and/or Asian) ancestry, respectively. These markers were chosen for their historical significance. Their continued use in South Africa is important for monitoring improvements in health and socio-economic disparities, identifying vulnerable sections of the population, and planning effective prevention and intervention programs.] Forty-three percent and 38% reported Afrikaans (a local derivative of Dutch and certain Eastern languages) and English respectively as their home language. Sixteen per cent reported isiXhosa (a local African language) as their home language. Based on the SES question, 19% of the students came from lower income households (i.e. they chose one of the first two options of the SES question), 54% came from middle income households (i.e. they chose one of the third or fourth options of the SES question), and 27% chose the highest category on the SES question. The mean age of the students was 14.9 years (SD=1.34), ranging from 12 to 19 years. Almost 30% had repeated at least one year at school and 23% were older than the normal age for their grade (Table 1).

At Time 1, 8.8% of the students had tried methamphetamine at least once in their life, with a slightly higher proportion (though not significant) for male students (9.8%) than female students (7.9%), and 4.8% had used in the past year (Table 1). A similar division was noted for the 25% of students who had used cannabis at least once, with 12% of student having used in the past year. A quarter of the students reported smoking cigarettes in the past seven days and 7% reported drinking alcohol during the seven days prior to the survey. Of the students who completed a follow-up questionnaire, 21 reported having tried methamphetamine at least once who did not report methamphetamine use at Time 1.

Table 2 shows the differences in prevalence of methamphetamine use for students that were in school versus those that were not present at Time 2 for a number of substance use variables and selected other potential risk factors for non-attendance. The table also shows unadjusted odds ratios, which showed that life-time methamphetamine use, life-time cannabis use, current smoking, repeating a year at school, and being older than the norm for current grade were all significantly associated with non-attendance at Time 2. An adjusted logistic regression model (described in the methods section) showed that students who were current smokers, students who were current smokers and had tried cannabis, and students who were current smokers and had tried both cannabis and methamphetamine were significantly more likely, namely two to two and a half times, to be classified as non-attenders than students who were not current smokers and had not tried cannabis or methamphetamine (Table 3). In this adjusted model being older than the normal age for current grade remained significantly associated with non-attendance, while repeating a year at school was no longer significant (Table 3). Further logistic regression analyses did however not show significant differences in the odds ratios between the various groups of substance users in Table 3.

DISCUSSION

The high rate of students who were not present at school 12 months after they were originally surveyed, can be compared with findings of a previous study conducted in Cape Town, showing similar rates of high school dropout.[10] This finding alone is of concern, particularly in a country where poverty is endemic and educational achievement could play a significant role in addressing economic disparities.[12] In addition to

poverty, organized criminal gangs are also highly prevalent in the communities surveyed in the present study, with drug dealing forming a significant part of their criminal activity. Many adolescents join these gangs in order to survive and those who are no longer in school are particularly vulnerable.[13]

The methamphetamine use prevalence found in our study indicated substantial use of this drug among high school students, although the life-time prevalence of 9% was slightly lower than the prevalence of 12% found in a study a year earlier in Cape Town covering a larger geographic area [3]. The past 12 months prevalence of 4.8% was similar to the 4.2% (past year amphetamine use for 12-17 year-olds) found in a national survey of schools in Australia in 2005, a country with one of the highest rates of methamphetamine use in the world.[14,15]

Methamphetamine use in combination with other drugs doubled the odds of not attending school. Students who did not complete the survey at Time 2 were twice as likely to have reported life-time methamphetamine use at Time 1. This association remained significant in a regression model where multiple substance use was considered and with the inclusion of two confounding variables, namely repeating a year at school and being older than the expected normal age for current grade. These confounding variables have been found to be related to high school dropout in other studies.[16] A review by Townsend et al. similarly concluded a largely consistent relationship between dropping out of high school and substance use, although the studies in this review did not investigate methamphetamine specifically and studies differed in their findings of which substances were related to dropout.[12] Subsequent studies have continued to confirm this

relationship, with a recent study finding a robust relationship between early cannabis use and educational attainment, including high school dropout.[17]

