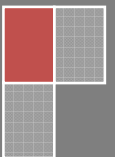


**A review of estimation methods  
on prevalence of drug abuse  
population in Hong Kong**

***Final Report***

Prepared by  
***Policy 21 Limited***  
February 2013



# I. Introduction

## 1. Background

1.1 There is no universally accepted method to accurately measure the size of the drug abuse population in a country or territory. This is because drug abuse is a socially unacceptable and relatively rare phenomenon. Traditional estimation methods such as territory-wide surveys tend to be inaccurate due to large sampling and possibly under-reporting errors.

1.2 As such, Hong Kong all along adopts a multi-dimensional approach to monitor the local drug abuse situation. The Central Registry of Drug Abuse (CRDA), research studies focusing on specific sub-populations and drug-related statistics (e.g. drug seizure figures) play a central role in this regard. The Narcotics Division conducts the Survey of Drug Abuse among Students regularly which provides estimates of the prevalence of drug abusers among young people attending schools. While such approach has proved to be efficient in monitoring the trends of drug abuse, which is crucial for policy formulation, it is unable to produce an accurate measure of the prevalence of drug abuse.

1.3 Furthermore, there are diverse views on the definition of drug abusers worldwide. For instance, some define persons who have ever used drugs within a certain period (e.g. four weeks, twelve months or other periods) as abusers; some only define frequent or heavy (at a variety of thresholds) drug users as abusers; and some define persons as drug abusers only if they show addicted symptoms (according to various medical criteria such as DSM IV or ICD 10 criteria). There is so far no universally accepted definition. In order to ascertain the extent of the problem, there is a need to review the various definitions adopted and consider their suitability in the local context.

1.4 In the literature, a number of indirect methods have been developed trying to answer the question of estimating the prevalence of drug abuse. For example, the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) has documented various methods and their applications in different European countries. Another newly established method called the “Respondent Driven Sampling” may also serve the purpose. These methods, including combinations of them, have been tried out by various researchers in other countries. However, each method has its limitations and not all of them are applicable to the local context. Hence, there is a need to review the pros and cons and applicability of these methods in Hong Kong.

## **2. Study objectives**

2.1 The objectives of the study are as follows:

- a) To review the definitions of drug abusers adopted worldwide and recommend a more suitable definition(s) in the context of Hong Kong with reference to international criteria;
- b) To review and document various methods for estimating the drug abuse population available, including their pros and cons, merits and limitations, possible biases and errors inherited;
- c) To assess the applicability of these methods in estimating the overall and sub-group (e.g. non-engaged youth, etc.) drug abuse population in Hong Kong and their merits and limitations;
- d) To recommend one or more pragmatic estimation methods, devise arrangements for their implementation and estimate the costs in the context of Hong Kong.

2.2 This report presents the findings of the study, based on a review of practices adopted in other countries on the definition of drug abusers, consultation with agencies involved in reporting information on drug abusers to the CRDA, review of research studies conducted in other countries on the estimation of the drug abuse population and estimations of drug abuse population in Hong Kong making use of anonymized data on drug abusers contained in the CRDA. The report is organized into the following sections:

- a) Introduction;
- b) Definitions of drug abusers;
- c) Estimation of drug abuse population;
- d) Summary of recommendations.

## II. Definitions of Drug Abusers

### 3. Overview

#### *Main considerations*

3.1 Several parameters are relevant in defining drug abusers over a certain period of time, which include the specific substance used (e.g. opioids, amphetamines), the administration method (e.g. injection, smoking), frequency of use (e.g. experimental, occasional, habitual), legal status of the substance used and clinical diagnosis (e.g. dependence). As data on drug abusers are usually derived from “institutionally visible” population when they are contacted by the legal, medical or social system. Any definition adopted should take into account the interests, norms and values of these three systems.<sup>1</sup>

3.2 Indeed, as pointed out by researchers, how drug abusers should be defined was closely linked to the purpose of compiling the estimate. If the purpose is to assess possible treatment needs, then the definition should be related to potential clients of treatment agencies, either now or in the future. If it is to assess the possible demand, and thus the illicit market, for a drug such as heroin, all heroin users should be included, regardless of whether they are likely to seek treatment.<sup>2</sup>

3.3 Furthermore, if the dominant aim is to suppress all drug use, a definition of drug abusers that includes all types of drug use would be more appropriate. If the emphasis is placed on “harm reduction”, the number of drug users should include those who are clients or potential clients for harm reduction intervention programmes.<sup>3</sup> It was also noted by researchers that drug use patterns changed quickly. The epidemiological task should therefore move beyond point prevalence estimation and towards an understanding of the dynamics of changes in drug use over time.<sup>4</sup>

3.4 In addition, the drug abuse habit differs from persons to persons, in terms of how much, how often and types of drug used. There are experimental, occasional or one-off users as well as those with problematic drug use. To facilitate an understanding of the dynamics of changes in drug use over time, to evaluate the impact of anti-drug programmes and to plan for the provision of treatment and preventive programmes, it is desirable to adopt a definition that covers different categories of drug abusers.

---

1 European Monitoring Centre for Drugs and Drug Addiction (2008), *Guidelines for estimating the incidence of problem drug use in Europe*, p.10.

2 European Monitoring Centre for Drugs and Drug Addiction (1996), *Estimating the prevalence of problem drug use in Europe*, EMCDDA Scientific Monograph Series, No. 1.

3 Cohen, Peter D A (1996), “The relationship between drug use prevalence estimation and policy interests”, in *Estimating the prevalence of problem drug use in Europe*, EMCDDA Scientific Monograph Series, No. 1.

4 Stimson, Gerry V. and Judd, Ali (1996), “Estimating the scale and nature of drug problems: the relationship between science, policy and drug strategy”, in *Estimating the prevalence of problem drug use in Europe*, EMCDDA Scientific Monograph Series, No. 1.

### ***Approach adopted***

3.5 In the circumstances, it is desirable to adopt a definition that covers different categories of drug abusers such that information obtained is useful for planning, policy formulation, programme evaluation and research purposes. Furthermore, due considerations have to be given to the feasibility of “operationalizing” the definitions in data collection and programme implementation, such that the respondents in surveys conducted to estimate the prevalence rate of drug abuse are able to answer questions asked, as well as frontline workers responsible are able to report cases to relevant authorities and/or CRDA. Needless to say, such definitions have to be compatible with existing rules and regulations adopted in law enforcement.

## **4. Practices in Hong Kong and other countries**

### ***Situation in Hong Kong***

4.1 In Hong Kong, “a drug abuser is defined to be a person who has come into contact with a particular agency and is known or suspected to have taken substances during the four weeks before the date of contact, and the substances if taken harm or threaten to harm the physical, mental or social well-being of an individual, in doses above or for periods beyond those normally regarded as therapeutic.”

### ***International recommendations***

4.2 It is noted that the International Classification of Diseases (ICD) and the Diagnostic and Statistical Manual of Mental Disorders (DSM) give clear criteria for dependence on specific psychotropic substance groups, as well as for abuse. According to DSM-IV, disorders related to psychotropic substances include the following substance groups. The DSM-IV has specific criteria for dependence on substances and abuse of substances and ICD-10 also has similar criteria for dependence on substances.<sup>5</sup>

- a) Alcohol;
- b) Opioids (e.g. heroin, morphine, codeine, methadone);
- c) Cocaine (e.g. cocaine, crack);
- d) Amphetamines (e.g. amphetamine, dextroamphetamine, methamphetamine, methylphenidate);
- e) Sedatives, hypnotics, anxiolytics (e.g. benzodiazepines, barbiturates);
- f) Hallucinogens (e.g. LSD, mescaline, ecstasy, psilocybin, DMT);
- g) Phencyclidine (e.g. PCP, ketamine);
- h) Inhalants;
- i) Cannabis;
- j) Nicotine;

---

<sup>5</sup> European Monitoring Centre for Drugs and Drugs Addiction (2004), *Key Epidemiological Indicator: prevalence of problem drug use*, p.9.

- k) Caffeine;
- l) Multiple substance use which is defined as use of substances of at least three substance groups in the last twelve months, without a clear preference for one main substance (except nicotine and caffeine)

4.3 Apart from dependence and abuse, researchers noted that the extent of harm depended also on the patterns of drug abuse. First and foremost was the mode of administration with direct injection being the most harmful to health as the drugs would be absorbed almost instantaneously. The second pattern was the level of intoxication and third was regular or prolonged use.<sup>6</sup> Thus, the European Monitoring Centre for Drugs and Drug Addiction defines problem drug use as “injecting drug use or long duration/regular use of opioids, cocaine and/or amphetamines”.<sup>7</sup>

4.4 In practice, however, the definitions adopted in gathering information on drug abusers do not always conform to international recommendations, for policy and practical considerations. These issues are discussed in the paragraphs to follow, in connection with discussions on practices adopted in a number of countries.

### *Canada*

4.5 In Canada, drugs are considered in the broadest sense to include any substance, other than food, which is taken to change the way the body and/or mind function. Drug use becomes a problem when it results in negative consequences for the person using it, and its continued use is generally referred to as drug abuse. The importation, production, distribution and possession of various drugs and substances are governed primarily by provisions of the *Controlled Drugs and Substances Act* (CDSA). Drugs covered by CDSA include the following:<sup>8</sup>

- a) Hallucinogens which are drugs dramatically affecting perception, emotions and mental processes. More popular examples of such drugs are LSD and MDMA “Ecstasy”;
- b) Central Nervous System (CNS) depressants which are drugs causing a slowing down or depression of the central nervous system. More popular examples are opioid analgesics, alcohol, inhalants, benzodiazepines, barbiturates and other sleeping pills;
- c) Stimulants which are drugs exciting or speeding up the central nervous system. Examples are nicotine and caffeine;
- d) Cannabis, which includes marijuana, hashish and hash oil. It is basically a hallucinogen and is the most widely-used of all drugs that are used illegally;

---

6 Paglia-Boak, Angela and Adlaf, Edward (2007), “Substance use and harm in the general youth population”, in Canadian Centre on Substance Abuse (2007), *Substance Abuse in Canada: youth in focus*, p.8.

7 European Monitoring Centre for Drugs and Drug Addiction (2008), *Guidelines for estimating the incidence of problem drug use in Europe*, p.10.

8 Health Canada (2000), *Straight facts about drugs and drug abuse*.

- e) Antidepressants which are drugs used to treat clinical depression and some other disorders such as panic attacks, obsessive compulsive disorders and bulimia. Examples include tricyclic antidepressants and Selective Serotonin Reuptake Inhibitors (SSRIs);
- f) Anabolic androgenic steroids which belong to a class of drugs known as ergogenic or performance-enhancing drugs. They include both testosterone and synthetic drugs related chemically to testosterone.

4.6 Statistics on drug abusers are collected through the Canadian Alcohol and Drug Use Monitoring Survey which is an on-going general population survey of alcohol and illicit drug use among Canadians aged 15 and older, sponsored by Health Canada. The data are collected through telephone interviews on reported abuse of drugs in the past twelve months prior to enumeration. Commonly abused drugs are covered in the survey, including cannabis and other illicit drugs like hallucinogens, ecstasy, cocaine or crack and speed, salvia which is becoming popular, and psychoactive pharmaceutical drugs like opioid pain relievers (such as Percodan®, Demerol®, and OxyContin®), stimulants (such as Ritalin®, Concerta®, Adderall®, and Dexedrine®) and tranquilizers and sedatives, (such as Valium®, Ativan®, and Xanax®).<sup>9</sup>

4.7 It may be worth noting that salvia or magic mushroom is included in the general hallucinogens category in the survey, because it is a substance readily available in Canada and is becoming increasingly popular. However salvia is not regulated under the *Controlled Drugs and Substances Act*.<sup>10</sup> It may also be noted that no attempt is made in gathering data on drug abusers through the Canadian Alcohol and Drug Use Monitoring Survey to assess drug dependence and abuse, following DSM-IV and ICD-10 recommendations. This is probably due to operational considerations as it is difficult to conduct long and complicated interviews over the telephone in the Canadian Alcohol and Drug Use Monitoring Survey.

### ***United Kingdom (UK)***

4.8 In the UK, the Misuse of Drugs Act 1971 classifies illegal drugs into three categories (Class A, B and C) according to the harm that they cause, with Class A drugs considered to be the most harmful. In practice, however, the definition of drug abuse covers not only illegal drugs but also other drugs the misuse of which is harmful to health.

4.9 Furthermore, it is noted that the definitions of drug abuse adopted are invariably dictated by practical considerations on the part of the data source(s), and in particular the case definitions used by the contributing data sources. For instance, in an attempt to estimate the prevalence of problem users, making use of drug treatment, probation, police and prison data, the coverage of drug abusers include those who use opiates and/or crack cocaine and drug injectors. It may be noted that the focus is on opiate drugs and injection drugs dealt

---

<sup>9</sup> [http://www.hc-sc.gc.ca/hc-ps/drugs-drogues/stat/\\_2010/summary-sommaire-eng.php#defin](http://www.hc-sc.gc.ca/hc-ps/drugs-drogues/stat/_2010/summary-sommaire-eng.php#defin), retrieved on 15 May 2012.

<sup>10</sup> Royal Canadian Mounted Police (2010), *Report on illicit drug situation in Canada – 2009*, p.14.

with by drug treatment centres, probation offices, police and prisons. It was also noted by researchers that while measures of drug dependence have been devised, based on ICD codes or DSM diagnostic criteria, these measures were not commonly used by relevant data sources.<sup>11</sup>

4.10 Nevertheless, data on drug abuse serve not only treatment and law enforcement purposes. In the widest sense, the data are useful for planning and policy formulation on matters related to health and wellbeing of the population. Indeed, as noted in the drug strategy paper of the UK government, the focus has moved from harms caused by heroin and crack cocaine to new kinds of drug abuse including for example the use of psychoactive substances. In addition, there are groups of clients of treatment centres who are not stereotype dependent drug users, including those who are younger.<sup>12</sup>

4.11 Accordingly, in gathering information on the use of illegal drugs from the population in say the British Crime Survey, a list of drugs commonly used and for which the majority of users are householders is adopted. The list covers the following commonly used drugs shown in the table below. The frequency and length of time in which drugs are used are more relaxed. Statistics on the use of drugs are collected from persons who have ever used drugs, used at least once the year prior to interview or at least once in the month prior to interview.<sup>13</sup> Apparently, the use of this definition covering problematic, experimental, occasional and one-off drug use is underpinned by the purposes for which the British Crime Survey is conducted, which are for prevention, intervention and treatment purposes.

<b>Classification</b>	<b>Drug</b>
Category A	Powder cocaine
	Crack cocaine
	Ecstasy
	LSD
	Magic mushrooms
	Heroin
	Methadone
	Methamphetamine
Class A/B	Amphetamines
Class B	Cannabis
Class B/C	Tranquillisers
Class C	Anabolic steroids
	Ketamine
Not classified	Amyl nitrite
	Glues (including glues, solvents, gas or aerosols)

11 Nicola Singleton, Rosemary Murray, Louise Tinsley (2006), *Measuring different aspects of problem drug use: methodological developments*, UK Home Office Online Report, 16/06.

12 UK Home Office (2010), *Drug Strategy 2010, reducing demand, restricting supply, building recovery: supporting people to live a drug free life*.

13 UK Home Office (2010), *Drug misuse declared: findings of the 2009/10 British Crime Survey - England and Wales*.



4.12 In addition, similar to practices in Hong Kong, a survey of smoking, drinking and drug abuse by secondary school students aged 11 to 15 in England has been conducted since 1982. Since 2000, the survey is conducted annually by the National Centre for Social Research and the National Foundation for Educational Research. In the survey, those who usually take drugs at least once a month are classified as frequent drug users. In addition, data on those who have ever taken drugs and taken drugs in the previous year and the previous month are collected. Specific drugs covered in the survey include Class A, B or C drugs as defined in the Drugs Act 2005, like amphetamines, anabolic steroids, cannabis, cocaine, crack, ecstasy, heroin, ketamine, LSD, magic mushrooms, methadone, poppers (e.g. amyl nitrite) and tranquillisers, as well as volatile substances such as gas, glue, aerosols and other solvents, and 'other' drugs (not obtained from a doctor or chemist).<sup>14</sup> In other words, the list of drugs adopted is much broader than Classes A, B and C drugs though no attempt has been used in the school survey to assess drug dependence and abuse.

### ***United States of America (USA)***

4.13 In USA, statistics on illicit drug use by the population collected in household surveys cover only the more popular or commonly used drugs. The National Survey on Drug Use and Health (NSDUH) obtains information on different categories of illicit drug use, as shown below. Statistics related to current illicit drug users refer to those who have used an illicit drug during the month prior to interview.<sup>15</sup>

- a) marijuana (including hashish);
- b) cocaine (including crack);
- c) heroin;
- d) hallucinogens (including LSD, PCP, peyote, mescaline, mushrooms, and "Ecstasy" (MDMA));
- e) inhalants (including a variety of substances, such as amyl nitrite, cleaning fluids, gasoline, paint, and glue); and
- f) nonmedical use of prescription-type pain relievers, tranquilizers, stimulants (e.g. Methamphetamine) and sedatives.

4.14 To assess dependence on and abuse of substances, a number of questions are asked in the survey, based on criteria specified in the *Diagnostic and Statistical Manual of Mental Disorders*, 4th edition (DSM-IV). Questions on dependence are related to health and emotional problems associated with substance use, unsuccessful attempts to cut down on use, tolerance, withdrawal, reducing other activities to use substances, spending a lot of time engaging in activities related to substance use, or using the substance in greater quantities or for a longer time than intended. Questions on abuse are related to problems at work, home, and school; problems with family or friends; physical danger; and trouble with the law due

---

14 UK Health and Social Care Information Centre (2011), *Smoking, drinking and drug use among young people in England in 2010*,

15 US Department of Health and Human Services, Substance Abuse and Mental Health Services Administration (2009), *Results from the 2008 National Survey on Drug Use and Health: National Findings*.

to substance use.<sup>16</sup> Apparently, more complicated questions on drug dependence and abuse are possible in the National Survey on Drug Use and Health which is conducted through face-to-face interviews.

4.15 It may be noted that the National Survey on Drug Use and Health described above is the primary source of information on the prevalence of illicit drug use among the civilian, non-institutionalized population aged 12 or older. The data are collected through face-to-face computer-assisted interviews. Items on sensitive topics such as drug use are self-administered to ensure privacy and promote accurate reporting. Apart from questions on dependence and substance abuse, information on the (current) use of illicit drugs during the month prior to enumeration and on first-time use in the past twelve months is collected in the survey, based on which estimates of the number of illicit drug users are compiled.

4.16 It may also be worth noting that the non-medical use of prescription drugs is included as one of the conditions for the classification of drug abusers. This is because prescription drug abuse has become a major public health concern in the US. While in 2009 there were 39,147 drug-induced deaths, exceeding deaths from motor vehicle crashes (36,216), there were in 2008 20,044 unintentional prescription drug overdose deaths.<sup>17</sup>

4.17 Apart from this survey, there is a system (namely the Treatment Episode Data Set) containing data on the demographic characteristics and substance abuse problems of those admitted to substance abuse treatment, primarily at facilities that receive some public funding. It should be noted that the data are kept at the admission (and discharge) level, and not at individual level, such that an individual may have more than one admission.<sup>18</sup> Apparently, the coverage of drug abusers in the Treatment Episode Data Set only applies to those who are admitted formally into institutions for drug abuse treatment. The system also covers co-dependents who have no drug or alcohol problem but are seeking services because of problems arising from their relationship with an alcohol or drug user.<sup>19</sup>

## **5. Definitions adopted for the CDRA**

### ***Relevant factors to consider***

#### *Uses of CRDA data*

5.1 As discussed above, the intended use of statistics on drug abusers is closely related to how drug abusers should be defined. In other words, how drug abusers should be defined in the CRDA depends to a large extent on the uses of the CRDA data. Established in 1972, the CRDA provides relevant drug abuse statistics for monitoring changes in drug abuse

---

16 US Department of Health and Human Services, Substance Abuse and Mental Health Services Administration (2009), *Results from the 2008 National Survey on Drug Use and Health: National Findings*.

