EVIDENCE BASED PUBLIC HEALTH POLICY AND PRACTICE

Capture-recapture estimates of problem drug use and the use of simulation based confidence intervals in a stratified analysis

Islay Gemmell, Tim Millar, Gordon Hay

J Epidemiol Community Health 2004;**58**:758–765. doi: 10.1136/2003.008755

See end of article for authors' affiliations

Correspondence to: Tim Millar, National Drug Evidence Centre, C/O Evidence for Population Health Unit, Stopford Building, University of Manchester, Manchester M13 9PT, UK; tim.millar@man.ac.uk

Accepted for publication 11 December 2003

Study objective: To establish the prevalence of problem drug use in the 10 local authorities within the Metropolitan County of Greater Manchester between April 2000 and March 2001.

Setting and participants: Problem drug users aged 16–54 resident within Greater Manchester who attended community based statutory drug treatment agencies, were in contact with general practitioners, were assessed by arrest referral workers, were in contact with the probation service, or arrested under the Misuse of Drugs Act for offences involving possession of opioids, cocaine, or benzodiazepines.

Design: Multi-sample stratified capture-recapture analysis. Patterns of overlaps between data sources were modelled in a log-linear regression to estimate the hidden number of drug users within each of 60 area, age group, and gender strata. Simulation methods were used to generate 95% confidence intervals for the sums of the stratified estimates.

Main results: The total number of problem drug users in Greater Manchester was estimated to be 19 255 giving a prevalence of problem drug use of 13.7 (95% CI 13.4 to 15.7) per 1000 population aged 16–54. The ratio of men to women was 3.5:1. The distribution of problem drug users varied across three age groups (16–24, 25–34, and 35–54) and varied between the 10 areas.

Conclusions: Areas in close geographical proximity display different patterns of drug use in terms of prevalence rates and age and gender patterns. This has important implications, both for future planning of service provision and for the way in which the impact of drug misuse interventions are evaluated.

Accurate and timely estimates of prevalence of drug misuse are important for planning service provision for drug users at the local level. However, because a proportion of the drug using population are not in contact with services at any one point or period of time, prevalence of problem drug use has to be estimated indirectly. This paper describes the application of capture-recapture methods to provide estimates of prevalence of problem drug use in Greater Manchester. This is an urban area in the north west of England with a population (aged 16–54) of around 1.4 million, comprising 10 local government authorities with the City of Manchester LA at its centre. Each local authority is responsible for responding to problem drug use in its own area.

Capture-recapture methods were developed over a century ago to estimate the size of animal or fish populations^{1,2} and the method was first applied to human populations in case ascertainment studies during the 1940s.^{3–5} The application of capture-recapture methods in epidemiological studies was developed mainly through the work of Wittes,⁶ Hook and Regal^{7,8} and the International Working group for Disease Monitoring and Forecasting^{9,10} provide an extensive description of the methodology used in applying multi-sample capture-recapture techniques in epidemiology.

Within the UK, multi-sample capture-recapture has been applied to estimate the prevalence of problem drug in the north west of England,¹¹ London,¹² Liverpool,¹³ Glasgow,¹⁴ Dundee,¹⁵ the north east of Scotland,¹⁶ and, in one of few studies involving rural areas alone, Cheshire.¹⁷

Outside the UK, the European Monitoring Centre on Drugs and Drug Addiction (EMCDDA) funded a study, using three sample capture re-capture methods, to estimate the prevalence of opioid misuse within six European cities for the

age group 15–54.¹⁸ Other studies within Europe have estimated the prevalence of drug misuse in Amsterdam,¹⁹ Barcelona,²⁰ and Berlin,²¹ while further afield, capture recapture methods have been used to estimate the prevalence of drug misuse in Michigan,²² Los Angeles,²³ Bangkok,²⁴ and Australia.²⁵

METHODS

Unnamed identifier information on problem drug users resident in Greater Manchester during April 2000 to March 2001 was obtained from five sources: drug treatment services, general practitioners, the arrest referral system, Greater Manchester Police, and the probation service. With the exception of the probation sample, only cases involving the known use of opioids, crack, cocaine, or benzodiazepines by persons aged 16–54 were eligible for inclusion. This definition is comparable with other studies of problem drug use and covers the definitions used by the data sources.

