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Estimating prevalence of problem drug use: multiple methods in Brighton, Liverpool and London

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Home Office Online Report 36/04

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Further Acknowledgements can be found in Appendix A

Online Report 36/04

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Executive summary

Overview

Intelligence on the prevalence of injecting and problem drug use is critical to the development of health strategy and the implementation of public health interventions. Direct estimates of prevalence through general household surveys have not proved reliable. Indirect estimation techniques tend to start with existing data sources on injectors or problem drug users in order to estimate the number "unobserved" by the data sources and combining them to estimate the prevalence of injecting or problem drug use in the population. This report compares and develops existing indirect estimation techniques (capture-recapture and multiplier methods) in order to estimate the prevalence of injecting in three areas of England (Liverpool, Brighton and part of London). Estimates of the prevalence of problem opiate use also were generated for Liverpool and London, and problem drug use and crack-cocaine use for London.

The estimation exercise involved collecting data about problem drug users in contact with specialist drug treatment, arrest referral, needle exchange, and Accident and Emergency departments, and conducting a community-recruited survey in the three sites. The process of analysis and assumptions underpinning the methods are outlined in the report and appendices.

The "best" estimates for each of the areas summarised below were generated using covariate capture-recapture techniques.

Best estimates

Injecting drug use

Table 1 shows the best estimates of the prevalence of injecting drug use using capture-recapture in the three study areas, including the number observed within the data sources used in the study, the estimate of the unobserved and 95 per cent confidence interval.

Table 1
Summary of the capture-recapture estimates for injecting drug users: 2000/01

Site	Total population	Observed injectors	Estimated unobserved	Total number of injectors (95% CI)	Prevalence of injecting drug use (95% CI)
Brighton	117,032	856	1,448	2,304 (1,514 - 3,737)	2.00% (1.30% - 3.20%)
Liverpool	195,131	1,222	1,688	2,910 (2,546 - 4,977)	1.50% (1.30% - 2.60%)
12 London boroughs~	1,361,267	4,235	12,547	16,782 (13,793 - 21,621)	1.20% (1.00% - 1.60%)
4 Outer London	476,411	538	1,561	2,099 (1,554 - 3,743)	0.40% (0.30% - 0.80%)
8 Inner London	884,856	3,697	10,987	14,684 (10,744 - 29,203)	1.70% (1.20% - 3.30%)

~ Boroughs of Brent, Camden, City of Westminster, Ealing, Hammersmith and Fulham, Harrow, Hounslow, Islington, Kensingt and Chelsea, Lambeth, Lewisham,

Overall, we estimate that the prevalence of injecting drug use in those aged 15 to 44 years was two per cent in Brighton, 1.5 per cent in Liverpool, and 1.2 per cent in 12 London boroughs, and 1.7 per cent in the eight inner London boroughs.

In Table 1 the column "unobserved" does not necessarily mean "hidden" as the unobserved population includes injectors in contact with other data sources not included in the study or injectors in contact with one of our data sources but for one reason or other not reported by them.

Prevalence is high and clearly a cause for concern. However, the estimates are credible, consistent with each other and fit with the available evidence from some of the public health indicators. The prevalence estimates based on the multipliers were also calculated but were less robust, in all but one

example they were lower than the capture-recapture estimates, and in many cases lower than the number of observed injecting drug users in the population. Consequently, this methodology was considered inferior to capture-recapture and recommended as a method only to be used with extreme caution.

Public health indicators

Utilising the prevalence estimates Table 2 shows preliminary estimates of service coverage and key public health indicators in the three areas:

- Specialist drug treatment – estimate of the proportion of injecting drug users in contact with treatment services.
- Needle exchange activity and distribution – estimate of the proportion of injecting drug users registered with a needle exchange and annual number of syringes distributed per injecting drug user.
- Opiate overdose mortality – estimate of the opiate overdose mortality rate in 2000/01 based on capture recapture estimates and mortality statistics.

Table 2
Summary of the key public health indicators:2000/01

Public health indicator		Area with estimated injector population		
		Brighton	**Liverpool**	**London**
		2,304	***2,910***	***16,782***
Structured treatment	*Number in treatment*	*156*	*654*	*1826*
	Coverage of treatment	***6.8%***	***22.5%***	***10.9%***
Syringes distribution	*Number of syringes distributed*	*429,000*	*566,500*	*3,208,000*
	Number of syringes per injector per annum	***186***	***195***	***191***
Opiate overdose	*Number of opiate overdose deaths*	*48*	*28*	*126*
	Annual rate of opiate overdose deaths among injectors	***2.1%***	***1.0%***	***0.8%***

The preliminary measures of coverage emphasise some important public health messages. In Brighton, not only was the prevalence of injecting estimated to be higher (Table 1) but the proportion of opiate users reported as dying from overdose also was estimated to be higher at two per cent. The estimated coverage of needle exchange distribution was similar but inadequate in the three areas at approximately one clean syringe per injector every two days (or only 25% of all injections). Syringe exchange distribution needs to be expanded in order to reduce the opportunity for sharing and viral transmission, especially to prevent hepatitis C infections. Equally, national surveillance of syringe exchange needs to be established in order to provide ongoing intelligence on the uptake of this service.

The results also highlight the need to improve the completeness and quality of surveillance data on problem drug users in contact with other services. Significant efforts are being made to increase the proportion of injecting drug users in treatment and prevalence estimation though capture-recapture could be used to monitor progress. However, significant improvements are required in the quality of data collected on the number of people in specialist drug treatment, and to the routine data available for future capture-recapture studies.

Other estimates

Table 3 shows our current estimates for the number and prevalence of problem opiate users in Liverpool and London, and problem drug use and crack or cocaine use in London.

Overall, we estimated that the prevalence of problem opiate use was 2.1 per cent in Liverpool and London, and in London the prevalence of problem drug use and crack or cocaine use was 3.4 per cent and 0.8 per cent respectively.

Overall, these estimates suggest that the injecting population is approximately 70 per cent of that for opiate users in Liverpool and 60 per cent in London; and in London opiate users were estimated to be 63 per cent of the estimate of problem drug use. The estimates for crack/cocaine should be treated cautiously and perhaps as minimum estimates. However, these estimates are still an important step forward in measuring the spread of crack cocaine use and the first for this substance in the United Kingdom.

Table 3
Summary of the capture-recapture estimates for opiate, crack/cociane and problem drug use: 2000/01

Site	Total population	Observed users	Estimated unobserved	Total number of drug users (95% CI)	Prevalence of drug users (95% CI)
Liverpool					
Opiate	195,131	2,011	2,058	4,069 (3,633 - 4,386)	2.1% (1.9% - 2.2%)
London (12 boroughs~)					
Opiate	1,361,267	6,099	22,880	28,979 (22,368 - 43,022)	2.1% (1.6% - 3.2%)
Crack/cocaine	1,361,267	4,223	6,810	11,033 (10,176 - 12,074)	0.8% (0.7% - 0.9%)
Problem	1,361,267	7749	38,407	46,156 (35,326 - 64,705)	3.4% (2.6% - 4.8%)

~ Boroughs of Brent, Camden, City of Westminster, Ealing, Hammersmith and Fulham, Harrow, Hounslow, Islington, Kensington and Chelsea, Lambeth, Lewisham, Southwark

Summary recommendations

Overall, we recommend the use of covariate capture-recapture techniques for estimating prevalence of injecting drug use and other types of problem drug use, and that local prevalence estimation be extended to other Drug Action Team areas.

Data quality and availability were limitations on the prevalence estimation exercise. Therefore, we recommend that prevalence estimation become an objective of our investment in data sources on problem drug use, and that key stakeholders nationally and locally consider which data sources can be used for prevalence estimation and identify what action, if any, needs to be taken to enhance the data collected.

We do not recommend the wider use of multiplier methods as a sole method for estimating the prevalence of problem drug use.

We recommend the improvement of data on specialist drug treatment and needle exchange activity.

Finally, national policy-makers must urgently consider increasing the distribution of clean injecting equipment by as much as two-fold, in order further to reduce the opportunity for sharing syringes and prevent transmission of blood borne viruses.

Introduction

Intelligence on the prevalence of injecting and problem drug use is critical in the development of health strategy and the implementation of public health interventions. Such intelligence should inform planning and allocation of resources for control, treatment and prevention of problem drug use and its consequences and should help identify the proportions of problem drug users in contact with treatment and harm reduction activities (i.e. coverage). This report compares and develops existing epidemiological methodologies in order to estimate the prevalence of injecting drug use in Brighton, Liverpool and parts of London. For some of these areas the report also identifies levels of opiate use, crack-cocaine use, and problem use. Finally, using estimated levels of problem drug use the report calculates preliminary coverage for a number of public health indicators in each locality.

Estimating prevalence

Direct methods for estimating levels of any behaviour in a population (e.g. population or household surveys) are often considered a gold standard for measuring prevalence and can be very effective in monitoring common drug using behaviours such as tobacco or alcohol. However, direct methods are inefficient and ineffective at measuring the prevalence of rare, more covert and more problematic forms of drug use such as injecting or heroin and crack-cocaine use[1 2]. This can be illustrated through two examples of non-response and lack of power.

First, the 2001 British Crime Survey, which now has a sample size of almost 33,000, found less than 50 people reporting that they used heroin in the last month[3]. The resulting population estimates (33,000, range 19,000 to 53,000) are implausible, falling short of the number of heroin users presenting to treatment sites and only just higher than the number of heroin users screened through arrest referral.

Second, a national survey of adolescents (aged 12 to 17) in the USA found an annual prevalence of illegal drug use of between 13 per cent and 35 per cent in 1991 and 19 per cent and 39 per cent in 1997. However, as insufficient information was known about the non-responders (those not returning questionnaires) it is possible that the prevalence fell from 35 per cent to 19 per cent or increased from 13 per cent to 39 per cent. Trends in the incidence of heroin and crack-cocaine use derived from population surveys are even less certain[2].

Consequently, indirect methods have been developed to estimate prevalence when direct methods are impracticable or unreliable. Indirect methods start with data on a sample of *problem* drug users as the observed data set, and seek by a variety of different techniques to estimate the proportion of the total problematic drug using population that are represented by these observed data. From this it is then possible to estimate the total number or prevalence. A number of indirect methods have been developed (see Box 1), which are discussed more fully elsewhere[4 5 6 7 8 9].

Box 1. Indirect methods of estimating prevalence of problem drug use

Capture-recapture methods [10 11 (34 to 63)]
Capture-recapture methods – open populations[12]
Multiplier methods[**13** 14 15 (24, 25, 57, 65-70)]
Event based multipliers[16]
Synthetic estimation/ multiple indicator methods [17]
Truncated Poisson[18]
Back-calculation[19 20]

In this study we used two methods: capture-recapture and multipliers. Capture-recapture is one of the most accepted methods for prevalence estimation in drug use epidemiology, and has been widely used and promoted in other epidemiological fields [21 22 23]. Multiplier estimates also have been widely used for estimating drug use [10 14 15] and have been proposed as a means of estimating prevalence in rural areas (where there are insufficient data for capture-recapture) [**24**] and as an option for developing

countries [25]. In order to identify the most appropriate methods for indirect estimation of prevalence, several different multipliers and capture-recapture techniques have been tested in each of the three sites. Consequently, this study had the aim of estimating the prevalence of injecting, opiate use, and problem drug use in three sites in England (Brighton, Liverpool and 12 London boroughs) and the following objectives:

1. to undertake population estimation studies using consistent methodologies
2. to compare capture-recapture and multiplier methodologies
3. to recommend methods for use in other sites across the United Kingdom
4. to provide reliable estimates of prevalence for use in national estimation of problem drug use

Rationale for choosing Liverpool, London and Brighton

The three sites were not intended to be representative of the English population, but crucially were large enough and had sufficient data to allow testing of prevalence estimation techniques in different sites. The three sites also offer contrasting populations. London is important because of its size, its ethnically and culturally diverse composition and because previous studies have suggested it has higher than average levels of problematic drug use[26]. Not all of London was covered by this survey with the study limited to 12 London boroughs covering much of central London and including both affluent and deprived areas. Liverpool is one of the major cities in the north west of England and has a considerable track record in drug research and monitoring with relevant local expertise. Much of the north-west region, and in particular Liverpool, is characterised by high levels of deprivation. By contrast, Brighton is a smaller popular coastal resort town on the south coast. However, it also has a history of problems relating to drug use, especially relating to overdose, and has a Drug Action Team capable of supporting this study.

Population data and deprivation indicators for these three areas are summarised below in Table 4.

Table 4
Comparison of the populations and deprivation ranks for the three areas

Local authority name	Total population	Population aged 15 to 44 years	Proportion 15 to 44	Sub-area of London	Deprivation rank
Brent	127,804	64,744	51%	Outer	68
Camden	95,385	52,770	55%	Inner	54
Ealing	147,556	74,131	50%	Outer	107
Hammersmith and Fulham	78,982	44,397	56%	Inner	77
Harrow	100,254	44,844	45%	Outer	230
Hounslow	104,233	51,476	49%	Outer	115
Islington	84,208	45,729	54%	Inner	11
Kensington and Chelsea	75,918	38,479	51%	Inner	171
Lambeth	131,138	75,091	57%	Inner	42
Lewisham	119,949	62,137	52%	Inner	53
Southwark	119,822	65,207	54%	Inner	14
Westminster	88,781	49,271	55%	Inner	136
Total for 12 London boroughs	*1,274,030*	*668,276*	*52%*	*NA*	
Brighton and Hove	247,820	117,032	47%	*NA*	95
Liverpool	439,476	195,131	44%	*NA*	3

Deprivation ranks: rank out of the 354 local authorities, lowest rank indicates greatest deprivation. Rank is the 'Average of Ward Scores' for each area were the ward scores are obtained from measures of number unemployed and income deprived. These deprivation scores are from Department of the Environment, Transport and the Regions, *Indices of Deprivation 2000.*

Population data from Office of National Statistics (ONS). Census first findings obtained from the ONS website October 2002.

Methods

Overview

Capture-recapture

In practice, capture-recapture requires two or ideally three or more data sources which in some way identify individual problem drug users (e.g. initials, date of birth and sex) and can identify the number of matches between the data sources (i.e. the number of people that occur in more than one data source). The data sources are referred to as the observed or raw data, and the proportion matched represents the overlap or sampling intensity (i.e. the proportion of the total population of problem drug users observed in the data sets). Statistical techniques can be utilised to estimate the number of drug users who appear in none of the data sources, which combined with the observed number generates the prevalence estimate.

