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Matthew Law & Louisa Degenhardt**

**How many dependent opioid users are there
in Australia?**

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HOW MANY DEPENDENT OPIOID USERS ARE THERE IN AUSTRALIA?

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Wayne Hall, Joanne Ross, Michael Lynskey, Matthew Law & Louisa Degenhardt

National Drug and Alcohol Research Centre

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EXECUTIVE SUMMARY

INTRODUCTION

One of the questions most commonly asked about heroin use is "how many Australians are dependent on heroin?" Problems related to heroin dependence, such as, blood borne virus transmission, premature death from overdose and crime, have a negative effect on the community that is disproportionate to the relatively small proportion of Australian adults who are dependent on heroin.

Credible estimates of the number of dependent heroin users are needed to plan an appropriate public health and public order response to dependent heroin use in Australia. Credible estimates are especially pertinent at present. Over the past 5 years heroin use has had increased media attention because of a substantial increase in the rate of heroin overdose deaths. The rising overdose death rate has prompted claims of a substantial increase in heroin use and speculative media estimates of the number of dependent heroin users in Australia.

Household surveys, which are often used to estimate the prevalence of alcohol and other health-related behaviour, are not well suited to estimating the prevalence of dependent heroin use. First, household surveys underestimate the number of dependent heroin users in the population because these users are concentrated in a small number of geographic areas where heroin is most readily available. Second, dependent heroin users' lifestyles also make them less likely to live in conventional households and less likely to participate in household surveys either because of their unavailability at the time the interviewer calls or their reluctance to be interviewed. Third, when heroin users are selected in a household sample, their use is likely to be underreported because it is an illegal and stigmatised behaviour.

There is no widely accepted "gold standard" method for estimating the size of the "hidden population" of dependent heroin users. The most widely used approach has been to look for a convergence of estimates derived by applying a number of different indirect methods of estimation to data on the consequences of dependent heroin use, such as overdose death and persons seeking treatment. We used this strategy to estimate the number of dependent heroin users in Australia.

STUDY AIMS

The current study aimed:

1. To use indicator data to assess *trends* in dependent heroin use and its health and social consequences in New South Wales (and where possible, Australia) over the past decade;
2. To estimate trends in the *number* of dependent heroin users in New South Wales (and where available Australia) over the past decade;
3. To use the Australian estimates to provide provisional estimates of the number of heroin dependent persons in each of the States and Territories;
4. To compare the estimated population prevalence in Australia with that in comparable European societies.

METHOD

Data Sources

Trends in use

Analysis of trends in heroin use was carried out using the following data sets:

- (1) national data on the number of fatal opioid overdoses per year compiled by the Australian Bureau of Statistics;
- (2) the NSW Health Department's methadone client database provided by the Pharmaceutical Services Branch (PSB);
- (3) data on arrests for heroin offences from the NSW police service;
- (4) data on ambulance attendances at suspected drug overdoses provided by the NSW ambulance service;
- (5) data provided by the Alcohol and Drug Information Service (ADIS) on calls received related to heroin use;
- (6) needle and syringe program (NSP) data from the AIDS and Infectious Diseases Unit at NSW Health on the numbers of needles and syringes distributed per year.

Number of users

Estimates of the number of heroin users were derived from secondary analyses of the following data sets:

- (1) national data on the number of fatal opioid overdoses per year between 1964 and 1997 compiled by the Australian Bureau of Statistics;
- (2) the NSW Health Department's methadone client database between 1987 and 1998 provided by the Pharmaceutical Services Branch (PSB);
- (3) data on arrests for heroin offences in the period 1997-1999 from the NSW police service.

Because these databases permit counts of individuals they can be used to derive estimates of the number of dependent heroin users. Other databases that count occurrences related to heroin dependence (e.g. suspected overdoses attended by an ambulance and calls to telephone counselling services) were not used because they did not permit counts of individuals.

Methods of estimation of the number of users

Three indirect estimation methods were used to estimate the number of dependent heroin users in NSW and Australia. The methods of estimation were:

- (1) **Multiplier methods** from data on the number of national opioid overdose fatalities and NSW methadone maintenance clients. Two multipliers were used for mortality: the conventional 100 which assumes an annual overdose mortality rate of 1% and a slightly larger 120 derived from a meta-analysis of cohort studies of treated opioid users which suggests an annual mortality rate of 0.8%. The multiplier of 3 for methadone treatment was derived from an earlier study of demand for this type of treatment in Australia.
- (2) **Capture-recapture estimates** were based on the numbers of individuals entering methadone treatment (1995-1998) and arrested for heroin offences (1997-1998). The form of capture-recapture was across study periods of one year, rather than capture-recapture across different data sources in the same time period.
- (3) **Back-projection or back-calculation methods** were applied to data on national fatal opioid overdose, and first time entrants to methadone maintenance in NSW, to estimate the incidence and prevalence of heroin dependence. The form of back-projection used was that suggested by Becker et al. The current study examined the degree of convergence between the back projection estimates derived from the two different data sources.

A national estimate was derived from national opioid overdose deaths. NSW estimates were derived from NSW methadone and arrest data and these were doubled to produce national estimates because NSW accounts for just under half of all opioid overdose deaths in Australia and just over half of the number of people enrolled in methadone treatment in Australia.

RESULTS

Trends in use

A number of indicators of the health and social consequences of dependent heroin use in NSW have shown increases since the early 1990s. The number of fatal opioid overdoses has increased dramatically since 1991, and so have the number of first time entrants to methadone maintenance treatment, and the number of heroin-related calls to the Alcohol and Drugs Information Service. The number of non-alcohol intoxicated automobile drivers who tested positive for morphine has also risen from 1995/96 to 1998/99. The number of needles and syringes dispensed through the public needle and syringe programs and the pharmacy fit-pack program has also increased since the mid 90's, although it is impossible to distinguish needles and syringes used by dependent heroin users from those used by regular injectors of other drugs such as amphetamines and cocaine.

National estimates of the number of dependent heroin users

The estimates produced by the various methods are shown in Table a. The estimates for Australia varied between 67,000 and 92,000, with a median of 74,000 and a mean of 77,000.

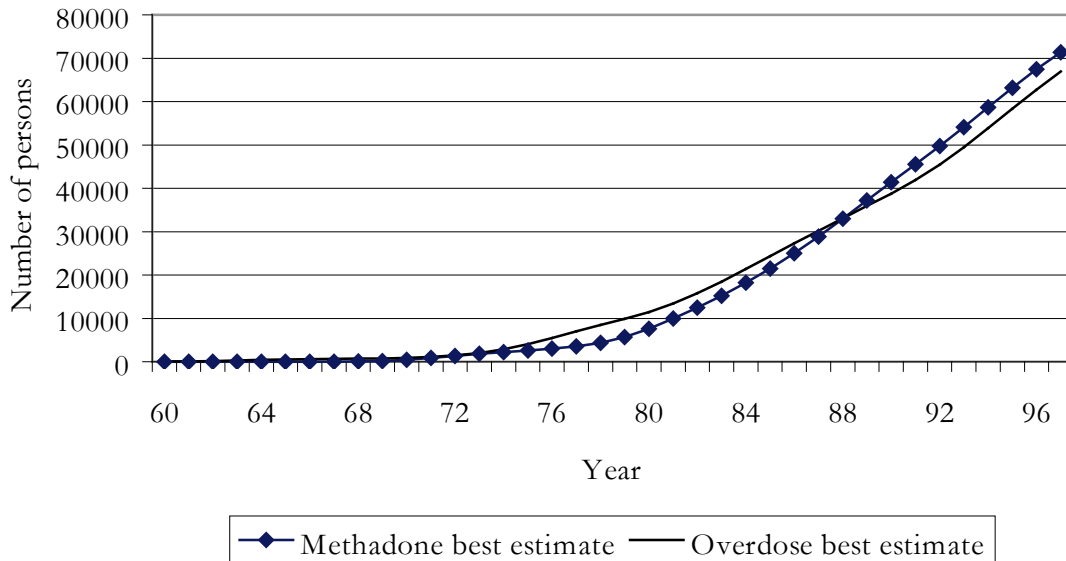
Table a: Estimates of the number of dependent heroin users in NSW and Australia (rounded to nearest 1000)

Method of estimation	Estimate for Australia	Range of estimates
Back projection		
National OD deaths	67,000	39,000 - 120,000 *
NSW MMT entrants	71,000	47,000 - 109,000 *
Capture-recapture		
MMT episodes	82,000	68,000 - 109,000 #
Arrests for heroin offences	86,000	78,000 - 102,000 #
Multiplier estimates		
OD fatalities:		
(x 100)	74,000	-
(x 125)	92,000	-
MMT entrants		
(x 3)	68,000	-
Median estimate	74,000	67,000-92,000

Key: * ranges from sensitivity analyses; # confidence intervals around estimates; no ranges for multiplier estimates

The degree of consistency between point estimates derived by different methods from different data sources was reassuring. In particular, the extent of the agreement between the two back projection estimates of trends in the prevalence of heroin dependence over the period 1970 to 1997 (figure a) was especially striking. All of this provides some reassurance that the true estimate of the number of dependent heroin users in Australia is likely to be included within the range of estimates that we have produced.

FIGURE A: BACK PROJECTION ESTIMATES OF THE NUMBER OF DEPENDENT HEROIN USERS



If we take the median national estimate of 74,000 as the best estimate then the population prevalence of dependent heroin use in Australia is 6.9 per 1000 adults aged 15 to 54 years, with a range 5.8 to 8.6 per 1000.

Jurisdictional estimates of the number of dependent heroin users

We derived provisional estimates of the number of heroin dependent people and the prevalence per 1000 adults aged 15 to 54 years in each of the Australian States and Territories by allocating the estimated number of heroin users in Australia as a whole (74,000) to each jurisdiction in proportion to the contribution that each jurisdiction made to national opioid overdose deaths in the period 1994 to 1998.

On this basis the estimate for NSW of 35,400 comprised just under half of the national estimate (48%). The estimated number of 19,600 opioid dependent persons in Victoria accounted for 27% of the national estimate. NSW and Victoria therefore account for 75% of all the estimated number of heroin dependent persons in Australia. The smaller states accounted for the remaining 25%. The estimated numbers of dependent heroin users in the some of the smaller states, particularly Queensland, appear to be under-estimates. Better local estimates need to be derived by applying our methods to data in each of the smaller states.

DISCUSSION

In this report we have summarised the results of a number of analyses estimating the size of the population of people who are heroin dependent in Australia. Estimates varied between 67,000 and 92,000 with the median estimate being 74,000, which equates to a population prevalence of 6.9 per 1,000 population aged 15-54 years. Each estimation method makes assumptions that are of uncertain validity. While these uncertainties mean that the estimates presented here should be interpreted with caution, we believe that there are a number of reasons why the current estimate provides a better basis for public policy than more speculative estimates quoted in the popular media.

Firstly, there is reassuring convergence between estimates produced by different methods. The two back projection estimation methods, applied to two very different data sets (new entrants to methadone treatment and opioid overdose deaths), produced estimates that were in close agreement. The ranges of estimates derived by plausibly varying the assumptions also substantially overlapped. The estimates produced by the mortality and treatment multiplier methods and the capture-recapture estimates were reasonably similar to those produced by the back-projection methods.

Secondly, the estimated national prevalence rate (6.9 per 1000 adults aged 15 to 54 years) is in the middle of the range of estimates of problem drug use recently derived in Europe, namely, 3 to 8 per 1000 adults aged 15 to 54 years. It is in fact the same as the estimated prevalence of opioid dependence in the United Kingdom, namely, 7 per 1000 adults aged 15 to 54 years.

Several factors explain the discrepancy between our estimates and media estimates of 200,000 Australian heroin users. Our estimate is of *dependent* heroin users, users who are highly visible in a small number of geographic areas in Sydney and Melbourne. This means that they often attract media attention out of all proportion to their numbers. Within these areas, intoxicated dependent heroin users are often highly visible, dealing, using drugs, and leaving discarded injecting equipment in public places. Criminally involved dependent heroin users often engage in high rates of shop-lifting and breaking and entering houses.

The national estimate for 1997 (74,000) represents a doubling of the 34,000 estimated in 1984-87, and a 25% increase on the estimate of 59,000 in the period 1988-1993. During this time, there was a corresponding increase in the rate of opioid dependence from 3.7 per 100,000 in 1984-87 to 5.9 per 100,000 in 1988-1993 and to 6.9 per 100,000 in 1997. There are at least three plausible reasons why the number of dependent heroin users has increased in Australia over the past decade.

First, there has been a substantial increase in the availability of very pure and very cheap heroin in Australia in the past decade. The very limited historical data indicate that the purity of street heroin in Sydney has increased from 10% in 1979 to a mean of 60% in 1993-1995. The nominal price has remained stable at \$30 for a street cap but its effective price per ounce of pure heroin has declined from approximately \$16,000 in 1979 dollars to \$5000 in 1999 dollars; the difference is even larger when account is taken of inflation.

Second, the high purity and low price has meant that it has been easier for new users to

initiate heroin use by non-injecting routes such as smoking or inhaling the fumes of heated heroin. This may have permitted more naïve users to begin heroin use before making a transition to injecting.

Third, the rise in heroin use in birth cohorts born in the later half of the twentieth century is paralleled by similar trends in a range of psychosocial disorders among young adults, including depression, suicide, anti-social behaviour and eating disorders. These trends and the reasons for them have been extensively reviewed by Rutter and Smith, who concluded that the increases are real and unlikely to be explained by any single social factor, such as, media, family breakdown, or unemployment. Rather, they probably reflect the combined influence of a range of broad societal changes that have occurred in the last half-century.

CONCLUSIONS

The estimated prevalence of heroin dependence in Australia is similar to that in countries of the European Union. This is an important finding because the media attention to opioid overdose deaths in Australia has created a false impression that the prevalence of heroin dependence is unusually high in Australia. Other data suggests that in Australia dependent heroin use causes a substantial public health and public order problem but the current estimates suggest that the number of dependent heroin users is of the same order of magnitude as in Britain and other European societies from which Australia's population until recently has largely derived.

1. INTRODUCTION

One of the most frequently asked questions about heroin use in Australia is: How many Australians are dependent on heroin? The imperative for answering this question arises from understandable community concerns about the health and social consequences of dependent heroin use (Stimson and Judd, 1997). Heroin dependence substantially increases the risk of experiencing fatal and non-fatal overdose and the transmission of blood-borne viruses (BBV) such as HIV and hepatitis B and C by sharing injecting equipment. It accounts for a significant proportion of the total burden of disease and injury due to illicit drugs in Australia (Mathers, Vos and Stevenson, 1999). A minority of dependent heroin users who engage in drug and property offences to finance their heroin use have an adverse impact on the communities in which they live that is out of proportion to their relatively small number.

1.1 HEROIN DEPENDENCE

Heroin dependence can be defined as the loss of control over heroin use, as indicated by continuing to use heroin in the face of problems that the user knows or believes are caused by its use, including legal difficulties, interpersonal problems and health problems. Dependent heroin users in Australia typically inject heroin daily or near daily (Bell et al, 1995).

Most heroin users who become dependent on heroin typically report 1 to 2 years between their first use of heroin and their first period of sustained daily use (a reasonable indicator of dependent use). The proportion of heroin users who become dependent users is estimated to be about one in four (23%) of those who ever use heroin. This is the second highest rate of dependence after nicotine (32%) and substantially higher than the equivalent risks for alcohol (15%), cocaine (15%) and cannabis (9%)(Anthony et al, 1994). In population surveys the prevalence of heroin dependence in the US population has been estimated to be between 0.4% (Anthony et al, 1994) and 0.7% (Anthony and Helzer, 1991) of the adult population.

Epidemiological research indicates that there are substantial numbers of heroin dependent persons who do not come to the attention of drug treatment services or the legal system (Anthony et al, 1994; Eisenhandler and Drucker, 1993). Some of these dependent users discontinue their heroin use without professional assistance (Biernacki, 1986; Johnson, 1978). However, dependent heroin users who seek treatment and who come to the attention of the legal system may continue to use heroin for decades (Goldstein and Herrera, 1995; Hser et al, 1993; Vaillant, 1988). Among these chronic users, periods of daily heroin use are interrupted by detoxification, drug treatment and incarceration for drug-related offences. The proportion who achieve enduring abstinence from opioid drugs after any treatment encounter is small but the proportion who become abstinent increases with age (Goldstein and Herrera, 1995; Hser et al, 1993; Vaillant, 1973).

Over 20 years or more, the chances of treated dependent heroin users becoming and remaining abstinent are approximately equal to their chances of dying prematurely (approximately a third in each case). The remaining third cycle through prison, drug treatment and active heroin use well into their 40s and 50s (Goldstein and Herrera, 1995;

Hser, Anglin and Powers, 1993; Vaillant, 1973). When periods of voluntary and involuntary abstinence during treatment or imprisonment are counted, dependent heroin users use heroin daily for between 40% (Maddux and Desmond, 1992) and 60% (Ball et al, 1983) of their addiction careers.

1.2 INFECTIOUS DISEASES AND HEROIN USE

In the USA and parts of Europe, sharing contaminated needles, syringes and other injecting equipment accounts for 50% of new HIV notifications (National Centre in HIV Epidemiology and Clinical Research (NCHECR), 1998). In Australia, approximately eight percent of new HIV diagnoses occur in persons with a history of injecting drug use, of whom just under half are men with a history of male sexual contact (NCHECR, 1998). The prevalence of HIV infection among people attending needle and syringe programs (NSPs) in Australia has been estimated at less than 3% (NCHECR, 1998). The low HIV infection among Australian injecting drug users reflects Australia's geographic isolation and the early introduction of needle and syringe programs that seems to have averted an HIV epidemic among Australian injecting drug users and their sexual contacts.

The prevalence of Hepatitis C virus (HCV) among IDU is much higher than that of HIV. Among IDU attending needle and syringe programs, between 50 and 60% have been infected with HCV (NCHECR, 1998). In 1997 there were estimated to be at least 197,000 Australians infected with Hepatitis C and 11,000 new infections each year as a result of injecting drug use. Chronic infection has been estimated to occur in 75% of infections, and 3-11% of chronic HCV carriers will develop liver cirrhosis within 20 years (Hepatitis C Virus Projections Working Group (HCVPWG), 1998). Given the larger number of people infected with HCV, and the more protracted nature of the complications of this infection, the net health and economic cost of HCV transmitted by injecting drug use is likely to considerably higher than that of HIV (HCVPWG, 1998; Wodak and Crofts, 1996).

HCV is spread by the shared use of injecting equipment. It is a more robust virus than HIV and more easily spread. The base rate of HCV infection among injecting drug users before Needle and Syringe Programs (NSP) were introduced was substantially higher than the base rate of HIV infection, ensuring that the risks of HCV infection from any episode of sharing were much higher than those for HIV. Injecting drug users are likely to spend time in prison at some point in their life and most inject drugs while in prison sharing needles with large numbers of other injectors (HCVPWG, 1998). The rate of HCV transmission in prison is not yet documented, but it is likely to be significantly higher than in the general community.

1.3 HEROIN USE AND PREMATURE DEATH

Dependent heroin users have a substantially increased risk of premature death from various causes (English et al, 1995). These include: drug overdoses, violence, infectious diseases spread by sharing contaminated injecting equipment, and alcohol-related causes (Goldstein and Herrera, 1995; Hser et al, 1993; Joe and Simpson, 1990; Vaillant, 1973). Mortality studies among cohorts of heroin users treated before the advent of HIV/AIDS indicated that they were 13 times more likely to die prematurely than their age peers (English et al, 1995). More recently, HIV/AIDS has been added to the causes of premature deaths among heroin users in the USA and Europe; emerging evidence suggests that this will become a more important cause of premature death among heroin users in Australia in the future, as will liver disease caused by infection with the hepatitis C virus (Crofts et al, 1993).

Analyses of premature mortality attributed to illicit drug use in Australia indicate that opioid overdose is one of the most frequent causes of death among heroin users (Hall et al, 1999a). In 1997, it accounted for 80% of all illicit drug-related deaths among Australians aged between 15 and 44 years. This represented 60% of the total deaths attributed to alcohol in the same age group and almost double the number of deaths due to motor vehicle accidents involving alcohol in this age group (Hall et al, 1999a).

Between 1964 and 1997 there was a 55 fold increase in the rate of overdose per million of population aged 15 to 44 years; males comprised 80% of these deaths (Hall et al, 1999a). The average age at death rose from early 20s to early 30s over this period. Most overdose deaths between 1979 and 1997 occurred among heroin users who initiated use in the late 1970s and early 1980s (Hall et al, 1999a). The increase in overdose deaths was observed in most Australian states and territories (Lynskey and Hall, 1998) and similar trends have been observed in Europe. Heroin dependence has been estimated as one of the largest increasing causes of mortality burden in Australia (Mathers et al, 1999). Among the risk factors for fatal opioid overdose are: a history of heroin dependence; being male; concurrent use of heroin, alcohol and benzodiazepines; and using heroin alone (Darke and Zador, 1996).

1.4 HEROIN USE AND CRIME

Dependent heroin users who come to attention through the legal system and drug treatment typically engage in high rates of criminal activity. These offences are most often street level drug dealing and property crimes (such as, robbery, break, enter and steal; forgery and shoplifting). Heroin dependent women may be involved in prostitution (Hall et al, 1993a; Bell et al, 1992; 1995). Lehman and Simpson (1990) found that 99% of a cohort of 490 treated American heroin users reported that they had engaged in some form of illegal activity during a 12-year period after treatment, and 60% had spent a year or more in gaol. High rates of convictions have been reported among methadone applicants in Australia: 90% had one or more convictions, 76% for drug offences, and 78% for property offences (Hall et al, 1993a).

There is no doubt that heroin use and crime are associated but there is disagreement about why (e.g. Dobinson, 1989; Chaiken and Chaiken, 1990; Hammersely et al, 1989). Heroin use is not a cause of criminal behaviour in the sense that most dependent heroin users would not have engaged in crime if they had not used heroin. At least half of the heroin users seeking

treatment were involved in property offences before they first used heroin (Dobinson and Ward, 1984, 1987; Hall et al, 1993a). This is especially true of male heroin users; heroin dependent women who are more likely to be introduced to heroin use by a male sexual partner are more likely to become involved in crime *after* they use heroin (Hser et al, 1987; Hall et al, 1993a).

Nonetheless, there is good evidence that dependent heroin use is a contributory cause of the *frequency* of offending in that the frequency of heroin use is positively correlated with the frequency of criminal activity. McGlothlin et al (1978) studied the criminal and drug use careers of 590 heroin addicts in California and Ball et al (1983) studied 343 heroin users in Baltimore. Both found a substantially higher rate of self-reported crime when users were using heroin daily than when they were abstinent in the community. In Ball et al's study, for example, there was a 75% drop in the number of days that addicts engaged in crime when they were abstinent. McGlothlin et al found the same sort of difference in the number of recorded arrests, indicating that the relationship was not the result of biases in self reported crime.

A survey of 200 heroin users in South-Western Sydney indicated that many were actively engaged in acquisitive property crime and dealing illicit drugs (Maher et al, 1998). Illegally obtained income accounted for 82% of the sample's income in the week before interview. From these data it was estimated that the total costs of heroin-related crime in Australia was between \$535 million and \$1.6 billion per annum (Maher et al, 1998).

2. METHODS OF ESTIMATING THE NUMBER OF DEPENDENT HEROIN USERS

There are substantial technical difficulties in estimating the number of dependent heroin users in Australia or in any other population. In most developed societies, heroin use is illegal and a stigmatised activity that is practiced in private by consenting adults who prefer others not to know about their behaviour. There are no well tested and widely accepted “gold standard” methods for producing credible estimates of the number of people who make up the "hidden population" of dependent heroin users (Hartnoll, 1997). The preferred strategy is to look for convergence in estimates produced by a variety of different methods of estimation (European Monitoring Centre for Drugs and Drug Addiction - EMCDDA, 1997; 1999). These methods can be classified into two broad types: direct estimation methods that attempt to estimate the number of dependent heroin users in representative samples of the population; and indirect methods which attempt to use information from known populations of dependent heroin users (such as those who have died of opioid overdoses, and those who are in treatment or the criminal justice system) to estimate the size of the hidden population of dependent heroin users.

