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Research Paper

HIV Incidence and Risk Behaviours of People Who Inject Drugs in Bangkok, 1995–2012

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ARTICLE INFO

Article history:

Received 19 November 2018

Received in revised form 15 March 2019

Accepted 19 March 2019

Available online 1 April 2019

Keywords:

HIV

People who inject drugs

HIV pre-exposure prophylaxis

Thailand

Tenofovir

ABSTRACT

Background: Three consecutive prospective studies were conducted among people who inject drugs (PWID) from May 1995 through June 2012 in Bangkok, Thailand. We examined data from these studies to evaluate HIV incidence and explore trends in risk behaviours.

Methods: We used data from a 1995–1998 cohort study, a 1999–2004 HIV vaccine trial, and a 2005–2012 HIV pre-exposure prophylaxis (PrEP) study to examine per-quarter trends in HIV incidence, using a restricted cubic spline function for time in a Poisson regression. We also examined temporal trends in HIV-associated risk behaviours.

Findings: HIV incidence declined from 5.7 per 100 person-years during the cohort study, to 2.7 per 100 person-years in the vaccine trial, to 0.7 per 100 person-years among PrEP study placebo recipients. Incidence peaked at 12.1 per 100 person-years in 1996 and declined to <1 per 100 person-years during 2005–2012. Reports of injecting drugs and sharing needles also declined from the cohort study to the PrEP study ($p < 0.0001$). Heroin was the most common drug injected during the cohort study and the vaccine trial, but stimulants (e.g., methamphetamine) and sedatives (e.g., midazolam) were injected more often during the PrEP study.

Interpretation: HIV incidence among PWID declined during 2005–2012. Several factors likely contributed to the decline, including decreases in the frequency of injecting and sharing, improved access to HIV testing and antiretroviral therapy, and the use of PrEP. Expanding access to effective HIV prevention tools can hasten control of the HIV epidemic among PWID.

Funding: The Bangkok Metropolitan Administration and U.S. Centers for Disease Control and Prevention, Division of HIV/AIDS Prevention.

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Research in context

Evidence before this study

We searched PubMed on June 20, 2018, for manuscripts describing HIV incidence among people who inject drugs (PWID) in Bangkok. We used the following search terms: “people who inject drugs”, “PWID”, “IDU”, “HIV”, “Bangkok”, and “Thailand”. We found 52 publications, including four HIV incidence studies in PWID, three were studies analysed in this report, and one was a retrospective study to estimate incidence among PWID treated at a drug treatment centre in Thailand. We did not identify any prospective studies of temporal trends in HIV incidence or HIV-associated risk behaviours among PWID.

Added value of this study

In this manuscript, we report temporal trends in HIV incidence, risk behaviours, and incarceration among PWID in Bangkok. To our knowledge, the three studies included in this analysis represent the largest prospective cohorts of PWID followed in Thailand, possibly in Asia. We describe a significant, 97%, decline in HIV incidence, changes in drug use, and reductions in needle and syringe sharing and activities among PWID in the studies.

Implications of all the available evidence

HIV prevalence among PWID in Bangkok increased from <1% to 40% in 1988. Beginning in 1995, three consecutive prospective studies enrolled a large proportion of HIV-uninfected PWID in Bangkok, providing frequent HIV risk-reduction counselling, access to methadone treatment, HIV testing with linkage to care if needed, and, in the Bangkok Tenofovir Study, pre-exposure prophylaxis (PrEP). HIV incidence among PWID declined from 12.1 per 100 person-years in 1996 to <1.0% during 2005–2012. Several factors likely contributed to the decline including decreases in the frequency of injecting and sharing of injection equipment, access to HIV testing and antiretroviral therapy, and the use of PrEP. Maintaining and expanding access to effective HIV prevention tools can hasten control of the HIV epidemic among PWID.

1. Introduction

HIV prevalence among people who inject drugs (PWID) in Bangkok, Thailand increased from <1% to 40% in 1988 [1,2]. In response, the Bangkok Metropolitan Administration (BMA), in collaboration with the U.S. Centers for Disease Control and Prevention (CDC), launched a series of studies to better understand the HIV epidemic among PWID and to identify and implement effective HIV prevention tools.

The studies provided HIV incidence [3–6] and population size estimates for PWID [7–9]; demonstrated the emergence of HIV-1 CRF01_AE as the predominant subtype among PWID in Bangkok [10, 11]; described HIV-associated risk behaviours [3,12–15], changes in drug use [16,17], and mortality of PWID [3,18]; showed that incarceration was associated with HIV infection [19,20], and that methadone and PrEP can reduce the risk of HIV infection [5,20].