Animal ecologists originally developed capture-recapture as a method for estimating animal abundance [27] [28]. Early in the 20th century it was adopted for use in estimating the under-count of census populations and more recently has been used extensively in epidemiological studies [29] [30] [22] [23]. However, most epidemiological uses of capture-recapture seek to adjust for under-ascertainment of surveys or routine data sources, such as cancer registries or diabetic diagnoses[31] [32]. In such cases diagnoses of missing cases have usually taken place but have not been reported. In drug use, capture-recapture methods estimate both the hidden population of problem drug users who have not yet been (and may never be) identified by treatment or criminal justice systems and those that have failed to be reported by the original data sources. A fuller review of the epidemiological uses of capture-recapture are presented elsewhere [22] [23].

Bishop *et al* were one of the first to identify the potential for capture-recapture methods in estimating the prevalence of addiction [33]. Since then capture-recapture methods have been applied to drug use in many cities and countries worldwide [15] [34] [35] [36] [37] [38] [39] [40] [41] [42] [43] [44] [45] [46] [47] [48] [49] [50] [51] [52] [53] [54] [55] [56] [57] [58] [59] [60] [61] [62]. Most recently a study in Scotland derived a national estimate for problem drug use using multiple capture-recapture estimates in each Health Board and Drug Action Team area[63].

Data sources for capture-recapture

In the study, data on problem drug users were collected from six data sources covering the period April 2000 to end of March 2001 inclusive. These were:

- Criminal justice - arrest referral assessments: arrest referral workers are located in police custody suites throughout England. They interview arrestees, assess their drug problem, and if appropriate refer to specialist drug agencies. During the assessment they complete a standardised report form that was used as the data source[64].
- Drug treatment - new and ongoing clients at specialist drug treatment agencies reported to the Regional Drug Misuse Database (now the National Drug Treatment Monitoring System). In Brighton, data from the local system were used, and in London from the regional system. In Liverpool, data from the regional system were combined with data from a 'Period Prevalence Database'.
- Needle exchange services – clients who were registered with and attended selected agency-based needle exchange with client record systems.
- Accident and Emergency – visits due to an overdose (opiate, cocaine, other illicit drug).
- Community-recruited survey – injecting drug users resident in the study area.

In the capture-recapture analyses the Accident and Emergency and community survey data sources were combined to make a single data source, as they were the two smallest data sources and they had very little overlap of cases.

Further details of the data sources used in the three areas are summarised in Appendix C. Data on attendance for drug treatment services and on contacts by arrest referral workers were centrally available in electronic format for all three areas. The format of all other data varied between areas. Accessing data not in electronic format proved time consuming, especially for overdose data from accident and emergency departments. Box 2 shows the process of analysis.

Multiplier methods

Multiplier methods (also referred to as ratio-estimation) come in a variety of guises, but have two elements in common. First, a data source called a "benchmark" is required, which represents the number of problem drug users that have experienced a particular event, such as the number of problem drug users in treatment. Second, an estimate of the proportion of all problem drug users that have or have not experienced that event is required. The inverse of this proportion is called the multiplier. For example, if the benchmark was 100, and it was estimated that 10 per cent of the population under investigation were recorded on the benchmark, then the estimated total would be calculated as 1,000 (i.e. 100*10).

Multiplier methods have been used extensively to estimate prevalence in the UK, USA, Canada, Australia, and Pakistan and have used a variety of multipliers and benchmarks including: overdose deaths, specialist drug treatment, arrests, and HIV tests [12 13 14 15 24 25 57 65 66 67 68 69 70]. For instance, in the UK, Hartnoll *et al* multiplied the annual number of opiate overdose deaths by 50 to 100 on the basis that opiate overdose mortality rate was 1-2 per cent per annum to estimate prevalence in Camden; and in Canada, Archibald *et al* multiplied the annual number of laboratory tests for HIV attributed to injecting drug use by 4.35 on the basis that the proportion of injectors tested annually for HIV was 23 per cent to estimate prevalence in Toronto[15 14].

In this study, multipliers were collected through a community-recruited survey, conducted between July and November 2001[71]. Indigenous fieldworkers were trained in each site (13 in Liverpool, six in Brighton, and 25 in London) to recruit injecting drug users through social networks or directly on the street. Respondents were aged 16 years or over, resident in the site between April 2000 and March 2001 and had injected drugs in the previous month. A standardised questionnaire collected data on contact with benchmarks for the multiplier study, basic demographic details (initials, sex, and date of birth) for inclusion in the capture-recapture study and drug using information, such as, drug use history and injecting behaviour.

The following multipliers were collected:-

1. Attendance at a named specialist drug agency.
2. Registration and attendance at a named agency based needle exchange.
3. Assessment by an arrest referral worker at a named police station.
4. Attendance at an Accident and Emergency department due to an overdose associated with injecting or opiate use.
5. Arrest under the Misuse of Drugs Act for an offence involving heroin.

In addition to using multipliers from the community survey a number of ***historical multipliers*** were used. These were:

1. *The treatment demographic method*

   The number of new users entering treatment in a year is multiplied by the mean duration of use prior to entering treatment, which in a recent Home Office study was assumed to be five years[67].

2. *The treatment coverage method.*

   The number of users in treatment is multiplied by an estimate of the proportion of users in treatment, which was assumed to be between 33 per cent to 50 per cent (giving a multiplier of two to three)[67].

3. *Mortality multiplier.*

The number of opiate overdose deaths is multiplied by 50 to 100 under the assumption that the opiate overdose mortality is one per cent to two per cent[17].

Assumptions

Capture-recapture

The main assumptions of the capture-recapture method are:

1. That the population being estimated is closed - i.e. that the number of drug users entering or exiting the population over the time period studied is negligible.
2. In two sample studies that the data sources are independent - i.e. that appearing in one data source does not mean an individual is more or less likely to appear in another.
3. Importantly, this assumption can be modified in n-way studies (i.e. those with three or more data sources) by using Poisson regression techniques to test and adjust for "dependencies" between data sources with a weaker assumption that there is no "n" way interaction (e.g. if four data sources that there is not a dependency between all four data sources).
4. That there is no 'heterogeneity' (i.e. that all subjects have an equal probability of being captured by a particular data source). For example, that younger, or male, or black ethnic minority group problem drug users are not more or less likely to be on a data source than their counterparts.
5. That no misclassification of data occurs – i.e. that the matching of individuals between the data-sets is accurate.
6. That all data sources are broadly representative of the population being studied.

Finally, we assume that the model that fits the observed data applies also to the "unobserved" population; and as there is no way of testing this assumption it has been argued that interpreting capture-recapture, and indirect methods in general, call for a leap of faith [72]. For this reason it is essential that the estimates are "evidence based", i.e. that other knowledge and expertise is used in corroboration and to help judge whether the estimates are credible. Furthermore, confidence intervals should be interpreted with caution as they do not and cannot account for bias or "model misspecification", i.e. that the wrong model has been selected and/or that the unobserved population is not represented by the model fitted to the observed data.

The assumptions are fully discussed elsewhere[22 23 33]. However, in practice, almost all of these assumptions are violated to some extent during capture-recapture, but steps can be taken to limit the effects of such violations (the steps taken in this study are addressed briefly in the discussion). In general, capture-recapture studies of drug misuse tend to collect at least three data sources *and* include both treatment and criminal justice systems, they usually consider estimates over time periods of no more than one year and ideally contain sufficient observed data to allow estimates by age and sex[6].

In this study we employed covariate capture-recapture techniques[73 74]. Standard information criterion (BIC and AIC) for selecting models, and bootstraps methods, in which the data cells were re-sampled, were used to estimate confidence intervals of the best fitting model[75 76 77 78]. See Box 2 for a summary of the analysis approach used for capture-recapture.

Box 2. Capture-recapture analysis

The aim of the analysis is to find the simplest model with the best fit to the observed data (i.e. patterns of overlap between data sources of known drug users). This model can then be used to estimate the number of unobserved problem drug users. A fuller description of the general equations and statistical methods is given by Bishop *et al*, and Hook and Regal, and the covariate method by Tilling *et al*. Poisson regression can be used to test dependency (i.e. the strength of relationships) between data sources and alter the model fit accordingly. A dependency between any two data sources (say S1 and S2) is said to be:

- a positive dependency if a person in S1 is more likely to be in S2 than someone who is not in S1, or
- a negative dependency if a person on S1 is less likely to be on S2 than someone not on S1.

More complex interactions or dependencies can be tested, for instance involving a combination of three data sources. A number of different Poisson regression models are then fitted to the data, according to which dependencies are included and which omitted. The best fitting model is determined usually by seeing which one best predicts the patterns of observed data.

In this study we undertook the following steps to select appropriate models and calculate final estimates (see appendix for a worked example).

1. In order to later help calculate prevalence only cases aged 15-44 were included.
2. The data were organised into contingency tables, showing matches between each of the data sources.
3. All possible Poisson regression models were run from independent (i.e. no dependencies) to all three-way interactions (dependencies between three of the data sources) for capture-recapture with four data sources in each model.
4. To select the best model the goodness of fit "G^2" was examined, models with different number of interactions were compared using LRT (log likelihood ratio test), and the overall scores were compared using information criterion AIC (Akaike Information Criterion) and BIC (Bayesian Information Criterion).
5. A weighted estimate across all possible models was generated using the BIC score as a weight (1/exp (BIC/2)).
6. The analysis was repeated for males only, females only and by age-group.
7. Covariate capture-recapture methods took the best fitting interactions identified in the previous stratified analysis to generate estimates of the unobserved population by age group and gender. If necessary separate covariate models were run for males and females.
8. Confidence intervals were generated using bootstrap methods.
9. The analyses were repeated where possible to calculate separate estimates for injecting drug users, opiate users, crack-cocaine users, and problem drug users. The mix of data sources varied for different target groups, as some data sources were exclusively composed of injecting drug users.

Multiplier methods

The assumptions underpinning multiplier methods are similar to two sample capture-recapture methods namely:

a. that the population being estimated is closed

b. that the multiplier is independent from benchmark and representative of population to be estimated

c. that the benchmark is completely and accurately recorded and that the multiplier accurately records events recorded by the benchmark.

The multiplier should be obtained from a representative sample of problem drug users and collected over the time period and place corresponding to the benchmark data. In practice, perfectly random and representative samples of problem drug users cannot be collected although measures can be taken to limit any potential bias.

Ethical approval

Ethical approval was obtained from Scottish Multi-Centre Research Ethics Committee (Reference MREC/01/0/1), and appropriate Local Research Ethics Committees for the three areas one in Liverpool, one in Brighton, 10 in London (Appendix B).

Findings

The community surveys

Community surveys were undertaken in all three locations. These data were used both as multipliers (for the multiplier method) and as a data source for the capture-recapture analyses. Over 650 current injecting drug users were recruited across the three sites: 96 in Brighton, 151 in Liverpool, and 436 in London. A summary of the surveys sample and key findings can be found in the Table 5.

Table 5
Results from the community surveys undertaken in the three areas: demographic characteristics, drug use and service contact
Note: All participants

Characteristic		Brighton	Liverpool	London
Sample sizes		*96*	*151*	*436*
Gender	*Male*	72%	76%	71%
	Female	27%	24%	27%
Country of birth	*UK*	93%	97%	83%
	Not UK	6%	3%	16%
Age	*Mean*	32.1	32	28.3
	Minimum	19	18	17
	Maximum	46	64	55
Age first used #	*Mean*	19.3	19.0	20.5
Years using#	*Mean*	12.8	13.2	7.9
Age first injected#	*Mean*	20.2	21.0	22.0
Years injecting#	*Mean*	11.9	11.3	6.3
When last injected	*Today*	67%	77%	64%
	Yesterday	25%	14%	16%
	Prior to yesterday	8%	9%	20%
Type of drug mainly injected	*Opiates*	75%	63%	66%
	Cocaine	1%	1%	5%
	Amphetamine	0%	1%	3%
	Opiates and cocaine	16%	34%	18%
	Other combinations	5%	2%	7%
Contact with services providing multiplier benchmarks in previous year	*Received treatment at specialist agencies*	87%	57%	41%
	Registered with and used agency based needle exchanges	83%	39%	41%
	Contacted by arrest referral workers	33%	23%	24%
	Reported injecting to AR worker	29%	18%	9%
	Attended A&E department with overdose after injecting drugs	16%	6%	10%
	Attended A&E department with opiate overdose	16%	9%	8%
	Arrested for heroin offence	9%	16%	25%
Use real identifiers when using services	*Use real name initials*	84%	95%	90%
	Use real date of birth	84%	95%	90%

Further details of the survey findings at each site are given in Appendix C
A&E = Accident and Emergency AR = arrest referral
any of the following forms of drug uses: any use of opiates, crack, or cocaine; or injecting benzodiazepines or amphetamines.

In all three sites the sample was predominately male and born in the United Kingdom. The difference in the mean age of the respondents (four years higher in Brighton and Liverpool than in London) was an artefact, because we supplemented the London community survey with data from another survey recruited using the same techniques but which selected injectors with short injecting careers. The majority of respondents injected either opiates, or opiates and cocaine together. Table 5 also contains the proportion of the survey respondents who were in contact with those services (between April 2000 and March 2001) that provided data for use in multiplier estimations.

These proportions varied across areas with almost nine in ten (87%) injecting drug users in Brighton having attended a specialist treatment agency compared with only four in ten (41%) in London and around six in ten (57%) in Liverpool. Furthermore, in Liverpool and London almost four in ten individuals were registered with an agency-based needle exchange, compared with eight in ten in Brighton. Community survey participants in all three areas were more likely to report contact with treatment agencies or agency based needle exchanges than with arrest referral workers, or Accident and Emergency departments due to an overdose or the police as a result of a heroin offence. However, respondents in Brighton were more likely than those in Liverpool or London to have attended an Accident and Emergency department for an opiate overdose. Respondents in London were more likely than those in Liverpool and Brighton to have been arrested for a heroin offence. Very few survey respondents reported giving either false initial or dates of birth to the services they were registered with.