The treatment sample included persons in contact with statutory, community based, drug treatment services in the Greater Manchester area. It was derived by combining information from a national census of persons receiving drug misuse treatment with information from drug misuse database (DMD)²⁶ and the new national drug treatment monitoring system (NDTMS).²⁷ Cases reported by statutory specialist treatment services were considered separately from those reported by GPs.

Arrestees who acknowledged a drug problem and who agreed to be assessed when interviewed by an arrest referral worker were included in the arrest referral sample and details of these people were obtained from the Greater Manchester arrest referral initiative (GMARI).

The police arrest sample included arrests for possession of heroin, methadone, other opioids, cocaine, crack, or benzodiazepines extracted from the Greater Manchester Police database of arrests under the Misuse of Drugs Act (1971).

Greater Manchester Probation service undertakes assessment of offenders using the assessment, case recording and evaluation system,²⁸ which records the severity of an offenders drug problem and the degree to which the drug problem is related to offending. The severity of a drug problem is classified on a four point scale relating to "none", "mild", "moderate", and "severe". Offenders whose drug problem was assessed as "moderate" or "severe" were included in our sample.

People from each sample were matched according to their unique identifiers (initials, date of birth, gender) within each area and identifiers were encrypted before matching. Four samples were used in the initial analysis: statutory treatment services, arrest referral, police, and probation. The GP data source was not used in the initial analysis as the number of cases from this source were very small in most areas. The data were stratified by age group (16–24, 25–34, and 35–54) and gender and were aggregated into contingency tables describing the overlaps of individuals among sources within each stratum for each area.

All ethical safeguards were met and ethical approval for the use of NHS data in this study was granted by the North West Multi-Centre Research Ethics Committee.

ANALYSIS

The analysis of each contingency table entailed firstly fitting a log-linear model that assumed independence between samples. Interaction terms were subsequently applied and models containing one interaction were compared with the independence model using the log-likelihood ratio test.²⁹ A significant change in deviance implied that the model containing the interaction provided a better fit to the data than the independence model. Competing models with the same degrees of freedom were compared using the AIC (akaike information criteria)^{7–30} and the BIC (Bayesian information criteria).^{7–31} Where an interaction model provided a better fit than the independence model, subsequent interaction models were applied and the simplest model was selected on the basis that it had the lowest AIC and/or BIC value and was not significantly improved by adding a further interaction. The final model provided an estimate of the number of people who did not appear in any of the samples. Confidence intervals for the estimate for each stratum were calculated using the likelihood interval method³² and the estimate of the total number of unknown problem drug users within each area was obtained by summing the stratified age-gender

estimates. The GP dataset was substituted for the probation dataset in the City of Manchester to enable suitable models to be obtained for all six age-gender strata.

For each stratum in each of the 10 areas we derived an estimate of the unknown population x together with an upper and lower confidence limits, ciu and cil . The sum of these estimates provided an estimate of the unknown number of problem drug users in each area. However, a confidence interval derived from summing the upper and lower bounds of the 10 95% confidence intervals does not provide a 95% confidence interval for the summed estimate. We therefore used simulation methods to generate confidence intervals for the summed estimates. Assuming a log-normal distribution for x , the estimate of the unknown population, then $\mu = \ln(x)$ is the mean of this distribution and the standard deviation σ of the distribution can be estimated as.

$$\sigma = \frac{(\ln(ciu) - \ln(x)) + (\ln(x) - \ln(cil))}{2 \times 1.96}$$

The simulation procedure involved generating, for each strata, 10 000 random deviates from a log-normal distribution with mean μ and variance σ^2 . Confidence intervals for the sum of the strata were calculated by summing the six log-normal distributions and deriving the 2.5 and 97.5 centiles for the summed distribution. The log-normal distributions were generated using Minitab.

RESULTS

Table 1 shows the number of problem drug users identified from each source. The total number of known drug users in Greater Manchester from the contingency table that accounts for the overlap between sources was 8359.