Our study followed an 'additive approach' to substance use, rather than considering different substances as confounders of each other, as a number of previous studies have done. For example, a U.S. study by McCaffrey et al. found that the positive association between cannabis use and high school dropout became insignificant when measures of cigarette smoking were included in their analysis.[18] A study of high school dropout in Australia found that while current smoking was also a significant predictor of high school dropout, it did not diminish the association between weekly cannabis use and dropout for those students who left school in year 10 or year 11.[19] Flisher et al. (2010) found that current smoking had a stronger association with high school dropout than life-time illicit drug use, and Ellickson et al. (1998) found that in all ethnic groups except Latinos, early smoking was a predictor of high school dropout while alcohol and cannabis use were not.[10, 20] Our findings indicated similar associations between school non-attendance and (i) current smoking without life-time cannabis or methamphetamine use, (ii) life-time cannabis use in addition to current smoking, (iii) and life-time methamphetamine use in addition to life-time cannabis use and current smoking.

The high degree of 'overlap' in substances used creates challenges for understanding the unique contributions of different substances to non-attendance at school. For example, 89% of life-time methamphetamine users in our study were also life-time cannabis users and 72% of life-time methamphetamine users were also current smokers, leaving too few students who used methamphetamine but had not used cannabis or did not smoke

currently for analysis comparisons. More in depth research may be required to determine if methamphetamine use alone contributes significantly to high school dropout or absenteeism, given its documented detrimental cognitive and behavioural effects. Future studies may benefit from collecting more data on quantity and frequency of methamphetamine use and comparing non-attendance of frequent and regular users of methamphetamine with those who have only used it occasionally.

The limitations of our study include, firstly, that it is possible that some students may have under-reported substance use, despite our efforts to ensure confidentiality and anonymity. Secondly, while it is plausible that methamphetamine use leads to poor school attendance and/or early school drop-out, it is also possible that students with a lower academic aptitude, or other risk factors for poor academic performance (e.g. deviance and problem behaviours), are more inclined to use drugs, and this could account for the association between drug use and not attending school. Other than a question on repeating a year at school, our study did not measure academic performance or other behaviour problems shown to be related to dropout.[21] It is also possible that some of the students had moved and were hence enrolled in another school and still attending school. Our study was not able to capture this. Lastly, the present study was only able to examine life-time use of methamphetamine as there were too few students in the groups who had used methamphetamine more recently/frequently to conduct advanced analysis.

In conclusion, this study is the first we are aware of to investigate the impact of methamphetamine specifically on high school non-attendance. While an association between methamphetamine use and non-attendance was found and students who had used

methamphetamine in addition to having used cannabis and smoking cigarettes currently had the highest odds ratio for non-attendance, we did not find this ratio to be significantly higher than those for students who reported current smoking but had not used cannabis or methamphetamine, and students who reported current smoking and had tried cannabis but not methamphetamine. Our study did support a serious consideration of the role of methamphetamine and other drugs in high-school non-attendance for policy makers. Early identification of students with methamphetamine and other substance use problems, and a supportive rather than punitive school policy, may be valuable in improving high school completion and student retention rates. In order to facilitate the identification of students with methamphetamine and other substance use problems and early intervention, a shift in government policy regarding the appointment and ratios of school psychologists and psychological services for students is required. These services and posts have been cut back in recent years, a policy which needs to be revisited.

Declaration of interests

The authors declare that they have no conflict of interests.

Authors'contributions

All authors have materially participated in the research and/or manuscript preparation. All authors have approved the final manuscript.

AP was the principal investigator of the study and primarily responsible for the drafting of the manuscript. AF, CP and RM were involved in the design of the study, revisions of the manuscript, and supervision of the study throughout. CL and RM assisted with statistical analysis and guidance on methods of analysis.

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References

1. Morris K, Parry C: **South African methamphetamine boom could fuel further HIV**. *Lancet Infect Dis* 2006, **6**:471.

2. Pluddemann A, Myers BJ, Parry CD: **Surge in treatment admissions related to methamphetamine use in Cape Town, South Africa: implications for public health**. *Drug Alcohol Rev* 2008, **27**:185-189.

3. Pluddemann A, Flisher AJ, Mathews C, Carney T, Lombard C: **Adolescent methamphetamine use and sexual risk behaviour in secondary school students in Cape Town, South Africa.** *Drug Alcohol Rev* 2008, **27**:687-692.

4. Pluddemann A, Flisher AJ, McKetin R, Parry C, Lombard C: **Methamphetamine use, aggressive behavior and other mental health issues among high-school students in Cape Town, South Africa.** *Drug Alcohol Depend* 2010, **109**:14-19.