Three consecutive prospective studies were conducted from May 1995 through June 2012. The first was an observational cohort study [3], the second was an HIV vaccine trial (AIDSVAX B/E) [4], and the third was an HIV pre-exposure prophylaxis (PrEP) study, the Bangkok Tenofovir Study [5]. We examined longitudinal data from the three consecutive prospective studies to evaluate HIV incidence, and to explore

trends in risk behaviours and other factors that may have influenced HIV incidence over time.

2. Methods

2.1. Participants and Setting

Descriptions of the three consecutive prospective studies have been published [3–5]. Briefly, HIV-uninfected individuals who reported injecting drugs during the previous year were candidates for enrolment. Volunteers meeting eligibility criteria could enrol after signing informed consent. Some volunteers participated in more than one study, but participant identification codes were unique for each study, and data could not be linked for participants in consecutive studies.

The studies were conducted in BMA drug-treatment clinics located in densely populated urban communities of Bangkok. The clinics offer a range of services to PWID including HIV counselling and testing, risk-reduction counselling, including the importance of using new unused needles and syringes, social and welfare services, health education, primary medical care and medical referrals as needed, methadone treatment, and condoms, all free of charge [2,3,21]. Thailand's narcotics law prohibits the distribution of syringes and needles to inject illicit drugs. Consequently, injection equipment was not provided in the clinics during the studies. However, new syringes and needles can be purchased without a doctor's prescription at low cost (5–10 baht/0.12–0.25 U.S. dollars) in pharmacies in Bangkok.

The 1995–1998 cohort study was a prospective observational study that aimed to describe HIV associated risk behaviours, estimate HIV incidence, and assess the willingness of PWID to participate in HIV prevention trials [3]. Based on the willingness of PWID to join the cohort study and return for follow-up visits, the sustained high HIV incidence, and phase 1/2 trials of subtype B and B/E recombinant glycoprotein 120 vaccines demonstrating safety and immunogenicity [22,23], in 1999 a randomised, double-blind, placebo-controlled trial of the AIDSVAX B/E HIV vaccine was launched in the same 15 BMA drug-treatment clinics as the cohort study, plus two newly opened BMA drug-treatment clinics [4].

Vaccine trial participants who completed 36 months of follow-up were offered enrolment in a vaccine trial extension study through September 2004. The extension study used the same procedures as the vaccine trial except no vaccine was given. We combined data from the AIDSVAX B/E HIV vaccine trial and the extension study for this analysis. The AIDSVAX B/E vaccine did not prevent HIV transmission [4] and in June 2005, we launched the Bangkok Tenofovir Study [5,21], a randomised, double-blind, placebo-controlled PrEP study in the same drug-treatment clinics as the vaccine trial.

2.2. Study Procedures

An interviewer-administered questionnaire was used to assess injection drug use, needle sharing, risk behaviours, and incarceration at enrolment and every 4 months during the cohort study, and every 6 months during the vaccine trial, and an audio computer-assisted self-interview was used every 3 months to assess the same factors during the PrEP study. Risk-reduction counselling and health education were provided at every study visit.

Staff collected blood from cohort study participants at enrolment and every 4 months, and from vaccine trial participants every 6 months to test for HIV antibodies using enzyme immunoassays (EIA) (Genetic Systems-Biorak ELISA) and Western blot [3,4]. In the PrEP study, oral fluid was collected monthly (OraQuick Rapid HIV-1/2 Antibody Test; OraSure Technologies Inc., Pennsylvania, USA) and blood every 3 months, to test for HIV infection using EIA (Genetic Systems HIV-1/HIV-2 Plus O EIA) and Western blot (Bio-Rad, Washington, USA) [5].

2.3. Statistical Analysis

Because HIV incidence was similar in vaccine and placebo recipients in the vaccine trial, we included both groups in our analysis ($n = 2545$); however, HIV incidence was lower in tenofovir recipients in the PrEP study, therefore, we limited HIV incidence analysis to placebo recipients ($n = 1209$).

We used descriptive statistics to summarise demographic and risk behaviour data using Kruskal-Wallis nonparametric tests to compare continuous variables, and chi-square tests to compare categorical variables. HIV incidence and exact 95% Poisson confidence intervals (CI) were calculated for per 100 person-years. We calculated HIV incidence per quarter (3 months), assuming a uniform probability distribution throughout the seroconversion interval between the last negative and first positive HIV tests [6]. We assessed temporal trends in HIV incidence in the 3 studies by quarter, using a restricted cubic spline function for time with 3 knots in a Poisson regression with robust standard error [24,25]. The restricted cubic spline function provides flexible fitting of curves, and allows assessment of linearity and graphical characterisation of the association between the outcome and the predictor. The number of knots chosen was based on the recommendation that 3–5 knots are sufficient [25]. We used Poisson regression to assess the difference in HIV incidence in the studies, and generalised estimating equation logistic regression to adjust for repeated responses by individuals to questions about injecting, sharing needles and syringes, drugs injected, and incarceration.