Though we would expect some differences in the coverage of services in contact with injectors between the three areas (highlighted below in the section on public health indicators), the scale of the differences in coverage suggested by the community surveys is likely, at least in part, to be due to selection bias (especially between Brighton and the other areas).

Capture-recapture results

Table 6 provides a summary of the data sources available for capture-recapture analyses in each area. Availability and data quality issues are raised in the discussion.

Overall, in Brighton nearly 1,200 records were collected on 1,038 individual problem drug users. Of these individuals 15 per cent were recorded by more than one data source with 8 per cent being recorded in both the treatment and needle exchange data sources. In Liverpool over 3,000 records were collected on 2,557 problem drug users. There were over 1,600 records from 1,224 injecting drug users, and of these injectors 247 were on both the treatment and needle exchange data sources. In London, nearly 9,000 records were collected on 7,766 problem drug users, of which about 5,300 records were injecting drug users. Of these individuals 14 per cent were recorded by more than one data source with 7 per cent being recorded in both the treatment and needle exchange data source

In Brighton there were 857 (83% of the total) individuals identified as injecting drug users, 1,224 (48%) in Liverpool and 4,252 (55%) in London. Although the variations in the proportion of records that were due to injecting drug use may reflect differences in the pattern of drug use between the areas, they will be strongly related to the proportion of records collected from the different data sources and the quality of record-keeping on route of drug administration in these sources. In Brighton over half of the records were collected from the local needle exchange, whilst in both Liverpool and London specialist drug treatment was the largest data source. Over 70 per cent of the records included in the injecting drug use analysis were from treatment and/or needle exchange.

In all three areas the proportion of females and those under 25 varied between the data sources indicating an element of data 'heterogeneity'. For example, in Brighton and Liverpool there were proportionally less people under 25 in treatment and needle exchange data sources than in the other sources (excluding the community survey), and in London, there were proportionally less females in the arrest data source than in the other data sources. Such heterogeneity could introduce bias unless dealt with in analysis through covariate analysis.

The final capture-recapture estimates using covariate analyses are presented as overall estimates for those aged 15 to 44, as well as by age group and gender. London estimates have been further

subdivided into eight inner London and four outer London boroughs. All estimates relate to the period from April 2000 to March 2001 inclusive. Contingency tables showing the overlaps between the data sources, as well as summaries of the best fitting models are given in Appendix D.

Table 6
Summary of data sources used in capture-recapture prevalence estimation after matching, 2000/1

Data source	Individuals 15-44, with unique date of birth and initials						
	Total*	No. female		No. under 25		No. Injectors	
Brighton							
Structured treatment	***293***	53	*18%*	44	*15%*	193	*66%*
Arrest referral	***128***	52	*41%*	41	*32%*	82	*64%*
Registered with needle exchange	***631***	141	*22%*	95	*15%*	631	*100%*
Overdose attendance's at A&E	***43***	12	*28%*	9	*21%*	33	*77%*
Community survey	***96***	26	*27%*	11	*11%*	95	*99%*
Totals unmatched, cases	***1,191***	284	*24%*	200	*17%*	1,034	*87%*
*Totals matched, individuals***	***1,038***	*239*	*23%*	*170*	*16%*	857	*83%*
Liverpool							
Structured treatment	***1,815***	651	*36%*	159	*9%*	654	*36%*
Arrest referral	***446***	132	*30%*	66	*15%*	232	*52%*
Agency needle exchange	***599***	120	*20%*	54	*9%*	599	*100%*
Overdose attendance's at A&E	***68***	27	*40%*	26	*38%*	38	*56%*
Community survey	***146***	36	*25%*	24	*16%*	146	*100%*
Totals unmatched, cases	***3,074***	966	*31%*	329	*11%*	1,669	*54%*
*Totals matched, individuals***	***2,557***	*836*	*33%*	*279*	*11%*	1,224	*48%*
London~							
Structured treatment	***5,020***	1,293	*26%*	986	*20%*	2,225	*44%*
Arrest referral	***1,535***	242	*16%*	472	*31%*	755	*49%*
Agency needle exchange	***1,645***	359	*22%*	234	*14%*	1,627	*99%*
Overdose attendance's at A&E	***383***	101	*26%*	131	*32%*	281	*73%*
Community survey	***415***	119	*28%*	92	*24%*	414	*100%*
Totals unmatched, cases	***8,998***	2,114	*23%*	1,915	*21%*	5,302	*59%*
*Totals matched, individuals***	***7,766***	*1,859*	*24%*	*1,663*	*21%*	4,252	*55%*

Notes:
* Totals include those cases where gender was missing (these cases were dropped fr the analyses).
** This is the total matched between data sources
~ Boroughs of Brent, Camden, City of Westminster, Ealing, Hammersmith & Fulham, Harrow, Hounslow, Islington, Kensington & Chelsea, Lambeth, Lewisham, Southwark.
Further information on the data sources can be found in Appendix C.

Injecting drug use

Estimates for injecting drug users were obtained for all three areas and are shown in Table 7. Typically, age specific estimates are calculated for those under 25 and those 25 and over. However, due to the small number of individuals aged under 25 in Brighton, estimates by age group were generated for those under 30 years, and 30 years and over for all sites. However, estimates for those under 25 were obtained for Liverpool and the London boroughs and can be found in Table 8.

In Brighton we estimated that there were an additional 1,448 injecting drug users not observed by the study data sources giving an estimated total of about 2,300 injectors (95% confidence interval 1,500 to 3,700), which in a population of just over 100,000 aged 15 to 44 gives a prevalence of two per cent (95% confidence interval of 1.3% to 3.2%). This is a high prevalence (one in 50 adults aged 15 to 44),

but the ratio of observed to unobserved was less than two. In Liverpool we estimated there were an additional 1,688 unobserved injectors giving a total of about 2,900 (95% confidence interval 2,500 to 5,000) injectors and a prevalence of 1.5 per cent (95% confidence intervals 1.3% to 2.6%). In London we estimated that there were an additional 12,547 injectors giving a total of over 16,700 (95% confidence interval 13,800 to 21,600) and a prevalence of 1.2 per cent (95% confidence interval 1.0% to 1.6%). The London estimate, when subdivided into inner and outer London, suggest that the prevalence in outer London was less than a third of that in inner London (0.4%, 95% confidence interval 0.3% to 0.8%, and 1.7%, 95% confidence interval 1.2% to 3.3% respectively).

Table 7
Estimates of the numbers of injecting drug users aged 15 to 44 in all three areas: 2000/01
From covariate analyses: covariates gender and age (split into aged under 30 and aged 30 and over)

Location, age and sex	Total population*	Observed injectors	Estimated unobserved injectors	Total number of Injectors estimated (95% CI)	Estimated prevalence of injecting drug use (95% CI)
Brighton					
Females < 30	29,042	106	172	278 (174 - 853)	1.0% (0.6% - 2.9%)
Females 30-44	29,622	98	319	417 (144 - 2,165)	1.4% (0.5% - 7.3%)
Females 15-44	*58,664*	*204*	*490*	*694 (369 - 2,196)*	*1.2% (0.6% - 3.7%)*
Males < 30	27,156	259	132	391 (326 - 528)	1.4% (1.2% - 1.9%)
Males 30-44	31,212	393	826	1,219 (773 - 2,598)	3.9% (2.5% - 8.3%)
Males 15-44	*58,368*	*652*	*957*	*1,609 (1,154 - 3,109)*	*2.8% (2.0% - 5.3%)*
Total	**117,032**	**856**	**1,448**	**2,304 (1,514 - 3,737)**	**2.0% (1.3% - 3.2%)**
Liverpool					
Females < 30	52,391	122	170	292 (166 - 3,242)	0.6% (0.3% - 6.2%)
Females 30-44	49,450	174	148	322 (207 - 2,814)	0.7% (0.4% - 5.7%)
Females 15-44	*101,841*	*296*	*318*	*614 (384 - 2,904)*	*0.6% (0.4% - 2.9%)*
Males < 30	47,544	306	350	656 (529 - 862)	1.4% (1.1% - 1.8%)
Males 30-44	45,746	620	1,020	1,640 (1,401 - 2,641)	3.6% (3.1% - 5.8%)
Males 15-44	*93,290*	*926*	*1,370*	*2,296 (2,019 - 3,297)*	*2.5% (2.2% - 3.5%)*
Total	**195,131**	**1,222**	**1,688**	**2,910 (2,546 - 4,977)**	**1.5% (1.3% - 2.6%)**
12 London boroughs~					
Females < 30	336,000	438	1,208	1,646 (1,060 - 3,405)	0.5% (0.3% - 1.0%)
Females 30-44	356,991	563	2,144	2,707 (1,696 - 12,211)	0.8% (0.5% - 3.4%)
Females 15-44	*692,991*	*1,001*	*3,352*	*4,353 (3,156 - 10,658)*	*0.6% (0.5% - 1.5%)*
Males < 30	317,606	1,255	3,483	4,738 (3,641 - 6,682)	1.5% (1.1% - 2.1%)
Males 30-44	350,670	1,979	5,712	7,691 (5,901 - 10,649)	2.2% (1.7% - 3.0%)
Males 15-44	*668,276*	*3,234*	*9,195*	*12,429 (9,994 - 15,413)*	*1.9% (1.5% - 2.3%)*
Total	**1,361,267**	**4,235**	**12,547**	**16,782 (13,793 - 21,621)**	**1.2% (1.0% - 1.6%)**
12 London boroughs estimate subdivided by inner & outer London~					
Outer: 4 boroughs					
Females < 30	114,880	60	165	225 (145 - 466)	0.2% (0.1% - 0.4%)
Females 30-44	126,336	44	168	212 (133 - 954)	0.2% (0.1% - 0.8%)
Females 15-44	*241,216*	*104*	*333*	*437 (278 - 1,421)*	*0.2% (0.1% - 0.6%)*
Males < 30	114,158	227	630	857 (659 - 1,209)	0.8% (0.6% - 1.1%)
Males 30-44	121,037	207	597	804 (617 - 1,114)	0.7% (0.5% - 0.9%)
Males 15-44	*235,195*	*434*	*1,228*	*1,662 (1,276 - 2,322)*	*0.7% (0.5% - 1.0%)*
Total	**476,411**	**538**	**1,561**	**2,099 (1,554 - 3,743)**	**0.4% (0.3% - 0.8%)**
Inner: 8 boroughs					
Females < 30	221,120	378	1,043	1,421 (915 - 2,939)	0.6% (0.4% - 1.3%)
Females 30-44	230,655	519	1,976	2,495 (1,563 - 11,257)	1.1% (0.7% - 4.9%)
Females 15-44	*451,775*	*897*	*3,019*	*3,916 (2,478 - 14,195)*	*0.9% (0.5% - 3.1%)*
Males < 30	203,448	1,028	2,853	3,881 (2,982 - 5,473)	1.9% (1.5% - 2.7%)
Males 30-44	229,633	1,772	5,115	6,887 (5,284 - 9,535)	3.0% (2.3% - 4.2%)
Males 15-44	*433,081*	*2,800*	*7,968*	*10,768 (8,266 - 15,008)*	*2.5% (1.9% - 3.5%)*
Total	**884,856**	**3,697**	**10,987**	**14,684 (10,744 - 29,203)**	**1.7% (1.2% - 3.3%)**

~ Boroughs of Brent, Camden, City of Westminster, Ealing, Hammersmith % Fulham, Harrow, Hounslow, Islington, Kensington & Chelsea, Lambeth, Lewisham, Southwark.

*Population Data from Office of National Statistics (ONS), Census first findings obtained from the ONS website Octo 2002.

Table 8
Estimates of the numbers of injecting drug users aged 15 to 24: Liverpool and 12 London boroughs 2000/01
From covariate analyses: covariates gender and age (split into aged under 25 and aged 25 and over)

Location, age and sex	Total population	Observed injectors	Estimated unobserved injectors	Total number of Injectors estimated (95% CI)	Estimated prevalence o injecting drug use (95% CI)
Liverpool					
Females < 25	36,753	42	24	66 (43 - 426)	0.2% (0.1% - 1.2%)
Males < 25	33,988	78	148	226 (142 - 460)	0.7% (0.4% - 1.4%)
12 London boroughs~					
Females < 25	183,773	213	1,351	1,564 (429 - 1,960)	0.9% (0.2% - 1.1%)
Males < 25	177,500	489	1,623	2,112 (1,412 - 3,837)	1.2% (0.8% - 2.2%)
12 London boroughs subdivided by inner & outer London~					
Outer: 4 boroughs					
Females < 25	66,539	36	228	264 (73 - 331)	0.4% (0.1% - 0.5%)
Males < 25	69,434	101	335	436 (292 - 792)	0.6% (0.4% - 1.1%)
Inner: 8 boroughs					
Females < 25	117,234	177	1,122	1,299 (357 - 1,628)	1.1% (0.3% - 1.4%)
Males < 25	108,066	388	1,288	1,676 (1,120 - 3,044)	1.6% (1.0% - 2.8%)

~ Boroughs of Brent, Camden, City of Westminster, Ealing, Hammersmith & Fulham, Harrow, Hounslow, Islingtc Kensington & Chelsea, Lambeth, Lewisham, Southwark.
*Population Data from Office of National Statistics (ONS), Census first findings obtained from the ONS website October 2002.
See Appendix E for further details.

In London the ratio of observed to unobserved injectors was higher than for the other areas at three, but not implausibly high. Furthermore, it is important to note that unobserved does not necessarily mean “hidden” as the unobserved population includes injectors in contact with other data sources not included in the study or injectors in contact with one of our data sources but for one reason or other not reported by them.

Prevalence was found to vary with age and gender in all three areas and was typically higher in men and older age groups. In Brighton and Liverpool the prevalence among men aged 15 to 44 was 2.8 per cent and 2.5 per cent respectively compared to 1.2 per cent and 0.6 per cent among women, whilst among men aged 30 to 44 the prevalence was estimated to be more than one in 30 of the population at 3.9 per cent in Brighton and 3.6 per cent in Liverpool, compared with one in 71, or 1.4 per cent, among men under 30 in both cities. Overall in the 12 London boroughs the prevalence of injecting drug use was 1.9 per cent among men and 0.6 per cent among women aged 15 to 44. Among men aged 30 to 44 prevalence in London (2.2%) was lower than Brighton and Liverpool although levels in males under 30 was similar to the other sites. However, in inner London the prevalence was 2.5 per cent and 0.9 per cent among men and women aged 15 to 44, and three per cent among men aged 30 to 44 compared to 1.9 per cent among those under 30.

