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Estimating the number of people who inject drugs and syringe coverage in Australia, 2005–2016

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ABSTRACT

Background: Effective targeting of harm reduction programs for people who inject drugs (PWID) requires timely and robust estimates of the size of this population. This study estimated the number of people who inject drugs on a regular basis in Australia, calculated syringe coverage per person and the proportion of their injections covered by a sterile needle and syringe.

Methods: We used trends in indicators of injection drug use to extend the 2005 estimate of the population of people who regularly inject drugs from 2005 to 2016. Included indicators were lifetime/recent injection of illicit drugs, drug-related arrests, drug-related seizures, accidental deaths due to opioids, opioid-related hospital admissions/separations and new diagnoses of hepatitis C virus infection among those aged 15–24 years. Syringe distribution and frequency of injection data were used to assess syringe coverage per PWID and the proportion of their injections covered by a sterile syringe.

Results: The estimated number of people who regularly inject drugs in Australia increased by 7%, from 72,000 in 2005 to 77,270 in 2016. The annual number of syringes distributed per person increased 34%, from 470 syringes in 2005 to 640 syringes in 2016. Syringe coverage per injection first exceeded 100% in Australia in 2013.

Conclusions: Despite Australia's high syringe coverage by international standards, the number of syringes distributed is likely to be only narrowly meeting demand. It is critical that needle syringe programs be provided with sufficient resources to continue their role as the key intervention required to prevent HIV and HCV transmission among PWID.

1. Introduction

There is good evidence that needle syringe programs (NSPs) are effective in the prevention of human immunodeficiency virus (HIV) infection (Palmateer et al., 2010) and emerging evidence that high coverage NSP can reduce the risk of hepatitis C virus (HCV) infection among people who inject drugs (PWID) (Platt et al., 2018). UNAIDS 2018 guidance for global AIDS monitoring defines needle and syringe coverage (hereafter syringe coverage) as high where > 200 syringes per PWID are distributed per annum, with PWID population size the key denominator (Joint United Nations Programme on HIV/AIDS (UNAIDS), 2017). PWID population size estimates are also essential for disease transmission and mathematical modeling, and to optimize the allocation of scarce public health resources, evaluate the coverage of prevention interventions, and frequently required as a denominator for epidemiologic measures of disease burden and incidence (Wesson et al., 2017). However, injection drug use is a stigmatized, illicit and frequently hidden behavior. As a consequence, population size estimates for PWID are challenging to produce and often a very sensitive, uncertain and hard-to-reach parameter.

Various population size estimation methods, such as capture-recapture, multiplier, reverse tracking, successive sampling, and population surveys have been used to enumerate the hidden population size in different settings. Wesson et al. (2017) assessed different population size estimation methods by systematically reviewing peer-reviewed studies where at least two methods were used to estimate the size of the same hidden target population. The review determined that there was no evidence for a single most rigorous method, with high variability across multiple settings and populations and that multiple potential biases can result in over or underestimation. Wesson et al. (2017) concluded that estimating population size using multiple different methods reduces concern regarding reliability of results and that, peer-

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reviewed publication of multiple estimates is advantageous (Sabin et al., 2016; Wesson et al., 2017).

Previously in Australia, Law et al. (Law et al., 2001) estimated the population size of people who injected illicit drugs on a regular basis (defined as people who had injected for ≥12 months, an average of 10 times per month, with injection in most months) and occasionally (injected at least once in the last 12 months but not in most months) from 1996 to 2000 using the reverse tracking (back-projection) method. Results from the Law et al. study was subsequently used by Razali et al. (2007), to extend the number of PWID using the ratio of change among indicators of injection drug use between 2000 to 2005. More recently, a study deployed the multiplier method using the number of people engaged in opioid substitution therapy as benchmark data, to derive an estimate of the population size of PWID (defined as any injection of illicit drugs in the previous 12 months) in Australia in 2014 (Larney et al., 2017a). Given the propensity for rapid and significant changes in Australian drug markets (Day et al., 2004; Degenhardt et al., 2017; Topp et al., 2003) and the introduction of broad access to highly efficacious direct-acting antiviral hepatitis C treatments in March 2016 (Dore and Hajarizadeh, 2018), there is considerable benefit to producing timely annual estimates of the population size of PWID in this setting.

