R. McKetin, J. McLaren, E. Kelly, W. Hall &
M. Hickman

Estimating the number of regular and dependent methamphetamine users in Australia

NDARC Technical Report No. 230

ESTIMATING THE NUMBER OF REGULAR AND DEPENDENT METHAMPHETAMINE USERS IN AUSTRALIA

Rebecca McKetin, Jennifer McLaren, Erin Kelly, Wayne Hall and Matthew Hickman

Technical Report No. 230

ISBN: 0 7334 2273 X

Table of Contents

LIST OF TABLES

ACKNOWLEDGEMENTS

This research was funded by the Australian Government Department of Health and Ageing and was also supported by a UNSW John Yu Fellowship. NSW data were provided by the NSW Department of Health and the NSW Bureau of Crime Statistics and Research. Thanks go to the staff at these agencies for assisting with data extraction and interpretation, particularly Jackie Fitzgerald and Kim Lim. Many sincere thanks go to Amanda Roxburgh for deriving the national benchmark data on stimulant-related hospital admissions.

EXECUTIVE SUMMARY

Background

Almost one in ten Australians have ever tried methamphetamine (known locally by the street terms 'speed', 'base', 'ice', and 'crystal', AIHW, 2005) and around half a million Australian adults are current users of the drug. Although many of these people would use the drug infrequently, there are indications of a substantial population of regular methamphetamine users, many of whom are dependent on the drug. Heavy or dependent methamphetamine use is associated with a range of adverse consequences for both the individual and society. Specifically, heavy methamphetamine users are at elevated risk for psychosis, suffer a range of mental and physical health problems, and, if they inject the drug, they are at risk of contracting and transmitting blood borne viruses. Heavy methamphetamine users also show high levels of criminal involvement and contact with the criminal justice system, while police, together with other frontline services, bear the brunt of managing aggressive behaviour associated with methamphetamine-induced psychosis.

We need to know the size of the population of dependent methamphetamine users in order to understand their impact on public health and order, and to estimate the services that are needed to reduce this impact. The current best estimates of the scale of heavy methamphetamine use come from the National Drug Strategy Household Survey. According to the 2001 national household survey, almost 1% of the population had used methamphetamine at least monthly during the past year, and 0.4% of Australian adults took methamphetamine on a daily or weekly basis. This corresponds to an estimated 63,000 heavy methamphetamine users in Australia. However, household surveys tend to under-estimate the extent of heavy illicit drug use because marginalised groups such as illicit drug users are under-represented in household surveys, and stigmatised patterns of drug use are under-reported by those drug users who do participate.

Indirect prevalence estimation techniques offer an alternative way of measuring the extent of heavy illicit drug use. One of the more common and conceptually simple indirect prevalence estimation techniques is the multiplier-benchmark method. This method has previously been used to estimate the size of opioid using populations and injecting drug using populations. Much less use has been made of this method with other populations of drug users, such as dependent stimulant users. The aims of the current study were to: (1) use the multiplier-benchmark technique to estimate the number of regular and dependent methamphetamine users in Sydney, NSW and Australia, and (2) critically examine the methodological issues that arise when using this technique to estimate the size of a stimulant using population.

Method

The benchmark data sources were drug treatment data, hospital separation data and arrest data, which were derived for Sydney, New South Wales and Australia.

Treatment benchmark data consisted of closed treatment episodes collected through the Minimum Data Set for Alcohol and Other Drug Treatment Services (MDS-AODTS) where the main drug of concern was 'amphetamines' (includes amphetamine and methamphetamine).

Three sets of *hospital benchmark data* were derived that corresponded to separations in which there was: (a) a primary diagnosis of a stimulant-related disorder (ICD-10 codes F15.X and T43.6); (b) a primary or any secondary diagnosis of these stimulant-related disorders; and (c) a primary diagnosis of stimulant psychosis (ICD-10 code F15.5). Hospital diagnoses for stimulant-related disorders excluded cocaine, but included other stimulant drugs such as caffeine and ecstasy.

Arrest benchmark data within NSW were based on persons of interest who were charged with offences related to amphetamine or methamphetamine (including use/possession, dealing/trafficking, import or other drug offences), but excluded offences related to ecstasy or unspecified stimulants. National arrest benchmark data included arrests for all amphetamine-type stimulants, including ecstasy.

Benchmark data included only events that occurred among people aged 15-49 years during the financial year 2002/03. The exception was national treatment benchmark data, which included people aged 10-49 years.

Multipliers were derived from a survey of 310 regular methamphetamine users aged 16 years or older who were recruited from across Sydney between December 2003 and July

2004. Multipliers were based on the number of benchmark events that the participant experienced within the previous year. The criteria for having experienced a benchmark event were similar to those used to define the respective benchmark data. The derived multipliers were specific to methamphetamine-related events, excluding events that were related to other forms of stimulant use. Multipliers were based on survey participants aged 15-49 years who were residing within Sydney at the time of the survey (n = 297). An additional set of multipliers were derived for the sub-group of methamphetamine users who were dependent on the drug (n = 166).

Results

It was estimated that there were around 17,700 regular methamphetamine users and 14,700 dependent methamphetamine users in Sydney. This represents 8.5 and 7.0 regular and dependent methamphetamine users per 1000 persons aged 15 to 49 years respectively. The number of heavy methamphetamine users per population was higher in NSW (11.0 to 8.4 per 1000 persons aged 15 to 49 years), and there were an estimated 36,900 regular methamphetamine users of whom 28,000 were dependent on the drug within this age bracket.

The estimated number of regular methamphetamine users in Australia was 102,600, or 10.3 per 1000 persons aged 15 to 49 years. Of these regular methamphetamine users, it was estimated that there were 72,700 dependent methamphetamine users, or 7.3 per 1000 population aged 15-49 years. The bulk of regular and dependent methamphetamine users were located outside of Sydney (83% and 80% respectively).

Median prevalence estimates for the number of regular and dependent methamphetamine users aged 15-49 years in Sydney, NSW and Australia

	Number	Rate per 1000 persons
Regular users		
Sydney	17,700	8.5
NSW	36,900	11.0
Australia	102,600	10.3
Dependent users		
Sydney	14,700	7.0
NSW	28,000	8.4
Australia	72,700	7.3

Note. The estimated number of methamphetamine users is rounded to the nearest 100.

Methodological considerations

The treatment multiplier holds the greatest promise for monitoring the size of the dependent methamphetamine using population in Australia, because of its simplicity, and specificity to dependent methamphetamine use, which is most likely to be predictive of treatment seeking and other methamphetamine-related harms. Although we were also able to derive comparable and plausible prevalence estimates using the hospital multipliers, it was difficult to derive these multipliers from survey data, and they also suffered from a number of limitations. Similarly, the arrest multipliers were not very robust because the frequency of methamphetamine-related arrests was very low among the current sample of methamphetamine users, and likely to have been affected by the incarceration of methamphetamine users who had been arrested within the past year. Also, the national arrest prevalence estimates were spuriously inflated by the inclusion of ecstasy offences in the benchmark data, and therefore needed to be excluded when calculating the median national prevalence estimate.

The current exercise produced provisional prevalence estimates for regular and dependent methamphetamine use in NSW and Australia, by applying multipliers derived from within Sydney to benchmark data from these respective regions. These state-wide and national estimates are provisional and need to be improved through the development of treatment multipliers from surveys of methamphetamine users in other geographic areas within Australia, including regional and rural areas. Further investigation of factors affecting access to treatment services is also needed to understand to what extent these prevalence estimates capture various sub-components of the methamphetamine dependent population. Multipliers need to be stratified by factors that affect treatment entry, such as concurrent heroin use, unemployment and being born outside of Australia.

The validation of the multipliers derived in the current study against other indirect methods of prevalence estimation, such as capture-recapture methods, would also be desirable. This is more likely to be feasible at a local rather than a national level because of the current lack of identity linkage across different data sets both within most jurisdictions and at a national level.

Implications

Previous estimates of problematic drug use in Australia have focussed on dependent heroin users who contribute to disease burden disproportionately to their numbers in the population. The current findings demonstrate that Australia also has a large population of dependent methamphetamine users, most of whom inject the drug. The size of this population appears to be larger than recent estimates of the size of the heroin using population in Australia, and similar to the estimated size of the heroin using population in the late 1990s.

