

## Effectiveness of needle and syringe programmes for preventing HIV transmission

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### Abstract

**Objective:** To examine the effectiveness of needle and syringe programmes (NSPs) in preventing HIV transmission among injecting drug users (IDUs).

**Methods:** An ecological study design was used to determine change in HIV prevalence among injecting drug users between cities with and without NSPs. Several data sources, such as electronic journal databases, surveillance reports, websites, and index review of relevant journals, were used to identify studies of HIV seroprevalence among IDUs, and presence of NSPs. The rate of change in HIV prevalence was estimated by regression analysis.

**Results:** There were 778 years of data from 99 cities globally included in the analysis. HIV prevalence decreased by 18.6% per annum in cities that introduce NSPs, and increased by 8.1% in cities that had never introduced NSPs (mean difference  $-24.7\%$  [95% CI:  $-43.8, 0.5\%$ ],  $P = 0.06$ ). The mean difference was  $-33\%$  when comparison was weighted to one over the variance of the regression estimator (29% decrease in cities with NSPs and 5% increase in cities without NSPs,  $P < 0.001$ ). When analysis was restricted to cities with first HIV seroprevalence less than 10%, the average annual change in seroprevalence was 18% lower in cities with NSPs ( $P = 0.03$ ).

**Conclusions:** Despite the inherent limitations within an ecological study design, the study provides additional evidence that NSPs reduce transmission of HIV infection. The rapid spread of HIV among IDU populations and increasing rates of injecting in many countries calls for scaling up of NSPs as well as other harm reduction strategies.

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### Introduction

Measures to prevent HIV infection among people who inject drugs generally focus on preventing blood contact during injection by reducing injection or promoting use of sterile equipment when injecting. Consequently, needle and syringe programmes (NSPs) are a key strategy for preventing transmission of HIV infection in many developed countries (Drucker, Lurie, Wodak, & Alcabes 1998). In some countries, implementation has often been limited by uncertainty about their effectiveness.

Randomised trials of the effectiveness of NSPs in preventing HIV transmission have not been conducted. It is lo-

gistically difficult to randomly allocate access to NSPs, although community randomisation is feasible. However, because of the strong biological plausibility of avoiding HIV infection by using a sterile syringe for injection, there are grave ethical concerns attached to randomised trials of this nature.

Several studies have assessed the impact of NSPs on self-reported risk behaviours, in particular use of sterile syringes or re-use of one's own syringe since NSP introduction (reviewed in Drucker et al., 1998). A few studies have compared HIV incidence or prevalence between participants and non-participants of NSPs (Bruneau, Lamothe, & Franco 1997; Des Jarlais, Hagan, & Friedman, 1996; Hagen, McGough, & Thiede 1999; Van Ameijden, Van den Hoek, Mientjes, & Coutinhovan, 1993). One study compared NSP implementation in countries with sustained low HIV prevalence to those with high HIV prevalence (Des Jarlais et al., 1995). Another used an ecological study design to compare

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changes in HIV prevalence in cities with and without NSPs (Hurley, Jolley, & Kaldor, 1997).

Data generally, but not always, show NSPs to be effective in preventing HIV transmission. Based on the previous ecological study methodology (Hurley et al., 1997), we have examined the effectiveness of NSPs in reducing HIV infection because several countries have introduced NSPs since the initial study was carried out in the mid-1990s.

## Methods

Comparison of HIV infection among studies of injecting drug users (IDUs) in cities with and without NSPs was made using an ecological study design. Data on HIV seroprevalence and presence or absence of NSPs were identified to the end of 2000. HIV prevalence estimates based on saliva sampling were also included. NSPs were defined as programmes distributing needles and syringes. The operational characteristics of NSPs vary widely both within and between cities and countries. However, for the purposes of this study NSPs were included irrespective of whether they provided syringes free or with minimal charge, whether they operated from a fixed or mobile site, whether return of a used syringe was mandatory, or the range of other HIV prevention and treatment services provided.