The prevalence of injecting drug use in males and females under 25 in Liverpool and London was lower than the prevalence of injecting drug use among those over 30 but within the range of the 95 per cent confidence interval of the estimates for under 30s.

The prevalences obtained for the eight inner and four outer London boroughs were applied to the population data for the whole of these areas to obtained an estimate for the whole of London. This produced an estimate for the whole of London of 34,400 (1.0%) injectors aged 15 to 44, with 25,000 (1.7%) in inner London.

Problematic opiate use

Estimates of opiate use were not undertaken for Brighton as the data set was composed mostly of injectors with too few non-injectors to calculate a robust estimate of all problematic opiate use. Opiate estimates for Liverpool and the 12 London boroughs are shown in Table 9.

Overall, we estimated that there were approximately 4,000 (95% confidence intervals 3,600 to 4,400) problem opiate users in Liverpool and 29,000 (22,400 to 43,000) problem opiate users in the 12 London boroughs. These gave similar estimates of prevalence at two per cent (one in 50) of the population aged 15 to 44 years. In inner London the prevalence was higher at 2.7 per cent (95% confidence interval 2.1% to 4.0%). These estimates measure heroin chasers and injecting opiate users, as well as those in treatment and receiving substitution treatment.

Table 9
Estimates of the numbers of problematic opiate users aged 15 to 44 in Liverpool and 12 London boroughs: 2000/01
From covariate analyses: covariates gender and age (split into aged under 25 and aged 25 and over)

Location, age and sex	Total population*	Observed user	Estimated unobserved users	Total number of users estimated (95% CI)	Estimated prevalence of use (95% CI)
Liverpool					
Females < 25	36,753	108	143	251 (163 - 379)	0.7% (0.4% - 1.0%)
Females 25-44	65,088	611	626	1,237 (1,032 - 1,490)	1.9% (1.6% - 2.3%)
Females 15-44	*101,841*	*719*	*769*	*1,488 (1,239 - 1,739)*	*1.5% (1.2% - 1.7%)*
Males < 25	33,988	79	131	210 (126 - 310)	0.6% (0.4% - 0.9%)
Males 25-44	59,302	1,213	1,158	2,371 (2,147 - 2,719)	4.0% (3.6% - 4.6%)
Males 15-44	*93,290*	*1,292*	*1,289*	*2,581 (2,299 - 2,889)*	*2.8% (2.5% - 3.1%)*
Total	**195,131**	**2,011**	**2,058**	**4,069 (3,633 - 4,386)**	**2.1% (1.9% - 2.2%)**
12 London boroughs~					
Females < 25	183,773	325	2,000	2,325 (1,088 - 11,451)	1.3% (0.6% - 6.2%)
Females 25-44	509,218	1,147	2,253	3,400 (2,051 - 7,187)	0.7% (0.4% - 1.4%)
Females 15-44	*692,991*	*1,472*	*4,253*	*5,725 (3,494 - 13,731)*	*0.8% (0.5% - 2.0%)*
Males < 25	177,500	884	4,250	5,134 (2,774 - 10,715)	2.9% (1.6% - 6.0%)
Males 25-44	490,776	3,743	14,377	18,120 (13,426 - 25,288)	3.7% (2.7% - 5.2%)
Males 15-44	*668,276*	*4,627*	*18,627*	*23,254 (17,476 - 30,209)*	*3.5% (2.6% - 4.5%)*
Total	**1,361,267**	**6,099**	**22,880**	**28,979 (22,368 - 43,022)**	**2.1% (1.6% - 3.2%)**
12 London boroughs estimate subdivided by inner & outer London~					
Outer: 4 boroughs					
Females < 25	66,539	74	455	529 (248 - 2,607)	0.8% (0.4% - 3.9%)
Females 25-44	174,677	113	222	335 (202 - 708)	0.2% (0.1% - 0.4%)
Females 15-44	*241,216*	*187*	*677*	*864 (444 - 1,744)*	*0.4% (0.2% - 0.7%)*
Males < 25	69,434	315	1,514	1,829 (989 - 3,818)	2.6% (1.4% - 5.5%)
Males 25-44	165,761	536	2,059	2,595 (1,923 - 3,621)	1.6% (1.2% - 2.2%)
Males 15-44	*235,195*	*851*	*3,573*	*4,424 (3,214 - 5,556)*	*1.9% (1.4% - 2.4%)*
Total	**476,411**	**1,038**	**4,251**	**5,289 (3,807 - 7,322)**	**1.1% (0.8% - 1.5%)**
Inner: 8 boroughs					
Females < 25	117,234	251	1,545	1,796 (840 - 8,844)	1.5% (0.7% - 7.5%)
Females 25-44	334,541	1,034	2,031	3,065 (1,849 - 6,479)	0.9% (0.6% - 1.9%)
Females 15-44	*451,775*	*1,285*	*3,576*	*4,861 (3,050 - 11,986)*	*1.1% (0.7% - 2.7%)*
Males < 25	108,066	569	2,736	3,305 (1,786 - 6,897)	3.1% (1.7% - 6.4%)
Males 25-44	325,015	3,207	12,318	15,525 (11,503 - 21,667)	4.8% (3.5% - 6.7%)
Males 15-44	*433,081*	*3,776*	*15,054*	*18,830 (14,262 - 24,653)*	*4.3% (3.3% - 5.7%)*
Total	**884,856**	**5,061**	**18,630**	**23,691 (18,561 - 35,700)**	**2.7% (2.1% - 4.0%)**

~ Boroughs of Brent, Camden, City of Westminster, Ealing, Hammersmith and Fulham, Harrow, Hounslow, Islington, Kensington and Chelsea, Lambeth, Lewisham, Southwark.
*Population Data from Office of National Statistics (ONS), Census first findings obtained from the ONS website October 2002.

The prevalence was higher among men than women in both areas: 2.8 per cent compared with 1.5 per cent in Liverpool and 3.5 per cent compared with 0.8 per cent in London. The highest prevalence was found amongst men aged 25 to 44: one in 25 (4%) in Liverpool and 3.7 per cent in 12 London boroughs and 4.8 per cent in inner London. Overall, compared to the estimates of injecting drug use these estimates suggest that the injecting population is approximately 70 per cent of that for opiate users in Liverpool and 60 per cent in London. However, some of the sub group estimates give similar numbers of injectors and problem opiate users, for example males under 25 in Liverpool. Rather than meaning that, in this group, all opiate users are injectors this probably reflects an underestimation of levels of opiate use due to the scarcity of data on non-injecting users.

Applying the prevalence estimates obtained in inner and outer London to the whole of London yields an estimate of 62,000 (1.8%) opiate users aged 15 to 44, with 40,000 (2.7%) of these in inner London.

Crack or cocaine use

Only London had sufficient data to attempt capture-recapture estimates of crack and cocaine use (Table 10). The estimates suggest that there were around 11,000 (95% confidence interval 10,200 to 12,100) crack or cocaine users aged 15 to 44 years in the 12 London boroughs in 2000/01, or around one in 125 (0.8%) of the 15 to 44 population of these 12 boroughs. The highest prevalence, one in 63 (1.6%), was found among men aged 25 to 44 years in the eight inner London boroughs, and the lowest, one in 615 (0.2%) amongst women of the same age group in the four outer London boroughs. Applying these prevalence estimates to the whole of London yields an estimate of 24,000 (0.7%) crack or cocaine users aged 15 to 44, with 15,000 (1.0%) of these in inner London.

Table 10
Estimates of the numbers of crack or cocaine users aged 15 to 44 in the 12 London boroughs: 2000/01
From covariate analyses: covariates gender and age (split into aged under 25 and aged 25 and over)

Location, age and sex	Total population*	Observed user	Estimated unobserved users	Total number of users estimated (95% CI)	Estimated prevalence of use (95% CI)
12 London boroughs~					
Females < 25	183,773	257	726	983 (693 - 1,616)	0.5% (0.4% - 0.9%)
Females 25-44	509,218	756	1,411	2,167 (1,789 - 2,769)	0.4% (0.4% - 0.5%)
Females 15-44	*692,991*	*1,013*	*2,137*	*3,150 (2,639 - 3,889)*	*0.5% (0.4% - 0.6%)*
Males < 25	177,500	735	975	1,710 (1,507 - 2,055)	1.0% (0.8% - 1.2%)
Males 25-44	490,776	2,475	3,698	6,173 (5,687 - 6,896)	1.3% (1.2% - 1.4%)
Males 15-44	*668,276*	*3,210*	*4,673*	*7,883 (7,315 - 8,636)*	*1.2% (1.1% - 1.3%)*
Total	**1,361,267**	**4,223**	**6,810**	**11,033 (10,176 - 12,074)**	**0.8% (0.7% - 0.9%)**
12 London boroughs estimate subdivided by inner & outer London~					
Outer: 4 boroughs					
Females < 25	66,539	54	152	206 (146 - 340)	0.3% (0.2% - 0.5%)
Females 25-44	174,677	99	185	284 (234 - 363)	0.2% (0.1% - 0.2%)
Females 15-44	*241,216*	*153*	*337*	*490 (399 - 587)*	*0.2% (0.2% - 0.2%)*
Males < 25	69,434	237	314	551 (486 - 663)	0.8% (0.7% - 1.0%)
Males 25-44	165,761	427	638	1,065 (981 - 1,190)	0.6% (0.6% - 0.7%)
Males 15-44	*235,195*	*664*	*952*	*1,616 (1,513 - 1,786)*	*0.7% (0.6% - 0.8%)*
Total	**476,411**	**817**	**1,290**	**2,107 (1,969 - 2,336)**	**0.4% (0.4% - 0.5%)**
Inner: 8 boroughs					
Females < 25	117,234	203	573	776 (548 - 1,277)	0.7% (0.5% - 1.1%)
Females 25-44	334,541	657	1,226	1,883 (1,555 - 2,407)	0.6% (0.5% - 0.7%)
Females 15-44	*451,775*	*860*	*1,799*	*2,659 (2,241 - 3,301)*	*0.6% (0.5% - 0.7%)*
Males < 25	108,066	498	661	1,159 (1,021 - 1,392)	1.1% (0.9% - 1.3%)
Males 25-44	325,015	2,048	3,060	5,108 (4,705 - 5,706)	1.6% (1.4% - 1.8%)
Males 15-44	*433,081*	*2,546*	*3,721*	*6,267 (5,802 - 6,849)*	*1.4% (1.3% - 1.6%)*
Total	**884,856**	**3,406**	**5,520**	**8,926 (8,207 - 9,738)**	**1.0% (0.9% - 1.1%)**

~ Boroughs of Brent, Camden, City of Westminster, Ealing, Hammersmith and Fulham, Harrow, Hounslow, Islington, Kensington and Chelsea, Lambeth, Lewisham, Southwark.
*Population Data from Office of National Statistics (ONS), Census first findings obtained from the ONS website October 2002.

These estimates are the first for crack or cocaine using capture-recapture methods in the United Kingdom. They should be treated cautiously and perhaps as minimum estimates given that the ratio

of “observed” to “unobserved” were generally lower than for the estimates of injecting drug users or problem opiate use. In addition, the overlap between crack or cocaine use and injecting drug users and opiate users was high: 65 per cent (2,761/4,223) of those recorded as crack or cocaine users were also recorded as opiate users. There may be important differences in the chances of being on a data source between crack or cocaine users that use heroin and crack-cocaine users that do not (i.e. “heterogeneity”). Further analyses of crack or cocaine estimates (with opiate use as a covariate) should help interpret heterogeneity levels.

Problematic drug use

Estimates of the number of problem users (injectors and non injecting users of opiates, crack, cocaine, or benzodiazepines) were also possible in London. In Brighton too few non-injecting users were identified, whilst in Liverpool most individuals identified were problematic opiate users (either injecting or non-injecting) with too few recorded in other drug using categories. Again, rather than the absence of the problem users in the population, this reflects the limitations of utilising certain data sources and problems caused by restricted data sets collected at certain agencies.

The number of hidden problem users in the 12 London boroughs was estimated at 38,400, which gives a total estimate of around 46,000 (95% confidence interval 35,300 to 64,700) problem users aged 15 to 44 years in 2000/01: one in 24 (4.2%) of the 15 to 44 population (table 11). The highest prevalence was found among men aged 25 to 44 years in inner London (7.5%), and the lowest was found among women of the same age group in outer London (0.4%).

Table 11
Estimates of the numbers of problematic drug users aged 15 to 44 in the 12 London boroughs: 2000/01
From covariate anyalses: covariates gender and age (split into aged under 25 and aged 25 and over)

Location, age and sex	Total population*	Observed user	Estimated unobserved users	Total number of users estimated (95% CI)	Estimated prevalence of use (95% CI)
12 London boroughs~					
Females < 25	183,773	429	3,374	3,803 (2,400 - 22,264)	2.1% (1.3% - 12.1%)
Females 25-44	509,218	1,430	4,077	5,507 (3,131 - 11,910)	1.1% (0.6% - 2.3%)
Females 15-44	*692,991*	*1,859*	*7,451*	*9,310 (5,987 - 23,434)*	*1.3% (0.9% - 3.4%)*
Males < 25	177,500	1,233	6,946	8,179 (4,391 - 16,109)	4.6% (2.5% - 9.1%)
Males 25-44	490,776	4,657	24,011	28,668 (20,944 - 41,012)	5.8% (4.3% - 8.4%)
Males 15-44	*668,276*	*5,890*	*30,956*	*36,846 (27,700 - 50,086)*	*5.5% (4.1% - 7.5%)*
Total	**1,361,267**	**7,749**	**38,407**	**46,156 (35,326 - 64,705)**	**3.4% (2.6% - 4.8%)**
12 London boroughs estimate subdivided by inner and outer London~					
Outer: 4 boroughs					
Females < 25	66,539	91	716	807 (509 - 4,723)	1.2% (0.8% - 7.1%)
Females 25-44	174,677	183	522	705 (401 - 1,524)	0.4% (0.2% - 0.9%)
Females 15-44	*241,216*	*274*	*1,237*	*1,511 (882 - 3,454)*	*0.6% (0.4% - 1.4%)*
Males < 25	69,434	400	2,253	2,653 (1,425 - 5,226)	3.8% (2.1% - 7.5%)
Males 25-44	165,761	723	3,728	4,451 (3,252 - 6,367)	2.7% (2.0% - 3.8%)
Males 15-44	*235,195*	*1,123*	*5,981*	*7,104 (5,281 - 9,549)*	*3.0% (2.2% - 4.1%)*
Total	**476,411**	**1,397**	**7,218**	**8,615 (6,369 - 11,665)**	**1.8% (1.3% - 2.4%)**
Inner: 8 boroughs					
Females < 25	117,234	338	2,658	2,996 (1,891 - 17,541)	2.6% (1.6% - 15.0%)
Females 25-44	334,541	1,247	3,556	4,803 (2,730 - 10,386)	1.4% (0.8% - 3.1%)
Females 15-44	*451,775*	*1,585*	*6,214*	*7,799 (5,104 - 19,980)*	*1.7% (1.1% - 4.4%)*
Males < 25	108,066	833	4,692	5,525 (2,967 - 10,883)	5.1% (2.7% - 10.1%)
Males 25-44	325,015	3,934	20,283	24,217 (17,693 - 34,645)	7.5% (5.4% - 10.7%)
Males 15-44	*433,081*	*4,767*	*24,975*	*29,742 (22,419 - 40,536)*	*6.9% (5.2% - 9.4%)*
Total	**884,856**	**6,352**	**31,189**	**37,541 (28,958 - 53,040)**	**4.2% (3.3% - 6.0%)**

~ Boroughs of Brent, Camden, City of Westminster, Ealing, Hammersmith and Fulham, Harrow, Hounslow, Islington, Kensington and Chelsea, Lambeth, Lewisham, Southwark.
*Population Data from Office of National Statistics (ONS), Census first findings obtained from the ONS website October 2002.

