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Trends in Injection Risk Behaviors among People Who Inject Drugs and the Impact of Harm Reduction Programs in Ukraine, 2007–2013

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Abstract The study examined trends in injection risk behaviors among people who inject drugs (PWIDs) and assessed the impact of harm reduction programs in Ukraine during 2007–2013. We performed a secondary analysis of the data collected in serial cross-sectional bio-behavioral surveillance surveys administered with PWIDs in Ukraine in 2007, 2008, 2011, and 2013. Using data from 14 Ukrainian cities, we assessed short-term trends in injection risk behaviors with the Cochran-Armitage test for trend and multivariable logistic regression models, adjusted for age, sex, region, marital status, education level, occupation, age at injection drug use initiation, experience of overdose, and self-reported HIV status. The overall test for trend indicated a statistically significant decrease over time for sharing needle/syringe during the last injection ($p < 0.0001$), sharing needle/syringe at least once in the last 30 days ($p < 0.0001$), and using a common container for drug preparation ($p < 0.0001$). The prevalence of injecting drugs from pre-loaded syringes was high (61.0%) and did not change over the study period. After adjusting for all significant confounders and comparing to 2007, the prevalence of sharing needle/syringe during the last injection was unchanged in 2008 (OR = 1.06, 95% CI = 0.92, 1.21), and declined in 2011 (OR = 0.18, 95% CI = 0.15, 0.22) and 2013 (OR = 0.17, 95% CI = 0.14, 0.21). Sharing needles/syringes in the last 30 days significantly decreased when compared to that in 2007 (2008: OR = 0.81, 95% CI = 0.74, 0.89; 2011: OR = 0.43, 95% CI = 0.38, 0.47; and 2013: OR = 0.31, 95% CI = 0.27, 0.35). The prevalence of using common instruments for drug preparation also decreased compared to that in 2007 (2008: OR = 0.88, 95% CI = 0.85, 0.91; 2011: OR = 0.85, 95% CI = 0.85, 0.90; and 2013: OR = 0.74, 95% CI = 0.71, 0.76). The observed reduction in the prevalence of injection risk behavior over time is encouraging. Our findings suggest that prevention programs in Ukraine have positive impact and provide support for governmental expansion of these programs.

Keywords People who inject drugs · Injection risk behavior · HIV · Trend · Ukraine

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Introduction

Ukraine is a country with an HIV epidemic concentrated mainly among people who inject drugs (PWIDs) [1]. From the beginning of the HIV epidemic in 1995 to 2007, about 60% of newly diagnosed HIV cases were related to injection drug use [2]. By 2014, HIV transmission due to injection drug use was responsible for approximately 36% of all newly diagnosed HIV cases and sexual contact accounted for the majority of cases [3]. Although injection drug use is no longer the primary mode of HIV transmission in Ukraine, PWIDs remain a group at high risk [4].

Sharing injection equipment is a major predictor of HIV infection among PWIDs [5–10]. There are a number of demographic, social, and other factors that have been consistently associated with injection risk behavior in prior studies. Although PWIDs are more likely to be male, females are more likely to inject with used needles/syringes and have overlapping sexual and injection partnerships [11–15]. Older PWIDs have been shown to report less needle sharing and a lower risk of heroin overdose [16–18], whereas younger PWIDs report more frequent injection risk behaviors [19]. Injection risk behavior also varies between opiate and stimulant users [20–23]. Higher alcohol use was found to be associated with more frequent injection risk practices [24, 25]. In Ukraine, the overall number of HIV-infected PWIDs remains high, and this predominantly male group continues to be a major source for new heterosexual infections, especially among their female partners [1].

Injection risk behavior is a major predictor of HIV infection among PWIDs [9, 10, 26, 27]. The ultimate goal of prevention programs is to reduce or prevent HIV infection through decreasing risk behavior. During the last decade, Ukraine has implemented a number of HIV prevention programs for PWIDs using an evidence-based intervention approach, also known as harm reduction services. These programs are an important part of the global response to reduce the spread of HIV infection [4, 28]. Among the programs implemented in Ukraine are access to needle and syringe exchange programs (NSPs) and opioid agonist treatment (OAT). HIV incidence has been steadily decreasing among young (15–24 year olds) PWIDs in Ukraine since 2008 [1]. This apparent decrease in HIV prevalence among PWIDs with short lifetime duration of injection drug use may be explained by the annual increase in prevention program coverage [29].