17 The White House (2012), *National Drug Control Strategy*, p.47.

18 US Office of Applied Studies, Substance Abuse and Mental Health Services Administration (2007), *A day in the life of American adolescents: substance use facts*.

19 US Substance Abuse and Mental Health Services Administration (2010), *Treatment Episode Data Set State Instruction Manual*.

trends and characteristics of drug abusers to facilitate the planning of anti-drug strategies and drug abuse programmes in Hong Kong. More specifically, the objectives of the CRDA are as follows:<sup>20</sup>

- a) To identify trends in the nature of drug addiction and the addict population in Hong Kong with reference to the demographic characteristics of the overall population;
- b) To coordinate statistics from various sources for analyzing the characteristics of the reported drug addict population at any given time, and to contrast these characteristics among abusers reported from various sources;
- c) To provide a database which is responsive to requests for monitoring selected groups of reported drug abusers with regard to their drug abusing patterns over a period of time for research purposes;
- d) To provide a basis for integrating with other drug-related statistical systems so that information in these systems can be captured and statistics related and compared; and
- e) To provide up-to-date statistics in a timely manner for dissemination to the public.

5.2 Recognizing youth drug abuse is a complex problem, the Government has adopted a holistic approach in its anti-drug policy, following a five pronged approach comprising preventive education and publicity, treatment and rehabilitation, legislation and law enforcement, external cooperation and research.<sup>21</sup> To provide the necessary information to facilitate the planning of anti-drug strategies and drug abuse programmes, the CRDA invariably has to cover different patterns of drug abuse.

#### *Reporting agencies*

5.3 There are a number of reporting agencies to the CRDA, covering law enforcement departments, methadone clinics, Counselling Centres for Psychotropic Substance Abusers (CCPSA), drug treatment and rehabilitation centres, youth outreaching teams of non-governmental organizations (NGOs), Substance Abuse Clinics (SAC), other hospitals and clinics. Each reporting agency provides different services to different types of drug abusers, following procedures and service criteria applicable to the agency concerned. For example, law enforcement departments are mainly concerned with drug related offenders or offenders who admit to have abused drugs, while youth outreaching teams provide services to drug abusers regardless of whether the drug abusers concerned have committed a crime. For medical clinics, they will only provide services to drug abusers who have health problems, based on such factors as drug dependence, abuse and intoxication.

---

<sup>20</sup> [http://www.nd.gov.hk/en/crda\\_background.htm](http://www.nd.gov.hk/en/crda_background.htm), retrieved on 15 May 2012.

<sup>21</sup> Task Force on Youth Drug Abuse (2008), *Report of the Task Force on Youth Drug Abuse: Say no to drugs, say yes to youth*, p.26.

5.4 As noted above, given that CRDA data are derived from “institutionally visible” population when they are contacted by the legal, medical or social systems. Any definition adopted should take into account the interests, norms and values of these three systems. For instance, it is not desirable and indeed not practicable to expect youth outreaching teams to define drug abusers according to criteria adopted by law enforcement departments or medical clinics. Indeed, as recommended in the Report on Review of Central Registry of Drug Abuse, the definitions adopted should be simple enough to be used by all reporting agencies.<sup>22</sup>

### ***Proposed changes to the definition of drug abusers***

#### *Overview*

5.5 As discussed above, several parameters are relevant in defining drug abusers over a certain period of time, which include the specific substance used (e.g. opioids, amphetamines), the administration method (e.g. injection, smoking), frequency of use (e.g. experimental, occasional, habitual), legal status of the substance used and clinical diagnosis (e.g. dependence). These parameters will be discussed in the paragraphs below.

#### *Specific substances used*

5.6 For the purposes of reporting to the CRDA, “a drug abuser is defined to be a person who has come into contact with a particular agency and is known or suspected to have taken substances during the four weeks before the date of contact, and the substances if taken harm or threaten to harm the physical, mental or social well-being of an individual, in doses above or for periods beyond those normally regarded as therapeutic.” Substance of abuse can be broadly divided into two categories - narcotics analgesics and psychotropic substances. Narcotics analgesics refer to heroin, opium, morphine and physeptone or methadone, while psychotropic substances include hallucinogens, depressants, stimulants, tranquillizers and other substances such as ketamine, cough medicine and organic solvents.<sup>23</sup>

5.7 This definition is broad enough to cover practically any drugs or substances other than tobacco and alcohol that are considered harmful to the physical, mental or social well-being of an individual. This is consistent with Government’s anti-drug policy and not very much different from the approach adopted in the countries reviewed above. It is recommended that this definition of drugs and substances should continue to be adopted.

5.8 Given the broad coverage of drugs and substances, some frontline staff may inevitably have difficulties in deciding whether or not the use of certain drugs or substances should be reported or not. To facilitate reporting agencies in reporting data to the CRDA, a list of commonly abused drugs and substances are given to reporting agencies. *As drug*

---

22 Narcotics Division, Security Bureau (2001), *Report on Review of Central Registry of Drug Abuse*, p.12.

23 Narcotics Division, Security Bureau (2010), *Central Registry of Drug Abuse, 16<sup>th</sup> report, 2001 – 2010*.

*abuse patterns change quite often, in response to the availability of new, synthetic drugs, it is recommended that the list should be updated more frequently. In particular, reporting agencies should be encouraged to report the use of drugs or substances that are considered harmful to the physical, mental or social well-being of an individual, including those not shown in the list of commonly abused drugs and substances, especially the nonmedical use of prescription drugs.*

#### *Frequency of use*

5.9 As indicated above, within the ambit of the CRDA, a drug abuser is defined as a person who has come into contact with a particular agency and is known or suspected to have taken substances during the four weeks before the date of contact. Other than the reference period of four weeks, there is no requirement on the frequency of use. In other words, CRDA can cover occasional, experimental and habitual drug abusers.

5.10 The CRDA review in 2001 considered the four-week guideline reasonable to ensure that memories of drug abusers were still fresh to provide accurate details of their drug abuse experience.<sup>24</sup> On the other hand, during discussions for this study, some social workers opined that the reference period of four weeks prior to contact was too restrictive. Some drug abusers contacted by reporting agencies would only abuse drug in certain times of the year like school holidays and festive seasons (e.g. Christmas and New Year holidays). If the reference period of four weeks is strictly applied, the CRDA may not be able to capture drug abusers contacted by reporting agencies in other times of the year (e.g. school days).

5.11 Separately, it is noted that information on life-time use and past year use of drugs or substances, in addition to use during the last 30 days is collected in the school survey conducted by Narcotics Division to monitor the prevalence of drug-taking among students.<sup>25</sup> Similar practices are adopted in countries reviewed above in conducting surveys on drug abuse. Besides, during discussions with social workers of CCPSA, it was noted that abstinence from drugs of more than 3 months or even 6 months was required before a drug abuser could be considered as having successfully completed his or her treatment plan.

5.12 Indeed, the criteria adopted in the Diagnostic and Statistical Manual of Mental Disorders (DSM) for dependence on or abuse of specific psychotropic substance groups use a reference period of twelve months. For instance, according to DSM-IV, substance dependence is defined by a maladaptive pattern of substance use over a twelve-month period which is manifested by, among other things, tolerance, withdrawal or having the substance often taken in larger amounts or over a longer period than intended. For substance abuse, it is defined by a maladaptive pattern of substance use over a twelve-month period which is manifested by, among other things, recurrent substance use.<sup>26</sup>

---

24 Narcotics Division, Security Bureau (2001), *Report on Review of Central Registry of Drug Abuse*, p.12.

25 Narcotics Division, Security Bureau (2010), *The 2008/09 Survey of Drug Use among Students: Report*.

26 European Monitoring Centre for Drugs and Drug Addiction (2004), *Key Epidemiological Indicator: prevalence of problem drug use*, p.10.

5.13 In Canada, as discussed above, continued use of drug is referred to as drug abuse when it becomes a problem or when it results in negative consequences for the person using it, with no restriction as to the period of drug use. Nevertheless, in collecting data through telephone interviews on reported abuse of drugs, the reference period of past twelve months prior to enumeration is used. Similar practices are also adopted in countries like UK and USA in collecting drug abuse statistics through surveys of the population.

5.14 Overall speaking, the current reference period of four weeks should be maintained to ensure comparability of data and more accurate reporting by drug abusers. Indeed, according to the 2001 review, the four-weeks guideline is not meant to be rigid but “only a reference time frame to ensure data compatibility and the accuracy of the information provided by the drug abusers”. For drug abusers who are found to be taking drugs irregularly but persistently, reporting agencies are requested to report such cases to CRDA as well.

5.15 At the same time, there is a case to explore further how to better capture those who have not, for various reasons, taken drugs during the four-weeks reference period. One possible direction is to consider adding a new reference period of one year if it is deemed feasible and useful after a thorough assessment. It is noteworthy that CRDA data is collected from 72 reporting agencies of various natures, including welfare organizations, law enforcement departments, drug treatment and rehabilitation centres, educational and healthcare institutions. While some agencies such as drug treatment and rehabilitation centres would ask their clients anyway about their drug abuse pattern beyond the four-week reference period in order to provide appropriate services, some others may find such questions challenging in view of the circumstances of engagement and attitude of respondents. More fundamentally, CRDA is intended to shed light on the drug trend across time rather than the exact size of drug abuse population. Unless the limitations of the estimate methods considered by this study can be satisfactorily resolved, a new reference period may not add much value to the current system.

5.16 To sum up, *while the current reference period of four weeks prior to contact by reporting agencies should be maintained, consideration can be given to introducing an additional reference period of one year.* Before introducing such a change, a thorough assessment of the feasibility and usefulness should be conducted. There should also be consultation with reporting agencies and users of the CRDA data.

#### *Legal status of the substance used*

5.17 No specific requirement is included in the current definition on the legal status of drugs or substances used. This is consistent with practices adopted in countries reviewed above and the anti-drug policy of Government. Beside, for reporting agencies in the medical and social systems, their concern is on the service needs of their drug abuse clients, rather than the legal status of the drugs or substances their clients have taken. In any case, it is not practicable and will affect the reporting agencies’ relationship with their clients, if the

reporting agencies have to ascertain the legal status of drugs or substances used. In short, it is suggested not to include the legal status of the substance used in the definition of drug abuse.

### *Clinical diagnosis*

5.18 In providing services to drug abusers, reporting agencies in the medical system would undoubtedly take steps to assess the clinical conditions of drug abusers, including whether they have drug dependence, physically or mentally. It is conceivable that reporting agencies in the social system would undertake similar if less sophisticated assessment of the conditions of drug abusers in determining whether their drug abuse clients require medical services or referrals to say SAC. For reporting agencies in law enforcement departments, they should have similar medical assessment of the health conditions of the drug abusers, such that special arrangements could be made when the drug abusers are put under their custodial care.

5.19 There are guidelines, based on ICD codes or DSM diagnostic criteria, which could help non-medical professional to assess drug dependence and abuse of their clients. In the USA, as noted above, questions on drug dependence and abuse are included in their National Survey on Drug Use and Health which is conducted through face-to-face interviews. Similar questions could be devised for the CRDA to help frontline workers of reporting agencies, if required, to gather information on drug dependence and abuse of their clients. Such information undoubtedly will be of use in facilitating planning of anti-drug and treatment programmes.

5.20 It is reckoned that gathering information on drug dependence and abuse will pose additional reporting burden on reporting agencies, at the risk of reducing incentives of reporting agencies to submit drug abuse data to the CRDA. There will be a need to train frontline staff responsible for reporting data to the CRDA on assessing drug dependence and abuse of their clients. The costs involved on the part of reporting agencies will not be insignificant. Thus, the expected benefits to be derived from having information on drug dependence and abuse should be weighed against the likely costs involved. *It is recommended that the benefits and costs of collecting information on drug dependence and abuse, following ICD codes and DSM diagnostic criteria, by reporting agencies should be examined and the feasibility investigated.*

5.21 It was noted by researchers that measures of drug dependence devised based on ICD codes and DSM diagnostic criteria were not commonly used by data sources in the UK. The applicability of such measures in Hong Kong should be thoroughly examined and if found suitable, promoted to all relevant data sources. In any case, social workers of CCPSAs are using their own criteria in assessing drug dependence. Thus, it is desirable that efforts be made to develop and promulgate measures of drug dependence applicable to Hong Kong.

### III. Estimation of Drug Abuse Population

#### 6. Overview of estimation methods

6.1 There are a variety of methods available for estimating the prevalence of drug use, including population-based surveys, case-finding studies, capture-recapture method, multiplier techniques, nomination techniques (including snowball sampling), synthetic estimates based on social or demographic variables assumed to have correlation with drug prevalence and a variety of more sophisticated statistical modelling approaches.<sup>27</sup> It may be worth noting that the prevalence of drug use, which is defined as the number of existing number of drug abusers at a certain point in time is different from incidence which is defined as the number of new drug abusers within a given time period.<sup>28</sup>

#### *Case-finding method*

6.2 Case-finding is a standard epidemiological method for obtaining an adequate number of cases for observation and research, especially for the purposes of investigating rare health events in a population. It is basically a counting method involving the search of actual drug abusers through an extensive network. Case-finding is important, as seen by the fact that nearly every study involving nomination techniques or capture-recapture started with case-finding procedures. Pure case-finding studies are rare, but the findings are used in different ways to establish valid prevalence estimations.

6.3 As there is no single way or information source which can find all or at least most drug users, a combination of different strategies is needed. Multi-sources information is one method widely used to overcome the lack of completeness and representativeness of a single source and can provide estimates of the prevalence of drug users. When different sources are combined, there is considerable risk of over-estimating the total number of cases unless personal identifiers are available on a reliable and standardized way in all sources to enable the identification and removal of duplicates.<sup>29</sup>

6.4 Case-finding is applicable to study drug use for several reasons. Firstly, drug use is rare. Secondly, as an illegal activity, it is largely hidden. Therefore, general population sample survey techniques will be too costly, inefficient, and may be ineffective for identifying drug users. Thirdly, a readily-made sampling frame or register does not exist, which, in part, is the reason for carrying out a case-finding study.

---

27 Council of Europe (1996), *Estimating the prevalence of problem drug use in Europe*, EMCDDA Scientific Monograph Series, No. 1.

28 Council of Europe (2008), *Guidelines for estimating the incidence of problem drug use in Europe*, EMCDDA February 2008, p.7.

29 Hickman, M et al (1999), "Surveillance of problem drug use in the UK: a review of the Regional Drug Misuse Database", in *Journal of Public Health Medicine*, 21(3): 271 – 277.



6.5 Although a proportion of the drug-abusing population will always remain hidden, there are times when drug users are more “visible”. These instances include – the process of buying and selling drugs, places where drug users meet, contact with law enforcement as a result of the need to buy or sell drugs or generate income illegally to obtain drugs, or when drug users seek attention for social, psychosocial or somatic consequences of drug use. In each of these areas and situations, drug users may be contacted.

6.6 To be useful, the case-finding study must be acceptable to reporters and drug-users. Information sources and screening strategies may need to be assessed in order to test whether they can provide reliable data required by the study. For example, it can be difficult to conduct more in-depth research studies on subjects who are contacted by the police.

6.7 The CRDA is a good example of the case-finding method. For the purpose of CRDA reporting, a drug abuser is defined to be a person who has taken any kind of substances which harms or threatens to harm the physical or mental health or social well-being of an individual, in doses above or for periods beyond those normally regarded as therapeutic in the last four weeks, irrespective of the number of takings. Alcohol and tobacco are, however, not regarded as drug abuse.<sup>30</sup>

6.8 It is noted that all information supplied in the CRDA record sheets is handled in strict confidence and is accessible only to the people who are directly involved in the operation of CRDA and workers of reporting agencies. They are required to observe the rule of confidentiality. The confidentiality of all records held by CRDA and its reporting agencies is safeguarded by the Dangerous Drugs Ordinance (Chapter 134) and the Personal Data (Privacy) Ordinance (Chapter 486). This has nevertheless severely limited the use of individual personal information contained in the CRDA for research purposes.

### ***Capture-recapture method (CRM)***

6.9 The capture-recapture method (CRM) refers to a technique developed over a century ago to estimate the size of wild animal populations. For instance, researchers used this technique to estimate the number of injected drug users affected with HIV in Bangkok, based on a two-sample capture-recapture method.<sup>31</sup> The two-source capture-recapture method has also been used to estimate the number of persons with communicable diseases in Sweden.<sup>32</sup> Similar study was also conducted on the incidence of meningococcal disease in Denmark.<sup>33</sup>

---

30 Based on the Narcotics Division website

31 Mastro, Timothy D, et al (1994), “Estimating the number of HIV-infected injection drug users in Bangkok: a capture-recapture method”, in *American Journal of Public Health*, 84(7): 1094 – 1099.

32 Jansson, A et al (2005), “Sensitivity of the Swedish statutory surveillance system for communicable diseases 1998 – 2002, assessed by the capture-recapture method”, in *Epidemiology Infection*, 133: 401 – 407.

33 Howitz, M F, Samuelsson, S and Molbak, K (2008), “Declining incidence of meningococcal disease in Denmark, confirmed by a capture-recapture analysis for 1994 and 2002”, in *Epidemiology Infection*, 136: 1088 – 1095

6.10 It involves “capturing” a random sample which is then “marked” and returned to its habitat. Subsequently, a second random sample is “recaptured” and the number of marked animals from the first sample is observed. The ratio of marked size to the recaptured sample size is assumed to be the same as the ratio of the first captured sample to the total population. Thus, if a “captured” sample of 200 animals is marked and released, and a “recapture” sample of 100 contains ten animals which are marked, the estimate for the total population would be 2,000.

6.11 In view of the real or perceived problems of asking people directly about drug use, CRM affords a means of estimating prevalence indirectly from data on known drug users. It should be noted that the following assumptions of the method are important for its success:

- a) The population under study must be closed, in the sense that individuals do not enter or leave the population during the study period;
- b) The samples must be randomly selected and the probability of each individual being selected must be the same in each sample;
- c) The samples must be mutually independent.

6.12 As not all of the above conditions can be met in reality, researchers have attempted to use multiple data sources for circumstances where the probabilities of selection are not the same (condition b) above) or that the samples are not mutually independent (condition c) above).<sup>34</sup> <sup>35</sup> For example, using a 3-source capture-recapture technique and log-linear modelling, researchers have attempted to estimate the number of deaths among HIV-affected adults in France.<sup>36</sup> Similar study was also conducted by researchers to estimate the prevalence of opiate use in Dublin.<sup>37</sup> For the condition that the population under study must be closed, researchers attempted to shorten the reference period in order to minimize the effect of any violation of this condition.<sup>38</sup> This method will be discussed further in the next section.

---

34 Domingo-Salvany, Antonia (1996), “Estimating the prevalence of drug use using the capture-recapture method: an overview”, in *Estimating the prevalence of problem drug use in Europe*, EMCDDA Scientific Monograph Series, No. 1.

35 See for example Calkins, Richard F and Aktan, Georgia B (2000), “Estimation of heroin prevalence in Michigan using capture-recapture and heroin problem index methods”, in *Journal of Drug Issues*, 30(1): 187 – 204; Aaron, D J, et al (2003), “Estimating the lesbian population: a capture-recapture approach”, in *Journal of Epidemiology and Community Health*, 57(3): 207 – 209; Hay, Gordon and McKeganey, Niel (1996), “Estimating the prevalence of drug misuse in Dundee, Scotland: an application of capture-recapture methods”, in *Journal of Epidemiology and Community Health*, 50(4): 469 – 472; Holland, Richard, et al (2006), “The prevalence of problem drug misuse in a rural county of England”, in *Journal of Public Health*, 28(2): 88 – 95.

36 Lweden L, et al (2006), “Number of deaths among HIV-infected adults in France in 2000, three-source, capture-recapture estimation”, in *Epidemiology Infection*, 134:1345 – 1352.

37 Comiskey, C M and Barry J M (2001), “A capture-recapture study of the prevalence and implications of opiate use in Dublin”, in *European Journal of Public Health*, 11(2): 198 – 200.