The estimated number of unobserved problem users was five times greater than the number of observed users, suggesting that only one-sixth of the estimated population had been captured by the

data sources. Comparison with the opiate estimate indicates that the total estimate of the number of opiate users is around 63 per cent (28,979/46,156) of the estimated number of problem users, and that this proportion varies little with the age and gender subgroups.

Applying the prevalence estimates obtained for the inner and outer London boroughs to the whole of London yields an estimate of 99,000 (1.8%) problem drug users aged 15 to 44, with 63,000 (4.2%) of these in inner London.

Multiplier results

Multiplier estimates of the number of injectors were undertaken in all three areas. Table 12 gives the benchmark data (see Methods for definitions) and any adjustments that were made in order to correct for missing or incomplete data. For example, the benchmark number of recorded overdose attendances at Brighton Accident and Emergency department was obtained by applying the proportion of injecting overdoses in those records that could be located and contained information on drugs and route to both the records that could not be located and to those records with incomplete information; this increased the benchmark from 39 to 51.

Estimates for the multipliers for the three areas are given in Table 13. Multipliers provide a range of estimates for each of the three areas, most of which are implausible as they are either lower than the observed data collected for another benchmark, or less than the number of individuals identified for the capture-recapture exercise. For example, the Brighton overdose data multiplier gives an estimate of 323 injecting drug users yet there were 631 individuals registered with their needle exchange. In fact, in Brighton all the multiplier estimates were lower than the 857 individuals observed in the capture-recapture study, and the maximum value, 768, was approximately a third of the capture-recapture estimate.

Table 13
Multiplier estimates for injecting drug users aged 15 to 44 in Brighton, Liverpool and the 12 London boroughs: 2000/01

Event	Benchmarks (corrected)		Multipliers			Estimate
Brighton						
Arrests for heroin supply or possession	Number arrested	120	Proportion of injectors arrested	16%	6.4	768
Attendance the agency needle exchange	Number of registered attenders	631	Proportion of injectors registered	84%	1.2	749
Arrest referral	Number of injectors contacted by arrest referral worker	74	Proportion telling arrest referral work they inject	29%	3.4	251
			Proportion injectors arrest referral assesment	16%	6.3	469
Attendance at Accident and Emergency with overdose	Number of individuals attending with overdose	51	Proportion reporting overdose attendance	16%	6.3	323
Structured treatment	Number receiving treatment	172	Proportion reporting treatment attendance	86%	1.2	199
Mean						*460*
Median						*396*
Maximum						*768*
Liverpool						
Arrests for heroin supply or possession	Number of arrested	84	Proportion of injectors arrested	16%	6.4	533
Attendance at needle exchange	Number of registered attenders	496	Proportion of injectors registered	38%	2.6	1,293
Arrest referral	Number of injectors contacted by arrest referral worker	248	Proportion telling arrest referral work they inject	18%	5.4	1,341
			Proportion injectors arrest referral assesment	23%	4.3	1,065
Attendance at Accident and Emergency with overdose	Number of individuals attending with an injecting overdose	76	Proportion reporting injecting overdose attendance at Accident and Emergency providing data	5%	18.3	1,387
	Number of individuals attending with an opiate overdose	61	Proportion reporting opiate overdose attendance at Accident & Emergency providing data	8%	12.2	742
Treatment	Number injectors or opiate users receiving treatment	403	Proportion reporting treatment attendance	57%	1.8	709
Mean						*1,010*
Median						*1,065*
Maximum						*1,293*
12 London boroughs~						
Arrests for heroin supply or possession	Number arrested	643	Proportion of injectors arrested for heroin offence	22%	4.6	2,936
Attendance at needle exchanges (mobile or agency)	Number of registered attenders	4,308	Proportion of injectors registered	41%	2.5	10,559
Arrest referral	Number of injectors contacted by arrest referral worker	730	Proportion telling arrest referral work they inject	9%	11.8	8,588
			Proportion injectors arrest referral assesment	8%	12.2	8,902
Attendance at Accident and Emergency with overdose	Number of individuals attending with overdose	349	Proportion reporting overdose attendance at Accident & Emergencyproviding data	7%	13.5	4,716
Treatment	Number injectors receiving treatment	1,826	Proportion reporting treatment attendance	42%	2.4	4,400
	Number injectors or opiate users receiving treatment	3,491	Proportion reporting treatment attendance	42%	2.4	8,412
Mean						*6,931*
Median						*8,412*
Maximum						*10,559*

Note: Multipliers will be different to the comparable survey results reported as they are only for those ages 15 to 44
~ Boroughs of Brent, Camden, City of Westminster, Ealing, Hammersmith and Fulham, Harrow, Hounslow, Islington, Kensington and Chelsea, Lambeth, Lewisham, Southwark.

The multiplier estimates for Liverpool ranged from 533 to 1,387 (median 1,065). Although all the estimates were greater than the largest benchmark, four were lower than the 1,222 injectors observed in the capture-recapture study. The maximum estimate obtained using the multiplier method was less than half the estimate obtained using capture-recapture.

In London the multiplier approach gave estimates ranging from 2,936 to 10,559 (median 8,412). Only one of the estimates was less than both the largest benchmark and the 4,235 injectors observed in the capture-recapture study. The maximum estimate was almost two-thirds of the capture-recapture estimate and below the lower 95 per cent confidence interval of the capture-recapture estimate.

The performance of the individual multiplier estimates varied between the sites: in Brighton the highest and lowest multiplier were arrest for possession and treatment respectively; whereas in Liverpool and London the highest and lowest multipliers were Accident and Emergency and arrest for possession, and registration with needle exchange and arrest for possession respectively. None of the multiplier estimates can be viewed as plausible.

Historical multipliers

Three 'historical multiplier' estimates are shown in Table 14. Overall, these gave estimates ranging from 310 to 4,800 for Brighton, from 1,300 to 2,800 in Liverpool, and from 3,650 to 12,600 in the 12 London boroughs.

Table 14
Historical multipliers estimates for injectors for the three areas: treatment demographic, treatment coverage and mortality

Historical method	Calculation	Brighton		Liverpool		12 London boroughs~	
		Benchmark	Estimate	Benchmark	Estimate	Benchmark	Estimate
Treatment demographic	Number of new treatment demands multiplied by 5	156	*780*	654	*3,270*	1,826	*9,130*
Treatment coverage	Number in treatment divided by proportion in treatment of either 33% or 50%	156	*310-470*	654	*1,300-1,980*	1,826	*3,650-5,530*
Mortality	Number of OD deaths divided by the proportion dying of overdoses of either 1% or 2%	48	*2,400-4,800*	28	*1,400-2,800*	126	*6,300-12,600*

~ Boroughs of Brent, Camden, City of Westminster, Ealing, Hammersmith and Fulham, Harrow, Hounslow, Islington, Kensington and Chelsea, Lambeth, Lewisham, Southwark

In all three sites the treatment multipliers were below, or roughly the same as, the number of observed injectors in the capture-recapture studies. In Brighton the mortality multiplier gave a higher value than the capture-recapture estimate, and would suggest that prevalence of injecting was between two per cent and four per cent among adults aged 15 to 44, which even for Brighton would be too high. Whereas for London and Liverpool the mortality multiplier estimates were lower than the capture-recapture ones, with the mid-range values below the lower 95 per cent confidence interval of the capture-recapture estimate.

There are likely to be problems both with the benchmarks and the multipliers. For example, for the treatment multiplier – we just do not know accurately enough how many injectors are newly in treatment ("first demand") or the total number of injectors that are in treatment. There are no reliable data on the average time before presentation, and we have no evidence to suggest that an overdose mortality rate of one per cent to two per cent is appropriate in all three sites for 2000/01.

Public health indicators

Estimates of the number of problem drug users are useful not only in providing an indication as to the extent of the problem, but critically for examining the coverage of services provided to address problematic drug use and to reduce the harm caused. In addition, they can provide evidence on the credibility of the estimates. Preliminary data on 'Public Health Indicators' for injecting drug use are shown in Table 15.

These indicators raise interesting questions and must be treated cautiously as some of the indicator data may not provide complete information on, for instance, the full extent of service use because of missing or incomplete records. For instance, the indicators suggest low coverage of treatment: from one in 10 of injectors in Brighton and London to one in five in Liverpool. However, the treatment data are likely to be incomplete and refer to the number that present to specialist treatment agencies which are thus likely to miss injectors using primary care services. Ideally, we would measure the number of injectors in receipt of substitution treatment, but this number was not calculable within the time frame of this study.

Equally, the indicators suggest that a quarter of injectors are registered with agency needle exchanges in Brighton and London, whereas in Liverpool one-fifth are registered with an agency needle exchange but over a third are registered with a pharmacy based exchange. Data on the number of injectors in contact with pharmacies are not currently available from Brighton and London.

Data on the total number of needles and syringes distributed in the three areas indicate similar numbers are distributed per injector in Brighton, Liverpool and the 12 London boroughs. In each area the number of syringes distributed per injector during 2000/01 was approximately equal to one clean syringe every two days for each injector. As the community survey findings suggest that most injectors inject every day (and many inject more than once each day) insufficient syringes are distributed to ensure a clean syringe is used for each injection. Data from the London community survey indicate that injectors inject on average 25 days per month and on each day they inject they do so an average of 2.9 times. This would suggest that current levels of needle exchange activity provide coverage for approximately 25 per cent of all injections. It is important to note, that this represents a very high coverage in comparison to many other countries. For instance, it was estimated that coverage was less than 10 per cent in Newhaven, US and Vancouver, Canada [79] [80].

The estimated annual opiate mortality rate was two per cent in Brighton compared to approximately one per cent in Liverpool and London. There are several potential reasons for such a disparity, including the age structure of the injecting population, environmental risks, injecting risk behaviours, and coding by coroners.

The similarity of needle exchange coverage between the three sites and realistic estimates of the overdose mortality rate lend support to the credibility of the prevalence estimates obtained through capture-recapture. However, if the estimates from the multipliers had been used as the denominator, the public health indicators would give a very different, and possibly misleading, picture.

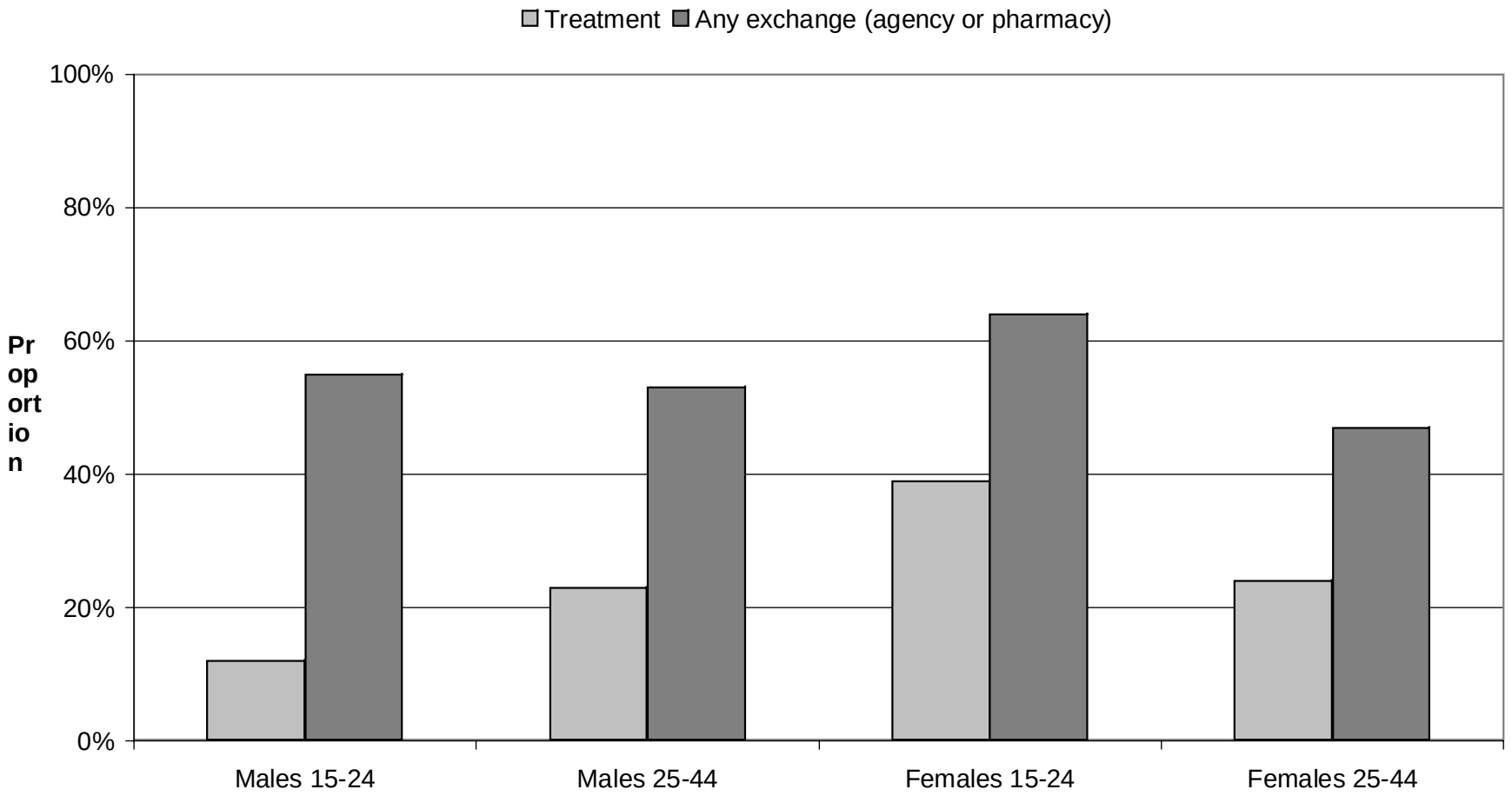
Finally, for Liverpool it was possible to calculate the proportion of injectors by age and gender that were in contact with either a treatment service or a needle exchange service (agency-based or pharmacy). This public health indicator for different age and gender groups is shown in Figure 1 and suggest that proportionally more women injectors (and particularly younger women), are in contact with both treatment and syringe exchange services.