In an environment of increased access and uptake of HCV treatment among Australian PWID (Iversen et al., 2018), it is important to monitor trends in syringe coverage to ensure that HCV prevention interventions are adequately maintained. Sufficient syringe coverage is required to maximize any potential treatment as prevention benefits (Martin et al., 2013) and to minimize the risk of reinfection among those who have cleared their HCV infection, either spontaneously or through treatment. Notwithstanding the difficulties obtaining estimates of the size of the PWID population, syringe coverage defined as the 'number of needles and syringes distributed per person who injects drugs per annum' (Joint United Nations Programme on HIV/AIDS (UNAIDS), 2017) is a measure that is easily calculated in settings with accurate and timely needle and syringe distribution data. While this measure is useful to assess and monitor UNAIDS syringe coverage targets, the measure does not take injection frequency into account and cannot, therefore, provide any indication of the extent to which demand for sterile syringes is met. To resolve this limitation and provide a more nuanced approach, several attempts to develop and standardize a measure of individual-level syringe coverage have been made (Bluthenthal et al., 2007; Burrows, 2006; Iversen et al., 2012; McCormack et al., 2016; Sharma et al., 2007). Currently, there is no internationally agreed measure for individual-level syringe coverage, the measure is subject to considerable recall bias (Iversen et al., 2012) and increasingly complex measures have been proposed (McCormack et al., 2016; O'Keefe et al., 2017).

The current study attempted to address some of the limitations surrounding the need for a sustainable method to produce timely and consistent PWID population size estimates. This study adopted the previous estimates (Razali et al., 2007) and used the relative change method to present annual population size estimates of people who regularly inject illicit drugs using the best available local data between 2005–2016. The study subsequently utilized these population size estimates to calculate the number of syringes distributed per PWID per annum (population-level syringe coverage). We also outlined an alternate approach to individual-level syringe coverage, whereby the extent to which demand for sterile syringes is met is determined by assessing syringe coverage per injection according to frequency of injection among the population of people who regularly inject illicit drugs.

2. Methods

2.1. Population size of PWID

We collated the most recent and robust Australian data sources over the period 2005–2016 (Table 1) and extended estimates of the number of people who inject illicit drugs on a regular basis from 2005 (Razali et al., 2007). Data sources used to determine the relative change in the population since 2005 included:

- Lifetime and recent injection of illicit drugs obtained from the National Drug Strategy Household Survey (2017), Australian Institute of Health and Welfare.
- Illicit drug arrests (*Amphetamine-type stimulants [ATS], Heroin and other opioids, Cocaine, and Steroids*) obtained from Illicit Drug Report 2005/06–2015/16, Australian Crime Commission.
- Illicit drug seizures (*ATS, Heroin, and Steroids*) obtained from Illicit Drug Report 2005/06–2015/16, Australian Crime Commission.
- Mortality (*Accidental opioid-related deaths*) obtained from Australian Drug Trends 2017, the National Drug and Alcohol Research Centre.
- Morbidity (*Opioid-related hospital admissions and Opioid-related hospital separations*) obtained from Australian Drug Trends 2015 and 2017, the National Drug and Alcohol Research Centre.
- New diagnoses of hepatitis C virus infection among people aged 15–24 years, obtained from the National Notifiable Diseases Surveillance System, 2005–2016, Australian Government Department of Health.

Given each of these six key indicators is an incomplete measure of probable trends in injection drug use, the best estimate was generated using a combined median of all indicators. The median of the indicators was then fitted with a log function to obtain a smooth fit of the data. Based on this estimate, the Australian population of people who regularly inject illicit drugs over the period 2005–2016 was calculated using a constant multiplier to describe the relative change of the indicators compared to 2005.

2.2. Syringe distribution

Needle and syringe distribution data were collected by Australia's Needle Syringe Program National Minimum Data Collection (Heard et al., 2017; Iversen et al., 2016). Quarterly national data on needles and syringes distributed to PWID from both public NSP (including automatic dispensing/vending machines) and private (pharmacy) sectors were collated. The data definition for 'Injecting Equipment Distributed' defines items as a) combined needle and syringe, b) syringe without needle, c) needle without syringe and d) other. Given that both a needle and a syringe are required to undertake an injection, these two items combined to comprise one unit of injecting equipment. To avoid double counting a needle and a syringe as two units, the total number of units of injecting equipment distributed consisted of a count of a) combined needles and syringes plus b) syringes without needles. Needles distributed without syringes were excluded from the count.