The contribution of dependent methamphetamine use to the health and social consequences associated with illicit drug use in Australia cannot be ignored. This population will generate a substantial number of hospital presentations for methamphetamine-psychosis that will adversely affect emergency medical and mental health services. Dependent methamphetamine users also reflect a large pool of injecting drug users, who are at risk of contracting and transmitting HIV and other blood borne viruses.

Not only does dependent methamphetamine use represent a public health concern in its own right, but this large population of dependent injecting stimulant users is at high risk of making a transition to heroin injection, among other patterns of polydrug use. This population is therefore also likely to contribute to other drug trends in Australia in the future. Conversely, a proportion of the current population of dependent methamphetamine users is likely to be former or concurrent dependent opioid users. In this regard, the overlap between the current population of dependent methamphetamine users and dependent opioid users needs to be taken into account when understanding trends in dependent injecting drug use and their likely impact on both the individual and society.

Reducing the number of heavy methamphetamine users and consequential problems will require effective treatment for methamphetamine dependence and improvements in treatment coverage. Only one in ten methamphetamine users reports receiving treatment for their methamphetamine use in the past year (Kelly et al., in preparation), a much lower rate of treatment coverage than for problem opioid users. This reflects the scarcity of effective treatment options for methamphetamine use, and the problems that users experience in accessing treatment. We also need to prevent the initiation of methamphetamine use if we want to ensure that the size of this population does not increase, particularly with the increasing popularity of crystalline methamphetamine among younger non-injecting drug users.

In conclusion, further research is needed to better understand the public health impact of methamphetamine dependence, and we need to improve our efforts to reduce the size of this population by implementing prevention initiatives and by providing effective and accessible treatment for methamphetamine dependence. Harm reduction initiatives should also be examined that reduce the up-take of risky patterns of methamphetamine use (i.e., smoking ice and injecting) and minimise the adverse consequences of methamphetamine use among people who are currently heavy users but do not respond well to conventional treatment approaches.

1 INTRODUCTION

1.1 Methamphetamine use in Australia

Almost one in ten Australians have ever tried methamphetamine (known locally by the street terms 'speed', 'base', 'ice', and 'crystal', AIHW, 2005) and around half a million Australian adults are current users of the drug. However, the bulk of people who use methamphetamine do so infrequently, and are therefore unlikely to have a substantial impact on the health and criminal justice sector or require drug treatment.

According to the national household survey, only 12% of methamphetamine users take the drug weekly or more often, and are therefore at risk of experiencing dependent use. This represents approximately 0.4% of Australian adults, or 63,000 people (AIHW, 2002). It is these heavier methamphetamine users who are most likely to have an impact on the health and criminal justice systems, be at risk of contracting and transmitting blood borne viruses, and benefit from effective drug treatment.

The number of heavy methamphetamine users derived from the household survey is likely to be an under-estimate of the true extent of the methamphetamine problem. Dependent injecting drug users are likely to be under-represented in the household survey because: (a) a proportion do not live in conventional households (e.g., are in residential rehabilitation, incarcerated or homeless), (b) heavy drug users tend to cluster in specific geographic regions, such as illicit drug 'hot-spots', and (c) illicit drug users may also under-report on their methamphetamine use because of the stigma associated with illicit drug use and fear of punitive legal action.

There are other indications that Australia has a substantial number of heavy stimulant users whose drug use is likely to be associated with adverse personal and societal outcomes. Methamphetamine accounts for around one-third of all injecting drug use in Australia (Thein et al., 2004), so methamphetamine injectors are a substantial risk group for the transmission of Hepatitis C, which is epidemic among injecting drug users in Australia. Evidence of heavy methamphetamine use has also accrued from its other adverse personal and social consequences, including dependence and related treatment demand, crime, health problems and methamphetamine-induced psychosis (Bartu et al., 2003; Curran et al., 2004; Hall & Hando, 1994; Hall et al., 1996; McKetin et al., submitted; Petitti et al., 1998; Riehnam et al., 2002; Sato et al., 1992; Topp & Mattick, 1997a). The emergence of high purity crystalline methamphetamine in Australia since the late 1990s has been associated with an increase in stimulant-related harms, including methamphetamine psychosis and related aggressive behaviour, which is having a marked impact on frontline services (Kelly et al., in preparation; McKetin et al., submitted; Topp et al., 2002). To understand the impact of methamphetamine use on pubic health and order, and to estimate the scope of services required to address the problem, we need better estimates of the size of this problem.

1.2 Estimating the size of dependent drug using populations

The alternative method for estimating the size of heavy drug using populations is through the use of indirect prevalence estimation techniques (e.g., bench-mark multiplier techniques, capture-recapture, back-calculation methods and multiple indicator methods; Frischer et al., 2001; UNODC, 2003). Indirect prevalence estimation techniques involve using the probability of a drug user being detected within a known subset of drug users (e.g., arrested drug users, drug users in treatment, or an actively recruited sample of drug users) to derive an estimate of the total population size. These techniques hold great promise for public health research on drug use because they can be re-applied at regular time intervals at relatively low cost. For example, indirect prevalence estimation techniques are used routinely in Europe to monitor the injecting drug use situation (EMCDDA, 2004).

One of the more common techniques applied to estimating the size of illicit drug using populations is the multiplier-benchmark method (Frischer et al., 2001; UNODC, 2003). The multiplier-benchmark method is a popular way to estimate the size of dependent drug using populations because it is conceptually simple and relatively easy to undertake. Essentially, this method of estimation involves identifying the number of drug users detected through a routine data source within a given time frame, and then working out what proportion of drug users are represented within that particular routine data source during the corresponding time frame. For example, if one knows that there have been 1000 heroin users treated within a one year period, and one also knows from surveys of heroin users that only half of heroin users have received treatment within the past year, the total number of heroin users can be estimated by doubling that observed in treatment (i.e., 2000). In this example, the 'benchmark' is the number of treatment entries for heroin use recorded in treatment data during the year, and the 'multiplier' is the inverse of the proportion of drug users who entered treatment for heroin use within that year (i.e., 1/0.5, or 2). The validity of the multiplier-benchmark technique depends on two key assumptions: (1) that the multiplier is derived from an unbiased and representative sample of the target population; and (2) that the benchmark data are representative of the target population.

The overwhelming majority of studies that have employed the multiplier-benchmark method (or other indirect prevalence estimation methods) within the illicit drugs field have focussed on estimating the number of injecting drug users or dependent opioid users (Augustin & Kraus, 2004; Comiskey, 2001; Friedman et al., 2004; Frischer et al., 2001; Hall et al., 2000). The use of the multiplier-benchmark technique to estimate the size of a dependent stimulant using population is likely to involve different methodological issues and assumptions than those traditionally encountered with injecting opioid use. These methodological issues are discussed below.

1.3 Applying the multiplier-benchmark technique to methamphetamine use

Identifying benchmark data sources

The application of the multiplier-benchmark method to estimating the size of illicit drug using populations most often involves using drug treatment data, data on HIV testing among injecting drug users, arrest data and mortality data. These data sources are able to detect a reasonable proportion of opioid users because opioid use is associated with high rates of mortality from overdose, the need for HIV testing among people who inject opioids, criminal involvement, and entry into drug treatment. Not all of these data sources are as likely to detect stimulant users, because the harms from stimulant use differ from those associated with opioid use, as do users' patterns of contact with health and law enforcement services. For example, fatal overdose on methamphetamine is uncommon, not all dependent methamphetamine users inject the drug, and there are no widely implemented and effective treatments for methamphetamine use that are equivalent in efficacy or attractiveness to methadone pharmacotherapy for opioid dependence.

The natural history of methamphetamine use and service contact among heavy methamphetamine users suggests that arrest data and drug treatment data may be viable benchmark data sources. Other potential data sources include hospital presentations for methamphetamine psychosis or for physical problems arising from methamphetamine intoxication (e.g., cardiovascular symptoms), and presentations to ambulance and emergency services for similar methamphetamine-related problems.

