Public Health Scotland

Prevalence of Problem Drug Use in Scotland: 2015/16 Estimates

A review of definitions and statistical methods

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An Official Statistics publication for Scotland (Experimental)

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Introduction

The principal results of the 2015/16 Prevalence of Problem Drug Use Study were published on the Public Health Scotland (PHS) website as Official Statistics on Tuesday 5 March 2019. In line with previous studies Problem Drug Use (PDU) was defined as the problematic use of opioids (including illicit and prescribed methadone use) and/or the illicit use of benzodiazepines, and implies routine and prolonged use as opposed to recreational and occasional drug use. The final report can be found here:

https://www.isdscotland.org/Health-Topics/Drugs-and-Alcohol-Misuse/Publications/

Although the study has been replicated a number of times in Scotland since 2000, no previous attempt has been made to systematically estimate the national prevalence of Problem Drug Use in a way that captures the extended problematic use of other substances such as cocaine (including crack cocaine), amphetamines (including amphetamine-type substances) and cannabis (including synthetic cannabinoids).

In their 2019 report[1], the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) noted that “Europe has witnessed some dramatic changes in the challenges the drugs area presents, including the appearance of more non-controlled substances. We have also seen significant changes in the drug market and drug use”.

Notably there has not been a comparable definition or methodological approach adopted across the other regions of the United Kingdom.

As part of the commission of the Study, the Scottish Government asked Public Health Scotland to consider, in addition to the current definition of PDU, the feasibility of estimating prevalence for a wider definition of drug types. This report describes the outcome of this work and also makes recommendations for future studies of the prevalence of Problem Drug Use based on the experience of this work.

Main Points

- Much of the problem drug using population is hidden, therefore drug prevalence figures can only ever be estimates, combining available data on observed cases with an estimate of the unknown population.
- It is possible to generate estimates of prevalence for different definitions of Problem Drug Use using statistical techniques if sufficient source data on known cases can be accessed.
- Drug Prevalence estimates must be interpreted with caution as there is much debate on the appropriate application of these methods amongst experts.
- Three definitions have been considered.
    - Definition 1: Opioids (including illicit and prescribed methadone use) and/or the illicit use of benzodiazepines.
    - Definition 2: As definition 1, plus illicit use of cocaine and amphetamines / amphetamine type substances.
    - Definition 3: As definition 2, plus illicit use of cannabis / synthetic cannabinoids.
- Estimated prevalence of problem drug users in 2015/16 increased from 1.62% under definition 1, to 1.91% under definition 2, and 2.51% under definition 3.
- The percentage of problem drug users that are male was 71% under definition 1. This compares to 74% under definition2, and 77% under definition 3.
- The percentage of problem drug users that are in the oldest age category (35-64) was 64% under definition1. This compares to 58% under definition 2, 52% under definition 3.
- The robustness of the estimates may decrease with the inclusion of previously excluded drug categories as defined previously for Scotland.
- It is likely that the patterns of problem drug use in the population are changing as the demographic changes, and future studies will need to take account of this.
- Ideally future studies should be based on routine, centrally held data and improvements to these will benefit these studies.
- Potential future data sources should aim to capture representative samples of the target population, and avoid being heavily correlated.
- Before undertaking a future approach additional external evidence and contextual data on the target population that could provide alternative estimates must be explored.
- It is recommended that future studies are not only restricted to replicating the current methodology and data sources.

Methods

Definition of Problem Drug Use

The estimates reported here have been calculated separately for each Council Area using the same three data sources described in the 2015/16 main report. These were:

- Clients registering with specialist drug treatment services
- Drug-related hospital admissions
- Criminal Justice Social Work (CJSW) reports

In order to help Scottish Government (SG) and other stakeholders better understand the potential scale of wider Problem Drug Use distributions across Scotland, provision was made at the outset of the project to collect data for a wider range of drug-types whilst maintaining capabilities to replicate the previous methods as closely as possible.

Prior to the data collection phase of the study, Public Health Scotland consulted with the Advisory Group set up for the study and the Harms subgroup of the Partnership for Action on Drugs in Scotland (PADS) for advice. Based on this and in discussion with the SG, two new definitions were agreed to be explored in addition to the existing definition of PDU.

Where reference is made to Definition 1 in this report, this relates to the current published definition and selection criteria which includes Opioids and Benzodiazepines only.

Collecting additional data on cocaine (including crack cocaine), amphetamines (including amphetamine-type substances) and cannabis (including synthetic cannabinoids), created new opportunities to expand the breadth of composite PDU definitions. Two further PDU definitions were therefore selected for analysis. The constituents of each definition are described below:

Drug Category	Definition 1	Definition 2	Definition 3
Opioids	✓	✓	✓
Benzodiazepines	✓	✓	✓
Cocaine (including crack cocaine)		✓	✓
Amphetamines and amphetamine-type substances (ATS)		✓	✓
Cannabis/Synthetic Cannabinoids			✓

A full description of the inclusion criteria (substances or diagnostic codes) adopted for case selection within each drug category is provided in Appendix 1.

Statistical Methods

The statistical methods used to estimate the prevalence based on the wider definitions were the same as for the original report, namely capture-recapture using log-linear modelling. This allowed direct comparison of the effect of the changing definitions of problem drug use on estimates.

A fundamental aspect of this statistical technique is the ultimate selection of a single best-fitting model (or composite set of best-fitting stratified models) for each council area. The original report describes the selection fully in terms of ten hierarchical steps. This iterative process begins with an initial construct of 63 statistical models, made up of 7 model configurations and 9 strata, produced separately for each council area. This process was replicated for the two new definitions. Deviation from the criteria used to select the best-fitting model in the original report was necessary on occasion to derive valid estimates from log-linear models. These are described in more detail in Appendix 2.

Many of the council area estimates were formed without the need to stratify the models. As a result, further breakdowns of the estimates by age and sex could not be directly computed. In order to provide estimates according to age and sex, fully stratified models were created at an aggregate regional level. Age/Sex-specific weightings were extracted from each of the three stratified sets of regional models, and these were used to distribute the previously calculated council area estimates according to age and sex. This method is described fully in the main report.

Having a measure of uncertainty in each of the modelled estimates is vital and is reflected through the use of 95% confidence intervals. The method used to construct confidence intervals in this and previous iterations of drug prevalence studies for Scotland, is known as a bootstrap method.

Bootstrapping is the practice of estimating prevalence by repeatedly re-sampling the same data and computing the estimate of the unknown population for each sample. Cases are selected randomly, with replacement, from the original sample to create each new sample. Typically, each new sample has the same cases as the original sample, but some cases may be selected multiple times and others not at all. After a suitably large number of bootstrap samples are made, the empirical distribution of the estimate is observed and the interval between two percentiles is taken as the confidence interval.

This method is described fully in the main report.

Results and Commentary

This section presents both observed populations, based on actual number of individuals with problem drug use ascertained across the data sources, and the estimated populations, which in addition include predicted numbers of problem drug users not captured on any of the data sources.

Population rates are based on 2015 published population estimates for Scotland.

Observed Number of Individuals with Problem Drug Use

Table 1 - Known Population Gender Distributions for Scotland Overall

	Female	(%)	Male	(%)	Total
Definition 1	10,520	31.5%	22,891	68.5%	33,411
Definition 2	10,937	30.6%	24,863	69.4%	35,800
Definition 3	11,703	29.1%	28,539	70.9%	40,242

Table 2 - Known Population Demographic Age Distributions for Scotland Overall

	15 - 24	(%)	25 - 34	(%)	35 - 64	(%)	Total
Definition 1	1,827	5.5%	9,278	27.8%	22,306	66.8%	33,411
Definition 2	2,703	7.6%	10,066	28.1%	23,031	64.3%	35,800
Definition 3	4,369	10.9%	11,398	28.3%	24,475	60.8%	40,242

Table 3 - Known Population Data Source Distributions for Scotland Overall*

	Services	(%)	SMR	(%)	CJSW	(%)	Total
Definition 1	30,046	89.9%	4,052	12.1%	4,164	12.5%	33,411
Definition 2	31,134	87.0%	4,891	13.7%	4,864	13.6%	35,800
Definition 3	33,217	82.5%	5,678	14.1%	6,869	17.1%	40,242

* Note data sources do not sum to total due to individuals appearing on more than one source.