2.1 DIRECT ESTIMATES: SAMPLE SURVEYS OF DRUG USE

The most direct way to estimate the proportion of people who have engaged in behaviour that affects health is to ask a representative sample of the at risk population whether and how often they have engaged in that behaviour. School surveys detect too few dependent heroin users to be useful because dependent heroin use typically develops after adolescents have left school (Lynskey et al, 1999). Household surveys of adults provide better representation of the population at risk but they are likely to underestimate the number of heroin users in the Australian population for a number of reasons.

First, household surveys of drug use are likely to under-sample heroin users who are concentrated in a small number of geographic areas, usually those where heroin is most readily available (Griffiths et al, 1997). In New South Wales, for example, 35% of overdose deaths between 1992 and 1996 occurred in two areas of Sydney around major heroin markets, namely Kings Cross and Cabramatta (Darke et al, 1999). A representative sample of the Australian population will include very few persons who are resident in these areas.

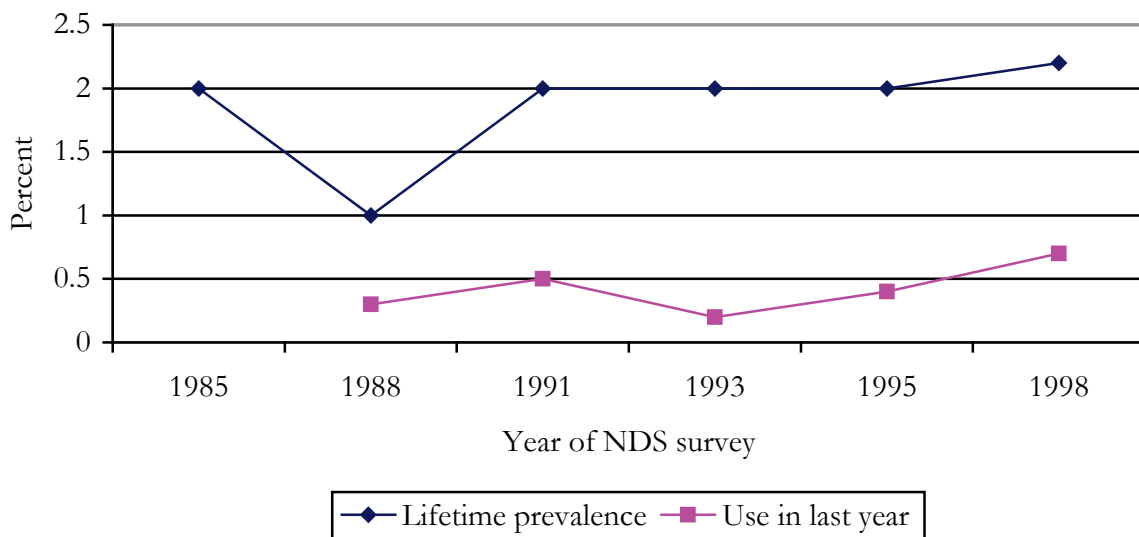
Second, heroin users' lifestyles also make them less likely to live in conventional households and less likely to participate in household surveys because of their unavailability at the time the interviewer calls or their reluctance to agree to be interviewed. Heroin dependent persons are accordingly likely to be over-represented among the 35% to 50% of eligible respondents who decline to participate in NDS Surveys (Makkai and McAllister, 1998).

Third, even when heroin users are selected in a sample and agree to be interviewed, their heroin use is likely to be under-reported because it is an illegal and stigmatised behaviour.

Fourth, these surveys provide at best a crude indication of dependent heroin use. In most surveys respondents are asked whether they have ever used heroin and the frequency of heroin use in the past year. Rarely is any attempt made to estimate daily heroin use or to assess symptoms of heroin dependence.

Fifth, heroin use is rarely reported in household surveys. In the National Drug Strategy surveys, for example, only 1% to 2% of respondents reported that they have ever used heroin and 0.5% or less reported that they had used heroin in the past year. These represent small numbers of heroin users. In surveys between 1985 and 1995, which had a sample size of 3,000, persons there were typically only 30 persons who reported any heroin use and less than 10 who reported heroin use in the past year. Figure 1 shows the reported prevalence of lifetime and recent (in the preceding 12 months) heroin use in Australia, based on the six NDS household surveys conducted to date. While it would appear that the prevalence of heroin use has remained relatively stable over the 14 years covered by the NDS surveys, the problems with these data need to be borne in mind.

FIGURE 1: NATIONAL HOUSEHOLD SURVEY ESTIMATES OF THE PREVALENCE OF LIFETIME AND RECENT HEROIN USE IN AUSTRALIA



The 1998 NDS Household survey had a sample size of 10,000 adults. The proportion of respondents reporting heroin use in the past year increased from 0.4% in 1995 to 0.7% in 1998. The 1998 survey estimated that 112,600 Australians had used heroin in the past year (Australian Institute of Health and Welfare, 1999). A 95% confidence interval around this estimate produces a range of between 0.5% and 0.9% of adults, or a range from 87,000 to 138,000.

A number of caveats need to be made about this estimate. Firstly, as already argued, regular heroin users are likely to be under-represented in household surveys because: they are more likely to live in non-conventional households or be imprisoned, they tend to be concentrated

in a small number of geographical areas, and those who are contacted may be reluctant to admit to illegal and socially stigmatised activities. Secondly, the estimate includes occasional as well as regular heroin users. Even individuals who had only tried heroin once in the 12 months preceding interview were counted.

The recent Australian National Survey of Mental Health and Well-Being (NSMHWB) produced an estimate of the proportion of the Australian population that met ICD-10 criteria for heroin dependence (Hall et al, 1999b). The NSMHWB improved on the NDS Household surveys in a number of respects. It sampled 10,641 adults using the World Health Organization Composite International Diagnostic Interview (CIDI-A) to assess heroin dependence and it achieved a response rate of 78% compared to 56% for the 1998 NDS Survey (Australian Institute of Health and Welfare, 1999). The NSMHWB estimated that there were only 26,000 persons (0.2% of Australian adults) who were opioid dependent in the past year.

The NSMHWB estimate is manifestly an underestimate. There were 21,000 heroin dependent persons in methadone maintenance treatment (MMT) in Australia as at 30 June 1997, and another 25%-50% who had been in MMT during that year. In addition, there were several thousand opioid dependent persons receiving other forms of drug treatment or imprisoned for offences related to their opioid dependence. Even when allowance is made for double counting, it is extremely unlikely that nearly all opioid dependent persons in Australia were in treatment in 1997, as would be the case if the NSMHWB estimate was correct. This is unlikely given evidence of unmet demand for treatment and the fact that surveys of regular heroin users in the Illicit Drug Reporting System typically find that only a third are currently in treatment (McKetin et al, 2000).

The population prevalence of heroin dependence was also estimated as part of the Australian Burden of Disease and Injury (ABDI) (Mathers, Vos, and Stevenson, 1999). The ABDI corrected the NSMHWB estimate for under-reporting to arrive at a prevalence estimate of 42,000 opioid dependent persons, which represented 0.3% of the adult Australian population. The ABDI estimate is larger than the NSMHWB but it is also likely to be an underestimate because it implies that more than half of all opioid dependent persons in Australia are treated in any year.

2.2 MULTIPLIER METHODS

A simple way to estimate the number of heroin users in the population has been to multiply the number of known heroin users in some accessible population (e.g. persons being treated for opioid dependence or persons who have died from an opioid overdose) by a factor (e.g. 6 or 10) that is the ratio of known to unknown heroin users in the community. The multiplier method is simple and easy to understand and it requires very little data. It also begins with a count of the number of persons who one can be reasonably confident are dependent heroin users, or at least that subset who have experienced problems as a consequence of their heroin use and either sought help to address these problems or come to police attention. The method nonetheless has its limitations (Frischer, 1998).

First, multiplier methods presuppose that we know the ratio of known to unknown heroin

users in the population. The recommendation to use multipliers of 100-200 for opiate-related deaths derives from data on the overdose mortality rate among New York heroin users known to the police in the early 1960s (Reuter, 1993; Frischer, 1998). The multipliers of 6 to 10 for the number of persons in treatment for opiate dependence are based on data collected in London in the early 1980s (Hartnoll et al, 1985). It would be unwise to assume that either of these factors has remained constant in recent times in the same locations, let alone to assume that they are applicable to other countries and cultures. We know, for example, that the death rate among heroin users in many countries has increased with the advent of HIV and other infectious diseases. The ratio of treated to untreated heroin users can also be expected to vary between health care systems and over time with changes in drug price, and treatment availability, accessibility and attractiveness.

The multiplier based on mortality has been the most frequently used (Frischer, 1998). It has often produced estimates that have been consistent with estimates produced by other methods, such as, capture-recapture methods (Frischer, 1998; Hartnoll, 1997). Multiplier estimates have also been derived from treatment data using an estimate of the ratio of treated to untreated heroin users derived by nomination techniques in which heroin users report on the proportion of their heroin using friends who have been in treatment (Taylor, 1997).

2.3 CAPTURE-RECAPTURE METHODS

The simplest form of the capture-recapture method (CRM), the two sample model, has been used by a number of Australian research groups to estimate the number of dependent heroin users in Australia (e.g. Duque-Portugal et al, 1994; Kehoe et al, 1992). This method was developed in population biology where it has been used to estimate the numbers of fish and other animals in wild populations. It requires a minimum of two samples from the population of interest. Members of the first sample are returned to the wild after being "marked" in a way that permits those who are recaptured in a second sample to be identified. When applied to estimating dependent heroin users, the samples comprise two or more record sets (e.g. arrests or entry to treatment) and individuals' names (or some other unique identifier) are used to "mark" individuals.

The rationale of the two sample method is simple: given some key assumptions, the ratio of the original sample size (m) to the total population (N) will be the same as the ratio of the number of recaptured individuals (r) to the number in the second sample (s). i.e.

$$m/N = r/s.$$

Algebraic manipulation reveals that the total population N can be estimated by the formula:

$$N = s*m/r.$$

The method has two principal attractions: it has an explicit mathematical rationale; and it produces confidence intervals around the estimate that provide an indication of its imprecision. Its major disadvantage is that it only provides valid estimates when its underlying assumptions are correct. These are: that all members of the population have an

equal chance of being captured, that there are no new entrants or losses from the population in the time between the samples, and that the chances of being captured in the two samples are independent. Sandland (1984, 1986) has argued that these assumptions are almost always false when using the method to estimate the number of dependent heroin users. Moreover, the consequence of their violation is that estimates of the number of heroin users in the population are seriously biased (Hook and Regal, 1995; Domingo-Salvay, 1999).

In more recent applications of capture-recapture methods to estimating the number of problem drug users, the preferred approach has been to use three or more samples (Hook and Regal, 1995; Domingo-Salvay et al, 1998). This permits model assumptions of independence of samples to be tested and it provides estimates that allow for dependence between samples. There are also methods for assessing the extent of heterogeneity among users in risk of capture and recapture (Hook and Regal, 1995). However, these expanded methods require more data sources and confidentiality is an issue when linking different data sets using unique identifiers. The reliability of matching using only initials, sex and date of birth (often the only common identifiers across different sources) is uncertain and the reliability of the estimates is affected by the size of overlap between different sources. If this overlap is small, as it can be across multiple sources, then estimates can be quite variable, especially when allowance is made for errors in identifying overlap.

Sandland (1984, 1986) adopted a different technique for deriving prevalence estimates from multiple sample capture-recapture methods. This involved using repeated samples over a series of six month periods from the same source (in his case arrest data) to estimate the size of the heroin dependent population in New South Wales. These methods are more like those originally developed and applied in animal ecology (Richardson, 1997). They also have their limitations but a modified form of the repeated samples or multiple sample CRM is an improvement on the two sample CRM. It is still not the “gold standard” and so must be compared with estimates derived in other ways. In this report we use the procedures outlined by Sandland (1986) to produce two separate multiple sample CRM estimates of the number of heroin dependent individuals in NSW. The data used for these analyses were: a) data on arrests for heroin related offences during the four year period from 1995-1998 and; b) data on entry to MMT from July, 1997 to June, 1999.

2.4 MULTIVARIATE INDICATOR METHOD

A number of studies have applied multivariate statistical methods to indicator data to derive regression equations that relate the prevalence of heroin or other problem drug use in local areas to social, demographic and drug use indicators for each of the areas (EMCDDA, 1999a). The regression equation so derived is then used to estimate the prevalence of problem drug use in local areas where local estimates are not available. The method presupposes credible prevalence estimates in a number of local areas to derive the regression equation. The absence of such estimates in a number of different local areas in Australia precluded the use of this method in the current project.

2.5 BACK PROJECTION METHODS

The back-projection method has been widely used to estimate HIV incidence from AIDS incidence data (see De Angelis et al, 1998 (with discussion)). The method uses the number of cases diagnosed in the present to estimate the number of incident cases in the past. This requires assumptions about the time between infection and development of AIDS to produce by back-projections or back-calculations estimates of the number of incident cases (e.g. Becker et al, 1993).

The low prevalence of HIV in Australian injecting drug users (NCECHR, 1998) makes this approach of limited value. However, the method can be applied to other indicators of heroin dependence, such as, the observed numbers of opioid overdose deaths and new entrants to methadone treatment, to estimate the past incidence of heroin dependence. Its application to these data requires that assumptions are made about the rate of progression from heroin dependence to fatal overdose and methadone treatment entry. By making assumptions about the rate of exit from heroin dependence, the population prevalence of heroin dependence in any one year can be estimated from incidence data.

3. PREVIOUS ESTIMATES OF THE NUMBER OF AUSTRALIAN HEROIN USERS

3.1 CAPTURE-RECAPTURE ESTIMATES

Sandland (1986) applied refined capture-recapture methods to NSW records of arrest for drug offences between 1979 and 1984. He estimated that there was a large increase in the number of dependent heroin users in NSW over this period from less than 3,000 in 1979 to over 10,000 in 1984.

Larson and Bammer (1996) used multiple capture-recapture methods to estimate the numbers of heroin dependent individuals in the Australian Capital Territory in 1989. They used information from methadone treatment services, other drug treatment agencies and arrest data. They estimated that there were between 890 and 1229 dependent heroin users in the ACT in 1989.

Two independent two-sample capture recapture studies were conducted in the early 1990s to estimate the number of dependent heroin users in Sydney (Duque-Portugal et al, 1994; Kehoe et al, 1992). Kehoe et al used two consecutive years of case records from a drug counselling service, a methadone treatment program and an HIV testing service in an area of Sydney that was known to have a high prevalence of heroin use (Eastern Sydney). Concerns about patient confidentiality prevented linkage of records from the different services so Kehoe et al looked at the overlap between samples from each service over two consecutive years. Kehoe et al estimated that there were approximately 3000 heroin dependent persons in Eastern Sydney and 15,000 in New South Wales in 1988-1989. Duque-Portugal et al (1994) used the overlap between samples in two consecutive surveys of injecting drug users in Sydney to estimate the prevalence of injecting drug use and heroin dependence in Sydney in 1990. They estimated that there were 3000 heroin dependent persons in Eastern Sydney, the same geographic area as Kehoe et al.

3.2 AVERAGED MULTIPLE ESTIMATES

Because no single method of estimation is satisfactory one approach has been to estimate the number of heroin users in Australia using multiple methods to converge upon a credible range of estimates. A series of estimates of the number of heroin users in the Australian population were produced in 1988 by the National Drug Abuse Data System (NDADS) to provide a range of estimates of the number of heroin users in Australia in the middle 1980s. The way in which these were derived is described in detail in Appendix A.

The estimate was derived was the median of 4 multipliers applied to: a state-based capture-recapture estimate from 1984; the number of opiate overdose deaths in Australia number of heroin users in Australia in 1986; household survey estimates in 1988 of the percentage of the population that had injected a drug in the past year, and the number of persons in methadone treatment in 1987. The median estimate was 34,000 opioid dependent persons.

The 1988 NDADS estimates were updated by Hall (1995) using data gathered between 1988

and 1993 (see Appendix A). This was derived by taking the median of multiple estimates derived in the same way from data collected in the period 1988-1992. These included multiples of: a capture-recapture estimate in NSW in 1988-89; the number of opiate-related deaths in Australia in 1992; a household survey estimate of the percentage of the population that had used heroin in the past year; and the number of persons in methadone treatment in 1991. The median estimated number of dependent heroin users was 59,000.

Population rates of opiate dependence were estimated to take account of changes in the size and composition of the Australian population between the mid 1980s and the early 1990s. These calculations suggest that the estimated prevalence of regular heroin users (per 1,000 of population) had increased from 4.5 in 1986 to 7.2 in 1990. This increase was statistically significant.

3.3 CONSENSUS OR DELPHI ESTIMATES

Recently a consensus estimate of the number of injecting drug users in Australia was produced in a study to produce projections of hepatitis C infections in Australia (Hepatitis C Virus Projections Working Group, 1998). A group of nominated experts in the epidemiology of injecting drug use was surveyed as to their best estimates of the number of injecting drug users and key variables that affect the prevalence of injecting drug use, such as, rates of recruitment to injecting drug use, rates of transition from occasional to regular drug use, and rates of exit from regular injecting drug use. The results of this first estimates were summarised and given to the experts who were asked to revise their estimates. The best estimate of the number of regular injecting drug users in Australia in 1997 produced by this method was 100,000, with a range between 80,000 and 120,000. This estimate included not only heroin injectors but also regular injectors of other drugs, such as, amphetamines and cocaine.

4. AIMS OF THE CURRENT STUDY

The current study aimed to provide updated and improved estimates of the number of heroin dependent adults in Australia. As in previous attempts, we did not rely upon a single method but looked for a convergence of estimates produced by a number of different methods of estimation that were, perhaps optimistically, of independent imperfection (Campbell, 1969) and which were applied to a number of different indicators of dependent heroin use.

The report relies largely upon data on trends in various indicators of heroin dependence and its health consequences collected in the state of New South Wales (NSW). This is the Australian state that has historically accounted for half of the national number of opioid overdose deaths (Lynskey and Hall, 1998). It has also accounted for over half of the individuals enrolled in methadone maintenance treatment (MMT) for opioid dependence (Hall, 1996). We used national data on deaths attributed to opioid dependence because fatal overdoses are relatively rare events.

These data were used to estimate trends in the underlying numbers of heroin dependent individuals in NSW and Australia. Our intention is to apply the methods developed in New South Wales to data collected in other jurisdictions and then to aggregate estimates from each jurisdiction to validate the approximate estimate of the total number of heroin dependent individuals in Australia provided in this report. These approximate estimates of the number of opioid dependent persons in Australia were obtained by multiplying the NSW estimates by 2 to produce a national estimate. The best national estimate of the number of heroin dependent Australians is then divided between the different jurisdictions in proportion to the contribution that each made to national opioid overdose deaths between 1994 and 1998.

The project aims were:

1. To use indicator data to assess *trends* in dependent heroin use and its health and social consequences in New South Wales (and where possible, Australia) over the past decade.
2. To estimate trends in the *number* of dependent heroin users in New South Wales (and where possible Australia) over the past decade.
3. To use these estimates to provide provisional estimates of the number of heroin dependent persons in each of the other jurisdictions.
4. To compare the estimated population prevalence in Australia with that in comparable European societies

5 METHOD

The data sources that were used to examine trends in heroin use and the prevalence of heroin dependence in NSW and where possible, Australia included:

- (1) national data on the number of fatal opioid overdose per year compiled by the Australian Bureau of Statistics;
- (2) the NSW Health Department's methadone client database provided by the Pharmaceutical Services Branch (PSB);
- (3) data on arrests for drug offences provided by the NSW Police Service;
- (4) data on ambulance attendances at suspected drug overdoses provided by the NSW ambulance service;
- (5) data provided by the Alcohol and Drug Information Service (ADIS) on calls received related to heroin use;
- (6) needle and syringe program (NSP) data from the AIDS and Infectious Diseases Unit at NSW Health on the numbers of needles and syringes distributed per year.

The first three databases contained information that permitted unique individuals to be identified. The remaining databases that did not contain unique individual identifiers were only used to assess trends in heroin use; those with unique identifiers were used to derive estimates of the number of dependent heroin users. A description of the databases used and the analyses conducted on each of these databases is provided below.

5.1. OPIOID OVERDOSE DATA

Data were obtained from the Australian Bureau of Statistics (ABS) on gender and age at death for fatal opioid overdoses among Australian adults aged 15-44 years, between 1964 and 1998 inclusive. Data were also obtained from the ABS on the number of adults in the Australian population in each age group. The age range was selected on the basis of previous analyses of illicit drug mortality (English et al, 1995) and trends in opioid overdose deaths in Australia (Hall & Darke, 1998), which suggest that most heroin use and opioid overdose deaths occur among adults in these age groups. Population estimates were obtained from the ABS estimates of the resident population in the mid point of each calendar year.

Between 1964 and 1967 opioid overdose deaths were defined as deaths due to opioid dependence (ICD-7 code 323) and accidental opioid poisoning (ICD-7 codes E870, E872). Between 1968 and 1978 ICD-8 codes for opioid dependence (304.0) and opioid poisoning (E853.0, E853.1) were used. Between 1979 and 1997 opioid overdose deaths were defined as deaths due to opioid dependence (included in ICD-9 codes E850.0, E850.1). Deaths in which opiates were used to commit suicide were not included.

It would have been desirable to analyse data on heroin overdose deaths but the ABS codes do not distinguish between licit and illicit opioid overdose deaths. They also do not distinguish between deaths in which opiates were the primary cause or a contributory cause when taken together with non-opiate CNS depressant drugs, such as, alcohol and

benzodiazepines. Other Australian studies indicate that most opioid overdose deaths that do not involve heroin (e.g. methadone syrup and physeptone) occur in persons with a history of heroin dependence (Sunjic, Zador & Basili, 1998).

5.1.1 AGE-PERIOD-COHORT ANALYSIS

The overdose rate per million Australian adults aged 15 to 44 years from 1964 to 1997 was examined, as was the proportion of all deaths that were caused by overdose. Opioid overdose mortality rates were estimated for each year between 1964 and 1997 for males in each of three age groups: 15-24 years; 25-34 years, and 35-44 years. Cumulative proportional overdose mortality was estimated for each of eight five-year birth cohorts born between 1940 and 1979 (1940-44, 1945-49, 1950-54, 1955-59, 1960-64, 1965-69, 1970-74, 1975-79). An age-period-cohort analysis (Kupper et al, 1985), using Poisson Regression (as implemented in the STATA package) (Stata Statistical Software, 1997), was used to examine trends over time in rates of opioid overdose mortality. Cumulative rates of opioid overdose mortality were plotted by age at death for males in each birth cohort to illustrate cohort trends in the rates of this cause of death. The analysis was restricted to males since they accounted for 80% of overdose deaths over the whole study period. These analyses have been published in greater detail elsewhere (Hall et al, 1999a).

5.1.2 BACK PROJECTION ESTIMATES

The number of opioid overdose deaths in Australia for each year between 1964 and 1997 was also used to estimate the number of dependent heroin users in Australia by the back-projection method. Estimates for New South Wales were derived by multiplying the national estimates by the proportion of fatal overdoses that occurred in NSW between 1994 and 1998.

This method used the observed number of overdose deaths to estimate the number of people who became dependent in any year. It used an estimate of the rate at which people progress from becoming dependent on heroin to dying from an opioid overdose. The method has been used most widely to estimate HIV incidence from AIDS incidence data (see De Angelis, Gilks & Day, 1998 with discussion). The method of back-projection used in the report was that suggested by Becker, Watson and Carlin (1991) because it has the advantage that it does not require strong parametric assumptions about the shape of the progression distribution from heroin dependence to fatal overdose; it only assumes that this pattern follows a smooth curve. The analysis assumed that there were negligible numbers of dependent heroin users prior to 1960, an assumption supported by analyses of opioid overdose deaths (Hall et al, 1999a) and historical analyses of illicit drug use in Australia (Manderson, 1993; McCoy, 1980).