The purpose of this study was to perform a secondary analysis of data from serial cross-sectional bio-behavioral surveys conducted among PWIDs in 2007, 2008, 2011, and 2013 to examine trends of injection risk behavior. Additionally, the study aimed to determine whether an expansion of prevention programs among PWIDs in Ukraine was associated with decreases in risky injection-related behaviors.

Methods

Sample

We reviewed and analyzed data collected within the surveys "Monitoring the behavior and HIV-infection prevalence among injection drug users (IDUs) as a component of the second generation HIV surveillance" in 25 cities in Ukraine in 2007, 16 cities in 2008, 26 in 2011, and 29 in 2013. Details on study design can be found in analytic reports from the International Charitable Foundation (ICF) "Alliance for Public Health" (formerly the International HIV/AIDS Alliance in Ukraine) [30–33]. Cross-sectional surveys were administered by the Yaremenko Ukrainian Institute for Social Research (UISR). The study procedures included individual face-to-face interviews (lasting approximately 1 h) and rapid HIV testing with blood via fingerprick (DoubleCheckGold™ HIV 1 & 2 Whole Blood, Orgenics Ltd, Israel—in 2007 and CITO TEST HIV 1/2/07, Acon Biotech/Hangzhou Co., Ltd., P.R. China—in 2008, 2011, and 2013).

Study interviewers were trained by the UISR, Ukrainian Center for Disease Control (formerly—Ukrainian National AIDS Center), and ICF "Alliance for Public Health." Testing for HIV was conducted by qualified and certificated medical workers from the regional AIDS centers or other medical establishments.

The target sample size for each city and year was defined by combining group size estimation and HIV prevalence estimates from the previous IBBS studies. Respondents were recruited using respondent-driven sampling. Primary respondents ("seeds") were recruited by the representatives of different non-governmental structures/organizations having access to and working with PWIDs. Seeds selected in each city had at least one of the following characteristics: (1) age under 25 years, (2) residency of different areas of the surveyed city, (3) self-reported negative HIV status, and (4) having more than seven close friends (or acquaintances) who inject

drugs and who can be recruited to participate in the survey by a respondent. The number of seeds varied from two to eight based on estimated sizes of PWIDs in the surveyed cities [30–33]. The number of RDS recruitment waves ranges from 3 to 14.

The eligibility criteria for PWIDs were different from year to year. As a result, analyses were restricted to participants in each year who met specific criteria. The inclusion criteria for these analyses, which were similar for each year, included (1) age 14 years or older, (2) injecting drugs in the last 30 days, and (3) living in the city where interview was conducted for more than 1 year. The analysis was restricted to 14 cities that participated in the surveys for all of the study years.

There is the possibility that respondents participated in more than one of the serial cross-sectional surveys. We assessed the dataset for repeated observations using date of birth as reported by the study participants. Though this is not an accurate method for ascertaining unique individuals, we found that overall less than 10% of the whole study sample had similar birthdates. Because we could not reliably determine if individuals had repeated measures, we were not able to control for this in the analysis.

Main Outcomes

The main study outcomes included four injection risk behaviors: (1) injecting drugs with a syringe previously used by another person during the last injection, (2) injecting drugs with a syringe previously used by another person at least once in the last 30 days, and (3) using common instruments for sharing (i.e., preparation) of a drug at least once in the last 30 days. Because drug dealers in Ukraine often sell drugs already loaded in syringes, a fourth outcome was injecting with a preloaded syringe at least once in the last 30 days.

Exposure

For this analysis, the year of interview was defined as the exposure. We used year as a surrogate for exposure to different prevention and harm reduction services such as needle and syringe programs, OAT with buprenorphine or methadone, HIV testing, and consultations provided to PWIDs in Ukraine. During the study period, prevention programs were expanding, and the number of PWIDs who received these services was increasing. According to the annual reports from the Alliance for Public Health, the number of PWIDs who utilized prevention services in the study regions annually was 121,236 (29% of the estimated number of PWIDs in Ukraine) [34] in 2007 [30], 169,728 (40%) [34] in 2008 [31], 138,847 (45%) [35] in 2011 [32], and 178,178 (57%) [35] in 2013 [33]. The number of PWIDs on OAT started growing substantially with the introduction of methadone maintenance treatment (MMT) in 2008. However, OAT coverage still remains inadequate to effectively decrease HIV transmission [36]. An increasing trend in PWID coverage with prevention services was reported in all study cities.