Table 1 shows that the number of individuals with problem drug use as identified across the data sources increased from 33,411 under definition 1 to 35,800 under definition 2. This represents an increase of 2,389 or 7% by including cocaine/crack and amphetamines/ATS. There was a further increase of 4,424 or 12% under Definition 3 which also included Cannabis.

Table 1 also shows that 68.5% of the known population according to definition 1 were male. The impact of adding cocaine (including crack cocaine) and amphetamines (including

amphetamine-type substances) into definition 2 resulted in a slight increase in the proportion that were male (69.4%), and this increased further when cannabis (including synthetic cannabinoids) were included in definition 3 (70.9%).

Table 2 shows that 5.5% of the known population according to definition 1 were in the youngest age category (15-24). This increased to 7.6% when cocaine (including crack cocaine) and amphetamines (including amphetamine-type substances) were incorporated into definition 2, and rose further with the inclusion of cannabis (including synthetic cannabinoids) in definition 3 (10.9%).

Table 3 shows that under definition 1, the vast majority of individual problem drug users appeared, and only appeared, in the treatment services data. Very few appeared in the hospital admission data (12%) and criminal justice data (12%). However, the additional problem drug users identified under definition 2 were more likely to appear in both the hospital admission data (35%) and criminal justice data (29%). The further problem drug users of cannabis identified under definition 3 were more likely to appear in the criminal justice data (45%) rather than the hospital admission data (17%).

Estimated Number of Individuals with Problem Drug Use

Table 4: Estimated prevalence (numbers and rates) of problem drug use for Scotland

	Number			Rates (%)		
		95% Conf Interval			95% Conf Interval	
		Low	High		Low	High
Definition 1	57,272	55,788	58,857	1.62%	1.58%	1.66%
Definition 2	67,522	65,833	69,600	1.91%	1.86%	1.97%
Definition 3	89,000	85,726	94,029	2.51%	2.42%	2.66%

Following statistical modelling at council area level, Table 4 presents prevalence estimates for each definition in terms of the number of cases and associated rate (%) per head of population for Scotland as a whole. Estimated prevalence of problem drug users increased markedly from 1.62% under definition 1, to 1.91% under definition 2, and 2.51% under definition 3.

Figure 1: Estimated prevalence rates (%) of problem drug use for Scotland

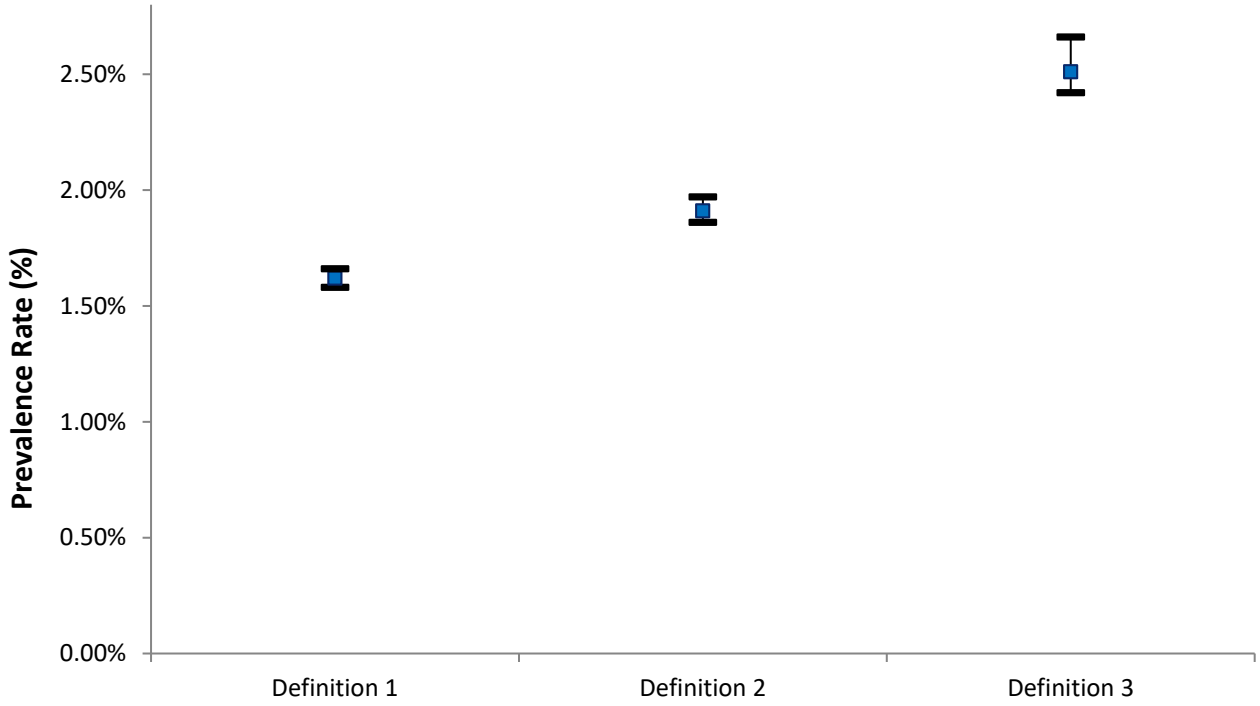

Figure 1 shows the estimated prevalence rates per head of population with associated confidence intervals for each of the definitions. Confidence intervals quantify the extent of uncertainty that exists around the point estimate.

Table 5: Estimated prevalence of problem drug use by age and gender for Scotland

	Definition 1			Definition 2			Definition 3		
	15-24	25-34	35-64	15-24	25-34	35-64	15-24	25-34	35-64
Males	4,800	9,700	26,200	9,600	11,700	28,500	13,700	20,500	34,600
Females	1,100	5,200	10,300	1,400	5,500	10,700	2,400	6,000	11,800
Total	5,900	14,900	36,500	11,000	17,200	39,200	16,100	26,500	46,400

Figure 2: Gender (%) distribution of the estimated prevalence of problem drug use for Scotland

