

Prevalence of Problem Drug Use and Injecting Drug Use in Luxembourg: A Longitudinal and Methodological Perspective

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Key Words

Drug dependence surveillance systems • Prevalence estimation • Epidemiology • Methodology • Public health

Abstract

Background: To estimate the prevalence of problem drug use (PDU) and injecting drug use (IDU) in Luxembourg and analyze trends between 1997 and 2009. To assess the feasibility of prevalence estimations based on drug use surveillance systems. **Methods:** Serial multi-method PDU/IDU prevalence estimations based upon capture-recapture, Poisson regression, multiplier and back-calculation methods. Comparative analysis of methods and assessment of their robustness to variations of external factors. **Results:** National PDU and IDU prevalence rates were estimated at 6.16/1,000 (95% CI 4.62/1,000 to 7.81/1,000) and 5.68/1,000 (95% CI 4.53/1,000 to 6.85/1,000) inhabitants aged 15–64 years, respectively. Absolute prevalence and prevalence rates of PDU increased between 1997 and 2000 and declined from 2003 onwards, whereas IDU absolute prevalence and prevalence rates witnessed an increasing trend between 1997 and 2007. **Conclusions:** Drug use surveillance systems can be valuable instruments for the estimation and trend analysis of drug misuse prevalence given multiple methods are applied that rely on serial and representative data from different sources and different settings, control multiple counts and build

upon standardized and sustained data collection routines. The described institutional contact indicator revealed to be a useful tool in the context of PDU/IDU prevalence estimations and thus contributes to enhancing evidence-based drug policy planning.

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Introduction

There is a series of reasons why it may be important to know the size of a population showing drug use or misuse in a given area, such as gathering knowledge on its composition and its distribution within the general population and the willingness to affect its prevalence.

Different techniques exist to estimate the extent of drug use. Also, researchers and stakeholders want these techniques to be valid, reliable, reproducible and cost-effective at best. Summarily, direct and indirect methods may be applied. Indirect estimation techniques tend to build upon existing data and their mutual relationship in order to estimate the number of non-observed cases in a given population. The latter include capture-recapture techniques [1–8], benchmark-multiplier methods [1, 9–11], the truncated Poisson method [1, 12, 13], and the multivariate indicator method [14–19]. However, none of currently known methods is considered to be the gold

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standard since they all rely on a series of assumptions and limitations [20].

A first reason for this refers to data sources and data settings. Methods to estimate drug prevalence may rely on various data such as provided by routine drug use surveillance or monitoring systems, by cross-sectional studies or by more or less representative surveys. In case drug use reporting systems do provide data for prevalence estimations, one has to bear in mind that these are by definition selective as they generally gather information on drug use from services in contact with drug users [21]. As such, they merely include cases that come to the attention of those institutions, thus representing only a variable share of the target population.

Additionally, in the context of drug prevalence estimations, drug use surveillance systems predominantly relying on drug treatment data, also present serious limitations [22] such as possible delays between onset of drug use and first treatment demand [23], variable availability and accessibility of treatment facilities, exclusion of out-of-treatment subpopulations and possible lack of control mechanisms to avoid multiple counting [24].

Previous research does suggest favoring a multisource approach (e.g. in- and out-of-treatment settings) [22, 23], multi-method study designs [6, 20, 25, 26] and cross-checking indirect trend indicators [23, 27]. This said, there appears to be a lack of a formal and appropriate framework to combine various instruments, methods and data to optimize the validity of drug prevalence estimates other than simply look for their concordance and to assess the extent to which they converge to a plausible estimate [26, 28].

In the light of these constraints, the Luxembourg drug use surveillance system (RELIS), established in 1995, was built upon the methodological assumption that data exclusively from drug treatment settings may not provide an accurate picture of problem drug use (PDU) as these notably exclude out-of-treatment users whose drug use has generated conflicts with law enforcement only. Hence, to approach the genuine heterogeneity of the drug misuse phenomenon, RELIS routinely compiles data from all existing specialized in- and out-of-treatment sources, in- and outpatient service sources ($n = 7$), low threshold agencies ($n = 2$), psychiatric departments of general hospitals ($n = 5$), substitution treatment program ($n = 1$), prison ($n = 1$) and law enforcement registers ($n = 2$). Also, RELIS relies on the 'institutional contact indicator' as an alternative to the more commonly used 'treatment demand indicator' [23] and does not primarily apply case definitions such as injecting drug users,

heroin or opiate users. Even though RELIS software does allow to extract data on these subgroups, it targets 'problem drug use' defined as follows: 'Injecting drug use or long duration/regular use of opioids, cocaine and/or amphetamines'.