5. Parry CDH, Myers BJ, Pluddemann A: **Drug policy for methamphetamine use urgently needed.** *S Afr Med J* 2004, **94**:964-965.

6. Maxwell JC: **Emerging research on methamphetamine**. *Curr Opin Psychiatry* 2005, **18**:235-242.

7. Zweben JE, Cohen JB, Christian D *et al*.: **Psychiatric symptoms in methamphetamine users**. *Am J Addict* 2004, **13**:181-190.

8. Fergusson DM, Boden JM: **Cannabis use and later life outcomes**. *Addiction* 2008, **103**:969-976.

9. Department of Education. **Education Statistics in South Africa at a glance in 2001**. Pretoria, South Africa: Department of Education, 2003.

10. Flisher AJ, Townsend L, Chikobvu P, Lombard CJ, King G: **Substance use and psychosocial predictors of high school dropout in Cape Town, South Africa**. *J Res Adolescence* 2010, **20**:237-255.

11. Flisher AJ, Parry CDH, Evans J, Muller M, & Lombard C: **Substance use by adolescents in Cape Town: Prevalence and correlates**. *J Adolescent Health 2003*, **32**:58-65.

12. Townsend L, Flisher AJ, King G: **A systematic review of the relationship between high school dropout and substance use**. Clin Child Fam Psychol Rev 2007, **10**:295-317.

13. Standing A: *Organised Crime: A study from the Cape Flats.* Institute for Security

Studies, Pretoria, 2006.

14. White, V, Hayman, J: **Australian secondary school students' use of over-the-counter and illicit substances in 2005**. Australian Government, 2006. http://www.nationaldrugstrategy.gov.au/internet/drugstrategy/publishing.nsf/Content/mono60 Accessed 19 March 2009

15. United Nations Office on Drugs and Crime: **World Drug Report 2009**. New York: United Nations, 2009.

16. Calderon JM, Robles RR, Reyes JC, Matos TD, Negron JL, Cruz MA: **Predictors of school dropout among adolescents in Puerto Rico**. *P R Health Sci J* 2009, **28**:307-312.

17. Horwood LJ, Fergusson DM, Hayatbakhsh MR *et al.*: **Cannabis use and educational achievement: Findings from three Australasian cohort studies**. *Drug Alcohol Depend* 2010.

18. McCaffrey DF , Liccardo Pacula R, Han B, Ellickson P: **Marijuana use and high school dropout: the influence of unobservables.** *Health Econ* 2009.

19. Lynskey MT, Coffey C, Degenhardt L, Carlin JB, Patton G: **A longitudinal study of the effects of adolescent cannabis use on high school completion**. *Addiction* 2003, **98**:685-692.

20. Ellickson P, Bui K, Bell R, McGuigan KA: **Does early drug use increase the risk of dropping out of high school?** *J Drug Issues* 1998, 28(2):357-380.

21. Archambault I, Janosz M, Fallu JS, Pagani LS: **Student engagement and its relationship with early high school dropout.** *J Adolesc 2009*, **32**:651-670.

Table 1: Descriptive data for entire sample (N =1535)

Variable	**n***	**% (95% confidence interval)**
Gender	1527	
Male		46.9 (43.5 – 50.3)
Female		53.1 (49.7 – 56.5)
Age category	1505	
12-14 years		42.1 (34.4 – 50.3)
15 years		26.8 (22.8 – 31.3)
16 years		17.1 (13.6 – 21.4)
17 years or older		13.9 (8.9 – 21.0)
Methamphetamine use	1535	
Never		91.2 (88.1 – 93.6)
Life-time use (not past 12 months)		4.0 (2.9 – 5.7)
Past 12 months use		4.8 (3.3 – 6.8)
Cannabis use	1535	
Never		75.2 (70.9 – 79.1)
Life-time use (not past 12 months)		12.0 (9.8 – 14.6)
Past 12 months use		12.8 (10.4 – 15.7)
Current smoking (past 7 days)	1535	25.4 (20.6 – 30.2)
Current alcohol use (past 7 days)	1535	7.0 (4.9 – 9.0)
Ever repeated a year at school	1534	29.1 (23.3 – 35.8)
Dropout/absent status	1535	
Dropped out/absent		43.1 (37.8 – 48.5)
In school		56.9 (51.5 – 62.2)
Age > than norm for grade	1498	22.8 (13.5 – 32.0)