Covariates

Potential covariates were chosen based on the findings of previous research on factors associated with injection risk behaviors. Social and demographic variables included age (i.e., 14–25, 26–35, and over 35 years old), marital status (i.e., live with husband/wife or sexual partner, do not live with husband/wife or sexual partner), educational level (i.e., primary (<9 years), secondary (9–11 years, community college), college or more (Bachelor's or higher level)), occupation (i.e., students and people permanent or occasional work vs. unemployed), and regions of Ukraine (i.e., Northern/Western (Kyiv, Poltava, Sumy, Lutsk), Southern (i.e., Simferopol, Odesa, Kherson, Mykolaiv), Eastern (i.e., Kharkiv, Luhansk, Donetsk), Central (Kyrovograd, Cherkasy, Dnipropetrovsk)). Several variables included were related to injection behavior including age of injection drug use initiation (i.e., 6–17, 18–20, and 20+ years old), type of injection drugs used in the last 30 days (i.e., opiates only, stimulants only, both opiates and stimulants), and overdose in the last 12 months.

HIV-related characteristics included knowledge of HIV transmission, HIV testing in the last 12 months, and self-reported HIV status. The results of HIV testing were presented only for the last 3 years because in 2007, testing was only conducted in 3 of the 14 survey cities. HIV knowledge was assessed with six items: (a) One can avoid HIV infection using a condom correctly every time during the sexual intercourse, (b) A healthy looking person can be HIV-positive, (c) A person can get HIV by using a needle for injection which was used by another person, (d) HIV infection can be transmitted from an HIV-positive mother to her child during pregnancy, (e) HIV infection can be transmitted from an HIV-positive mother to her child during delivery, and (f) HIV infection can be transmitted from an HIV-positive mother to her

child during breast-feeding. HIV knowledge was considered as a binary covariate (i.e., all correct vs. one or more incorrect responses).

Statistical Analysis

Bivariate analyses of social, demographic, injection, and HIV-related characteristics by interview year were performed using a Chi-square test. The Cochran-Armitage test for trend was used to assess trends in injection risk behaviors over time. A multivariable logistic regression for rare outcomes (<10%) was used to determine the effect of interview year on injecting drugs with a syringe previously used by another person during the last injection. A log-binomial regression model was used for the three other outcome variables (i.e., injecting drugs with a syringe previously used by another person, using common instruments for sharing (preparation) of drug, and injecting with pre-loaded syringe at least once in the last 30 days). The log-binomial regression was applied because it is a more appropriate model with outcomes that are not rare (>10%) [37–39]. Crude and adjusted models were estimated for all the four outcomes. Multivariable regression models were adjusted for all covariates significantly associated with both the exposure and outcome in bivariate analysis. HIV knowledge and self-reported HIV status were highly correlated with each other; therefore, only self-reported HIV status was considered as a covariate as the more important factor associated with injection risk behavior. As we assumed that the interview year was a surrogate of prevention programs implemented each year, variables related to characteristics of the prevention programs were excluded from analysis.

The best-fit model for each outcome was identified using a backward elimination model building approach, removing factors that were not associated with the outcome of interest when $\alpha > 0.05$. Factors were removed one at a time and assessed for confounding by adding each back into the model to assess the impact on the exposure-outcome association using the 5% rule. After all the confounders were defined, the associations between the exposure and outcomes were tested for possible effect modification by age, gender, and region. Interactions were assessed using a likelihood ratio test. Model fit was assessed using a χ^2 goodness-of-fit test. Statistical analyses were performed using SAS version 9.3 (SAS Institute Inc., Cary, NC, USA).

Ethical Considerations

The study was reviewed and approved by the Committee on Medical Ethics at the Lev Gromashevskiy Institute of Epidemiology and Infectious Diseases of the National Academy of Sciences of Ukraine and the Institutional Review Board of the State University of New York, University at Albany.

Results

The overall study sample included 17,304 PWIDs, of whom 2895 (16.7%) were recruited in 2007, 3336 (19.3%) in 2008, 5721 (33.1%) in 2011, and 5352 (30.9%) in 2013 (Table 1). Surveys were conducted in four regions of Ukraine: 28.1% of the participants were from the Northern/Western region, 31.8% from the Southern region, 19.1% from the Eastern region, and 21.0% from the Central part of Ukraine. The mean age of the study sample was 32.6 years old (SD = 8.5, range = 14–68), and the participants were significantly older in 2011 and 2013 compared to those in 2007 ($p < 0.0001$). The proportion of PWIDs aged 14–25 years decreased significantly each year ($p < 0.0001$), while the proportion of those aged 36 years and older increased, and the proportion of the participants aged 26–35 years did not change.