Defining and identifying the target population

Defining the target population is essential in any prevalence estimation exercise. Indirect prevalence estimation procedures are applied within the illicit drugs field to estimate the number of heavier users or dependent members of the drug using population who are less likely to be captured through general population surveys. Assumptions need to be made about what constitutes dependent or heavy methamphetamine use. This issue is clearer with injecting drug use but more difficult when defining the target population for methamphetamine use because patterns of stimulant use range on a continuum from infrequent use through to daily injection of the drug. There is no clear-cut behaviour that defines heavy or dependent use that is likely to be reflected within a benchmark data source.

Often the fact that people are represented in a routine data set (such as drug treatment or arrest data) is taken as evidence that the person is experiencing problems with their drug use. However, the extent to which benchmark data for methamphetamine use reflects heavy or dependent methamphetamine use versus recreational methamphetamine use is not as well established as it is for opioid use. A further issue that is likely to arise with benchmark data for stimulant use is that many routine data include ecstasy or other non-specified forms of amphetamine-type stimulants under the broad banner of 'amphetamines'.

Obtaining an accurate multiplier

As with all multiplier-benchmark methods, the application of this technique to stimulant use will require an unbiased multiplier. This will require: (a) avoiding recruitment strategies that will over-represent methamphetamine users who turn up in benchmark data sources (e.g., recruiting through treatment centres); (b) ensuring that the benchmark events are sufficiently frequent among methamphetamine users to obtain a robust multiplier; and (c) checking whether the multiplier varies greatly between geographic locations or among sub-groups of the methamphetamine using population.

Controlling for the rate of presentations in benchmark data

A finer point affecting the validity of all multiplier-benchmark prevalence estimates is that an individual can be recorded in the benchmark data on more than one occasion during the time period under examination. This is not the case when using a mortality multiplier, or when the multiplier is constrained to behaviours that pertain to a very brief time period (e.g., current enrolment in out-patient treatment). However, in most settings, multipliers need to be based on behaviours that occur over a reasonably long period of time (e.g., months rather than days), simply because the probability of being recorded in benchmark data is low. This problem is likely to arise when estimating the prevalence of methamphetamine use because the level of methamphetamine-related service contact among this population is typically low (Kelly et al., in preparation). Consequently, a long time frame will be necessary to capture sufficient benchmark cases to derive a multiplier-benchmark estimate. In this situation, individuals who are recorded more than once will spuriously inflate the population size estimate, unless either: (a) duplicate cases are eliminated from the benchmark data, or (b) the number of incidents that occurred within the time frame are incorporated into the multiplier. The latter approach has been explored by Simeone et al. (2003) in using treatment data to derive population estimates for opioid use. It is this approach that will be adopted in the current research.

Summary of methodological considerations

In summary, the main challenge in applying the multiplier-benchmark method specifically to dependent methamphetamine use, as distinct from estimating the size of injecting opioid using populations, is identifying unbiased benchmark data that reflect the target population because: (a) some benchmark data sources are likely to include ecstasy-related cases; (b) it is not known to what extent these data include only dependent methamphetamine users (versus recreational methamphetamine use); and (c) it is unclear whether benchmark data are representative of the broader population of dependent methamphetamine users. Because a long time frame will also be needed to capture sufficient benchmark events, estimates derived from the benchmark data may also be inflated by repeat presentations. As with any multiplier-benchmark prevalence estimation exercise, biases in the survey on which the multiplier is derived will need to be considered when interpreting the final prevalence estimates.

Measures that will be taken to minimise these problems in the current study include: (a) ensuring an accurate match between the criteria used to define benchmark events in the multiplier and the benchmark data source; (b) using a multiplier based on the rate of benchmark events per methamphetamine user; (c) deriving multipliers specifically for dependent methamphetamine users; and (d) examining factors associated with the likelihood of experiencing benchmark events among methamphetamine users. Other problems will be difficult to eliminate, such as controlling for the inclusion of ecstasy-related events in some benchmark data sources, and inherent biases in the survey of methamphetamine users on which the multiplier is based. In these situations it will be necessary to consider these biases when interpreting the resultant prevalence estimates.

1.4 Aims of the current study

The primary purpose of the current study was to use the multiplier-benchmark technique to estimate the number of regular and dependent methamphetamine users in Sydney, NSW and Australia. The specific aims of the research were to:

1. identify routine data sources that can be used as benchmark data to estimate the number of heavy methamphetamine users;
2. derive multipliers that match existing benchmark data sources that can be used to estimate the number of regular and dependent methamphetamine users;
3. apply the multiplier-benchmark method to estimate the number of regular and dependent methamphetamine users in Sydney, Australia;
4. apply the derived multipliers to NSW and Australia-wide benchmark data, to provide provisional estimates of the prevalence of regular and dependent methamphetamine use in these respective regions;

5. develop an understanding of the strengths and limitations of the multiplier-benchmark method in estimating the size of dependent stimulant using populations; and
6. consider the public health implications of methamphetamine use in light of the number of regular and dependent users and their reported contact with various health services.

2 METHOD

2.1 Benchmark data sources

A number of data sources were explored for their potential to be used as benchmark data. These included hospital admission data, drug treatment data, arrest data, emergency data and ambulance data. Of these data sources, hospital, drug treatment and arrest data were chosen because they included identifiable methamphetamine-related cases. Investigation of ambulance data revealed that there was no routinely collected information within the patient records that would accurately identify methamphetamine-related presentations. Emergency data did identify methamphetamine-related cases under the ICD-9 diagnoses of '*Drug dependence – amphetamine and other psychostimulant*' and '*Poisoning by psychotropic agents – psychostimulants*'. However, emergency data did not identify methamphetamine psychosis presentations because the ICD-9 diagnostic system subsumes methamphetamine psychosis under a general category of drug-induced psychosis. Therefore, emergency data would miss a large proportion of stimulant-related admissions. For this reason, and other documented limitations of emergency data (Barker, 2003; McKetin et al., submitted), emergency data were not used as a benchmark in the current study.

Treatment and hospital data for NSW were provided by the NSW Health Department, and NSW arrest data were provided by the NSW Bureau of Crime Statistics and Research. National hospital data were obtained from online data cubes maintained by the Australian Institute of Health and Welfare (AIHW, 2004a). National treatment data were based on published figures from the National Minimum Data Set on Alcohol and Other Drug Treatment Services (AIHW, 2004b). National arrest statistics were those published by the Australian Crime Commission (Australian Crime Commission, 2004).

2.1.1 Definitions of benchmark events

Benchmark data were derived for three geographic regions: (a) Sydney, (b) New South Wales, and (c) Australia (Table 1). The geographic location of treatment and hospital events were based on the locality of the service attended. Arrest data were based on the geographic locality in which the criminal incident occurred. Hospital and treatment events for Sydney were defined as those that occurred in services located within the Area

Health Services of Central Sydney, Northern Sydney, Western Sydney, South-eastern Sydney, South-western Sydney and Wentworth. Arrest events for Sydney included arrests made in Local Government Areas that corresponded to these Area Health Services (see Appendix 1 for mapping of Local Government Areas to Area Health Services). Benchmark events were defined as those occurring among people aged 15-49 years during the financial year 2002/03, with the exception of national treatment benchmark data, which included people aged 10-49 years.

Treatment events

Treatment events consisted of closed treatment episodes collected through the Minimum Data Set for Alcohol and Other Drug Treatment Services (MDS-AODTS) where the main drug of concern was 'amphetamines' (includes amphetamine and methamphetamine). The MDS-AODTS records the main drug of concern as that reported by the drug treatment client, which is then classified according to the Australian Standard Classification of Drugs of Concern (Australian Bureau of Statistics, 2000). Treatment centres that submit data to the MDS-AODTS are all publicly funded government and non-government specialized drug treatment services. For further details on the nature of data included in the MDS-AODTS, refer to the Australian Institute of Health and Welfare website (AIHW, 2004c).

Hospital events

Hospital events included separations where there was a stimulant-related diagnosis, specifically including the diagnoses of '*Mental and behavioural disorders due to use of other stimulants including caffeine*' (ICD-10 codes F15.X) and '*Poisoning by psychotropic drugs not elsewhere classified – Psychostimulants with potential for use disorder*' (ICD-10 code T43.6). Three sets of hospital benchmark data were derived corresponding to events where there was: (a) a <u>primary diagnosis</u> of a stimulant-related disorder; (b) a <u>primary or any secondary diagnosis</u> of a stimulant-related disorder; and (c) a primary diagnosis of stimulant psychosis (i.e., '*Mental and behavioural disorders due to use of other stimulants including caffeine, psychotic disorder*', ICD-10 code F15.5).