Several sources were used to identify reports of HIV prevalence among injecting drug users and implementation of NSPs. Three electronic databases, Medline, Embase and Current Contents, were searched from January 1984 to June 2001. Additional studies were obtained from country specific surveillance reports, the HIV/AIDS Surveillance Database (US Census Bureau & UNAIDS, 2000), relevant websites, and through review of the index of relevant journals. Email contact was also made with key researchers in most countries.

Studies with sample size of at least 50 were included. Cities with HIV prevalence studies were only included if HIV was measured among injecting drug users in 2 or more calendar years. Studies of HIV among incarcerated injecting drug users were excluded because very few countries provided NSPs during imprisonment. Studies reported in journals published in languages other than English were only included if all required data points and sufficient information to determine whether the study was suitable for inclusion were provided in the abstract. References for seroprevalence data used in the analysis are available on request.

Number of injectors tested per calendar year, percentage with HIV antibody, presence or absence of NSP, and recruitment site were recorded for all studies. If studies reported data aggregated for more than 1 calendar year, the mid-point of the study period was used as the survey date.

Analyses compared city specific change in HIV prevalence in cities with NSPs to those without NSPs at the time of the surveys. The annual rate of change of HIV prevalence was estimated for each city by fitting a regression line on

a logit scale, with calendar years centred to 1990. Annual rate of change of HIV prevalence was also estimated using regression weighted comparison of cities with and without NSPs according to one over the variance of the regression estimator to allow comparison with the previous ecological study (Hurley et al., 1997). The effect of NSPs was assessed by comparing the annual rate of change in HIV seroprevalence in cities that had ever introduced NSPs with cities that had never introduced NSPs.

Analyses of HIV seroprevalence were performed comparing all cities, and also in the subset of cities with an initial HIV seroprevalence of less than 10% that had results from at least three surveys available over at least 3 years. Analyses were repeated using regressions weighted according to survey sample size, and excluding cities in developing countries.

## Results

### *HIV seroprevalence*

There were 778 calendar years of data from 99 cities with HIV seroprevalence measurements from more than 1 year and information on NSP implementation. Studies were from 63 cities without NSPs and 36 cities with NSPs (Table 1). HIV prevalence ranged from 0 to 79% at the first data point for each city (median 18). Studies with first HIV prevalence of 10% or less were available from 19 cities without and 25 cities with NSPs. To illustrate the fitting procedure, the fitted regression lines and the reported HIV seroprevalence survey results are shown for two typical cities (Milan, Italy and Sydney, Australia) in Fig. 1a and b, respectively.

The overall comparison of annual rates of change of HIV seroprevalence in cities that never introduced NSPs with cities that did introduce NSPs are summarised in Table 2. Cities that introduced NSPs had a mean annual 18.6% decrease in HIV seroprevalence, compared with a mean annual 8.1% increase in HIV seroprevalence in cities that had never introduced NSPs (mean difference  $-24.7\%$ ,  $P = 0.06$ ). The mean difference was 32.7% when comparison was weighted to one over the variance of the regression estimator (29.2% decrease in cities with NSPs and 5.1% increase in cities without NSPs,  $P < 0.001$ ).

In cities with an initial HIV prevalence less than 10% and with sero-surveys over a period of at least 3 years, the mean annual weighted increase in HIV prevalence was 32.1% in cities that did not introduce NSPs, compared with a mean annual decrease of 7.8% in cities with NSPs (weighted mean difference  $-18.4\%$ ,  $P = 0.03$ ).

Variability of the point estimate was markedly reduced and statistical significance markedly increased when the analyses for all cities and cities with HIV prevalence less than 10% were weighted according to one over the regression estimate. There was little change in the point estimate using weighted analysis. Other analyses, using regressions