38 Buster, M C A, van Brussel, G H A and van den Brink, W (2001), “Estimating the number of opiate users in Amsterdam by capture-recapture: the importance of case definition”, in *European Journal of Epidemiology*, 17(10): 935 – 942.

### ***Multiplier method (MM)***

6.13 The multiplier method (MM) involves applying a “multiplier” to a “benchmark” (the total of a sub-group of the drug-abusing population). The most commonly used “benchmark” is the total number of drug-related deaths (or mortality data).<sup>39</sup> There are other benchmark data such as the total number of abusers in treatment or total number of abusers arrested. The benchmark is then multiplied by an appropriate multiplier to estimate the total drug abuse population.

6.14 MM for estimating the prevalence of drug user was first developed in the US in the 1970s. The method involved determining the annual number of drug-related deaths in New York City and assuming that these deaths represented a proportion of active heroin users in the city. The proportion was obtained by a follow-up study of addicts receiving treatment, and was crudely estimated by the death rates observed among these users.

6.15 However, it is usually difficult for mortality data to show all deaths that are related to drug abuse. Hence, other researchers have chosen to apply a multiplier to some other indicators such as the number of arrests for drug offences. However, any extension of the method could be quite arbitrary and must be carefully studied. Researchers noted that using mortality data was considered plausible because a wide range of studies had reported similar mortality rates. Rate for activities such as drug-related arrests could vary within and between locations and could change over time.

6.16 As an example of an extension of the MM method, researchers collected information on the average number of visits made by men who had sex with men (MSM) to public places frequented by MSM and the total visits counted during the same period. Using MM, researchers estimated the number of MSM in Chengdu. It was noted by researchers that MM was easier to implement but more costly than CRM.<sup>40</sup> As mortality and hospitalization due to health problems arising from the use of drugs are not recorded as drug related incidents, this method is considered not applicable in Hong Kong. As demonstrated in the section to follow, statistics on the number of arrests for drug offenses are used as a counter-check but not as a basis for estimating the drug abuse population.

### ***Nomination method***

6.17 The use of nomination method as a means of obtaining information about difficult-to-reach populations dates back many years. The methods have enjoyed a certain amount of fame and notoriety in the 1970s. Interest in these methods is now developing again in drug use epidemiology, with its main virtue being its usefulness in dealing with relatively rare events.

---

39 Frischer, Martin, “Estimating the prevalence of drug abuse using the mortality multiplier method: an overview”, in *Estimating the prevalence of problem drug use in Europe*, EMCDDA Scientific Monograph Series, No. 1.

40 Luan, Rongshan, et al (2005), “A study on methods of estimating the population size of men who have sex with men in Southwest China”, in *European Journal of Epidemiology*, 20: 585 – 585.

6.18 The principles involved in using the nomination method specifically to estimate the prevalence of drug abuse are the same as the multiplier method. The procedure followed in the nomination method typically involves the following:

- a) A benchmark – the total number of the drug-abusing population who are in treatment at some points during the year in question (e.g. 3,000);
- b) A multiplier – an estimate from sample surveys on a proportion of the drug abusing population who are in treatment that year (e.g. 20%).

6.19 Broadly put, the sampled members are asked to name or nominate drug-abusing acquaintances and to say whether these acquaintances have been in touch with drug treatment centres, health services or any other similar body, within a stipulated time period. The proportion of treatment receivers nominated by the sample is then used as a multiplier to give an estimate of the total number of drug users in conjunction with the benchmark known attendance figures at the treatment agencies.

6.20 Typically, two questions are asked, namely “How many of your acquaintances have used drugs regularly last year?” and “How many of these acquaintances have been under treatment last year?” From answers to these two questions, the proportion of drug users in treatment can be calculated. Needless to say, the questions will need rather more precise definitions of “drug user” and “treatment”. Furthermore, whether one year or another time span is more appropriate also needs to be determined.

6.21 In the course of conducting the study, discussions were held with representatives from a number of reporting agencies in the legal, medical and social systems. Suggestions to contact drug abusers were floated and were all rejected due to confidentiality considerations. Reporting agencies are also reluctant to approach their clients to seek their consent for the release of personal information for the purposes of the study, for fear that doing so would ruin the relationship with their clients and increase reluctance on the part of their clients to report their information to them. In the circumstances, the nomination method is not considered feasible for the purposes of the present study.

## **7. The estimation method adopted**

7.1 As discussed above, a number of discussions have been held with reporting agencies to the Central Register of Drug Addicts (CRDA). It transpires from the discussions that it not possible for the Project Team to contact clients of the reporting agencies who are drug abusers due to confidentiality considerations. Thus, the “nomination method”, which relies on a sample of drug abusers to nominate drug-abusing acquaintances, is not likely to be feasible. For reasons explained above, the “multiplier method” is also not quite feasible. Nevertheless, as explained in the later part of the report, an attempt has been made to use the “multiplier method” to counter-check the reliability of estimates compiled based on data obtained from the CRDA. In the circumstances, the CRDA remains the main source of information for the present study and the “capture re-capture method” is the only feasible method for estimating the prevalence of drug use. In the paragraphs to follow, findings using an anonymous database extracted from the CRDA and the capture re-capture method are discussed.

### *Use of CRDA data*

7.2 During the period from 1999 to 2009, about 13,300 – 18,300 cases were reported to the CRDA each year. Among these reported cases, about 3,100 – 5,600 cases each year were newly reported cases, accounting for about 25% – 33% of all reported cases. The balance 75% - 67% were previously reported cases.<sup>41</sup>

7.3 In 2009, about 48.5% of cases (48.7% for newly report cases and 48.3% for previously reported cases) were reported by enforcement departments including Hong Kong Police Force, Correctional Services Department and Probation Officers under Social Welfare Department; 32.9% by methadone clinics (5.5% for newly report cases and 45.6% for previously reported cases); 23.5% by drug treatment and rehabilitation centres, Counselling Centres for Psychotropic Substance Abusers (CCPSA) (22.7% for newly report cases and 23.9% for previously reported cases); 13.5% by youth outreach teams of NGOs (24.2% for newly report cases and 8.5% for previously reported cases); and 3.4% by Substance Abuse Clinics (SAC) and other hospitals and clinics (4.6% for newly report cases and 2.8% for previously reported cases).<sup>42</sup>

7.4 Cases reported by different reporting agencies would have different likelihood of being reported again by other reporting agencies. For example, cases reported by the Correctional Services Department will unlikely be reported by say CCPSA, as the persons concerned would be under the custody of Correctional Services Department, at least for a certain period of time, and hence unlikely to be contacted by social workers of CCPSA. This is what is commonly known as “negative dependence”, which would arise when inclusion in one list reduces the chances of being included in another list.<sup>43</sup> Thus, in processing CRDA data, it is necessary to identify cases by different report agencies.

7.5 To match “capture” and “recapture” cases, it is necessary to have a unique identifier for each case. To protect confidentiality of drug addicts included in the CRDA, a list of CRDA records, with a unique identifier without revealing the identity of individual drug addicts assigned to each record, was extracted from the CRDA. In addition, the following information items are also included in the list:

- a) Year of birth, sex and ethnicity. This would facilitate computation by different categories of CRDA records and computation of prevalence for different age-sex groups and ethnicity. As noted by researchers, stratification would help reduced heterogeneity in that the lists obtained from different reporting agencies were not independent of each other<sup>44</sup>;

---

41 Narcotics Division (2010), *Central Register of Drug Addicts: 59<sup>th</sup> Report*, p. 4.

42 Narcotics Division (2010), *Central Register of Drug Addicts: 59<sup>th</sup> Report*, p. 15 and 29.

43 Domingo-Salvany, Antonia (1996), “Estimating the Prevalence of Drug Use using the Capture-Recapture Method: an Overview” in *Estimating the prevalence of problem drug use in Europe*, EMCDDA Scientific Monograph Series, No. 1, Council of Europe, p. 79.

44 Richardson, Clive (1996), “Capture and re-capture methodology: lessons from studies of animal populations” in *Estimating the prevalence of problem drug use in Europe*, EMCDDA Scientific Monograph Series, No. 1, Council of Europe, p. 89.

- b) Types of substance and frequency of taking. As noted by researchers that the severity of the drug problem may affect the likelihood of being captured<sup>45</sup>, the information will help further refinement to the methodology, by separately analyzing less serious and more serious drug abusers, in terms of frequency of taking drugs. For instance, as noted by researchers, heavier users would more likely than lighter users to be on both a police and treatment list<sup>46</sup>;
- c) Categories of reporting agencies, with separate identification for Hong Kong Police Force, Correctional Services Department and Probation Officers under Social Welfare Department. As discussed in para. 5 above, separate lists of CRDA records for different categories of reporting agencies will be analyzed to identify effects of “trap avoidance” which refers to cases where the inclusion in one list from say Correctional Services Department will reduce the probability of inclusion in another list from say youth outreach teams of NGOs, and “trap addiction” which refers to cases where the inclusion in one list from say the Hong Kong Police will increase the probability of inclusion in another list from say Correctional Services Department.

7.6 To facilitate different computations of the prevalence rate for different time points, as a counter-check on the reliability of the estimates of prevalence rate, the anonymous list of CRDA records obtained includes newly reported and previously reported cases during the twelve-year period from 2000 to 2011. As noted by researchers, the “capture re-capture method” can be applied to a sample of records over a longer time period by sub-dividing the sample into time intervals, with each being a separate sample.<sup>47</sup>

7.7 Furthermore, one of the assumptions required for the validity of the “capture re-capture method” is that the population under study is closed, which means that individual included will not enter or leave the population. This assumption is more likely to be true for short periods of time (e.g. up to about one year).<sup>48</sup>

### **The “capture re-capture method” (CRM) revisited**

7.8 As briefly discussed above, CRM refers to a technique developed over a century ago to estimate the size of wild animal populations and involves “capturing” a random

---

45 Domingo-Salvany, Antonia (1996), “Estimating the Prevalence of Drug Use using the Capture-Recapture Method: an Overview” in *Estimating the prevalence of problem drug use in Europe*, EMCDDA Scientific Monograph Series, No. 1, Council of Europe, p. 82.

46 Richardson, Clive (1996), “Capture and re-capture methodology: lessons from studies of animal populations” in *Estimating the prevalence of problem drug use in Europe*, EMCDDA Scientific Monograph Series, No. 1, Council of Europe, p. 90.

47 Domingo-Salvany, Antonia (1996), “Estimating the Prevalence of Drug Use using the Capture-Recapture Method: an Overview” in *Estimating the prevalence of problem drug use in Europe*, EMCDDA Scientific Monograph Series, No. 1, Council of Europe, p. 81.

48 Domingo-Salvany, Antonia (1996), “Estimating the Prevalence of Drug Use using the Capture-Recapture Method: an Overview” in *Estimating the prevalence of problem drug use in Europe*, EMCDDA Scientific Monograph Series, No. 1, Council of Europe, p. 78.

sample that are then “marked” and returned to their habitat. Subsequently, a second random sample is “recaptured” and the number of marked animals from the first sample is observed. The ratio of marked animals to the recaptured sample is assumed to be the same as the ratio of the first captured sample to the total population. Thus, if a “capture” sample of 200 animals is marked and released, and a “recapture” sample of 100 contains ten animals which are marked, the estimate for the total population would be 2,000. This may be illustrated in the equation shown below.<sup>49</sup>

$$a/d = c/b$$

where  $a$  is the number marked and released into the population,  
 $b$  is the size of the second catch,  
 $c$  is the number recaptured in the second catch, and  
 $d$  is the size of the population as a whole, such that

$$\text{Estimate of population size } (d) = a.b/c$$

7.9 A number of research studies have been conducted using the CRM to estimate the size of the “hard-to-reach” population. For instance, researchers used this technique to estimate number of injected drug users affected with HIV in Bangkok, based on a two-sample capture-recapture method. All persons who were enrolled in the methadone treatment programmes for opiate addiction at 17 clinics and the Thanyarak Hospital during the period from 17 April to 17 May 1991 were first captured. The “recapture” was conducted during the period from 6 June to 30 September 1991 at 72 police stations in all areas in Bangkok to identify persons arrested and urine tested positive for opiate metabolites or methadone. From information on persons identified in first and second captures, the opiate population was estimated by the following formula:

$$n = c_1 c_2 / m$$

where  $c_1$  and  $c_2$  are the number of persons identified in the first and second captures respectively and  $m$  is the number of persons identified in both captures (i.e. the matched cases). Researchers noted that since the population was not closed, they had to limit the study to a relatively short period of less than 6 months, so that the number of opiate users entering or leaving Bangkok might not be substantial during the study period. Researchers also believed that there was no clear negative or positive dependence between receiving methadone treatment and being arrested a few months later. Given methadone treatment was free all opiate users had a non-zero probability of seeking methadone treatment, though users with different socio-economic background might have different probabilities of seeking treatment. As opiate usage was illegal, all opiate users would have a probability of being arrested. By conducting the analysis by age groups and by all ages, researchers derived two separate estimates and found that the two estimates were quite similar.<sup>50</sup>

---

49 Luan, Rongsheng, et al (2005), “A study on methods of estimating the population size of men who have sex with men in Southwest China”, in *European Journal of Epidemiology*, 20: 581–585

50 Mastro, Timothy D, et al (1994), “Estimating the number of HIV-infected injection drug users in Bangkok: a

7.10 The two-source capture-recapture method has also been used to estimate the number of persons with communicable diseases in Sweden.<sup>51</sup> Similar study was also conducted on the incidence of meningococcal disease in Denmark.<sup>52</sup> In view of the real or perceived problems of asking people directly about drug use, CRM affords a means of estimating prevalence indirectly from data on known drug users. It should be noted that the following assumptions of the method are important for the success of the method:

- a) The population under study must be closed, in a sense that individuals do not enter or leave the population during the study period;
- b) The samples must be randomly selected and the probability of each individual being selected must be the same in each sample;
- c) The samples must be mutually independent.

7.11 Not all of the above conditions can be met in reality. Thus, researchers have attempted to use multiple data sources for circumstances where the probabilities of selection are not the same (condition (b) above) and that the samples are not mutually independent (condition (c) above).<sup>53 54</sup> Log linear models were suggested by researchers to model the dependence between samples and adjust the estimates accordingly. For example, researchers making use of three data sources on problem drug users, including Regional Drug Misuse Database, HIV test records on drug users and police arrest data, log linear models were applied to the data generated in the 2x2x2 contingency table. Making use of “overlapping” records captured by different sources, estimates for the “empty” cell were computed which would correspond to the “unobserved” or hidden population. Different models were compared using a log-likelihood ratio test for models with different degrees of freedom and the AIC (Akaike Information Criterion) for models with same degree of freedom. The simplest model was chosen on the basis of having lowest AIC score or being no worse than a complex model as tested by the log-likelihood ratio test.<sup>55</sup> In a similar study using a 3-source capture-recapture technique and log-linear modelling, researchers have attempted to estimate the number of deaths among HIV-affected adults in France.<sup>56</sup>

---

capture-recapture method”, in *American Journal of Public Health*, 84(7): 1094 – 1099.

51 Jansson, A et al (2005), “Sensitivity of the Swedish statutory surveillance system for communicable diseases 1998 – 2002, assessed by the capture-recapture method”, in *Epidemiology Infection*, 133: 401 – 407.

52 Howitz, M F, Samuelsson, S and Molbak, K (2008), “Declining incidence of meningococcal disease in Denmark, confirmed by a capture-recapture analysis for 1994 and 2002”, in *Epidemiology Infection*, 136: 1088 – 1095

53 Domingo-Salvany, Antonia (1996), “Estimating the prevalence of drug use using the capture-recapture method: an overview”, in *Estimating the prevalence of problem drug use in Europe*, EMCDDA Scientific Monograph Series, No. 1.

54 See for example Aaron, D J, et al (2003), “Estimating the lesbian population: a capture-recapture approach”, in *Journal of Epidemiology and Community Health*, 57(3): 207 – 209; Holland, Richard, et al (2006), “The prevalence of problem drug misuse in a rural county of England”, in *Journal of Public Health*, 28(2): 88 – 95.

55 Hickman, Matthew, et al (1999), “Estimating the prevalence of problem drug use in inner London: a description of three capture-recapture studies”, in *Addiction*, 94(11): 1653 – 1662.

56 Lweden L, et al (2006), “Number of deaths among HIV-infected adults in France in 2000, three-source, capture-recapture estimation”, in *Epidemiology Infection*, 134:1345 – 1352.



7.12 In another research study, a four-source capture-recapture method was used by researchers to estimate the prevalence of opiate and benzodiazepine misuse in Dundee, Scotland. Researchers collected the data from four sources, namely Dundee Drug Problem Centre, Tayside HIV Register, Scottish drug misuse database on new problem drug users and police data on all persons arrested under the Misuse Drug Act (1971), over a five-year period from January 1990 to December 1994. Based on the number of persons identified in the four sources, a contingency table was compiled and log linear models were applied to the data. The model that best fit the data was then chosen in estimating the expected number for the unobserved cell. To reduce heterogeneity, researchers had also run the models on breakdowns by age and sex and found that there was no major difference between different estimates, though this could be attributed to small number of observations available. Researchers noted that the research had several limitations. Firstly, as the study period of 5 years was quite long, some users might have left the area or had stopped using drugs, violating the closed population assumption. Secondly, the data sources might have excluded young drug abusers or those who had not experienced problems due to drug use and thus had not approached the data sources for assistance.<sup>57</sup> Another four-source capture-recapture research study was conducted to estimate the lesbian population in a county in the US.<sup>58</sup> Similar study was also conducted by researchers to estimate the prevalence of opiate use in Dublin.<sup>59</sup>

7.13 For the condition that the population under study must be closed, researchers attempted to shorten the reference period in order to minimize the effect of any violation of this condition.<sup>60</sup> Apart from testing for dependence between samples, efforts were made by researchers to reduce heterogeneity (due to different recapture probabilities) by applying log linear modeling together with stratification by age and sex. Researchers found that stratification had facilitated the identification of suitable models that fitted well the data.<sup>61</sup>

7.14 Nevertheless, it was pointed out by researchers that the use of the log linear methods on multiple samples might not be always possible due to the presence of empty cells resulting from small sample size. Besides, if the probability of recapture was different (e.g. for light and heavy drug users), the estimates derived would be biased.<sup>62</sup>

---

57 Hay, Gordon and McKeganey, Niel (1996), "Estimating the prevalence of drug misuse in Dundee, Scotland: an application of capture-recapture methods", in *Journal of Epidemiology and Community Health*, 50(4): 469 – 472.

58 Aaron, D J, et al (2003), "Estimating the lesbian population: a capture-recapture approach", in *Journal of Epidemiology and Community Health*, 57(3): 207 – 209.

59 Comiskey, C M and Barry J M (2001), "A capture-recapture study of the prevalence and implications of opiate use in Dublin", in *European Journal of Public Health*, 11(2): 198 – 200.

60 Buster, M C A, van Brussel, G H A and ven den Brink, W (2001), "Estimating the number of opiate users in Amsterdam by capture-recapture: the importance of case definition", in *European Journal of Epidemiology*, 17(10): 935 – 942.

61 Comiskey, C M and Barry, J M (2001), "A capture-recapture study of the prevalence and implications of opiae use in Dublin", in *European Journal of Public Health*, 11(1):198 – 200.

62 Calkins, Richard F and Aktan, Georgia B (2000), "Estimation of heroin prevalence in Michigan using capture-recapture and heroin problem index methods", in *Journal of Drug Issues*, 30(1): 187 – 204.

## 8. Simulation runs of the “capture re-capture method”

8.1 To reduce heterogeneity, the anonymous list of CRDA records is divided into the following datasets. Based on the datasets, a number of CRM models were run and the findings are presented in the paragraphs to follow.

- a) Stratification of the list into male and female;
- b) Twelve datasets of previously reported and newly reported cases in each of the twelve-year period from 2000 to 2011 for males and another twelve sub-sets for females;
- c) For each dataset, information contained in the list includes reported year, year of birth, ethnicity, type of substances and frequency of use, as well as an indication on the categories of reporting agencies.