Arrest events

Arrest events within NSW were based on persons of interest who came to the attention of police for criminal incidents involving amphetamine or methamphetamine and who were charged for use/possession, dealing/trafficking, import or other drug offences relating to amphetamine or methamphetamine, and excluded criminal incidents relating to ecstasy or unspecified stimulants. National data on arrests included arrests for all amphetamine-type stimulants, including ecstasy. This was necessary because data recording practices in some jurisdictions did not distinguish between ecstasy-related arrests and arrests related to amphetamine or methamphetamine.

Table 1. Benchmark data for methamphetamine-related events in Sydney, NSW and Australia, 2002/03

	Sydney	NSW	Australia
Methamphetamine treatment episodes	1905	4304	13,131 [a]
Stimulant-related hospital admissions [b]			
Primary or secondary diagnosis	2,080	4,450	10,868
Primary diagnosis	621	1,184	3,091
Stimulant psychosis	185	439	1,303
Methamphetamine-related arrests	605	1,242	8,313 [c]

Note. Benchmark data for arrests and treatment include both methamphetamine-related and amphetamine-related events.

[a] Age range 10-49 years

[b] Includes all stimulants other than cocaine

[c] Includes arrests for ecstasy or unspecified stimulants

2.2 Derivation of multipliers

Multipliers were derived from a survey 310 methamphetamine users recruited from across Sydney. Methamphetamine users were recruited through advertisements in local newspapers and free press publications, advertisements on websites (e.g., the '*pill reports*' website), word of mouth, flyers in needle exchanges or other venues likely to be frequented by drug users, and referral from other research studies. Recruitment took place from December 2003 to July 2004. To be included in the survey the person had to have used methamphetamine at least monthly in the past year and to be at least 16 years of age. The majority of participants (82%) had used methamphetamine weekly or more often during the year prior to being interviewed and 64% injected methamphetamine. Polydrug use was common, with a median of seven drug types used in the past year, and 39% of the sample reporting heroin injection during the past year.

Multipliers were based on participants aged 15-49 years who were residing within Sydney at the time of the survey (n = 297) and included only benchmark events that occurred within Sydney. Multipliers were also based on the number of events that occurred per person during the past year – that is, the annual rate of events (Table 2). An additional set of multipliers was calculated for participants who were dependent on methamphetamine during the past year (n = 166). Dependence was defined as having a score of four or greater on the Severity of Dependence Scale, which corresponds to a DSM-III-R diagnosis of severe methamphetamine dependence (Topp & Mattick, 1997b). The majority of dependent methamphetamine users injected the drug (76%), and dependent users were more likely to have a history of heroin use than their non-dependent counterparts (72% vs. 58%, OR = 1.9, p = 0.007).

Definitions for events included in each multiplier were matched to the respective benchmark data source. Treatment events included only those where methamphetamine (or amphetamine) was the main drug for which the person sought treatment and where the treatment centre they attended submitted data to the NSW MDS-AODTS. Hospital events included admissions to acute care and psychiatric facilities that submit data to the National Hospital Morbidity Database (NHMD). Three hospital admission multipliers were derived corresponding to: (a) any hospital admission in the past year (i.e., corresponding to a hospital admission where there was either a primary or secondary stimulant-related diagnosis); (b) hospital admissions where methamphetamine was the main reason for the admission (i.e., corresponding to a primary stimulant-related diagnosis); and (c) hospital admissions where methamphetamine psychosis specifically was the main reason for admission (i.e., corresponding to a primary diagnosis of stimulant psychosis). The arrest multiplier included charges for the use/possession, dealing/trafficking or importation of amphetamine or methamphetamine. Only those arrests where methamphetamine was the most serious offence for which the person was charged were included as benchmark events. This was done to match the data collation procedures used by the NSW Bureau of Crime Statistics and Research in deriving the benchmark data. No arrest events were excluded on this basis.

Table 2. The rate of benchmark events per 100 persons per year and multipliers for regular and dependent methamphetamine use

	Regular use		Dependent use	
	Rate	Multiplier	Rate	Multiplier
Methamphetamine treatment episodes	10.8	9.3	18.1	5.5
Hospital admissions				
All admissions	14.9	6.7	18.1	5.5
Methamphetamine-related	3.7	26.9	4.2	23.7
Methamphetamine psychosis	1.0	99.0	1.2	83
Methamphetamine-related arrests	3.4	29.7	2.5	40.5

Note. Multipliers represent the inverse of benchmark rates per person. Multipliers are based on the absolute benchmark rate rather than the rounded rate presented in this table.

2.3 Population denominators

Population prevalence was based on the Australian Bureau of Statistics estimated population aged 15 to 49 years within Sydney, NSW and Australia as of June 2003. The estimated population for Sydney and NSW was provided by the NSW Department of Health. The estimated population for Australia was obtained by the Australian Bureau of Statistics (Australian Bureau of Statistics, 2004). Population denominators were Sydney 2,093,313; NSW 3,346,550; and Australia 10,007,880.

2.4 Factors associated with lifetime experience of benchmark events

One of the assumptions of the multiplier-benchmark method is that drug users are equally likely to experience benchmark events and therefore equally likely to be represented in the benchmark data. Any substantial variation in the multiplier across different types of methamphetamine users or across geographic regions is likely to bias the resultant prevalence estimate. For this reason, we compared the drug use and demographic characteristics of methamphetamine users who had experienced benchmark events with those who had not. It should be noted that this analysis will only highlight biases in whether methamphetamine users are represented in the benchmark data to the extent that the community survey of methamphetamine users was representative of the entire population of regular and dependent methamphetamine users.

This analysis was based on lifetime events that were roughly equivalent to the benchmark events, due to the small number of participants who had experienced benchmark events within the past year. Events examined were: (a) having ever received treatment for methamphetamine use; (b) having ever been to hospital for a methamphetamine-related problem; and (c) having ever been arrested for methamphetamine use, possession or supply. Comparisons were made between participants who had experienced a benchmark event and the remaining participants, using either a Pearson's Chi-Square or a rank-order median comparison test (Stata Corporation, 2003).

The majority of methamphetamine users that had experienced benchmark events were dependent on methamphetamine and were injecting the drug (Table 3). This finding is in keeping with the expectation that benchmark data would capture the heavier use end of the methamphetamine using spectrum. Methamphetamine users who injected heroin were also more likely to be selected in benchmark data, although heroin injection was very highly correlated with both methamphetamine injection and dependence.

Unemployed methamphetamine users were more likely to have experienced benchmark events than employed methamphetamine users. However, unemployment was strongly associated with being dependent on methamphetamine, injecting methamphetamine and having a history of heroin injection. After controlling for these confounding factors there was still a trend toward employment being associated with all three benchmark events, but particularly treatment exposure (Treatment OR = 0.55, CI: 0.28-1.0, $p = 0.06$;

Hospital OR = 0.62, CI: 0.31-1.2, p = 0.17; Arrest OR = 0.64, CI: 0.29-1.4, p = .25), suggesting that employed methamphetamine users were less likely than their unemployed counterparts to be detected in benchmark data.

Other biases in having experienced benchmark events were that females were less likely to have been arrested for methamphetamine-related offences than males, and people born outside of Australia were less likely to have engaged in treatment or attended hospital for methamphetamine use relative to their Australian born counterparts (Table 3).

Lifetime experience of benchmark events also varied by geographic region within Sydney. Methamphetamine users who lived in the northern regions of Sydney were significantly less likely to have ever received treatment for methamphetamine use or have been admitted to hospital for a methamphetamine-related problem than methamphetamine users in other parts of Sydney, even after adjusting for their lower levels of injecting drug use (Table 3).

The fact that particular sub-groups of methamphetamine users are more likely than others to have experienced benchmark events suggests heterogeneity in our multiplier, which may affect the validity of the derived prevalence estimates. To overcome this problem, we would need to stratify our multiplier and our benchmark data according to the factors that create heterogeneity (e.g., employment status). This was not done in the current study because not all of the benchmark data sources contained information on factors causing heterogeneity, and also because of the small number of methamphetamine users who fell into some of these sub-groups (e.g., methamphetamine users who were born outside of Australia).