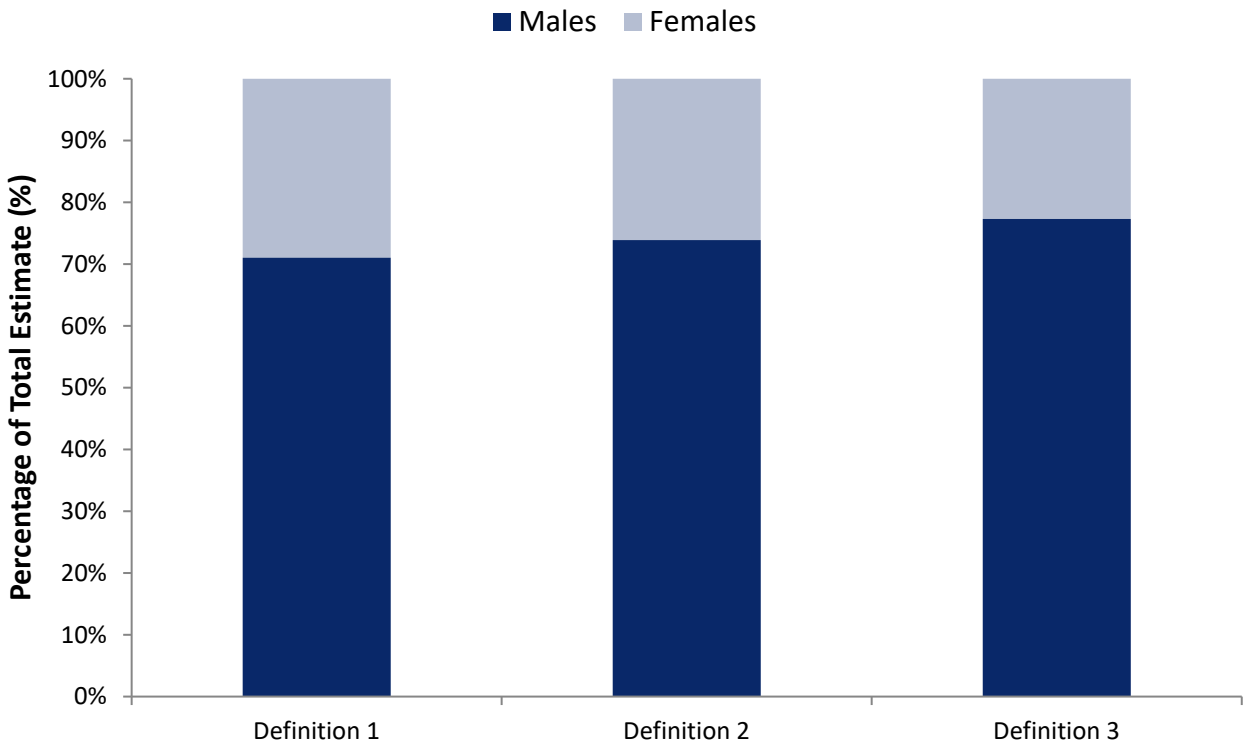

Figure 2 shows that after the introduction of specific new drug categories, the resulting models simulate a more male dominated profile of problem drug use in Scotland. The percentage of problem drug users that are male was 71% when PDU was defined in terms of the problematic use of opioids and benzodiazepines only. However, this increased to 74% with the addition of cocaine (including crack cocaine) and amphetamines (including amphetamine-type substances), and to 77% when cannabis (including synthetic cannabinoids) was ultimately included in definition 3. Table 5 shows that the percentage of problem drug users in the youngest age category that are male was 81% for definition 1 and increased to 87% for definition 2 and 85% for definition 3.

Figure 3: Age (%) distribution of the estimated prevalence of problem drug use for Scotland

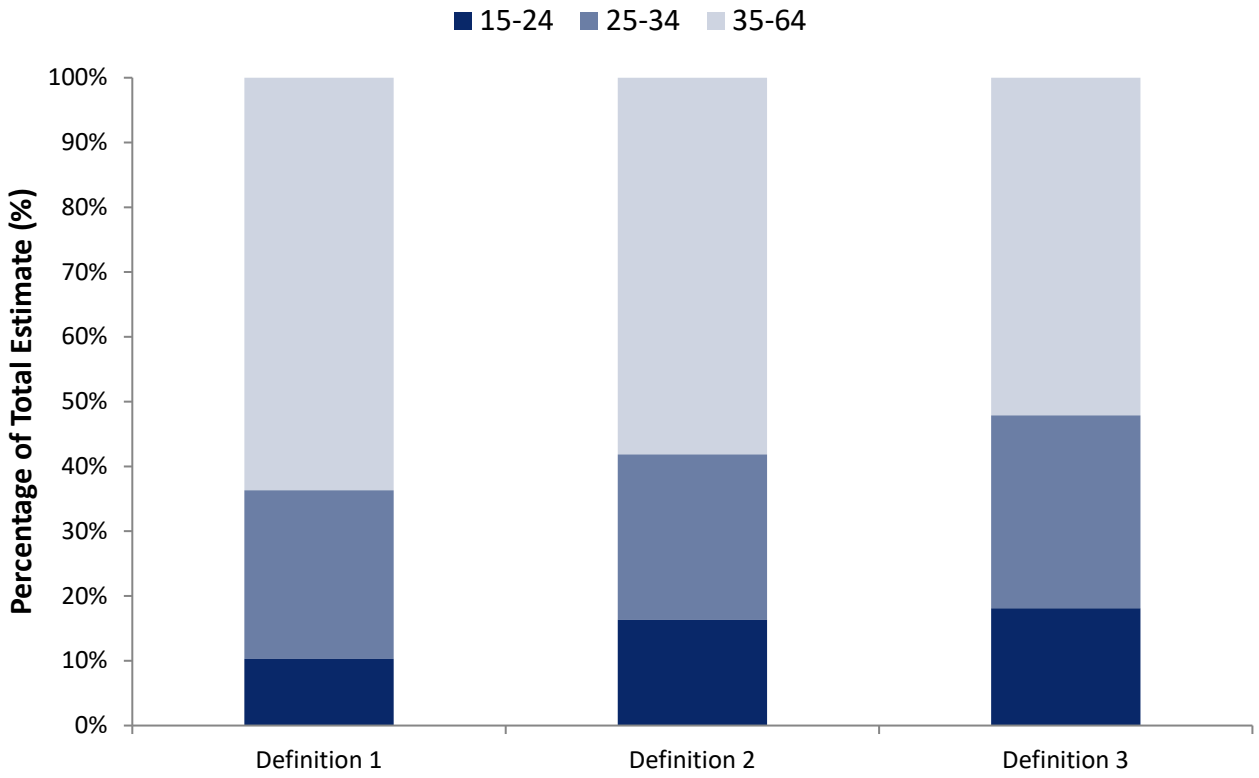

Table 5 and Figure 3 show the effect of age after the introduction of the new drug categories, and how the chosen models in these circumstances simulate the emergence of a younger profile of problem drug use in Scotland. The percentage of problem drug users that are in the oldest age category (35-64) was 64% when PDU was defined in terms of the problematic use of opioids and benzodiazepines only. However, this decreased to 58% with the addition of cocaine (including crack cocaine) and amphetamines (including amphetamine-type substances), and to 52% when cannabis (including synthetic cannabinoids) was ultimately included in definition 3.

Figure 4: Known and Estimated Populations as % of the Scottish Population (aged 15-64)