This definition leads to a second important consideration, namely the use of data gathered through drug use surveillance systems. The national surveillance data on drug misuse are intended to serve policy-making, action planning and resources allocation, building upon the principle that 'Effective drug policy should be based on a systematic and comprehensive assessment of the nature extent and distribution of drug use within a community' [29]. The first aim of drug use surveillance and prevalence studies should be to reach benefits in terms of care for the target population. This target population does not exclusively consist of heroin addicts or drug users in treatment for instance. It is composed of persons encountering diverse problems stemming from their drug use in the first place and potentially also causing damage to the community. Therefore, the case definition of PDU is preferred to more restrictive ones because it arguably provides a more accurate picture of the extent of the problem and its correlates.

The particular question addressed in this paper is to know how to conceive a reliable, construct valid and cost-effective battery of tools and methods within the framework of a national drug use surveillance routine to assess the prevalence of PDU. In other words, what are possible ways to arrange the patchwork of mostly scattered data on the extent and the pattern of PDU into a structured, reliable and valid body of evidence? There is presumably no single answer to this question, but it should be possible to investigate relationships between different instruments and methods as well as their respective strengths and weaknesses to assess the robustness of a national drug prevalence estimation procedure and thus the accuracy of its outcome.

Methods

Serial estimates of problem drug users were obtained by applying the following methods: two-, three- and four-source capture-recapture (CR) based on data from all existing national facilities for detoxification treatment, outpatient substitution treatment, inpatient drug therapy, as well as data on drug users yearly indexed by law enforcement agencies; truncated Poisson regression model (tPm) associated to Zelterman's and Chao's estimators on RELIS contact frequencies and four multiplier computations respectively combining datasets on first drug law offenders and the rate of acute drug death victims known by law enforcement agen-

cies (M1)¹, on drug use law offenders and the proportion of problem drug users in contact with police (M2), on drug-related death cases and drug-related mortality rates (M3), and on drug treatment admissions and in-treatment rates (M4). CR on two and three sources, tPm, M1 and M2 were performed in all serial studies from 1999 to 2009 respectively on the same sources. Due to the restructuration of the main national psychiatric hospital (CHNP), detoxification treatment has been decentralized within four regional hospitals running psychiatric services, which were included in CR models in 2009 instead of the CHNP.

Estimates of injecting drug users were obtained by multiplying PDU estimates by IDU rates in the national PDU population as provided by RELIS on a yearly basis (P[PDU/IDU]). In order to consolidate the final estimation outcome, a back-calculation method based on HIV data was also applied. The number of HIV-infected injecting drug users has been used as numerator and the proportion of HIV infections among injecting drug users as denominator to estimate the total number of injecting drug users (M[IDU/HIV]). Where appropriate, 95% CI and mid-point estimates were calculated. Lower and upper bounds of results, as provided by applied methods, were used to set estimation margins.

Data were provided by the national RELIS surveillance system, maintained by the Luxembourg focal point of the EMCDDA. Drug users indexed by RELIS are digitally anonymized by means of an encryption algorithm approved by the National Commission on Data Protection. The thus obtained individual RELIS code allows respondents' recognition within and between sources and to avoiding multiple counts.

Statistical analysis was carried out with SPSS 13.0/19.0 software and GLIM 4 update 9 (for 2003 and 2007 CR computations only). log-linear analysis was used for three- and four-source CR computations. CR models were compared using the log likelihood ratio (G^2), the Aikake's information criterion (AIC) [30] and the bayesian information criterion (BIC) [31]. The simplest models with the lowest AIC and BIC scores were retained in case any more complex model with a significantly lower G^2 was observed.