Table 3. Percentage of methamphetamine users who had ever experienced methamphetamine-related drug treatment, hospital admissions or arrests, by drug use and demographic characteristics.

	Treatment (n = 77)	Hospital admission (n = 62)	Arrest (n = 51)	Total sample (n = 310)
Drug use				
Dependent (%)	74***	71**	63	56
Injecting (%)	82***	79**	84**	64
Ever injected heroin	77***	79***	80**	60
Demographics				
Median age (years)	31	30	32	28
Male (%)	66	65	78**	59
Employed (%)	23**	24**	22*	39
Non-English speaking	1	0	4	4
Australian born	10*	15	16	20
Region				
Inner	53	52	49	45
Northern	5**	7*	16	18
Southwest	16	18	16	17
Western	26	23	20	20

* $p < .05$, ** $p < .01$, *** $p < .0001$.

3 RESULTS

Estimates for the number of regular and dependent methamphetamine users were produced for Sydney, NSW and the whole of Australia (Tables 4 and 5).

Regular use

The estimated prevalence of regular methamphetamine use derived using treatment and hospital multipliers were in the same vicinity as prevalence estimates provided by the National Drug Strategy Household Survey of 2001. Treatment and hospital prevalence estimates ranged between 0.7% and 1.3% of people aged 15-49 years in comparison with 1% of people surveyed by the National Drug Strategy Household Survey having taken the drug monthly or more often. The prevalence estimates for regular methamphetamine use derived from arrest data were similar to hospital and treatment prevalence estimates for Sydney and NSW (0.9 – 1.1% of people aged 15 to 49 years). National prevalence estimates derived using the arrest multiplier were markedly higher at 2.5% of people aged 15 to 49 years. National arrest prevalence estimates were particularly high due to the inclusion of ecstasy-related offences in national benchmark data, and also the inclusion of people who had been arrested but not necessarily charged with methamphetamine-related offences.

These prevalence estimates are a likely under-estimate of the true extent of monthly methamphetamine use, because the multipliers used in the current study were based on a sample of methamphetamine users who typically took the drug at least weekly. Therefore the current estimates of 'regular' methamphetamine use more honestly reflect the number of methamphetamine users who take the drug at least weekly.

Dependent use

The prevalence estimates for dependent methamphetamine use that were derived using the treatment and hospital multipliers were almost double the prevalence of weekly or daily use as assessed by the national household survey (i.e., 0.5-1.1% vs. 0.4%). The comparable prevalence estimates derived using the arrest multiplier were slightly higher, at 1.2% and 1.5% for Sydney and NSW respectively. Again, national arrest estimates were spuriously inflated by the inclusion of ecstasy arrests in the benchmark data, giving a national prevalence estimate of 3.3% for dependent methamphetamine use.

Table 4. The estimated number of regular and dependent methamphetamine users in Sydney, NSW and Australia

	Sydney	NSW	Australia
Regular methamphetamine users			
Treatment	17,717	40,027	122,118 [a]
Hospital			
Any admission	13,936	29,815	72,816
Stimulant admission	15,468	31,850	83,148
Methamphetamine psychosis	18,315	43,461	128,997
Arrest	17,969	36,887	246,896 [b]
Dependent methamphetamine users			
Treatment	10,478	23,672	72,221 [a]
Hospital			
Any admission	11,440	24,475	59,774
Stimulant admission	14,718	28,061	73,257
Methamphetamine psychosis	15,355	36,437	108,149
Arrest	24,503	50,301	336,677 [b]

[a] Age range 10-49 years

[b] Includes arrests for ecstasy or unspecified stimulants

Table 5. The estimated number of regular and dependent methamphetamine users per 1,000 persons aged 15-49 years in Sydney, NSW and Australia.

	Sydney	NSW	Australia
Regular methamphetamine use			
Treatment	8.5	12.0	12.2 [a]
Hospital			
Any admission	6.4	8.5	7.3
Stimulant admission	7.4	9.5	8.3
Methamphetamine psychosis	8.7	13.0	12.9
Arrests	8.6	11.0	24.7 [b]
Dependent methamphetamine use			
Treatment	5.0	7.1	7.2 [a]
Hospital			
Any admission	5.2	6.9	6.0
Stimulant admission	7.0	8.4	7.3
Methamphetamine psychosis	7.3	10.9	10.8
Arrests	11.7	15.0	33.6 [b]

Median prevalence estimates

A single prevalence estimate was derived for regular and dependent methamphetamine use in Sydney, NSW and Australia, by taking the median of the various prevalence estimates (Table 6). The median national prevalence estimate excluded estimates based on the arrest multiplier because these were inflated by the inclusion of ecstasy-related cases in the national arrest benchmark data. Median prevalence estimates have been produced solely for the convenience of having a single prevalence estimate. Readers are advised to consider the relative merits and weaknesses of each multiplier when choosing the most appropriate prevalence estimate (see the discussion section of this report for a summary of factors affecting the interpretation of each estimate).

Taking the median of the various prevalence estimates, there were around 17,700 regular methamphetamine users and 14,700 dependent methamphetamine users in Sydney. This represents a rate of 8.5 and 7.0 regular and dependent methamphetamine users respectively per 1000 population aged 15 to 49 years.

The prevalence of regular and dependent methamphetamine users was higher across NSW, at 11.0 and 8.4 per 1000 persons aged 15-49 years respectively. This corresponded to an estimated 36,900 regular methamphetamine users in NSW, of whom around 28,000 were dependent on the drug.

The estimated number of regular methamphetamine users in Australia was 102,600, or 10.3 per 1000 persons aged 15 to 49 years. Of these regular methamphetamine users, it was estimated that there were 72,700 dependent methamphetamine users, or 7.3 per 1000 population aged 15-49 years.

Only 17% and 20% of regular and dependent methamphetamine users respectively were located in the city of Sydney, and just over one-third were located within NSW (36% and 38% respectively).

It should be noted that the multipliers were derived from methamphetamine users in Sydney and have been applied to benchmark data for the whole of NSW and Australia. This process is only accurate to the extent that health service access among methamphetamine users is uniform across Australia. Therefore, prevalence estimates for NSW and Australia should be regarded as provisional.

Table 6. Median prevalence estimates for the number of regular and dependent methamphetamine users aged 15-49 years in Sydney, NSW and Australia

	Regular		Dependent	
	Number	Rate per 1000 persons	Number	Rate per 1000 persons
Sydney	17,700	8.5	14,700	7.0
NSW	36,900	11.0	28,000	8.4
Australia	102,600	10.3	72,700	7.3

Note. The estimated number of methamphetamine users is rounded to the nearest 100.

4 DISCUSSION

4.1 The size of the methamphetamine problem in Australia

The current study found that there is a large population of heavy or dependent methamphetamine users in Australia. The prevalence of dependent methamphetamine use was around 0.7% of the population aged 15 to 49 years, while the prevalence of regular methamphetamine use was estimated at around 1% of the population aged 15 to 49 years. The actual number of dependent and regular methamphetamine users aged 15 to 49 years was estimated at around 73,000 and 103,000 respectively. These national estimates are provisional, as they are based on a multiplier derived from a sample of Sydney methamphetamine users, which may not generalise to the rest of Australia. The prevalence estimates for Sydney were based on a multiplier derived from methamphetamine users within this city, which makes them more accurate than the NSW and Australia-wide estimates, but these estimates should still be treated with caution because they are based on a single method of estimation which is subject to limitations.

While these prevalence estimates may be imprecise and subject to limitations, they still provide an idea of the scale of the methamphetamine problem in Australia, and indicate that it is roughly in the same league as dependent heroin use during the peak of the heroin problem in the late 1990s. In 1998 there were an estimated 74,000 dependent heroin users or 6.9 per 1000 persons aged 15 to 54 years (Hall et al., 2000). Since 1998, the number of heroin users has dropped dramatically following a shortage in the supply of the drug in 2001. Consequent to the heroin shortage it was estimated that the number of regular heroin users had fallen to 45,000, or 4.0 per 1000 persons aged 15-54 years (Degenhardt et al., 2004). A similar trend could be seen in NSW, where there were an estimated 19,900 regular heroin users in comparison with the current estimates of 36,900 regular methamphetamine users. This finding suggests that the current number of regular methamphetamine users in Australia exceeds the number of regular heroin users.