The majority of the study sample is male (74.2%), and 74.9% had completed secondary education; however, in 2011 and 2013, significantly higher proportions of PWIDs received college degree or more (25.1 and 22.0%, respectively, compared to 17.0% and 15.7% in 2007 and 2008). Only 19.1% of all the participants lived with a husband/wife or sexual partner; 71.9% lived alone. An increasing trend was observed in the proportion among PWIDs who studied/had permanent work/had occasional earnings (from 64.6% in 2007 to 74.5% in 2013, $p < 0.0001$).

The mean age of injection drug use initiation was 19.1 years, and this significantly varied by survey years (Table 2): age of IDU onset was 19.6 years in 2007, 21.1 years in 2008, 16.9 years in 2011, and 19.6 years in 2013 ($p < 0.001$). In the 30 days before the interview, the majority (63.7%) of the participants had injected opiates only, 13.8% had injected stimulants only, and 22.5% had injected both opiates and stimulants (poly-substance injection). By year, the number of poly-substance PWIDs decreased significantly during the study period (p trend < 0.0001). There was also a decreasing trend over

Table 1 Demographic characteristics of 17,304 PWIDS in 14 Ukrainian cities, by year: 2007–2013

	Total *N* (%) *N* = 17,304	2007 *N* (%) *N* = 2895	2008 *N* (%) *N* = 3336	2011 *N* (%) *N* = 5721	2013 *N* (%) *N* = 5352	*p* value*	*p* value, trend**
Mean (SD) age	32.6 (8.5)	30.2 (8.1)	31.9 (8.4)	33.2 (8.5)	33.8 (8.6)	<0.0001	–
Age						<0.0001	–
14–25 years old	3842 (22.2)	904 (32.2)	851 (25.5)	1142 (20.0)	945 (17.7)		
26–35 years old	7539 (43.6)	1238 (42.8)	1471 (44.1)	2530 (44.2)	2300 (43.0)		
36+ years old	5923 (34.2)	753 (26.0)	1014 (30.4)	2049 (35.8)	2107 (39.3)		
Sex (male)	12,835 (74.2)	2132 (73.6)	2482 (74.4)	4137 (72.3)	4084 (76.3)	<0.0001	0.0245
Region						<0.0001	–
Northern/Western	4865 (28.1)	857 (29.6)	948 (28.4)	1560 (28.0)	1500 (28.0)		
Southern	5511 (31.8)	909 (31.4)	1150 (34.5)	1851 (29.9)	1601 (29.9)		
Eastern	3297 (19.1)	528 (18.2)	463 (13.9)	1205 (20.6)	1101 (20.6)		
Central	3631 (21.1)	601 (20.8)	775 (23.2)	1105 (21.5)	1150 (21.5)		
Marital status (*n* = 17,289)						<0.0001	<0.0001
Live with husband/wife/sexual partner	3393 (19.6)	734 (25.3)	744 (22.3)	942 (16.5)	973 (18.2)		
Do not live with husband/wife/sexual partner	13,896 (80.4)	2161 (74.6)	2592 (77.3)	4764 (83.5)	4379 (81.8)		
Education (*n* = 17,277)						<0.0001	–
Primary	718 (4.2)	178 (6.1)	144 (4.3)	149 (2.6)	247 (4.6)		
Secondary	12,937 (74.9)	2225 (76.9)	2666 (80.0)	4128 (72.3)	3918 (73.4)		
College or more	3622 (20.9)	492 (17.0)	524 (15.7)	1429 (25.1)	1177 (22.0)		
Occupation						<0.0001	<0.0001
Student or permanent/occasional work	11,611 (67.3)	1869 (64.6)	2093 (62.7)	3673 (64.6)	3976 (74.5)		
Do not work/disabled	5642 (32.7)	1026 (35.4)	1243 (37.3)	2009 (35.4)	1364 (25.5)		

*p value for Chi-square test

**p value for Cochran-Armitage trend test computed for characteristics with two categories

time in overdose in the 12 months prior to the interview (p trend < 0.0001).