### *Two-source capture-recapture models*

#### *Estimation by gender*

8.2 Taking the CRDA as a one combined, single data source, the capture-recapture estimation was conducted by estimating the proportion of reported drug abusers in say 2000 that were reported again in 2001.<sup>63</sup> Following this approach, the total number of drug abusers during the period from 2001 to 2011 has been estimated and is shown in the table below. One of the conditions for the capture-recapture approach, as noted above, is that the samples must be randomly selected and the probability of each individual being selected must be the same in each sample. However, it is believed that the probability of recapturing male and female drug abusers is likely to be different. To reduce heterogeneity, separate capture-recapture models were run for male and female drug abusers.

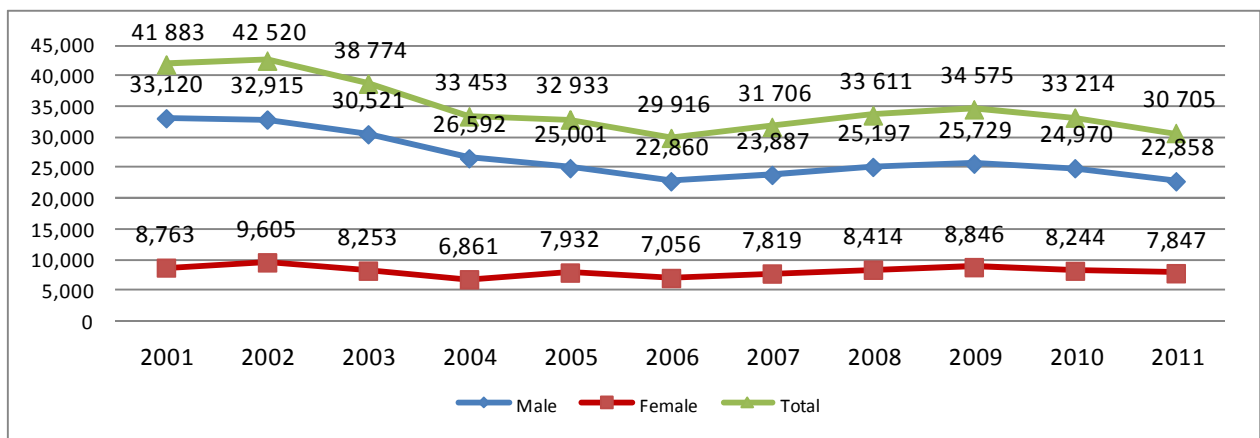
<b>Male</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>
(a) No. of reported drug abusers in the previous yr.	15,355	15,640	14,780	13,272	12,200	11,449	10,706	11,127	11,334	11,221	10,007
(b) No. of reported drug abusers in this yr.	15,640	14,780	13,272	12,200	11,449	10,706	11,127	11,334	11,221	10,007	9,338
(c) No. reported in both (a) and (b)	7,251	7,023	6,427	6,089	5,587	5,362	4,987	5,005	4,943	4,497	4,088
(d) Estimated total no. of drug abusers	33,120	32,915	30,521	26,592	25,001	22,860	23,887	25,197	25,729	24,970	22,858

<sup>63</sup> In the present study, two different time periods are taken, mirroring an ecological study in which the recapture occurs after the first capture. Researchers have pointed out that in epidemiological studies, this is not essential. The two sources (i.e. capture and recapture) could take place over the same time period. (Reference: United Nations Office on Drugs and Crime (2003), *Estimating prevalence: indirect methods for estimating the size of the drug problem*, p.36).

<b>Female</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>
(a) No. of reported drug abusers in the previous yr.	2,980	2,873	3,186	2,518	2,654	2,666	2,546	2,466	2,907	2,769	2,526
(b) No. of reported drug abusers in this yr.	2,873	3,186	2,518	2,654	2,666	2,546	2,466	2,907	2,769	2,526	2,131
(c) No. reported in both (a) and (b)	977	953	972	974	892	962	803	852	910	848	686
(d) Estimated total no. of drug abusers	8,763	9,605	8,253	6,861	7,932	7,056	7,819	8,414	8,846	8,244	7,847

<b>Total</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>
<b>Estimated total no. of drug abusers</b>	41,883	42,520	38,774	33,453	32,933	29,916	31,706	33,611	34,575	33,214	30,705

8.3 It may be noted from the tables above and the chart below that the estimated number of male drug abusers was around 32,920 in 2002, decreasing steadily to 22,860 in 2006, and then rising again to 25,730 in 2009, before falling back to 24,970 in 2010 and 22,860 in 2011. The number of female drug abusers was much lower, at around one third of the number of male drug abusers, and followed similar trend as that of male drug abusers except that the number was lowest in 2004, at 6,860.



8.4 It may be worth noting that the precision level of the estimates obtained from the two-source capture-recapture models is quite high. For instance, as shown in the table below, the upper limit of the estimates for male drug abusers, at 95% confidence, ranges from 1.8% above the estimate in 2011 to 1.2% in 2001. The lower limit of the estimates, at 95% confidence, falls within the range of 1.2% and 1.8% below the estimates. In other words, the estimated number of male drug abusers in say 2011 could be within the range of 23,260 and 22,450. This level of precision is clearly very acceptable.

<b>Male</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>
(a) Estimated total no. of drug abusers	33,120	32,915	30,521	26,592	25,001	22,860	23,887	25,197	25,729	24,970	22,858
(b) Upper limit	33,526	33,330	30,925	26,941	25,347	23,175	24,248	25,585	26,133	25,390	23,263
(c) Lower limit	32,713	32,500	30,117	26,243	24,654	22,544	23,526	24,810	25,325	24,550	22,453
(d) % of upper limit above estimate	1.2%	1.3%	1.3%	1.3%	1.4%	1.4%	1.5%	1.5%	1.6%	1.7%	1.8%
(e) % of lower limit below estimate	1.2%	1.3%	1.3%	1.3%	1.4%	1.4%	1.5%	1.5%	1.6%	1.7%	1.8%

8.5 For female drug abusers, as shown in the table below, the upper limit of the estimates for male drug abusers, at 95% confidence, ranges from 5.3% above the estimate in 2011 to 3.9% in 2004. The lower limit of the estimates, at 95% confidence, falls within the range of 3.9% and 5.3% below the estimates. In other words, the estimated number of female drug abusers in say 2011 could be within the range of 8,260 and 7,430. This level of precision is clearly quite acceptable

<b>Female</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>
(a) Estimated total no. of drug abusers	8,763	9,605	8,253	6,861	7,932	7,056	7,819	8,414	8,846	8,244	7,847
(b) Upper limit	9,129	10,022	8,593	7,130	8,278	7,337	8,186	8,798	9,236	8,625	8,260
(c) Lower limit	8,397	9,187	7,914	6,592	7,586	6,774	7,451	8,029	8,455	7,871	7,434
(d) % of upper limit above estimate	4.2%	4.3%	4.1%	3.9%	4.4%	4.0%	4.7%	4.6%	4.4%	4.6%	5.3%
(e) % of lower limit below estimate	4.2%	4.3%	4.1%	3.9%	4.4%	4.0%	4.7%	4.6%	4.4%	4.6%	5.3%

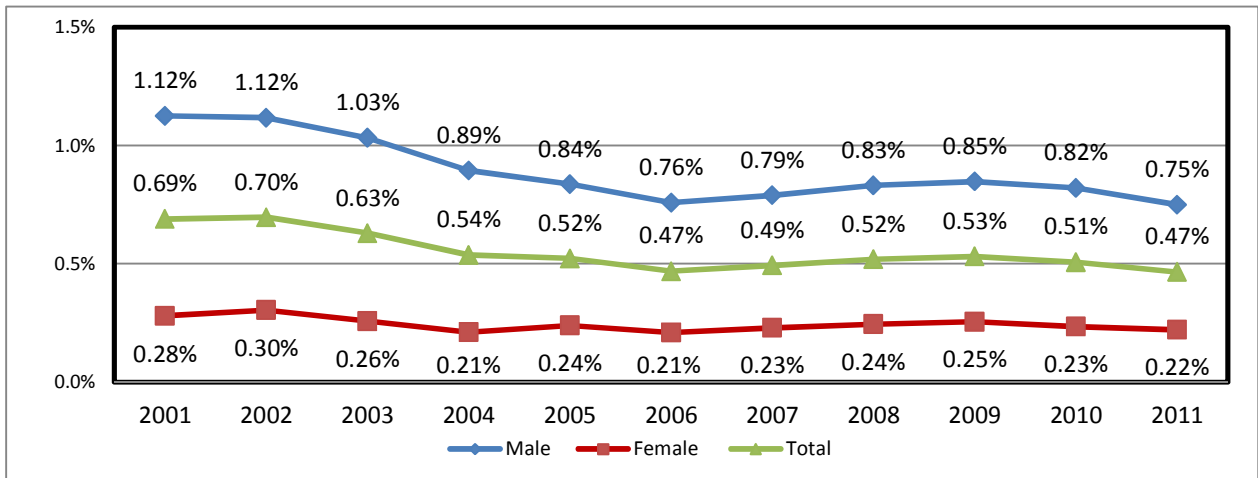
8.6 Based on the number of drug abusers estimated above, the incidence rate of drug abusers<sup>64</sup> was computed, by expressing the number of drug abusers as a percentage of the total population aged 10 or above.<sup>65</sup> The incidence rate is shown in the table and chart below, separately for male, female as well as the overall total. It may be seen that the incidence rate for male drug abusers has been decreasing steadily from 1.12% in 2002 to 0.76% in 2006, and then rising slowing to 0.85% in 2009. In 2011, the incidence rate was lower, at 0.75%.

<b>Incidence rate *</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>
Male	1.12%	1.12%	1.03%	0.89%	0.84%	0.76%	0.79%	0.83%	0.85%	0.82%	0.75%
Female	0.28%	0.30%	0.26%	0.21%	0.24%	0.21%	0.23%	0.24%	0.25%	0.23%	0.22%
<b>Total</b>	<b>0.69%</b>	<b>0.70%</b>	<b>0.63%</b>	<b>0.54%</b>	<b>0.52%</b>	<b>0.47%</b>	<b>0.49%</b>	<b>0.52%</b>	<b>0.53%</b>	<b>0.51%</b>	<b>0.47%</b>

\* Number of drug abusers as a percentage of population aged 10 or above

64 For reporting to the CRDA, a drug abuser refers to a person who is known or suspected to have taken drugs or substances during the four weeks before the date of contact with the reporting agency.

65 The age of 10 is chosen because this is the youngest age of drug abusers recorded in the CRDA.



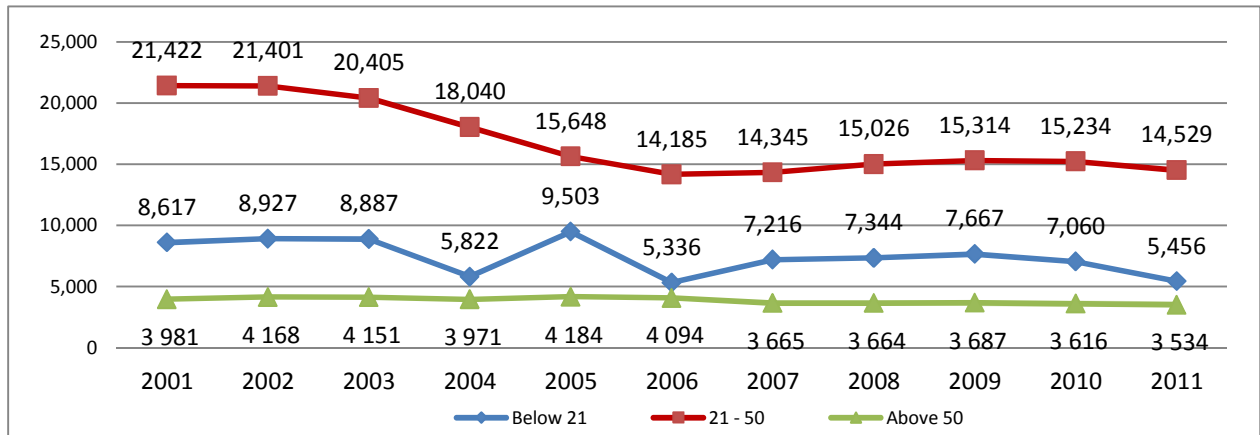
8.7 For female drug abusers, the incidence rate stayed at below 0.30% throughout the period from 2003 to 2010, and has almost stabilized at around 0.21% - 0.25% in 2004 – 2011. For both male and female drug abusers, it follows the trend of male drug abusers and has been decreasing steadily from 0.70% in 2002 to 0.47% in 2006, and then rising slowing to 0.53% in 2009. In 2011, the incidence rate was lower, at 0.47%.

*Estimation by gender and age group*

8.8 Apart from gender, it is believed that the probability of recapturing drug abusers of different age groups is likely to be different. To further minimize heterogeneity due to different recapture probabilities, separate capture-recapture models were run for drug abusers of different age-sex groups. Findings of the models would not only produce estimates of the number of drug abusers by age groups but also as a counter-check to the estimates computed above.

8.9 Estimates of the number male drug abusers for three age groups are shown in the table and chart below. It may be seen that for male drug abusers aged above 50, the number has remained fairly stable at around 3,970 to 4,180 in 2002 – 2006 and started to decline steadily to 3,620 in 2010 and 3,530 in 2011.

Male	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
(a) Age below 21	8,617	8,927	8,887	5,822	9,503	5,336	7,216	7,344	7,667	7,060	5,456
(b) Aged 21 – 50	21,422	21,401	20,405	18,040	15,648	14,185	14,345	15,026	15,314	15,234	14,529
(c) Aged above 50	3,981	4,168	4,151	3,971	4,184	4,094	3,665	3,664	3,687	3,616	3,534
(d) Sub-total	34,021	34,496	33,443	27,833	29,334	23,615	25,226	26,034	26,668	25,910	23,519

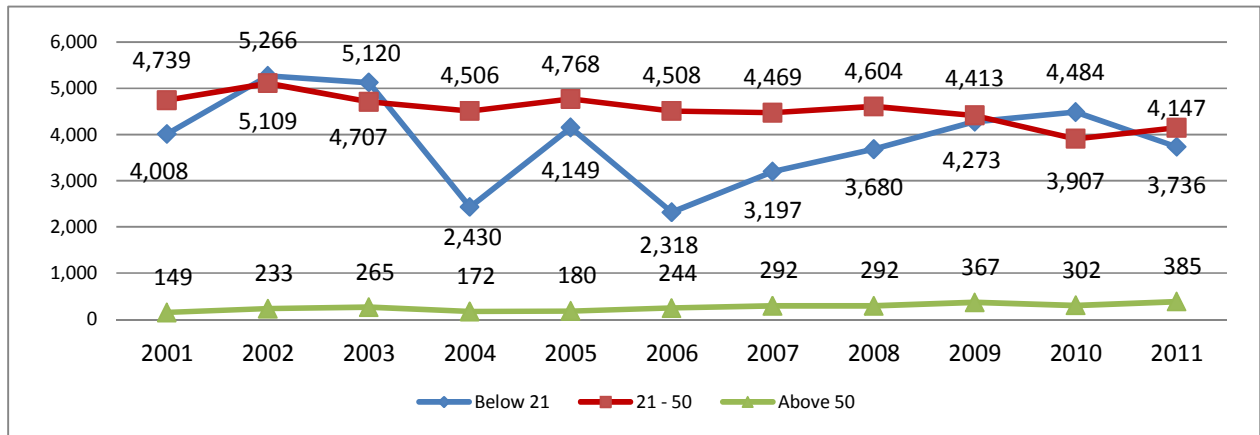


8.10 For male drug abusers aged below 21, the number was highest in 2005, at 9,500 and then dropped to 5,340 in 2006, before rising steadily to 7,670 in 2009; in 2011, the number was lower, at 5,460. For those aged 21 – 50, the number has been declining steadily from 21,400 in 2002 to 14,190 in 2006 and then increased slowly to 15,310 in 2009; the number was lower in 2011 at 14,530.

8.11 For female drug abusers, the pattern of changes is quite different from that for their male counterparts. For female drug abusers aged above 50, the number has remained fairly stable at around 170 to 270 in 2002 – 2005, started to increase steadily to 370 in 2009 and then dropped to 300 in 2010, before rising again to 390 in 2011.

Female	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
(a) Age below 21	4,008	5,266	5,120	2,430	4,149	2,318	3,197	3,680	4,273	4,484	3,736
(b) Aged 21 – 49	4,739	5,109	4,707	4,506	4,768	4,508	4,469	4,604	4,413	3,907	4,147
(c) Aged 50 and above	149	233	265	172	180	244	292	292	367	302	385
(d) Sub-total	8,896	10,608	10,092	7,108	9,097	7,070	7,958	8,576	9,053	8,694	8,267

8.12 For female drug abusers aged below 21, the number was highest in 2002, at 5,270, decreased to 2,430 in 2004, increased to 4,150 in 2005 and dropped back to 2,320 in 2006. Since 2006, the number has been increasing steadily to 4,480 in 2010 and then decreased to 3,740 in 2011. For those aged 21 – 50, the number was more or less on a declining trend, from 5,110 in 2002 to 3,910 in 2010. In 2011, the number was higher, at 4,150.



8.13 It may be worth noting that the precision level of the estimates obtained from the two-source capture-recapture models, with separate estimates computed for different age groups, is quite high. For instance, as shown in the table below, the upper limit of the estimates for male drug abusers, at 95% confidence, ranges from 1.7% above the estimate in 2011 to 1.2% in 2001. The lower limit of the estimates, at 95% confidence, falls within the range of 1.2% and 1.7% below the estimates. In other words, the estimated number of male drug abusers in say 2011 could be within the range of 23,920 and 23,110. This level of precision is considered very acceptable.

Male	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
(a) Estimate	34,021	34,496	33,443	27,833	29,334	23,615	25,226	26,034	26,668	25,910	23,519
(b) Upper limit	34,427	34,911	33,847	28,182	29,680	23,931	25,587	26,421	27,071	26,330	23,924
(c) Lower limit	33,614	34,081	33,039	27,485	28,988	23,299	24,865	25,646	26,264	25,490	23,114
(d) % of upper limit above estimate	1.2%	1.2%	1.2%	1.3%	1.2%	1.3%	1.4%	1.5%	1.5%	1.6%	1.7%
(e) % of lower limit below estimate	1.2%	1.2%	1.2%	1.3%	1.2%	1.3%	1.4%	1.5%	1.5%	1.6%	1.7%

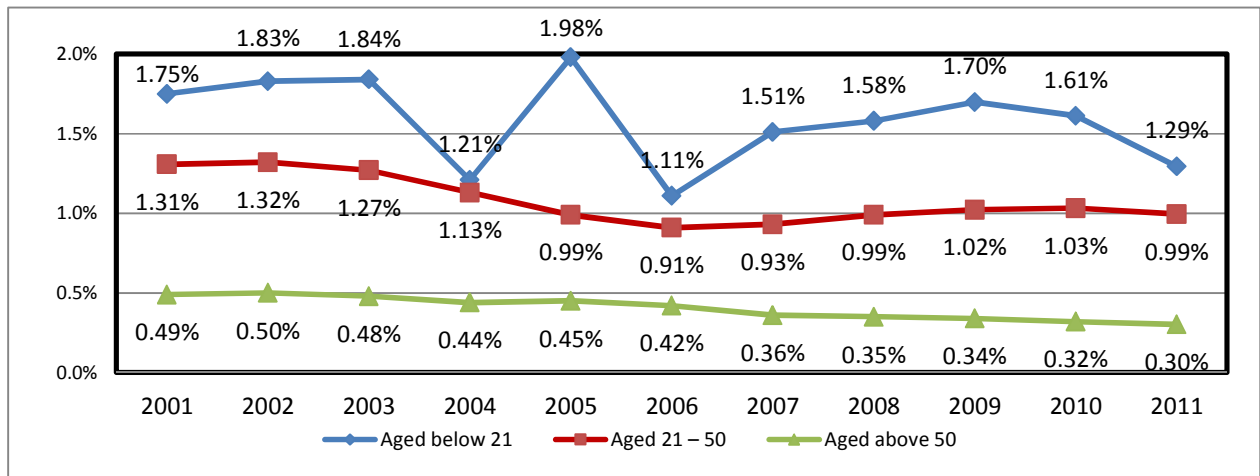
8.14 For female drug abusers, as shown in the table below, the upper limit of the estimates for male drug abusers, at 95% confidence, ranges from 5.0% above the estimate in 2011 to 3.4% in 2003. The lower limit of the estimates, at 95% confidence, falls within the range of 3.4% and 5.0% below the estimates. In other words, the estimated number of female drug abusers in say 2011 could be within the range of 8,680 and 7,860. This level of precision is clearly quite acceptable.