2.3. Syringe distribution per PWID

The number of syringes distributed per person injecting per annum is one of three key indicators specific to PWID included in the UNAIDS Global AIDS monitoring framework (Joint United Nations Programme on HIV/AIDS, 2016). UNAIDS defines 'low' syringe coverage as < 100 syringes per PWID per annum, 'medium' syringe coverage as 100–200 syringes per PWID per annum and 'high' syringe coverage as > 200 syringes per PWID per annum, with a disclosure that coverage definitions are based on studies of HIV transmission in low and middle-income countries and that syringe coverage required to prevent HCV transmission is likely to be considerably higher (Joint United Nations Programme on HIV/AIDS (UNAIDS), 2017). In this study, the mean number of syringes per PWID is the total number of syringes distributed per annum (by both public and pharmacy NSP services) divided by the estimated size of the population of people who regularly inject illicit drugs. Although this measure does not account for syringes required by people who occasionally inject illicit substances or needles and/or

Table 1
Indicators of trends in injecting drug use in Australia, 2005–2016.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
History of injection of illicit drugs[1]												
Lifetime			1.9			1.76			1.5			1.6
Recent			0.5			0.43			0.3			0.3
Illicit drug arrests[2]												
ATS	10,958	13,532	15,632	16,250	15,217	13,440	14,863	19,509	24,229	30,869	41,547	47,625
Heroin & other opioids	2,777	2,207	2,222	2,486	2,730	2,659	2,633	2,589	2,617	2,999	3,101	2,975
Cocaine	411	548	684	759	1,046	1,042	917	1,139	1,374	1,779	2,342	2,592
Steroids	96	105	153	189	264	340	438	586	799	1,073	1,254	1,297
Illicit drug seizures[3]												
ATS	9,294	11,615	13,170	13,199	11,922	10,878	13,202	18,124	23,931	29,787	35,891	39,014
Heroin	1,426	1,387	1,444	1,551	1,637	1,641	1,729	1,671	1,591	1,756	1,998	2,081
Steroids	54	75	98	109	124	170	207	270	344	443	519	509
Mortality[4]												
Accidental opioid-related deaths	374	381	360	500	563	613	617	564	597			
Morbidity[5]												
Opioid-related hospital admissions	411	440	439	452	438	415	416	425	446	467	475	
Opioid-related hospital separations	406	417	447	448	460	467	449	439	453	471	475	
HCV notifications 15-24 years[6]												
	1825	1597	1389	1354	1263	1200	1126	1165	1295	1131	1189	1156

[1] National lifetime and recent (past 12 months) injection of illicit drugs among people aged 14 years or older, 2001–2016 [National Drug Strategy Household Survey 2017].
[2] National number of illicit drug arrests [Illicit Drug Data Report, Australian Crime Commission (2005/06–2015/16)].
[3] National number of illicit drug seizures [Illicit Drug Data Report, Australian Crime Commission (2005/06–2015/16)].
[4] National number of accidental deaths due to opioids among those aged 15–54 years (2005–2013) [Roxburgh, A. and Burns, L. (2017). Accidental drug-induced deaths due to opioids in Australia, 2013. Sydney: National Drug and Alcohol Research Centre].
[5] Number of principal opioid-related hospital admissions/separations per million persons aged 15–54 years [Australian Drug Trends 2015. Findings from the Illicit D Reporting System (IDRS); Roxburgh, A. and Burns, L. (2017). Drug-related hospital stays in Australia, 1993-2015. Sydney: National Drug and Alcohol Research Centre].
[6] National number of new diagnoses of hepatitis C virus infection among people aged 15–24 years [National Notifiable Diseases Surveillance System, 2005–2016].

syringes that are not used for injection (for example those used for drawing up or failed injection attempts), it is a robust quantitative measure that can be used to assess trends in syringe coverage in the core population at risk over time.

2.4. Syringe coverage per injection

In order to assess the extent to which demand for sterile syringes was met, additional analyses that took frequency of injection into account were conducted. We used data on frequency of injection (in the last month) from the Australian NSP Survey (Iversen and Maher, 2015; Memedovic et al., 2017) and assumptions from the Return on Investment 2 report (National Centre in HIV Epidemiology and Clinical Research, 2010) to estimate the number of sterile syringes that would be required to cover all injections among people who regularly inject illicit drugs where one sterile syringe was used per injection.