Overall, 7.8% of PWIDs injected drugs with a syringe previously used by another person during the last injection, and prevalence of this risk behavior decreased significantly over the study period (p trend < 0.0001). The proportion of PWIDs who reported using common syringes with other drug users at least once in the last 30 days was 14.1%, and a significant decline in this proportion was observed each year. Using common instruments for sharing (preparation) of a drug at least once in the last 30 days was the most prevalent risk behavior among our sample of PWIDs. The total number of study participants who practiced this behavior was 10,457 (61.8%), although a significant decreasing pattern (p trend < 0.0001) was observed. Injecting drugs from a pre-loaded syringe was also common (61.0%), and prevalence did not change over time.

HIV testing increased significantly over time (Table 3). Sixty-six percent of PWIDs had been tested for HIV during their lifetime, and 38% reported that they were tested within the past 12 months. Among PWIDs who had ever been tested, 86% reported their HIV status. The proportion of PWIDs who reported negative HIV status increased across survey years, while the proportion with unknown HIV status decreased. According to the results of rapid HIV tests in 2008, 2011, and 2013, HIV prevalence in the study sample significantly decreased over time (35.2% in 2008, 24.1% in 2011, and 19.7% in 2013, p trend < 0.0001). Overall, many of the study participants had accurate knowledge of HIV transmission. The percentage of PWIDs who agreed that HIV infection could be avoided using condom every time during the sexual intercourse increased over the study period from 80.9% in 2007 to 85.9% in 2013 (p trend < 0.0001). Most of the participants knew that a healthy looking person could be HIV-positive (83.6% in 2007 and 89.8% in 2013, p trend = <0.0001). The majority of PWIDs knew that HIV could be transmitted through sharing injection equipment (96.1%),

Table 2 Injection-related characteristics and injection risk behavior among 17,304 PWIDS in 14 Ukrainian cities, by year: 2007–2013

	Total *N* (%) *N* = 17,304	2007 *N* (%) *N* = 2895	2008 *N* (%) *N* = 3336	2011 *N* (%) *N* = 5721	2013 *N* (%) *N* = 5352	*p* value*	*p* value, trend**
Mean (SD) age of injection drug use initiation	19.1 (5.2)	19.6 (4.4)	21.1 (6.1)	16.9 (4.1)	19.6 (5.2)	<0.0001	–
Age at injection drug use initiation (*n* = 16,558)						<0.0001	–
6–17 years old	7453 (45.0)	935 (34.9)	935 (28.0)	3504 (69.3)	2006 (38.0)		
18–20 years old	4975 (30.1)	1056 (36.6)	1059 (31.8)	1093 (21.6)	1767 (33.4)		
20+ years old	4129 (24.9)	821 (28.5)	1340 (40.2)	459 (9.1)	1509 (28.6)		
Drugs injected in the last 30 days						<0.0001	–
Opiates	11,026 (63.7)	1766 (61.0)	2128 (63.8)	3345 (58.5)	3787 (70.8)		
Stimulants	2389 (13.8)	301 (10.4)	389 (11.7)	1007 (17.6)	692 (12.9)		
Opiates and stimulants/other	3889 (22.5)	828 (28.6)	819 (24.5)	1369 (23.9)	873 (16.3)		
Overdose in last 12 months (*n* = 17,122)	1755 (10.3)	404 (14.1)	474 (14.4)	511 (9.1)	366 (6.9)	<0.0001	<0.0001
Injection risk behavior							
Injected with used needle/syringe during the last injection (*n* = 17,096)	1327 (7.8)	454 (15.9)	546 (16.6)	178 (3.2)	149 (2.8)	<0.0001	<0.0001
Injected with used needle/syringe in the last 30 days (*n* = 17,129)	2406 (14.1)	732 (25.7)	687 (20.8)	592 (10.5)	395 (7.4)	<0.0001	<0.0001
Used common instruments for sharing (preparation) in the last 30 days (*n* = 17,119)	10,457 (61.8)	2027 (71.8)	2079 (62.9)	3525 (62.4)	2826 (47.0)	<0.0001	<0.0001
Injected from pre-filled syringe in the last 30 days (*n* = 17,212)	10,501 (61.0)	1764 (61.9)	1915 (58.2)	3532 (61.7)	3290 (61.5)	0.0038	0.3302

*p value for Chi-square test

**p value for Cochran-Armitage trend test computed for characteristics with two categories

and as a result, there was no significant increase in knowledge during the study period. Additionally, we observed comparatively lower knowledge of mother-to-child transmission—approximately 25% did not know about risk of transmission during pregnancy or delivery, and 31% did not know about transmission via breast-feeding. There was no significant improvement in knowledge about HIV transmission among the study participants. Overall, only 47.2% of PWIDs gave correct answers on all the questions about the ways HIV can be transmitted.