Quarterly data were available from the 2nd quarter of 1995 through the 2nd quarter of 2012, except for the 4th quarter of 2004 and the 1st quarter of 2005, when the vaccine trial closed and the PrEP study started. There were different time frames for the risk questionnaires in the studies, but we believe the results provide a reasonable and comparable assessment of the risk behaviours and other factors over time. The overall time curves were estimated using a locally weighted scatterplot smoother (LOWESS). We used SAS (Version 9; SAS Institute, Cary, North Carolina, USA) and Stata/SE 13 (Stata Press, College Station, Texas, USA) for analysis.

2.4. Ethical Oversight

Ethical Review Committees of the BMA and the Thailand Ministry of Public Health, and the CDC Institutional Review Board approved all three studies. In addition, the Ethical Review Committee of Mahidol University approved the vaccine trial. A Community Relations Committee, made up of one or more PWID from each of the BMA drug-treatment clinics, met with investigators every two months to provide community input and guidance throughout the vaccine trial and the PrEP study [21].

2.5. Role of Funding Source

Staff of the studies sponsors (i.e., BMA and CDC Division of HIV/AIDS Prevention) participated in the analysis and interpretation of the results. The corresponding author had access to all the data and decided to submit the manuscript for publication.

3. Results

The median age of the 1209 participants in the cohort study was 31 years (interquartile range [IQR] 24–38), of the 2545 vaccine trial participants was 26 years (IQR 22–34), and of the 2413 PrEP study participants was 31 years (IQR 26–37) ($p < 0.0001$) (Table 1). The proportion of women enrolled in the studies increased from 6.5% in the cohort study and 6.6% in the vaccine trial to 20.3% in the PrEP study ($p < 0.0001$). At enrolment, 95.5% of cohort study participants and 93.8% of vaccine trial participants reported injecting drugs in the previous 6 months, and 95.3% of cohort study participants and 92.5% of vaccine trial participants reported injecting heroin. PrEP study participants were asked about behaviours during the previous 3 months, and a

lower percentage reported injecting drugs (62.7%) and injecting heroin (21.9%). A higher percentage of participants in the PrEP study reported injecting stimulants (e.g., methamphetamine) and sedatives (e.g., midazolam) than participants in the two earlier studies. The proportion of participants reporting sexual intercourse with more than one partner at enrolment increased from 9.3% in the cohort study to 12.0% in the vaccine trial to 21.7% in the PrEP study ($p < 0.0001$) (Table 1).

Among the 1209 PWID who enrolled in the cohort study in 1995–1996 there were 133 incident HIV infections, yielding an HIV incidence of 5.7 per 100 person-years (95% CI 4.8–6.8) (Table 2). HIV-1 CRF01_AE (subtype E) accounted for 78.6% of infections [3]. HIV incidence peaked at 12.1 per 100 person-years in the 3rd quarter of 1996, then declined through mid-1997 and stabilised in 1998 (Fig. 1). The restricted cubic spline function showed linear ($p < 0.0001$) and non-linear trends ($p < 0.0001$), with an inverted-U shape (Table 2, Fig. 1).

A total of 2545 participants enrolled in the vaccine trial in 1999–2000, 2295 (90.2%) were followed until they completed 36 months of follow-up or had a positive HIV test result, and 1848 (89.5%) HIV-uninfected participants continued follow-up in the extension study [4]. During the vaccine trial and extension study, 251 participants tested HIV-positive, yielding an HIV incidence of 2.7 per 100 person-years (95% CI 2.4–3.1) (Table 2). HIV incidence increased from 1.6 per 100 person-years in the 3rd quarter of 1999 to 4.4 per 100 person-years in the 2nd quarter of 2000 then declined to 1.3 per 100 person-years in the 3rd quarter of 2004 (Fig. 1). The restricted cubic spline function showed linear ($p = 0.002$) and non-linear trends ($p < 0.0001$) (Table 2).

During 2005–2012, 2413 PWID enrolled in the PrEP study [5]. Among the 1209 participants randomly assigned to placebo, there were 33 incident HIV infections yielding an HIV incidence of 0.7 per 100 person-years (95% CI 0.5–1.0). The restricted cubic spline function did not show a trend ($p = 0.7$); that is, HIV incidence was relatively constant at 1.0 per 100 person-years or less throughout the PrEP trial (Table 2). HIV incidence declined from 5.7 per 100 person-years in the cohort study to 2.7 per 100 person-years in the vaccine trial to 0.7 per 100 person-years in the placebo arm of the PrEP study ($p < 0.0001$) (Table 2). Incidence peaked at 12.1 per 100 person-years in the 3rd quarter of 1996 during the cohort study declining to < 0.06 per 100 person-years in the final year of the PrEP study (Fig. 1).