Results

Table 1 shows estimates of problem and injecting drug users as calculated by applied methods. Results provided by different methods show reasonable inter-estimate margins per year, varying from 400 to 743 persons between 1997 and 2009, excluding estimates derived from the tPm Zelterman estimator. As a matter of fact, the Zel-

¹ Calculated for the average duration of drug dependence of the target population. Duration of dependence being a routine item of the RELIS surveillance protocol, 10 and 11 years were determined and applied for 1999/2000/2009 and 2007 respectively. Data on first offenders and acute drug deaths have been extracted from the national registers on drug law offenders and on drug-related deaths. Toxicological evidence allowed to determine that all included overdose cases showed ante-mortem heroin and/or cocaine and/or amphetamines consume. Heroin use was detected in almost all cases. Three indexed victims, on transit and not residents of Luxembourg, were excluded.

terman estimator provides the highest estimates for all years except for 2009, thus not reflecting, likewise the M2 estimates, the serial prevalence trend line documented by all other methods. Capture-recapture methods on two, three and four sources, tPm and M1 provided the most consistent PDU estimates. tPm Chao's estimator tend to bring up lower-bound estimates and M2 to provide highest serial estimates.

Until 2003, serial IDU estimates provided by the P(PDU/IDU) method were higher than those derived from M(IDU/HIV), but observed differences are reasonably small, varying between 20 and 310 persons.

Table 2 provides an overview of mean PDU and IDU prevalence estimates as calculated by different methods and sources, associated 95% CIs and prevalence rates per 1,000 inhabitants in the total national population and in the population aged 15–64 years.

The latest serial estimate (2009 data) provided a mean prevalence of 2,070 (median 2,094) problem drug users at the national level (95% CI 1,553–2,623). In terms of prevalence rates, 4.19/1,000 and 6.16/1,000 inhabitants out of the general population and aged between 15 and 64 years respectively show PDU. The number of injecting drug users was estimated at 1,907 persons representing an IDU prevalence rate of 5.68/1,000 inhabitants aged between 15 and 64 years.

According to serial estimates performed between 1997 and 2009 (fig. 1), absolute prevalence and prevalence rates of PDU showed an increasing trend until 2000. After a brief stabilization phase, a downward trend, observed from 2003 onwards, was confirmed by most applied methods. Absolute prevalence of IDU, however, increased between 1997 and 2007, and so had the IDU prevalence rate in the national population aged 15–64. Data for 2009 show a decrease in IDU prevalence that should, however, be interpreted only in the light of future serial data.

Discussion

We conducted a serial, multi-method/multi-source prevalence study on problem and injecting drug users in Luxembourg, applying various estimation techniques based on data provided by the national drug use surveillance system (RELIS). We then confronted serial estimates, provided by comparable methodologies allowing to follow-up the evolution of national PDU and IDU prevalence over a period of 13 years between 1997 and 2009.

Serial estimates suggest that even though the absolute number of problem drug users has not been increasing

for several years, the needs in terms of prevention, care and treatment have nonetheless changed to a large extent. The high and increasing rate of polydrug use in problem drug users (2007) and the increasing number of drug-related death cases during the referred period [32] tend to corroborate this statement. In other words, a seemingly decreasing number of drug users appear to have developed more hazardous and care-demanding consume pattern. This is an important observation since it shows that prevalence data might allow to assess the size of a population but not necessarily the extent of a problem and its correlates.

A detailed comparative analysis of single estimates revealed that capture-recapture models are valuable tools for drug prevalence estimation and its methodological constraints have been thoroughly described in the literature [1–8]. Accordingly, a fundamental application assumption of CR requires the studied population to be closed; there should be no movement into or out of the population during the study period. Obviously, applied to problem drug users, this condition is unlikely to be fully

met as some of them might die, relapse, quit or newly join the PDU population during the study. A capture-recapture period limited to 1 year was therefore chosen to reduce potential bias introduced by the violation of the ‘closed population assumption’.

A second important assumption regards homogeneity of the study population; each individual should have the same probability of being present in each source. The likelihood of being indexed, however, relies on individual factors such as severity of drug dependence in association with increased risk behavior, socioeconomic status [33], current treatment or incarceration status as well as on structural factors such as differences in availability or accessibility of existing treatment facilities.

Since Luxembourg stands for a rather small territory and the PDU population is concentrated in two major cities where demand reduction and supply reduction offers and measures were comparable and stable between 1997 and 2009, the impact of structural factors should be limited. On the other hand, easy and payment-free access to national treatment offers may result in increased treat-

Table 1. Estimates of absolute prevalence of PDU and IDU in Luxembourg, 1997–2009