After controlling for all the potential confounders, the final model included year of interview as the main exposure variable and two other covariates: self-reported HIV status and types of injecting drugs used in the last 30 days (Table 4). Interview year was found to be significantly associated with the outcome. While there was no difference in the odds ratio for 2008 compared to that for 2007, the odds of the outcome were significantly lower in 2011 (adjusted odds ratio (AOR) = 0.18, 95% confidence interval (CI) = 0.15–0.22) and 2013 (AOR = 0.17, 95% CI = 0.14–0.21) compared to that in 2007.

The final log-binomial regression model for the association between interview year and injecting drugs with a syringe previously used by another person in the last 30 days was only adjusted for having overdosed in the last 12 months (Table 4). We found a significant decrease in the prevalence of injection risk behavior for each year relative to 2007 (2008: adjusted prevalence ratio (APR) = 0.81, 95% CI = 0.74–0.89; 2011: APR = 0.43, 95% CI = 0.38–0.47; and 2013: APR = 0.31, 95% CI = 0.27–0.35).

For the association between interview year and using common instruments for drug preparation, we report results of the crude log-binomial regression model, as no covariate was found to be a significant confounder (Table 4). Prevalence of this risk behavior was significantly lower for every year of interview compared to that for 2007 (2008: PR = 0.88, 95% CI = 0.85–0.91; 2011: PR = 0.85, 95% CI = 0.85–0.90; and 2013: PR = 0.74, 95% CI = 0.71–0.76). We did not observe significant change in the injection with pre-filled syringes in bivariate analysis or after adjustment for all the potential confounders. Though there was a small decrease in the

Table 3 HIV-related characteristics among 17,304 PWIDS in 14 Ukrainian cities, by year: 2007–2013

	Total *N* (%) *N* = 17,304	2007 *N* (%) *N* = 2895	2008 *N* (%) *N* = 3336	2011 *N* (%) *N* = 5721	2013 *N* (%) *N* = 5352	*p* value*	*p* value, trend**
HIV knowledge (agreed with statement)							
One can avoid HIV infection using a condom correctly every time during the sexual intercourse	14,869 (85.9)	2342 (80.9)	2813 (84.3)	5116 (89.4)	4598 (85.9)	<0.0001	<0.0001
A healthy looking person can be HIV-positive	15,586 (90.1)	2421 (83.6)	2951 (88.5)	5405 (94.5)	4809 (89.8)	<0.0001	<0.0001
A person can get HIV by using a needle for injection which was used by another person	16,627 (96.1)	2756 (95.2)	3234 (96.9)	5537 (96.8)	5110 (95.3)	<0.0001	0.4673
HIV infection can be transmitted from an HIV-positive mother to her child during pregnancy	12,902 (74.6)	2175 (75.1)	2821 (84.6)	4050 (70.8)	3856 (72.1)	<0.0001	<0.0001
HIV infection can be transmitted from an HIV-positive mother to her child during delivery	12,993 (75.1)	2219 (76.7)	2751 (82.5)	4137 (72.3)	3886 (72.6)	<0.0001	<0.0001
HIV infection can be transmitted from an HIV-positive mother to her child during breast-feeding.	11,913 (68.8)	1928 (66.6)	2505 (75.1)	3863 (67.5)	3617 (67.6)	<0.0001	0.0240
HIV knowledge						<0.0001	0.8715
Correct answers on all questions	8158 (47.2)	1262 (43.6)	1738 (52.1)	2664 (46.6)	2494 (46.6)		
HIV testing in the last 12 months (n = 16,912)						<0.0001	–
Yes	6427 (38.0)	882 (32.1)	1196 (36.6)	2228 (40.1)	2121 (39.7)		
No (>12 months ago)	4748 (28.1)	403 (14.6)	734 (22.5)	1674 (30.2)	1937 (36.2)		
Never did HIV test	5737 (33.9)	1467 (53.3)	1334 (40.9)	1647 (29.7)	1289 (24.1)		
Self-reported HIV status						<0.0001	–
Positive	2451 (14.2)	313 (10.8)	611 (18.3)	792 (13.8)	735 (13.7)		
Negative	7147 (41.3)	716 (24.7)	954 (28.6)	2735 (47.8)	2742 (51.2)		
Unknown	7706 (44.5)	1866 (64.5)	1771 (53.1)	2194 (38.4)	1875 (35.1)		
Tested HIV-positive (n = 14,405)	3606 (25.0)	–	1172 (35.2)	1378 (24.1)	1056 (19.7)	<0.0001	<0.0001

*p value for Chi-square test

**p value for Cochran-Armitage trend test computed for characteristics with two categories

prevalence of this risk behavior in 2008 compared to that in 2007 (PR = 0.94, 95% CI = 0.90–0.98), prevalence of injecting from a pre-filled syringe remained the same in 2011 (PR = 1.00, 95% CI = 0.96–1.03) and in 2013 (PR = 0.99, 95% CI = 0.96–1.03) compared to that in 2007.