The high prevalence of regular and dependent methamphetamine use in Australia is not surprising given the high level of exposure to the drug among the general population.

Almost one in ten Australians have tried methamphetamine, and 3.2% of Australians surveyed through the 2004 National Drug Strategy Household Survey had used the drug in the past year. By way of comparison, only 1.4% of Australians surveyed had ever tried heroin. The overall prevalence of methamphetamine use in Australia has not changed significantly since 1998 according to population surveys (AIHW, 2002, 2005). However, there have been indications of increasing problems associated with methamphetamine use coupled with the emergence of high purity crystalline methamphetamine on the drug market (Degenhardt & Topp, 2003; McKetin & McLaren, 2003; McKetin et al., submitted; Topp et al., 2002). The use of crystalline methamphetamine is associated with high levels of dependence (McKetin et al., submitted) and its popularity is likely to be a driving factor in the large number of dependent methamphetamine users in Australia.

Methamphetamine use appeared to be more pervasive in Australia than heroin use, in that 83% of regular methamphetamine users were located outside Sydney compared with an estimated half of regular heroin users according to the indirect prevalence estimates derived by Degenhardt et al. (2004). The higher proportion of methamphetamine users outside of Sydney is consistent with a large proportion of methamphetamine supply being sourced from domestic clandestine methamphetamine laboratories, which are often located outside of the major metropolitan centres. This trend may shift consequent to the recent increases in the importation of crystalline methamphetamine, most of which has been detected at major cities on the east coast of Australia (Australian Crime Commission, 2003; McKetin et al., submitted).

The current population size estimates for dependent methamphetamine use include a proportion of primary heroin users who inject methamphetamine as a pattern of polydrug use. This would include heroin users who made a transition to methamphetamine use following the heroin shortage of 2001, and people who enter methadone pharmacotherapy but continue to use stimulant drugs. Transitions between heroin and methamphetamine among heavy drug users have been previously documented in Australia, as has the polydrug using nature of injecting drug users (Darke et al., 1999). Future estimates of the number of dependent or injecting drug users in Australia need to take into account the overlap between the dependent opioid and stimulant using populations.

4.2 Methodological considerations

The current study has demonstrated that it is feasible to apply the multiplier-benchmark method to the task of estimating the size of a dependent stimulant using population in Australia. The prevalence estimates produced were within the same league or slightly higher than comparable prevalence estimates derived from the National Drug Strategy Household Survey (AIHW, 2002, 2005). However, one of the issues in applying the multiplier-benchmark method to stimulant use was defining the target population of 'heavy' or 'dependent' methamphetamine users. In anticipation of this problem, the current exercise produced prevalence estimates for both regular and dependent methamphetamine use.

The current study defined regular use of methamphetamine as at least monthly use, because this was the inclusion criteria for the survey of methamphetamine users from which the multipliers were derived. However, the majority of methamphetamine users surveyed took methamphetamine at least weekly (82%). Similarly, methamphetamine users who were likely to experience the benchmark events tended to be dependent methamphetamine users who injected the drug, not those who took the drug only on a monthly basis. Therefore, the prevalence estimates for 'regular' use better reflect the number of methamphetamine users who take the drug weekly or more often.

The prevalence estimates for dependent methamphetamine use were based on multipliers derived from a sample of methamphetamine users who were likely to meet DSM-III-R criteria for severe dependence. Dependent methamphetamine users typically took the drug twice per week or more often, and were usually injecting the drug. It is dependent methamphetamine use that is most predictive of methamphetamine-related harms, such as methamphetamine psychosis and risk behaviour for blood borne viruses (McKetin et al., submitted; Hall et al., 1996; Hall & Hando, 1994; Hando et al., 1997). It is therefore the prevalence of methamphetamine dependence that is likely to have the most marked impact on both the individual and society.

The prevalence estimates derived from the treatment multiplier probably provide the most accurate estimate of dependent methamphetamine use. This is because: (a) treatment data better reflect dependent methamphetamine users who seek help for their drug use; (b) treatment entries for methamphetamine use could be clearly defined; (c) there was likely to be a good match between the drug user's self-report of treatment experience and the definitions used to identify the benchmark data; and (d) treatment entry for methamphetamine use was sufficiently prevalent to obtain a robust multiplier. There may have been some inflation of the treatment prevalence estimates because treatment data would have included a small number of duplicate episodes where a person has been transferred between services or received several distinct modalities of treatment (e.g., detoxification followed by counselling). On the other hand, our analysis of factors influencing whether or not methamphetamine users had experienced benchmark events suggested that the treatment prevalence estimates may under-represent immigrant methamphetamine users and methamphetamine users who are employed.

Prevalence estimates based on the hospital multipliers were similar to treatment estimates, but nonetheless subject to several limitations. The main limitation was the low frequency with which methamphetamine-related hospital presentations occurred among dependent methamphetamine users. Only 4% had been to hospital in the past year for a methamphetamine-related problem, and only 1% had been admitted to hospital for methamphetamine psychosis. Therefore, the multipliers we derived for methamphetamine-related hospital presentations are not very robust. The multipliers derived for 'any' hospital admission, regardless of whether methamphetamine was the main reason for admission, are likely to be more robust, with around 13% of methamphetamine users having experienced a hospital admission during the past year.

There were also several other limitations with the hospital prevalence estimates. First, the hospital benchmark data included all stimulant admissions other than cocaine, and were therefore likely to include ecstasy and to a lesser extent caffeine and pharmaceutical stimulant drugs (e.g., methylphenidate). Second, a proportion of methamphetamine-related hospital admissions would go undetected either because the patient did not report on their methamphetamine use or because medical staff did not record this information in the medical record. Finally, the hospital multiplier was based on the methamphetamine user's self-reported reason for admission to hospital, which may have been discrepant with the primary diagnosis provided in their medical record. For example, a methamphetamine overdose may be diagnosed according to the presenting physical symptoms (e.g., tachycardia) rather than the underlying cause (i.e., stimulant intoxication).

The prevalence estimates for methamphetamine dependence that were derived using the arrest multiplier were higher than those derived using other multipliers. Prevalence estimates derived using the arrest multiplier were also higher for dependent methamphetamine use than for regular methamphetamine use. This is implausible because in the current study dependent methamphetamine users were defined as a subset of regular methamphetamine users. A likely explanation for the high arrest prevalence estimates is that methamphetamine users who had recently been arrested would have been under-represented in our survey of methamphetamine users, because a proportion would have been incarcerated. National arrest prevalence estimates were particularly inflated, being six to eight times higher than the prevalence of heavy methamphetamine use according to the national household survey, and approximately two to five times higher than the estimates derived using the treatment and hospital multipliers. This inflation is likely to have resulted from the inclusion of ecstasy and other stimulant offences in national arrest data, differences in the definitions used for national arrest data and those used to define the arrest multiplier in the current study (e.g., arrests vs. charges), and other data artifacts (e.g., possible duplicate recording of arrests). As they stand, the national prevalence estimates based on the arrest multiplier appear to be spuriously high and should be interpreted with caution.

All of the derived prevalence estimates assume that the survey of methamphetamine users on which the multipliers were based was representative of the underlying 'target' population of heavy methamphetamine users. It is impossible to establish conclusively whether our sample of methamphetamine users was representative of all heavy methamphetamine users, because of the inherently 'hidden' nature of illicit drug using populations. However, we are aware of several factors that may have biased our sample. First, the survey was advertised and conducted in English, and would therefore under-represent methamphetamine users from non-English speaking backgrounds. Second, face-to-face surveys on illicit drug use tend to attract unemployed heavier drug users, and therefore our survey is likely to under-represent employed drug users from higher socioeconomic backgrounds. Third, one of the recruitment points for the survey was Needle and Syringe Programs, which would have led to an over-representation of injecting drug users, including injecting heroin users. These survey biases are important because they involve factors that were found to be predictive of whether or not methamphetamine users had experienced benchmark events. Specifically, benchmark events were more likely to occur among unemployed injecting drug users, and less likely to occur among methamphetamine users who were born outside of Australia. Future multiplier-benchmark methods could consider over-sampling these population sub-groups and stratifying prevalence estimates for each sub-group to obtain a more accurate overall prevalence estimate.