Sources ^a /models	Year	Retained model	Total observed	Hidden population (estimation)	Total population	95% CI
<i>PDU estimates – method: capture-recapture</i>						
<i>CR 2 sources</i>						
p ¹⁹⁹⁹ & M ¹⁹⁹⁹	1999	/	700	1,375	2,075	1,587–2,563
p ²⁰⁰⁰ & M ²⁰⁰⁰	2000	/	636	1,980	2,616	1,801–3,431
p ²⁰⁰³ & M ²⁰⁰³	2003	/	574	1,816	2,390	1,966–2,814
p ²⁰⁰⁷ & M ²⁰⁰⁷	2007	/	536	1,837	2,373	1,479–3,266
p ²⁰⁰⁹ & HO ²⁰⁰⁹	2009	/	371	1,485	1,856	1,016–2,696
<i>CR 3 (1) sources</i>						
H ¹⁹⁹⁹ & P ¹⁹⁹⁹ & M ¹⁹⁹⁹	1999	H ¹⁹⁹⁹ * p ¹⁹⁹⁹ H ¹⁹⁹⁹ * M ¹⁹⁹⁹	664	1,663	2,327	1,510–3,926
H ²⁰⁰³ & p ²⁰⁰³ & M ²⁰⁰³	2003	H ²⁰⁰³ * p ²⁰⁰³	594	2,051	2,645	1,871–3,986
H ²⁰⁰⁷ & p ²⁰⁰⁷ & M ²⁰⁰⁷	2007	H ²⁰⁰⁷ * p ²⁰⁰⁷	497	2,114	2,611	1,703–4,401
H ²⁰⁰⁹ & p ²⁰⁰⁹ & M ²⁰⁰⁹	2009	p ²⁰⁰⁹ * M ²⁰⁰⁹	409	1,691	2,100	1,373–3,375
<i>CR 3 (2) sources</i>						
p ²⁰⁰⁰ & M ²⁰⁰⁰ & T ²⁰⁰⁰	2000	p ²⁰⁰⁰ * T ²⁰⁰⁰ T ²⁰⁰⁰ * M ²⁰⁰⁰	656	1,920	2,576	1,917–3,578
p ²⁰⁰³ & M ²⁰⁰³ & T ²⁰⁰³	2003	Independence	505	2,043	2,548	1,773–3,911
p ²⁰⁰⁷ & M ²⁰⁰⁷ & T ²⁰⁰⁷	2007	Independence	491	1,699	2,190	1,567–3,244
<i>CR 4 sources</i>						
H ²⁰⁰⁰ & p ²⁰⁰⁰ & T ²⁰⁰⁰ & M ²⁰⁰⁰	2000	H ¹⁹⁹⁹ * p ¹⁹⁹⁹ H ¹⁹⁹⁹ * T ¹⁹⁹⁹ p ²⁰⁰⁰ * T ²⁰⁰⁰ T ²⁰⁰⁰ * M ²⁰⁰⁰	719	2,156	2,875	2,156–3,948
H ²⁰⁰³ & p ²⁰⁰³ & T ²⁰⁰³ & M ²⁰⁰³	2003	p ²⁰⁰³ * H ²⁰⁰³ T ²⁰⁰³ * H ²⁰⁰³	629	1,827	2,456	1,825–3,466
H ²⁰⁰⁷ & p ²⁰⁰⁷ & T ²⁰⁰⁷ & M ²⁰⁰⁷	2007	p ²⁰⁰⁷ * H ²⁰⁰⁷	534	1,644	2,178	1,595–3,131

Table 1 (continued)

Estimator	Year	Total observed	Hidden population (estimation)	Total population	95% CI
<i>PDU estimates – method: truncated Poisson model (tPm) – Zelterman & Chao estimators (1 source)</i>					
Zelterman est. (Zn)	1999	744	2,133	2,877	2,659–3,133
	2000	783	2,141	2,924	2,710–3,176
	2003			3,206	2,880–3,537
	2007			3,175	2,780–3,786
	2009	779	1,308	2,087	1,809–2,467
Chao est. (Cn)	1999	744	1,333	2,077	1,912–2,290
	2000	783	1,349	2,132	1,968–2,342
	2003			2,332	2,105–2,621
	2007			2,470	2,146–2,890
	2009	779	944	1,723	1,496–2,022