The proportion of participants who reported injecting drugs increased to 83.8% in the 4th quarter of 1995, 95.5% in the 3rd quarter of 1999, and 85.8% in the 3rd quarter of 2005 (Fig. 2), coinciding with enrolment activities for the three cohorts. Reports of injecting drugs were higher in the cohort study (odds ratio [OR] 1.0) and the vaccine trial (OR 0.7; 95% CI 0.7–0.8) than the PrEP study (OR 0.2; 95% CI 0.1–0.2), declining significantly from 1995 through 2012 ($p < 0.0001$) (Table 3). Reports of sharing needles also declined over time ($p < 0.0001$) (Fig. 2, Table 3).

The proportion of participants who were incarcerated increased from 10% to 15% during 1995–1999 to 20% to 25% in 2000, and peaked in late 2002 and 2003 at 30% (Fig. 3). Participants in the vaccine trial (1999–2004) were more likely to be incarcerated than participants in the cohort study or the PrEP study ($p < 0.0001$) (Table 3).

Heroin was the most common drug injected during the cohort study (i.e., 65.5% reported injecting heroin at one or more visits) and the vaccine trial (54.7% injected heroin), but stimulants (e.g., methamphetamine) and sedatives (e.g., midazolam) were injected more often than heroin in the PrEP study (Table 3, Fig. 4). Overall, there was a decline in heroin use from the cohort study (OR 1.0) and vaccine trial (OR 0.6; 95% CI 0.6–0.7) to the PrEP study (OR 0.04; 95% CI 0.04–0.05, $p < 0.0001$) and modest declines in the injection use of stimulants and sedatives during the same time period (Table 3).

4. Discussion

HIV incidence among PWID participating in three consecutive prospective studies in Bangkok declined from 12.1 per 100 person-years

Table 1
Baseline characteristics of participants in three prospective studies in people who inject drugs in Bangkok, Thailand 1995–2012.

Characteristic	Cohort study 1995–1998 ³ N = 1209	Vaccine trial 1999–2004 ⁴ N = 2545	PrEP study 2005–2012 ⁵ N = 2413	p value ^a
Male – no. (%)	1130 (93.5)	2376 (93.4)	1924 (79.7)	
Female – no. (%)	79 (6.5)	169 (6.6)	489 (20.3)	<0.0001
Age in years, median (interquartile range)	31 (24–38)	26 (22–34)	31 (26–37)	<0.0001
Education level – no. (%)				
Primary or less (<6 years)	499 (41.3)	834 (32.8)	1154 (47.8)	
Secondary (7–12 years)	483 (40.0)	1177 (46.2)	1045 (43.3)	
Post-secondary	226 (18.7)	534 (21.0)	214 (8.9)	<0.0001
Risk behaviours	Past 6 months (n = 1209)	Past 6 months (n = 2545)	Past 3 months (n = 2405)	
Incarceration – no. (%)				
In police holding cell (jail)		359 (14.1)	552 (23.0)	<0.0001
In prison		188 (7.4)	389 (16.2)	<0.0001
Drug use – no. (%)				
Injected drugs	1155 (95.5)	2388 (93.8)	1507 (62.7)	<0.0001
Injected heroin	1152 (95.3)	2354 (92.5)	527 (21.9)	<0.0001
Injected stimulants (e.g., methamphetamine)	70 (5.8)	388 (15.2)	801 (33.3)	<0.0001
Injected sedatives (e.g., midazolam)	28 (2.3)	236 (9.3)	559 (23.2)	<0.0001
Shared needles – no. (%)	430 (35.6)	790 (31.0)	435 (18.1)	<0.0001
Injection frequency (among those who injected) – no. (%)				
Daily	1042 (90.2)	936 (39.2)	204 (13.5)	
Weekly	58 (5.0)	776 (32.5)	541 (35.9)	
Less than weekly	55 (4.8)	676 (28.3)	762 (50.6)	<0.0001
Sexual behaviours				
Sexual intercourse with more than one partner – no. (%)	113 (9.3)	305 (12.0)	522 (21.7)	<0.0001
Sexual intercourse with live-in partner – no. (%)	533 (44.1)	852 (33.5)	1044 (43.4)	<0.0001
Sexual intercourse with casual partner – no. (%)	136 (11.2)	348 (13.7)	914 (38.0)	<0.0001

PrEP = pre-exposure prophylaxis.