The following assumptions were used (National Centre in HIV Epidemiology and Clinical Research, 2010): people who injected > 3 times per day required a mean of 5 syringes per day (range 4–6 syringes per day), people who injected 2–3 times per day required a mean of 2.5 syringes per day (range 2–3 syringes per day), people who injected once per day required one syringe per day, people who injected more than weekly but not daily required a mean of 3.5 syringes per week (range 2–6 syringes per week) and people who injected monthly but not weekly required a mean of 0.5 syringes per week (range 0.3–0.9 syringes per week). Syringes required for injections among people who injected less than monthly were excluded.

The total number of annual syringes required to cover all injections among people who regularly inject illicit drugs was calculated by multiplying the percentage of PWID in each injection frequency category by the total number of people who regularly inject illicit drugs, then multiplying by the mean number of syringes required per day and finally multiplying by 365 days to obtain the annual quantity of syringes required for each injection frequency group and summing these quantities. The proportion of injections covered by a sterile syringe was calculated by dividing the total number of syringes distributed by the total number of syringes required to cover all injections. Coverage of 100% equated to all injections administered by people who inject illicit drugs on a regular basis covered by a sterile syringe. We conducted uncertainty analyses using lower and upper limits of the number of syringes required in each frequency of injection category.

3. Results

The relative change in key indicator data each year since 2005 is shown in Fig. 1, reflecting trends in injection drug use over time. Opioid-related deaths and new diagnoses of HCV among people aged 15–24 years declined between 2005 and 2016 (relative change of less than 1) but most other indicators (lifetime/recent injection, drug-related arrests and seizures, and opioid-related hospital admission/separations) increased or were relatively stable. The log fit of the median of these indicators shows a moderate increase in the prevalence of injection drug use over the period 2005–2016 (Fig. 1).

Our data indicate that the Australian population of people who regularly inject illicit drugs was stable over the past five years (range 76,420 [57,400 – 113,870] in 2012 to 77,270 [58,040–115,140] in 2016). Although we observed a 7% increase in the population between 2005 (72,000) and 2016 (77,270, Fig. 2), the Australian population of people aged ≥15 years increased by 21%, from 16.2 million in 2005 to 19.6 million in 2016, resulting in a decline in population prevalence of injection drug use from 0.44% in 2005 to 0.39% in 2016. We observed a 44% increase in the annual number of syringes distributed over the same period, from 34 million syringes distributed in 2005 to 49 million syringes distributed in 2016. Similarly, the number of syringes distributed per people who regularly inject illicit drugs increased by 36%, from 470 syringes/person in 2005 to 640 syringes/person in 2016 (Table 2).

Estimates of syringe coverage per injection are shown in Table 3. We calculated that although the proportion of injections covered by a sterile syringe in Australia increased over time, the number of syringes

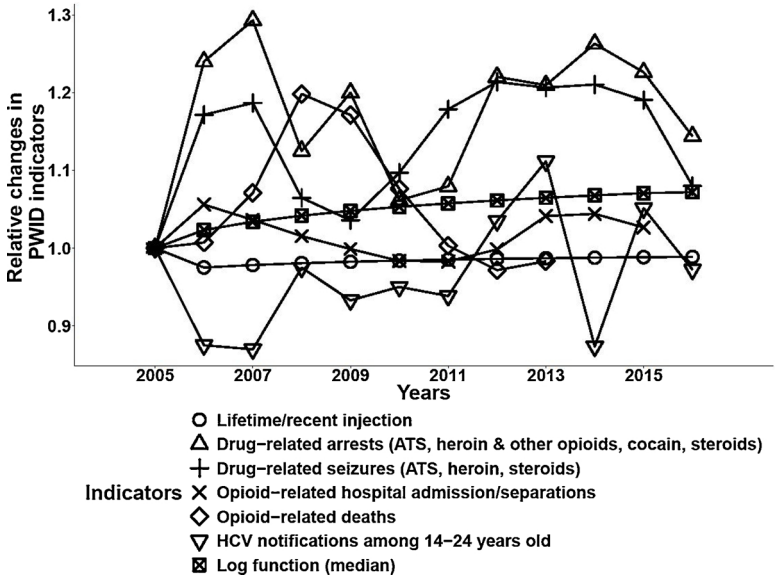

Fig. 1. Relative changes in PWID indicators, 2005–2016.

distributed was inadequate to cover all injections between 2005 and 2012, with the mid-point estimate of the proportion of injections covered by a sterile syringe exceeding 100% for the first time in 2013 (Fig. 3). In 2016, 108% (88%–134%) of injections among people who regularly inject illicit drugs were covered by a sterile syringe.