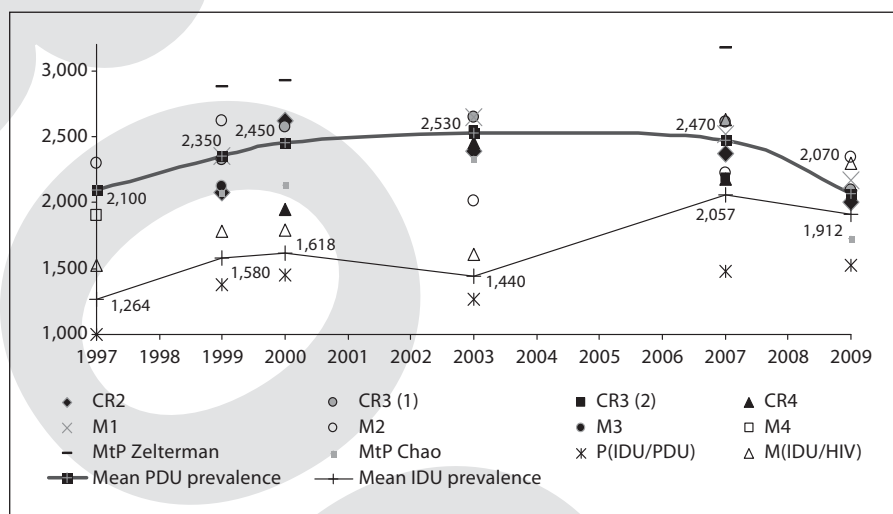
Sources	Year	Total Population	Estimation margins
<i>PDU estimates – method: benchmark multipliers</i>			
M1			
Law enforcement data/drug-related death data	1999	2,350	2,209–2,483
	2003	2,650	2,587–2,721
	2007	2,515	2,347–2,681
	2009	2,166	1,994–2,338
M2			
Law enforcement data/law enforcement contact rate	1997	2,300	/
	1999	2,624	/
	2003	2,008	/
	2007	2,220	/
	2009	2,340	/
M3			
Drug-related death data/DRD rate	1999	2,120	2,087–2,155
M4			
Treatment data/in-treatment rate	1997	1,900	/
<i>IDU estimates</i>			
Method: P(IDU/PDU)	1997	1,785	/
	1999	1,828	/
	2000	1,920	/
	2003	1,755	/
	2007	1,924	/
	2009	1,524	/
Method: M(IDU/HIV)	1997	1,582	/
	1999	1,686	/
	2000	1,610	/
	2003	1,735	/
	2007	2,422	/
	2009	2,301	/

^a CHNP (H) = clients registered by main national detoxification unit; Hospitals (HO) = all national hospitals providing detoxification treatment; SPJ (P) = drug users indexed by national law enforcement agencies; CTM (T) = inpatient drug therapy clients nationwide; MP (M) = outpatient substitution treatment demanders indexed nationally by specialized agencies; PDU = problem drug users; IDU = injecting drug users.

Table 2. Absolute prevalence and prevalence rates according to selected subgroups in Luxembourg, 1997–2009

	1997	1999	2000	2003	2007	2009
<i>General population</i>						
National population on 1st January	418,300	429,200	435,700	448,300	476,200	493,500
National population aged 15–64 years on 1st January	281,100	287,100	291,000	300,800	322,000	336,015
<i>Problem drug users</i>						
PDU mean prevalence	2,100	2,350	2,625	2,530	2,470	2,070
Mean 95% CI	1,900–2,300	1,994–2,758	2,246–3,295	2,144–3,293	1,945–3,343	1,553–2,623
Total mean prevalence rate	5/1,000	5.48/1,000	6.02/1,000	5.64/1,000	5.19/1,000	4.19/1,000
Total mean prevalence rate (age 15–64)	7.47/1,000	8.19/1,000	9.02/1,000	8.41/1,000	7.67/1,000	6.16/1,000
<i>Injecting drug users</i>						
IDU mean prevalence	1,656	1,757	1,765	1,745	2,173	1,907
Estimate margins	1,528–1,785	1,686–1,828	1,610–1,920	1,735–1,755	1,924–2,422	1,524–2,301
Total mean prevalence rate	3.96/1,000	4.09/1,000	4.05/1,000	3.89/1,000	4.56/1,000	3.86/1,000
Total mean prevalence rate (age 15–64)	5.89/1,000	6.12/1,000	6.07/1,000	5.80/1,000	6.75/1,000	5.68/1,000

Fig. 1. Absolute prevalence estimates of PDU and IDU, Luxembourg, 1997–2009 [1]. CR2/CR3/CR4 = Capture-recapture methods on two, three and four sources. M1 = Multiplier method: police and drug-related deaths registers; M2 = multiplier method: number of drug law offenders/law enforcement contact rate of drug offenders; M3 = multiplier method: number of fatal overdose cases/drug-related mortality rate; M4 = extrapolation from treatment data. P(IDU/PDU) = Multiplier method: PDU estimates/IDU rates; M(IDU/HIV) = multiplier method: number of HIV-infected IDU/rate of HIV infections among IDU.



ment rotation by patients. In order to assess the homogeneity of the target population, we performed a comparison of the sum of estimations applied to gender-stratified samples with the total estimation performed on non-stratified samples. As the results obtained by both approaches were highly similar, homogeneity of the study population could be reasonably assumed.