The final regression models were checked for effect modification by age, gender, and region. All interaction terms were not significant.

Discussion

This study utilized data from bio-behavioral surveillance surveys conducted among PWIDs in 14 large Ukrainian cities in 2007, 2008, 2011, and 2013 to assess trends in injection risk behavior, as this is a major risk factor for HIV transmission among PWIDs [9, 10, 26, 27]. The results of our study demonstrate that the level of syringe sharing decreased across the study years. Using a syringe previously used by another person during the last injection in the last 30 days declined from 25.7% in 2007 to 7.4% in 2013, and from 15.9% in 2007 to 2.8% in 2013. Although the prevalence of using a common container for preparation of a drug also decreased over the study period, 47% of PWIDs were sharing containers in 2013. A majority of PWIDs (61%) used pre-loaded syringes, and there were no significant changes in the prevalence of this behavior over time.

Table 4 Multivariable regression models assessing trends in injection risk behaviors among 17,304 PWIDS in 14 Ukrainian cities, 2007–2013

Variable	Injecting with used needle/syringe during the last injection[a]		Injecting with used needle/syringe in the last 30 days[b]		Used common instruments for sharing (preparation) in the last 30 days[b]	Injected from pre-filled syringe in the last 30 days[b]
	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude PR (95% CI)	Adjusted PR (95% CI)	Crude PR (95% CI)	Crude PR (95% CI)
Year						
2007	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
2008	1.05 (0.92–1.2)	1.06 (0.92–1.21)	0.81 (0.74–0.88)	0.81 (0.74–0.89)	0.88 (0.85–0.91)	0.94 (0.90–0.98)
2011	0.17 (0.14–0.21)	0.18 (0.15–0.22)	0.41 (0.37–0.45)	0.43 (0.38–0.47)	0.85 (0.85–0.90)	1.00 (0.96–1.03)
2013	0.15 (0.13–0.18)	0.17 (0.14–0.21)	0.28 (0.26–0.33)	0.31 (0.27–0.35)	0.74 (0.71–0.76)	0.99 (0.96–1.03)
Self-reported HIV status						
Positive	Ref.	Ref.	–	–	–	–
Negative	0.44 (0.37–0.52)	0.55 (0.46–0.65)				
Unknown	0.91 (0.78–1.06)	0.76 (0.65–0.89)				
Type of injecting drugs used						
Opiates only	Ref.	Ref.	–	–	–	–
Stimulants only	1.03 (0.86–1.22)	1.23 (1.02–1.47)				
Opiates and stimulants	1.67 (1.47–1.90)	1.55 (1.36–1.77)				
Overdose in last 12 months (no)	–	–	0.42 (0.39–0.46)	0.50 (0.46–0.54)	–	–

OR odds ratio, *PR* prevalence ratio

[a] Multivariable logistic regression models

[b] Multivariable log-binomial regression models

A decrease in the prevalence of injection risk behavior among PWIDs has been significantly associated with implementation of prevention programs such as needle/exchange programs[40–43] and OST [44–48], also known as harm reduction services for PWIDs [49]. Countries, which succeed in providing harm reduction services for PWIDs, have a marked decline of injection risk behavior. During the last 10 years, Ukraine has been implementing a number of HIV prevention programs for PWIDs including needle exchange programs and drug substitution therapy. The coverage by prevention programs for PWIDs has expanded over time [29]. However, the Ukrainian government itself has been doing very little prevention work among PWIDs, as well as among other populations at high risk for HIV transmission. The majority of prevention programs have been implemented by non-governmental organizations, particularly by the Alliance for Public Health with financial support of The Global Fund. Ukraine is one of the poorest countries in Europe [50], and therefore, the lack of financial resources is the main reason why the Ukrainian government mainly supports the provision of medical services and does not finance preventive services.