Table 2 describes the log-linear models that were applied to each stratum in each area. For six of the strata, models containing three interactions provided the best fit to the observed data. Four models contained two interactions and for 29 strata, models with one interaction provided the best fit to the data. For 17 strata there was no improvement to the model by adding an interaction and the independence model was used, however for four strata no suitable model could be found. For these strata, the combined males and females estimate for that age group was used to calculate an overall estimate for the area. Further model checks entailed comparing the sum of the age strata estimates with the model estimates for men and women and comparing the sum of the gender strata with the model estimates for each age group. A p value of <0.05 indicates that the selected model is not a good fit of the observed data, in only one of the strata did we have to use a poorly fitting model.

Table 1 Number of problem drug users identified from each source

Local authority	Treatment		Arrest referral		GP		Probation		Police	
	n	%	n	%	n	%	n	%	n	%
Bury	307	5.4	29	2.1	89	18.0	133	5.3	23	3.7
Bolton	728	12.9	265	19.6	30	6.1	376	15.0	136	22.1
Manchester	1819	32.2	473	35.0	99	20.0	652	26.0	177	28.7
Oldham	430	7.6	84	6.2	99	20.0	286	11.4	25	4.1
Rochdale	422	7.5	61	4.5	136	27.5	256	10.2	44	7.1
Salford	261	4.6	112	8.3	9	1.8	179	7.1	31	5.0
Stockport	346	6.1	44	3.3	3	0.6	134	5.3	23	3.7
Tameside	360	6.4	47	3.5	26	5.3	178	7.1	53	8.6
Trafford	356	6.3	87	6.4	3	0.6	78	3.1	17	2.8
Wigan	627	11.1	150	11.1	0	0.0	235	9.4	87	14.1
Greater Manchester	5656	100.0	1352	100.0	494	100.0	2507	100.0	616	100.0

Table 2 (A) Results of log-linear modelling (men)

Local authority	Age	Known	Interactions	Deviance	p Value	AIC	Model estimate	Total estimate	95% CI	Prevalence rate per 1000 population
Bolton	16-24	291	prob×ar×ar×treat+police×ar	7.07	0.422	-6.93	450	741	560 to 1044	54.55
	25-34	458	prob×ar×ar×treat×police×prob	2.12	0.983	-11.88	504	962	793 to 1207	43.21
	35-54	119	Prob×ar×ar×treat	14.72	0.065	-1.28	187	306	212 to 486	8.10
Bury	16-24	85	none	9.36	0.498	-10.64	80	165	123 to 236	18.83
	25-34	173	none	13.88	0.179	-6.12	164	337	269 to 439	22.81
	35-54	69	none	4.31	0.932	-15.69	98	167	103 to 330	6.01
Manchester	16-24	234	ar×treat+gp×treat	3.9	0.866	-12.1	788	1022	644 to 1834	24.99
	25-34	955	police×ar+gp×treat	1.85	0.985	-14.15	1388	2343	2051 to 2773	67.30
	35-54	475	treat×police	11.23	0.260	-6.77	684	1159	903 to 1555	21.53
Oldham	16-24	132	prob×ar×ar×treat+police×ar	7.44	0.385	-6.56	419	551	307 to 1242	48.12
	25-34	291	prob×ar×ar×treat	5.93	0.655	-10.07	316	607	491 to 776	37.17
	35-54	106	prob×ar	11.72	0.230	-6.28	123	229	163 to 354	7.50
Rochdale	16-24	112	prob×ar	7.98	0.536	-10.02	288	400	245 to 758	34.89
	25-34	256	none	11.16	0.345	-8.84	231	487	410 to 592	27.67
	35-54	122	none	9.1	0.523	-10.9	131	253	189 to 362	8.69
Salford	16-24	106	ar×treat	13.45	0.143	-4.55	298	404	245 to 769	26.29
	25-34	188	ar×treat	26.31	0.002	8.31	427	615	428 to 955	37.95
	35-54	68	ar×treat	7.83	0.551	-10.17	213	281	147 to 705	9.01
Stockport	16-24	94	prob×treat	7.36	0.600	-10.64	80	174	120 to 295	12.78
	25-34	190	prob×ar×ar×treat+police×treat	1.5	0.982	-12.5	363	553	366 to 947	26.64
	35-54	91	ar×treat	10.13	0.340	-7.87	199	290	170 to 599	6.81
Tameside	16-24	129	none	8.62	0.569	-11.38	99	228	185 to 289	20.93
	25-34	236	prob×ar	15.21	0.085	-2.79	208	444	371 to 546	25.15
	35-54	68	ar×treat	6.26	0.714	-11.74	157	225	121 to 547	6.91
Trafford	16-24	63	none	4.92	0.896	-15.08	165	228	130 to 481	18.65
	25-34	165	none	7.94	0.635	-12.06	143	308	242 to 411	19.54
	35-54	110	none	7.78	0.650	-12.22	65	175	132 to 258	5.36
Wigan	16-24	195	prob×ar×ar×treat+police×ar	11.23	0.129	-2.77	363	558	389 to 885	37.99
	25-34	115	prob×ar	11.67	0.233	-6.33	113	228	173 to 320	5.06
	35-54	324	prob×ar×ar×treat+police×ar	8.52	0.289	-5.48	214	538	456 to 653	19.83