The homogeneity assumption appears to be related to an additional condition requiring that being present in one source should not affect the probability of being in another source. A positive dependence between two sources included in the CR model would result in an underestimation of the total population, and vice versa. To reduce the potential impact of a violation of the mutual independence assumption, both supply and demand re-

duction sources were included in the CR models. Furthermore, sources linked to each other by agreed, routine or systematic referral procedures were not combined for the same reason. Ultimately, it should be stressed that CR analysis including more than two sources accounts for potential dependences between selected sources in the selection of best-fitted regression models.

The truncated Poisson model (tPm) may be seen as a particular application of a CR model, based on a single data source. Also, a ‘drug use-related institutional contact’ can be described as being a rare event, following a Poisson-shaped distribution [34]. Matching observational data with a Poisson distribution thus allows estimating the number of persons that have not been indexed in a given setting or database, hence representing the hidden

population. The applicability of the tPm relies on the same assumptions as CR models, although the independence condition is specific as it assumes that an individual does not show a behavioral response to being indexed at least once. The particularity of the tPm model applied in this study lies in the fact that frequency data were provided by the RELIS database, indexing all national drug-related contacts with both drug demand or drug supply reduction institutions. All sources included in RELIS, and previously described, have thus been aggregated into a single national and highly representative dataset on drug-related institutional contacts.

Available data also allowed applying a series of multiplier methods. The 'first offender – mortality' method (M1) builds upon the number of first drug law offenders (for drug use) during a time window equal to the average duration of dependence of national problem drug users (A), the number of acute drug deaths during the same period (B) and the respective number of acute drug deaths having been registered as problem drug users previously (C) to provide the total number of problem drug users (T) = $A \times B/C$. The average duration of drug dependence has been calculated for each study year on the basis of national RELIS data, which reduced the bias that may result from the application of international literature-based dependence duration estimates. Moreover, M1 has been applied by including all drug-related deaths cases (direct and indirect²) and results were similar to the ones obtained by using acute cases only. As can be seen in table 1, both estimates have been used as upper and lower bounds of estimates calculated by applying M1.

Due to the representativeness of collected data, described precautions to reduce potential bias and the consistency of estimates with results provided by other estimation methods, it can be assumed that the described method (M1) is a valuable tool to estimate PDU prevalence in Luxembourg. The fact that dependence duration can be accurately determined generally via both monitoring and survey data, and that annual variations in the number of reported drug offenders and drug-related deaths cases have less impact on a given year estimation since both represent multi-annual sums in the final equation, makes this method, as applied, a presumably robust and generally recommendable instrument to estimate drug misuse prevalence.

² Indirect drug-related deaths include known problem drug users who died from accidents under the influence of illicit drugs, suicide, drug-related infectious diseases or consequences of long-term abuse. Aggregated data were provided by the police.

The second applied multiplier method (M2) also relies on police data as it estimates the total PDU prevalence by dividing the number of registered problem drug users in a given year by the proportion of problem drug users having reported previous contact with law enforcement. Contact with law enforcement is a standard item of the national RELIS data protocol and thus allows calculating contact rates on a yearly basis and applying them selectively for each serial estimate. However, this method is sensitive to the yearly number of registered offenders that may differ greatly according to law enforcement activity and changes in supply reduction strategies.

Likewise, the mortality multiplier method (M3), though one of the simplest ways to estimate the prevalence of drug misuse, is highly sensitive to variations in drug-related mortality rates (e.g. HIV/AIDS epidemics, high purity or contamination of street drugs). This is even more so when the absolute yearly number of drug-related deaths is relatively small as is the case in Luxembourg. Even slight changes in mortality, not necessarily due to a change in the size of the population at risk, may have a significant bias impact on estimation results. For that reason, and the fact that no national mortality rates were available after 1999, this specific method could not be applied on a serial basis.