^a Pearson Chi-square tests for comparing proportions by study and Kruskal-Wallis test for age (continuous).

in 1996 to <1.0% during 2005–2012. Several factors likely contributed to the decline in HIV incidence including information provided to PWID about HIV transmission and prevention practices, significant decreases in the frequency of injecting and sharing of injection equipment, and access to methadone, new unused needles, and syringes [2,13,17,20].

There was a steady decline in HIV incidence from 1996 through 2004 from 5.7 per 100 person-years in the cohort study to 2.7 per 100 person-years in the vaccine trial, then in 2005, as the PrEP study began HIV incidence dropped below 1.0 per 100 person-years. Using respondent-driven sampling, investigators estimated there were 3595 PWID in Bangkok in 2004 [8], and 4200 in 2009 [9], suggesting a substantial proportion of HIV-uninfected PWID in Bangkok were participating in the vaccine trial and the PrEP study and had access to the HIV prevention services offered in the clinics. Thailand's national guidelines for

antiretroviral therapy evolved during the studies: in 2010, the CD4 cell count threshold to initiate antiretroviral therapy increased from 200 cells/mm³ to 350 cells/mm³, and in 2014 Thailand moved to treatment for all regardless of CD4 cell count [26]. Monthly HIV testing was provided in the PrEP study, hastening HIV diagnosis and allowing health care providers to target counselling and treatment services to acutely infected individuals possibly interrupting chains of HIV transmission. Expanded HIV testing, antiretroviral therapy [27], and provision of PrEP to a large population of PWID in Bangkok may have achieved an epidemiologic tipping point leading to a decline in HIV incidence. Similar declines in new HIV infections have been reported among men who have sex with men in London [28] and New South Wales [29] when strategies to increase access to HIV testing, antiretroviral treatment, and use of PrEP were implemented. HIV incidence among participants

Table 2
Temporal trend in HIV incidence among people who inject drugs in three prospective studies in Bangkok, Thailand, 1995–2012.

	p value ^a	HIV incidence per 100 person-years (95% CI)	Relative risk (95% CI)	p value ^b	Trend p value ^b
Cohort study, 1995–1998 (N = 1209)		5.7 (4.8–6.8)	1.0		
Time					
Overall	<0.0001				
Restricted cubic spline, linear	<0.0001				
Restricted cubic spline, spline1	<0.0001				
Restricted cubic spline, spline2	<0.0001				
Vaccine trial, 1999–2004 (N = 2545)		2.7 (2.4–3.1)	0.5 (0.4–0.6)		
Time					
Overall	<0.0001				
Restricted cubic spline, linear	0.002				
Restricted cubic spline, spline1	<0.0001				
PrEP study placebo arm, 2005–2012 (N = 1209)		0.7 (0.5–1.0)	0.06 (0.05–0.07)	<0.0001	<0.0001
Time					
Overall	0.7				
Restricted cubic spline, linear	0.9				
Restricted cubic spline, spline1	0.7				

CI = confidence interval.

^a Chi-square test from Poisson regression with restricted cubic spline.^b Chi-square test (homogeneity/trend) from Poisson regression for comparing the overall rates from the 3 studies.

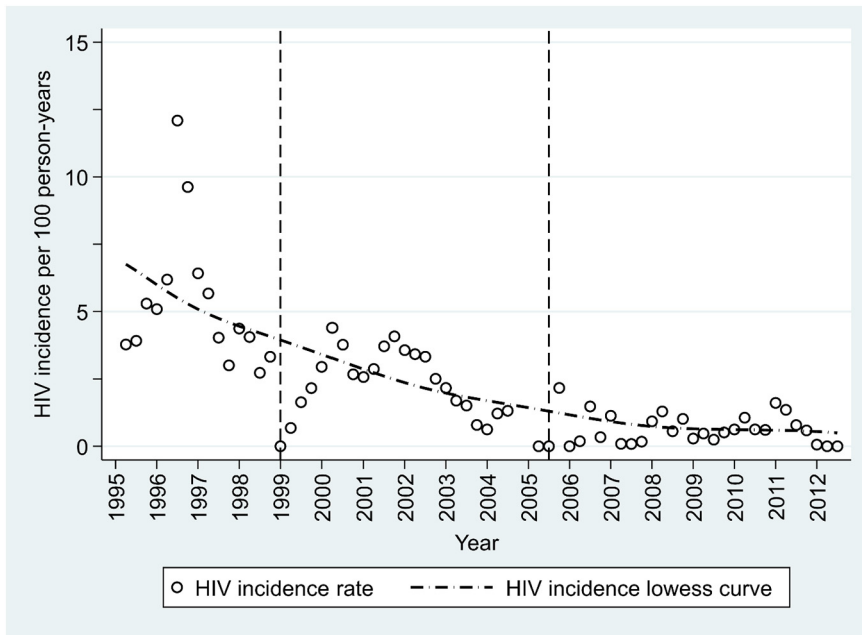


Fig. 1. HIV incidence density curve by quarter among people who inject drugs in three consecutive prospective studies in Bangkok, Thailand, 1995–2012. Cohort study 1995–1998; vaccine trial 1999–2004; PrEP study 2005–2012.

randomised to receive tenofovir in the PrEP study was 0.35 per 100 person-years [5], a 97% reduction in HIV incidence from the peak incidence during the cohort study.