* values are less than 1535 owing to missing values

Confidence intervals adjusted for design of the study

Table 2: Prevalence rates stratified by school attendance status and odds ratios for substance abuse and
selected covariates (N = 1535)

	Prevalence		Odds ratio (95% CI) p-value
	Not in school % (95% CI)	In-school % (95% CI)	Simple models, adjusted for design only[1]
Life-time meth. use (Reference category (Ref)): Never used meth)	12.4 (8.5 – 17.7)	6.1 (4.1 – 9.0)	2.19 (1.39 – 3.46) p < 0.01
Life-time cannabis use (Reference category (Ref)): Never used cannabis)	30.7 (23.3 – 39.3)	20.3 (17.6 – 23.2)	1.75 (1.22 – 2.49) p < 0.01
Current alcohol use (Ref: Not using alcohol currently)	7.7 (4.9– 12.0)	6.4 (4.6– 8.8)	1.22 (0.7 – 2.12) p > 0.05
Current smoking (Ref. Not smoking currently)	34.2 (26.0 – 43.4)	18.8 (14.9 – 23.4)	2.25 (1.45 – 3.48) p <0.01
Ever repeated a year at school (Ref. Never repeated a year)	37.7 (30.7 – 45.3)	22.7 (16.7 – 30.0)	2.07 (1.42 – 3.02) p < 0.01
Age > than norm for grade (Ref. Age normal)	32.2 (22.3 – 44.1)	15.7 (9.2 – 25.6)	2.55 (1.85 – 3.52) p < 0.01

[1] Logistic regression adjusted for survey design (df = 14)

Table 3: Logistic regression model for school attendance status by different groups of substance users
adjusted for selected variables and study design (N=1265)

Dropout/absent	n	Odds ratio	95% CI
(Reference category = Never used meth, never used cannabis and not current smoker)	974		
Current smoking, but never used meth or cannabis	150	2.16**	1.44 – 3.25
Current smoking + life-time cannabis use, but never used meth	125	1.94*	1.09 – 3.47
Current smoking + life-time cannabis use + life-time meth use	47	2.58*	1.24 – 5.36
Age > than norm for grade (Ref. Age normal)	1265	2.16**	1.60 – 2.93
Ever repeated a year at school (Ref. Never repeated a year)	1265	1.32	0.98 – 1.79

* Significant at $p < 0.05$ level
** Significant at $p < 0.01$ level
df = 14
Note: Some cases excluded from model owing to missing values

CHAPTER 8

CONCLUSION

The findings of this thesis indicated methamphetamine use to be a substantial problem among high school students in Cape Town, not only in terms of prevalence but also with regard to associated mental health problems, sexual risk behaviour (and therefore HIV risk), and high school dropout and absenteeism. The thesis has presented among the first and most comprehensive studies on adolescent methamphetamine use and associated problems internationally, and to our knowledge the first publications on this problem among adolescents in Africa. Investigating methamphetamine use, and its detrimental effects, among adolescents is of particular importance as adolescents are still in a process of development, including brain development, emotional development and identity formation.

8.1 Summary of findings

8.1.1 Treatment admissions related to methamphetamine

As indicated in the first article in this thesis (Chapter 3), methamphetamine related treatment admissions have increased significantly in Cape Town since 2004. Since the second half of 2005, methamphetamine has been the most common primary substance of abuse reported by patients admitted for drug counselling or rehabilitation, reaching a

peak of 42% of all patients in the second half of 2006. This proportion has only declined slightly to 36% in the second half of 2009 (Plüddemann et al., 2010). The proportion of adolescent patients reporting methamphetamine as a primary or secondary substance of abuse peaked at 72% in 2006, however this proportion declined to 51% in the second half of 2009. The mean age of methamphetamine patients has also increased from 19.7 years in 2004 to 24.4 years in the second half of 2009 (Plüddemann et al., 2010).

Thus while the proportion of adolescents admitted for treatment who use methamphetamine has declined somewhat since the publication of the article in Chapter 3 and the average age of methamphetamine patients has increased, the proportion of adolescents who require counselling and treatment for methamphetamine dependence remains substantial. Treatment services continue to face challenges in meeting the demand for treatment as well as dealing with the side effects of methamphetamine use such as psychosis.