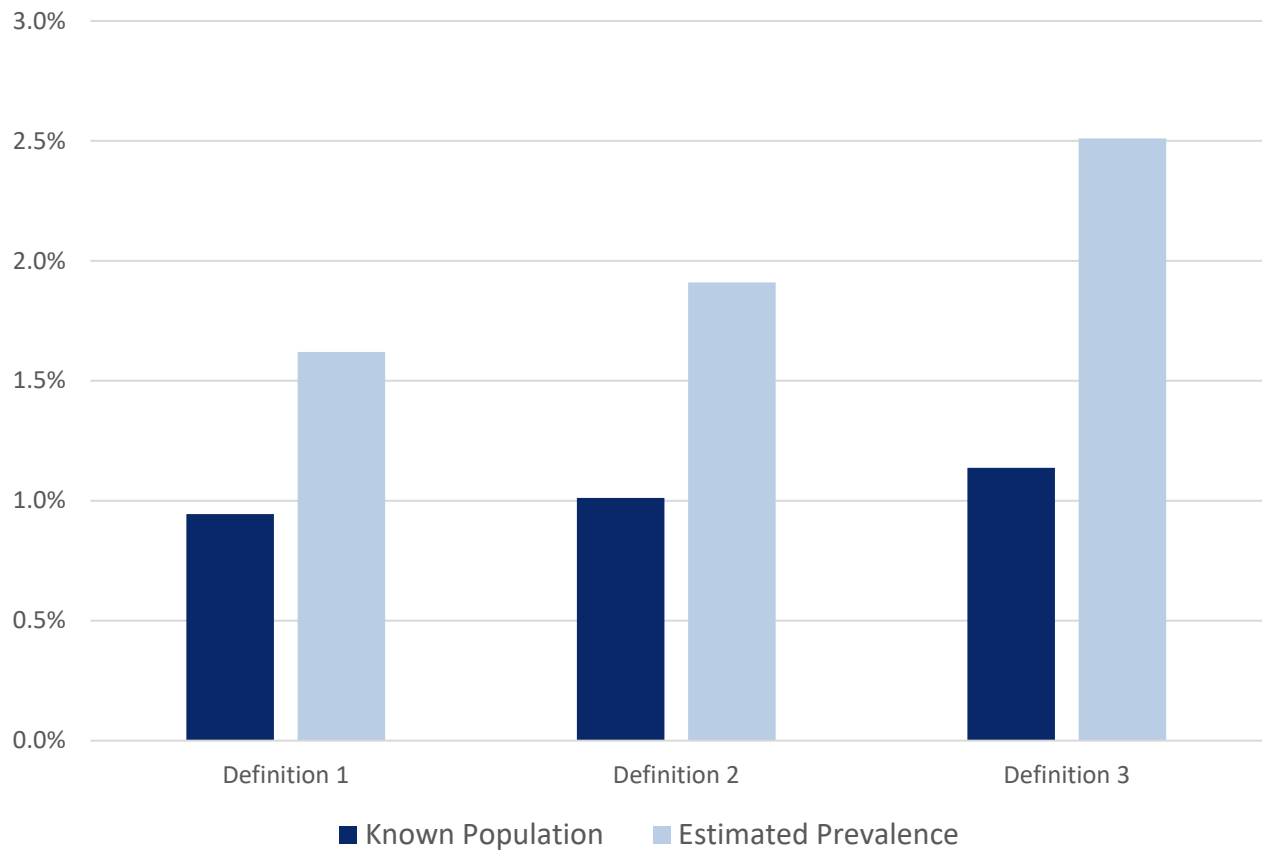

Figure 4 presents estimated prevalence rates compared against the known population counts similarly expressed as rates per head of population. The chart demonstrates that the incremental increase in the known population level, as new substances are added to the definitions, results in a disproportionately larger increase in the levels of estimated prevalence. The inclusion of cocaine (including crack cocaine), and amphetamines (including amphetamine-type substances) resulted in an increase in the known population of 7% but an increase in the estimated population of 18%. The inclusion of cannabis (including synthetic cannabinoids) into definition 3 resulted in a further increase in the known population of 12% but a further increase in the estimated population of 32%.

Discussion

This extended work has shown that it is possible to generate estimates of prevalence for wider definitions of Problem Drug Use using log-linear capture/recapture techniques. However, the results suggest that the robustness of the estimates may decrease with the inclusion of previously excluded drug categories.

Ultimately the estimates are a function of the extent of overlaps observed for each individual across data sources, and the pattern of overlaps changes markedly with the introduction of the new categories. The methods adopted in Scotland require us to accept that certain underlying modelling assumptions hold. This includes the assumption that the models used to estimate are based on a single homogeneous population with the relationships between individuals appearing in different data sources adequately captured by the interactions. This will not be met if there is 'heterogeneity' within the population, leading to specific groups of individuals having different probabilities of appearing in a particular source.

As we have added cocaine (including crack cocaine) and amphetamines (including amphetamine-type substances) to Definition 1 in order to form Definition 2 and further added cannabis (including synthetic cannabinoids) to form Definition 3, we can see in the known populations a probable exacerbation of bias against this assumption, and this is likely having a significant influence on the observed need to relax model acceptance criteria.

In the published results for Definition 1 we encountered that younger male problem drug users are more likely to appear in criminal justice social work reports than through drug treatment or hospital admission records. So an element of bias would already exist. The results show that this pattern continues with the expansion to definitions 2 and 3, where younger males are disproportionately appearing in criminal justice social work reports.

Optimal compliance against the above assumptions is entirely subject to the quality and completeness of the source data. The robustness of estimates is subject to the inherent representativeness of the sources, but this is complicated by potential inconsistencies in the data gathered across each of Scotland's 32 council areas. The ascertainment of cases for the new drug categories, from drug treatment services, highlighted some further potential bias in the data. In order to focus on problematic users, criteria had been set such that these observations should be recorded on the basis of main drug. The inclusion of cocaine and cannabis in the returns provided by local services showed larger regional variations than existed when Opioids and Benzodiazepines were considered in isolation.

The project advisory group, which is made up of long-standing leading experts in this field cautioned at the outset that the methods would not hold up well against certain underlying assumptions, and this appears to come through in the data collected.

The uncertainty in the estimates is reflected through confidence intervals however these are specific to the final chosen models and assume all statistical assumptions for these models hold. There can be a tendency for users to focus on the point estimate and assume this as an absolute comparator, rather than consider the error-bounds and look for overlaps. We present further discussion in this regard by considering some individual council area estimates in Appendix 2.

Methodological Considerations for Future Studies

Other UK Countries

The latest available prevalence estimates for Wales cover the period 2015-16, and were published by Public Health Wales[2] in November 2018. Their definition includes “injecting drug use or long-duration/regular use of opioids, cocaine and/or amphetamines (including amphetamine type substances)”.

The authors of this report were also members of the Advisory Group to the Scottish study. The estimates for Wales are not stratified by age and sex. Their source datasets include records of police arrests, engagement with drug intervention programmes managed by probation services, assessments by substance misuse treatment, hospital admissions and accessing statutory, voluntary and pharmacy needle and syringe programmes (NSPs). Previous estimates for Wales used only three data sets (police arrests, probation assessment and treatment referrals) and as such the report cautions that they are not comparable with latest estimates as a result. Prevalence statistics for Wales are now derived from applying Bayesian techniques to the data, although they do describe the approach preferred in Scotland as the “traditional statistical method” “still used by many researchers”. Updated figures for 2016-17 and 2017-18 are not currently available but work is ongoing within Public Health Wales to progress this. This is due to concerns around the variability in the known datasets and how this reconciles against the modelling techniques.

Prevalence statistics for England are produced on behalf of Public Health England by Liverpool John Moores University. The latest available estimates for England cover the period 2016-17, and were published[3] in March 2019. Their definition includes the use of opiates and/or the use of crack cocaine. They emphasise that the case definition focuses on the ‘use’ of opiates and/or crack cocaine rather than the ‘misuse’ of these drugs or addiction to either drug. Furthermore, the case definition does not include the use of cocaine in a powder form or the use of any other substances such as amphetamines, ecstasy or cannabis.

The lead author of the report was also a member of the Advisory Group to the Scottish study. Unlike Scotland and Wales, England also provides separate estimates for their constituent drug categories, such as the prevalence of opiate use, and the prevalence of crack cocaine use. Like Scotland, their estimates are stratified by the same three age categories. Four sources of data underpin the estimates, these are routinely available and include, drug treatment, probation, police and prison data. The methods used to estimate the size of the 'hidden' opiate and/or crack cocaine using population are similar to those used in the current study. Indeed, the methodology used in Scotland was originally set up by the English team and has not changed in recent studies. The current English method however supplements the capture-recapture log-linear modelling approach with the multiple indicator method for areas where a valid estimate could not be derived.

Data Sources

The majority of problem drug users are hidden. In order to estimate the hidden population good quality representative data on known problem drug users has to be sourced for all Council Areas in Scotland. In previous studies four sources (Drug Treatment, Hospital Admissions, Criminal Justice Social Work and Police) provided the most readily accessible data.