4. Discussion

NSPs are highly cost-effective and have prevented considerable HIV and HCV transmission globally (Platt et al., 2018), as well as in Australia, where they have also been shown to be cost saving (Kwon et al., 2012, 2009). Australia has a well-developed and widespread network of NSPs which has existed for more than three decades (Iversen et al., 2014). In 2016, Australia distributed 49 million syringes to an estimated population of 77,270 people who regularly inject illicit drugs, equating to 640 syringes per person, the equivalent of ˜2 syringes per person per day. Although we observed only a marginal increase (7%) in the size of the population of people who regularly inject illicit drugs between 2005 and 2016, both overall syringe distribution and the estimated number of syringes per person increased by 44% and 34% respectively. It should also be noted that the increase in syringe distribution commenced around 2009 and coincided with an increase in the total number of NSP services operating in Australia, from 2882 in 2008 to 3627 in 2016 (Iversen et al., 2016).

Despite high syringe coverage, with more than double the 200 syringes per PWID per annum as defined by UNAIDS (Joint United Nations Programme on HIV/AIDS (UNAIDS), 2017) distributed in all years since 2005, syringe coverage as a proportion of all injections among people who regularly inject illicit drugs in Australia only exceeded 100% for the first time in 2013, when 550 syringes per person were distributed. This is well in excess of the 33 syringes provided per

Table 2
Syringe distribution per PWID, 2005–2016.

Year	Needle syringe distribution	Estimated number of PWID (best estimate and lower-upper bounds)	Syringes per PWID[1] (best estimate and lower-upper bounds)
2005	34,072,110	72,000 (54,080 - 107,290)	470 (320 - 630)
2006	32,374,880	73,680 (55,340 – 109,790)	440 (300 – 590)
2007	34,168,070	74,440 (55,910 -110,450)	460 (310 – 610)
2008	33,878,260	75,010 (56,340 – 111,290)	450 (300 – 600)
2009	35,399,550	75,450 (56,670 – 112,430)	470 (320 – 630)
2010	35,674,730	75,830 (56,950 – 112,990)	470 (320 – 630)
2011	39,104,930	76,140 (57,190 – 113,460)	510 (350 – 680)
2012	41,646,020	76,420 (57,400 – 113,870)	550 (370 - 730)
2013	43,009,490	76,670 (57,580 – 114,240)	560 (380 – 750)
2014	43,740,410	76,890 (57,750 – 114,570)	570 (380 – 760)
2015	46,402,120	77,090 (57,900 – 114,870)	600 (400 – 800)
2016	49,090,810	77,270 (58,040 – 115,140)	640 (430 – 850)

[1] Formula to calculate syringes per PWID: syringes distributed/PWID.

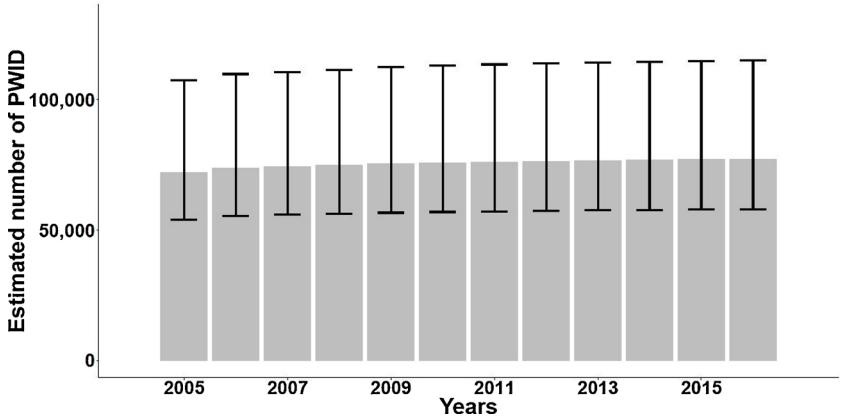

Fig. 2. Estimated size of the population of people who regularly inject drugs in Australia, 2005–2016 (best estimates, upper and lower bounds).

Table 3
Syringe coverage per injection among PWID, 2005–2016.