Darke & Zador (1996) identified several longitudinal studies on mortality among dependent opiate users (Bucknall & Robertson, 1986; Haastrup & Jepson, 1988; Joe, Lehman & Simpson, 1982; Joe & Simpson, 1987; Oppenheimer et al.,1994; Segest, Mygind & Bay, 1990; Vaillant, 1973). These studies included a total of 4,760 subjects and 26,830 person years of

observation. Based on an examination of these studies it was estimated that the annual rate of opioid overdose deaths is 0.8%. This estimate is derived by dividing the total number of opiate-related deaths reported in the studies by the total number of person years involved. For the purposes of the back projection estimates it was assumed that this rate applied to a population of dependent heroin users in which 5% of dependent heroin users stopped using heroin each year (English et al., 1995; Thorley, 1981).

An upper limit on the overdose mortality rate among people commencing dependent heroin use was obtained by taking an annual rate of opioid overdose deaths of 0.6% combined with a 3% annual rate of dependent heroin users ceasing use. A lower limit was obtained by combining a 1.0% annual rate of opioid overdose deaths with a 7% annual rate of dependent users ceasing use. The resulting overall rates of progression from commencing dependent heroin injecting to overdose deaths are shown in Appendix B (Figure B1). These rates of overdose deaths were assumed to be constant throughout the period 1960 to 1997.

5.1.3 MULTIPLIER ESTIMATES

Simple multiplier estimates of the number of dependent heroin users were produced using the number of opioid overdoses recorded in NSW and Australia during 1998. The multiplier used were 120 (based on the annual opioid overdose rate of 0.8%, discussed above) and the commonly used multiplier of 100 (Frischer, 1999; Larson, 1992).

5.2. METHADONE MAINTENANCE DATABASE

NDARC was given access to a subset of the methadone database maintained by the Pharmaceutical Services Branch (PSB) of the New South Wales Health Department for the period 1970 to September 1999. The PSB database is used by the NSW Health Department to monitor dispensing of methadone in New South Wales. The data it contains are derived from forms that are completed: when a medical practitioner applies for an authority to prescribe methadone to a client, when a course of methadone maintenance is terminated, or when a client is transferred to another program. All records were de-identified by the PSB to maintain client confidentiality. Individuals were uniquely identified by an arbitrary number assigned by the PSB. The variables used were: date of birth, sex, the date that the PSB file was first opened and the date of treatment entry/exit. As a computerised database was only established in 1985/86, clients entering methadone maintenance treatment (MMT) before 1987 did not have treatment details recorded beyond age, sex and the date on which their file was first opened.

5.2.1 POPULATION RATES

The rate of new entrants to MMT was examined for the period 1970 to 1997. Due to the limited treatment details pre-1987, this examination was based on the date on which the client's file first opened. Trends in the total number of clients in treatment on 30 June, mean age and gender of clients were also examined.

5.2.2 BIRTH COHORT TRENDS

The rate of entry to MMT per 100,000 Australian adults aged 16-44 years from 1970 to 1998 was examined. MMT entry rates were estimated for each year between 1970 and 1998 for three age groups: 16-24 years, 25-34 years and 35-44 years. Estimates were also made of the cumulative proportion of each of eight five-year cohorts born between 1940 and 1979 (1940-44, 1945-49, 1950-54, 1955-59, 1960-64, 1965-69, 1970-74, 1975-79) who entered MMT. As with the opioid overdose data, an age-period-cohort analysis, using Poisson Regression (as implemented in the STATA package) (Stata Statistical Software, 1997) was used to examine birth cohort and time trends in rates of entry to MMT. Cumulative rates of entry to MMT were plotted by age on entry for individuals in each cohort to illustrate birth cohort trends.

5.2.3 CAPTURE-RECAPTURE ESTIMATES

Using the methods of Sandland (1984; 1986) the MMT data for the period from July, 1997 to June, 1999 was recoded to create four summary variables. These variables represented: a) whether the individual had entered MMT during the six month period from 1st July to 31st December, 1997; b) whether the individual had entered MMT during the six month period from 1st January to 31st June, 1998; c) whether the individual had entered MMT during the six month period from 1st July to 31st December, 1998 and; d) whether the individual had entered MMT during the six month period from 1st January to 31st June, 1998. Following recommendations of Maxwell (1999), these data referred only to whether the person had entered a program. People who entered MMT at the start of the program and remained in the MMT program throughout the four six-month periods of the study would be coded as 1 0 0 0.

For the period of the study there were $2^4 = 16$ possible patterns of entry to MMT ranging from those who had entered MMT in each of the four six-month periods to those who had not entered MMT in any study period but were heroin dependent and therefore eligible for entry to MMT. The frequency of 15 of the 16 patterns can be obtained from the existing data; the capture-recapture analysis estimates the size of the sixteenth (hidden) population.

5.2.4 BACK PROJECTION ESTIMATES

The number of new entrants to MMT in NSW for each year during 1970 to 1998 was also used to estimate the number of dependent heroin users in NSW and Australia using the back-projection method (described earlier). The number of new entrants to MMT was used to estimate the number of people who became dependent in any year. The method used estimates of the rate at which people progress from developing heroin dependence to entering MMT. As with the analysis of opioid overdose fatalities, we assumed that there were negligible numbers of dependent heroin users before 1960.

It was assumed that 50% of dependent heroin users who were still using heroin after 6 years of dependent heroin use would have entered MMT at some time in 6 years. It was assumed

that 80% of persons who had been heroin dependent for 15 years would have entered MMT at some time in that period. These assumptions are consistent with data from a recent survey of Sydney heroin users (Weatherburn, Lind & Forsyth, 1999). They were also consistent with data on mean age at entry to methadone treatment, self-reported data from needle and syringe exchange attendees (MacDonald M, NCHECR Sydney, personal communication 1999), and self-reported data from injectors surveyed in the Australian Study of HIV and Injecting Drug Use (Loxley, Carruthers & Bevan, 1995).

Upper and lower limits of rate of entry to methadone were specified as follows. It was assumed that 50% of heroin users entered MMT by 4 years and 8 years respectively, and that 90% and 70% respectively had entered MMT by 15 years. The final progression rate distribution, and upper and lower limits, were modelled using a log-logistic distribution, assuming that 5% (upper and lower limits of 7% and 3%) of dependent heroin users ceased heroin use each year and the rate at which they did so was independent of whether or not they entered methadone treatment (Appendix B, Figure B2). The latter assumption is supported by evidence that long term abstinence rates in treated heroin users are the same whether they entered abstinence-oriented drug treatment or methadone maintenance treatment (Maddux & Desmond, 1992). The rates of progression from dependent heroin use to entry to methadone treatment were assumed constant throughout the period 1960 to 1997.

5.2.5 MULTIPLIER ESTIMATES

The number of dependent heroin users in MMT in NSW were also used to generate multiplier estimates of the number of heroin dependent people in NSW on 30 June 1998. The multiplier used was 3 (Hall, 1995) rather than the 6 and 10 multiples derived in London in the early 1980s (Hartnoll et al, 1985).

5.3 DATA ON SUSPECTED OVERDOSES FROM THE AMBULANCE SERVICE OF NSW

The Ambulance Service of NSW provided data on cases where an ambulance attended a person with whom the poisonings protocol was used and naloxone administered. Information on the date of each ambulance attendance was provided for the period from the 1st July 1997, to the 30th June 1999. The postcode of the area where the ambulance was called was recorded for each attendance. In the absence of unique individual identifiers it was not possible to determine the number of individuals who were attended by the ambulance service.

For some cases, the gender and age of the attendee was recorded. These were used to calculate estimates of the sex and age distribution of cases. Unfortunately, these estimates are approximate because in 54.5% of cases age was not recorded and in 50.2% of cases gender was not recorded.

5.3.1 TRENDS IN THE NUMBER OF AMBULANCE ATTENDANCES

A plot of the number of ambulance attendances by month was calculated for the study period. Because of the limited period over which data were available a formal time series analysis was not attempted.

5.3.2 MULTIPLIER ESTIMATES

The ambulance data was also used in conjunction with data from other sources to produce multiplier estimates of the number of heroin users in NSW. Two studies conducted at NDARC within the period covered by the ambulance data asked current heroin users when they had last been administered naloxone by ambulance officers to treat a heroin overdose. In the first study, conducted in 1998, the sample comprised 174 IDU who had injected heroin in the preceding six months on a median of 128 days (Darke & Ross, 1999). Participants were recruited from all regions of Sydney. Naloxone was reported to have been administered to 12.1% of the sample in the preceding six months. The Illicit Drug Reporting System (IDRS) IDU survey (conducted in 1999) involved 155 IDU who had injected heroin in the six months prior to interview on a mean of 142 days (McKetin et al, 1999). Participants were recruited from the key drug market areas of Sydney, namely Cabramatta and Kings Cross. Naloxone was reported to have been administered to 10.2% of the sample in the preceding six months. Using these proportions, estimates were made of the number of heroin users during 1998/1999 from ambulance data for this period.

5.4 ARREST DATA FROM THE NSW POLICE SERVICE

Data were obtained from the NSW police service on all heroin-related arrests in NSW for the period 1995 to 1998. These offences included: possession of drug/plant, use or administration of a drug, possession of a drug utensil, other drug detection, supply of drug/plant, and importing a drug/plant. Each record in the database represents a new offence and an individual may be charged with several offences from one incident. Similarly, several people may be charged for the same incident. All records were de-identified by the police department, but each arrestee had a number that uniquely identified him or her which enabled the number of different charges per individual to be determined. The main variables of interest in the database were: type of offence, date of offence, and age and gender of the offender. For 22% of individuals the year of birth was unknown, preventing their age from being determined. Seventeen percent of individuals had no year of birth recorded, and a further 5% had more than one year of birth recorded.

5.4.1 TRENDS IN THE NUMBER OF ARRESTS

The number of new offenders, number of offences and type of offences were plotted by year (1995 to 1998). During the study period there was a marked increase in arrest rate following a period of falling arrests that is likely to be due to restructuring of the NSW police

service following the Wood Royal Commission into police corruption. This restructuring particularly involved local command centres in Sydney's key drug market areas. For this reason no formal time series analysis was done.

5.4.2 CAPTURE RECAPTURE ESTIMATES

This data was also used as the basis for a capture recapture study using similar methods to those outlined above (see section 5.2.3) for the MMT data. The data on arrests for heroin related offences during the years 1995-1998 were recoded to form four summary variables. These variables represented whether or not the individual had been arrested in each of the four one-year periods. Cross-tabulations of these four variables therefore created 16 profiles ranging from those who had been arrested in each of the four year periods to those who had not been estimated during the four years of the study. The purpose of the capture-recapture study was therefore to estimate the size of this hidden population.

5.4.3 MULTIPLIER ESTIMATES

Arrest data was used in conjunction with other data to provide multiplier estimates of the number of heroin users in NSW. In the IDRS IDU survey (conducted in 1999), 21.9% (34/155) of the heroin users interviewed reported that they had been arrested in the previous 12 months for use/possession or dealing/trafficking (McKetin et al, 1999). The number of individuals recorded in the police database for heroin offences in 1998 was then used to estimate the number of heroin users in NSW. This probably generated an underestimate as the IDRS figure would have included arrests for drug offences other than heroin, such as, the much more common offences of possessing and using cannabis.

5.5 ADIS CALL SHEET DATA

The Alcohol and Drug Information Service (ADIS) is a 24 hour telephone information and counselling service. Its staff complete a 'call register form' for each call that their service receives. ADIS provided a copy of the data on all heroin-related calls received from January 1992 to November 1999 inclusive. There were no unique identifiers so the same person may have called several times but this was true across all years. Callers making enquiries on their own behalf could be distinguished from those who were (or said that they were) calling on behalf of another person.

In order to examine the trend across time in the number of calls received by ADIS, the overall number of heroin-related calls received, and the number of calls made by heroin users, was plotted by year (1992 to 1998).

5.6 NEEDLE AND SYRINGE DATA

The AIDS and Infectious Diseases Unit of NSW Health provided data on the number of needles and syringes supplied to injecting drug users from July 1994 to June 1998. The number of needles and syringes dispensed by public needle and syringe programs (NSP) and through the Pharmacy Fitpack Scheme provides an indication of trends in injecting drug use. These data were plotted and the trend examined.

5.7 HIV AND HEPATITIS C DATA

Data on the point prevalence of HIV and Hepatitis C (HCV) among IDU has been collected by a selected number of NSPs across Australia since 1995. The NSP survey runs for one week each year, during which time all clients attending the NSP are asked to complete a self-administered questionnaire and provide a finger-prick blood sample for HIV and HCV antibody testing (MacDonald et al, 2000). Prevalence data from these surveys are reported in the Annual Surveillance Report of the National Centre in HIV Epidemiology and Clinical Research (NCHECR, 1999), as are the number of HIV and HCV notifications recorded each year by the National Notifiable Diseases System. The NCHECR also publish a quarterly report in which the cumulative number of new HIV diagnoses to date are recorded by exposure category. The HIV and HCV prevalence data were used to derive multiplier estimates of the number of IDUs in NSW.

5.8 PRISON DATA

The NSW Department of Corrective Services conducts an inmate census on the 30 June each year, as part of the National Australian Prison Census. This provides data on the number of persons incarcerated on a single day; it does not indicate how many prisoners pass through the system each year. Dolan (1997) indicates that in 1993 there were approximately 6,000 inmates in NSW prisons on census day and a total of 14,000 individuals who had been in prison during that year. This means that the census day population only represented approximately 43% of the total number of inmates for that year.

Based on the prevalence of HIV, HBV and HCV in NSW prisons and the community, Dolan and Crofts (2000) estimate that between 50 and 62% of the prison population are IDUs. The most useful estimate is that based on HCV (59%) since 80% of all HCV cases are thought to be the result of injecting drug use (Lowe & Cotton, 1999). The number of IDUs who were imprisoned in a year can be estimated by assuming that the number of inmates in the 1997 NSW prison census represents 43% of the annual throughput and that 50-62% of prisoners are IDUs. A study conducted by Darke et al (2000) found that 19.4% of the 144 heroin users who were interviewed reported that they had been imprisoned in the 12 months preceding interview. This was used to estimate the number of dependent heroin users in NSW.

5.9 IDRS DATA

Since 1996 annual IDU surveys and key informant interviews have been conducted in NSW as part of the IDRS, with the aim of monitoring drug trends (Hando, Darke, O'Brien, Maher & Hall, 1997; Hando, Darke, Degenhardt, Cormack & Rumbold, 1998; McKetin, Darke, Hayes & Rumbold, 1999; McKetin, Darke & Kaye, 2000). The IDRS is funded by the Commonwealth Department of Health and Aged Care, and is coordinated by NDARC.

The reports generated by the IDRS were examined for the proportion of IDUs reporting having injected heroin, having done so in the preceding six months, and the frequency of heroin use. Findings from the key informant interviews were also examined. As described above, IDRS data from the 1999 IDU survey was also used in conjunction with ambulance and arrest data to generate multiplier estimates of the number of heroin users in NSW.

5.10 JUVENILE JUSTICE DATA

In 1994 and 1999 a survey of alcohol and other drug use was conducted among young people detained in NSW juvenile justice centres (Hando, Howard & Zibert, 1997; Copeland, Howard, Keogh, & Seidler, 1999). The proportion that reported having used opioids was compared across the surveys.

6.0 RESULTS

6.1 TRENDS IN USE

6.1.1 TRENDS IN OPIOID OVERDOSE DEATHS 1964-1997

The number of deaths attributed to opioid overdose among Australian adults aged 15-44 years increased from 6 in 1964 to 600 in 1997. The rate (per million adults aged 15 to 44 years) increased 56-fold from approximately 1.3 in 1964 to 71.5 in 1997 (95% CI: 24.9, 124.5) (Figure 2). The proportion of all deaths among adults aged 15 to 44 years attributed to opioid overdose increased 90-fold from 0.08% in 1964 to 7.26% in 1997 (95%CI: 40.1, 200.5) (Figure 3). There has been a substantial increase in opioid overdose deaths between 1964 and 1997, whether this is assessed by rate per million of population at risk, or as the proportion of all deaths in the 15 to 44 year age group attributed to opioid overdose.

FIGURE 2: OVERDOSE DEATH RATE PER MILLION ADULTS AGED 15 TO 44 YEARS FROM 1964 TO 1997

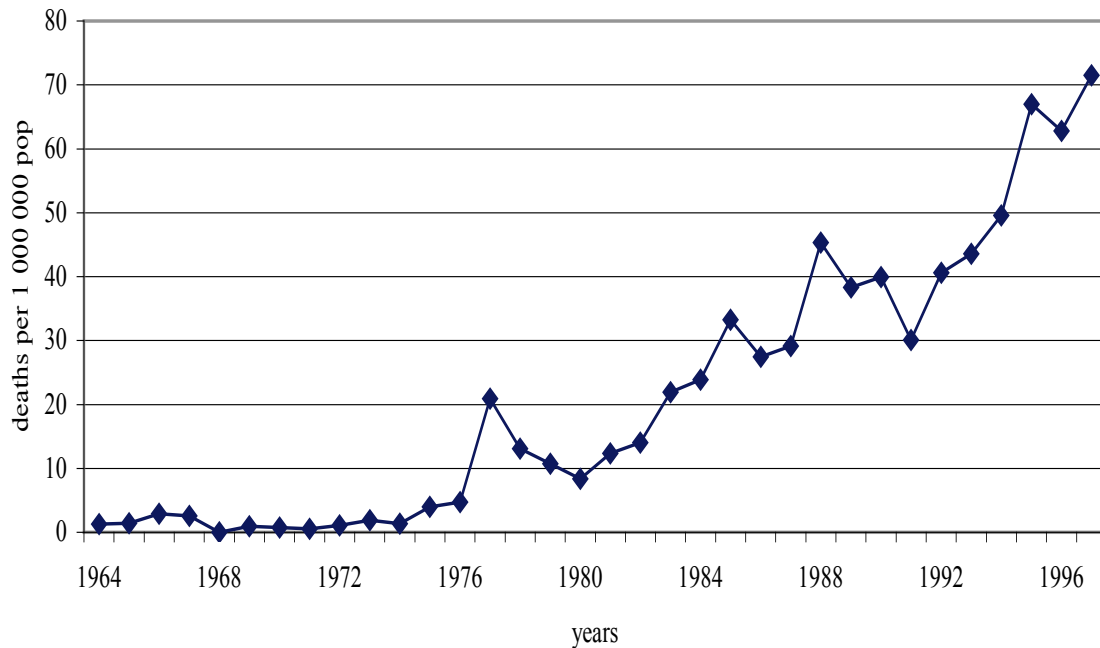
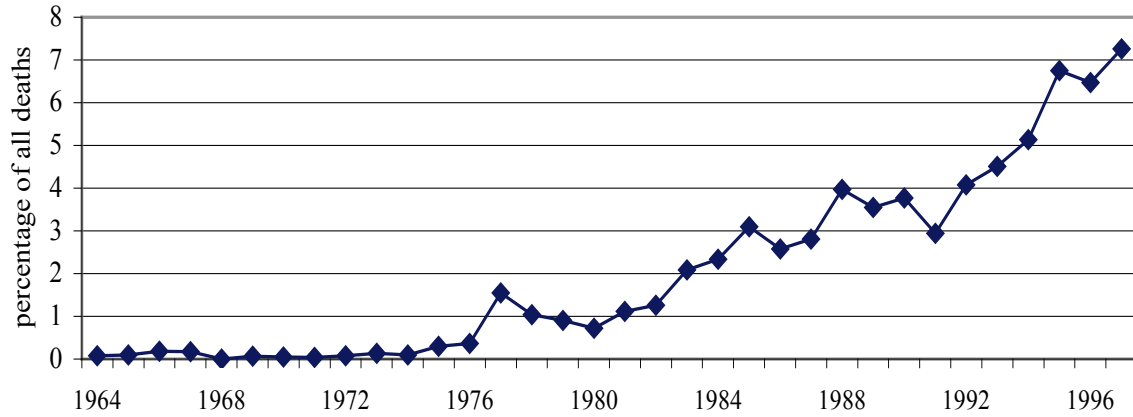


FIGURE 3: PROPORTION OF ALL DEATHS DUE TO OVERDOSE AMONG ADULTS AGED 15 TO 44 YEARS FROM 1964 TO 1997



In 1997 opioid overdose accounted for 80% of all deaths attributed to illicit drugs in Australians aged 15-44 years (Hall et al, 1999a). Opioid overdose deaths represented 60% as many deaths as were attributed to alcohol in this age group. It contributed 27% of all deaths attributed to alcohol, tobacco and illicit drugs among young Australians in this age group.

Data presented in Figures 4 and 5 suggests that 1969 was the year in which illicit opioid overdose deaths began to overtake overdose deaths from iatrogenic opioid dependence. Although the number of deaths was small, in this year there was an abrupt change in the proportion of deaths that were male (Figure 4) and in the average age at death (Figure 5). Iatrogenic opioid dependence has primarily been found among middle aged and older females who become dependent on opioids as a result of their use for chronic pain (Ball, 1970; Courtwright, 1982). Illicit opioid dependence, by contrast, has primarily been found among younger, anti-social males who initiate use in the late teens and begin to die of overdoses in their 20s (Courtwright, 1982).

Figures 4 and 5 show that between 1964 and 1967 the proportion of deaths involving males was less than 50% and the average age at death (for adults aged 15-44 years) was between 35 and 40 years. In 1969 the average age at death dropped dramatically to the mid 20s (with some instability because of the small number of deaths involved in the late 1960s). Thereafter, the average age at death steadily increased. In 1969 the proportion of deaths involving males also began to increase, reaching almost 80% in 1976 where it has remained throughout the study period.