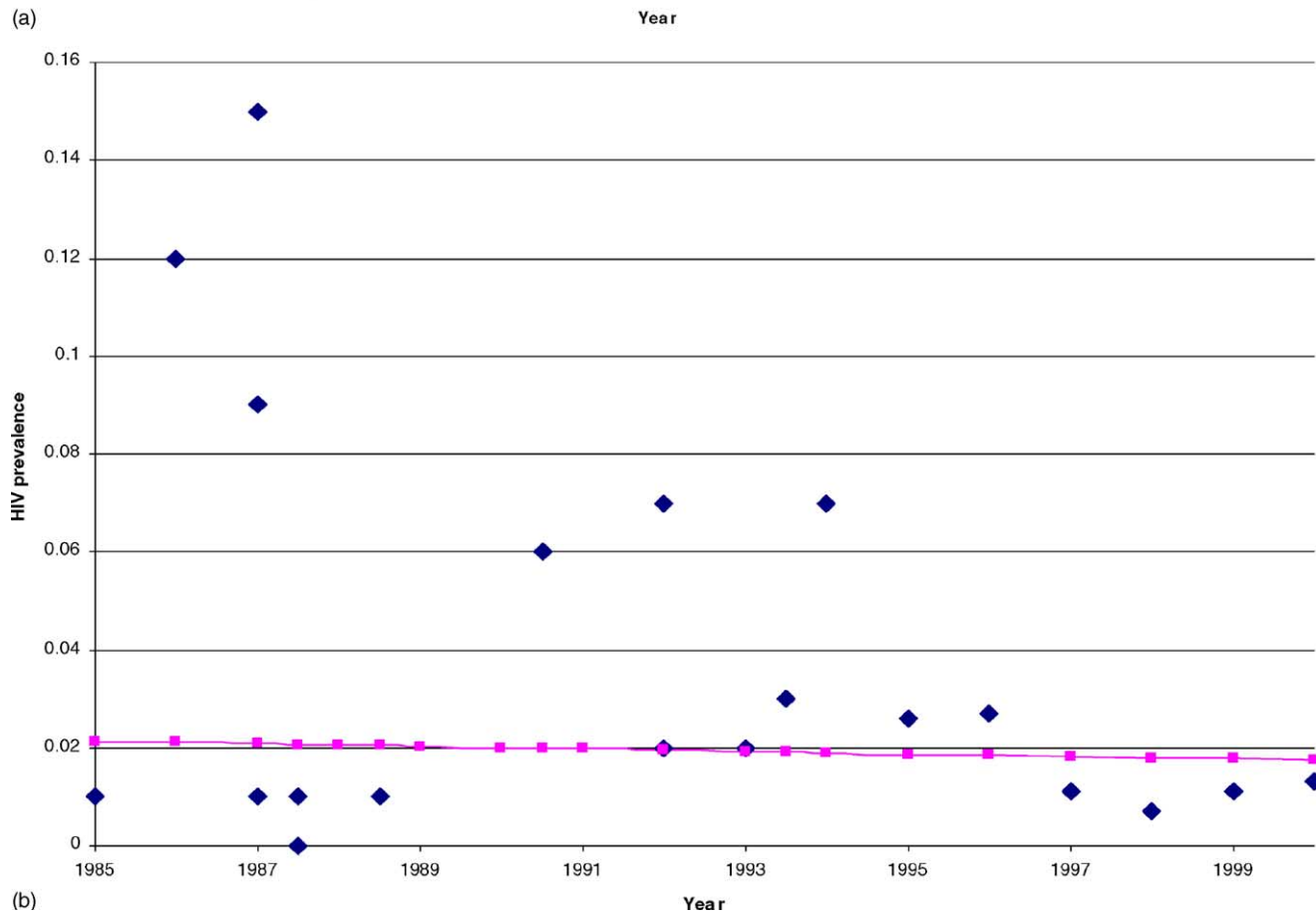
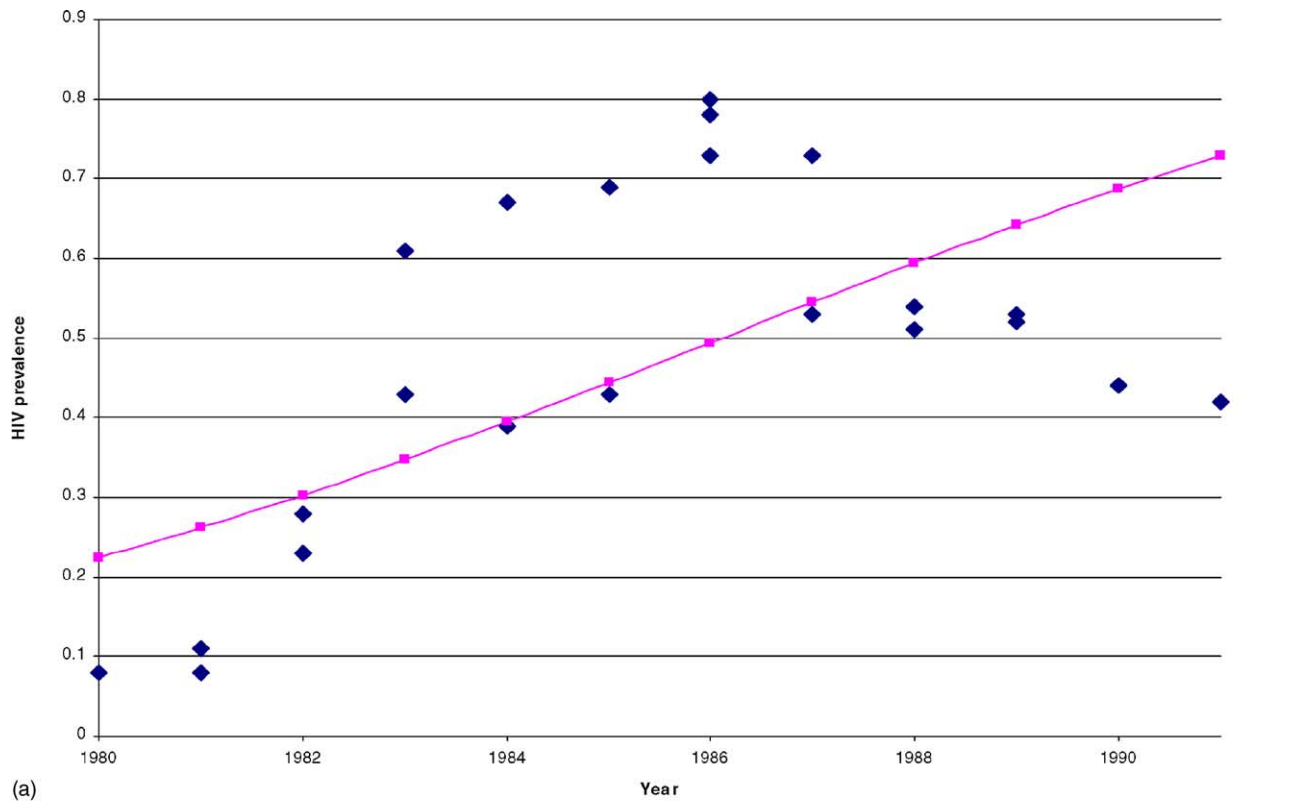