Table 2 (B) Results of log-linear modelling (women)

Local authority	Age	Known	Interactions	Deviance	p Value	AIC	Model estimate	Total estimate	95% CI	Prevalence rate per 1000 population
Bolton	16-24	109	ar×prob	7.76	0.559	-10.24	60	169	136 to 220	34.72
	25-34	116	ar×prob	10.05	0.346	-7.95	103	219	164 to 314	27.34
	35-54	24	ar×prob	7.33	0.603	-10.67	13	37	25 to 71	4.60
Bury	16-24	37	police×ar	10.01	0.350	-7.99	50	87	48 to 224	14.87
	*25-34	44	(mf)-m	-	-	-	-	132	102 to 179	16.65
	35-54	14	none	5.78	0.833	-14.22	4	18	17 to 21	3.42
Manchester	16-24	131	gp×treat	4.43	0.881	-13.57	280	411	270 to 699	17.44
	25-34	341	gp×treat	6.67	0.671	-11.33	528	869	623 to 1315	50.45
	35-54	160	treat×police	8.73	0.463	-9.27	73	233	180 to 341	13.09
Oldham	16-24	36	ar×treat	4.97	0.837	-13.03	81	117	55 to 388	30.20
	25-34	73	prob×ar	2.66	0.976	-15.34	42	115	88 to 163	21.70
	35-54	31	prob×ar	1.92	0.993	-16.08	18	49	32 to 106	4.59
Rochdale	16-24	48	prob×ar	4.89	0.844	-13.11	50	98	65 to 177	22.21
	25-34	77	none	6.73	0.751	-13.27	108	185	119 to 332	19.80
	35-54	50	prob×treat	7.15	0.622	-10.85	49	99	50 to 913	6.02
Salford	16-24	42	prob×treat	8.59	0.476	-9.41	13	55	44 to 78	15.80
	25-34	58	none	5.96	0.819	-14.04	50	108	78 to 165	23.05
	35-54	20	none	8.93	0.539	-11.07	46	66	27 to 322	5.81
Stockport	16-24	25	none	5.58	0.849	-14.42	32	57	29 to 172	8.55
	25-34	60	none	4.22	0.937	-15.78	94	154	91 to 329	16.85
	*35-54	28	(mf)-m	-	-	-	-	90	60 to 144	4.45
Tameside	16-24	48	prob×ar	5.21	0.816	-12.79	63	111	67 to 230	16.30
	25-34	51	none	2.81	0.986	-17.19	42	93	63 to 164	15.65
	35-54	14	none	3.38	0.971	-16.62	15	29	14 to 120	4.00
Trafford	*16-24	24	(mf)-m	-	-	-	-	171	223 to 861	16.62
	25-34	47	police×ar	4.14	0.902	-13.86	54	101	55 to 302	13.32
	*35-54	36	(mf)-m	-	-	-	-	95	62 to 163	4.26
Wigan	16-24	88	prob×ar	9.96	0.354	-8.04	26	114	96 to 145	23.35
	25-34	103	ar×treat	10.95	0.279	-7.05	66	169	127 to 247	13.47
	35-54	19	prob×ar	4.61	0.867	-13.39	7	26	19 to 53	2.86

*Denotes sub-strata for which a suitable model could not be found. For these sub-strata the estimate was derived by subtracting the male estimate from the combined male and female estimate for the age group.