8.1.2 Prevalence of methamphetamine use in Cape Town

Articles two and three in this thesis (Chapters 4 and 5) both provide an indication of the prevalence of methamphetamine use among adolescents attending high school in Cape Town. The first of these studies, conducted in 2005, indicated a life-time prevalence of 13% with a similar proportion for males and females and the sampling frame included all public high schools in the City of Cape Town. The second study, conducted in one of the four 'education districts' in Cape Town in 2006, indicated a life-time prevalence of 9%,

also with similar proportions for males and females. Most adolescents reported smoking the drug.

The prevalences found represent among the highest reported for school attending adolescents in the world, although other reported figures stem from national surveys in the U.S. and Australia while our data refer to city level figures. The 2003 U.S. national high-school survey found a life-time prevalence of 8% (Springer, Peters, Shegog, White & Kelder, 2007). A national survey of schools in Australia in 2005 found a past-year prevalence of 4.2% (compared to the 4.7% of the Cape Town study in Chapter 5) (White & Hayman, 2006). In the U.S. these figures have declined in more recent years, with the 2009 Monitoring the Future survey indicating a past year prevalence of between 1% and 2% for 8th, 10th and 12th graders (Johnston, O'Malley, Bachman, & Schulenberg, 2010).

Together with the treatment admissions data, the data collected among high school students indicated alarming use of methamphetamine among adolescents in Cape Town. In 2006 the Cape Town metropolitan area was estimated to have approximately 220,000 students attending public high schools. The findings in Chapters 4 and 5 thus indicate that between 20,000 and 30,000 of these high school students in Cape Town had tried methamphetamine at least once, provided an average prevalence is assumed across school districts.

8.1.3 Methamphetamine use and sexual risk behaviour

The first article relating to sexual risk behaviour and methamphetamine use in Chapter 4 provided an indication that methamphetamine use may be associated with earlier initiation of sexual activity, finding that ever having had vaginal sex and ever having had anal sex was related to methamphetamine use in the past 12 months. In the second article on methamphetamine use and sexual risk behaviour (Chapter 6), methamphetamine use in the past 12 months was related to being in a higher sexual risk behaviour category. These categories were derived from questions including sex with multiple partners, unprotected sex, as well as engaging in vaginal and anal sex.

It is important to note that both articles did not find associations between life-time use of methamphetamine and sexual risk behaviour, indicating that primarily more recent (or possibly more regular) methamphetamine use is associated with sexual risk behaviour. The articles support growing evidence on the relationship between both methamphetamine use and sexual risk behaviour in primarily heterosexual populations, and are among the first to investigate this issue among adolescents. They also add to the evidence on the relationship between the amphetamine-group substances and HIV risk, recently reviewed by an international team of authors, including the author of this thesis (Colfax et al., 2010). Colfax et al. (2010) highlight the fact that most research on this issue has been conducted in developed countries and among men-who-have-sex-with-men. The articles in this thesis begin to address this gap by investigating aspects of this issue in a developing country in an adolescent population.

8.1.4 Methamphetamine use and mental health

In Chapter 5 associations between methamphetamine use and mental health problems were investigated through a composite simple measure of mental health overall, a measure of aggressive behaviour and a measure of depression. Results showed that methamphetamine use in the past year was significantly associated with higher scores on all three of these measures. Again it is important to note that more recent (or possibly more regular) methamphetamine use was associated with elevated scores on these mental health measures. The findings thus indicate that adolescents who have perhaps experimented with methamphetamine in the past, but not used it recently are not at the same risk for mental health problems as those who have used it more recently. This indicates that intervention efforts should not only discourage any use of methamphetamine but also emphasise the benefit of discontinuing use for those who have recently used or are using the drug. The finding also indicates that identifying students at risk in a school setting and providing counselling and other targeted interventions to these students, may be most beneficial in addressing methamphetamine use in schools. The findings suggest the possibility of using mental health screening as a tool to identify at risk students, rather than using drug testing which may be more stigmatising and because of short detection windows potentially miss many at risk students.

8.1.5 Methamphetamine and high school non-attendance

While this article supported the evidence on the associations between substance use and high school dropout and was the first, to our knowledge, to investigate the association between methamphetamine and high school non-attendance, this article also indicated that one of the key challenges in addressing methamphetamine (and other substance) use, is to find strategies to improve high school completion and learner retention rates. The article clearly indicates that a large proportion of students who use substances are leaving high school early. These young people subsequently become far more difficult to reach with intervention efforts as they are no longer in the high school systems where interventions can be implemented programmatically with relative ease.