However much of this data is not routinely collected nationally, and a significant aspect of the work has been the coordination and management of new collections. Only hospital admission data are accessible from a national data repository. In England and Wales, representative data sources are more readily available to the lead researchers. The latest study for Scotland focussed at the outset on securing new data through Alcohol and Drug Partnerships (for those receiving specialist drug treatment), Social Work Services (for those subject to Criminal Justice Social Work Reports), and the Police (for those arrested or detained in relation to the Misuse of Drugs Act).

The most significant and unexpected challenge, was in accepting that data from Police Scotland could not be secured for this study. Despite their best efforts, complete data for all regions could not be gathered in a way that would be compliant with the requirements for the study. This was due to changes in the data system architecture introduced after the launch of Police Scotland and the last Drug Prevalence study for 2012/13. These system changes are designed to serve the specific nature of a new drug reporting framework for the Police, and could not be reconciled with the very specific prevalence data requirements.

In working towards a decision on whether to proceed without data from Police Scotland, analysis demonstrated that the scale of point estimates remained, for the majority of areas, reasonably stable compared to the corresponding previous estimates for 2012/13. Clearly there were some significant variations in particular areas, but overall the Scottish estimate was similar to the level previously obtained. We speculated that the high overlaps inherent between criminal justice social work and police arrests data could provide some degree of offset, and their high interdependency might actually call into question the logic of including both as independent sources.

Also the fact that we were proving successful in securing good quality new data directly from alcohol and drug partnerships and from criminal justice social work departments, satisfied us to proceed without Police Scotland data. Police Scotland advise that in future there are systems that could potentially be ‘mined’ for information of the nature required, but in the absence of a technological solution to extract the data, this would need to be done manually at significant cost.

Although the other data collections were providing fruitful returns, the process proved to be extremely time consuming and placed a significant burden on each local authority to find resource to administer the process across both of their ADP and CJSW arms. For the first time, the Scottish study had gone through and received approval from the Public Benefit and Privacy Panel for Health and Social Care. The application and approval process took six months and made further requirements on how the data should be collected and protected. Detailed data sharing agreements had to be negotiated with each individual area under new

legislative conditions introduced by the General Data Protection Regulations (GDPR) which came into force coincidentally during the negotiations (in May 2018), and had to be reconciled for compliance against existing study protocols.

The timeline from initial contact with service leads through to the conclusion of final data was 18 months. This was against an initial provision that was made for data to be collected in half that time. Despite the delays the study secured a comprehensive dataset for those in treatment that was validated by the service. The ability to link and augment direct drug treatment submissions with data already routinely collected through the Scottish Drug Misuse Database proved particularly useful and brought about an apparent sizeable increase in known cases compared to levels that had been achieved in previous studies.

If the need to estimate overall prevalence remains, a review of existing routine data may provide a more efficient future means of securing baseline data for estimation purposes. This would have to be carried out in conjunction with a review of methods (see section on Statistical Methods).

Public Health Scotland recommend a review of the potential utility of the following datasets be carried out in advance of future prevalence work:

- SDMD / DAISY
- Probation and prison service data
- Needle exchange data (NEO)
- Prescribing data (for ORT)
- GP data (SPIRE)

During work on the study, the Scottish Public Health Drug Linkage Programme has been under development in Public Health Scotland. This may go some way to address issues of access to linked drug-related data sources for prevalence purposes. This data linkage project includes drug treatment, prescribing and hospital admission records, so a large proportion of the population will be included.

This resource, in itself, will not circumvent the need to formulate an estimation technique, but could provide a platform for ready-access to linked data without the need to engage partners in bespoke single-use data collections. We envisage that it will be useful for looking at outcomes e.g. hospitalisation rates, death rates, and opens up opportunities for new and alternative methods to be brought online, e.g. synthesis or multiplication methods. Other benefits of having an established linked platform, will be the opportunity to refresh the estimates more regularly than the existing three-yearly cycle.

Statistical Methods

The current study aimed to keep the statistical methodology the same as in previous studies to allow for comparisons of trends in estimated prevalence and to investigate the effect on estimates of adding additional data for a wider set of problem drug types.

It is clear from literature there is no single universally accepted method to estimate a hidden population of problem drug users from available data sources and a number of approaches have been, and continue to be, proposed. Estimating a hidden population using data on individuals recorded in routine data sources is implicitly going to result in a degree of uncertainty, particularly when the hidden population can be at least as large as the recorded population as predicted here. Therefore, any statistical estimate requires assumptions to be made and the degree to which these assumptions hold can be difficult to validate. This in turn affects the range of uncertainty to be applied around a particular estimate.

There are a number of approaches that have been proposed over the years by bodies such as the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) and capture-recapture methods such as used in this study, also referred to as mark-recapture methods, are commonly used. Hay and Richardson (2016)[4] give a good summary of the development of these methods in this area, such as Bayesian analysis, and also address some of the criticisms of the approach. They do however recognise that "there is a general feeling that the quality of the data that are available in these applications is not adequate to support more than basic analyses".

Using capture-recapture there are options available and assumptions that can be made to produce a final, chosen estimate of the hidden population, including:

- which and how many data sources to use;
- choice of model parameters and interactions;
- whether to stratify or include covariates to account for population heterogeneity;
- Bayesian or maximum likelihood methods of model fitting;
- choice of prior distributions for Bayesian methods;
- choice of model selection criteria for maximum likelihood.

It was evident in this study the considerable range of estimates of the hidden population that are possible within a single local authority area, depending on these choices and their dependence on some pre-determined statistical criteria for selection of a 'final' estimate. Even confidence intervals that have been provided in this study are unlikely to capture the full range of uncertainty in estimates since they are conditional on the final selected model always being the true representation of reality.

Experts in these methods, including members of the Advisory Group, guard against the 'naive' and routine application of capture-recapture methods and stress the importance of the quality of the underlying data and an understanding of the pathways individual users may experience that are reflected across the data sources. Jones *et al* (2015)[5] in particular highlight that referrals between the data sources will impact on assumptions used in the

models and propose streamlining the data used in modelling by identifying and including only new incident cases appearing in data sources during the period of interest.

Given the uncertainty in the range of possible estimates using any single method, researchers in this field have proposed using more than one method and source of evidence to triangulate estimates and increase certainty in the likely range of estimates[6]. For example, the multiplier method, using drug-related death rates, or the multivariate indicator method as used in English estimates, could provide alternative approaches to complement capture-recapture based estimates.

Bayesian methods are a more formal way to include prior information and other relevant external data to take account of uncertainty in the model-fitting process for capture-recapture methods[7,8]. Where valid external data or research results exist that could inform prevalence rates, these could be articulated in prior estimates which are fed into the statistical modelling and guide the choices of the resulting, posterior, estimates. This results in a weighted average across the various estimates derived from competing models which quantifies a number of sources of uncertainty but in itself does not guarantee a valid estimate.

Bayesian methods can also be used when relevant prior information reflecting different aspects of the hidden population is available from a number of sources of varying reliability such as routine data sources and published research, or even expert opinion. These can be brought together and modelled within a multiple parameter evidence synthesis framework model[9]. Evaluating the Population Impact of HCV DAA Treatment as Prevention for PWID (EPIToPe) is a current research programme into treatment for hepatitis C that will employ such methods to estimate the prevalence of injecting drug users. The Scottish Public Health Drug Linkage Programme proposal to link a range of health service data such as hospitalisations, prescriptions and deaths to data on individuals receiving drug treatment services in Scotland will provide a ready source of information on outcomes and service use for a large cohort of known problem drug users. This will be instrumental in developing these methods as a possible alternative to the current capture-recapture method.