In summary, it is recommended that the prevalence estimate based on the treatment multiplier be regarded as the 'best' estimate of dependent methamphetamine use in Australia. Provisional estimates for NSW and Australia need to be improved through the development of treatment multipliers for other geographic areas of Australia, including regional and rural areas. Further investigation of factors affecting access to treatment services is needed to understand whether benchmark data accurately reflect the dependent methamphetamine using population. Appropriate stratification of the estimation procedure will be necessary to account for heterogeneity in service access between various geographic regions and sub-groups of methamphetamine users. The validity of the treatment multiplier also needs to be assessed against other indirect prevalence estimation techniques, such as capture-recapture.

4.3 Public health implications

Methamphetamine psychosis, and associated hostile and violent behaviour, is probably the most salient public health consequence of heavy methamphetamine use. Based on the current sample of methamphetamine users from which the multipliers were derived, 31% of dependent methamphetamine users experience psychosis at least once per year, and 16% would be likely to meet criteria for methamphetamine-induced psychosis (i.e., as opposed to a psychotic episode associated with a premorbid mental health problem, McKetin et al., submitted). Applying these proportions to the current population size estimates, between 11,000 and 12,000 Australians would experience an episode of methamphetamine psychosis during a one year period. There would be as many methamphetamine users again who experience psychosis that would probably be attributed to a pre-existing psychotic condition that may have been precipitated or exacerbated by methamphetamine use. This represents a substantial number of psychotic episodes in addition to those that are already occurring as a result of chronic psychotic illnesses (e.g., schizophrenia).

These additional presentations of psychosis are likely to place a heavy burden on psychiatric and emergency services, and present a significant cost to the health sector. Currently, management protocols for methamphetamine psychosis are not well established and the differential diagnosis of methamphetamine psychosis from other psychotic illnesses is also poor (Dawe and McKetin, 2004). There is also only limited knowledge of the risk factors for precipitating methamphetamine psychosis or its long-term prognosis. Dependence on methamphetamine and a predisposition to psychosis are both known predictors of psychosis among methamphetamine users (Curran et al., 2004; McKetin et al., submitted). Therefore, treatment of methamphetamine dependence, particularly among populations with mental health problems, should be a priority. Guidelines for the treatment of methamphetamine use among schizophrenic patients have been developed and are publicly available (Baker et al., 2004).

The significant size of the dependent methamphetamine using population in Australia also presents a major concern for the transmission blood borne and sexually transmitted viruses. The majority of regular and dependent methamphetamine users in our sample were injecting drug users (64% and 76% respectively) and were therefore at high risk of contracting and transmitting Hepatitis C. Hepatitis C is among the leading notifiable diseases in Australia, and the high levels of hepatitis C are being driven by injecting drug use, with an estimated 58% of injecting drug users being infected with the virus (National Centre for HIV Epidemiology and Clinical Research, 2003; Thein et al., 2004). The current estimates of dependent methamphetamine use suggest that the 'at risk' population for the transmission of blood borne viruses is likely to be at least double what would be expected if considering heroin injection alone. The fact that methamphetamine users have lower levels of contact with treatment and other health services than do heroin injectors (Kelly et al., in preparation) raises important issues around the dissemination of safe-injecting information and clean injecting equipment. The risk of contracting sexually transmitted diseases is also a concern among regular methamphetamine users. Methamphetamine use has often been associated with high rates of sexual activity and an increased incidence of unprotected sex with casual partners, although the precise nature of this relationship is unclear (Rawson et al., 2002; Darke et al., 1995; Molitor et al., 1998; Semple et al., 2004; Yen, 2004).

One of the clear public health implications of the current population size estimates is that only a small proportion of dependent methamphetamine users are receiving formal treatment for their methamphetamine use. The coverage of publicly funded treatment services for regular methamphetamine users was approximately 10% during the past year, in comparison with half or more of regular opioid users (Degenhardt et al., 2004; Kelly et al., in preparation). Dependence on methamphetamine is the key predictor of the major harms associated with the drug's use, including psychosis. Improving treatment coverage for methamphetamine use is essential if we are to reduce the impact of dependent methamphetamine use. Currently there are few, if any, evidenced-based treatment protocols for methamphetamine use (Baker et al., 2004). Methamphetamine users tend to seek help from a range of different services (Hando et al., 1997) and are thought to be difficult to engage in traditional drug treatment services (Hando et al., 1997; Klee and Morris, 1994; Wright et al., 1999). Also, there appear to be methamphetamine treatment access issues for immigrant populations and people who are employed. The number of dependent methamphetamine users in Australia suggests an urgent need to develop and implement effective and accessible treatment for methamphetamine users. The current findings also highlight the importance of preventing the up-take of methamphetamine patterns associated with dependence, such as smoking ice and injecting methamphetamine.

The number of dependent methamphetamine users also provides a potentially large pool of injecting drug users that could make a transition to heroin use, recreating the heroin problem experienced in Australia during the late 1990s. During the mid 1990s an emerging amphetamine epidemic in Australia rapidly shifted to a heroin use problem as many young injecting amphetamine users made a transition to injecting heroin use when heroin became cheap and readily available (Darke et al., 1999). Entrenched injecting drug use of any form leaves users vulnerable to polydrug use. Once established, a population of dependent injecting drug users is likely to absorb illicit drugs that become readily available. Therefore, the current population size estimates for dependent methamphetamine use not only have significant public health implications in their own right, but also in their potential to translate into other longer lasting patterns of dependent polydrug use.

4.4 Conclusion

Previous estimates of problematic drug use in Australia have focused on dependent injecting heroin use, which has been responsible for a host of health and social problems. However, the current findings demonstrate that Australia also has a large population of dependent methamphetamine users, most of whom inject the drug. The size of this population appears to be at least as large as the heroin using population in Australia in the late 1990s. Its contribution to the health and social consequences of illicit drug use in Australia cannot be ignored. Methamphetamine injectors are at risk of a range of health and social problems, even though the nature of these health risks may differ from those associated with heroin use. Further research is needed to more accurately understand the public health impact of methamphetamine dependence. Better efforts need to be made to reduce the size of this population through effective and accessible drug treatment and prevention initiatives.

The population size estimates provided by the current research are based on a first attempt at applying an indirect prevalence estimation procedure to dependent stimulant use. There were a number of biases evident in both the multipliers and the benchmark data. Multipliers were also derived from a sample of methamphetamine users within Sydney, which may not be indicative of the larger target population of dependent methamphetamine users either within Sydney or within the broader geographic regions of NSW and Australia. For these reasons, the current estimates should be treated as provisional estimates of the extent of the methamphetamine use problem. Further efforts need to be directed at improving estimates by deriving multipliers that are representative of regional and rural Australia, addressing the issue of heterogeneity in the multipliers, and also comparing estimates derived using the multiplier-benchmark method with those derived from other indirect prevalence estimation methods, such as capture-recapture techniques.

5 REFERENCES

Augustin R. & Kraus L. (2004). Changes in prevalence of problem opiate use in Germany between 1990 and 2000. *European Addiction Research, 10*, 61-67.

Australian Bureau of Statistics (2000). *Australian Standard Classification of Drugs of Concern.* Canberra: Commonwealth of Australia.

Australian Bureau of Statistics (2004). *Time Series Spreadsheet 3201.0. Population by Age and Sex, Australian States and Territories.* http://www.abs.gov.au/ausstats/abs@.nsf

Australian Crime Commission (2003). *Australian Illicit Drug Report 2001-02.* Canberra: Commonwealth of Australia.

Australian Crime Commission (2004). *Australian Illicit Drug Report 2002-03.* Canberra: Commonwealth of Australia.

Australian Institute of Health and Welfare (2002). *2001 National Drug Strategy Household Survey: Detailed findings.* Canberra: Australian Institute of Health and Welfare.