The last multiplier method (M4) also relies on a benchmark (problem drug users in treatment during a given year), available at the national level and a multiplier (in-treatment rate of problem drug users). As the latter has not been estimated by any national study since 1997, the referred method could not be applied in following years.

IDU prevalence estimates have been calculated using two methods. The P(IDU/PDU) method is straightforward but its outcome should be considered with caution since it relies on two further estimates that are: the estimated number of problem drug users and the proportion of injecting drug users in the national PDU population.

The M(IDU/HIV) method is obviously more sophisticated and demanding in terms of data input, but its accuracy largely depends on the proportion of HIV-infected injecting drug users not (yet) diagnosed and the reliability of provided HIV rates in injecting drug users (e.g. self-reported or serology-based data). In countries such as Luxembourg, where the HIV epidemic in drug users is small, even slight changes in the denominator have great impact on the estimation result (e.g. a change in the HIV infection rate in problem drug users from 2 to 4% will result in an estimation decreased by 100%). Moreover, the numerator varies according to the impact of new treatment options on the mortality of HIV-infected problem

drug users for instance. Especially in a longitudinal perspective, it is crucial that the epidemic remains structurally more or less stable.

The fact that, in contrast to previous years, the 2007 and 2009 upper bound estimates, obtained via M(IDU/HIV), appear to be consistently higher than the P(IDU/PDU)-based estimation, may stem from the fact that from 2004 onwards the absolute yearly number of HIV-infected persons (which sum is multiplied by the proportion of HIV-seropositive persons infected via IDU to obtain a proxy for the total number of HIV-infected injecting drug users) has been increasing, whereas the proportion of injecting drug users within the HIV-infected population has been showing a decreasing trend, partially due to well-documented [35] improvements in national harm reduction offers. Hence, having advanced knowledge of the national HIV/AIDS epidemic is of utmost importance when applying the referred method, especially when small figures are at stake. These observations also underline the need to confront obtained single estimations to results from other methods and indirect indicators.

A national drug use surveillance system, based on different (DR and SR) sources and settings, referred to as 'institutional contact indicator' in the present paper, and able to exclude multiple counts, appears to be a valuable instrument to estimate PDU and IDU prevalence and to consolidate these by a multi-method approach. National PDU estimation based on a single method should be avoided as the present study showed that for different years all applied methods may provide upper and lower bound estimates.

The framework of a national drug use surveillance system, based upon standardized and time-persistent data collection routines may reduce bias produced by external factors and cross-sectional data for instance – especially in the context of serial estimations and trends surveillance. The application of CR methods is feasible and particularly indicated if these surveillance systems build upon case-exhaustive sources. Selected multiplier methods may be applied via surveillance data if a series of pertinent items are included in the routine protocol (i.a. law enforcement contacts, HIV status, duration of dependence). Most multiplier methods, however, need additional data from other sources (e.g. mortality rate, in-treatment rate, proportion of HIV-infected problem drug users), which may impede their application.

This said, IDU and PDU prevalence estimates should be primary based on 'hard' data and methodologies least relying on specific rates, multipliers or preliminary estimates. Capture-recapture methods, tPms, applied on the

national PDU population showing institutional contact, and the M1 multiplier method, based on longitudinal data, showed to be applicable and most reliable in the context of PDU prevalence estimations. As a matter of fact, the latter methods seem to provide best input for consolidated PDU prevalence estimates but only to the extent that external and structural factors, not resulting from an actual increase of the population at risk (i.e. changes in treatment options or access, HIV outbreak, increased mortality due to quality variations in street drugs, changes in data quality), can be assumed to be stable.

Sound knowledge of the national drugs problem and its correlates is crucial when it comes to take appropriate decisions on the accuracy of a given prevalence estimation method and its results. Routine and serial application of a selected battery of estimation methods can be a valuable tool for drug misuse surveillance. If the choice of various methods to be best applied in a given national context largely depends on the availability, quality and consistency of required data, the methodological issues addressed in the present paper may serve the final decision making.

Further research should also investigate more dynamic ways to describe PDU and integrate recent findings on entry and cessation rates applied to hard drug use [36] as well as the possible associations between indirect trend indicators (e.g. drug-related mortality, seizures, service usage, treatment demand) and the prevalence of drug misuse in a longitudinal perspective in order to fine-tune, complement and further validate nationally applied prevalence estimations of drug misuse and thus contribute to enhance evidence based drug policy planning.

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