Female	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
(a) Estimate	8,896	10,608	10,092	7,108	9,097	7,070	7,958	8,576	9,053	8,694	8,267
(b) Upper limit	9,262	11,026	10,431	7,377	9,443	7,352	8,325	8,960	9,444	9,071	8,680
(c) Lower limit	8,530	10,191	9,753	6,840	8,751	6,789	7,590	8,191	8,663	8,317	7,855
(d) % of upper limit above estimate	4.1%	3.9%	3.4%	3.8%	3.8%	4.0%	4.6%	4.5%	4.3%	4.3%	5.0%
(e) % of lower limit below estimate	4.1%	3.9%	3.4%	3.8%	3.8%	4.0%	4.6%	4.5%	4.3%	4.3%	5.0%

8.15 Based on the number of drug abusers by age-sex groups estimated above, the age-sex specific incidence rate of drug abusers was computed, by expressing the number of drug abusers in a given age-sex group as a percentage of the total population in the corresponding age-sex group. The incidence rate is shown in the table and chart below for male drug abusers. It may be seen that the prevalence rate for male drug abusers aged below 21 fluctuated between 1.98% and 1.11% during the period from 2002 to 2006, before increasing steadily to 1.70% in 2009. In 2011, the incidence rate dropped to 1.29%.<sup>66</sup> It is worth noting that the incidence rate for male drug abusers aged below 21 is higher than the incidence rates for those aged 21 – 50 and those aged above 50.

Male incidence rate	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Aged below 21	1.75%	1.83%	1.84%	1.21%	1.98%	1.11%	1.51%	1.58%	1.70%	1.61%	1.29%
Aged 21 – 50	1.31%	1.32%	1.27%	1.13%	0.99%	0.91%	0.93%	0.99%	1.02%	1.03%	0.99%
Aged above 50	0.49%	0.50%	0.48%	0.44%	0.45%	0.42%	0.36%	0.35%	0.34%	0.32%	0.30%

8.16 For male drug abusers aged 21 – 50, the incidence rate has been decreasing steadily from 1.32% in 2002 to 0.91% in 2006, before rising steadily to 1.03% in 2010. The rate was 0.99% in 2011. For those aged above 50, the incidence rate is on a declining trend, dropping from 0.50% in 2002 to 0.32% in 2010 and 0.30% in 2011.



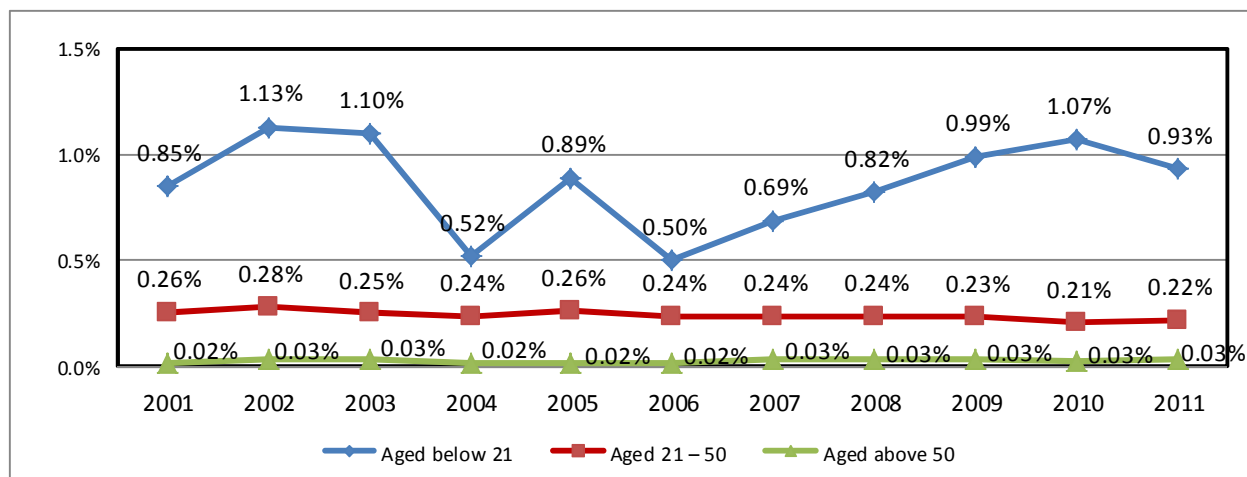
8.17 For female drug abusers, the incidence rate is shown in the table and chart below. It may be seen that the incidence rate for female drug abusers aged below 21 decreased from 1.13% in 2002 to 0.52% in 2004, increased to 0.89% in 2005 and then dropped back to 0.50% in 2006. Since 2006, the incidence rate has been increasing from 0.50% in 2006 to 1.07% in 2010.<sup>67</sup> In 2011, the rate dropped to 0.93%. It may be worth noting that the incidence rate for female drug abusers aged below 21 is much higher than the incidence rates for those aged 21 – 50 and those aged above 50.

<sup>66</sup> The incidence rate is calculated as a percentage of total population aged 10 – 20. The age of 10 is chosen because this is the youngest age of drug abusers recorded in the CRDA.

<sup>67</sup> The prevalence rate is calculated as a percentage of total population aged 10 – 20. The age of 10 is chosen because this is the youngest age of drug abusers recorded in the CRDA.



Female incidence rate	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Aged below 21	0.85%	1.13%	1.10%	0.52%	0.89%	0.50%	0.69%	0.82%	0.99%	1.07%	0.93%
Aged 21 – 50	0.26%	0.28%	0.25%	0.24%	0.26%	0.24%	0.24%	0.24%	0.23%	0.21%	0.22%
Aged above 50	0.02%	0.03%	0.03%	0.02%	0.02%	0.02%	0.03%	0.03%	0.03%	0.03%	0.03%

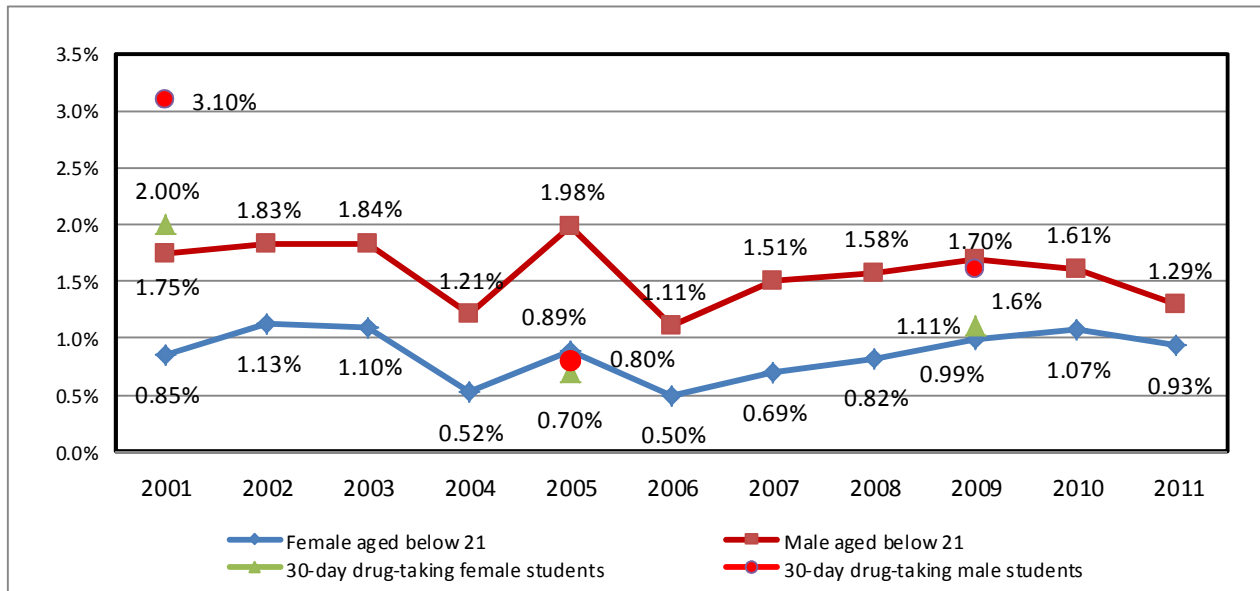


8.18 For female drug abusers aged 21 – 50, the incidence rate is more or less on a declining trend, decreasing steadily from 0.28% in 2002 to 0.22% in 2011. For those aged above 50, the incidence rate stabilized at around 0.02% - 0.03% during the period under review.

#### *Comparison with school survey*

8.19 For the purpose of CRDA reporting, a drug abuser refers to a person who is known or suspected to have taken drugs/substances during the four weeks before the date of contact with the reporting agencies. Thus the estimates computed above refer to drug abusers who have used drugs during the past four weeks. Similar information was collected through self-reports by students participating in the school surveys conducted by the Narcotics Division. The school surveys conducted in 2000/01 and 2004/05 covered students attending secondary schools and courses of the Institute of Vocational Education. In 2008/09, the survey was extended to cover upper primary, undergraduate courses offered by the UGC-funded institutions and other post-secondary courses. To facilitate comparison with data obtained from the 2000/01 and 2004/05 surveys, statistics in respect to the 2008/09 survey, presented in the chart below, cover only students attending secondary schools and post-secondary institutions (not include the undergraduate programmes under the University Grants Committee (UGC)-funded institutions). Statistics on the percentage of students who reported to have abused drugs during the 30 days prior to enumeration in the school surveys are

shown in the chart below. For comparative purpose, estimates of the incidence rates for drug abusers aged below 21 are also shown in the chart.



8.20 The following differences between the percentage of 30-day drug-taking male and female students reported in the school surveys and the estimated incidence rate for male and female drug abusers may be worth noting:

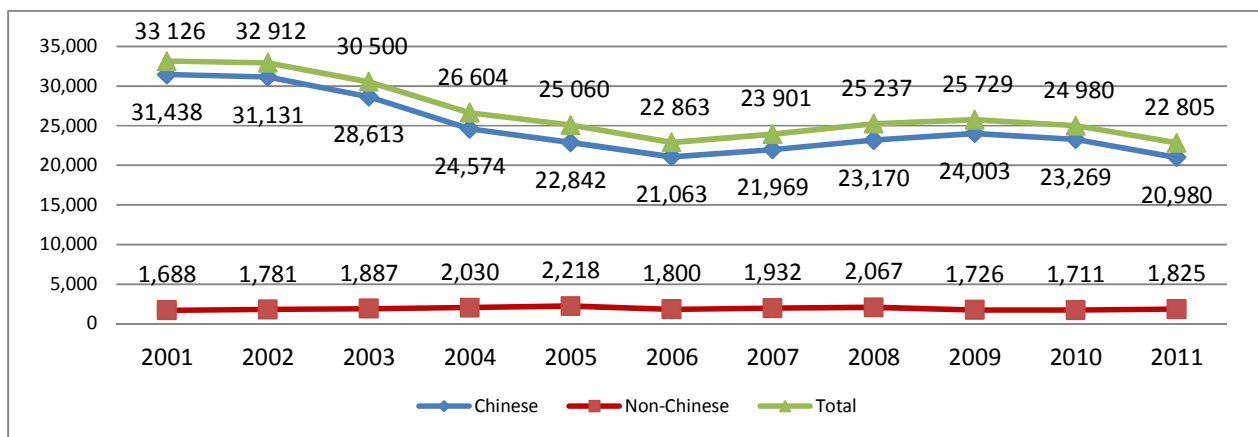
- The percentages of 30-day drug-taking male and female students in 2000/01 (at 3.1% and 2.0% respectively) are higher than the estimated incidence rates for male and female drug abusers in 2001;
- The percentages of 30-day drug-taking male and female students in 2004/05 (at 0.8% and 0.7% respectively) are quite close to the estimated incidence rate in 2005 for female drug abusers but lower than the estimated incidence rate for males;
- The percentages of 30-day drug-taking male and female students in 2008/09 (at 1.6% and 1.1% respectively), on the other hand, are quite close to the estimated incidence rates for male and female drug abusers in 2009.

8.21 The differences shown above may be accounted for by a number of factors. Data collected in the school surveys are subject to sampling errors, reporting errors and non-response errors. For estimates of incidence rates computed from the capture-recapture models, there are errors arising from the violations of assumptions, as discussed above, that the population under study must be closed, the probability of each individual being captured or recaptured must be the same and that the samples of capture and recapture must be mutually independent.

*Estimation by gender and ethnicity*

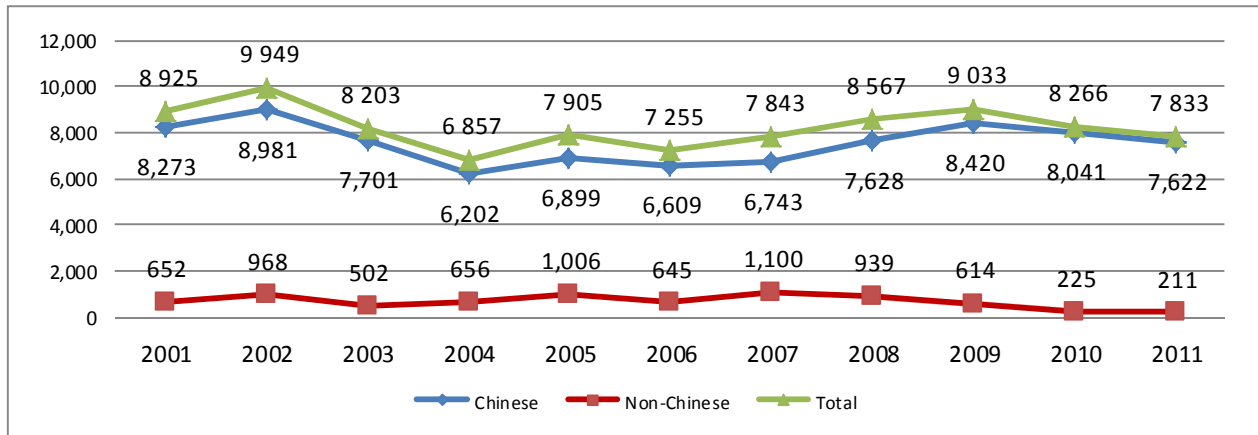
8.22 Information on ethnicity of drug abusers is available from the CRDA. Opportunity is thus taken to estimate the number of Chinese and non-Chinese drug abusers using the capture and recapture model. The findings are shown in the tables and charts below, separately for male and female drug abusers. It may be seen from the table and chart below that the number of non-Chinese male drug abusers increased from 1,780 in 2002 to 2,220 in 2005, then dropped to 1,800 in 2006, before increasing to 2,070 in 2008. The number decreased slightly in 2009 (at 1,730) and 2010 (1,710), before rising again to 1,830 in 2011. For Chinese male drug abusers, the pattern of changes over the years followed that for all male drug abusers during the period under review.

<b>Male</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>
(a) Chinese	31,438	31,131	28,613	24,574	22,842	21,063	21,969	23,170	24,003	23,269	20,980
(b) Non-Chinese or unknown	1,688	1,781	1,887	2,030	2,218	1,800	1,932	2,067	1,726	1,711	1,825
(c) Sub-total	33,126	32,912	30,500	26,604	25,060	22,863	23,901	25,237	25,729	24,980	22,805



8.23 For non-Chinese female drug abusers, the number increased from 970 in 2002 to 1,010 in 2005, then dropped to 650 in 2006, before increasing again 1,100 in 2007. Since 2007, the number of non-Chinese female drug abusers decreased steadily to 230 in 2010 and 210 in 2011. For Chinese female drug abusers, the pattern of changes over the years followed that for all female drug abusers during the period under review.

<b>Female</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>
(a) Chinese	8,273	8,981	7,701	6,202	6,899	6,609	6,743	7,628	8,420	8,041	7,622
(b) Non-Chinese or unknown	652	968	502	656	1,006	645	1,100	939	614	225	211
(c) Sub-total	8,925	9,949	8,203	6,857	7,905	7,255	7,843	8,567	9,033	8,266	7,833



8.24 It may be worth noting that the precision level of the estimates obtained from the two-source capture-recapture models, with separate estimates computed for Chinese and non-Chinese drug abusers, is quite high. For instance, as shown in the table below, the upper limit of the estimates for male drug abusers, at 95% confidence, ranges from 1.8% above the estimate in 2011 to 1.2% in 2001. The lower limit of the estimates, at 95% confidence, falls within the range of 1.2% and 1.8% below the estimates. In other words, the estimated number of male drug abusers in say 2011 could be within the range of 23,210 and 22,400. This level of precision is clearly very acceptable.

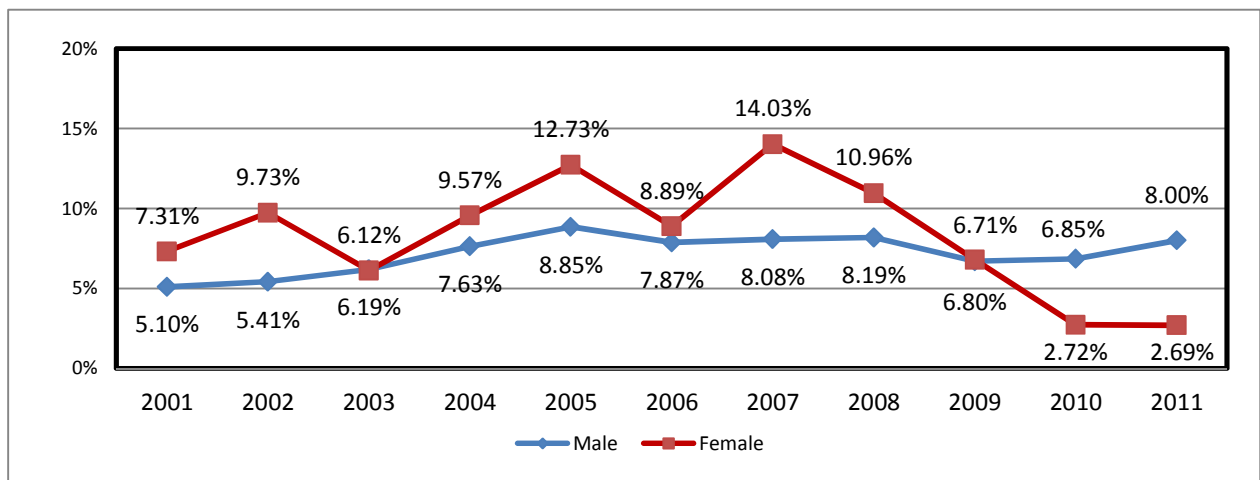
Male	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
(a) Estimate	33,126	32,912	30,500	26,604	25,060	22,863	23,901	25,237	25,729	24,980	22,805
(b) Upper limit	33,533	33,327	30,904	26,952	25,406	23,179	24,262	25,625	26,133	25,400	23,210
(c) Lower limit	32,719	32,497	30,096	26,255	24,713	22,547	23,540	24,849	25,325	24,560	22,400
(d) % of upper limit above estimate	1.2%	1.3%	1.3%	1.3%	1.4%	1.4%	1.5%	1.5%	1.6%	1.7%	1.8%
(e) % of lower limit below estimate	1.2%	1.3%	1.3%	1.3%	1.4%	1.4%	1.5%	1.5%	1.6%	1.7%	1.8%

8.25 For female drug abusers, as shown in the table below, the upper limit of the estimates for male drug abusers, at 95% confidence, ranges from 5.3% above the estimate in 2011 to 3.9% in 2004. The lower limit of the estimates, at 95% confidence, falls within the range of 3.9% and 5.3% below the estimates. In other words, the estimated number of female drug abusers in say 2011 could be within the range of 8,250 and 7,420. This level of precision is clearly quite acceptable.