Proportion of PWID by frequency of injection[1]						Total PWID[2]	Syringes required[3](millions)	Syringes distributed (millions)	% Injections covered by a sterile syringe[4]
Year	> 3 times per day	2-3 times per day	once per day	< daily	< weekly				
2005	14%	19%	22%	27%	18%	72,000	40.2 (32.4–49.1)	34.1	85 (69-105)
2006	14%	18%	21%	27%	21%	73,680	40.3 (32.5–49.3)	32.3	80 (66-100)
2007	11%	19%	23%	27%	20%	74,440	38.0 (30.8–46.6)	34.2	90 (73-111)
2008	13%	20%	21%	29%	17%	75,010	41.9 (33.7–51.4)	33.9	81 (66-100)
2009	12%	21%	24%	26%	17%	75,450	41.7 (33.8–50.8)	35.4	85 (70-105)
2010	12%	19%	19%	33%	18%	75,830	39.3 (31.4–48.6)	35.7	91 (73-114)
2011	12%	20%	23%	27%	18%	76,140	40.9 (33.1–49.9)	39.1	96 (78-118)
2012	13%	19%	21%	26%	21%	76,420	41.9 (33.8–51.1)	41.6	99 (81-123)
2013	12%	18%	20%	28%	21%	76,670	39.9 (32.1–49.0)	43.0	108 (88-134)
2014	14%	19%	21%	29%	17%	76,890	42.8 (34.5–52.5)	43.7	102 (83-127)
2015	14%	18%	21%	29%	18%	77,090	42.1 (33.9–51.7)	46.4	110 (90-137)
2016	15%	21%	20%	27%	17%	77,270	45.4 (36.5–55.5)	49.1	108 (88-134)

[1] Rounded data are shown. Source: Australian Needle Syringe Program Survey National Data Reports, The Kirby Institute, UNSW Sydney, Sydney Australia.
[2] Best PWID estimate.
[3] Formula to calculate annual syringes required: ((% PWID in each injection frequency category * total number of PWID) * syringes required per day) * 365.
[4] Formula to calculate injections covered: (syringes distributed/syringes required) *100.

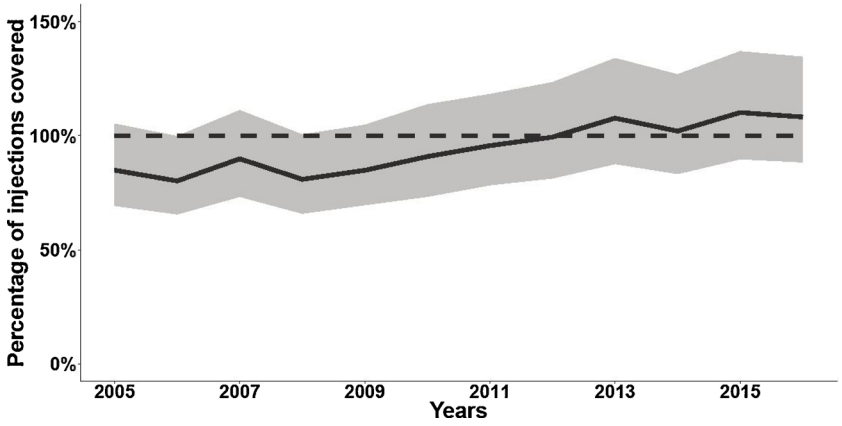

Fig. 3. Syringe coverage per injection among PWID, 2005–2016. The bold line represents the percentage of injections covered, the shaded area represents the upper and lower estimates of percentage injections covered, and the dashed line refers to 100% syringe coverage.

PWID per annum globally (Larney et al., 2017b), with only 1% of PWID (216,500) estimated to be living in countries with high coverage of NSP (Prins and Bruneau, 2017). Moreover, our results indicate that even in countries with high syringe coverage by UNAIDS standards, the demand for syringes is unlikely to be met. Although Australian syringe coverage as a proportion of injections was between 102–110% in all years since 2013, coverage of > 100% is required to account for syringes used by PWID who inject occasionally and needles and/or syringes that are not used for injection, including those used for drawing up, failed injection attempts, stockpiling and wastage (McCormack et al., 2016; O'Keefe et al., 2017).