FIGURE 4: PROPORTION OF OPIOID OVERDOSE DEATHS IN 15-44 YEAR OLDS OCCURRING AMONG MALES, 1964-1997

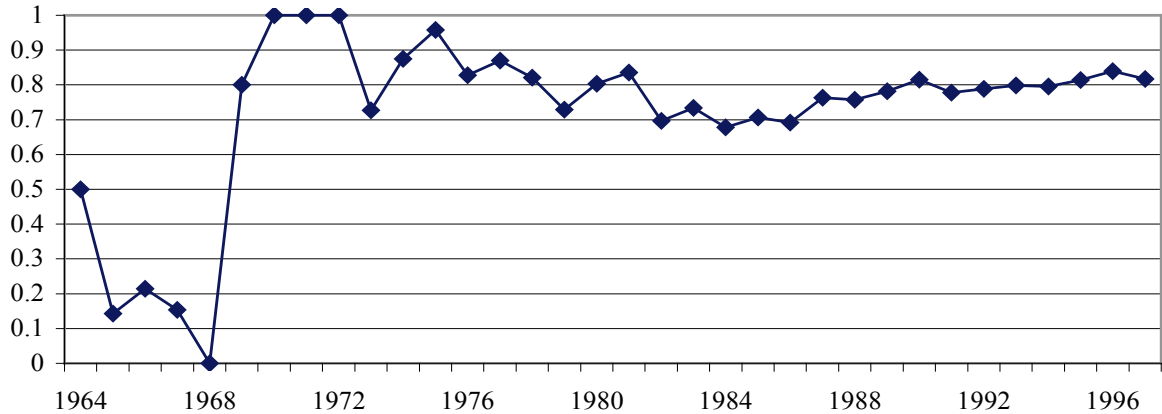
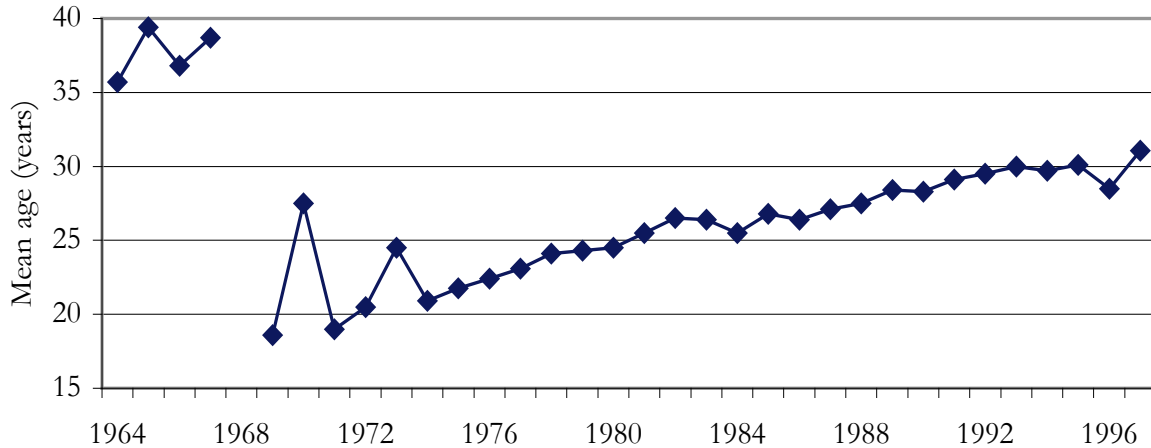
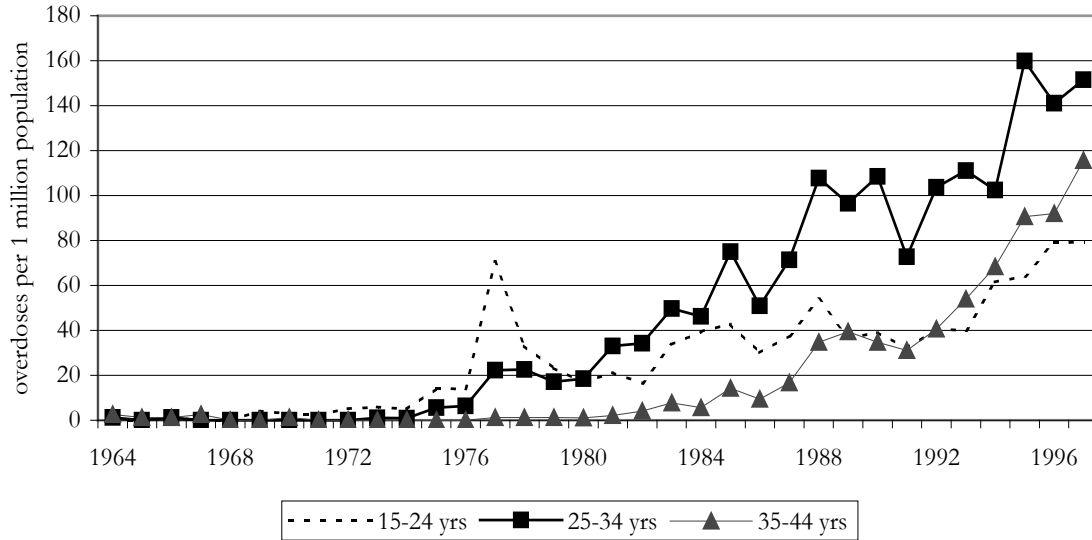


FIGURE 5: AVERAGE AGE OF OPIOID OVERDOSE DEATHS AMONG PERSONS 15-44 YEARS, 1964 TO 1997



The increase in the rate of opioid overdose death in the 15 to 44 year age group masks some interesting differences in rates between the 15 to 24, 25 to 34 and 35 to 44 year age groups (Figure 6). Only rates for males are discussed because males accounted for 80% of deaths and female rates are unstable because of the small number of female deaths for much of the 1964 to 1997 period. All three age groups have shown an increase over the study period in the rate of opioid overdose deaths but the largest increase has been among persons aged 25 to 34 years, followed by persons aged 35 to 44 years. Earlier analyses indicated that this reflected opioid overdose deaths occurring among an aging cohort of heroin users who initiated their heroin use in the late 1970s and early 1980s (Hall and Darke, 1998).

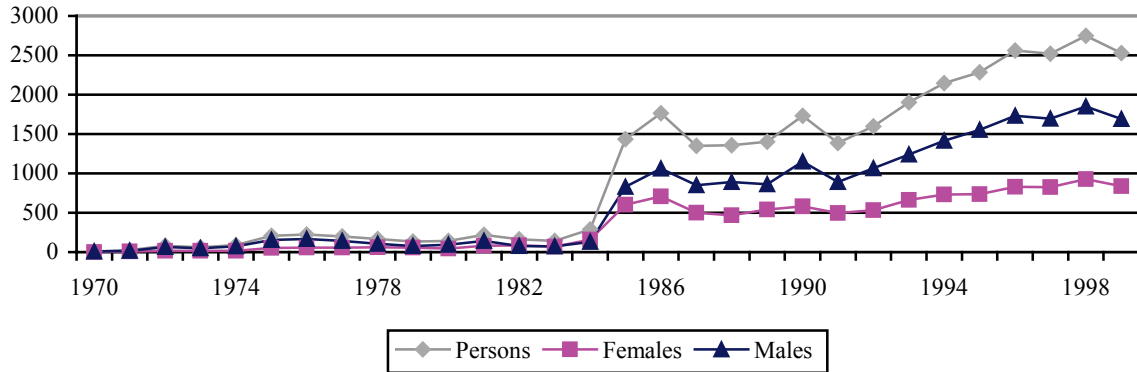
FIGURE 6: OVERDOSE RATE PER MILLION MALES AGED 15-24, 25-34 AND 35-44 YEARS, 1964 TO 1997



6.1.2 FIRST TIME ENTRANTS TO MMT

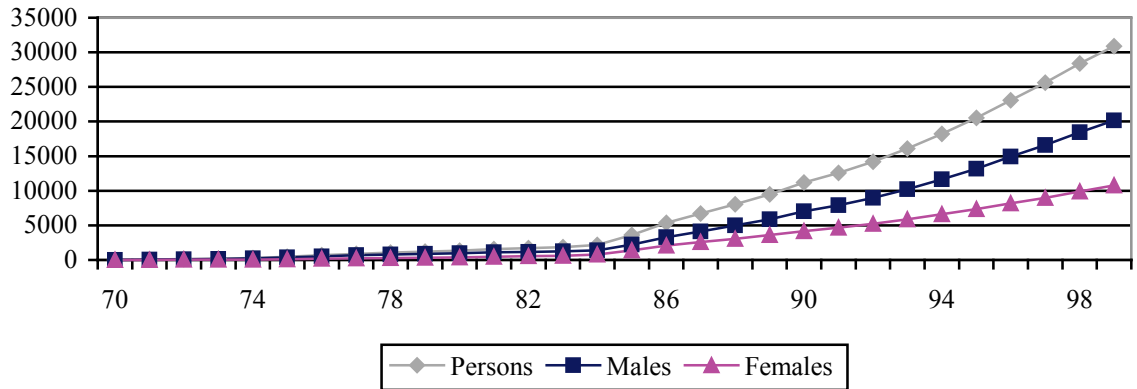
The number of people entering MMT for the first time increased from 10 in 1970 to 290 in 1984 (Figure 7). With the expansion of methadone maintenance services in 1985 there was a dramatic increase in the number of new MMT clients (1434 in 1985). The number of new entries to MMT then remained relatively stable until 1991, after which the numbers increased steadily with each year, reaching a peak of 2776 new clients in 1998. Figure 8 shows the cumulative number of people entering MMT for the first time. It highlights the dramatic increase in the number of new MMT clients since 1985. Approximately two thirds of new entrants to MMT since the mid 1970s have been male (Figures 7 & 8). As full treatment details are not available pre 1986/87, these figures are based on the date on which client files were first opened.

FIGURE 7: NUMBER OF CLIENTS ENTERING METHADONE MAINTENANCE TREATMENT BY YEAR (1970 - SEPTEMBER 30 1999)



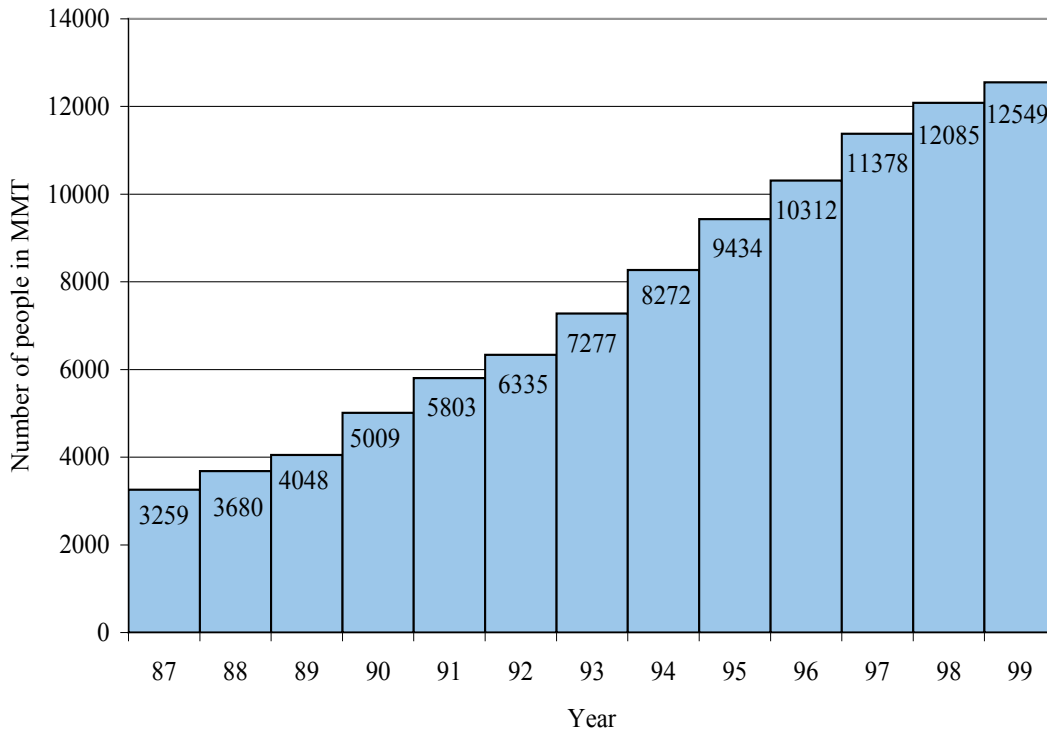
NB: At the time that these analyses were conducted complete data for 1999 was not yet available. The 1999 figures have been extrapolated from incomplete data for that year (1 Jan to 30 September 1999).

FIGURE 8: CUMULATIVE NUMBER OF PEOPLE ENTERING METHADONE MAINTENANCE TREATMENT BY YEAR (1970 – SEPTEMBER 30 1999)



The increase in the number of new recruits to MMT in NSW over the past 13 years is also reflected in the number of clients enrolled in MMT at a census date of 30 June. This number has increased yearly from 3,259 in 1987 to 12,549 in 1999 (Figure 9).

FIGURE 9: NUMBER OF METHADONE CLIENTS IN NSW ON 30 JUNE BY YEAR, 1987-1999

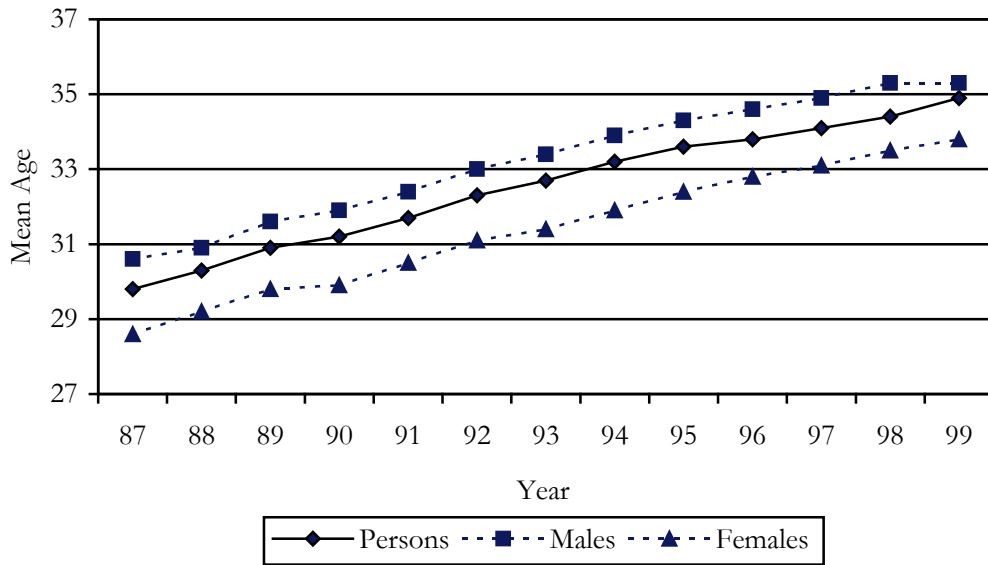


NB: 137 individuals have missing data for year the file first opened

Because of the expansion of methadone services in 1985 it is difficult to determine how much of the increase in the number of MMT clients reflects an increase in the number of dependent heroin users over time. An examination of the mean age of clients, however, is supportive of an underlying increase in the number of heroin users.

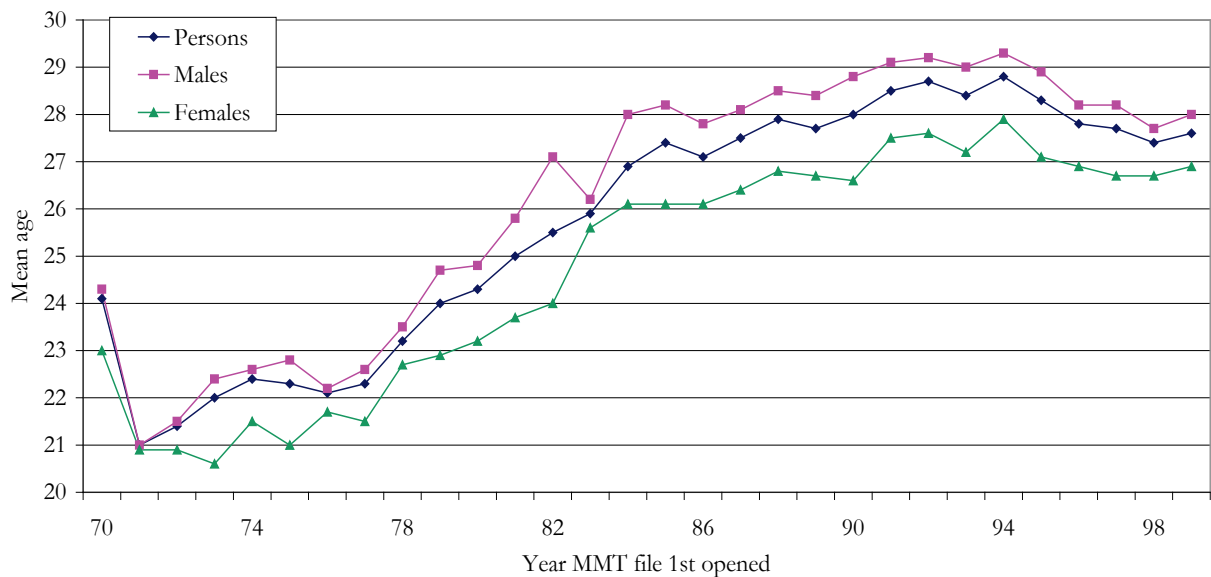
Figure 10 indicates that the mean age of clients engaged in MMT on census day has increased from 29.8 years in 1987 to 34.8 years in 1999. The mean age of male clients was consistently higher than that of female clients throughout this period. On 30 June 1999 the mean age of male clients was 1.5 years greater than that of female clients (35.3 v 33.8 years, $t_{12,547} = -10.1, p < .001$). While the average age of methadone clients has increased across the years, it is noteworthy that the mean age has not increased by a year per year (as would be necessary if there had been no new recruits to heroin use). Rather the increase has been more typically 6 months or less, which is consistent with continuing recruitment to heroin use over the past 13 years.

FIGURE 10: MEAN AGE OF PERSONS ENGAGED IN MMT ON 30 JUNE BY YEAR (1987-1999)



The mean age of clients entering MMT for the first time appears to have increased markedly from approximately 22 years in the mid to late 1970s, to approximately 29 years in the early 1990s. After 1994, there was a downturn in the age of first time entrants to MMT (Figure 11). This is consistent with the reduction in the age of new recruits to heroin use reported in the 1997 IDRS IDU survey (Hando et al, 1998).

FIGURE 11: MEAN AGE OF PERSONS ENTERING MMT FOR THE FIRST TIME BY YEAR (1970 TO SEPTEMBER 1999)



6.1.3 AMBULANCE CALLOUTS TO SUSPECTED OVERDOSES

A total of 10,324 calls were made in which the ambulance poisoning protocol was used and naloxone was administered in the period July 1997 to June 1999. Table 1 shows the distribution of cases by age and gender. By far the majority of cases were in the age range of 15-44 years (89%). Almost all cases (95%) were in the age range 15-54 years. This is consistent with literature examining fatal heroin overdoses (Hall & Darke, 1998). Around one third (31%) of cases for whom gender was recorded were female. This is higher than the proportion (15%) represented among opiate overdose fatalities (Darke et al, in press). Caution must be taken in interpreting these figures because of the large proportion of cases in which no age was recorded.

Table 1: Age and gender of suspected opioid overdoses attended by ambulance officers

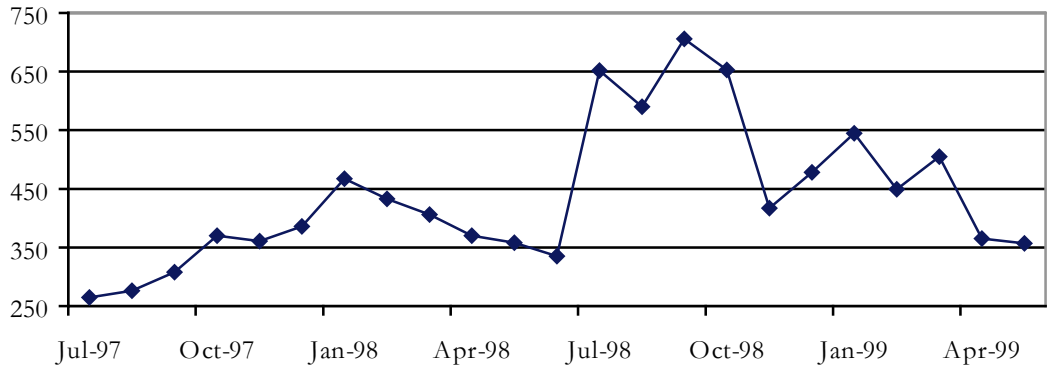
	Valid percent (N)	
Male	68.9	(3471)
Female	30.5	(1534)
Unknown	0.6	(32)
Not recorded		(5287)
Under 15 years	0.9	(41)
15-24 years	26.7	(1195)
25-34 years	38.9	(1742)
35-44 years	23.0	(1032)
45-54 years	6.3	(282)
55 +	4.2	(190)
Not recorded		(5842)
Total	10,324	

In the 1997-1998 period, there were 4,335 recorded ambulance attendances in which the poisonings protocol was used and naloxone was administered. In the same period in 1998-1999, there were 5,989 attendances, a 38.2% increase on the number in the previous year.

Figure 12 shows the frequency of ambulance attendances by month. In the 1997/1998 financial year, an average of 361 calls per month were made; in comparison, the average in 1998/1999 was 499. The primary reason for this large difference was the marked increase occurring in July 1998 (see Figure 12). Between July and October 1998, the number of calls in all cases was at least around 600, and reached 706 in September 1998. In contrast, there were no months in the 1997/1998 financial year in which the number of calls exceeded 500. The number of calls appeared to drop after October 1998, although it did not appear to return to the original levels, with higher numbers than in the beginning of the study period. Since formal analysis of this data was not possible due to the limited time over which data

were available, these findings must be interpreted cautiously.

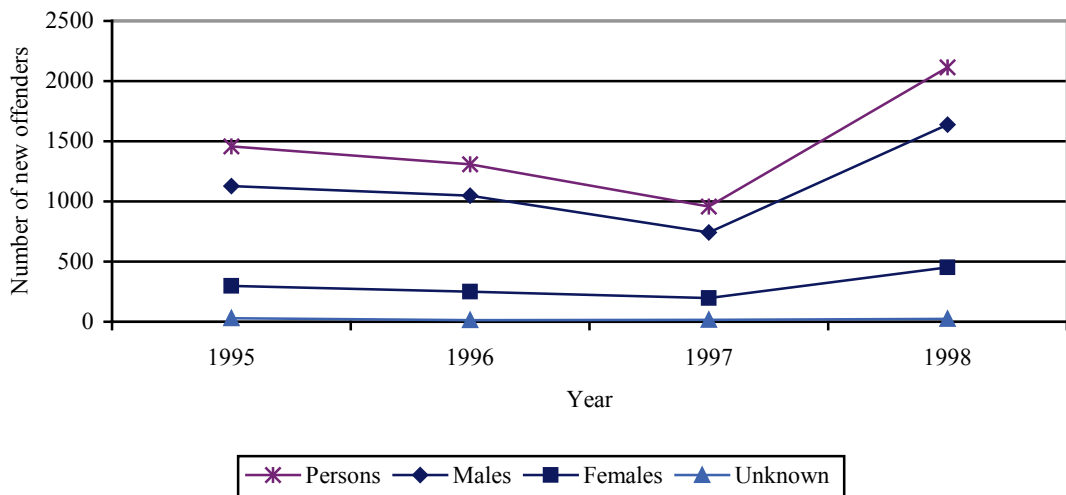
FIGURE 12: NUMBER OF AMBULANCE ATTENDANCES BY MONTH, NSW 1997-1999



6.1.4 ARRESTS FOR HEROIN POSSESSION AND DISTRIBUTION OFFENCES

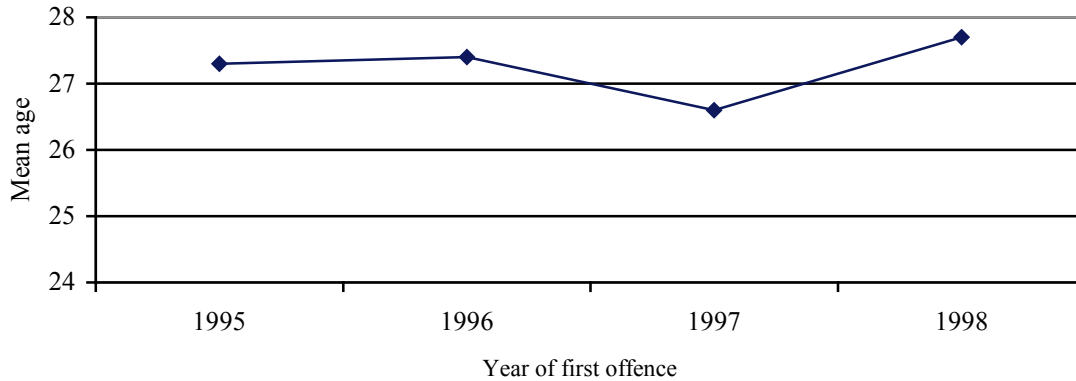
From 1995 to 1997 there were 9,728 heroin offences recorded by the NSW police committed by 5,837 individuals. Figure 13 indicates the year (within the four year range of the database) in which these individuals were first arrested for heroin related offences. The number of new offenders fell from 1,457 in 1995 to 957 in 1997. The fall was followed by a dramatic increase in the number of arrests in 1998 (n=2,114). Because all other indicators of heroin use in NSW suggest that heroin use increased over this period, the drop in 1997 seems anomalous. It is probably a consequence of a major restructuring of local command areas in NSW Police following the Wood Royal Commission into police corruption which identified systemic corruption in police stations located in Sydney’s key drug market areas. The sharp increase in 1998 probably reflects a marked increase in police activity in key heroin markets, such as Cabramatta, that began in 1998.

FIGURE 13: THE NUMBER OF NEW OFFENDERS BY YEAR AND GENDER



The mean age of first time offenders across the study period is shown in Figure 14. Age remained fairly stable, ranging from 26.6 to 27.7 years.