It seems probable that relationship between methamphetamine (and other substance) use and high school non-attendance is a 'two way street', where substance use may lead to dropout and dropout may lead to substance use. Further longitudinal research is required to establish which is the more common 'pathway' and therefore requires more intervention focus.

Perhaps a key issue for further in-depth investigation is the exact role of substances in the process of leaving school. This question may best be addressed through qualitative research to attempt to understand students' contexts and 'decision and thought processes' better which lead to absenteeism and dropout, particularly in developing countries.

8.2 Limitations of the thesis

The limitations of the various studies presented in this thesis are discussed in the various Chapters or articles. In summary, these include that much of work was cross-sectional in nature, therefore causal pathways could not be analysed, leaving some questions whether methamphetamine use is the cause of problems (including aggression, depression and sexual risk behaviour) or is related to these problems in other ways. For example, pre-existing social or family based problems could be leading to both methamphetamine use and depression, or even methamphetamine use, depression, aggression and sexual risk behaviour. Our follow up survey, used to predict high school non-attendance, also indicated that following up students who use methamphetamine through repeated contacts at schools poses challenges, as many of these students seem to drop out. The school-based studies therefore also clearly miss a large number of adolescents at risk for methamphetamine dependence who are no longer in the school system, leaving questions on the prevalence of methamphetamine use among out-of-school adolescents and how to reach these adolescents to identify problems and provide interventions.

8.3 Key recommendations for policy

The various Chapters (and articles) in this thesis make a number of recommendations for advocacy and policy. Key recommendations across the Chapters include the following:

- The prevention of methamphetamine use and treatment availability for adolescents in Cape Town and other affected countries should be paramount to local government authorities. As a whole, this thesis has demonstrated a number of associated problems, including pressure on substance abuse treatment demand, high levels of sexual risk behaviour, mental health problems, and high school non-attendance. The costs associated with dealing with this 'fallout' clearly indicate the importance of prevention and treatment.
- Considering mental health and other risk behaviour screening of students (with tools like the POSIT) and strengthening support structures in high schools to deal with students who may be at risk for developing further problems, could go a long way in curbing methamphetamine and other drug use and problems associated with this. These support structures could take the form of stationing social workers at schools and increasing the availability of psychological support services.
- Further efforts are needed to strengthen HIV prevention messages and these messages need to include the potential role of methamphetamine use in increasing this risk. This is particularly crucial for high HIV prevalence countries, like South Africa. Messaging should also ensure that content is relevant to adolescents and appeals to their culture and issues.
- Methamphetamine and other drug abuse prevention programmes need to incorporate issues around STI risks (including HIV) and STI prevention programmes need to incorporate the potential contribution of methamphetamine and other drug use to an elevated risk of exposure to STIs.

- Monitoring the prevalence of methamphetamine use through regular high school surveys is also recommended, to compliment treatment centre data. Mechanisms of monitoring prevalence among out-of-school youth should also be investigated.

A number of the above recommendations are in line with guidelines developed by the U.S. National Institute on Drug Abuse for preventing drug abuse among children and adolescents (Robertson, David & Rao, 2003). These principles suggest three levels of prevention:

- Universal programmes which are designed for all students in a school,
- Selective programmes which target at risk groups, and
- Indicated programmes which are designed for those already experimenting with drugs.

Thus finding methods of screening students who are at risk for methamphetamine (and other substance) use or at the experimentation stage is important in order to be able to target the selective and indicated programmes. These screening methods should go beyond drug testing and instruments like the POSIT should be considered for this purpose. The development of selective and indicated programmes is of particular importance for methamphetamine use due to the wide array of associated problems and side effects. A recent audit of substance use prevention programmes in Cape Town found that most programmes are currently universal in nature, and tend to focus on once-off or short-term awareness raising activities in schools (Harker, Myers & Parry, 2008). This

approach is likely to be similar in many developing countries, including those affected by methamphetamine use, and perhaps even in some developed countries.

Further efforts to integrate substance use prevention and HIV/AIDS education programmes are also required, with the audit by Harker et al. indicating that only about 60% of substance abuse prevention programmes include HIV/AIDS education. The associations shown in this thesis between methamphetamine use and sexual risk behaviour stress the importance of addressing these issues simultaneously, particularly in a country like South Africa where the HIV epidemic is primarily driven through heterosexual transmission.