When no relevant and reliable external data exist, however, Bayesian methods will not appreciably differ from maximum likelihood in that estimates will be driven by the study data. In the current study no prior external data was readily available a priori to inform estimation of PDU prevalence (other than previous estimates based on similar methodology). Previously however, prior information on drug related death rates from cohort studies has been used to inform estimates of injecting drug use specifically[10]. This research used, in addition to the three sources used in the current study, data on hepatitus C diagnoses likely due to injecting use. Therefore, future studies would benefit from systematically reviewing a priori evidence available to inform estimates of PDU for a given definition of drug types and its robustness.

Conclusions

The current study has been able to produce credible estimates for prevalence of PDU, based on the existing definition, despite the loss of police arrest data. However, this has been at considerable expense and longer than expected timescales to ensure good quality new data was available on individuals using drug treatment services and/or appearing on social work reports ahead of sentencing within the criminal justice system.

Data on a wider set of problem drugs, including cocaine, amphetamines and cannabis has also been collected for the first time. This data is highly beneficial in helping understand the emerging patterns of problem drug use in the population. However, population prevalence estimates for these additional drug types are less reliable using the same methods and data sources.

It is likely that the patterns of problem drug use in the population are changing as the demographic changes and this means greater heterogeneity within the population of drug users. Future studies of prevalence will need to take account of these changes when deciding on definitions of PDU, potential data sources, types of data collected and statistical methods used to estimate the hidden population. Since these four aspects are inter-dependent, this precludes there being a fixed methodology for estimating PDU going forward.

Future studies would benefit from an initial phase focussing on definitions of PDU and potential data sources available that capture these users. Potential data sources should aim to capture representative samples of the target population, and avoid being heavily correlated by covering different aspects of a problem drug use 'pathway', such as different treatment regimes, criminal justice system, outcomes and harms. Understanding the links and referral patterns between data sources will be of particular importance.

Ideally future studies would be based on routine, centrally held data and improvements to these will benefit these studies by reducing data collection costs. However, some new data collection might still be necessary to ensure full coverage of drug treatment services and to include data from criminal justice sources to complement health service data. The information governance requirements for any new data collection, and its effect on timelines, should be considered carefully given the experience of the current study following the implementation of GDPR in particular. Further work is recommended to explore the feasibility of more readily accessing data on potential drug users within Police Scotland records. This could take advantage of developing statistical methods for analysing text-based and unstructured data.

This initial phase could also review available external evidence and contextual data on the target population that could provide alternative estimates, e.g. using the multiplier method, or to form prior information to feed into a Bayesian approach such as an evidence synthesis model. This external evidence could be gleaned from reviews of published research, grey literature and other relevant analyses. The proposed Scottish Public Health Drug Linkage Programme would be a particular source of additional contextual data for a large proportion of the likely target population.

The outcome of this initial phase would inform the statistical methodology to be used and the format of data required to be collected from new sources. Therefore, it is recommended that future studies are not only restricted to replicating the current methodology and data sources.

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Glossary

Amphetamine	Amphetamines are central nervous system stimulants prescribed in the treatment of various conditions. Amphetamine-type stimulants (ATS) refer to a group of drugs whose principal members include amphetamine and methamphetamine. A range of other substances also fall into this group, such as methcathinone, fenetylline, ephedrine, pseudoephedrine, methylphenidate and MDMA or 'Ecstasy' – an amphetamine-type derivative with hallucinogenic properties.
Benzodiazepine	The most commonly prescribed minor tranquilisers, known as anxiolytics (for daytime anxiety relief) and hypnotics (to promote sleep). Includes diazepam (Valium), lorazepam, librium, nitrazepam, temazepam.
Cannabis	Cannabis is a generic term used to denote the several psychoactive preparations of the plant Cannabis sativa. The major psychoactive constituent in cannabis is Δ-9 tetrahydrocannabinol (THC). Compounds which are designed to act like THC are referred to as cannabinoids.
Capture-recapture	This form of analysis uses data sources which in some way identify individuals with problem drug use to identify the overlap between the data sources. Further analysis can then be used to estimate the hidden (unknown) population who appear in none of the data sources, which, combined with the known population, generates a prevalence estimate.
Cocaine	Also known as coke or crack, cocaine is a strong stimulant most frequently used as a recreational drug.
Confidence interval	Provides an estimated range of values within which the true value is likely to lie. The width of the confidence interval gives an indication of the reliability of the value (i.e. the smaller the range the more reliable the value).
Hidden population	The individuals with problem drug misuse who are not captured in any of the datasets used for the study.
Known population	The individuals identified with problem drug use in the datasets used for the study.

Opioid	A drug containing opium or its derivatives, used in medicine for inducing sleep and relieving pain. Includes heroin (diamorphine), morphine, methadone, opium, codeine, pethidine, dihydrocodeine (DF118).
Prevalence	In epidemiology, the prevalence of a health-related state (typically disease, but also other things like drug use) in a statistical population is defined as the total number of cases of the risk factor in the population at a given time. It is used as an estimate of how common a disease is within a population over a certain period of time. The prevalence rate is the number of individuals shown as a proportion of the overall population.
Problem drug use	The problematic use of opioids (including illicit and prescribed methadone use) and/or the illicit use of benzodiazepines and implies routine and prolonged use as opposed to recreational and occasional drug use.

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Further Information

Further Information can be found on the PHS website.

For more information on Drug Prevalence see the Prevalence of Problem Drug Use section of our website. For related topics, please see the Drugs Misuse pages.

Appendices

Appendix 1 – Drug Category Inclusion Criteria

Specialist Drug Treatment and Criminal Justice Social Work Reports

Drug Category	Inclusion Criteria
Opioid/Opioid Replacement Therapy (ORT)	Current users of **Heroin** or those on **Opioid Replacement Therapies (ORTs)** included within this category. The list of drugs that describe ORTs are as follows. Both **illicit and prescribed** use of ORTs should be considered problematic: Methadone Buprenorphine (Subutex) Buprenorphine & naloxone (Suboxone) Lofexidine (Britlofex) The following list of drugs also fall within the **Opioid** category and many of them are prescription drugs. **Illicit** use of these drugs should **always** be considered problematic. The prescribed use of these drugs is only to be considered problematic if they are being prescribed in the course of drug treatment (e.g. as a treatment for addiction). Dihydrocodeine Morphine Diamorphine Morphine sulphate Codeine Pethidine Tramadol Dipipanone Kratom Fentanyl Dextromoramide Hydromorphone Hydrocodone Oxycodone Oxymorphone Levorphanol Phenazocine Piritramide Meperidine (Demerol) W-15 W-18

	MT-45 O-desmethyltramadol AH-7921 (Doxylam)
Benzodiazepine use	Current problematic use of **Benzodiazepines** included within this category. The following list of drugs fall within the **Benzodiazepine** category and many of them are prescription drugs. **Illicit** use of these drugs should **always** be considered problematic. The prescribed use of these drugs is only to be considered problematic if they are being prescribed in the course of drug treatment (e.g. as a treatment for addiction). Diazepam (Valium) Temazepam Nitrazepam Chlordiazepoxide (Librium) Lorazepam (Ativan) Flurazepam Loprazolam Lormetazepam Alprazolam (Xanax, Xanax XR) Estazolam (Prosom) Clobazam (Onfi) Clonazepam (Klonopin) Clorazepate (Tranxene, Tranxene SD) Phenazepam Etizolam Pyrazolam Flubromazepam Flubromazelam Diclazepam Oxazepam Triazolam Quazepam Midazolam Flunitrazepam (Rohypnol) Slang terms: Blues, downers, roofies
Cocaine use	Current problematic use of **Cocaine or Crack Cocaine** should be included within this category. **Note**: The study aims to capture routine and prolonged use, therefore recorded only if cocaine or crack cocaine is the 'main' drug on specialist drug treatment records. The advice in relation to data sourced from CJSW records was to record if occasional or recreational use is implied in the report, but to err on side of recording if it was not clear.