During a period of high HIV incidence in the cohort study, investigators found that participants were more likely to report daily injecting and needle sharing than during periods of lower HIV incidence [14, 30], and that HIV strains were more closely clustered by sequence on phylogenetic analysis, indicating large sharing networks [31]. Viral loads of participants who seroconverted during this period were significantly higher for more than a year after infection than participants infected during periods of lower HIV incidence, suggesting that the sources of HIV infection were experiencing acute HIV infection. These behavioural activities and virologic findings likely spurred HIV transmission,

increasing HIV incidence. Decreases in injecting and needle sharing, along with increases in HIV testing and use of antiretroviral therapy, and PrEP use in the PrEP study, likely had an important bearing on the decline of HIV incidence.

Drugs injected by participants changed substantially during the studies. Heroin was the primary drug injected by participants in the cohort study and the vaccine trial, but injection of stimulants (e.g., methamphetamine) and sedatives (e.g., midazolam) began to increase during the vaccine trial [16,17] and these drugs were used more often than heroin in the PrEP study [13]. The decrease in injection drug use and the changes in drugs injected during the studies may have been, in part, due to the Thai government's 'War on Drugs' [32]. The drug war was launched in 2003 to decrease the

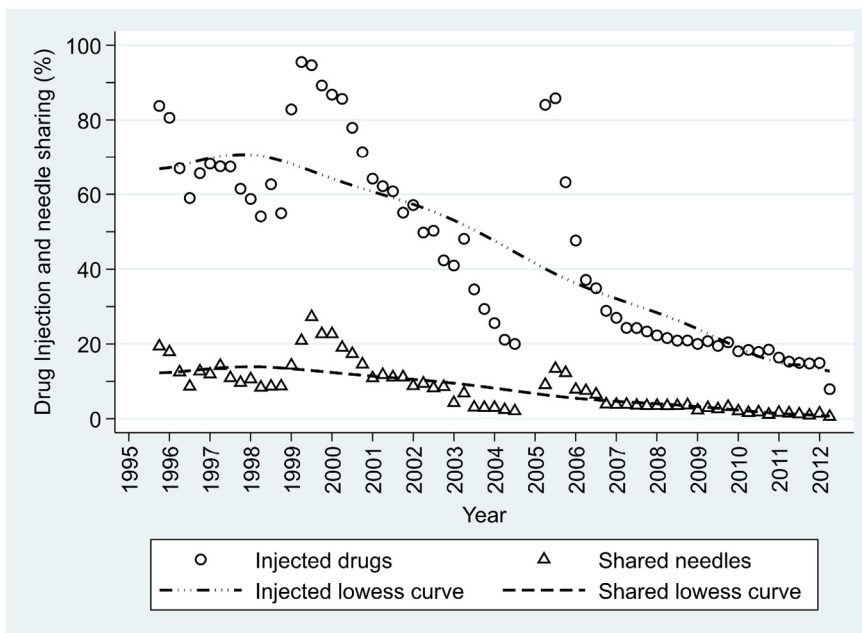


Fig. 2. Per cent of participants injecting drugs and sharing needles by quarter in three consecutive prospective studies among people who inject drugs in Bangkok, Thailand, 1995–2012.

Table 3
Temporal trends in drug use and incarceration among people who inject drugs participating in three prospective studies in Bangkok, Thailand, 1995–2012.