Table 15
A selection of public health indicators for injecting drug users in the three areas

Public health indicator	Brighton		Liverpool		12 London boroughs~	
	Number of events	*Proportion of the estimated 2,304 injectors aged 15 to 44 years using service*	Number of events	*Proportion of the estimated 2,910 injectors aged 15 to 44 years using service*	Number of events	*Proportion of the estimated 16,782 injectors aged 15 to 44 years using service*
Captured data						
Observed individuals used in capture recapture	856	37.2%	1,224	42.1%	4,235	25.2%
Service contact data						
Injectors receiving structured treatment	156	6.8%	654	22.5%	1,826	10.9%
Injectors registered with agency needle exchange*	631	27.4%	592	20.3%	4,308	25.7%
Injectors registered with pharmacy needle exchange*	-	-	1,047	36.0%	-	-
Injectors contacted by arrest referral workers	74	3.2%	232	8.0%	730	4.3%
Injectors attending Accident and Emergency with overdose	32	1.4%	38	1.3%	349	2.1%
Opiate data: assumes most are injecting related						
Arrest for heroin possession/supply **	120	5.2%	173	5.9%	643	3.8%
Attending Accident & Emergency with an opiate overdose	57	2.5%	48	1.6%	330	2.0%
Deaths due to an opiate overdose	48	2.1%	28	1.0%	126	0.8%
Activity data		***Number of needles and syringes distributed per each of the estimated 2,304 injectors aged 15 to 44 years***		***Number of needles and syringes distributed per each of the estimated 2,873 injectors aged 15 to 44 years***		***Number of needles and syringes distributed per each of the estimated 17,092 injectors aged 15 to 44 years***
Number of needles distributed annually by needle exchanges per injector ***	429,000	186.2	566,500	194.7	3,208,000	191.2

* registered and attended in Liverpool.
** opiates in Liverpool.
*** London data on number of needles a syringes is based data from 1997.
~ Boroughs of Brent, Camden, City of Westminster, Ealing, Hammersmith and Fulham, Harrow, Hounslow, Islington, Kensington and Chelsea, Lambeth, Lewisham, Southwark.

Proportion of injectors in Liverpool either in contact with a needle exchange or in treatment: by age and gender 2000/01



Discussion

The study aimed to estimate the prevalence of injecting, opiate, crack/cocaine and problem drug use in three areas of England (Liverpool, Brighton and part of London) using two different indirect estimation methods. Estimates were provided for the prevalence of injecting drug use in all three areas, but reliable estimates of opiate use could only be provided for two of the areas, and the prevalence of crack or cocaine use and problem drug use only in London. Capture-recapture methods did provide consistent, credible and plausible results. The estimates based on the multipliers were less robust, and could give a false impression of the coverage of services that in turn could hinder effective policy and public health action. The wider use of multiplier methods as a sole method for estimating the prevalence of problem drug use is not recommended.

The use of capture-recapture can be extended to other sites to improve evidence locally. The estimates generated in this study were used by a further study using multiple indicator methods to generate national estimates [81]. New sites for prevalence estimation could be selected on the basis that they increase the range and type of geographical areas covered, strengthen estimates from the multiple indicator method, and support other surveys investigating overdose mortality or the prevalence of blood borne viruses among injecting drug users.

The discussion considers first the credibility of the estimates and their implications, followed by consideration of the methodological implications of this study to future work.

Findings

Injecting drug use: estimates

The best estimates were generated using covariate capture-recapture. The prevalence of injecting drug use among those aged 15 to 44 years in 2000 was estimated to be two per cent (95% confidence interval 1.3% to 3.2%) in Brighton, 1.5 per cent (1.3% to 2.6%) in Liverpool, and 1.2 per cent (1.0% to 1.6%) in twelve London boroughs overall and 1.7 per cent (1.2% to 3.3%) in the inner London boroughs. These equate to one in 50 of the Brighton population aged 15 to 44; nearly 3000 injectors or one in 66 of the population aged 15-44 in Liverpool, and over 16,000 injectors in 12 London boroughs and greater than one in 60 of the population aged 15 to 44 in inner London. In London as a whole we estimate there to be 34,300 (1.0%) aged 15 to 44, with 25,000 (1.7%) in inner London. In all three areas prevalence is high and clearly of public health importance. We believe these estimates are credible, consistent with each other and fit with the available evidence from some of the public health indicators.

First, the similarity in prevalence between the three areas offers some construct validity. Second, the ratio between the observed number of injectors in the data sources used in capture-recapture to the estimated unobserved number of injectors were plausible and not excessive, and in keeping with other studies elsewhere. In Liverpool and Brighton for every observed injector (identified by the data sources) we estimated that there was less than two unobserved, and in London the ratio was about three unobserved to one observed. Importantly “unobserved” does not mean hidden but includes injectors in contact with other data sources not used in the capture-recapture exercise and injectors not reported by the data sources used in the capture-recapture exercise, as well as those truly out of contact. For instance, in London the number of injectors registered with a needle exchange was higher than the number of ‘observed’ individuals because a large number of needle exchanges failed to collect date of birth and so could not be used in the capture recapture analysis. In addition, the number of injectors in contact with pharmacy-based exchanges has not been counted, and it is likely that there is under-reporting of the number of injectors in treatment.

Third, historical studies and estimates elsewhere provide supporting evidence for our estimates. In Liverpool in 1998 the prevalence of injecting was similar at 1.3 per cent among those aged 15 to 44[59], in Glasgow in 1990[36] the prevalence was 1.3 per cent among a wider age group at 15 to 54, and in Manchester the prevalence of injecting was estimated to be 1.3 per cent among those aged 16 to 54.

The higher prevalence in Brighton in part was expected and fits with evidence on overdose mortality (discussed below).

The distribution of injectors by age group and gender also were plausible. In all cities the highest prevalence was among males aged 30 to 44 at 2.2 per cent to 3.9 per cent. This suggests that currently the bulk of the injecting population is an ageing cohort. Overall, the prevalence among men was two to three times higher than among women aged 15 to 44, though the difference is not as wide among the younger age group.

Finally, in Brighton and Liverpool where consultation has already taken place local experts and policy-makers supported the estimates.

Injecting drug use: public health indicators

As part of the study some provisional data for examining coverage (i.e. the proportion of injectors in contact with treatment or needle exchange services) and other public health indicators were gathered. These emphasise the need for action in a number of areas:-

- improve surveillance data
- increase specialist treatment
- increase needle exchange distribution
- reduce opiate overdose deaths

Treatment

Results suggest the need to increase the number and proportion of injecting drug users in treatment in all three areas. However, better data on the number of people in treatment are also required across all three areas, even in Liverpool which had the best data and reported the highest proportion of injectors in treatment (23%). The data missed a substantial number of injecting drug users treated in primary care, and it is likely also that some injectors in treatment were not identified because of missing data on injecting status. Furthermore, the indicator data refer to those registered with a treatment agency not those who received substitution treatment, which may be lower.

Needle exchange

In the 12 London boroughs over 4,300 (25%) injectors were registered with a local agency needle exchange. In Liverpool and Brighton 20 per cent and 27 per cent respectively were registered with a local agency needle exchange and had received clean injecting equipment in the last year. These proportions would be substantially higher if the number in contact with pharmacy based exchanges were included, as is shown by the data for Liverpool were the numbers registered with Pharmacy exchanges are available – 36 per cent were registered with pharmacy exchange, and 53 per cent were registered with any needle exchange.

Unfortunately, national surveillance of needle exchange has not yet been established which is critical to monitoring coverage. The best available data suggested that in the part of London covered by our study about three million syringes are distributed, with over 400,000 in Brighton, and 560,000 (agency based syringe exchanges only) in Liverpool. Interestingly this equates to approximately the same coverage in the three sites – that is around 190 syringes per person per year – or one syringe every two days – which is about one free syringe per four injections and a coverage of 25 per cent of all injections. These data are supported by behavioural surveillance, which suggest that injectors use their syringe on average two to four times per day.

Data from the ongoing behavioural surveillance of injectors in contact with services indicated that in 2001 one in three injectors had shared needles and syringes in the last month, whilst the prevalence of Hepatitis C is higher in London and Liverpool than elsewhere in England (at over 50% compared with less than 30%)[82]. At current levels of coverage the opportunity for sharing syringes and viral transmission has not been eliminated. Consequently it is recommended that local and national policy-makers urgently consider increasing the distribution of clean injecting equipment by as much as two-fold, in order further to reduce the opportunity for sharing syringes and prevent transmission of blood-borne viruses.

Overdose and drug related mortality

Brighton has proportionately more opiate overdose deaths than any other city in England. In 2000, Brighton recorded 0.4 per 1,000 aged 15 to 44 opiate overdose deaths compared to 0.1 and 0.2 in Liverpool and London respectively. Taking the estimates of the prevalence of injecting drug use as the denominator the annual overdose mortality rate was estimated to be 0.8 per cent to one per cent in Liverpool and London, which though unacceptably high is in keeping with estimates from the literature[83]. In Brighton, however, not only was the prevalence of injecting estimated to be higher but the opiate overdose mortality rate also was higher at two per cent in 2000. In part this may be due to a cohort effect given that the highest prevalence of injecting was among those over 30, who also tend to experience higher overdose rates than younger injectors[84]. However, it certainly requires further attention and public health action to determine why the rates are so high in Brighton and to reduce them.

Prevalence and coverage

Deriving an estimate of the prevalence of injecting drug use (or other problematic use) is only half the picture. These data need to be seen in the context of coverage and other public health indicators in order to monitor progress and identify areas that need public health action by local and national policy-makers. It is recommended that other data are regularly collected to generate public health indicators of use to policy-makers. These could include the number of injecting drug users in contact with all needle exchanges, outreach, probation, social services, and prison.

The preliminary measures of coverage emphasise some public health messages but also highlight the need to improve the completeness and quality of surveillance data on injectors and problem drug users in contact with services. Otherwise the usefulness of knowledge of the prevalence of injecting drug use will be limited. Equally, estimates of prevalence have to be reliable, for example, if only the multiplier estimates (which were lower than the capture-recapture estimates) were available the study might have concluded that every injector had one syringe per injecting event, over half the injectors in Liverpool were in treatment and the annual mortality overdose rate by injectors was over four per cent in Brighton. An almost certainly inaccurate and seriously misleading picture that could hinder effective action.

Problem, opiate, and crack/cocaine use: estimates

Estimates of other types of problem drug use (i.e. other than numbers of injectors) were limited by the available data. Estimates were derived for problem opiate use in Liverpool and problem opiate use, problem drug use and crack-cocaine use in London. The credibility of these estimates varies.

There is support for the estimates of the prevalence of opiate use among those aged 15 to 44 years – at over two per cent in Liverpool and the 12 London boroughs and 2.7 per cent in inner London. The prevalence of problematic drug use has previously been estimated for parts of inner London 3.6 per cent (95% confidence interval 2.7% to 4.9%, 1993/4) in Camden and Islington, 3.1 per cent (95% confidence interval 2.5% to 3.9%, for 1992) in Lambeth, Southwark and Lewisham and 3.3 per cent (95% confidence interval 1.9% to 5.7%, 1995) in Newham [35]. Although these estimates are for those aged 15 to 49 years and used slightly different definitions of drug use they are comparable to our inner London estimate of problem drug use of 4.2 per cent. Estimates of problem drug use undertaken in other parts of England have also obtained similar prevalences, for example a study in Liverpool using data for 1998 found a prevalence of problem drug use among those aged 15 to 44 years of 3.7 per cent [59].

Our estimate of the prevalence of crack or cocaine use in London is one of the first examples of capture-recapture applied to crack/cocaine in the United Kingdom. However, as such the figures must be treated cautiously and perhaps as minimum estimates. Further work on crack-cocaine use is required to corroborate these findings, and to identify which data sources and methods may be the best for future studies.

More generally, questions remain as to what “problem drug use” represents. and whether it is meaningful without reference to drug type. Injecting drug users, opiate users, and possibly crack-cocaine users tend to be poly-drug users. For instance, the behavioural data suggested that though

nearly nine in ten of the injecting drug users in the survey injected heroin in the previous year over half had also used crack or cocaine. Treatment services and many other data sources on problem drug use are dominated by opiate and crack-cocaine use. The problematic use of illegally obtained benzodiazepines in non-heroin users may not be large. Cannabis, ecstasy, and non-injecting use of amphetamine and powder cocaine are estimable through different methods: direct methods or population surveys[85]. It is recommended, therefore, that prevalence estimation of problem drug use focus on injecting drug use, opiate and crack/cocaine use with an assessment of the most appropriate data sources for each type.

The methods

Indirect methods are inherently uncertain, and the estimates they produce need to be treated cautiously. There are "no simple rules" for determining reliability or the sample size required[57], though in general the larger the study the better. Nonetheless, as shown above, useful estimates that describe the extent of drug use in the population can be determined for policy makers.