Fig. 1. (a) HIV seroprevalence in injecting drug users per year of survey for a city without NSP, Milan, Italy. (Lines represent fitted values from the logistic regression model.) (b) HIV seroprevalence in injecting drug users per year of survey for a city with NSP, Sydney, Australia. (Lines represent fitted values from the logistic regression model.)

Table 1  
Location of studies and sites of recruitment for cities with at least two HIV prevalence studies according to NSP status

Location of studies	Number of cities without NSP	Number of cities with NSP
Asia		
China	3	0
India	1	1
Malaysia	4	0
Myanmar	4	0
Nepal	0	1
Thailand	18	2
Vietnam	0	1
Australia	0	10
Canada	0	3
Europe		
Austria	0	1
Czech Republic	1	0
Denmark	0	1
France	0	1
Germany	0	1
Greece	0	1
Israel	1	0
Italy	10	0
The Netherlands	0	2
Spain	3	0
Switzerland	0	1
South America		
Argentina	0	1
Brazil	5	0
United Kingdom	0	5
United States	13	4
Total cities	63	36
Recruitment sites		
Forensic medicine institutes	0	4
Detoxification/rehabilitation	226	19
Drug treatment agency	95	80
Entry to treatment	33	17
Field & snowball	16	32
Health service	0	2
HIV testing centre	6	17
Infectious diseases hospital	14	1
Multiple sites	15	67
NSP/pharmacy	0	62
Sexual health clinics	4	14
Other/not reported	26	28
Total studies	435	342

weighted according to survey sample size, and also excluding cities in developing countries, gave similar results (data not presented).