Study	Year	Percent reporting risk at any visit excluding enrolment (95% CI)	OR (95% CI)	p value ^a	Trend p value ^a
Injected drugs					
Cohort study	1995–1998	65.1 (63.0–67.3)	1.0		
Vaccine trial	1999–2004	58.0 (56.7–59.2)	0.7 (0.7–0.8)		
PrEP study	2005–2012	22.6 (21.2–24.0)	0.2 (0.1–0.2)	<0.0001	<0.0001
Shared needles					
Cohort study	1995–1998	11.8 (10.5–13.1)	1.0		
Vaccine trial	1999–2004	11.3 (10.7–12.0)	1.0 (0.8–1.1)		
PrEP study	2005–2012	3.1 (2.8–3.5)	0.2 (0.2–0.3)	<0.0001	<0.0001
Incarceration					
Cohort study	1995–1998	12.0 (11.0–13.1)	1.0		
Vaccine trial	1999–2004	22.6 (21.6–23.7)	2.1 (1.9–2.4)		
PrEP study	2005–2012	15.1 (14.2–16.0)	1.3 (1.2–1.5)	<0.0001	<0.0001
Injected heroin					
Cohort study	1995–1998	65.5 (63.4–67.6)	1.0		
Vaccine trial	1999–2004	54.7 (53.5–55.9)	0.6 (0.6–0.7)		
PrEP study	2005–2012	7.8 (7.0–8.6)	0.04 (0.04–0.05)	<0.0001	<0.0001
Injected stimulants					
Cohort study	1995–1998	14.6 (13.1–16.0)	1.0		
Vaccine trial	1999–2004	10.3 (9.6–11.1)	0.7 (0.6–0.8)		
PrEP study	2005–2012	8.9 (8.2–9.7)	0.6 (0.5–0.7)	<0.0001	<0.0001
Injected sedatives					
Cohort study	1995–1998	16.8 (15.3–18.3)	1.0		
Vaccine trial	1999–2004	13.3 (12.4–14.1)	0.8 (0.7–0.9)		
PrEP study	2005–2012	13.3 (12.1–14.5)	0.8 (0.7–0.9)	<0.0001	0.04

OR = odds ratio. CI = confidence interval.

^a Chi-square test (homogeneity/trend) from generalised estimating equations logistic regression for comparing proportions from the 3 studies. Cohort study (N = 1209), vaccine trial (N = 2545), PrEP study (N = 2405).

supply of illicit drugs [33]. In each of the studies, participants who were incarcerated were more likely to acquire HIV infection than participants who were not incarcerated [13,19,20]. The proportion of participants incarcerated increased in 2001 and peaked in 2003. During 2003, the supply of heroin in Bangkok declined and the price increased from approximately 2500 to 10,000 Thai baht (60 to 250 USD) per 1000 mg [16,17]. The price of amphetamine and midazolam also increased, but remained more affordable: amphetamine 150–250 baht (4 to 6 USD) per tablet and midazolam 40–60 baht (1 to 1.5 USD) per tablet.

The proportion of participants who reported sexual intercourse with more than one partner and with casual partners at enrolment in each of the three studies increased over time, but multivariable analyses of the studies did not find that higher levels of sexual activity were associated with a higher risk of HIV infection [3,13,20].

This report has several limitations. The data are from three studies with different objectives, procedures, and participants. These differences limited our ability to do an adjusted analysis of the impact of demographic characteristics and risk behaviours on HIV incidence over time. Although the risk behaviour questionnaires were similar they were

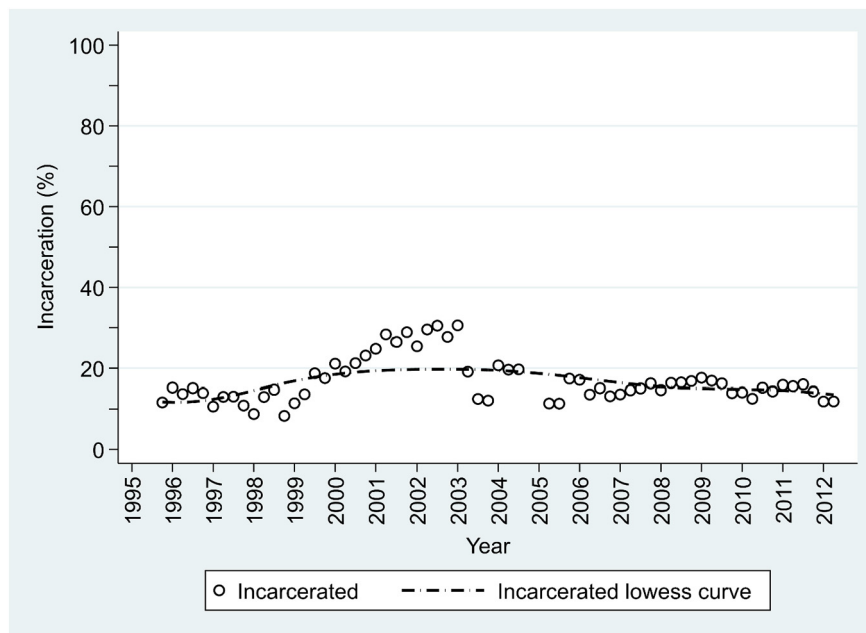


Fig. 3. Per cent of participants incarcerated by quarter in three consecutive prospective studies among people who inject drugs in Bangkok, Thailand, 1995–2012.