Table 3 Estimates of the number of problem drug users by local authority

Local authority	Total estimate			Population (age 16–54)	Prevalence rate per 1000	
	Known	Number	95% CI		Estimate	95% CI
Bolton	1117	2434	2161 to 2900	143923	16.91	15.0 to 20.1
Bury	422	906	772 to 1201	99293	9.12	7.8 to 12.1
Manchester	2296	6037	5377 to 7166	252160	23.94	21.3 to 28.4
Rochdale	669	1668	1316 to 2433	116017	14.38	11.3 to 21.0
Oldham	665	1522	1380 to 2418	114821	13.26	12.0 to 21.1
Salford	482	1529	1241 to 2241	120093	12.73	10.3 to 18.7
Stockport	488	1318	1064 to 1929	154352	8.54	8.0 to 14.4
Tameside	546	1130	984 to 1517	118672	9.52	8.3 to 12.8
Trafford	445	1078	860 to 1634	118169	9.12	7.28 to 13.8
Wigan	844	1633	1436 to 2007	170113	9.60	8.4 to 11.8
Greater Manchester	7974	19255	18731 to 21853	1407613	13.68	13.4 to 15.7

The models for female problem drug users contained fewer interactions than those for males. This may be attributable to smaller numbers in this group or because female drug users are a more homogenous group, or both. The most common interactions were between the arrest referral and probation data sources and the arrest referral and treatment data sources. This may be because clients who were included in the arrest referral data source were more likely to be referred for treatment and to be identified to the probation service, because of the nature of the arrest referral system.

The capture recapture analysis suggests that during the period April 2000 to March 2001 there were 19 255 (95%CI 18 731 to 21 853) problem drug users in Greater Manchester, a prevalence rate of 13.7 (95%CI 13.4 to 15.7) per 1000 population in the 16–54 age group (table 3). Around 43% of the problem drug users within Greater Manchester appeared in at least one of our samples.

The estimates indicate considerable variation in the gender distribution of problem drug users between areas. For Greater Manchester as a whole, we estimate that 78% of drug users are male, with a range by area from 66% in Trafford to 85% in Salford. The age distribution of problem drug users also

varies throughout the region. The local authorities of Bury, City of Manchester, and Stockport have a lower proportion of young users than most other areas while Tameside, Trafford, Bolton, and Wigan have a relatively high proportion of young users (figs 1 and 2).

In this analysis we have used 60 stratified estimates of problem drug use to estimate the number of problem drug users in Greater Manchester, to overcome problems of heterogeneity and to enable age and gender patterns to be described. The confidence intervals used for the 10 area estimates (table 3) are based on the 2.5 and 97.5 centiles of the sum of six simulated log-normal distributions whose mean and variance were derived from the stratified capture re-capture estimates and the likelihood interval. Table 4 provides a comparison between the area estimates obtained from unstratified models with their associated likelihood confidence intervals and the estimates obtained from the sum of the stratified estimates with their associated simulated confidence intervals. The difference between the lower and upper bounds and the estimate are similar for the sum of stratified models and the sum of the unstratified area models indicating no loss of precision through the use of simulated confidence intervals.

Figure 1 Prevalence of problem drug use by gender.

Figure 2 Prevalence of problem drug use by age group.

The models used in the un-stratified analyses were more likely to contain interaction terms than the stratum models, possibly reflecting heterogeneity within the samples, and two of the models (Bury and Salford) were a poor fit to the data. Furthermore, the best fitting model for the un-stratified Greater Manchester area contained five interaction terms and was still not a good fit to the data. The simulation method enables confidence intervals to be obtained for the prevalence of problem drug use in Greater Manchester derived from the sum of stratified prevalence estimates.

DISCUSSION

This study suggests that there were 19 255 problem drug users (PDUs) in Greater Manchester during 2000/01 giving a prevalence rate of 13.7 (95%CI 13.4 to 15.7) per 1000 population in the 16–54 age range. The greatest number of problem drug users was observed in the City of Manchester (6037 PDUs), a prevalence rate of 23.9 (95%CI 21.3 to 28.4) per 1000 population aged 15–54, this area accounted for almost a third (31%) of the county's PDUs but less than a fifth (18%) of the Greater Manchester population aged 16–54.