The U.S. National Institute on Drug Abuse guidelines for preventing drug abuse among children and adolescents also highlight the need for establishing and monitoring drug use trends in cities and communities. Thus the continuation of the South African Community Epidemiology Network on Drug Use (SACENDU), described in Chapter 3, and providing resources to improve and expand routine data collection is also an important element of future initiatives to prevent and address methamphetamine and other drug abuse.

8.8 Future directions for research

Studies on adolescent methamphetamine use and associated problems remain limited, especially in developing countries. Studies on adolescent methamphetamine use may be

particularly important for developing countries which have a high HIV prevalence. In these countries the development and evaluation of interventions which target methamphetamine use and sexual risk behaviour is a key area for future research, in the context of a heterosexually driven HIV epidemic. For South Africa factors that could contribute to HIV infection rates are of particular concern. Researchers have estimated that STIs accounted for 26% of all deaths in South Africa in 2000, and this proportion is expected to have increased in subsequent years (Johnson, Bradshaw, & Dorrington, 2007).

Longitudinal studies are also required to determine the causal role of methamphetamine use in terms of mental health problems among adolescents and to determine a clearer understanding of the role of longer term use versus shorter term use, as well as quantity and frequency of use, in the development of associated problems. More qualitative studies are also required to try to understand how adolescents experience methamphetamine use and dependence and how they experience the problems associated with the drug. Qualitative research to try to determine how methamphetamine contributes to aggression, mental health problems and sexual risk behaviour may also assist in gaining a better understanding of the extent to which these problems are related to other circumstances in the environment of methamphetamine users versus biological and neurological effects. Further research is also required on the effects and role of use of multiple substances and perhaps how to make better distinctions between the role and effects of different substances where multiple substances are being used. Future studies

should also examine factors that serve as protective factors among adolescents who do not engage in methamphetamine and other substance use.

8.9 Concluding remarks

This thesis has clearly demonstrated that methamphetamine use is a significant problem among school students in Cape Town, and that developing strategies to curb and address this problem should be given priority. The thesis has presented among the first and most comprehensive studies on adolescent methamphetamine use and associated problems internationally, and to our knowledge the first publications on this problem among adolescents in Africa. Further prevention efforts targeting both methamphetamine use and sexual risk behaviour should be a high priority for government and community based prevention efforts.

References

Colfax, G., Santos, G. M., Chu, P., Vittinghoff, E., Pluddemann, A., Kumar, S., & Hart, C. (2010). Amphetamine-group substances and HIV. *Lancet*, 376(9739), 458-74.

Harker, N., Myers, B., & Parry, C. (2008). *Audit of prevention programmes targeting substance use among young people in the greater Cape Town metropole: Technical report*. Cape Town: Medical Research Council.

Johnson, L., Bradshaw, D., Dorrington, R., South African Comparative Risk Assessment Collaborating Group. (2007). The burden of disease attributable to sexually transmitted infections in South Africa in 2000. *South African Medical Journal*, 97(8 Pt 2), 658-62.

Johnston, L. D., O'Malley, P. M., Bachman, J. G., & Schulenberg, J. E. (2010). *Monitoring the Future national results on adolescent drug use: Overview of key findings, 2009* (NIH Publication No. 10-7583).Bethesda, MD: National Institute on Drug Abuse.

Plüddemann, A., Dada, S., Parry, C.D.H, Bhana, A., Pereira, T., Nel, E., Mncwabe, T., Gerber, W N., & Aboagye, L. (2009). *Monitoring Alcohol and Drug Abuse Trends in South Africa (July 1996 – June 2009)*. SACENDU Research Brief, 12(2), 1-12. Medical Research Council of South Africa.

Robertson, E.B., David, S.L., & Rao, S.A. (2003). *Preventing drug abuse among children and adolescents: A research-based guide for parents, educators and community leaders (second edition)*. Bethesda, MD: National Institute on Drug Abuse.

Springer, A.E., Peters, R.J., Shegog, R., White, D.L., & Kelder, S.H. (2007). Methamphetamine use and sexual risk behaviors in U.S. high school students: findings from a national risk behavior survey. *Prevention Science*, 8(2), 103-113.

White, V. and Hayman, J., 2006. *Australian secondary school students' use of over-the-counter and illicit substances in 2005*. Australian Government. http://www.nationaldrugstrategy.gov.au/internet/drugstrategy/publishing.nsf/Content/mono60 Accessed 19 March 2009.