Surveillance: objectives of data sources

The majority of effort expended in this study was on obtaining ethical approval, gaining access and collecting routine data. The process also raised a number of issues on the quality of some of the data collected on problem drug users. Data quality and the completeness of data on drug profiles were partly responsible for the inability to estimate prevalence of problem drug use, opiate and crack use in all three areas. Future estimation exercises will benefit and become easier and more reliable with investment, better scrutiny, and improved quality assurance in data sources on problem drug use.

Prevalence estimation – through capture-recapture – should be included as a key objective of the United Kingdom's investment into current and future data sources, such as monitoring systems for drug treatment, and the national arrest referral scheme. In this way the delays and problems encountered in obtaining access to the data sets will be avoided, and estimation will become faster and central to the reason for collecting information on drug use. It is recommended that key stakeholders in drug information nationally and locally consider which data sources can be used for prevalence estimation and identify what action needs to be taken to enhance their use in routine prevalence estimation. Guidelines on data collection and prevalence estimation for regional and local areas could be produced (based on this work and other capture recapture studies such as the parallel study in Manchester).

Covariate capture-recapture methods

This study is the first to apply covariate capture-recapture techniques to problem drug use, and the first application of the method to four data sources. In addition, bootstrap methods were employed to estimate 95 per cent confidence intervals, rather than a traditional approach based on interval estimation. Covariate capture-recapture estimation methods attempt to deal with heterogeneity within a single model (i.e. that there are differences in the likelihood of being in any particular data source with covariates such as gender, age, area of residence). This method is more economical and efficient and an advance on traditional capture-recapture that stratifies data by age, sex, and area in order to deal with heterogeneity. The traditional method tends to result in a large number of model estimates often derived using little data in some subgroups, thereby increasing the uncertainty of each estimate and diluting the statistical power to distinguish the best fitting model.

Nonetheless, even the covariate technique cannot deal with all the heterogeneity and problems with data scarcity that may arise. For instance, in Liverpool separate models were used for males and females to deal with heterogeneity; and in London there were insufficient data from all the data sources for reliable estimates by Drug Action Team area. Improving the availability and completeness of routine data sources will solve some of these problems.

Further work is required on the covariate technique to identify limitations on the number of covariates, sample size and model complexity, and establish appropriate information criterion for model selection.

The technique is more complex than the traditional method, and we recommend that programmes (macros; i.e. subroutines for commercial statistical packages) are commissioned so that the method can be used in future estimate exercises in the United Kingdom and elsewhere.

Historical estimates, multiplier estimates

Historically the prevalence of opiate use was estimated by multiplying the number of addicts notified to the Home Office by five or 10[86]. Godfrey *et al*, recently estimated the number of problem drug users to be from 280,000 to 500,000 based on the assumption that in one year one-third or half the number of problem drug users are reported to the Drug Misuse Database, or that on average it takes five to eight years before a problem drug user first enters treatment [67]. NERA estimated the number of heroin users to be approximately 240,000 based on information from 'NEW ADAM' on the number of heroin users arrested and estimates of the probability of arrest[87]. Work commissioned by the European Centre for Monitoring for Drugs and Drug Addiction also estimated the prevalence of opiate use based on a mortality multiplier – assuming that the overdose mortality was between one per cent and two per cent annually and that prevalence was estimable by multiplying the number of overdose deaths by the overdose mortality rate.

The trouble with these approaches is that we do not know what proportion of problem drug users are in treatment. Similarly, we do not know the average delay between onset of problem drug use and presentation to treatment, or the probability of arrest of a heroin user; and it is likely that these quantities would vary over time and by age, gender, and geographically. The use of surveys of problem drug users as a source of locally specific multipliers in our study (and other unpublished studies we know of, e.g. Lucy Platt personal communication) failed because the sample was not representative of the target population and generated biased multipliers. The local surveys followed best practice in the design of community surveys, taking steps to reduce potential bias. However, for the purposes of prevalence estimation, it is difficult and perhaps impracticable to recruit a fully representative sample of injectors for an unbiased multiplier estimate.

Furthermore, it is likely that the benchmark data on the number of problem drug users in treatment or the number of heroin users arrested are currently inaccurate, and that there is not sufficient information to adjust the benchmarks accordingly for under-reporting. This implies that in England (and many other countries) the best national estimates of the prevalence of problem drug use (which are based on such techniques) are more likely to be best guesses.

Technically and statistically the multiplier method is equivalent to a two-sample capture recapture. Two-sample capture-recapture studies are not recommended because the assumption that the two sources are independent of each other cannot be tested, and there is no guarantee that epidemiological data sources are independent. The exception would be in situations where there is a high level of overlap in which case bias is minimised, or where the size and direction of independence were known and the objective was to provide minimum or maximum estimates. Importantly, neither of these situations applies to problem drug use.

Future development of the multiplier method must take account of these difficulties. A recent paper estimating prevalence of injecting drug use in Edinburgh reported an advance based in part on an HIV multiplier and using smoothing and extrapolation techniques to deal with heterogeneity generated by differences in the proportion HIV positive by age [57]. However, the final estimates were lower than those calculated using capture-recapture and the method still relies upon the assumption that the multiplier is representative, which is not certain.

Other developments of the multiplier method have been proposed, which seek to combine multipliers in order to estimate and adjust for any bias, though they still depend on the accuracy of benchmark data [16 88]. Currently, these methods are only theoretical or have been piloted once in the USA. It is therefore recommended that a statistical review and pilot feasibility test of an advanced multiplier be undertaken in England. This would establish whether advanced multipliers are reliable and could provide another alternative estimation method and source of corroboration for capture-recapture.

Data sources

Key to the successful application of both capture-recapture and multiplier methods of estimation are the data sources. The requirements for future work are clear: four or more data sources that collect reliable and consistent data on the person, drug profile and administration, and cover contact with treatment and criminal justice. It is recommended that work is undertaken to establish data collection for prevalence estimation as a key role of at least four data sources from among those potentially available. Furthermore it is suggested that these included the existing treatment and arrest referral data sets. A third source could be achieved through the establishment of a national needle exchange monitoring system and it is recommended that the feasibility of this be considered. A fourth data set could be either from social service, criminal justice or attendance at Accident and Emergency depending on local circumstances and the estimate desired.

All the data sources used in this study had problems (summarised below and in appendix C).

The treatment data and arrest referral data where the easiest of all the data sources to obtain as they are already collected through national/local monitoring systems. However the quality of the data could have been better. The treatment data generally had extensive information on the drugs used, but residence information was often incomplete and sometimes contradictory and problems were also encountered with gender coding, duplicate reports and inverted initials. The arrest referral data were generally of better quality, but had more limited drug related information. These two data sets, as they are routinely collected, will be key to any future estimation exercises.

Data from needle exchanges was only routinely collated in Liverpool. In Brighton and London the needle exchange data had to be manually collected, which was time consuming particularly as some agencies operated paper-based systems or used computer systems from which export of the data needed was difficult. The data quality between areas varied considerably. There was typically limited information on the drugs used as many needle exchanges only recorded the main drug injected. However, the main problem encountered was that a number of agency needle exchanges in London did not collect dates of birth (other needle-exchanges generally collect this information as they use initials and dates for birth as client identifiers). Data from needle exchanges could, if collected in a standardised way, provide a third accessible data source for prevalence estimation. The establishment of a national standard data set for needle exchanges is recommended, and it is also recommended that consideration be given to the establishment of a national needle exchange monitoring system.

The data source that was the most difficult and time consuming to collect was that on overdose attendances at Accident and Emergency departments, though the quality of the data that was obtained was generally high. This data was difficult to collect for a number of reasons, which applied to varying degrees to most of the Accident and Emergency departments that provided data. Firstly, a wide and diverse range of recording systems were in place. Most had computer database systems where it was possible to identify episodes involving possible overdose/poisonings either by searching for appropriate diagnostics codes or by using free text searches of episode descriptions. Where diagnostic codes were used there were often several codes under which overdose/poisonings could be recorded including a general code for drug/alcohol use. The use of such general codes typically produced lists of possible episodes that were too long to examine. As a result it was not practical to search for overdoses at some Accident and Emergency departments. Once a list of possible episodes had been identified it was then necessary to access the corresponding notes; these had usually been scanned or microfiched (so that they could be viewed or printed off). However, in some cases it was necessary to search in note stores and in others it was necessary to use a combination of these approaches as there had been changes in the technology used during the time period being examined. The process of examining notes was very slow and laborious and notes could not always be located. Overdose data from Accident and Emergency departments is potentially a very rich source of information. However it is costly to collect and identify only small numbers of episodes. This study has highlighted that the collection of Accident and Emergency data for use in capture-recapture studies is not recommended unless it is ‘easily’ available through a single electronic system.

Finally, there are a number of other potential sources of data that could be used in capture-recapture and need to be reviewed – for example, probation service, court reports, and social services.

Recommendations

Overall.

1. We recommend the use of covariate capture-recapture techniques for estimating prevalence of injecting drug use and other types of problem drug use, and that local prevalence estimation be extended to other Drug Action Team areas.
2. We recommend considering new sites in line with other work including, studies of the prevalence of blood-borne viruses among injecting drug users, and multiple indicator methods.
3. We recommend that key stakeholders in drug information nationally and locally consider which data sources can be used for prevalence estimation and identify what action, if any, needs to be taken to enhance the data collected towards estimating prevalence.
4. We recommend that contributing to "prevalence estimation" be introduced as a clear objective, and a condition of investment, of at least four data sources collecting data on problem drug users.
5. We recommend that the Home Office and National Treatment Agency consider producing guidelines on data collection and prevalence estimation for regional and local areas.
6. We recommend that indirect prevalence estimation of problem drug use in local areas focus on injecting drug use, opiate and crack-cocaine use with an assessment of the most appropriate data sources for each type.

Methodology

7. We recommend that a statistical macro is commissioned for generating prevalence estimates using covariate capture-recapture and confidence intervals through bootstrap methods.
8. We recommend further development of the covariate method, in particular on: methods of model selection; confidence interval calculation methods; and to consider the number of covariates.
9. We do *not* recommend the wider use of multiplier methods as a sole method for estimating the prevalence of problem drug use.
10. We recommend a statistical review and pilot feasibility test of the use of more advanced multipliers to estimate prevalence.

Public health and surveillance

11. We recommend that local and national policy-makers urgently consider increasing the distribution of clean injecting equipment by as much as twofold, in order further to reduce the opportunity for sharing syringes and prevent transmission of blood-borne viruses.
12. We recommend that surveillance of needle exchange activity is established.
13. We recommend that other data are collected to generate public health indicators of use to policy-makers.
14. We recommend further work and action on understanding and reducing drug related deaths in Brighton.

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Appendices

Appendix A: Data providers and acknowledgements

General acknowledgements

We are grateful to Simon Scott and Dr Martin Frischer for their help and support in the preparation of the bid.

We would particularly like to thank all those who took part in, and assisted with, the community surveys.

Data providers

We are indebted to the following people for helping us and providing us with data.

Brighton

Mr G Bryant, Accident and Emergency Department, Royal Sussex Hospital
Mr F McEwan, Addaction
Ms H Ellis, CRI
Ms B Brown
Ms E Cowlet, Sussex Police
Mr M Gomm, Brighton & Hove LA
Ms A Walker, Brighton & Hove LA
Brighton Users Group

Liverpool

Dr Una Geary, Accident and Emergency Department The Royal Liverpool and Broadgreen University Hospitals NHS Trust
Social Partnership (Liverpool)

London

Dr Adrian Wagg, Accident and Emergency Department, University College Hospital
Dr J Booth, Accident and Emergency Department, Chelsea and Westminster
Mr A Banerjee, Accident and Emergency Department, Whittington Hospital
Dr E Glucksman, Accident and Emergency Department, King's College Hospital
Dr P Leman, Accident and Emergency Department, St Thomas's Hospital
Mr N Nayeem, Accident and Emergency Department, University Hospital Lewisham
Dr M W Beckett, Accident and Emergency Department, West Middlesex Hospital
Mr J Knottenbelt, Accident and Emergency Department, Northwick Park Hospital
Ms E Spain, Ealing Drug Advisory Service
Mr A King, Druglink Hammersmith
Mr C Costenza, The Stockwell Project
Mr P Fenton, CDP - Old Kent Road
Mr R Morton, Dual Team (Catford)
Ms C Gillies, Mainliners
Ms P Nazran, Angel Drug Project
Mr C Kelly, Caravan Project
Ms J Kennedy, Harrow Community Drug and Alcohol Service
Mr S Gunn, The Basement Project
Ms G Latheron, Blenheim Project
Mr D Bamford, Westminster Drug Project
Mr A Woodridge and Ms L Maslanks, Hungerford Project
Mr D Robertson, Cleveland Street Exchange
Mr P Eastwood, Centre for Research on Drugs and Health Behaviour, Imperial College
Mr D Morgan, Centre for Research on Drugs and Health Behaviour, Imperial College
Ms J Oreton, South Bank University
Mr A Beaumont, Metropolitan Police

Local consultation

Two meetings have been held to discuss the findings locally:
Members of expert consultation group in Brighton
H Luck
A Walker
S Scott
J Bennett
J Gaudoin
A Iversen
S Nicholls
T Scanlon
P Wilkinson
J Rooney
C Hughes
G Taylor
M Byrne
J Hollinshead
J Morris
J Patience
B Purcell
J Cassell

Members of expert advisory committee in Liverpool
Professor M Bellis, Director of Public Health, Birkenhead and Wallasey PCT
M Hopkins, Clinical Director, Drugs Directorate, Mersey Care
C McCormack, Drugs Prevention Advisory Service (DPAS) Adviser
J McVeigh, Senior Lecturer, Centre for Public Health, Liverpool John Moores University
S Neely, Liverpool DAAT Co-ordinator
R Thomson, Public Health Project Specialist, Liverpool/Sefton.