The triennial Australian National Drug Strategy Household Survey reported that 0.3% of the general population aged 14 years or older had injected drugs at least once in the previous 12 months in 2016, equating to ˜60,000 PWID (Australian Institute of Health and Welfare, 2017). This is lower than our estimate of 77, 270 PWID in 2016, however, recruitment methods of household surveys typically undercount hidden population such as PWID, and high rates of unstable housing have been observed in this population (Topp et al., 2008). Further, people may be reluctant to disclose information relating to injection drug use due to the illegality and stigma associated with this activity. To address this limitation, we conducted additional analyses, where we a) applied a reduced weight for household survey data and b) excluded household survey data to minimize the impact of possible bias in this indicator. Both of these analyses had minimal impact on our annual PWID estimates (for example 77,270 PWID, 76,860 PWID, and 79,990 PWID in 2016 using 100% weights, 25% weights and excluding the household survey indicator respectively). Given these additional results, the difficulty determining the magnitude of bias in household survey data, and our use of temporal trends only, we have not reduced the weighting nor excluded this indicator.

A recently published indirect prevalence estimate, using one multiplier in a single year, estimated that in 2014 there were 93,000 (68,000–118,000) people aged 15–64 years who injected drugs in the previous 12 months in Australia (Larney et al., 2017a). Our estimate of 76,888 (57,750-114,570) PWID in 2014 overlaps with this study, thereby providing some validation that the two methods (relative change of indicators based on previous back projection estimates and multiplier method) provide consistent PWID size estimates. Given there is no gold standard for calculating PWID population size estimates and considerable benefits to peer-reviewed publication of multiple population size estimates (Wesson et al., 2017) we present our method as one that is relatively easy to reproduce on an annual basis, enabling both an assessment of trends in the population size over time and providing utility as an annual denominator for epidemiological studies.

While we have used the best available local data, we acknowledge that indicator data have limitations. As previously mentioned, the Australian Institute of Health and Welfare household survey estimate of the number of people who have recently injected illicit drugs is likely an underestimate, however, any biases are likely to be consistent at the

population level over time and have a minimal impact on trend analysis. It should also be noted that arrest indicator data may reflect policing activity that specifically targets PWID and that opioid-related mortality and morbidity indicators likely include people with routes of administration other than injection. We attempted to address these limitations by using a combined median of all indicators and using a log function regression to obtain a smooth fit of the data. Data on frequency of injection were self-reported and subject to potential reporting bias given that injection frequency among PWID may change over time. Finally, we provide estimates for the population size of people who inject illicit drugs on a regular basis, excluding those who inject occasionally who also require a small number of syringes per annum. Although this will result in a minor overestimate of syringe coverage, both per person and per injection, we present upper and lower confidence intervals which would account for syringes used by people who inject illicit drugs on an occasional basis. Despite these limitations, our methodology and results provide a platform from which to monitor trends in syringe coverage over time, an increasingly important endeavor given the advent of HCV DAA therapy and the need to monitor progress towards World Health Organization hepatitis elimination goals (World Health Organization, 2016).

We extended previous back projection estimates of the population of people who regularly inject illicit drugs from 2005 (Razali et al., 2007) to 2016 using the relative change of illicit drug-related indicators over time. Our study demonstrates that Australia's comprehensive and widespread network of NSPs have been highly effective in distributing sterile syringes and increasing syringe coverage over time, although syringe coverage per injection at 108% in 2016 is likely to be only narrowly meeting demand. Although further research is necessary to evaluate the impact of syringe coverage by geographic region, our analysis supports the need to maintain and enhance the role of NSPs as the key intervention for the primary prevention of HIV and HCV transmission among PWID (Iversen et al., 2017; Kwon et al., 2009). This is further supported by the additional benefits of NSP services, such as the prevention of injection-related injury and disease (Dwyer et al., 2009; Ivan et al., 2015; Topp et al., 2008), referral to a range of other health and social services, including drug and HCV treatment (Iversen et al., 2018), and access to naloxone (McDonald et al., 2017) and drug checking services (Harper et al., 2017; Sherman et al., 2018). In 2016, 80–90% of Australia's ~11,000 annual HCV notifications and 1–6% of the ~1000 annual HIV notifications were attributable to injection drug use (The Kirby Institute, 2017). We conclude that syringe distribution well in excess of UNAIDS syringe high coverage of 200 syringes per PWID per annum is required in order to cover all injections with a sterile syringe and to prevent transmission of blood borne viral infections, including reinfection following clearance of hepatitis C virus.

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Contributors

JAK conducted analysis, interpretation of findings and writing of the manuscript; ML, KD, and HW contributed to data interpretation and provided critical revisions of the manuscript; LM and JI led the study and contributed significantly to study design, interpretation of findings, writing and editing of the manuscript. All authors approved the final version of the manuscript.

Conflict of interest

No conflicts declared.

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