Amphetamine/ Amphetamine-Type Substance use	Current problematic use of **Amphetamines or Amphetamine-Type Substances** should be included within this category. The following list of drugs fall within the Amphetamine/ Amphetamine-Type Substance category. The **illicit** use of these drugs should **always** be considered problematic. The prescribed use of these drugs is only to be considered problematic if they are being prescribed in the course of drug treatment (e.g. as a treatment for addiction). **Note**: The study aims to capture routine and prolonged use, therefore record only if the Amphetamine or Amphetamine-Type Substance is the 'main' drug. Amphetamine (Speed) Amphetamine Sulphate (Benzedrine, or 'Bennies') Methamphetamine (Methedrine) Crystal Methamphetamine (Crystal Meth) Dexamphetamine/ Dextroamphetamine (Dexedrine) Methylenedioxymethamphetamine (MDMA)/Ecstasy 3,4-Methylenedioxyamphetamine (MDA) Levoamphetamine/Levamfetamine/(R) amphetamine/L-amphetamine 3,4-methylenedioxy-*N*-methylcathinone (Methylone)/MDMC/βk-MDMA 3,4-methylenedioxy-*N*-ethylcathinone/MDEC/βk-MDEA/ethylone 4-methyl methcathinone (4-MMC)(Mephedrone,M-Cat /Meow Meow) Methcathinone/ephedrone (Cat) 4-Methylethcathinone (4-MEC) 3-Methylmethcathinone/3-MMC (3-Mephedrone) Mexedrone Amphetaminoethyltheophylline/Fenetylline/amfetlyline Methylphenidate (Ritalin) Ephedrine Ethylphenidate (Blue,Burst) *para*-Methoxy-*N*-methylamphetamine (PMMA) *para*-Methoxyamphetamine (PMA) Phenmetrazine 3-Flourophenmetrazine (3-FPM) Benzylpiperazine (BZP) 3,4-methylenedioxy-N-ethyl-amphetamine (MDEA) 5,6-methylenedioxy-2-aminoindane (MDAI) Methiopropamine (MPA) α-Pyrrolidinopentiophenone (a-PVP) Pemoline Prolintane Fencamfamin

	Adderall Evekeo Dyanevel Adzenys ProCentra Zenzedi Vyvanse
Cannabis/Synthetic Cannabinoids	Current problematic use of **Cannabis or Synthetic Cannabinoids** included within this category. **Note**: The study aims to capture routine and prolonged use, therefore recorded only if Cannabis or Synthetic Cannabinoid is the 'main' drug on specialist drug treatment records. The advice in relation to data sourced from CJSW records was to record if occasional or recreational use is implied in the report, but to err on side of recording if it was not clear. The following terms are used to describe the drugs that fall within this category: *Cannabis:* Marijuana Spliff Hash/hashish Skunk Weed Ganja Pollum *Synthetic Cannabinoids, such as:* Spice Black Mamba K2 Bliss Fake weed

Drug-Related Hospital Admissions (SMR01 / SMR04)

Information was extracted from centrally held data within NHS National Services Scotland (NSS). The data, which was initially sourced from NHS hospital administration systems across Scotland, relates to inpatient and day case admissions to general acute (SMR01) and mental health specialties (SMR04).

The recording of diagnoses on SMR01 and SMR04 comprise a main condition and, optionally, up to five further conditions. All conditions on data submissions for hospital discharges from 1st April 1996 have been coded according to the 10th revision of the International Classification of Diseases and Injuries (ICD-10).

The following selection criteria have been applied to each of the study drug categories:

Opioids

F11 - Mental and behavioural disorders due to use of opioids

T40.0 - Poisoning by narcotics and psychodysleptics (Opium)

T40.1 - Poisoning by narcotics and psychodysleptics (Heroin)

T40.3 - Poisoning by narcotics and psychodysleptics (Methadone)

Benzodiazepines

F13 - Mental and behavioural disorders due to use of sedatives or hypnotics

Cocaine/Crack Cocaine

F14 - Mental and behavioural disorders due to use of cocaine

T40.5 - Poisoning by narcotics and psychodysleptics (Cocaine)

Amphetamines/Amphetamine-Type Substances

F15 - Mental and behavioural disorders due to use of other stimulants, including caffeine

T43.6 - Poisoning by psychotropic drugs, not elsewhere classified (Psychostimulants with abuse potential)

Cannabis

F15 - Mental and behavioural disorders due to due to use of cannabinoids

T40.7 - Poisoning by narcotics and psychodysleptics (Cannabis)

Appendix 2 – Local Area Estimates

The national estimates presented in this report are a function of individual estimates produced for each of Scotland's council areas. The inclusion of cocaine (including crack cocaine) and amphetamines (including amphetamine-type substances) in definition 2 resulted in three council areas (Aberdeenshire, East Ayrshire, Falkirk) where no models could be fitted using the established criteria (hierarchical steps). The further inclusion of cannabis (including synthetic cannabinoids) in definition 3 resulted in five areas where no models could be fitted using the established criteria (City of Edinburgh, East Ayrshire, East Dunbartonshire, Falkirk, Na h-Eileanan Siar). In order to generate estimates for these areas, it was necessary to progressively relax the criteria until a best-fitting model or composite set of stratified models could be found for each council area. We also encountered that variation in estimates across competing models increased with the widening criteria.

The uncertainty in the estimates at Scotland level have been reflected through confidence intervals, at council area level these are specific to the final chosen models and assume all statistical assumptions for these models hold. There can be a tendency for users to focus on the point estimate and assume this as an absolute comparator, rather than consider the error-bounds and look for overlaps.

The estimated prevalence counts for each council area that have been combined to form the national estimates are presented on the following page.

The wider results for certain areas demonstrate some challenges to the meaningful interpretation of estimates calculated across a spectrum of definitions. For instance, by looking solely at the point estimate for East Dunbartonshire the results suggest that prevalence increased from 706 to 862 with the addition of cocaine (including crack cocaine), and amphetamines (including amphetamine-type substances). However, when cannabis (including synthetic cannabinoids) is further added as a constituent of definition 3, the prevalence point estimate falls to 764. This is clearly counter-intuitive, but is entirely plausible from a methodological perspective. By looking at confidence intervals it becomes clear that prevalence for definition 3 could be as high as 1,046.

Other potential anomalies could be highlighted for Stirling and Scottish Borders. The known population for Stirling increased from 523 under definition 1 to 577 for definition 2. Despite an increase of 54, the corresponding point estimate increased only by 2 from 1,029 to 1,031. The opposite was observed for Scottish Borders, where a modest known population rise from 366 under definition 1 to 391 for definition 2 resulted in a large point estimate increase from 509 to 933 (up 83%). Only with the inclusion of confidence intervals can any estimates be reconciled against corresponding known populations and alternative definitions.

The results show that even when taking confidence intervals into account apparent anomalies can persist. A non-statistical audience may question the results for Dumfries and Galloway and Stirling for instance which both provide definition 2 estimates with upper confidence limits that are lower than the upper limits for definition 1. Again this is entirely plausible from a theoretical perspective, but as the Advisory Group reiterate, introduces a complexity to the interpretation when comparisons are made against other definitions.