Female	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
(a) Estimate	8,925	9,949	8,203	6,857	7,905	7,255	7,843	8,567	9,033	8,266	7,833
(d) Upper limit	9,292	10,367	8,542	7,126	8,252	7,536	8,211	8,952	9,424	8,643	8,246
(e) Lower limit	8,559	9,532	7,864	6,589	7,559	6,973	7,475	8,182	8,643	7,889	7,420
(d) % of upper limit above estimate	4.1%	4.2%	4.1%	3.9%	4.4%	3.9%	4.7%	4.5%	4.3%	4.6%	5.3%
(e) % of lower limit below estimate	4.1%	4.2%	4.1%	3.9%	4.4%	3.9%	4.7%	4.5%	4.3%	4.6%	5.3%

8.26 Expressed as a percentage of drug abusers who were non-Chinese, it may be noted from the table and chart below that the percentage for non-Chinese male drug abusers increased from 5.41% in 2002 to 8.85% in 2005, then decreased to 6.85% in 2010. The percentage was 8.00% in 2011. For non-Chinese female drug abusers, the percentage was higher than that for their male counterparts for most of the time during the period under review, except 2003, 2010 and 2011. The percentage also fluctuated between 6.12% and 14.03% during the period from 2002 to 2007. Since 2007, the percentage declined steadily to 2.72% in 2010 and 2.69% in 2011.

% non-Chinese	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Male	5.10%	5.41%	6.19%	7.63%	8.85%	7.87%	8.08%	8.19%	6.71%	6.85%	8.00%
Female	7.31%	9.73%	6.12%	9.57%	12.73%	8.89%	14.03%	10.96%	6.80%	2.72%	2.69%
Total	5.56%	6.41%	6.17%	8.03%	9.78%	8.12%	9.55%	8.89%	6.73%	5.82%	6.65%



#### *Estimation by gender and types of drugs*

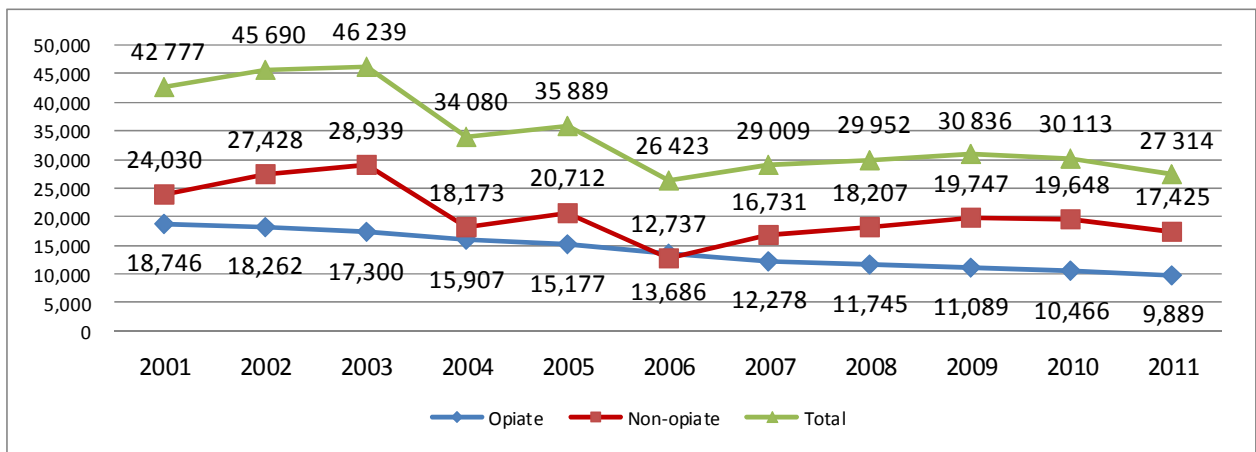
8.27 Apart from gender and age, the types of drugs used may also affect the chance of drug abusers being “captured” or “recaptured” by reporting agencies. Accordingly, drug abusers were classified into opiate and non-opiate users following practices adopted in Europe<sup>68</sup>. For drug abusers who have ever taken heroin and other opiates including opium, morphine, phsyseptone/methadone, dipipanone, doloxene, pethidine, fentanyl and other narcotic analgesics<sup>69</sup>, regardless of whether they have also taken other non-narcotic drugs, they are classified as opiate users. For drug abusers who have only used non-opiates, they are classified as non-opiate users. Based on this classification, records of the CRDA are grouped into the opiate or non-opiate users and estimates of the total number of drug abusers during the period from 2001 to 2011 belonging to each of the two groups are computed and shown in the tables and charts below.

68 European Monitoring Centre for Drugs and Drugs Addiction (2004), *Key Epidemiological Indicator: Prevalence of problem drug use*, p.12.

69 Based on classification adopted in the CRDA.

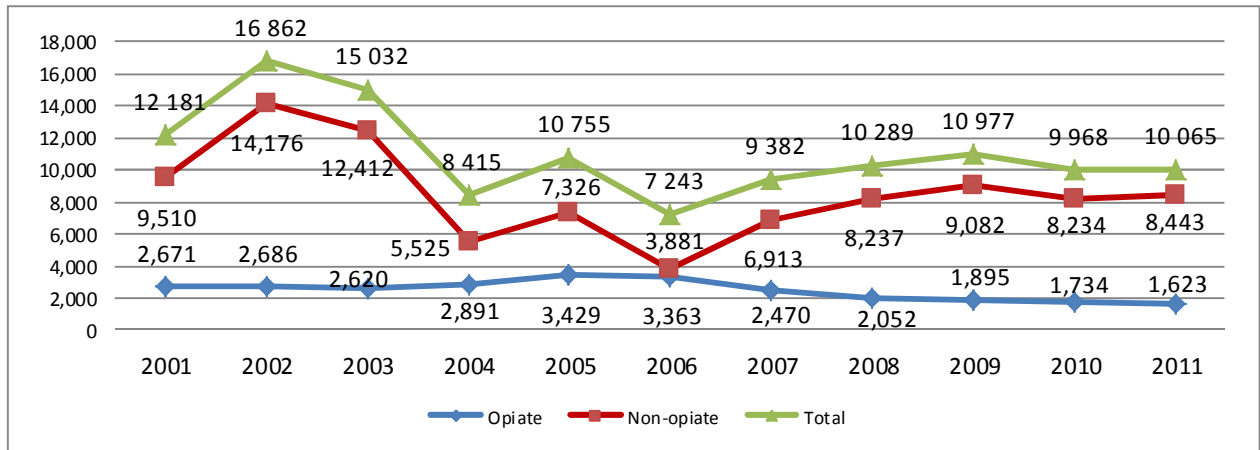
8.28 For male drug abusers, the number of opiate users has been decreasing steadily from 18,750 in 2001 to 9,890 in 2011. For non-opiate users, the number reached 28,940 in 2003 and then dropped to 12,740 in 2006, before rising steadily to 19,750 in 2009 and 19,650 in 2010. In 2011, the number of non-opiate users decreased to 17,430.

Male	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
(a) Opiate	18,746	18,262	17,300	15,907	15,177	13,686	12,278	11,745	11,089	10,466	9,889
(b) Non-opiate	24,030	27,428	28,939	18,173	20,712	12,737	16,731	18,207	19,747	19,648	17,425
(c) Sub-total	42,777	45,690	46,239	34,080	35,889	26,423	29,009	29,952	30,836	30,113	27,314



8.29 For female drug abusers, the number of opiate users increased from 2,670 in 2001 to 3,430 in 2005. Since 2005, the number of opiate users was on a declining trend, dropping to 1,620 in 2011. For non-opiate users, the number dropped significantly from 14,180 in 2002 to 3,880 in 2006, and then started to increase steadily, reaching 9,080 in 2009. The number of non-opiate users dropped to 8,230 in 2010 and 8,440 in 2011.

Female	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
(a) Opiate	2,671	2,686	2,620	2,891	3,429	3,363	2,470	2,052	1,895	1,734	1,623
(b) Non-opiate	9,510	14,176	12,412	5,525	7,326	3,881	6,913	8,237	9,082	8,234	8,443
(c) Sub-total	12,181	16,862	15,032	8,415	10,755	7,243	9,382	10,289	10,977	9,968	10,065



8.30 It may be worth noting that the precision level of the estimates obtained from the two-source capture-recapture models, with separate estimates computed for opiate and non-opiate drug abusers, is quite high. For instance, as shown in the table below, the upper limit of the estimates for male drug abusers, at 95% confidence, ranges from 1.5% above the estimate in 2011 to 0.9% in 2001. The lower limit of the estimates, at 95% confidence, falls within the range of 0.9% and 1.5% below the estimates. In other words, the estimated number of male drug abusers in say 2011 could be within the range of 27,720 and 26,910. This level of precision is clearly very acceptable.

Male	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
(a) Estimate	42,777	45,690	46,239	34,080	35,889	26,423	29,009	29,952	30,836	30,113	27,314
(b) Upper limit	43,183	46,105	46,643	34,429	36,235	26,739	29,370	30,340	31,240	30,533	27,719
(c) Lower limit	42,370	45,275	45,835	33,732	35,543	26,107	28,648	29,564	30,433	29,693	26,909
(d) % of upper limit above estimate	0.9%	0.9%	0.9%	1.0%	1.0%	1.2%	1.2%	1.3%	1.3%	1.4%	1.5%
(e) % of lower limit below estimate	1.0%	0.9%	0.9%	1.0%	1.0%	1.2%	1.2%	1.3%	1.3%	1.4%	1.5%

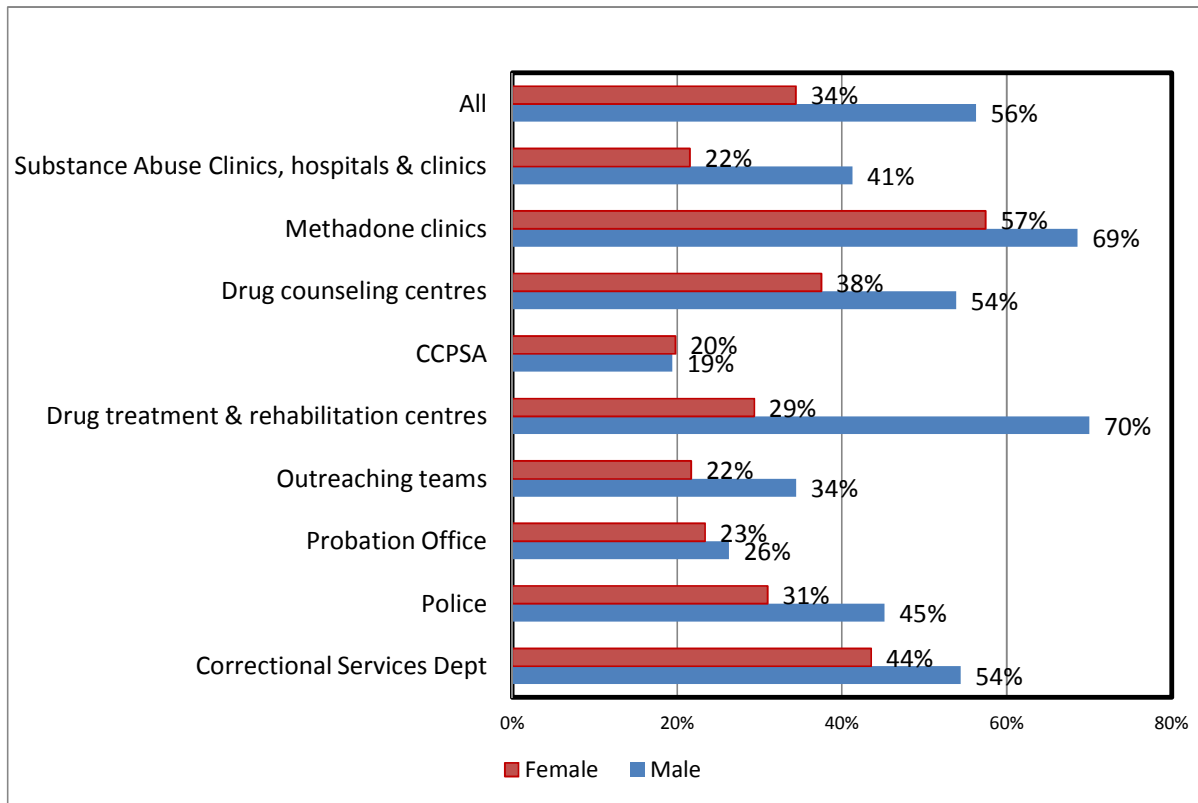
8.31 For female drug abusers, as shown in the table below, the upper limit of the estimates for male drug abusers, at 95% confidence, ranges from 4.1% above the estimate in 2011 to 2.3% in 2003. The lower limit of the estimates, at 95% confidence, falls within the range of 2.3% and 4.1% below the estimates. In other words, the estimated number of female drug abusers in say 2011 could be within the range of 10,480 and 9,650. This level of precision is clearly quite acceptable.

Female	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
(a) Estimate	12,181	16,862	15,032	8,415	10,755	7,243	9,382	10,289	10,977	9,968	10,065
(b) Upper limit	12,547	17,280	15,371	8,684	11,101	7,525	9,750	10,674	11,368	10,345	10,478
(c) Lower limit	11,815	16,444	14,692	8,147	10,409	6,962	9,015	9,905	10,587	9,591	9,653
(d) % of upper limit above estimate	3.0%	2.5%	2.3%	3.2%	3.2%	3.9%	3.9%	3.7%	3.6%	3.8%	4.1%
(e) % of lower limit below estimate	3.0%	2.5%	2.3%	3.2%	3.2%	3.9%	3.9%	3.7%	3.6%	3.8%	4.1%

### *Four-source capture-recapture model*

8.32 In the capture-recapture models presented above, attempts have been made to minimize heterogeneity by separately estimating the number of drug abusers by gender, age, types of drugs used and ethnicity by classifying reporting agencies into four different categories. Nevertheless, another assumption of the capture-recapture models is that the samples captured and recaptured are mutually independent. As shown in the chart below, the assumption that the probability of a drug abuser being recaptured again is the same is not likely to be valid for different reporting agencies or different categories of reporting agencies, and this cannot be addressed in the models presented above. Hopefully, by grouping all categories of reporting agencies into one single source, as in the case of the two-source capture-recapture models presented above, the assumption of the samples captured in one year and recaptured in the next being mutually independent should be partially met, as changes in the distribution of cases among different reporting agencies should not change significantly in a short span of just one year.

8.33 To properly assess variations in the recapture probabilities among different categories of reporting agencies, an analysis of the proportion of cases in 2010 which were reported again in 2011 was conducted. The findings are summarized in the chart below. Taking all agencies together, the probability of being recaptured is higher for male (at 56%) than for female (34%). This finding justifies estimating separately the number of male and female drug abusers in the capture-recapture models presented above.





8.34 As shown in the chart above, the probability of being recaptured also varies considerably for different categories of reporting agencies, ranging from 19% and 20% respectively for male and female drug abusers in respect of CCPSA to 69% and 57% respectively in respect of methadone clinics. The difference is probably due to the fact that most drug abusers treated by methadone clinics are those who have abused opiate drugs whereas clients of CCPSA are mainly those who have abused non-opiate drugs. This finding provides justifications for separately estimating the number of opiate and non-opiate users in the capture-recapture models presented above.

8.35 To take onboard differences in recapture probabilities for different categories of reporting agencies, a four-source capture-recapture model was used to estimate the number of male and female drug abusers. Reporting agencies were grouped into the following four categories. Log linear models were fitted to the CRDA data separately for male and female drug abusers, covering the years 2001 to 2011. In running the log linear models, overlaps of cases captured by the four categories of reporting agencies were identified and dependencies between different categories of reporting agencies were analyzed by fitting the models to the observed data. The “unobserved” or hidden population of drug abusers was then estimated from the models and summation of observed and “unobserved” data would yield the estimated total population of drug abusers. It may be noted that the grouping shown below is based on the characteristics of reporting agencies rather than the recapture probabilities shown in the chart above.

- a) Enforcement, including the Police, Correctional Services Department and Probation Office of Social Welfare Department;
- b) Outreaching teams of NGO;
- c) Drug treatment centres, including drug treatment and rehabilitation centres and centres of drug counseling of NGO and CCPSA;
- d) Clinics, including methadone clinics, Substance Abuse Clinics of Hospital Authority and other hospitals or clinics.

8.36 Different log linear models were fitted to the observed data, taking into account interactions between the four categories of reporting agencies using statistical package, SPSS. The preferred models were chosen based on the likelihood ratios in the goodness-of-fit tests and by selecting the simplest models with the least interactions between reporting agencies.<sup>70 71</sup> The results are summarized in the tables and chart below, separately for male and female drug abusers.

---

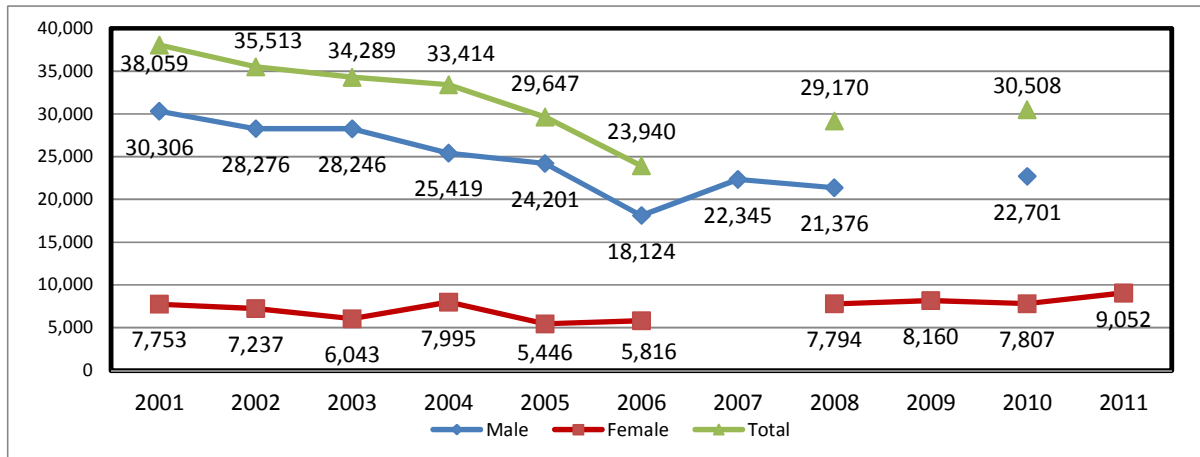
70 European Monitoring Centre for Drugs and Drug Addiction (1999), *Methodological guidelines to estimate the prevalence of problem drug use on the local level*.

71 Chan, Y H (2005), “Log linear models: Poisson regression”, in *Singapore Medical Journal*, 46(8): 377 - 386.

Male	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
(a) Selected model showing interaction terms*	s1*s2*s3, s2*s4, s3*s4	s1*s2*s3, s2*s4, s3*s4	s1*s2*s4, s2*s3*s4	s1*s2, s2*s3, s2*s4, s1*s4, s3*s4	s2*s4, s1*s2, s2*s3, s1*s4, s3*s4	s1*s2*s3, s2*s4, s3*s4	s1*s2*s3, s2*s4, s3*s4	s1*s2*s3, s2*s4, s3*s4	No model selected	s2*s3*s4, s1*s4, s1*s2, s1*s3	No model selected
(b) Goodness of fit (p-value)	0.440 (0.979)	1.391 (0.846)	2.102 (0.551)	0.358 (0.996)	3.755 (0.585)	4.481 (0.345)	0.043 (0.998)	1.096 (0.778)		4.725 (0.193)	
(c) Estimated total no. of drug abusers	30,306	28,276	28,246	25,419	24,201	18,124	22,345	21,376		22,701	
(d) % of unobserved cases	48.4%	47.7%	53.0%	52.0%	52.7%	40.9%	50.2%	47.0%		55.9%	

\* S1: Enforcement, S2: Outreaching and school, S3: Drug treatment, S4: Clinics. The term "s1\*s2\*s3", for example, indicates interaction term for S1, S2 and S3.