Appendix B: Ethical approval

The study was approved by the Scottish Multi-Centre Research Ethics Committee (MREC), and then by the following Local Research Ethics Committees (LRECs):

Liverpool Research Ethics Committee
Brighton Local Research Ethics Committee
Kings College Hospital Research Ethics Committee
St Thomas' Hospital Research Ethics Committee
Riverside Research Ethics Committee
Royal Free Research Ethics Committee
Whittington Local Research Ethics Committee
UCL/UCLH/NHNN Ethics Review Committee
Lewisham Research Ethics Committee
Harrow Research Ethics Committee
Hounslow District Local Research Ethics Committee
St Mary's Local Research Ethics Committee

Appendix C: Details of the data sources used

Summary of the data sources used for prevalence estimation in the three areas

Event	Data source and collection	Format	Number of sources	Issues	Capture-recapture	Multiplier benchmark
Brighton						
Received structured treatment at specialist drug agency	Local surveillance database	Electronic.	1 (collated from 7 drug agencies)	Individuals present more than once, as based on 3 monthly assessments. Coding concerns in relation to gender. Some incomplete data.	Yes	Yes
Registered with agency-based needle exchange	Administrative data	Paper-based. Collected.	1	Gender recording. False initials. Very limited information on drugs used, and on residency	Yes	Yes
Contacted by arrest referral worker/reported injecting to arrest referral worker	National surveillance database and administrative data	Electronic.	1 (collated from 2 police stations)	Quality of recording of drugs and route of drug use. National data only for half of year, and had better information on route of drug use. The local data better for drugs use.	Yes	Yes
Attended Accident Emergency department with problem drug overdose	Administrative data	Electronic and paper. Collection complex.	1	Incomplete: cause of overdose not always clear and problems locating notes. Route of drug use not always recorded.	Yes	Yes
Arrested for possession or supply of heroin	Local police administrative data	Summary data	1 (collated from 2 police stations)	Number of arrests, not persons	No	Yes
12 London boroughs						
Received treatment at specialist drug agency	Local surveillance database	Electronic.	1 (collated from 34 drug agencies)	Individuals present more than once. Coding concerns in relation to gender. Some incomplete data.	Yes	Yes
Registered with agency or mobile needle-exchange	Administrative data	Electronic or paper-based. Collected.	15	Incomplete information on some registrants. False initials. Very limited information on drugs used, and on residency. Five agencies did not collected dates of birth.	Yes	Yes
Contacted by arrest referral worker/reported injecting to arrest referral worker	National surveillance database.	Electronic.	1 (collated from 30 police stations)	Quality of recording of drugs and route of drug use.	Yes	Yes
Attended Accident Emergency department with problem drug overdose	Administrative data	Electronic and paper. Collection complex, from diverse range of systems.	9	Incomplete: various coding systems for overdoses, cause of overdose not always clear and problems locating notes. Route of drug use not always recorded.	Yes	Yes
Arrested for possession or supply of heroin	Local administrative data	Summary police data	1 (collated from 30 police stations)	Number of arrests, not persons	No	Yes
Liverpool						
Received treatment at specialist drug agency	National & regional surveillance databases	Electronic.	1 (collated from 6 drug agencies)	Period Prevalence Database does not record drug or injecting status - data had to be merged from the Regional Drug Misuse Database.	Yes	Yes
Registered with and attended agency-based needle exchange	Regional surveillance database	Electronic.	1 (collated from 2 exchanges)	Many had residency information missing. Only records drug used on first presentation.	Yes	Yes
Contacted by arrest referral worker/reported injecting to arrest referral worker	National surveillance database	Electronic.	1 (collated from 3 custody suites)	Many had residency information missing.Quality of coding of injecting status.	Yes	Yes
Attended Accident Emergency department with problem drug overdose	Administrative data	Electronic and paper. Collection complex.	1	Cause of overdose not always clear, and problems locating some notes. Route of drug use not always recorded.	Yes	Yes
Arrested for possession or supply of heroin	Regional surveillance database	Electronic.	1	Only records primary crimes, does not record secondary crimes.	No	Yes

Appendix D: Capture-recapture analyses and contingency tables

Estimate of injecting drug users in Brighton 2000/1, age 30 split.

Overlaps between data sources

		Drug treatment							
		No				Yes			
		Arrest Referral							
		No		Yes		No		Yes	
		Survey and A&E							
		No	Yes	No	Yes	No	Yes	No	Yes
Needle Exchange	No	.	74	42	2	103	6	7	2
	Yes	521	36	19	3	65	7	8	1

Final models chosen from covariate analysis

a = treatment data
b = arrest referral data
c = combined data from survey and Accident and Emergency overdoses
d = needle exchange data

Interactions	G2	Df	P value	Observed	Estimate	BIC	AIC
a*b a*d b*c c*d	11.81	24	0.98	856	males < 30 = 132 males 30+ = 826 females < 30 = 172 females 30+ = 417	-161.1	-36.2

Injecting drug use, Liverpool 2000/1 age 25 split

Overlaps between data sources

		Treatment data source							
		No				Yes			
		Arrest data source				*Arrest data source*			
		No		Yes		No		Yes	
		Survey/A&E data sources				*Survey/A&E data sources*			
		No	Yes	No	Yes	No	Yes	No	Yes
Needle exchange data source	No		124	89	5	321	18	64	4
	Yes	316	13	21	2	184	16	45	2

Final models chosen from covariate analysis

4 sample analysis

a = treatment data
b = arrest referral data
c = combined data from Survey and Accident and Emergency overdoses
d = needle exchange data

Analysis was stratified by gender

	Interactions	**G2**	**df**	**P value**	**Observed**	**Estimates**	**BIC**	**AIC**
Males	a*b a*d b*d	11.8	14	0.6	926	<25 = 148 25+ = 1,143	-90.2	-16.2
Females	a*b*c a*c*d	0.1	6	1.0	296	<25 = 24 25+ = 336	-36.8	-11.9

Problematic opiate use, Liverpool 2000/1age 25 split

Overlaps between data sources

Treatment data source							
No				Yes			
Arrest data source				*Arrest data source*			
No		Yes		No		Yes	
A&E data source				*A&E data source*			
No	Yes	No	Yes	No	Yes	No	Yes
.	29	241	3	1544	18	182	1

Final models chosen from covariate analysis

3 sample analysis

Analysis was stratified by gender

	Interactions	**G2**	**Df**	**P value**	**Observed**	**Estimates**	**BIC**	**AIC**
Males	Independent	3.6	6	0.7	1,292	<25 = 131 25+ = 1,158	-42.1	-8.4
Females	Independent	2.4	6	0.9	719	<25 = 143 25+ = 626	-39.8	-9.6

Injecting drug use, 12 London boroughs 2000/1 age 25 split

Overlaps between data sources

Treatment data source							
No				Yes			
Needle exchange source				*Needle exchange data source*			
No		Yes		No		Yes	
A&E, survey and arrest data source				*A&E, survey and arrest data source*			
No	Yes	No	Yes	No	Yes	No	Yes
.	901	1036	73	1395	328	411	91

Final models chosen from covariate analysis

3 sample analysis

a = treatment data

b = combined data from survey, Accident and Emergency overdoses and arrest referral data

c = needle exchange data

Interactions	**G2**	**Df**	**P value**	**Observed**	**Estimates**	**BIC**	**AIC**
a*c a*b	3.766	4	0.439	4,235	males < 25 = 1,623 males 25+ = 7,751 females < 25 = 1,351 females 25+ = 2,132	-31.4	-4.23

Crack or cocaine use, 12 London boroughs 2000/1 age 25 split

Overlaps between data sources

Treatment data source							
No				Yes			
Needle exchange source				*Needle exchange data source*			
No		Yes		No		Yes	
A&E, survey and arrest data source				*A&E, survey and arrest data source*			
No	Yes	No	Yes	No	Yes	No	Yes
.	1155	2258	385	106	57	186	76

Final models chosen from covariate analysis

3 sample analysis

a = treatment data

b = combined data from survey, Accident and Emergency overdoses and arrest referral data

c = needle exchange data

Interactions	**G2**	**Df**	**P value**	**Observed**	**Estimates**	**BIC**	**AIC**
a*c b*c	2.089	4	0.719	4223	males < 25 = 975 males 25+ = 3,698 females < 25 = 726 females 25+ = 1,411	-33.1	-5.92

Opiate use, 12 London boroughs 2000/1 age 25 split

Overlaps between data sources

		Drug treatment							
		No				Yes			
		Arrest referral							
		No		Yes		No		Yes	
		Survey and A&E							
		No	Yes	No	Yes	No	Yes	No	Yes
Needle exchange	No	.	477	684	21	3006	104	297	17
	Yes	936	24	47	5	401	25	60	7

Final models chosen

4 sample analysis

a = treatment data
b = arrest referral data
c = combined data from survey and Accident and Emergency overdoses
d = needle exchange data

Covariant analysis

Interactions	**G2**	**df**	**P value**	**Observed**	**Total Estimate**	**BIC**	**AIC**
b*c*d a*b a*d a*c	10.66	12	0.5576	6,099	males < 25 = 4,250 males 25+ = 14,377 females < 25 = 2,000 females 25+ = 2,253	-99.3	-13.33

Problem use, 12 London boroughs 2000/1 age 25 split

Overlaps between data sources

		Drug treatment							
		No				Yes			
		Arrest referral							
		No		Yes		No		Yes	
		Survey and A&E							
		No	Yes	No	Yes	No	Yes	No	Yes
Needle exchange	No		579	1014	25	4026	110	360	17
	Yes	1052	24	47	5	415	25	60	7

Final models chosen

4 sample analysis

a = treatment data
b = arrest referral data
c = combined data from survey and Accident and Emergency overdoses
d = needle exchange data

Interactions	**G2**	**df**	**P value**	**Observed**	**Total Estimate**	**BIC**	**AIC**
*b*c*d* *a*b* *a*d* *a*c*	12.72	12	0.390	7,749	males < 25 = 8,179 males 25+ = 24,011 females < 25 = 3,374 females 25+ = 4,077	-100.2	-11.28

Appendix E: Capture-recapture estimates of injecting drug users using age 25 split

Table E.1
Estimates of the numbers of injecting drug users aged 15 to 44: Liverpool & 12 London boroughs. From covariate analyses: covariates gender and age (split into aged under 25 and aged 25 and over).

uU Location, age and sex	Total population*	Observed injectors	Estimated un-observed injectors	Total number of Injectors estimated (95% CI)	Estimated prevalence of injecting drug use (95% CI)
Liverpool					
Females < 25	36,753	42	24	66 (43 - 426)	0.2% (0.1% - 1.2%)
Females 25-44	65,088	254	336	590 (365 - 6,078)	0.9% (0.6% - 9.3%)
Females 15-44	*101,841*	*296*	*360*	*656 (412 - 1,488)*	*0.6% (0.4% - 1.5%)*
Males < 25	33,988	78	148	226 (142 - 460)	0.7% (0.4% - 1.4%)
Males 25-44	59,302	848	1,143	1,991 (1,664 - 2,557)	3.4% (2.8% - 4.3%)
Males 15-44	*93,290*	*926*	*1,291*	*2,217 (1,828 - 2,709)*	*2.4% (2.0% - 2.9%)*
Total	**195,131**	**1,222**	**1,651**	**2,873 (2,260 - 3,775)**	**1.5% (1.2% - 1.9%)**
12 London boroughs~					
Females < 25	183,773	213	1,351	1,564 (429 - 1,960)	0.9% (0.2% - 1.1%)
Females 25-44	509,218	788	2,132	2,920 (2,059 - 4,868)	0.6% (0.4% - 1.0%)
Females 15-44	*692,991*	*1,001*	*3,483*	*4,484 (2,651 - 5,723)*	*0.6% (0.4% - 0.8%)*
Males < 25	177,500	489	1,623	2,112 (1,412 - 3,837)	1.2% (0.8% - 2.2%)
Males 25-44	490,776	2,745	7,751	10,496 (8,590 - 13,739)	2.1% (1.8% - 2.8%)
Males 15-44	*668,276*	*3,234*	*9,374*	*12,608 (10,069 - 15,505)*	*1.9% (1.5% - 2.3%)*
Total	**1,361,267**	**4,235**	**12,857**	**17,092 (13,334 - 19,352)**	**1.3% (1.0% - 1.4%)**
12 London boroughs estimate subdivided by inner and outer London					
Outer: 4 boroughs					
Females < 25	66,539	36	228	264 (73 - 331)	0.4% (0.1% - 0.5%)
Females 25-44	174,677	68	184	252 (178 - 420)	0.1% (0.1% - 0.2%)
Females 15-44	*241,216*	*104*	*412*	*516 (275 - 595)*	*0.2% (0.1% - 0.2%)*
Males < 25	69,434	101	335	436 (292 - 792)	0.6% (0.4% - 1.1%)
	165,761	333	940	1,273 (1,042 - 1,667)	0.8% (0.6% - 1.0%)
Males 15-44	*235,195*	*434*	*1,276*	*1,710 (1,351 - 2,081)*	*0.7% (0.6% - 0.9%)*
Total	**476,411**	**538**	**1,688**	**2,226 (1,694 - 2,458)**	**0.5% (0.4% - 0.5%)**
Inner: 8 boroughs					
Females < 25	117,234	177	1,122	1,299 (357 - 1,628)	1.1% (0.3% - 1.4%)
Females 25-44	334,541	720	1,948	2,668 (1,881 - 4,448)	0.8% (0.6% - 1.3%)
Females 15-44	*451,775*	*897*	*3,071*	*3,968 (2,376 - 5,129)*	*0.9% (0.5% - 1.1%)*
Males < 25	108,066	388	1,288	1,676 (1,120 - 3,044)	1.6% (1.0% - 2.8%)
Males 25-44	325,015	2,412	6,811	9,223 (7,548 - 12,072)	2.8% (2.3% - 3.7%)
Males 15-44	*433,081*	*2,800*	*8,099*	*10,899 (8,718 - 13,425)*	*2.5% (2.0% - 3.1%)*
Total	**884,856**	**3,697**	**11,169**	**14,866 (11,640 - 16,893)**	**1.7% (1.3% - 1.9%)**

~ Boroughs of Brent, Camden, City of Westminster, Ealing, Hammersmith and Fulham, Harrow, Hounslow, Islington, Kensington and Chelsea, Lambeth, Lewisham, Southwark.

*Population Data from Office of National Statistics (ONS), Census first findings obtained from the ONS website October 2002.

Produced by the Research Development and Statistics Directorate, Home Office

This document is available only in Adobe Portable Document Format (**PDF**) through the RDS website

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ISBN 1 84473 321 1