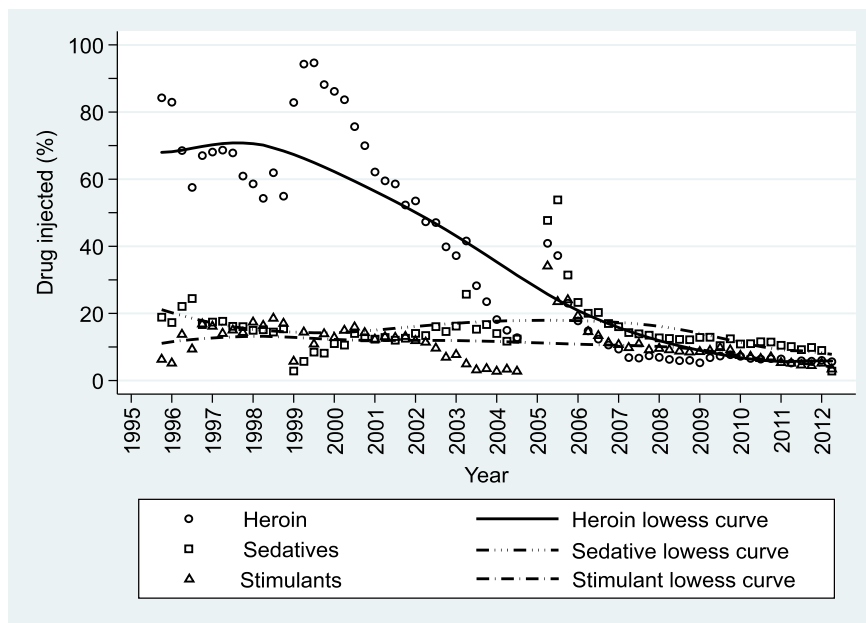


Fig. 4. Per cent of participants who injected heroin, stimulants, or sedatives by quarter in three consecutive prospective studies in Bangkok, 1995–2012.

administered at different times (i.e., every 4 months in the cohort study, 6 months in the vaccine trial, and 3 months in the PrEP study). The optimal time period for reporting risk behaviours is not known and likely varies depending on the type of behaviour [34]. Given the longer time frame in the cohort study and vaccine trial, we may have underestimated the decline in risk behaviour in the PrEP study. High HIV incidence [3–5] and mortality [18] among PWID in Bangkok may have altered the risk behaviour characteristics of the population over time by removing high risk PWID from the HIV uninfected population of PWID. However, some measures of risk, including incarceration and mortality [18–20], did not show consistent declines over time. Participants may have under-reported stigmatised and illegal behaviours [35], but the illegality and stigma attached to these activities did not change during the studies; so, rates of under-reporting should have remained constant, allowing comparisons over time. Participants were willing to come to drug-treatment clinics in Bangkok and report injection practices and sexual activity. Their risk behaviours may differ from PWID not in the study, limiting the generalisability of the results [36].

The successful launch and completion of the three prospective trials among PWID over 17 years described in this manuscript required the strong enduring commitment of trial participants, their communities, health care providers, the research team and trial sponsors, local and national government, and regulatory authorities. With growing evidence that expanding HIV testing, and increasing the use of antiretroviral therapy and PrEP can reduce HIV transmission [27–29], it may be possible to control the HIV epidemic. Thailand has experience with HIV epidemic control. In the late 1980s and early 1990s, a generalised HIV epidemic was expanding in Thailand; HIV prevalence among pregnant women was 2.0% and the mother-to-child transmission rate was >20% [37,38]. The government of Thailand responded by working with domestic and international medical experts and researchers, civil society, people living with HIV, and nongovernmental organisations to gather data, initiate studies where needed, train health care workers, and implement nationwide HIV education efforts, a 100% condom use campaign among sex workers and their partners, and prevention of mother-to-child-transmission activities [39–41]. In June 2016, Thailand became the first country in Asia to validate the elimination of mother-to-child transmission as a public health problem [41]. Expanding access to effective HIV prevention tools including HIV testing services, antiretroviral therapy, and PrEP can hasten control of the HIV epidemic among PWID.

Contributors

MM and PAM conceived and designed the work. PAM was responsible for data management, and PAM and MM for statistical analysis. MM drafted the manuscript with input from the other authors. All authors helped interpret the data, revise the manuscript, and all authors approved the final version.

Conflicts of Interests

The authors declare that they have no conflicts of interest.

Acknowledgments

We thank the study participants and their community representatives for their dedication and consistent support throughout the three studies. We thank Dwip Kitayaporn for managing clinical trial data in Bangkok during the vaccine trial. We also want to thank the doctors, nurses, counsellors, social workers, research nurses, and staff of the Bangkok Metropolitan Administration Drug-Treatment Clinics who worked with enthusiasm and grace to make the trials a success.

Disclaimer

The findings and conclusions in this paper are those of the authors and do not necessarily represent the official position of the U.S. Centers for Disease Control and Prevention.

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