Female	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
(a) Selected model, showing interaction terms	s1*s2, s2*s3, s2*s4, s3*s4	s2*s3*s4, s1*s2	s1*s2, s2*s3, s2*s4, s3*s4	s1*s2, s1*s4, s2*s3, s2*s4, s3*s4	s1*s2, s2*s3, s2*s4, s3*s4	s1*s2, s2*s3, s2*s4, s3*s4	No model selected	s1*s2*s3, s1*s2*s4	s1*s2, s1*s4, s2*s3, s2*s4	s1*s2, s1*s4, s2*s3, s2*s4, s3*s4	s1*s2, s1*s4, s2*s3, s2*s4
(b) Goodness of fit (p-value)	0.844 (0.991)	8.868 (0.114)	3.723 (0.714)	3.258 (0.660)	5.447 (0.488)	6.104 (0.412)		1.760 (0.624)	5.118 (0.529)	0.158 (0.999)	0.693 (0.995)
(c) Estimated total no. of drug abusers	7,753	7,237	6,043	7,995	5,446	5,816		7,794	8,160	7,807	9,052
(d) % of unobserved cases	62.9%	56.0%	58.3%	66.8%	51.0%	56.2%		62.7%	66.1%	67.6%	76.5%



8.37 It may be noted from the tables and chart above that the estimated number of male drug abusers has been decreasing steadily from 30,310 in 2001 to 18,120 in 2006, before increasing to 22,700 in 2010. For female drug abusers, the number fluctuated between 5,450 and 8,000 during the period from 2001 to 2006. In 2011, the number was 9,050.

8.38 It may be worth noting that the precision level of the estimates obtained from the four-source capture-recapture models is quite low. For instance, as shown in the table below, the upper limit of the estimates for male drug abusers, at 95% confidence, ranges from 3.1% above the estimate in 2002 to 14.0% in 2010. The lower limit of the estimates, at 95% confidence, falls within the range of 2.9% and 11.2% below the estimates. In other words, the estimated number of male drug abusers in say 2010 could be within the range of 25,880 and 20,160. This level of precision is considered not quite acceptable.

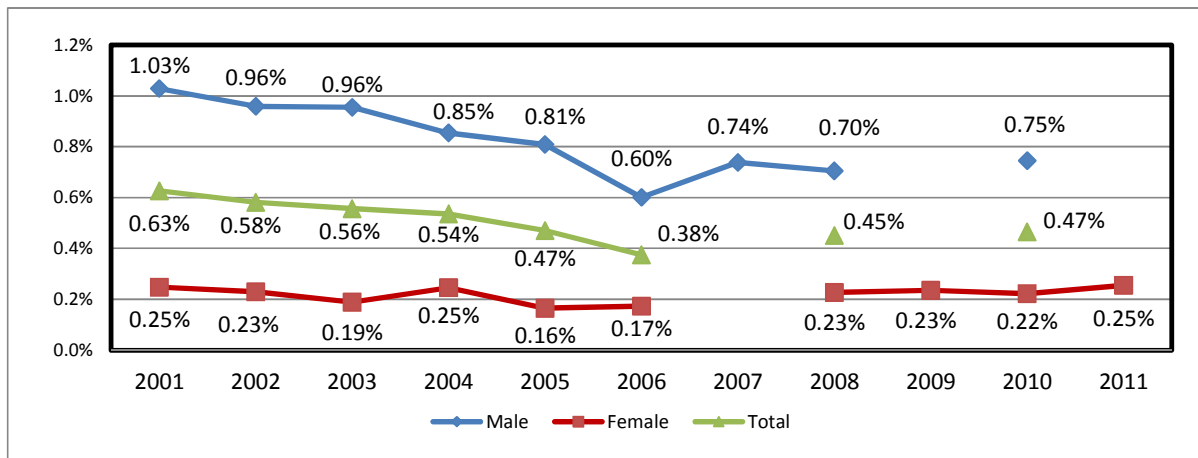
Male	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
(a) Estimate	30,306	28,276	28,246	25,419	24,201	18,124	22,345	21,376	-	22,701	-
(b) Upper limit	31,283	29,162	30,170	27,017	25,913	18,741	24,850	22,219	-	25,880	-
(c) Lower limit	29,389	27,443	26,541	23,993	22,691	17,555	20,298	20,599	-	20,158	-
(d) % of upper limit above estimate	3.2%	3.1%	6.8%	6.3%	7.1%	3.4%	11.2%	3.9%	-	14.0%	-
(e) % of lower limit below estimate	3.0%	2.9%	6.0%	5.6%	6.2%	3.1%	9.2%	3.6%	-	11.2%	-

8.39 For female drug abusers, as shown in the table below, the upper limit of the estimates for male drug abusers, at 95% confidence, ranges from 25.7% above the estimate in 2004 to 8.4% in 2005. The lower limit of the estimates, at 95% confidence, falls within the range of 7.0 and 18.6% below the estimates. In other words, the estimated number of female drug abusers in say 2011 could be within the range of 10,860 and 7,620. This level of precision is clearly not acceptable at all.

<b>Female</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>
(a) Estimate	7,753	7,237	6,043	7,995	5,446	5,816	-	7,794	8,160	7,807	9,052
(b) Upper limit	8,595	7,816	6,611	10,052	5,906	6,400	-	9,849	9,378	9,603	10,859
(c) Lower limit	7,036	6,730	5,555	6,510	5,051	5,320	-	6,348	7,167	6,467	7,618
(d) % of upper limit above estimate	10.9%	8.0%	9.4%	25.7%	8.4%	10.0%	-	26.4%	14.9%	23.0%	20.0%
(e) % of lower limit below estimate	9.2%	7.0%	8.1%	18.6%	7.3%	8.5%	-	18.6%	12.2%	17.2%	15.8%

8.40 Expressed as a percentage of population aged 10 or above, the incidence rate for male drug abusers follows similar trend as the total number of drug abusers and has been decreasing steadily from 1.03% in 2001 to 0.6% in 2006. The rate increased to 0.75% in 2010. For female drug abusers, the incidence rate fluctuated between 0.16% and 0.25% in 2001 – 2006. In 2011, the rate was 0.25%.

<b>Incidence rate</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>
Male	1.03%	0.96%	0.96%	0.85%	0.81%	0.60%	0.74%	0.70%	-	0.75%	-
Female	0.25%	0.23%	0.19%	0.25%	0.16%	0.17%	-	0.23%	0.23%	0.22%	0.25%
Total	0.63%	0.58%	0.56%	0.54%	0.47%	0.38%	-	0.45%	-	0.47%	-

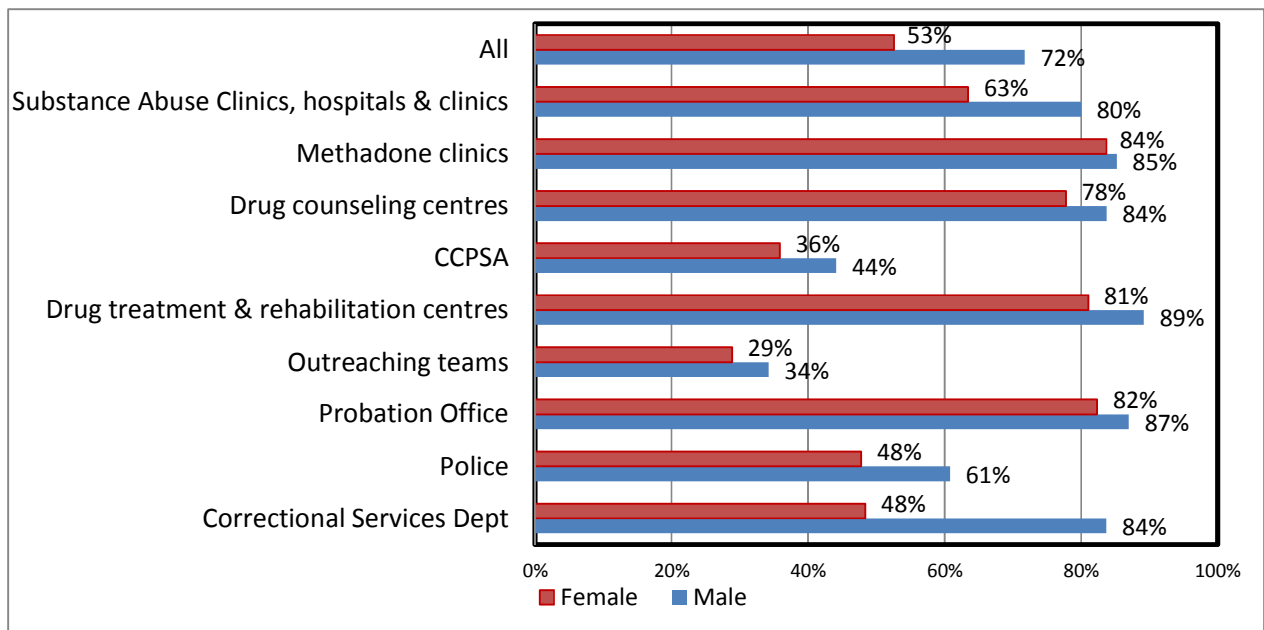


8.41 It may be noted from the above that no model can be selected for the years 2009 and 2011 in respect of male drug abusers and for year of 2007 in respect of female drug abusers. Attempts have been made to run the four-source capture-recapture models using the aggregate data covering a period of 3 years. In other words, the model was run on the 2000-2002, 2003-2005, 2006-2008 and 2009-2011 data. However, no model can be selected for both male and female drug abusers.

	2000-2002	2003-2005	2006-2008	2009-2011
<b>Male</b>				
(a) Selected model showing interaction terms*	No model selected	No model selected	No model selected	No model selected
<b>Female</b>				
(a) Selected model showing interaction terms*	No model selected	No model selected	No model selected	No model selected

***Three-source capture-recapture model***

8.42 As shown above, with the use of the four-source capture-recapture model, no satisfactory model can be found in 2009 and 2011 for male drug abusers and in 2007 for female drug abusers. Attempt has made to reclassify reporting agencies such that those with similar recapture probabilities are grouped into one single source. In classifying reporting agencies into different sources, analysis has been made of the recapture statistics for the years 2000 – 2011. The recapture probabilities for different report agencies are shown in the chart below.



8.43 It may be seen from the chart above that, for instance, the recapture probabilities of Correctional Services Department and Police are similar, for obvious reasons. The recapture probabilities for outreaching teams of NGO and CCPSA are also quite close. Accordingly, different reporting agencies are grouped into three sources as follows:

- a) Outreaching teams of NGO and CCPSA;
- b) Correctional Services Department and Police; and

- c) Methadone clinics, Substance Abuse Clinics, hospitals and clinics, Drug treatment & rehabilitation centres of NGO, Drug counseling centres of NGO and Probation Office of Social Welfare Department.

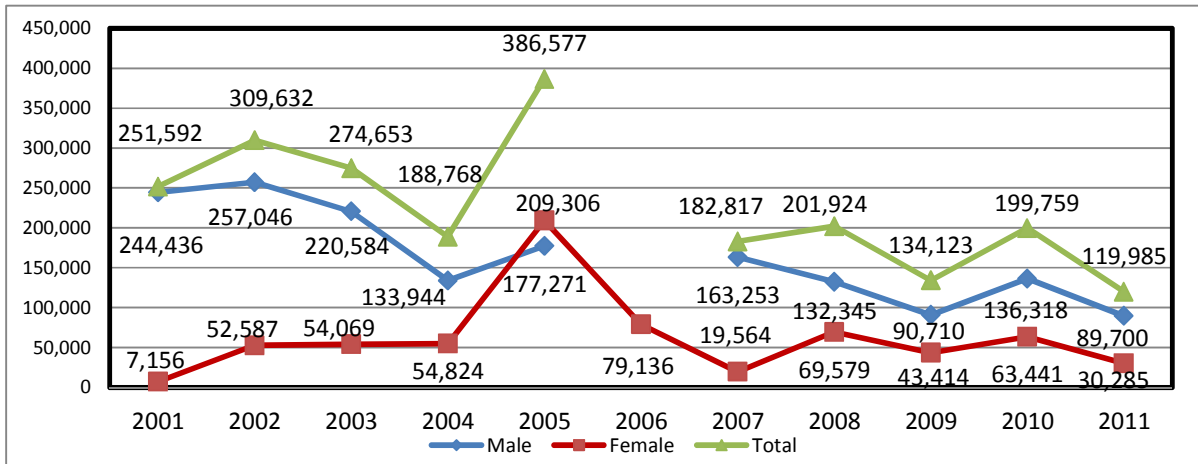
8.44 Different log linear models were fitted to the observed data, taking into account interactions between the three categories of reporting agencies using statistical package, SPSS. The preferred models were chosen based on the likelihood ratios in the goodness-of-fit tests and by selecting the simplest models with the least interactions between reporting agencies. The results are summarized in the tables and chart below, separately for male and female drug abusers.

8.45 It may be seen that the estimated number of drug abusers is much greater than those estimated above, using the four-source and two-source capture-recapture models presented above. For instance, the estimated number of male drug abusers in 2010, using the three-source capture-recapture model, is 136,320. This estimate is much higher than the figure of 22,700 based from the four-source capture-recapture mode, the figure of 30,110 based on the two-source capture-recapture model with separate estimates for opiate and non-opiate drug abusers, the figure of 24,980 based on the two-source capture-recapture model with separate estimates for Chinese and non-Chinese drug abusers and the figure of 25,910 based on the two-source capture-recapture model with separate estimates by age groups.

<b>Male</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>
(a) Selected model showing interaction terms*	s2*s3, s1*s3	s2*s3	s2*s3	s2*s3	s2*s3	No model selected	s2*s3	s2*s3	s1*s2, s2*s3	s1*s2, s2*s3	s1*s2, s2*s3
(b) Goodness of fit (p-value)	0.500 (0.479)	0.803 (0.669)	0.263 (0.877)	0.779 (0.677)	2.083 (0.353)		0.912 (0.634)	1.856 (0.395)	0.352 (0.553)	0.31 (0.577)	0.044 (0.833)
(c) Estimated total no. of drug abusers	244,436	257,046	220,584	133,944	177,271		163,253	132,345	90,710	136,318	89,700
(d) % of unobserved cases	93.6%	94.3%	94.0%	90.9%	93.5%		93.2%	91.4%	87.6%	92.7%	89.6%

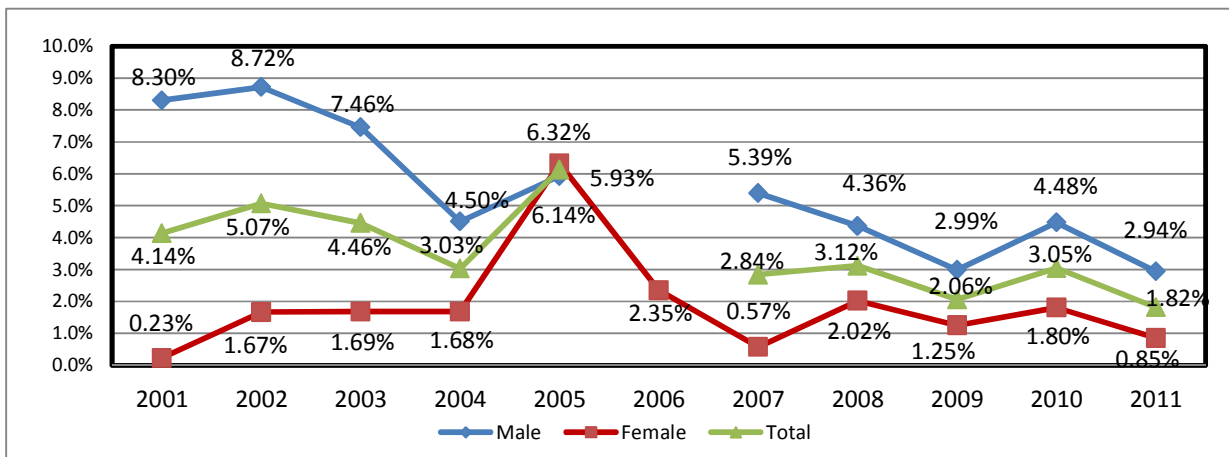
<b>Female</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>
(a) Selected model, showing interaction terms	s1*s2, s1*s3	s2*s3	s2*s3	s2*s3	s2*s3, s1*s3	s2*s3, s1*s3	s1*s2, s2*s3	s2*s3, s1*s3	s2*s3, s1*s3	s2*s3	s1*s2, s2*s3
(b) Goodness of fit (p-value)	0.044 (0.833)	2.276 (0.32)	1.184 (0.553)	3.387 (0.184)	0.186 (0.666)	0.186 (0.667)	0.453 (0.501)	0.07 (0.791)	0.131 (0.718)	0.781 (0.677)	0.005 (0.945)
(c) Estimated total no. of drug abusers	7,156	52,587	54,069	54,824	209,306	79,136	19,564	69,579	43,414	63,441	30,285
(d) % of unobserved cases	59.9%	93.9%	95.3%	95.2%	98.7%	96.8%	87.4%	95.8%	93.6%	96.0%	93.0%

8.46 The total number of drug abusers estimated from the above models is plotted in the chart below. Based on the models selected, the total number of drug abusers is estimated to be as high as 251,590 in 2001, rising to 386,580 in 2005. The estimates for 2007 – 2011 are much lower, ranging from 201,920 in 2008 to 119,990 in 2011.



8.47 Expressed as a percentage of population aged 10 or above, the incidence rate for male drug abusers follows similar trend as the total number of drug abusers and has been decreasing steadily from 8.30% in 2001 to 5.93% in 2005. The rate was highest in 2002, at 8.72%, following steadily to 4.50% in 2004. In 2011, the rate was 2.94%. For female drug abusers, the incidence rate increased significantly from 0.23% in 2001 to as high as 6.32% in 2005 and then dropped to only 0.85% in 2011.

Incidence rate	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Male	8.30%	8.72%	7.46%	4.50%	5.93%	-	5.39%	4.36%	2.99%	4.48%	2.94%
Female	0.23%	1.67%	1.69%	1.68%	6.32%	2.35%	0.57%	2.02%	1.25%	1.80%	0.85%
Total	4.14%	5.07%	4.46%	3.03%	6.14%	-	2.84%	3.12%	2.06%	3.05%	1.82%



8.48 Furthermore, it may also be noted that the precision level of the estimates obtained from the three-source capture-recapture models is quite low. For instance, as shown in the table below, the upper limit of the estimates for male drug abusers, at 95% confidence, is as high as 18.5% to 36.3% above the estimates. The lower limit of the estimates, at 95% confidence, is as high as 15.4% to 26.2% below estimates. In other words, the estimated number of male drug abusers in say 2011 could fall within the range of 113,880 and 71,120. This level of precision is considered not quite acceptable.

<b>Male</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>
(a) Estimated total no. of drug abusers	244,436	257,046	220,584	133,944	177,271	-	163,253	132,345	90,710	136,318	89,700
(b) Upper limit	333,172	336,186	288,338	163,211	220,027	-	200,476	156,770	111,211	182,611	113,876
(c) Lower limit	180,498	197,392	169,519	110,349	143,279	-	133,348	112,023	74,412	102,441	71,115
(d) % of upper limit above estimate	36.3%	30.8%	30.7%	21.9%	24.1%	-	22.8%	18.5%	22.6%	34.0%	27.0%
(e) % of lower limit below estimate	26.2%	23.2%	23.1%	17.6%	19.2%	-	18.3%	15.4%	18.0%	24.9%	20.7%

8.49 For female drug abusers, the upper limit of the estimates, at 95% confidence, ranges from as low as 10.1% in 2001 to as high as 208.7% above the estimates in 2005. The lower limit of the estimates, at 95% confidence, also jumps from as low as 8.6% in 2001 to as high as 67.0% in 2005 below estimates. In other words, the estimated number of female drug abusers in say 2005 could fall within the very wide range of 646,130 and 69,030. This level of precision is clearly not acceptable at all.