Although there was clearly a concentration of drug problems in the City of Manchester, most (69%) of the county's PDUs lived in the surrounding areas. Within Greater Manchester male PDUs outnumbered females by a factor of 3.5:1 and prevalence was highest in the 25–34 age group. The stratified analysis showed variations in the age and gender distribution of PDUs across the 10 areas.

The rates observed here are slightly lower, but within the range, of those observed for other, predominantly urban, European areas, however other studies have used different age groups, time periods, and case definitions so direct comparison is hindered. Within the age group 15–55, the prevalence of PDUs in Dundee was estimated at 29 per 1000 population between 1990 and 1994¹⁵ and at 20 per 1000 in Aberdeen in 1997 for the age group 15–54.¹⁶ In London, Hickman¹² showed levels of problem drug use of over 30 per 1000 population aged 15–49 between 1992 and 1995. Brugha¹⁷ estimated a prevalence of two opioid users per 1000 population in Cheshire within the age group 15–55 in 1993 while Comiskey³³ estimated that there were 21 opioid users per 1000 population aged 15–54 in Dublin in 1996.

Table 4 Comparison of likelihood and bootstrap estimate and confidence intervals

Local authority	Number of interactions	Deviance	p Value	AIC	Model estimate	Model total	Likelihood 95% CI	Sum of sub-strata estimates	Centile 95% CI
Bolton	3	9.13	0.243	–4.87	1358	2475	2176 to 2850	2434	2161 to 2900
Bury	2	18.42	0.018	2.42	592	1014	995 to 1453	906	772 to 1201
Manchester	3	6.00	0.540	–8.00	3637	5933	5250 to 6771	6037	5377 to 7166
Oldham	3	9.29	0.233	–4.71	1045	1714	1436 to 2090	1668	1316 to 2433
Rochdale	3	10.39	0.168	–3.61	1223	1888	1557 to 2343	1522	1380 to 2418
Salford	1	40.37	<0.001	22.37	982	1464	1177 to 1871	1529	1241 to 2241
Stockport	2	5.8	0.670	–10.20	1544	2032	1483 to 2938	1318	1064 to 1929
Tameside	1	14.92	0.093	–3.08	560	1106	966 to 1282	1130	984 to 1517
Trafford	1	10.35	0.323	–7.65	661	1106	892 to 1415	1078	860 to 1634
Wigan	3	11.83	0.159	–4.17	832	1676	1466 to 1944	1633	1436 to 2007
Summed total	–	–	–	–	12461	20108	19689 to 22386	19255	18731 to 21853
Greater Manchester	5	34.25	<0.001	24.25	13491	21850	19549 to 24628		

Key points

- Within a large urban conurbation, different patterns of drug use in terms of age group and gender patterns exist between areas, indicating different stages of growth in the prevalence of drug problems.
- Simulation can be used to provide reliable confidence intervals for the sum of stratified prevalence estimates.
- Stratified prevalence estimates can provide policy makers with essential information for future planning of service provision.

Benyon¹¹ showed rates of 34 per 1000 in Liverpool Health Authority, 37 per 1000 in Manchester Health Authority, and 18 per 1000 in Bolton Local Authority in 1997 for 15–44 the age group.

The 1997 prevalence rate estimated for Manchester Health Authority (co-terminus with the local authority in 1997) is higher than that observed here, however it is based on an estimate and population figures for the 15–44 year age range, rather than 16–54. Because the number of PDUs aged 15 or 45–54 is likely to be very small, a crude adjustment for the purposes of comparison is unlikely to introduce major error. Scaling the 1997 estimate for the 16–54 local authority population, gives a rate of 31.0 (95% CI 26.2 to 37.1) per 1000. Applying the same adjustment to the 1997 estimate for Bolton local authority gives an adjusted prevalence rate of 13.8 (95% CI 12.1 to 15.7) per 1000 population aged 16–54. Combining the results from the two studies might suggest that the prevalence of problem drug use has declined in the City of Manchester and increased in Bolton.