Australian Institute of Health and Welfare (2004a). The National Hospital Morbidity Database: Principal Diagnosis Data Cubes. *http://www.aihw.gov.au/hospitals/datacubes/datacube_pdx.cfm*

Australian Institute of Health and Welfare (2004b). Alcohol and other drug treatment services in Australia 2002-03: report on the national minimum data set. *Drug Treatment Series 3.* Canberra: Australian Institute of Health and Welfare.

Australian Institute of Health and Welfare (2004c). *Definitions for AODTS-NMDS data items: 2001-02 and 2002-03.* http://www.aihw.gov.au/drugs/datacubes/def.cfm

Australian Institute of Health and Welfare (2005). *2004 National Drug Strategy Household Survey: First Results.* Canberra: Australian Institute of Health and Welfare.

Baker, A., Bucci, S., & Kay-Lambkin, F. (2004). Intervention for alcohol, cannabis and amphetamine use among people with a psychotic illness. *NDARC Technical Report No. 193*. Sydney: National Drug and Alcohol Research Centre.

Baker, A., Lee, N. K., & Jenner, L. (2004). Models of intervention and care for psychostimulant users, Second Edition. *National Drug Strategy Monograph Series 51*. Canberra: Commonwealth of Australia.

Barker, B., Conroy, E., Degenhardt, L., Kimber, J., & Dolan, K. (2003). *Report to the NSW Cabinet Office of Drug Policy: Global indicators for monitoring the illicit drug environment in NSW*. Sydney: National Drug and Alcohol Research Centre, University of New South Wales.

Bartu, A., Freeman, N. C., Gawthorne, G. S., Codde, J. P. & Holman, C. J. (2003). Psychiatric comorbidity in a cohort of heroin and amphetamine users in Perth, Western Australia. *Journal of Substance Use, 8*, 150-154.

Comiskey, C. M. (2001). Methods for estimating prevalence of opiate use as an aid to policy and planning. *Substance Use & Misuse. 36,* 131-50.

Curran, C., Byrappa, N., & McBride, A. (2004). Stimulant psychosis: systematic review. *British Journal of Psychiatry, 185*, 196-204.

Darke, S., Kaye, S., & Ross, J. (1999). Transitions between the injection of heroin and amphetamines. *Addiction, 94*, 1795-1803.

Darke, S., Ross, J., Cohen, J., Hando, J., & Hall, W. (1995). Injecting and sexual risk-taking behaviour among regular amphetamine users. *AIDS Care, 1*, 19-26.

Dawe, S. & McKetin, R. (2004). Comorbidity and psychostimulant use. In. *Models of Intervention and Care for Psychostimulant Users. National Drug Strategy Monograph Series No. 51* (Eds. A. Baker. N. Lee, and L. Jenner). Canberra: Australian Government Department of Health and Ageing.

Degenhardt, L., Rendle, V., Hall, W., Gilmour, S., & Law, M. (2004). Estimating the number of current regular heroin users in NSW and Australia 1997-2002. *NDARC Technical Report No. 198*. Sydney: National Drug and Alcohol Research Centre.

Degenhardt, L., & Topp, L. (2003). 'Crystal meth' use among polydrug users in Sydney's dance party subculture: Characteristics, use patterns and associated harms. *International Journal of Drug Policy,* 14, 17-24.

European Monitoring Centre for Drugs and Drug Addiction (2004). *Annual report 2004: the state of the drugs problem in the European Union and Norway.* Luxembourg: Office for Official Publications of the European Communities.

Friedman S. R., Tempalski, B., Cooper, H., Perlis, T., Keem, M., Friedman, R. & Flom, P. L. (2004). Estimating numbers of injecting drug users in metropolitan areas for structural analyses of community vulnerability and for assessing relative degrees of service provision for injecting drug users. *Journal of Urban Health, 81,* 377-400.

Frischer, M. Hickman, M., Kraus, L., Mariani, F., & Wiessing, L. (2001). A comparison of different methods for estimating the prevalence of problematic drug misuse in Great Britain. *Addition, 96,* 1465 – 1476.

Hall W. & Hando, J. (1994). Route of administration and adverse effects of amphetamine use among young adults in Sydney, Australia. *Drug and Alcohol Review 13*, 277-284.

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

Hall, W., Ross, J., Lynskey, M., Law, M., & Degenhardt, L. (2000). How many dependent heroin users are there in Australia? *Medical Journal of Australia, 173,* 528-31.

Hando, J., Topp, L. & Hall, W. (1997). Amphetamine-related harms and treatment preferences of regular amphetamine users in Sydney, Australia. *Drug and Alcohol Dependence, 46*, 105-113.

Kelly, E., McKetin, R., & McLaren, J. (in preparation). Health service utilisation among regular methamphetamine users. *NDARC Technical Report.* Sydney: National Drug and Alcohol Research Centre.

Klee, H. & Morris, J. (1994). Factors that lead young amphetamine misusers to seek help: implications for drug prevention and harm reduction. *Drugs: Education, Prevention and Policy, 1,* 289-297.

McKetin, R. & McLaren, J. (2003). The methamphetamine situation in Australia: A review of routine data sources. *NDARC Technical Report No. 197.* Sydney: National Drug and Alcohol Research Centre.

McKetin, R., McLaren, J. & Kelly, E. (submitted). *The Sydney Methamphetamine Market: Patterns of supply, use, harms and social consequences.* Report submitted to the National Drug Law Enforcement Research Fund.

Molitor, F., Truax, S.R., Ruiz, J.D., & Sun, R.K. (1998). Association of methamphetamine use during sex with risky sexual behaviours and HIV infection among non-injection drug users. *Western Journal of Medicine, 168*, 93-97.

National Centre in HIV Epidemiology and Clinical Research. (2003). *HIV/AIDS, viral hepatitis and sexually transmissible infections in Australia: Annual Surveillance Report 2003.* Sydney: National Centre in HIV Epidemiology and Clinical Research, University of New South Wales.

Petitti, D. B., Sidney, S., Quesenberry, C., & Bernstein, A. (1998). Stroke and cocaine or amphetamine use. *Epidemiology, 9*, 596-600.

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

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,* 333-337.

Sato, M., Numachi, Y., & Hamamura, T. (1992). Relapse of paranoid psychotic state in methamphetamine model of schizophrenia. *Schizophrenia Bulletin, 18*, 115-122.

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

Simeone, R., Holland, L., & Viveros-Aguilero, R. (2003). Estimating the size of an illicit-drug-using population. *Statistics in Medicine, 22*, 2969-2993.

Stata Corportation (2003). *Intercooled Stata Statistics/Data Analysis Version 8*. Texas, USA.

Thein, H., Maher L., & Dore, G. (2004). *Australian NSP Survey: National Data Report 1999-2003*. Sydney: National Centre in HIV Epidemiology and Clinical Research.

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 and Alcohol Review, 21*, 341-348.

Topp, L., & Mattick, R. (1997a). Validation of the amphetamine dependence syndrome and the SamDQ. *Addiction, 92*, 151-162.

Topp, L., & Mattick, R. (1997b). Choosing a cut-off on the Severity of Dependence Scale (SDS) for amphetamine users. *Addiction, 92*, 839-845.

UNODC (2003). *Estimating prevalence: Indirect methods for estimating the size of the drug problem.* Global Assessment Programme on Drug Abuse, Toolkit Module 2. Vienna: United Nations Office on Drugs and Crime.

Wright, S., Klee, H., & Reid, P. (1999). Attitudes of amphetamine users towards treatment services. *Drugs: Education, Prevention and Policy, 6,* 71-86.

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

6 APPENDIX 1

Area Health Service	Local Government Area
Central	Ashfield, Burwood, Canterbury, Leichhardt, Marrickville, South Sydney, Strathfield,
Northern	Hornsby, Ku-ring-gai, Lane Cove, Manly, Mosman, North Sydney, Pittwater, Ryde, Warringah, Willoughby
South Eastern	Botany Bay, Hurstville, Kogarah, Randwick, Rockdale, Sutherland, Sydney, Waverley, Woollahra
South Western	Bankstown, Camden, Campbelltown, Fairfield, Liverpool, Wingecarribee, Wollondilly
Wentworth	Blue Mountains, Hawkesbury, Penrith
Western	Auburn, Baulkham Hills, Blacktown, Holroyd, Parramatta