However, the unavailability of government-sponsored harm reduction programs may also be related to high levels of stigma against the population of drug users in Ukraine. Drug injection is considered a violation of behavior according to the accepted social norms [51]. In Ukraine, HIV-related stigma is also a problem among people living with HIV, particularly PWIDs. People living with HIV often face issues with maintaining the confidentiality of their HIV status, being treated differently than other patients, and receiving blame for spreading HIV to the general population [52]. This stigma may result to a lack of prevention programs being developed and implemented for PWIDs.

Our study provides some evidence of the effectiveness of harm reduction programs for reducing injection

risk behaviors among PWIDs. Using interview year as a proxy for the number of provided prevention services, which increased each year studied, we can hypothesize that the decrease in risk behavior is related, at least in part, to the increase in prevention program coverage.

In Ukraine, locally produced opiates are often obtained in pre-loaded syringes, which in fact could result to both sharing needles/syringes and using common containers for the preparation of a drug without the knowledge of PWIDs [53]. In our study, we found relatively high overall prevalence of injecting with pre-loaded syringes with no decreasing trend during the study period, suggesting that this risk behavior was not affected by any of the implemented prevention programs. However, this finding may have a logical explanation, as using drugs with a pre-loaded syringe mainly depends on a drug-dealer's behavior rather than the drug user's behavior. Although HIV prevention programs are not designed to influence this behavior directly, increasing knowledge about ways of HIV transmission among PWIDs could be effective in this case as it could encourage drug dealers to access needles from safe sources and to use clean syringes for their pre-loaded syringe sales. In our study, we found that overall HIV knowledge was not improved significantly over the time. However, we observed an increase in awareness regarding condom use during each sexual encounter. The majority of the sample knew that a person can get HIV by using a needle or syringe used by another person, with no significant increases in knowledge over time.

It is important to note that our results demonstrated declining HIV prevalence among PWIDs among all age groups of the sample. However, the most substantial decrease in HIV prevalence was observed among older PWIDs. Although the decline in HIV prevalence occurred during a period of increasing coverage of harm reduction and OAT, there are several possible alternative explanations of the decreasing prevalence. First, the mortality rate among people living with HIV is very high in Ukraine especially among PWIDs due to high prevalence of HIV and tuberculosis comorbidity among this population [54–56]. Second, older HIV-infected PWIDs could have stopped injecting drugs once they were diagnosed with HIV, thus being ineligible for the survey. Another explanation might be related to limitations of the sampling methodology as different populations could be captured during each survey year. However, such significant reduction among young PWIDs could suggest a decline in HIV incidence among the study population.

Strengths and Limitations

This is the first study that analyzed changes of injection risk behaviors among PWIDs in Ukraine. We used two approaches to evaluate associations of the exposure with each of the outcomes of interest. The Cochran-Armitage test for trend was applied to evaluate an overall, monotonic trend for unadjusted data. We also used multivariable regression analyses to evaluate the association between each interview year, compared to baseline, and each outcome adjusted for all the important confounders.

This study included several limitations. The most serious challenge when conducting surveillance among PWIDs and other hidden subpopulations is related to choosing a sampling strategy that results to a representative sample [57]. The recruitment was conducted using an RDS sample methodology, which allows researchers to address potential selection bias using RDS weights [58]. However, there is a lack of developed methodology using RDS weights in studies aimed to assess multivariable-adjusted associations [59, 60]. Therefore, the data in these analyses were not weighted, and comparison of risk behaviors by year could be biased. Consequently, the obtained results describe the study samples only and may not be generalizable to the general population of PWIDs in Ukraine. We did not control for several important covariates that could be potential confounders (e.g., alcohol use, frequency of injections), because the surveillance surveys differed from year to year, and these questions were not included in all years. Additionally, the data were available for only 14 cities of Ukraine. Thus, other regional differences in the outcomes of interested could not be explored. Due to the cross-sectional nature of the study design, causal inference could not be made. Finally, self-reported data could be a source of recall or social desirability biases.

Despite these limitations, the results of our analyses suggest the possible positive impact of prevention programs in Ukraine and provide support for governmental expansion of these programs. The reduction in the prevalence of injection risk behavior over time was considerable. This suggests that the expansion of prevention programs for PWIDs was associated with the declining prevalence of injection risk behavior. Due to significant reductions in the financing of Ukrainian non-governmental organizations by international donors, the Ukrainian government should consider the positive influence of harm reduction programs on reducing injection risk behavior, and increase support for HIV prevention programs among PWIDs in Ukraine. In light

of the current economic crisis in Ukraine, international donors should consider supporting these programs at higher levels than the status quo.

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