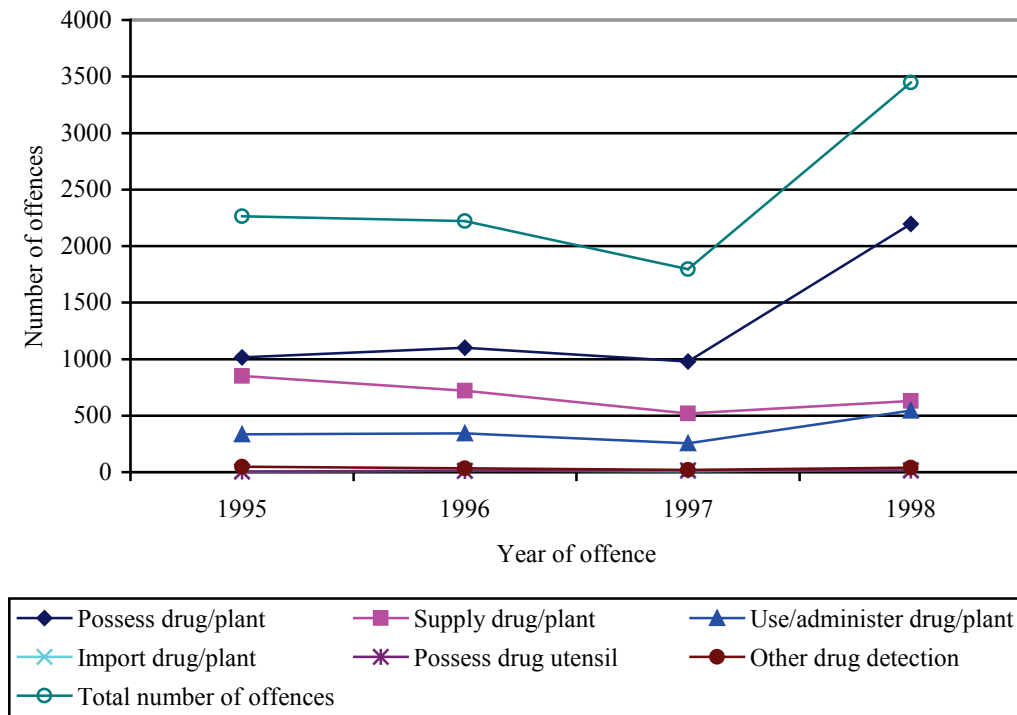
FIGURE 14: MEAN AGE OF NEW OFFENDERS BY YEAR



NB: N=4543 as year of birth is missing for 22% of individuals

Figure 15 shows the number of the various offence types recorded by year. The number of offences recorded remained relatively stable over the four-year period, except for possession of drug/plant, which more than doubled from 622 offences recorded in 1997 to 1,480 in 1998.

FIGURE 15: NUMBER OF HEROIN-RELATED OFFENCES BY OFFENCE TYPE AND YEAR

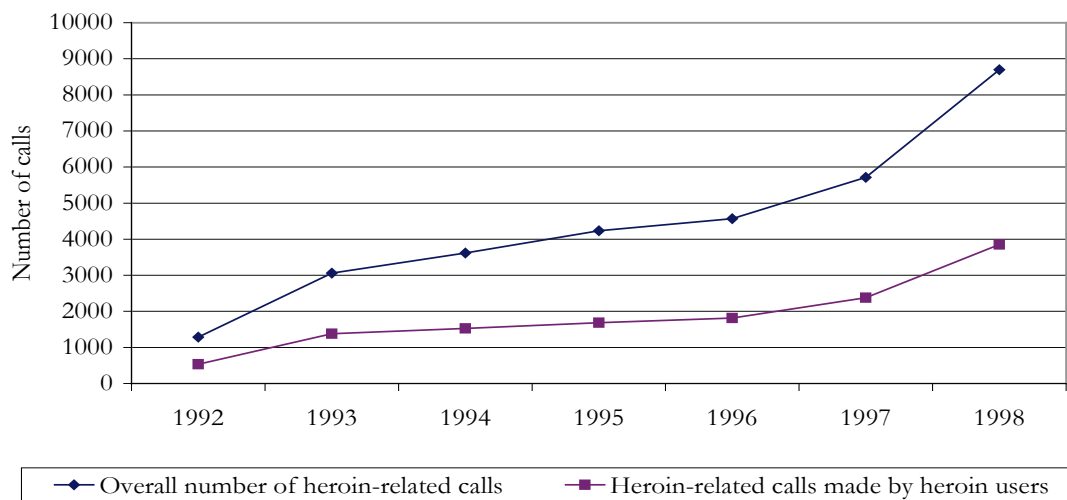


Trends in the arrest data from the NSW Police Service for 1995 to 1998 should be interpreted with caution. Factors such as the enquiry into police corruption and the consequent restructuring that took place in this period are likely to have affected the probability of arrests for heroin offences independently of any underlying trends in dependent heroin use.

6.1.5 CALLS TO ADIS

As shown in figure 16, the number of *all* heroin-related calls made to the Alcohol and Drugs Information Service increased by 576% from 1992 to 1998 while calls from heroin users have increased by 619%. This is strongly suggestive of an underlying increase in the number of heroin users. While it is possible that individuals may ring ADIS several times, this was true across the study period and so is unlikely to explain such a dramatic increase in calls to the service. The increase is also consistent with the other indicators such as the increased number of fatal heroin overdoses and first time entrants to methadone maintenance. It should be acknowledged, however, that the increase in calls may also be partially attributable to an increased awareness of ADIS among the public.

FIGURE 16: NUMBER OF HEROIN-RELATED CALLS MADE TO ADIS

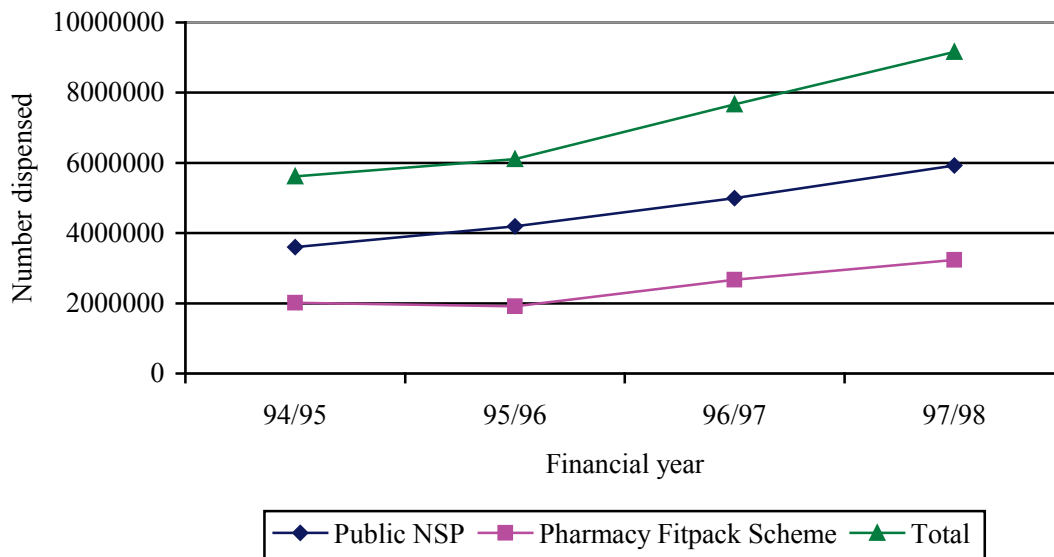


6.1.6 SYRINGES DISTRIBUTED BY NSP

The total number of needles and syringes dispensed by public NSPs and through the pharmacy fitpack scheme has increased from 5,610,967 in 1994/5 to 9,164,498 in 1997/98 (Figure 17). While these figures do not indicate the number of IDU recipients, a 63% increase in dispensing over four years strongly suggests an underlying increase in the number of IDUs. It should be borne in mind, however, that changes in patterns of drug use may be

partially responsible. In 1998, for instance, the IDRS detected a dramatic increase in the use of cocaine among Sydney based IDU (McKetin et al, 1998). Because cocaine is injected more frequently than heroin, the demand for syringes would be expected to increase. In 1999 the IDRS also detected an increase in the frequency with which heroin users were injecting heroin, providing an alternative explanation for the increased demand for syringes. Despite these caveats, the increase in the number of needles and syringes dispensed is consistent with increases in other trend data presented here.

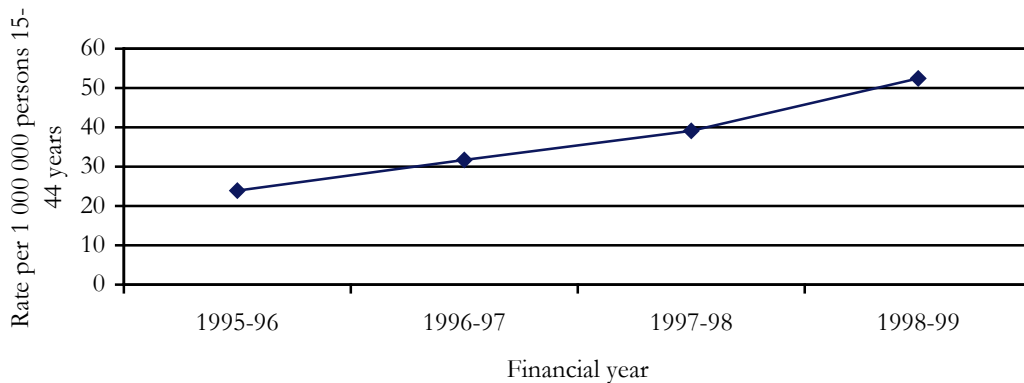
FIGURE 17: NUMBER OF NEEDLES AND SYRINGES DISPENSED



6.1.7 PERCENTAGE OF DANGEROUS DRIVERS WHO TESTED POSITIVE FOR MORPHINE

Figure 18 shows the rate of dangerous drivers per 1,000,000 of the population aged 15 to 44 years who were stopped by the police on suspicion of being intoxicated who tested positive for morphine. These data are based on the toxicology reports on drivers who were deemed to be driving while intoxicated but who did not test positive for alcohol. This has risen from 23.9 in 1995/96 to 52.4 in 1998/99 (McKetin et al, 1998), suggesting an increase in the prevalence of heroin use. The number of drivers tested in each financial year also increased from 1995/6 to 1998/99 (namely, 1995/96 N=598; 1996/97 N=737; 1997/98 N=820; 1998/99 N=1007).

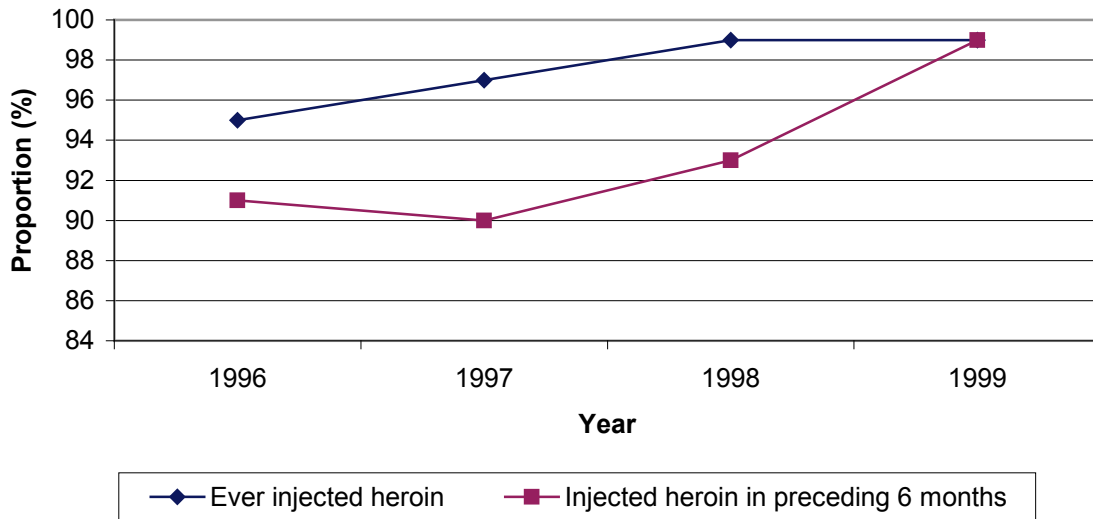
FIGURE 18: RATE PER 1 000 000 PERSONS AGED 15 TO 44 YEARS OF DANGEROUS DRIVERS TESTING POSITIVE FOR MORPHINE, 1995-1999



6.1.8 PREVALENCE AND FREQUENCY OF HEROIN USE REPORTED IN THE IDRS (1996-1999)

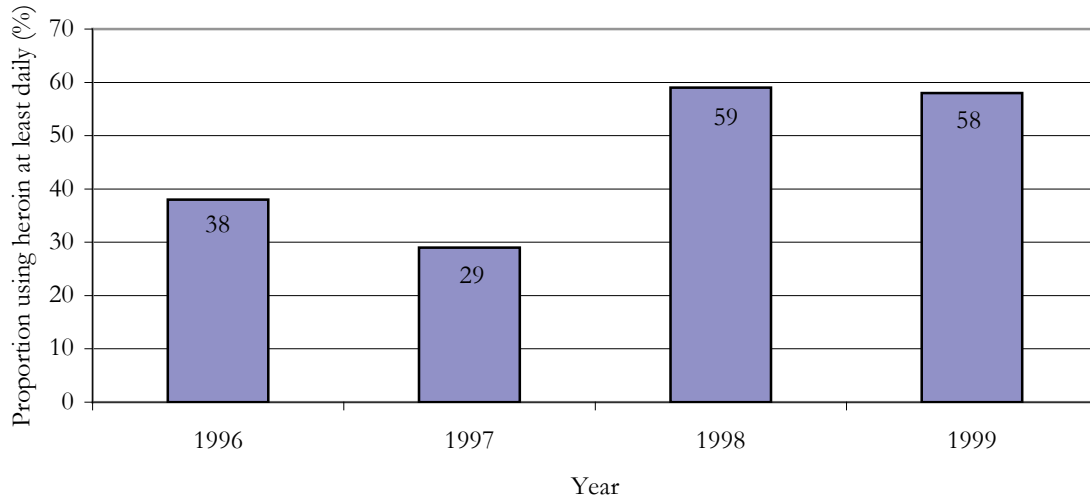
The IDRS surveys of IDU also suggest that the lifetime prevalence of heroin injecting among IDUs has increased slightly from 95% in 1996 to 99% in 1999 (Figure 19) while the prevalence of heroin injecting in the past six months has increased from 91% to 99%.

FIGURE 19: PREVALENCE OF LIFETIME AND CURRENT HEROIN INJECTING AMONG IDUS



A more marked increase was noted in the frequency of heroin injecting among IDU. In 1996 38% of current heroin injectors in the IDRS were injecting daily, by 1999 the proportion had increased to 58% (Figure 20).

FIGURE 20: PROPORTION OF CURRENT HEROIN INJECTORS USING HEROIN AT LEAST DAILY

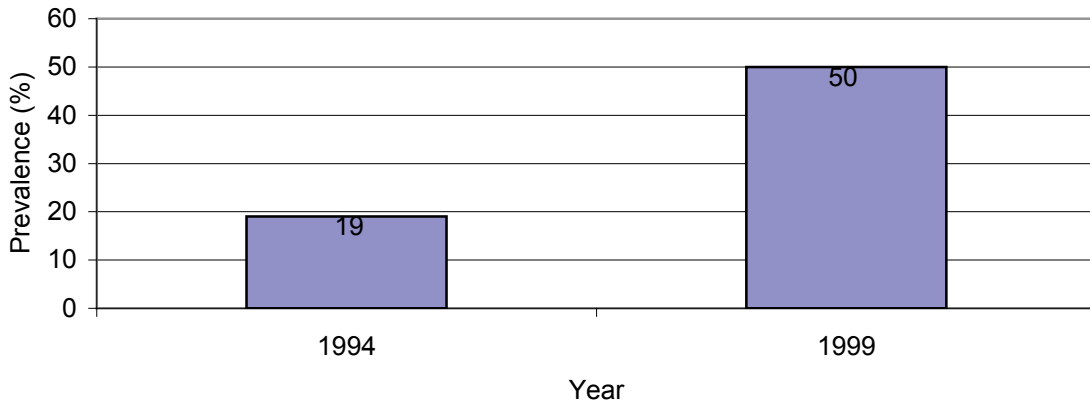


Consistent with the findings of the IDU survey, key informants reported an increase in the number of people using heroin, an increase in the number of ‘young’ heroin users in particular, and an increase in the frequency of heroin use (McKetin et al, 1999).

6.1.9 PREVALENCE OF OPIOID USE AMONG YOUNG PEOPLE ATTENDING JUVENILE JUSTICE CENTRES

As shown in Figure 21, there was a 263% increase in the number of attendees at juvenile justice centres in NSW who had used opioids, from 1994 (19%) to 1999 (50%) (Copeland, Howard, Keogh & Seidler, 1999).

FIGURE 21: PREVALENCE OF OPIOID USE AMONG JUVENILE JUSTICE DETAINEES



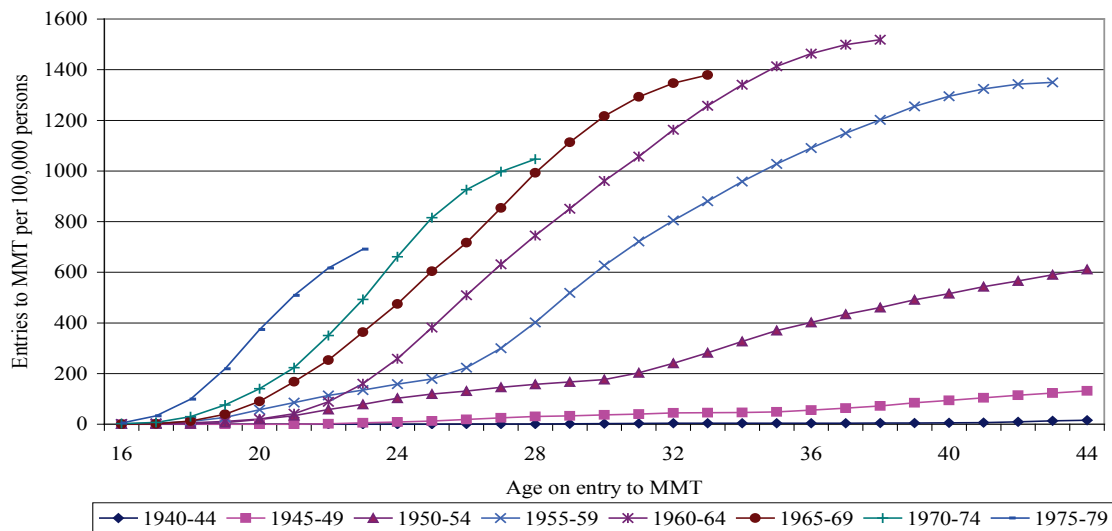
6.2 TRENDS IN NUMBERS OF DEPENDENT HEROIN USERS

6.2.1 AGE-PERIOD-COHORT ANALYSES USING INDIVIDUAL LEVEL DATA

6.2.1.1 Birth cohort trends in new entrants to MMT 1987-1997

Figure 22 shows the cumulative rate of entry to MMT per 100,000 of population for each birth cohort using age at entry. While it appears that there is a cohort effect, with successive cohorts having a higher rate of entry, an age-period-cohort analysis (using Poisson regression) reveals that period of entry into treatment is the more relevant factor.

FIGURE 22: CUMULATIVE RATE OF ENTRY TO MMT PER 100,000 PERSONS BY AGE ON ENTRY AND BIRTH COHORT



The cumulative rate of entry into MMT was significantly lower among cohorts born before 1950 than among later cohorts (Figure 22), with the rate of entry for persons born between 1940-44 remaining low throughout the study period. The rate increased among the 1945-49 birth cohort (Incidence Rate Ratio=4.23, 95% CI: 3.08-5.81), with the increase being more marked among subsequent cohorts (1950-54; 1955-59; 1960-64; 1965-69; 1970-74; 1975-79) which did not differ from each other (IRR= 14.99, 95% CI: 11.04-20.35).

The rate of entry to MMT was greater when people were aged between 25 and 34 than between 16 and 24 (IRR 1.26, 95% CI: 1.23-1.29). People were less likely to enter MMT between the ages of 35 and 44 than between 16 and 24 (IRR=0.45, 95% CI: 0.43-0.46).

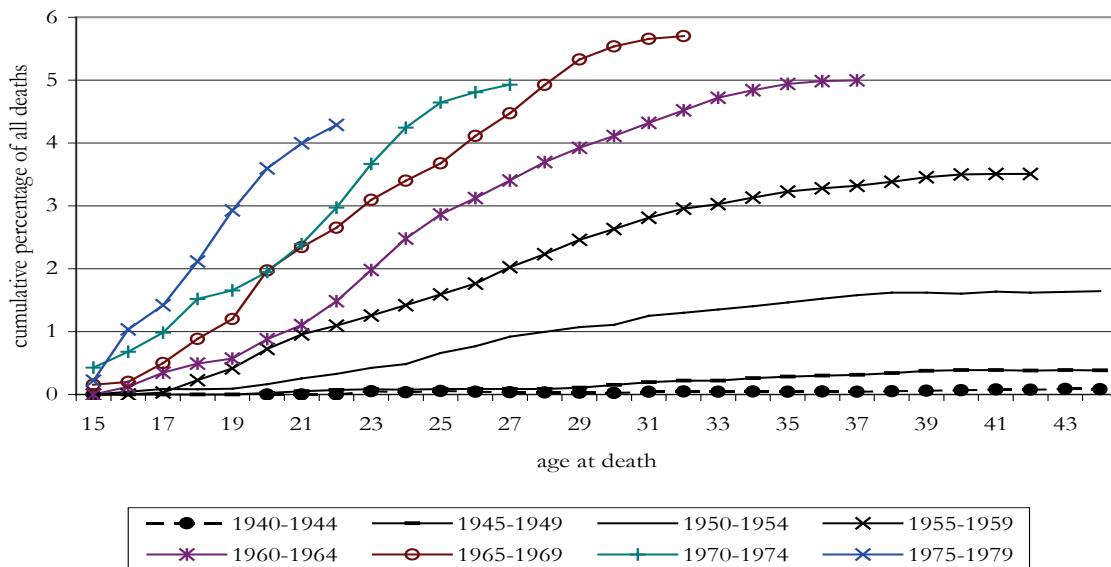
First time entry into MMT was more likely to occur in 1975-79 (IRR 2.11, 95% CI 1.84-2.43) and 1980-84 (IRR 1.52, 95% CI 1.32-1.75) than in 1970-74. The rate of entry for 1985-89 did not differ significantly from that for 1990-94, with both having a higher rate of entry than the reference period (IRR 10.10, 95% CI 8.90-11.46). The rate increased further in

1995-1998 relative to 1970-74 (IRR 14.84, 95% CI 13.06-16.85). This period effect is very likely the result of policy changes in the mid-eighties, and again in the early nineties, that resulted in the expansion of methadone services. While this does not rule out an increase in the number of heroin users across time, it highlights the need to look at other data sources, such as fatal opioid overdose data, which are not as sensitive to changes in government policy.

6.2.1.2 Birth cohort trends in opioid overdose mortality

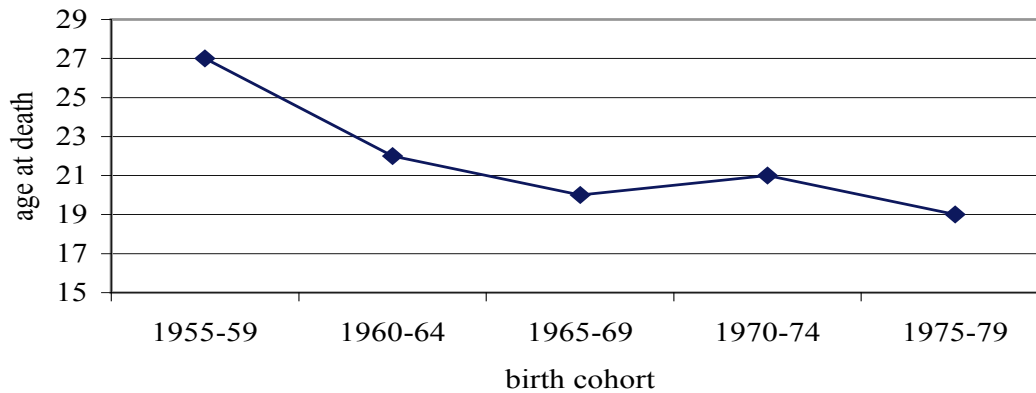
The analysis of cumulative proportional overdose mortality revealed marked differences between birth cohorts in the proportion of deaths that were attributed to opioid overdose (Figure 23). Persons born between 1944-49 had a consistently low proportion of deaths attributed to opioid overdose throughout the period 1964-1997. Persons in this birth cohort were in their mid to late 20s at the beginning of this period (1964) and so were at much lower risk than later birth cohorts of initiating heroin use. The two cohorts born in the 1950s (1950-54 and 1955-1959) showed a proportional overdose mortality rate that exceeded that of the two preceding birth cohorts born in the 1940s. Each of the subsequent birth cohorts (1960-64, 1965-69, 1970-74) showed a higher proportion of all deaths attributed to opioid overdose than its immediate predecessor did. The 1975-1979 cohort has yet to complete the period of highest risk of initiating heroin use (15 to 25 years) (Chen and Kandel, 1995).