<b>Female</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>
(a) Estimated total no. of drug abusers	7,156	52,587	54,069	54,824	209,306	79,136	19,564	69,579	43,414	63,441	30,285
(b) Upper limit	7,877	76,081	89,067	83,525	646,132	150,724	27,768	118,587	68,788	94,093	46,282
(c) Lower limit	6,539	36,664	33,223	36,309	69,026	42,133	14,020	41,333	27,792	43,049	20,084
(d) % of upper limit above estimate	10.1%	44.7%	64.7%	52.4%	208.7%	-	41.9%	70.4%	58.4%	48.3%	52.8%
(e) % of lower limit below estimate	8.6%	30.3%	38.6%	33.8%	67.0%	-	28.3%	40.6%	36.0%	32.1%	33.7%

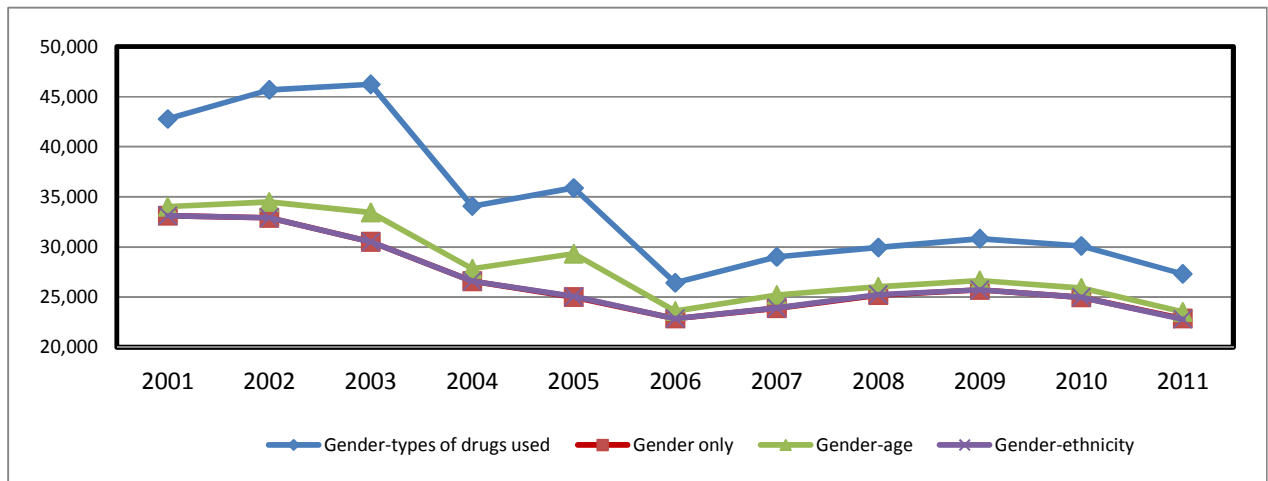


## 9. Proposed methods of estimating the total number of drug abusers

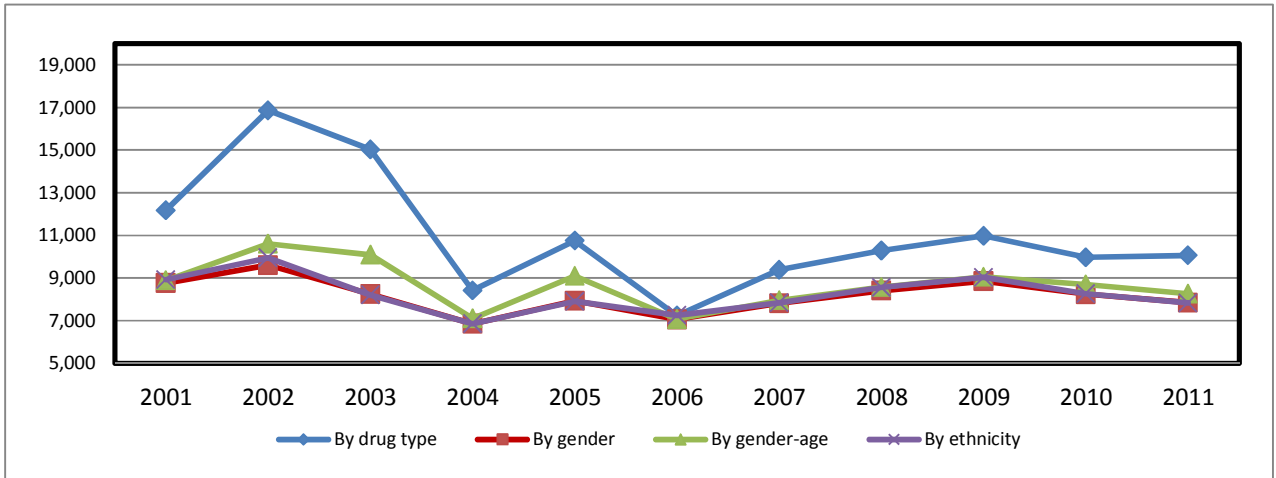
### *Comparing estimates derived from different models*

9.1 It follows from the above discussion that estimates derived from the four-source and three-source capture-recapture models are subject to unacceptably large margins of estimation errors, while precision levels for those derived from the two-source capture-recapture models, with separate estimates by gender, gender-age, gender-ethnicity and gender-types of drugs used, are much higher. In view of the above findings, *it is recommended that the two-source capture-recapture models should be adopted in estimating the total number of drug abusers.*

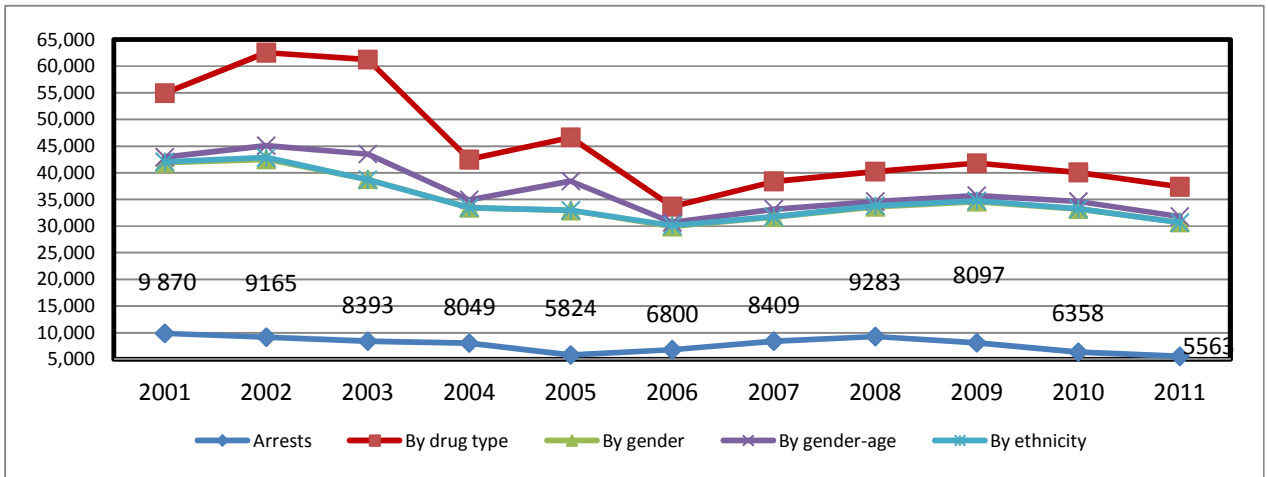
9.2 Adopting the two-source capture-recapture models, as demonstrated in the paragraphs above, different sets of estimates were obtained by computing four sets of separate estimates for gender only, gender-age, gender-ethnicity and gender-types of drugs used. In the chart below, different estimates of the number of male drug abusers derived are compared in the chart below. It may be seen that the estimates derived by the capture-recapture models based on gender only and gender-ethnicity are almost the same. The estimates derived from capture-recapture model based on gender-age are slightly higher, and those derived from the capture-recapture model based on gender-types of drugs used are much higher. Nevertheless, the patterns of changes are quite similar for all four sets of estimates.



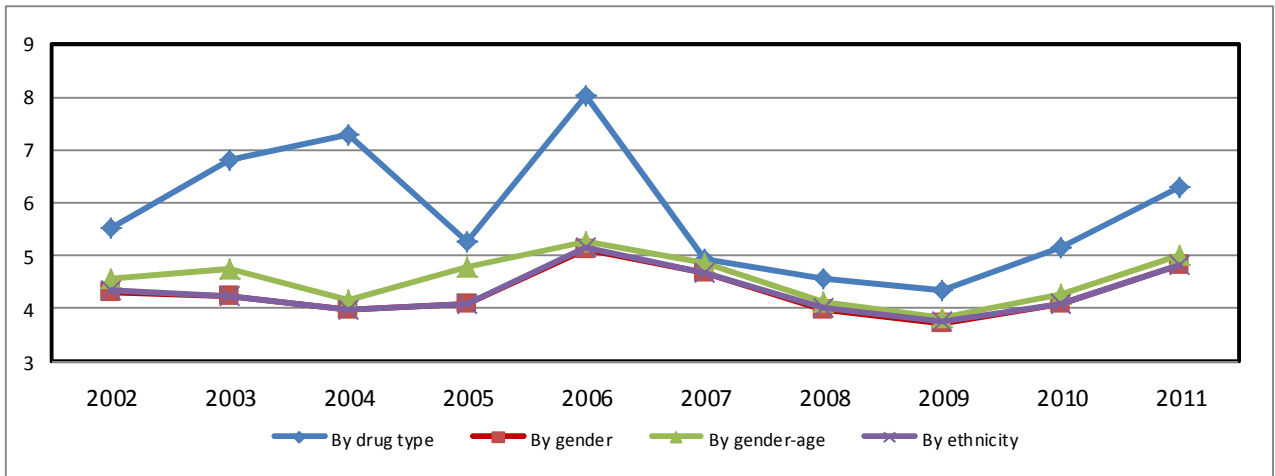
9.3 For female drug abusers, the estimates derived by the capture-recapture models based on gender and ethnicity are almost the same. The estimates derived from capture-recapture model based on gender-and-age are slightly higher during the period from 2002 to 2005 and are almost the same as those derived based on gender and ethnicity for the years 2006 – 2011. The estimates derived from the capture-recapture model based on drug types are higher except for the year of 2004. Nevertheless, the patterns of changes are quite similar for all four sets of estimates.



9.4 Apart from estimates of student drug abusers obtained from the school surveys, there is no other independent estimate of the number of drug abusers. As discussed above, the school survey data are not comparable with the estimates derived from the CRDA data. Statistics on arrests related to drugs are examined and as shown in the chart below, the pattern of changes in the number of arrests related to drugs is quite similar to the patterns for the estimated numbers of drug abusers derived from the different two-source capture-recapture models.



9.5 It is plausible that the number of arrests related to drug abusers is a proxy indicator of the supply of drugs in Hong Kong, and hence is a leading indicator of the number of people taking drugs. Assuming a time lag of one year, the ratio of the estimated total number of drug abusers in say 2002 to the number of arrests related to drugs in 2001 is computed and the time series data are shown in the chart below.



9.6 It may be seen from the chart above that apart from the ratios in respect of estimates derived from the two-source capture-recapture model based on separate estimates by drug types, the ratios for estimates derived from the remaining three models fall within the range of 3.7 and 5.3, and follow similar patterns of changes. The findings show that there appears to be a fairly stable relationship between the number of arrests related to drugs and the number of drug abusers. Such findings may support the use of the multiplier model based on the number of arrests related to drugs in estimating the total number of drug abusers.

9.7 However, as the ratio of the estimated total number of drug abusers to the number of arrests related to drugs range of 3.7 and 5.3 represents a variation of as much as 41% (of 3.7), using the multiplier method based on the number of arrests related to drugs will produce estimates which are subject to a margin of estimation errors of as high as 41%. This margin of errors is clearly not acceptable. Besides, a priori, there is little justification supporting the use of arrests related to drugs as the basis in estimating the number of drug abusers. The number of arrests related to drugs, for example, is determined by the detection rate by law enforcement agencies of drug offenses rather than the supply of drugs. Besides, the number of arrests is also not related to the quantity of drugs seized in connection with such arrests.

***Recommended methodology for estimating the number of drug abusers***

9.8 In the paragraphs above, different methods for estimating the drug abuse population are discussed, including their pros and cons, merits and limitations, and possible biases and errors. The two-source capture-recapture model is proposed to be adopted. Making use of an anonymous list of drug abusers extracted from the CRDA, different capture-recapture models were tested and compared. The salient findings are summarized below

- a) Based on three-source and four-source capture-recapture models and using log linear regression techniques, separate estimates of the number of male and

female drug abusers were computed. However, no valid model could be selected for a number of years during the study period from 2001 to 2011. Besides, the margin of estimation errors is found to be unacceptably large;

- b) Based on two-source capture-recapture models, four sets of estimates were computed separately for male and female drug abusers for each year during the study period from 2001 to 2011. The margin of estimation errors is very small.

9.9 As noted by researchers, using many sources capture-recapture techniques and log-linear modeling was considered too complex. On the other hand, the use of two-source capture-recapture techniques when appropriate, allowed for more simplified analysis.<sup>72</sup> *In view of the above findings, it is proposed to adopt the two-source capture-recapture methodology in estimating the number of drug abusers.*

9.10 To reduce heterogeneity, different two-source capture-recapture models have been tested. As demonstrated above, estimates derived from models with breakdowns by gender and by ethnicity (i.e. Chinese and non-Chinese) are almost the same, while those derived from the model with breakdowns by gender-age are slightly higher. For estimates derived from the model with breakdowns by drug type is higher than those derived from the other three models. Admittedly, it is difficult to choose from among the four two-source capture-recapture models which one to adopt for use in estimating the number of drug abusers in Hong Kong.

9.11 On closer examination of the four models, it may be worth noting that there is unlikely to be errors in classifying drug abusers into gender, age or ethnicity groups. Nevertheless, there may be classification errors for drug types. For example, drug abusers may not inform the reporting agencies that they have abused opiate drugs, especially for those who are occasional users of opiates and cannot easily recognized to be so. Non-opiate drug abusers may become opiate drug abusers between the capture-recapture intervals. These classification errors will definitely affect the accuracy of the estimates. Thus, while estimates of opiate and non-opiate drug abusers, it is not recommended to adopt this model in estimate the number of drug abusers in Hong Kong.

9.12 For the remaining three models, *it is proposed to adopt the estimates derived from the two-source capture-recapture model with breakdowns by gender-age groups.* This is because the model is a more sophisticated version of the one using only the gender variable, as it reduces heterogeneity due to age. In addition, this model will yield estimates of drug abusers by age groups. For the model based on ethnicity data, the heterogeneity arising from drug abusers of Chinese origin, which represent the great majority of drug abusers, is not controlled by say stratification into age groups or gender. Hence, this model is inferior to the one based using both gender and age group data.

9.13 Nevertheless, given that the three models produce estimates which are quite close to each other, *it is recommended that estimates based on the two-source capture-recapture*

---

72 Orton, Heather, et al (2001), "Using Active Medical Record Review and capture-recapture methods to investigate the prevalence of down syndrome among live-born infants in Colorado", in *Teratology*, 64: S14 – S19.

*with breakdowns by gender, ethnicity and drug type should continue to be compiled, to provide a rough indication of the size of sub-groups of interest and relevant to policy formulation (e.g. the number of non-opiate drug abusers). As re-runs of the three models, based on updated data obtained from the CRDA may be performed in-house, the cost involved is not likely to be significant.*

9.14 Theoretically, attempts may be made to re-run the CRM models with more detailed breakdown by say gender-age groups (e.g. male drug abusers aged 30 – 35). While such estimation is possible, the estimates derived will be subject to higher estimation errors due to smallness of the sample size and tend to be unstable. The findings discussed above show that estimates based on three broad age groups (namely under 21, 21 – 50 and above 50) separately for male and female drug abusers are fairly precise and stable. It is suggested that the overall estimates by these broad gender-age groups should be used as control totals.

9.15 Three other methods in estimating the size of the drug abuse, namely the case-finding, multiplier and nomination method, have been examined in this research. As noted above, the CRDA is in fact a notable example of the case-finding method. For the multiplier method, it has been used to serve as a counter-check of the reliability of estimates derived from the capture-recapture method, making use of statistics on the number of arrests related to drug offenses. As discussed above, statistics on drug related arrests or mortality arising from the use of drugs suffer from a number of limitations rendering such statistics unsuitable for the purposes of multiplier method. Reluctance on the part of reporting agencies to seek consent from drug abusers to participate in surveys or interviews required for the purposes of the nomination method also severely reduce the usefulness of this method in estimating the size of the drug abuse population. *In the circumstance, the multiplier and nomination method are not recommended for the purposes of estimating the size of the drug abuse population.*

## **10. Limitations**

10.1 As discussed above, estimation methods based on the CRM approach were used in the analysis presented in the report. For reasons explained above, the CRM is recommended. However, the success of the CRM depends on the following assumptions:

- a) The population under study must be closed, in the sense that individuals do not enter or leave the population during the study period;
- b) The samples must be randomly selected and the probability of each individual being selected must be the same in each sample;
- c) The samples must be mutually independent.

10.2 In practice, the above assumptions could rarely be met. For example, the drug abuse population in Hong Kong can hardly be closed, as there are individuals leaving through mortality or migration. Each year, there are people beginning to take drugs, thus joining the drug abuse population. For obvious reasons, the probability of reporting agencies

coming into contact with drug abusers is unknown, not the same for individual drug abusers and may not be non-zero. Besides, the samples of drug abusers selected from the drug abuse population through the use of the CRDA are not random samples. Furthermore, the probability of reporting agencies contacting again the drug abusers who have been reported by, say, the Correctional Services Department will be much lower than that for drug abusers who have been reported by, say, outreach social workers, as drug abusers in the former case will mostly likely be in the custodial care provided by the Correctional Services Department and will unlikely be contacted again by other reporting agencies. In other words, the samples are not mutually independent.

10.3 To meet the condition that the population under study must be closed, as discussed above, researchers have attempted to shorten the reference period in order to minimize the effect of any violation of this condition. In the present study, the reference period adopted is one year, which hopefully would help minimize the mobility into or out of the drug abuse population. To minimize the differences in the probability of selection, separate estimates have been compiled for different gender groups, age-sex groups, ethnicity groups and types of drugs used. By modeling the CRM separately on, say, male abusers aged under 21, 21 to 50 and over 50, variations within each age-sex group in the probability of selection will be much smaller than variations for all male drug abusers or all drug abusers.

10.4 Attempts have also been made to minimize the impact of the fact that the samples are not mutually independent by separately modeling the CRM on drug abusers reported by different categories of reporting agencies, using the four-source and three-source CRM. The model findings, however, are found to be unstable and the estimates are subject to large estimation errors.

10.5 It is reckoned that there are drug abusers who will never be contacted by reporting agencies. This group of drug abusers includes occasional drug abusers who seldom venture out of their homes or conclaves of close friends or relatives, and who will seek medical treatment at hospitals or clinics, never be contacted by law enforcement agencies, hospitals or clinics or even social workers. The existence of such a group of drug abuser, however small in absolute or proportionate term, implies that the CRM will under-estimate the total size of drug abuse population due to the omission of this group of drug abusers who will not appear in the “capture” and “re-capture” samples.

10.6 As it is not possible to derive an independent estimate of drug abusers by contacting the drug abusers, it is not possible to assess the impact of the deviations from the assumptions required of the CRM. It follows from the discussion in para.10.5 above, estimates derived from the CRM are likely to be under-estimated by the omission of drug abusers who for various reasons will never be contacted by reporting agencies. Nevertheless, it may be worth noting that the estimates derived from the two-source CRM, for different gender groups, age-sex groups, ethnicity groups and types of drugs, are not far apart. In other words, the impact of the partial deviations from the assumption that the probability of selection should be the same is not large.

10.7 Nevertheless, readers should note the limitations spelt out above that the

assumptions required of the CRM are in practice not met. Thus, the estimates derived from the present study should serve as a reference only. The estimates should not be taken as the basis for resource planning. The estimates presented in this study could be at best give a rough estimate of the size of the drug abuse population. Given that the CRM is consistently applied, the estimates could also provide an indication of the changes over time. There is still a continued need to publicize the use of the CRDA and the confidentiality protection it has afforded to individuals affected and to urge reporting agencies to report fully drug abusers they have contacted, such that the extent of under-reporting of drug abusers to the CRDA would be reduced.

*15 February 2013*