## Discussion

On average, HIV seroprevalence decreased in studies of injecting drug users in cities with NSPs whereas in studies

from cities without NSPs, HIV seroprevalence increased. Similar results were obtained when analysis was restricted to cities with initial HIV prevalence of less than 10%, weighted according to survey sample size or when cities in developing countries were excluded.

There are several limitations associated with the ecological study design that should be considered when interpreting the findings from these studies. Seroprevalence data used in the analyses were collected according to different protocols and in diverse populations. It is possible that recruitment through NSPs might provide access to less dependent injectors than those recruited through treatment services. However, there is also some evidence to suggest that some NSPs attract injectors with high levels of HIV risk behaviour (Hagen et al., 1999; Hahn, Vranizan, & Moss, 1997; Miller, Tyndall, Spittal, Li, & Palepu, 2002). Because cities were selected for analysis by the existence of published HIV serological surveys, bias may have been introduced by the decision to do a survey in a particular city at a particular time.

Data on NSPs used in the analyses were based on presence or absence of NSPs rather than on the extent and uptake of these services. Given the positive findings, that is, that presence of NSPs results in a decreased HIV prevalence, then it is likely that HIV prevalence would be lower in cities where availability and uptake of NSPs is extensive compared to cities with limited uptake. In addition, it was not possible to separate the effects of implementation of NSPs from the other HIV prevention strategies such as pharmacy availability of syringes and methadone maintenance treatment (Fischer, Rehm, & Blitz-Miller, 2000). The excess risk of HIV in people who inject drugs is not due solely to sharing needles as other injecting practices and sexual behaviour patterns increase HIV risk.

It is also possible that HIV seroprevalence may have remained low in some of the cities with NSPs, irrespective of their introduction. If NSPs decrease the incidence of HIV, the rate of increase in seroprevalence should decrease, although the seroprevalence itself may not decrease, at least initially. The annual mean decrease in HIV seroprevalence was much lower in the repeated study, around half, than in the original paper (Hurley et al., 1997) possibly due to the longer time period represented by the studies.

NSPs influence HIV transmission by increasing use of sterile syringes for injection and lowering the rate of syringe sharing thereby reducing contact with the virus. In many settings, NSPs also provide condoms, education about minimising risk and referrals to drug treatment centres. Even though the difference in rate of change of HIV seroprevalence between cities with and without NSPs may not be due solely to NSPs, the study provides strong evidence that NSPs reduce the spread of HIV infection. Consequently, the rapid spread of HIV among IDU populations and increasing rates of injecting in many countries calls for scaling up of NSPs as well as other harm reduction strategies.

Table 2

Estimated annual rate of change in HIV seroprevalence according to weighting of analysis and sample selection for cities without and with NSPs

Weighting of analysis/sample selection	Cities without NSPs	Cities with NSPs
No weighting of analysis		
All cities		
Number	63	36
Mean (95% CI)	8.1% (−2.8, 20.1%)	−18.6% (−42.6, 15.3%)
Mean difference (95% CI)	−24.7% (−43.8, 0.5%), $P = 0.057$	
Cities with initial HIV prevalence <10%, 3 calendar years of data		
Number	19	25
Mean 95% CI	28.6% (−4.9, 73.8%)	−4.0% (−28.5, 29.0%)
Mean difference (95% CI)	−25.3% (−50.8, 13.3%), $P = 0.165$	
NSP comparison weighted to one over the variance of the regression estimator		
All cities		
Number	63	36
Mean (95% CI)	5.1% (1.4, 9.1%)	−29.2% (−30.8, −27.6%)
Mean difference (95% CI)	−32.7% (−37.5, −27.6%), $P = <0.001$	
Cities with initial HIV prevalence <10% and 3 calendar years of data		
Number	19	25
Mean	32.1%	7.8
95% CI	(22.1, 42.8%)	(−4.8, 22.0%)
Mean difference (95% CI)	−18.4% (−32.0, −2.0%), $P = 0.030$	

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