FIGURE 23: CUMULATIVE PROPORTIONAL MORTALITY ATTRIBUTED TO OPIOID OVERDOSE BY AGE AT DEATH AND BIRTH COHORT



The other trend in the data is that the proportional overdose mortality rate in each birth cohort began to increase at a progressively earlier age than that of the immediate preceding cohort. This was typically of the order of one to two years earlier in each succeeding birth cohort between 1955-59 and 1975-79 (Figure 24).

FIGURE 24: AGE AT WHICH THE PROPORTION OF DEATHS ATTRIBUTED TO OPIATE OVERDOSE REACHED 5% OF DEATHS IN THAT YEAR



The magnitude of the increase in opioid overdose deaths in Australia between 1964 and 1997 makes it unlikely to be an artefact of changes in diagnosis. Similar increases have also been observed in other countries (Sanchez et al, 1995). The steady increase in age at death and the striking birth cohort differences are also unlikely to reflect an increased propensity for coroners and forensic toxicologists to diagnose opioid overdose as a cause of death; any such diagnostic errors would have to be strongly related to age at death and to birth cohort to explain the striking patterns reported here (Hall et al, 1999a).

These birth cohort trends in proportional opioid overdose mortality, and in entrants to MMT, are consistent with historical data on post-war illicit heroin use in Australia (Manderson, 1993; McCoy, 1980). These historical data suggest that illicit heroin use first came to police attention in Sydney and Melbourne in the late 1960s after Australia began to host Rest and Recreation visits by US servicemen who were on active service in Vietnam. US servicemen in Vietnam were subsequently shown to have high rates of heroin use in Vietnam where the drug was cheap, pure and freely available (Robins, 1993).

6.2.2 BACK PROJECTION ESTIMATES OF NUMBERS OF DEPENDENT HEROIN USERS

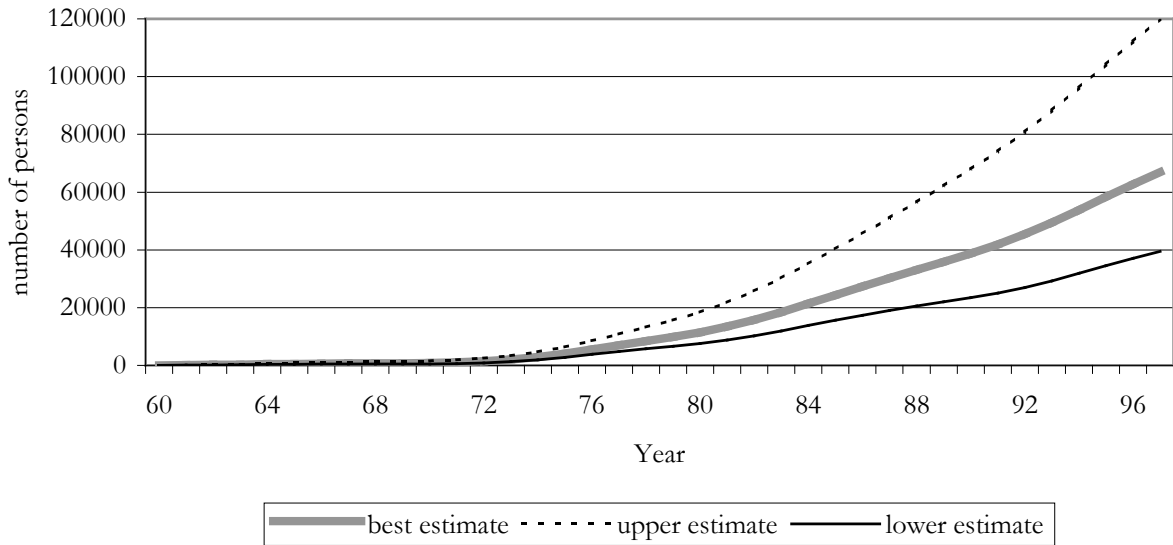
6.2.2.1 Opioid overdose deaths

The reported annual number of opioid overdose deaths has increased from around 10 per year in the late 1960s to over 500 per year from 1995 onwards (see Appendix B, Figure 3). Also shown in this figure are the annual overdose deaths between 1964 and 1997 predicted by the back-projection model fitted to these data, assuming the rate of progression distribution described above.

The back-projection estimates of the numbers of people commencing dependent heroin use in Australia are shown in Figure 25. The upper and lower limits shown were derived from analyses based on the lower and upper limits specified on the progression rate distribution.

All analyses show an increasing number of people starting dependent heroin injecting throughout the period 1960 to 1997. The total number of people who were ever heroin dependent during this period was estimated to be 104,000 (lower and upper limits of 72,000 to 157,000). If we assume that dependent heroin users cease using at the rate of 5% per year (3% to 7%), then the number of dependent heroin users at the end of 1997 was 67,000 (39,000 to 120,000).

FIGURE 25: BACK-PROJECTION ESTIMATES FROM OVERDOSE DEATHS



6.2.2.2 New entrants to methadone treatment in NSW

The annual numbers of new entrants to methadone treatment in NSW are shown in Appendix B (Figure B4). There was a very rapid increase in the numbers of new entrants in the mid-1980s when there was substantially increased funding for methadone programs and a consequent increase in the availability of treatment. The back-projections analyses were therefore based on smoothed numbers of new entrants to methadone that were obtained by using an 11-year moving average. These smoothed numbers of entrants to methadone treatment, and the corresponding fitted numbers from the back-projection analyses, are also shown in Appendix B (Figure B4).

Back-projection estimates were made from numbers of methadone entrants of the number of people who became heroin dependent in NSW. As with the overdose back-projections, there was a substantial increase in the number of dependent heroin users between 1960 and 1997. The total number of dependent heroin users in NSW over this time period was estimated to be 59,000 (45,000 to 78,000). At the end of 1997 there were estimated to be 39,000 (26,000 to 60,000) dependent heroin users in NSW.

New South Wales accounts for 55% of all people receiving methadone maintenance treatment in Australia (Hall, 1996). Using this correction factor to scale up New South Wales estimates to national estimates indicates that there were 108,000 (82,000 to 141,000) persons

who were dependent on heroin at some time between 1960 and 1997. At the end of 1997 there were an estimated 71,000 (47,000 to 109,000) dependent heroin users in Australia (Figure 26).

FIGURE 26: BACK-PROJECTION ESTIMATES FROM NEW ENTRANTS TO MMT

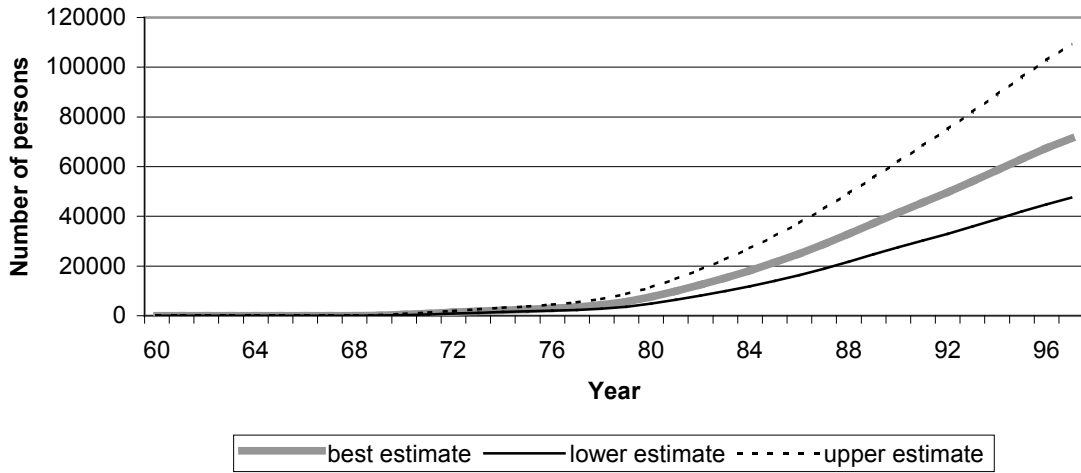
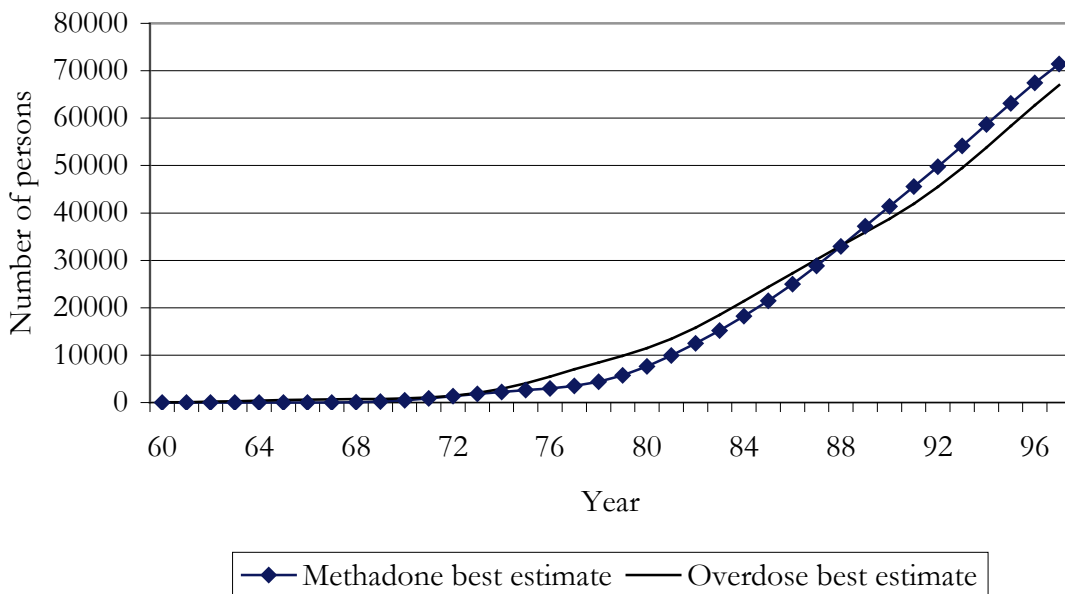


Figure 27 highlights the similarities between the most plausible back-projection estimates derived from overdose and methadone data.

FIGURE 27: BACK PROJECTION ESTIMATES OF THE NUMBER OF DEPENDENT HEROIN USERS



6.2.3 CAPTURE-RECAPTURE ESTIMATES

6.2.3.1 Arrest data in New South Wales

Using the procedures outlined by Sandland (1986) the NSW arrest data for the period from January, 1995 to December, 1998 were coded so that it was recorded whether each individual had been arrested for a heroin related crime during each of the four one-year periods. Thus, for the four year data there were $2^4 = 16$ possible patterns of arrest (and non-arrest) ranging from those who had been arrested in each of the four one year periods to those who had never been arrested (but because of their heroin use were potentially 'available' for arrest for a heroin related offence). The frequency of 15 of the 16 patterns can be obtained from the data while the capture-recapture analysis estimates the size of the sixteenth (hidden) pattern.

Table 2 shows the data created using this procedure: for each of the four periods. The data are coded as arrested (1) or not arrested (0) and the final column gives the count data for each possible combination. Thus, it can be seen from the final row that there were 21 people who were arrested for a heroin-related offence in each of the four years 1995, 1996, 1997 and 1998. The top row of the Table represents those people who are heroin users (and may therefore potentially be arrested for heroin related offences) but who have not been arrested at any time during the four-year period. Thus, this row represents the hidden population that we are attempting to estimate.

Table 2: Numbers of people arrested for heroin related offences in New South Wales, 1995-1998

1998	1997	1996	1995	Count
0	0	0	0	???
0	0	0	1	1056
0	0	1	0	1079
0	0	1	1	131
0	1	0	0	811
0	1	0	1	69
0	1	1	0	107
0	1	1	1	37
1	0	0	0	2114
1	0	0	1	87
1	0	1	0	97
1	0	1	1	35
1	1	0	0	146
1	1	0	1	21
1	1	1	0	25
1	1	1	1	21

Note: 1 = arrested; 0 = not arrested

The data above were analysed using Poisson regression as implemented in STATA (STATA Statistical Software, 1997). In fitting models of this form there are potentially a number of different interaction terms that can be included in the model. These interaction terms represent associations between different data periods and they can be interpreted as indicating that the probability of being ‘captured’ in each of the time periods is not mutually independent.

As has been discussed by Hook and Regal (1995) there are a number of strategies for selecting the model from which to derive final estimates. The theoretically best solution is to fit a model that includes only those interaction terms for which there is a strong theoretical justification, and to report the results of this model, regardless of the fit of the model to the data. A problem with this strategy is that in most instances (and certainly in the current example) there are no strong theoretical justifications for including or excluding specific interaction terms. Alternatively, interaction terms may be added (or subtracted) until an adequately fitting model is obtained. The problem with this approach is that while it may be possible to obtain an adequately fitting model, it is not possible to distinguish between competing models that provide similar fit to the data yet produce markedly different estimates of the size of the hidden population.

An alternative strategy has been recommended by Hook and Regal (1995), when there are no strong a priori theories to distinguish between different models. This is to fit an array of models to the data and use a weighted average of the estimates from these different models to calculate a best estimate of the size of the hidden population. This was the strategy used in the current analyses.

Table 3 summarises the models fitted to this data. The first column of this Table describes the interaction terms included in the model. The second and third columns give the degrees of freedom and goodness of fit statistic for each model. The fourth and fifth columns give values of the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) respectively. These quantities are calculated using the following formulae:

$$\text{AIC} = G^2 - 2(\text{df})$$

$$\text{BIC} = G^2 - (\log N_{\text{obs}} / 2\pi)(\text{df})$$

where G^2 is the value of the likelihood ratio goodness-of-fit measure, df is its degrees of freedom, and N_{obs} is the number of observed cases in the dataset. The AIC was first proposed by Akaike (1974), the BIC by Schwarz (1978). They have been described in detail by Hook and Regal (1995). AIC and BIC provide indices for comparing the relative fit of competing models, with smaller (including negative) values of the BIC indicating better fitting models.

For a saturated model (one which contains all possible interaction terms and therefore has 0 degrees of freedom) the value of both the AIC and BIC is zero. Thus, only models which have negative values for AIC and BIC are preferable to the saturated model.

The final two columns of the Table provide an estimate of the size of the hidden (non-captured) population derived from each model and the confidence interval surrounding this estimate. As Table 3 indicates, the different models produced estimates of the size of the hidden population that ranged from 30,470 to 76,260. This highlights the problems in basing estimates on one model.

In the absence of *a priori* theoretical reasons to prefer one model to another, a procedure for combining multiple model estimates to produce a single estimate of the size of the hidden population has been formulated by Draper (1995) and discussed at length by Hook and Regal (1995). This method, referred to by Hook and Regal (1995) as “weighted BIC”, involves calculating a weighted average of the multiple estimates with the weight assigned to the estimate from each model (i) being given by:

$$[1/\exp(\text{BIC}_i/2)]$$

Thus, the weight assigned to the saturated model is 1 ($1/\exp(0) = 1$) and the lower (more negative) the BIC value of a given model, the higher will be the weight assigned to this estimate.

Table 3: Summary of model fit and estimates of the number of heroin users in NSW derived from capture-recapture models of NSW arrest data, 1995-1998

Model Description	d.f	Goodness of fit	AIC	BIC	Estimated hidden population	95% Confidence Interval
Saturated	0	0	0	0	53,073	19,740-142,500
abc, abd, acd	1	1.6	-4	-5.2	30,520	18,230-51,100
abc, abd, bcd	1	.2	-1.8	-6.6	43,380	24,650-76,330
abc, acd, bcd	1	.7	-1.3	-6.1	76,260	47,120-123,429
abd, acd, bcd	1	.9	-1.1	-6.0	35,350	21,730-57,500
abc, abd	2	1.8	-2.2	-11.9	32,690	22,670-47,130
abc, acd	2	8.1	4.1	-5.6	47,540	33,170-68,130
abc, bcd	2	2.8	-1.2	-10.5	60,360	41,650-87,480
abd, acd	2	1.6	-2.4	-12.0	30,470	21,190-43,800
abd, bcd	2	.9	-3.1	-12.8	36,445	24,710-53,760
acd, bcd	2	5.7	1.7	-8.0	51,320	36,160-72,840
Abc	3	8.4	2.4	-12.1	44,450	33,810-58,450
Abd	3	1.8	-4.2	-18.7	31,980	24,110-42,420
Acđ	3	9.3	3.3	-11.2	41,820	31,540-55,440
Bcd	3	5.9	-0.1	-14.6	48,920	36,490-65,590
-	4	9.3	1.3	-18.0	41,120	32,880-51,420

Notes: a=1995; b=1996; c=1997; d=1998.

AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; for models including three way interactions, all two way interactions were included as well as those three way interactions listed; For models including only two-way interactions all two-way interactions were included *except* those listed.

This procedure was applied to the data described above on NSW arrest data. In selecting models for inclusion in these analyses only models that included all two-way interaction terms were included; models that did not include all these terms showed extremely poor fit to the data. Applying this weighting procedure to the data in Table 3 suggested that there were 37,020 people in NSW during the 1995-1998 who had not been arrested for heroin related offences but who, because of their heroin use, were potentially available for arrest for heroin related offences. Adding this number to the numbers from other cells (those individuals known to have been arrested for a heroin related offence) gives a total estimate of 42,856 heroin users in New South Wales (confidence interval = 34,166 to 54,296).

6.2.3.2 Entrants to MMT 1970-1997

A similar data set to that displayed in Table 2 was constructed from recent data on admission to the methadone maintenance program in New South Wales. This data has been described above (see section 5.3). For the purposes of the present data analysis, four summary variables were constructed. These variables represented: a) whether the individual had entered MMT during the six month period from 1st July to 31st December, 1997; b) whether the individual had entered MMT during the six month period from 1st January to 31st June, 1998; c) whether the individual had entered MMT during the six month period from 1st July to 31st December, 1998 and; d) whether the individual had entered MMT during the six month period from 1st January to 31st June, 1998. Following the recommendations of Maxwell (1999), these data referred only to whether the person had entered a program. Thus, people who entered MMT at the start of the program and remained in the MMT program throughout the four six-month periods of the study would be coded as 1 0 0 0.

Table 4: Numbers of people entering MMT in New South Wales, July, 1997-June, 1999

Jan-June, 1999	July-Dec, 1998	Jan-June, 1998	July-Dec, 1997	Count
0	0	0	0	???
0	0	0	1	1869
0	0	1	0	2022
0	0	1	1	255
0	1	0	0	2098
0	1	0	1	241
0	1	1	0	283
0	1	1	1	93
1	0	0	0	2148
1	0	0	1	184
1	0	1	0	231
1	0	1	1	57
1	1	0	0	280
1	1	0	1	45
1	1	1	0	78
1	1	1	1	23

Note: 1 = entered MMT; 0 = did not enter MMT

Table 4 shows the data created using this procedure: for each of the four periods the data is coded as entered methadone treatment (1) or did not enter methadone treatment (0) and the final column gives the count data for each possible combination. Again, the top row of the Table represents those people who are heroin dependent (and may therefore potentially enter methadone maintenance) but who have not entered MMT at any time during the two-year period. Thus, this row represents the hidden population that we are attempting to estimate.

A series of models were fitted to this data in which the underlying assumptions about the dependencies between different ‘captures’ (as represented by the interaction terms) were varied. These models are summarised in Table 9 which: describes the model fitted to the data by listing the interaction terms included in each model; provides measures of the goodness of fit (GoF) of each model and the associated degrees of freedom; lists the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC) for each model and gives an estimate of the hidden population of people dependent on heroin who do not enter MMT (and its associated 95% confidence interval) derived from each model. Table 5 indicates that the different models produced markedly different estimates ranging from 20,025 to 66,565.

Table 5: Summary of model fit and estimates of the number of heroin dependent people in NSW derived from capture-recapture models of NSW methadone data, July, 1997-June, 1999

Model Description	d.f	Goodness of fit	AIC	BIC	Estimated hidden population	95% Confidence Interval
Saturated	0	0	0	0	66,565	32,505-136,305
abc, abd, acd	1	2.7	.7	-4.6	38,830	28,360-53,160
abc, abd, bcd	1	6.5	4.5	-0.9	30,530	20,950-44,470
abc, acd, bcd	1	1.8	-2	-5.4	42,400	31,320-57,400
abd, acd, bcd	1	1.9	-.1	-5.5	42,690	29,950-60,860
abc, abd	2	6.5	2.5	-8.2	31,700	24,820-40,490
abc, acd	2	2.8	-1.2	-11.9	37,920	29,670-48,440
abc, bcd	2	6.7	2.7	-8.0	32,500	24,920-42,385
abd, acd	2	2.7	-1.3	-12.0	38,575	30,680-48,500
abd, bcd	2	7.1	3.1	-7.7	34,150	26,775-43,565
acd, bcd	2	2.2	-1.8	-12.6	40,215	31,650-51,090
abc	3	6.7	0.7	-15.4	32,635	26,830-39,700
abd	3	7.1	1.1	-15.0	33,635	27,800-40,700
acd	3	2.8	-3.2	-19.3	38,020	31,330-46,135
bcd	3	7.1	1.1	-15.0	34,420	28,260-41,910
-	4	7.1	-.9	-22.3	33,940	28,930-39,820

Notes: a = July-December, 1997; b = January-June, 1998; c = July-December, 1998; d = January-June, 1999. For models including three way interactions, all two way interactions were included as well as those three way interactions listed; For models including only two-way interactions all two-way interactions were included *except* those listed; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion

The estimates of the hidden population derived from these various models were combined using the “weighted BIC” method of Hook and Regal (1995). This suggested that there were 34,670 people in NSW between July, 1997 and June, 1999 who had not entered MMT but who were heroin dependent and therefore potentially available for entry to MMT. Adding this number to the numbers from other cells (those individuals who had entered MMT during the course of the study period) gives a total estimate of 44,577 heroin users in New South Wales (confidence interval = 39,180 – 50,990).

These estimates are broadly consistent with other estimates for the number of heroin dependent people in NSW. There are, however, a number of caveats that need to be considered. Firstly, and most importantly, the assumptions underlying the capture–recapture methods are unlikely to be valid when applied to populations of heroin dependent people. It is not, for example, a closed population because people can enter (e.g. by initiating heroin use) or leave (by ceasing heroin use, moving out of New South Wales or dying) during the observation period. There is also the problem of “trap dependence”. Specifically, these techniques assume that an individual’s probability of being ‘captured’ during a time period is independent of their capture history. This is likely to be problematic in arrested heroin users because it is likely that prior arrest increases the risk of subsequent arrest.

The results of this method are affected by changes in the number of people who become heroin dependent during the course of the study. These estimates may accordingly be interpreted as estimates of the number of people in NSW who were heroin dependent at some time during the period of the study but were not necessarily dependent for the entire period of study.

Despite these limitations, capture-recapture methods provide an important set of estimates that contribute to the strategy of using multiple methods to estimate the number of heroin dependent people in Australia. The advantages of this modified version of the method are that it raises fewer concerns about confidentiality than more traditional capture-recapture methods that require linkage of personal data between agencies. Given increasing concerns about the confidentiality of agency data we believe that it will become increasingly difficult to use CRM that link data from different service agencies.