In this analysis we have stratified our estimates by age and gender. This approach has many advantages, it enables more detailed comparison of prevalence patterns across areas and can help indicate how patterns of drug use may be changing over time. Within Greater Manchester, our analysis indicates, that the “epidemic” was initially concentrated in the geographical centre of the region, the City of Manchester. Over time, the number of young (new) users has declined in this area the epidemic has diffused out to more outlying areas, in particular to Bolton, where there are mainly young (new) users. Age and gender stratification is also useful for policy makers who may be able to target resources more effectively at certain sub-groups within local government areas. Furthermore, stratifying the analysis may improve the validity of total area estimates by reducing heterogeneity within the samples. Stratification also identified different interactions within area, age, and gender strata. This may reflect different patterns of service provision between areas, particularly with respect to joint working between health and criminal justice as well as differences in which interventions access their target (age and gender) population.

Simulation methods were used to provide reliable confidence intervals for the sum of the stratified estimates for each area. This procedure was implemented using Minitab and the 95% limits obtained from the log-normal distribution provided a close approximation to the likelihood based confidence intervals for each stratum. As far as we are aware this is the first application of these methods within capture-recapture analysis of problem drug use and, as shown here, this method can provide researchers with a relatively simple method of combining stratified estimates to generate total area estimates with valid and reliable confidence limits. However, a refinement to the simulation method may be obtained through the use of the multinomial distribution, as

applied in this study to derive the likelihood interval CIs and as used by Cormack.³²

As in other studies a potential limitation of this study is the issue of case definition. Within the police sample we identified people arrested for possession of opioids, crack, cocaine, or benzodiazepines but had no information as to whether these people were actual problem drug users, however we attempted as far as possible to limit the sample to users by including possession offences only. During data extraction it was apparent that most of these people were arrested for possession of relatively small amounts of illegal drugs that are likely to indicate personal use. Within the probation data source, severity of problem levels of drug were categorised as “none”, “mild”, “moderate”, and “severe” and the relatedness of drug use to offending was categorised in a similar way but the exact drugs used were not recorded. To identify “problem” drug users we selected those people whose drug problem was recorded as, “moderate” or “severe”. Hence case definitions are as similar as was possible but would be improved if all data sources used in the analysis recorded individual drug use.

This research has established prevalence estimates for problem drug use, based on capture-recapture methods applied at the local strategic level, for the 10 local authorities within Greater Manchester and showed how simulated confidence intervals can be used in a summed stratified analysis. The findings presented here show that areas in close geographical proximity display different patterns of drug use in terms of age group and gender patterns, indicating different stages of growth in the prevalence of drug problems. This has important implications, both for future planning of service provision and for the way in which the impact of drug misuse interventions are evaluated.³⁴ Although direct capture-recapture prevalence estimates are available for relatively few areas in England and Wales, datasets suitable for this purpose are likely to exist in most areas. Further studies of this nature would provide policy makers with essential information and enable further exploration of the methodological developments described in this paper.

ACKNOWLEDGEMENTS

This research could not have been undertaken without the help of the following individuals and organisations, who provided access to data: Claire Brown-Allan (Greater Manchester Police), Libby Brundrett (Greater Manchester Police), Sandra McFarlane (Greater Manchester Probation Service), Andrew Jones, Helen Morey, and Petra Meier (Drug Misuse Research Unit).

Authors' affiliations

I Gemmell, T Millar, National Drug Evidence Centre, University of Manchester, MHSS NHS Trust, Manchester, UK
G Hay, Centre for Drug Misuse Research, University of Glasgow, Glasgow, UK

Funding: this study was funded by the Home Office Drugs and Alcohol Research Unit.

Conflicts of interest: none declared.

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APHORISM OF THE MONTH

"You have to remember that they are coming here to get away from us." (Lowell Levin)

Migration of population has always been a public health issue. Historically, in Europe, it was a phenomenon of the Irish, of the Scandinavians, and of other groups who moved around to escape epidemics, or in search of a better life. Push and pull factors have operated for 200 years between the rural and urban areas, accelerated by technological change, war, and colonial enterprise. Today, the movement that begins in the villages of the southern hemisphere and ends in the cities in the North has become a global challenge to world development. Refugees and asylum seekers are at the top of the public health agenda, but as Levin says, they're coming here to get away from us—to get away from our failures to support sustainable development in the third world. Unless we do much better, we are faced with fortress continents in the decades ahead.

JRA