Final Estimated Prevalence[1] by Council Area (including 95% confidence intervals)

	PDU Definition 1			PDU Definition 2			PDU Definition 3		
		95% CI			95% CI			95% CI	
		Low	High		Low	High		Low	High
Aberdeen City	2,371	2,177	2,596	2,662	2,438	2,936	3,130	2,892	3,409
Aberdeenshire[2]	1,185	1,050	1,360	1,308	1,148	1,555	1,600	1,366	1,878
Angus	803	696	942	876	767	1,014	1,130	991	1,301
Argyll and Bute	558	460	735	636	509	817	1,009	802	1,351
City of Edinburgh[3]	6,012	5,604	6,486	7,552	6,940	8,280	9,049	8,299	9,926
Clackmannanshire	610	410	786	759	637	958	1,105	938	1,339
Dumfries and Galloway	1,090	938	1,332	1,109	996	1,243	1,428	1,284	1,630
Dundee City	2,270	2,150	2,427	2,367	2,265	2,473	3,077	2,870	3,300
East Ayrshire[2,3]	1,625	1,499	1,781	1,954	1,707	2,287	2,833	2,468	3,351
East Dunbartonshire[3]	706	477	764	862	432	862	764	417	1,046
East Lothian	919	794	1,080	1,102	917	1,321	1,383	1,160	1,679
East Renfrewshire	804	606	1,198	1,046	804	1,592	1,536	1,169	1,986
Falkirk[2,3]	1,228	1,120	1,359	1,390	1,289	1,522	2,091	1,838	2,384
Fife	2,792	2,537	3,120	3,398	3,022	3,398	4,089	3,758	4,644
Glasgow City	11,869	11,119	12,765	13,840	12,984	13,840	18,060	16,969	19,339
Highland	1,354	1,243	1,526	1,603	1,414	1,603	1,909	1,721	2,150
Inverclyde	1,489	1,296	1,697	1,655	1,451	1,655	2,022	1,776	2,352
Midlothian	763	650	973	857	703	1,090	1,135	957	1,407
Moray	269	207	350	367	294	367	569	486	787
Na h-Eileanan Siar[3]	47	39	70	56	47	86	108	75	179
North Ayrshire	1,590	1,477	1,758	1,858	1,711	2,054	3,023	2,662	3,667
North Lanarkshire	3,619	3,251	4,118	4,038	3,748	4,390	5,840	5,288	6,524
Orkney Islands	27	16	45	52	28	85	123	62	178
Perth and Kinross	1,524	1,291	1,813	1,697	1,429	2,201	2,381	2,028	2,964
Renfrewshire	2,721	2,362	3,167	3,218	2,741	3,705	4,235	3,716	5,113
Scottish Borders	509	451	596	933	692	1,316	1,340	988	2,025
Shetland Islands	169	124	264	190	138	360	209	154	331
South Ayrshire	937	850	1,084	1,133	1,011	1,297	1,383	1,216	1,598
South Lanarkshire	3,978	3,562	4,667	5,048	4,437	5,833	6,362	2,622	7,230
Stirling	1,029	843	1,307	1,031	892	1,233	1,468	1,216	1,811
West Dunbartonshire	1,140	941	1,394	1,401	1,139	1,745	1,878	1,583	2,330
West Lothian	1,265	1,147	1,381	1,524	1,392	1,673	2,731	2,332	3,243
Scotland	**57,272**	**55,788**	**58,857**	**67,522**	**65,833**	**69,600**	**89,000**	**85,726**	**94,029**

1. Prevalence estimated according to published model selection criteria (10 hierarchical steps)

2. The criteria for the hierarchical steps for this area was relaxed to allow a ‘best-fitting’ model to be chosen for Definition 2

3. The criteria for the hierarchical steps for this area was relaxed to allow a ‘best-fitting’ model to be chosen for Definition 3

Appendix 3 – Publication Metadata

Metadata Indicator	Description
Publication title	Prevalence of Problem Drug Use in Scotland - 2015/16 Estimates A review of definitions and statistical methods
Description	This release provides a follow-up to the published estimates of the prevalence of problem drug use in Scotland between April 2015 and March 2016. The definition of problem drug use in the last report combined opioids such as heroin with the prescribed use of methadone or other opioid replacement therapies, and the illicit use of benzodiazepines. Using data collected for the original study, broader estimates have been constructed for Scotland based on the addition of substances such as cocaine (including crack cocaine), amphetamines (including amphetamine-type substances) and cannabis (including synthetic cannabinoids). This release presents patterns in the resulting estimates at Scotland level and explains limitations in the wider application of the estimation approach in a review of the underlying statistical methods and data sources.
Theme	Health and Social Care
Topic	Drugs and Alcohol Misuse
Format	PDF report
Data source(s)	Drug treatment services / Scottish Drug Misuse Database, SMR01 and SMR04, Criminal Justice Social Work Reports
Date that data are acquired	December 2017 to October 2018
Release date	02/06/2020
Frequency	As commissioned
Timeframe of data and timeliness	The timeframe for this publication is April 2015 to March 2016.
Continuity of data	This report relates to data originally collected for the previous publication on 2015/16 prevalence. A change has been implemented to the inclusion criteria in order to estimate wider definitions of problem drug use for the first time. The statistical methods are otherwise the same as were used by to report on prevalence for 2015/16, 2012/13 and 2009/10.
Revisions statement	N/A
Revisions relevant to this publication	N/A
Concepts and definitions	See main report
Relevance and key uses of the statistics	Relevant to understanding extent of problem drug use in Scotland. Statistics will be used for policy making and service planning.
Accuracy	These data are estimates and users are advised to note the confidence intervals, which are provided to quantify a degree of uncertainty around any given point. Data have been provided from a number of sources, and where new data has been collected, validation (including assessment of completeness) has been undertaken through providers. Where data have been incorporated from routine sources, validation and data completeness are controlled through organisational protocols. Much of the report is dedicated to a review of the methods and consequences of their application on the robustness of estimates according to wider definitions.
Completeness	Data collected from all areas of Scotland in line with previous studies.
Comparability	Data is not comparable with the previous studies for wider definitions referred to in the report. Data relating to the original definition will be the same as published previously and is presented again here as a comparison against the

	wider definitions. Data may not be directly comparable with similar measures produced outwith Scotland, or through independent research studies.
Accessibility	It is the policy of PHS to make its web sites and products accessible according to published guidelines.
Coherence and clarity	The report is available as a PDF file, there are no ancillary tables or other visualisations.
Value type and unit of measurement	Estimated number and percentage of individuals with problem drug use
Disclosure	There is considered to be a low risk of disclosure.
Official Statistics designation	Official Statistics (Experimental)
UK Statistics Authority Assessment	Not undergoing assessment
Last published	05/03/2019
Next published	N/A
Date of first publication	September 2001
Help email	phs.isddrugprevalence@nhs.net
Date form completed	21/05/2020

Appendix 4 – Early access details

Pre-Release Access

Under terms of the "Pre-Release Access to Official Statistics (Scotland) Order 2008", PHS is obliged to publish information on those receiving Pre-Release Access ("Pre-Release Access" refers to statistics in their final form prior to publication). The standard maximum Pre-Release Access is five working days. Shown below are details of those receiving standard Pre-Release Access.

Standard Pre-Release Access:

Scottish Government Health Department

NHS Board Chief Executives

NHS Board Communication leads

Appendix 5 – PHS and Official Statistics

About Public Health Scotland (PHS)

PHS is a knowledge-based and intelligence driven organisation with a critical reliance on data and information to enable it to be an independent voice for the public's health, leading collaboratively and effectively across the Scottish public health system, accountable at local and national levels, and providing leadership and focus for achieving better health and wellbeing outcomes for the population. Our statistics comply with the Code of Practice for Statistics in terms of trustworthiness, high quality and public value. This also means that we keep data secure at all stages, through collection, processing, analysis and output production, and adhere to the 'five safes'.