6.2.4 MULTIPLIER ESTIMATES

6.2.4.1 Fatal overdose data from the ABS

As indicated earlier, commonly used multipliers based on fatal opioid overdoses are 100 and 200 (Larson, 1992). There were 358 fatal opioid overdoses recorded in NSW during 1998. Using multipliers of 100 and 200, the number of dependent opioid users in NSW during 1998 is estimated to have been between 35,800 and 71,600. With 737 fatal opioid overdoses recorded nationally, it is estimated that there were between 73,700 and 147,400 dependent opioid users in Australia during 1998. It should be recalled, however, that these multipliers are derived from data collected on American heroin users in New York in the early 1960s (Larson, 1992). A recent review of opioid overdose mortality (Darke & Zador, 1996) identifies several longitudinal studies of mortality among dependent opiate users. An examination of these studies suggests that it may be more appropriate to use a multiplier of

125 (see method section). Using this multiplier, it is estimated that in 1998 there were 44,750 dependent opioid users in NSW, and 92,125 nationally.

6.2.4.2 The number of methadone maintenance clients

The number of MMT clients in NSW on June 30 1999 (namely, 12,490) was multiplied by a factor of 3 based on Australian research that suggests that a third of heroin users are in treatment for dependence at any one time (Hall, 1995). Using this multiplier, the estimated number of heroin users in NSW was 37,647 and the national estimate was 68,449 (when the NSW estimate was multiplied by 1.82).

6.2.4.3 Ambulance overdose data

In the 12 months from July 1998 to June 1999 there were 5,989 ambulance calls in which the poisonings protocol was used and naloxone was administered. In the 1999 IDRS IDU survey 10.2% of 155 current heroin users (having used heroin in the preceding 6 months) reported having received naloxone in the 6 months prior to interview. This suggests a multiplier of 9.8 for overdoses attended by an ambulance. As the IDRS was based on a 6-month period, the number of ambulance calls was halved (n=2,995). Multiplying this figure by 9.8 produces an estimate of 29,346 heroin users in NSW.

Data similar to the IDRS was obtained from a study of heroin users conducted in 1998 (Darke & Ross, 1999), in which 12.1% of 174 current heroin users had received naloxone in the preceding 6 months. Using a multiplier of 8.26 produces an estimate of 24,739 heroin users in NSW.

The estimates based on non-fatal overdose are considerably lower than those based on the fatal overdose and methadone data. The most probable explanation is that the samples used in the IDRS and antidepressant studies represent street based heroin users who were primarily recruited from around key heroin markets such as Cabramatta and Kings Cross. Given that greater heroin dependence and longer heroin use have been identified as significant predictors of non-fatal heroin overdose (Darke, Ross & Hall, 1996), these estimates probably reflect the number of heroin users who are found in the vicinity of major heroin markets.

6.2.4.4 Arrest data

In 1998 the NSW police arrested 2,546 individuals for heroin-related offences. Data from the 1999 IDRS reported that 21.9% of 155 NSW heroin users reported that they had been arrested by the police for drug offences in the 12 months prior to interview. Using a factor of 4.57, the estimated number of heroin users in NSW is 11,635. This is also likely to be an underestimate for three reasons. Firstly, the IDRS did not specify the type of drug involved in the arrests. Secondly, it is unclear how the IDUs in the IDRS study defined arrest. It may be that they are reporting dealings with the police that were not formally recorded. Thirdly,

as indicated earlier, recruitment for the IDRS sample took place in key drug market areas such as Cabramatta and Kings Cross where police activity tends to be high. The arrest rate is probably inflated in persons interviewed for the IDRS and consequently, the estimate is an under-estimate.

6.2.4.5 HIV data

As of 31 December 1998, the cumulative number of new HIV diagnoses in which the exposure category reported was injecting drug user was 697 (NCHECR, 1999). The prevalence of HIV among the IDUs tested through the NSP survey has ranged from 2.4% in 1995 to 0.9% in 1998. The average prevalence across the four years was 1.7%. If the 697 HIV notifications represent 1.7% of the IDUs in NSW, the appropriate multiplier to use with HIV data is 58.82. Using this multiplier it is estimated that there are 40,998 IDU in NSW. There are a few problems associated with this estimate. Firstly, it is unclear what proportion of these IDU are dependent heroin users. Secondly, it is possible that female IDUs are under-represented in the cumulative HIV data, as the virus is more prevalent among men, with 74% of the HIV positive cases among the IDU being males. Lastly, as the HIV data is cumulative, the timeframe for the estimate is uncertain.

6.2.4.6 HCV data

According to Crofts et al (1999) the incidence rate of HCV among IDUs is approximately 15% per year. In 1998 there were 7,701 HCV notifications recorded by the National Notifiable Diseases Surveillance System (NCHECR, 1999). As 75-80% of HCV cases are estimated to be IDU related (Lowe & Cotton, 1999), between 5776 and 6161 of the HCV notifications in 1998 are likely to have been in this category. Using a factor of 6.67, the estimated number of IDUs in NSW for 1998 is between 38,526 and 41,094. It is unclear what proportion of these IDU would be dependent heroin users, but it is noteworthy that the estimated number of IDUs is consistent with the estimate based on HIV diagnoses.

6.2.4.7 Prison data

There were 7,957 inmates in prison on June 30 1997 (Corben, 1998). Assuming that the number of inmates in NSW prisons on census day represents 43% of the annual total (see method section), it is estimated that there were 18,505 inmates during 1997. If 59% of inmates are IDUs (Dolan & Crofts, 2000), then there were 10,918 IDUs incarcerated during 1997. Data from a study by Darke et al (2000) indicates that 19.4% of 144 heroin users reported having been imprisoned in the 12 months preceding interview. Multiplying the number of IDU inmates by a factor of 5.15 produces an estimated IDU population in NSW of 56,228. As with the HIV and HCV based estimates it is unclear what proportion of these individuals would be heroin users.

6.3 SUMMARY

Table 6 summarises the most plausible estimates of the number of dependent heroin users derived by different methods from different data sources. Estimates of the number of dependent heroin users in NSW vary between a minimum of 32,000 and a maximum of 45,000, with a mean of 40,000 and a median of 39,000. The estimates of the number of dependent heroin users in Australia vary between a minimum of 67,000 and a maximum of 92,000, with a median of 74,000 and a mean of 77,000.

Table 6: Estimates of the number of dependent heroin users in NSW and Australia (rounded to nearest 1000)

Method of estimation	Estimate for NSW	Estimate for Australia
Back projection		
National OD deaths	32,000	67,000
NSW MMT entrants	39,000	71,000
Capture-recapture		
MMT episodes	45,000	81,000
Arrests for heroin offences	43,000	86,000
Multiplier estimates <i>(a) No heroin dependent</i>		
OD fatalities:		
(x 100)	36,000	74,000
(x 125)	45,000	92,000
MMT entrants:		
(x 3)	38,000	68,000
Median estimate	39,000	74,000
Mean estimate	40,000	77,000

7. DISCUSSION

A range of indicators of dependent heroin use in NSW between 1990 and 1998 showed an increase that began in the early 1990s. Opioid overdose deaths have increased steeply since 1991 as have the number of new entrants to MMT and the number of calls to ADIS about heroin. NSW arrest data for heroin-related offences show a more mixed picture, with a small decrease in the number of arrests in the early part of the period from 1995 to 1997, followed by a sharp increase between 1997 and 1999. This probably reflects the unique historical circumstances arising from the Wood Royal Commission into Police Corruption, which resulted in a major restructuring of the police service, particularly of police services involved in drug law enforcement around major heroin markets in Sydney.

Estimates of the number of dependent heroin users suggest that these trends reflect in part an increase in the number of dependent heroin users in Australia during the 1990s. Estimates of the number of dependent users in 1997 produced by different methods showed some variation between different methods but there were between 32,000 and 45,000 dependent heroin users in NSW and between 40,000 and 92,000 dependent heroin users in Australia. The best estimates (to the nearest 1,000) are: 39,000 dependent heroin users in NSW, with a range of 32,000 to 45,000; and 74,000 in Australia, with a range of 67,000 to 92,000.

The best national estimate for 1997 (74,000) represents a doubling of the 34,000 estimated in 1984-87 (NDADS, 1988) and 25% increase on the estimate of 59,000 in the period 1988-1993 (Hall, 1995). The increases are larger still if retrospectively revised estimates for this period are derived by applying the methods used in the current study to data for these earlier time periods. This produces revised earlier estimates of 27,000 and 40,000 respectively.

The current estimates can be used to produce population prevalence estimates for Australia using ABS projections of the adult population aged between 15 and 54 years. This age range is used to permit comparisons with recent estimates produced by similar methods in countries of the European Union (EMCDDA, 1999). The current national estimate represents a population prevalence of opioid dependence in Australia of 6.9 per 1000 adults aged 15 to 54 years, with a range of 4.6 to 8.2 per 1000.

The Australian prevalence rate is within the range of recent European estimates of the population prevalence of "problem drug use" in the 15 to 54 year age group (Table 7), namely 3 to 8 per 1000 (EMCDDA, 1999). The majority of these European "problem drug users" are opioid dependent polydrug users (EMCDDA, 1999). The Australian data are not significantly different from the estimated rate of heroin dependence in the United Kingdom of 7 per 1000 (with a range of 3 to 11 per 1000). The Australian rate is only marginally higher than the estimated prevalence of *opioid dependence* in the USA from household surveys, namely, between 4 (Kessler et al, 1994) and 7 per 1000 (Anthony and Helzer, 1991). The fact that Australian prevalence estimates are similar to prevalence estimates in other developed societies, including other major English-speaking countries, such as the United Kingdom and the United States, increases our confidence in them.

Table 7: National prevalence estimates of problem drug use in some EU countries

Country	Rate per 1,000 for persons aged 15-54
Belgium	3.6
Denmark	3.8
Germany	3.7
France	4.6
Ireland	4.5
Italy	7.7
Luxembourg	8.4
Netherlands	3.0
Austria	2.8
Finland	2.8
Sweden	2.8
United Kingdom	6.6

NB: These figures represent the midpoint of the range of estimates derived within each country

7.1 APPROXIMATE JURISDICTIONAL ESTIMATES

The median national estimate of 74,000 can be used to produce approximate estimates of the number of dependent heroin users in each of the Australian states and territories. This can be done by dividing the estimated 74,000 dependent heroin users in Australia between the states and territories in accordance with the proportion of national overdose deaths accounted for by each jurisdiction over the period 1994-1998. These estimates are shown in Table 8. The NSW estimate differs marginally from that directly estimated from NSW data but is retained for consistency with the other state estimates.

Table 8: Estimated prevalence of opioid dependence by jurisdiction, 1997

Jurisdiction	Fatal ODs 1994-1998		Estimated number of dependent users (95% CI)	Estimated prevalence per 1000 adults aged 15 to 54 years
	N	% AUST (95%SE)		
NSW	1346	47.8 (46.0, 49.6)	35,400 (34,000 36,700)	9.8
VIC	737	26.5 (24.9, 28.1)	19,600 (18,400 20,800)	7.3
WA	296	10.5 (9.4, 11.6)	7,800 (6,900 8,600)	7.3
SA	177	6.3 (5.4, 7.2)	4,700 (4,000 5,300)	5.6
QLD	167	5.9 (5.0, 6.8)	4,400 (3,700 5,000)	2.3
ACT	45	1.6 (1.1, 2.1)	1200 (800 1,500)	6.1
TAS	23	0.8 (0.5, 0.83)	600 (300 800)	2.3
NT	18	0.6 (0.3, 0.9)	400 (200 700)	3.3
AUSTRALIA	2819	100	74,000	6.9

Comparison of the estimated number of dependent heroin users in each jurisdiction in with the number of persons enrolled in methadone maintenance treatment on 30 June 1999 provides a useful check on the plausibility of the estimates (Table 9). For the larger states and territories, the number of opioid dependent persons enrolled in methadone treatment is a little less than a third of the estimated number of opioid dependent persons in the state. Queensland and Tasmania are conspicuous outliers, with the majority of the estimated number of opioid dependent persons enrolled in methadone treatment. This seems unlikely given unmet demand for treatment in each state and the fact that Switzerland which has

made a major effort to enrol their opioid dependent populations in opioid substitution treatment have not enrolled more than 50% of their opioid dependent population in methadone treatment (Swiss Federal Office of Public Health, 1999).

Table 9: Number of opioid dependent persons in MMT on 30 June 1999 by jurisdiction

Jurisdiction	Number in MMT	Estimated N opioid dependent	% of number in MMT
NSW	11,272	35,400	31.8
VIC	6,700	19,600	34.8
WA	2,449	7,800	31.4
SA	1,184	4,700	42.2
QLD	3,341	4,400	75.9
ACT	559	1,200	46.6
TAS	370	600	61.6
NT	0	400	0
AUSTRALIA	26,676	74,000	36.0

The high proportion of the estimated number of opioid dependent persons who are in MMT in Queensland and Tasmania suggests that these estimates are under-estimates. This may reflect under-counting of opioid overdose deaths in each jurisdiction or it may reflect differences in opioid mortality between the smaller jurisdictions and the larger states of NSW, Victoria and Western Australia. Which is the most likely explanation can only be discovered by further research on rates of opioid deaths in each jurisdiction and the application of the methods of estimation described in this report to local jurisdictional data.

Until locally derived estimates have been produced, the jurisdictional estimates reported here for the smaller states and territories must be interpreted with considerable caution. The estimate for NSW derived by back projection from the national overdose deaths is in reasonable agreement with back projection and capture-recapture estimates derived from NSW data. This makes the NSW estimates more credible. The similar proportion of the total estimated number of opioid dependent persons in MMT in Victoria, Western Australia and South Australia suggest that the estimates for these states are reasonably plausible. Nonetheless, confidence in these state estimates will increase if they are in reasonable accord with estimates derived by applying the methods of estimation outlined here (back-projection, capture-recapture, and multiplier) to jurisdictional data on opioid overdose deaths, methadone treatment entrants and arrests for opioid offences.

Our aim in future research is accordingly to improve upon these jurisdictional estimates by encouraging researchers in each of the individual jurisdictions to apply the methods of estimation used in this report to data from their state or territory. This will be done in collaboration with research groups in each jurisdiction.

7.2 LIMITATIONS OF NATIONAL ESTIMATE

The estimates provided in this report are of the number of *dependent heroin users* in Australia, persons who are primarily daily or near daily heroin injectors (Hall et al, 1999a). The number of regular injectors of illicit drugs is likely to be higher because injecting amphetamine users and non-dependent heroin injectors are *not* included in these estimates. When allowance is made for these populations of injecting drug users, the current estimate is broadly consistent with the Delphi estimate of 100,000 regular (or dependent) injecting drug users in Australia in 1997 (Law, 1999).

Obtaining credible estimates of the number of Australians who are heroin dependent is a difficult task. Our approach has been to look for a convergence of estimates based on different data sources and different methods of estimation, all of which have weaknesses. All our estimates make assumptions that are of uncertain validity to varying degrees. The back projection estimates, for example, make assumptions about rates of progression from dependent heroin use to fatal overdose and methadone entry. They also make assumptions about rates of exit from heroin dependence. The extent of uncertainty in the estimates has been assessed by examining the impact of varying these assumptions on the resulting estimates. The range of national estimates produced by varying these assumptions was between 39,000 and 120,000 for the back projection estimate derived from overdose deaths and between 47,000 and 109,000 for the back projection estimate derived from numbers of new methadone entrants.

The fact that back projection methods of estimation that were applied to two different data sets produced estimates that were in reasonable agreement, and whose ranges substantially overlapped, provides some reassurance. So does the similarity between the back projection estimates, the CRM estimates and the most plausible multiplier estimates. Uncertainties remain which mean that our estimates should be interpreted cautiously. Nonetheless, these estimates, for all their uncertainties, substantially improve on more speculative estimates that

are often quoted in the media.

For a number of reasons we have not included estimates of the number of Australians who have ever used heroin or, even more speculatively, the number of Australians who are non-dependent heroin users in our tables. First, the public health and order significance of these prevalence estimates is much less evident than that of heroin dependent persons. It is the heroin dependent who are at highest risk of premature death from overdose and being imprisoned for property and drug offences. They also consume between 85% and 95% of all heroin that is consumed (see Appendix C). Second, the methods used to derive estimates of non-dependent heroin users typically involve using simple multipliers. For example, the estimated number of heroin dependent persons may be multiplied by a factor of 3, the proportion of past year heroin users who are heroin dependent (e.g. Hall et al, 1998). Third, we have not reported these simple calculations in our table because the media, politicians and the public tend to assume that all heroin users are dependent. This leads to inflated and alarmist estimates of the prevalence of heroin dependence in Australia. Our estimates of *dependent* heroin users better represent the dimensions of the public health and order problem posed by heroin use in Australia. They may, however, underestimate the risks of BBV transmission among nondependent injecting drug users.

7.3 WHY SO FEW?

Given speculative media estimates that there are more than 200,000 heroin dependent persons in Australia, the question will no doubt be asked: Why do we estimate that there are “only” 74,000 heroin dependent people?

Several factors explain the discrepancy between our estimates and media-generated expectations. First, our estimate is of dependent or daily heroin users. Second, dependent heroin users are highly visible in local areas in Sydney (Maher et al, 1998) and Melbourne (Fitzgerald et al, 1999) where they often attract media attention out of all proportion to their numbers. In NSW, for example, 35% of fatal opioid overdoses occur in two main geographic areas of the city (Darke et al, 1999). Within these areas, intoxicated dependent heroin users are often seen, dealing, and using drugs, and they leave discarded injecting equipment in public places. Third, criminally involved dependent heroin users often engage in a high rates of shop-lifting and breaking and entering houses (Maher et al, 1998), producing social nuisance and inconvenience out of all proportion to their numbers. Fourth, persons who inject heroin and engage in polydrug use are at high risk of experiencing non-fatal and fatal overdoses. These events also tend to be concentrated in a relatively small number of geographic areas in our larger cities.

7.4 WHY HAS THE NUMBER OF HEROIN USERS INCREASED IN AUSTRALIA?

There are at least three plausible reasons why the number of dependent heroin users has increased in Australia over the past decade. First, there has been a substantial increase in the availability of very pure and very cheap heroin in Australia in the past decade (for a discussion of this issue see Appendix D). The historical data indicate that the purity of street heroin in Sydney has increased from 10% in 1979 to a mean of 60% in 1997-1998 (IDRS,

1999). The nominal street price has remained stable at \$30 for a street cap but its effective price per gram has declined from \$3000 to \$1000 (without taking account of inflation which would amplify the drop in street price). Second, the high purity and low price has meant that it has been easier for new users to initiate heroin use by non-injecting routes such as smoking or inhaling the fumes of heated heroin. This may have permitted more naïve users to begin heroin use before making a subsequent transition to injecting. Third, more speculatively, is the hypothesis of intergenerational forgetting. According to this hypothesis (e.g. Johnstone, 1991; Kleiman, 1993; Musto, 1983), epidemics of illicit opiate and cocaine use occur when members of a birth cohort do not have the bad example of drug dependent older peers and siblings to deter them from initiating heroin use. In Australia, an epidemic of heroin use occurred in the middle 1980s when there was a sharp increase in the number of new users initiating heroin use. This generation of heroin users is now the age of the parents of new heroin users who, like many adolescents, believe themselves to be immune from the errors of their parents' generation.

7.5 IMPROVING ON THESE ESTIMATES

These estimates can be improved upon as follows. First, the provisional estimates for each jurisdiction should be tested against direct estimates produced by applying these methods to jurisdictional data. This approach may have a limited role in the smaller jurisdictions where small numbers of cases in different data sets will produce wide confidence intervals around locally derived estimates. Attempts to produce substantially better jurisdictional estimates may also encounter other difficulties, such as, issues of confidentiality in matching individuals across different data sets (especially those compiled by health and law enforcement agencies); the costs of extracting data from existing records; and poor data quality in routine administrative records.

Attempts to use existing data sources to produce improved estimates of the numbers of dependent heroin users may provide a motivation for better routine data collection. The implementation of national minimum data sets for alcohol and drug treatment, including methadone and other forms of drug substitution treatment, will be an important advance. Estimates can also be improved by: obtaining better estimates of treatment, non-fatal overdose, arrest and imprisonment multipliers from surveys of out-of-treatment heroin users in each jurisdiction. Longitudinal studies of Australian heroin users will also provide better estimates of rates of progression to fatal overdose and entry to methadone maintenance treatment.

These efforts should improve our estimates of the number of dependent heroin users in Australia. There will remain, however, an irreducible uncertainty in all estimates of the size of a relatively small proportion of adults who clandestinely engage in an illegal and stigmatised activity. We accordingly need to heed Aristotle's injunction that it is the mark of an educated person "to seek exactness so far in each subject as the nature of things admits" (Nichomachean Ethics, Book 1, p3).

How often should these estimates be updated? The simpler multiplier methods that involve modest amounts of data collection and trivial calculations can be updated annually whenever mortality, police arrest, ambulance and treatment data are updated. Given the fluctuations in annual data from smaller jurisdictions it may be better to look at smoothed data over a

period of two to three years to minimise the risk of public alarm from annual variations in these indicators, especially in the smaller jurisdictions.

Estimates derived by using more labour intensive methods, such as, back-projection and capture-recapture, could be done every three to five years. This should be sufficiently frequent unless there are good reasons to believe that the incidence or prevalence of heroin dependence is changing more rapidly than this. It would also be prudent to undertake five yearly reviews of the validity of multipliers and the assumptions required by back-projection methods. Any changes in the assumptions of these methods may require retrospective correction of earlier estimates.

7.5 CONCLUSIONS

The application of a number of different methods of estimation to several different data sets on indicators of the consequences of heroin dependence has produced a range of estimates of the prevalence of heroin dependence in Australia that vary between 67,000 and 90,000 with a "best estimate" of 74,000. This estimate corresponds to a prevalence of 6.9 per 1000 adults aged 15 to 54 years which is within the range of estimates recently derived in Europe and it is not substantially different from the estimated prevalence of heroin dependence in the UK and USA. Within Australia, New South Wales has the highest number of heroin dependent persons (comprising just under half the national total of 74,000) with a prevalence of 9.8 (per 1000 adults aged 15 to 54 years). Victoria and Western Australia have the next highest prevalence rates.

These estimates have their limitations, as do all such efforts to estimate the size of a small hidden population that comprises a relatively small proportion of the adult population. Nonetheless, they are probably the best estimates that can be feasibly achieved, given the costs of substantially improving upon them, issues of confidentiality in matching individual records across data sources, and the uneven quality of existing data sets. For all their acknowledged imperfections, they also provide a more secure basis for debate about public policy on heroin use than more conjectural estimates provided in the popular media.

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APPENDIX A: PREVIOUS MULTIPLE ESTIMATES OF OPIOID DEPENDENCE IN AUSTRALIA

A.1. NATIONAL DRUG ABUSE DATA SYSTEM (NDADS) 1988

A series of estimates of the number of heroin users in the Australian population were produced in 1988 by the National Drug Abuse Data System (NDADS) to provide a range of estimates of the number of heroin users in Australia in the middle 1980s. These were derived as follows:

1. A capture-recapture estimate of the number of heroin users in NSW in 1984 (10,000) was multiplied by a factor of 3 (the ratio of NSW population to that of the rest of Australia). This produced an estimate of 30,000 dependent heroin users in Australia.
2. The number of opiate-related deaths in Australia in 1986 (namely, 249) was multiplied by the 100 and 200 to give estimates of between 25,000 and 50,000 dependent heroin users in Australia.
3. A household survey estimate of the percentage of the population that had injected a drug in the past year (1.8%) was used to estimate that there were 172,000 persons who had injected a drug in the past year. This was known to be an overestimate because it included persons who had injected drugs other than heroin. A better estimate was derived from the percentage of persons who reported using heroin in the previous year in the 1988 NCADA household survey (the results of which were not available at the time of the NDADS report). The latter survey provides a much lower estimate of the number of persons who had used heroin in the past year, namely, 28,000.
4. The number of persons in methadone treatment in Australia in 1987 (namely, 5,735) was multiplied by two factors. The first factor was 1.5 to estimate the number of all heroin dependent persons in treatment. The second two factors were 6 and 10 (Hartnoll et al's 1985 factors) as ratios of heroin users in treatment to their numbers in the population. This gave estimates of 50,000 to 80,000 dependent heroin users.

A.2. AN UPDATED NDADS ESTIMATE (HALL, 1995)

The 1988 NDADS estimates were updated by Hall (1995) using data gathered between 1988 and 1993 (see table 1.3).

1. The capture-recapture estimate of the number of heroin users in NSW in 1988-89 derived by Kehoe et al (1992) (namely, 15,000) was multiplied by a factor of 3 to give an estimate of the number of regular heroin users in Australia of 45,000.
2. The number of opiate-related deaths in Australia in 1992, namely, 492, (National Drug Strategy, 1994) was multiplied by factors of 100 and 200 to give estimates (to the nearest 1000) of 49,000 to 98,000 regular heroin users in Australia.

3. The 1991 National Drug Strategy household survey estimate of the percentage of the population that had used heroin in the past year (0.3%) was multiplied by the relevant population estimate to give an estimate of 36,000 persons who had used heroin in the past year in Australia.

4. The number of persons in methadone treatment in 1991 (approximately 10,000 from Ward et al, 1992a) was multiplied by 1.5 (to estimate the number of all persons in opiate treatment) and then by 6 and 10 (Hartnoll's factors) to give estimates of 90,000 to 150,000 dependent heroin users.

Table A.1: Estimates of the number of Australian heroin users in 1984-1987 and 1988-1993 from various sources by different methods

Method	1984-87		1988-1993	
	Range	Midpoint	Range	Midpoint
1. Multiple (x 3) of NSW CRM estimate		30,000 ¹		45,000 ³
2. Multiples (x 100 and x 200) of N fatal ODS	25,000 50,000	37,500 ¹	49,000 98,000	73,500 ⁴
3. Multiples of % of population who used heroin in the past year	0 56,000	28,000 ²	0 105,000	36,000 ⁵
4. Multiples (x 4 & 15) of N heroin users in treatment	52,000 86,000	69,000 ¹	90,000 150,000	120,000 ⁶
Median Estimated No. dependent heroin users *	25,000 86,000	34,000	49,000 150,000	59,000

* to nearest 1000

Sources: 1. NDADS, 1988

2. Larson, 1992 using National Household Survey, 1988;

3. Kehoe et al, 1992

4. National Drug Strategy, 1994

5. National Household Survey, 1991

6. Projection of figures in Ward et al, 1992a

Population rates of opiate dependence were estimated to take account of changes in the size and composition of the Australian population between the mid 1980s and the early 1990s. This is shown in Table 4. The median estimates of the numbers of regular and irregular heroin users from table 3 were divided in each case by estimates of the population in the age groups in which most opiate users are found (namely, 15 to 44 years) for the nearest years (1986 and 1990) from data provided by the Australian Institute of Health and Welfare (1993).

Table A.2: Estimated population prevalence (per 1000 population) of dependent heroin users in Australia 1986 and 1990.

Estimate	1986		1990	
	Dependent heroin users	34,000	4.5	59,000
Population size (15-44 years) ¹	7,582,629		8,171,048	

Source: 1. Australian Institute of Health and Welfare, 1993.

These calculations suggest that the estimated prevalence of regular heroin users (per 1,000 of population) had increased from 4.5 in 1986 to 7.2 in 1990. This increase is statistically significant.

In retrospect two of the multipliers used in producing these estimates probably over-estimated the prevalence of heroin dependence. The first multiplied the NSW capture-recapture estimates by 3 to produce national estimates because the NSW population is approximately a third of the national population. A more appropriate multiplier would be 2 since NSW accounts for approximately half of the opioid overdose deaths (Hall et al, 1999a) and a little over half of the persons in methadone maintenance treatment (Hall, 1995). The other doubtful multipliers were the 6 and 10 used for methadone maintenance numbers that were derived from Hartnoll et al's (1985) study in London. A more realistic multiplier is probably 3 (Hall, 1995). Applying these modified multipliers produces lower mean estimates of 27,000 in 1984-1987 and 40,000 in 1988-1993. This still represents a significant increase in population prevalence from 3.6 to 4.9 per 1000 adults aged 15 to 44 years.

APPENDIX B

FIGURE B.1: CUMULATIVE PROBABILITY OF OPIOID OVERDOSE DEATH FROM COMMENCING DEPENDENT HEROIN USE

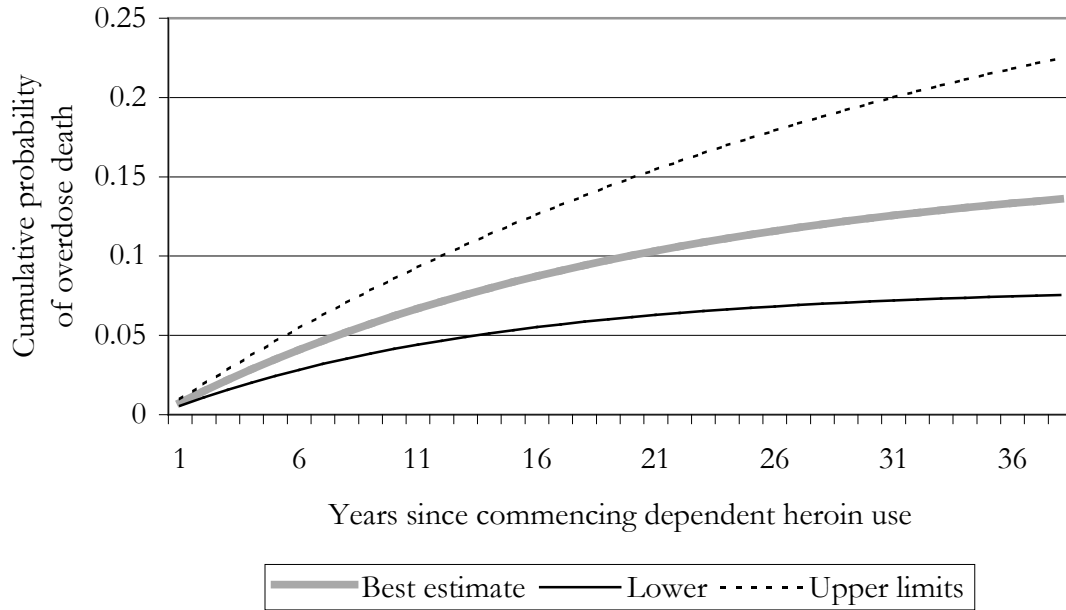


FIGURE B.2: CUMULATIVE PROBABILITY OF ENTRY INTO METHADONE TREATMENT FROM COMMENCING DEPENDENT HEROIN USE

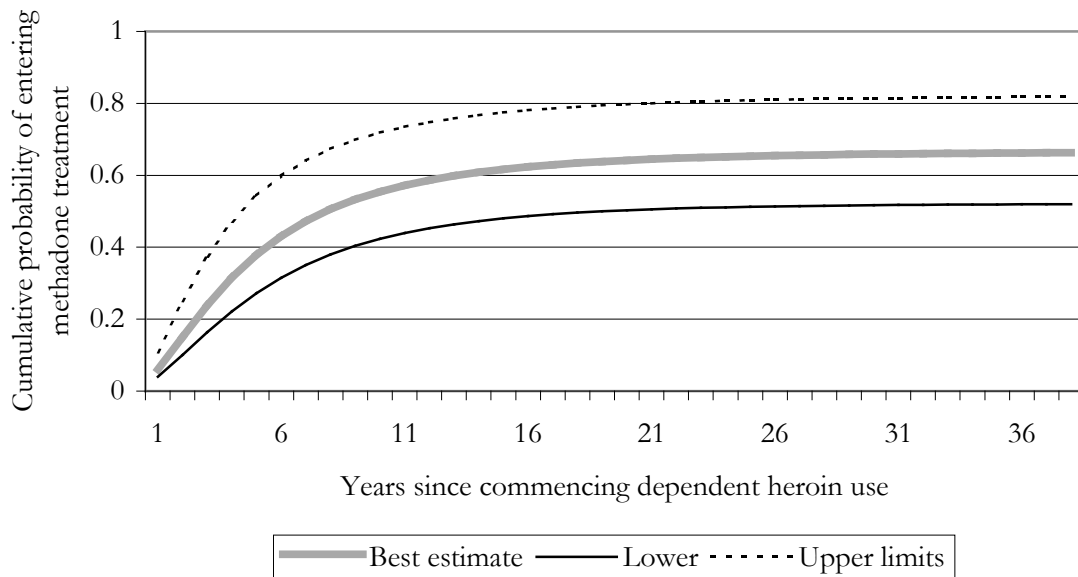


FIGURE B.3: REPORTED AND FITTED ANNUAL OVERDOSE DEATHS IN AUSTRALIA 1960-1997

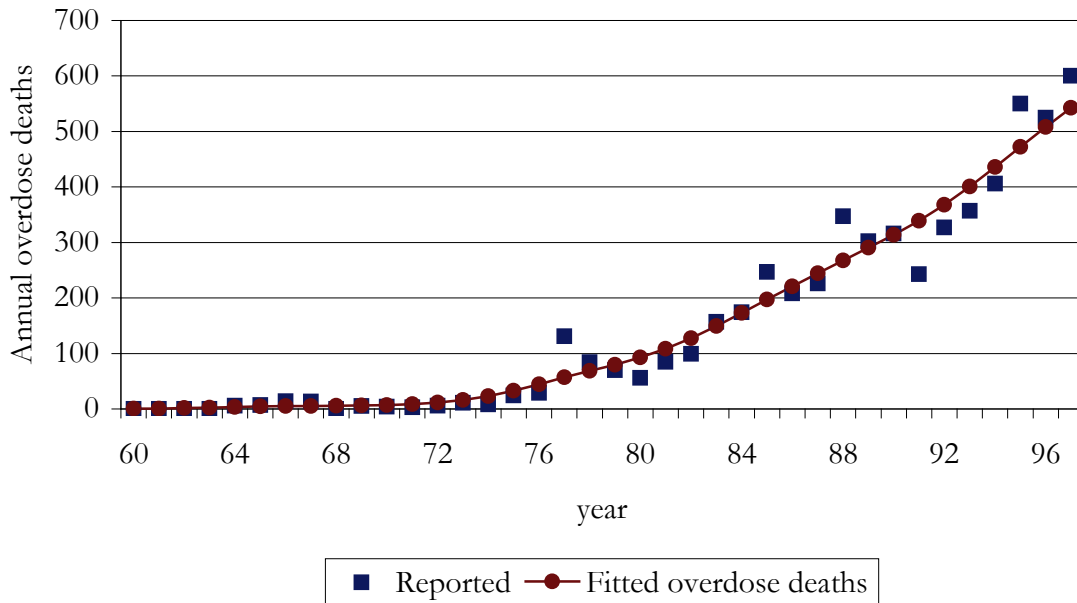


FIGURE B.4: BACK-PROJECTION ESTIMATES BASED ON OVERDOSE DEATHS OF NUMBERS OF PEOPLE COMMENCING DEPENDENT HEROIN USE IN AUSTRALIA 1960-1997

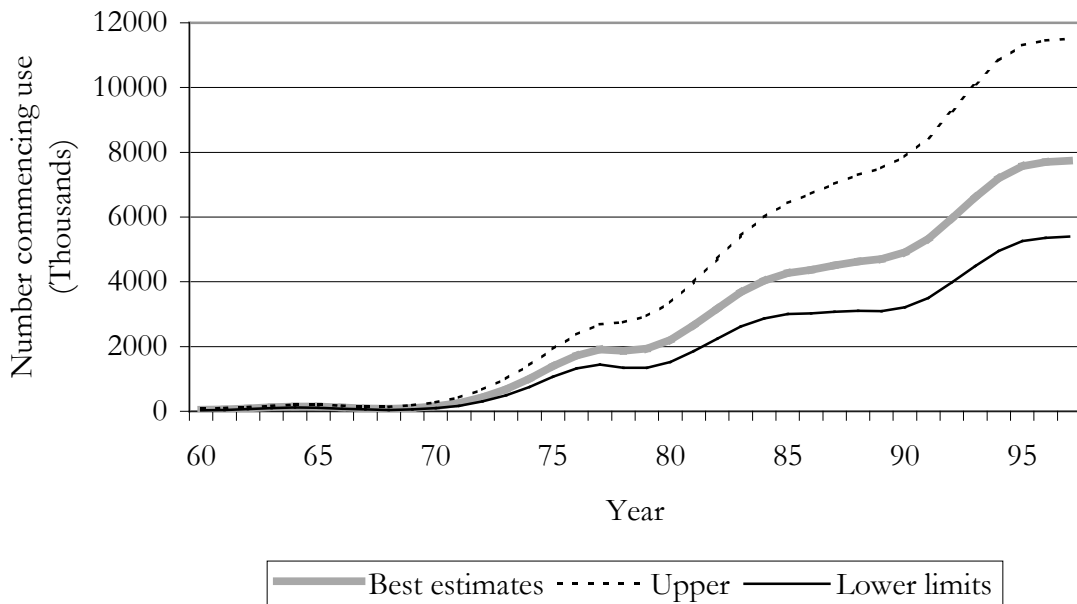


FIGURE B.5: REPORTED SMOOTHED AND FITTED ANNUAL ENTRANTS TO METHADONE TREATMENT IN NSW 1970-1997.

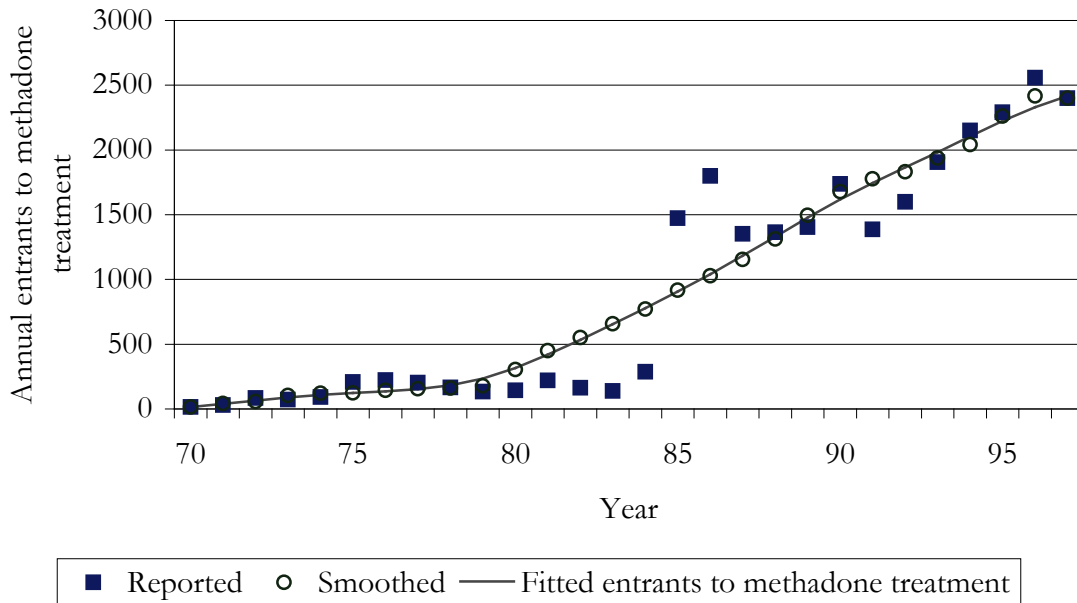
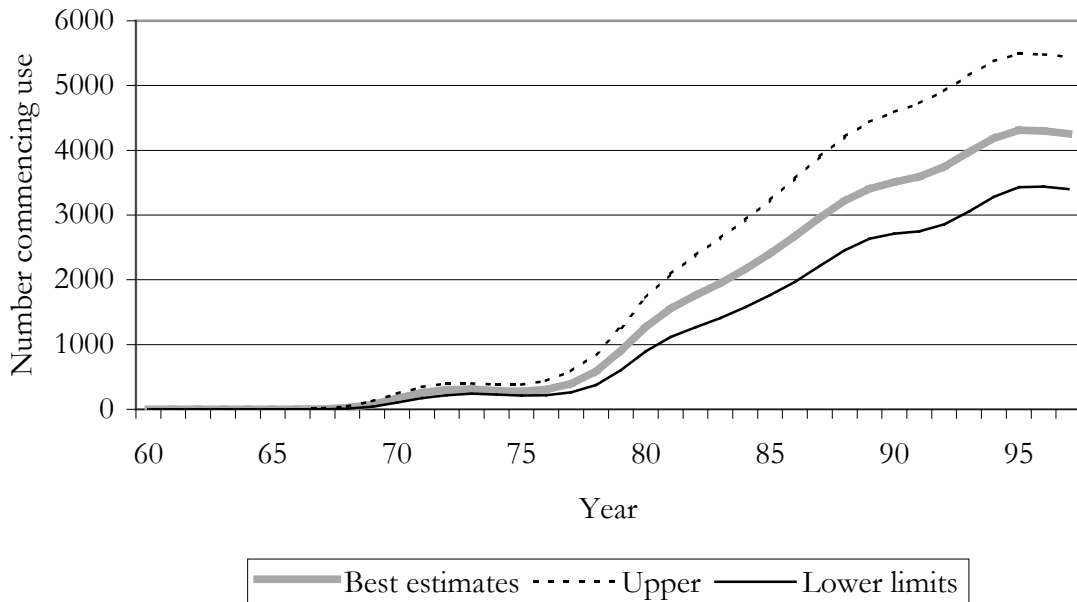


FIGURE B.6: BACK PROJECTION ESTIMATES BASED ON ENTRANTS TO METHADONE TREATMENT OF NUMBERS OF PEOPLE COMMENCING DEPENDENT HEROIN USE IN NSW 1960-1997



APPENDIX C: AMOUNT OF HEROIN CONSUMED BY HEROIN USERS

The current estimates of the number of dependent heroin users in Australia were used to estimate the amount of heroin used by dependent and non-regular heroin users. These calculations were made using the assumptions of Weatherburn and Lind (1995) in their estimates of the amount of heroin used by "regular and recreational heroin users". These were:

1. That there are 2-3 times as many recreational as there are regular heroin users.
2. That regular heroin users use heroin 2-3 times per day (i.e. 17.5 times per week).
3. That recreational heroin users use heroin on the weekend, between once per fortnight (0.5 times per week) and once per week.
4. The amount of pure heroin used in each injection is 0.03g.

The following numbers of regular and recreational heroin users were used:

Regular	74 000
Non-regular	148 000 – 222 000

Regular heroin users

Injections per regular users per annum = $17.5 \times 52 = 910$

Amount of heroin used per regular user per annum = $910 \times 0.03 = 27.3 \text{ g}$

Heroin consumption per annum among regular users

= $27.3 \text{ g} \times 74\,000 = 2\,020\,000 \text{ grams}$

= **2 020 kilos**

Recreational heroin users

Injections per recreational user per annum = $26 - 52$

Lower limit amount of heroin used per recreational user per annum = $26 \times 0.03 = 0.78 \text{ g}$

Upper limit amount of heroin used per recreational user per annum = $52 \times 0.03 = 1.56 \text{ g}$

Lower bound of heroin consumption per annum

= $0.78 \text{ g} \times 148\,000 = 115\,440 \text{ g}$

= **115.44 kilos**

Upper bound of heroin consumption per annum

= $1.56 \text{ g} \times 222\,000 = 346\,320 \text{ g}$

= **346.32 kilos**

Conclusion

Regular of dependent heroin users consume between 85% (2,020/2366.32 kg) and 95% (2020/2135.44 kg) of the total estimated heroin consumption in Australia

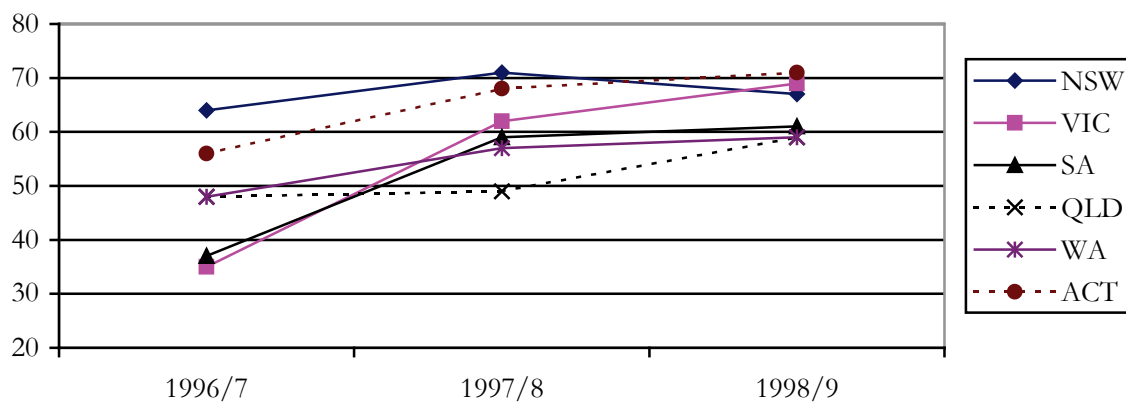
APPENDIX D: TRENDS IN HEROIN PRICE AND PURITY

Purity

In 1981, major heroin dealers in Melbourne conducted a survey of heroin supply in Melbourne (Marks, 1990). The purity of heroin that was handled by low-level dealers was around 16% pure, with caps purchased by users around 4-8% pure heroin. These findings were corroborated by other sources. In the Williams Commission report, in August 1979 law enforcement heroin seizures were reported to be typically between 10 to 20% pure (Williams, 1980). A submission from the Department of Business and Consumers' Affairs in 1977 reported that the typical purity of heroin bought by users was 10% (Williams, 1980).

The purity of heroin appears to have increased substantially since then. Street level samples of heroin in South Western Sydney between 1993 and 1995 had a purity of around 60% (Weatherburn and Lind, 1995). South Australian seizures of heroin between 1994 and 1997 ranged between 22-31% (McGregor et al., 1998). In 1998-1999, the average purity of heroin seizures in Australia was estimated at 57% (ABCI, 2000). Figure 1 shows that police heroin seizures have increased in purity over the past couple of years (source McKetin et al., 2000).

FIGURE C.1: PURITY OF SEIZED HEROIN 1996/7 TO 1998/9



Price

In 1978/9, estimates of the price of an average deal of heroin (per cap) ranged from around \$35 in the ACT and in South Australia, to around \$50-\$60 in New South Wales, Western Australia and Tasmania (Williams, 1980). Another common form of street dealing was in pharmaceutical capsules, the cost of which were generally between \$30 (New South Wales and South Australia) and \$50 (Western Australia). An ounce of heroin was estimated to cost between \$2400 (NSW) and \$3000 (NSW, Victoria and SA; Williams, 1980).

The price per street dealing unit has changed little between 1980 and the late 1990s. According to estimates from the 1998-1999 Australian Illicit Drug Report, an ounce of

heroin typically costs between \$2-4,000 in NSW (which is the cheapest state), with other states having higher prices (e.g. \$4-7,000 in SA; ABCI, 2000). The price of heroin caps is typically around \$20 in NSW.

The price of heroin has in real terms decreased markedly over the past two decades when one considers that the prices paid in 1999 are similar to those paid in 1980 for a product that was around 6 times purer in 1999. Table 2 shows the price of a pure ounce of heroin and a pure “cap” of heroin in 1999 dollars. Clearly, over the past 20 years there has been a substantial drop in the real price (1999 dollars) of heroin – an ounce of pure heroin is around 18% of the price in 1999 (\$5,000) that it was in 1980 (\$28,056). The price in 1999 dollars of a pure “cap” in 1999 (\$33) is around 6% of the price it was in 1980 (\$526).

Table C.1: Price of an ounce and a “cap” of heroin in 1980 and 1999

	1980	1999
Street ounce of heroin	2,400	3,000
	(15% pure)	(60% pure)
Price per pure ounce	16,000	5,000
Price per pure ounce adjusted for inflation (1999 \$)	28,056	5,000
Cap of heroin	30	20
	(10% pure)	(60% pure)
Price per pure cap	300	33
Price per pure cap adjusted for inflation (1999 \$)	526	33

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