Title

Incarceration history is associated with HIV infection among community-recruited people who inject drugs in Europe: a propensity-score matched analysis of cross-sectional studies

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TITLE

Incarceration history is associated with HIV infection among community-recruited people who inject drugs in Europe: a propensity-score matched analysis of cross-sectional studies

ABSTRACT

Aims

We measured the association between a history of incarceration and HIV positivity among people who inject drugs (PWID) across Europe.

Design

A cross-sectional, multisite, multiyear propensity-score matched analysis

Setting

Europe

Participants

Community-recruited PWID who reported a recent injection (within the last 12 months).

Measurements

Data on incarceration history, demographics, substance use, sexual behaviour and harm reduction service use originated from cross-sectional studies among PWID in Europe. Our primary outcome was HIV status. Generalised linear mixed models and propensity score matching were used to compare HIV status between ever- and never-incarcerated PWID.

Findings

Among 43,807 PWID from 82 studies surveyed (in 22 sites and 13 countries), 58.7% reported having ever been in prison, and 7.16% (n=3099) tested HIV positive. Incarceration was associated with 30% higher odds of HIV infection (adjusted odds ratio [aOR] 1.32, 95% confidence interval [CI] 1.09-1.59); the association between a history of incarceration and HIV infection was strongest among PWID with the lowest estimated propensity score for having a history of incarceration (aOR 1.78, 95% CI 1.47-2.16). Additionally, mainly injecting cocaine and/or opioids (aOR 2.16, 95% CI 1.33-3.53), increased duration of injecting drugs (per 8 years aOR 1.31, 95% CI 1.16-1.48), ever sharing needles/syringes (aOR 1.91, 95% CI 1.59-2.28), increased income inequality among the general population (measured by the Gini index, aOR 1.34, 95% CI 1.18-1.51) were associated with a higher odds of HIV infection. Older age (per 8

years aOR 0.84, 95% CI 0.76-0.94), male sex (aOR 0.77, 95% CI 0.65-0.91), and reporting pharmacies as the main source of clean syringes (aOR 0.72, 95% CI 0.59-0.88) were associated with lower odds of HIV positivity.

Conclusions

A history of incarceration appears to be independently associated with HIV infection among people who inject drugs (PWID) in Europe, with a stronger effect among PWID with lower probability of incarceration.

Keywords: HIV; incarceration; PWID; prison; injection drug use; Europe

INTRODUCTION

The average regional HIV prevalence rates in prison populations worldwide range from 3% in Asia, 4% in North America, and 5% in Europe to 6% in Africa.[1] Incarcerated individuals have a higher prevalence of HIV than the general population, primarily due to the overrepresentation of people who inject drugs (PWID).[2] In Europe, the proportion of people with a history of injecting drugs among incarcerated people ranges from 5% (France, Poland) to 50% (Estonia, Lithuania).[3,4] Data from community-recruited PWID in European countries suggest that between 20% and 80% of PWID have a history of incarceration.[5]

HIV prevalence among PWID in the community is highly variable across Europe.[6] In Eastern Europe and most Western European countries, HIV prevalence among PWID is higher than that among men who have sex with men (except in the UK and Finland)[7] or sex workers.[8] While data show that injection drug use continues in many prison systems[9] and that incarcerated PWID share injection equipment,[10,11] the evidence on HIV incidence in prison settings is scarce, and intra-prison transmission appears to be low in most countries, except for large-scale outbreaks in some.[12,13] A systematic review found that recent incarceration was associated with an 81% increase in HIV acquisition risk among PWID.[14] It has been suggested that people living with HIV who have a history of incarceration are most likely to have contracted the disease in the community rather than while in prison, potentially due to a high-risk period immediately after release.[15] Following release from prison, social instability, reengagement in key

transmission risk behaviours, and a disconnect from harm reduction services may lead to a high risk of blood-borne infections and high mortality.[16]

It has been suggested that incarceration could also provide an opportunity to intervene, by providing or continuing opioid agonist maintenance treatment (OMT),[5] needle/syringe programmes (NSPs) and by diagnosing unknown HIV and HCV infections and (re)starting anti-retroviral therapy (ART) and hepatitis C treatment.[17] HIV viral load suppression can be achieved in prison, promoted by a structured environment and routine clinical follow-up.[16] However, internationally, HIV prevention efforts in prisons have been poor in comparison to those in the surrounding communities.[6,18] Recent assessments of the access to HIV and HCV preventive interventions in prison settings of European countries have documented a low level of adherence to WHO/UNODC recommendations for these interventions (including OMT, NSPs and ART).[18,19]

Overall, the benefits to the individuals who receive such treatment in prison are very likely to be outweighed by the serious harms associated with incarceration, including an increased risk of HIV infection and overdose death after release. We aimed to examine to what extent a history of incarceration is associated with an increased risk of HIV infection among community-recruited PWID in Europe.

METHODS

We pooled and analysed individual-level data (2001-2017) from 82 cross-sectional, multi-site and multi-year studies, to assess the association between a history of incarceration and HIV status among community-recruited PWID in Europe.

Data

Data from PWID, who reported recent injections and had been recruited in community settings in 82 cross-sectional studies across Europe, were identified through an international collaboration of researchers and their contacts [20,21] and collated into one data-set (see the Supplement, Table S1, Page 2). We grouped the data into 22 "sites" based on the location (country or city), year, and/or methodology of data collection (Table 1). Data from each country were merged into one site if they originated from data collected within a short time period (1-3

years) and same geographic region using the same study design. The methods of the included source studies are described in detail elsewhere (see references in Supplementary Pages 4-6), and a summary is presented here (Table 1). In addition, aggregated (country- or site-level) data on structural level variables (including the Gini index, HIV prevalence among PWID in the community, incarceration rates in the general population and among PWID, and PWID population coverage of prevention and harm reduction services in prison and the community) were requested from all sites and screened by two authors (LWe, LWi) (Supplementary Table S3).

Insert Table 1 here

Sampling procedures, recruitment of participants, and data collection

The source studies included HIV testing among the participating PWID and were carried out in different settings (mainly community-based low-threshold programmes/NSPs and drug treatment programmes) during 2001–2017. Sampling/recruitment approaches suitable for hard-to-reach populations were used: respondent-driven sampling (RDS) (n=9 sites), other chain referral methods (n=2 sites), and venue-based convenience sampling (n=11 sites). Data on socio-demographic factors (age, sex), self-reported drug use (duration of drug injection, main drug injected, frequency of injection), injection (sharing needles/syringes, overdose experience) and sexual risk behaviours (e.g. number of sexual partners) were obtained. Recall periods for risk behaviours (needle/syringe sharing, number of sexual partners) varied across sites (see the Supplement, Table S2, Page 3). We use the term incarceration to refer to the detention of people in prisons or other closed settings and use the term prison to refer to any such setting where someone might be detained.[14] The exposure variable (a history of incarceration) was dichotomised—"ever" versus "never". Given that the source data originated from multiple different studies, we applied standardised data definitions while compiling the single dataset. Data were synchronised in terms of time—events with recall periods up to 12 months were categorised as 'recent' (recent needle/syringe sharing, recent main drug injected, recent frequency of injecting). Categorical variables were dichotomised into "ever" and "never" (OMT, needle/syringe sharing, overdose) (synchronised variables, see Table 2; source study variables, see Table S2). In the source studies, blood or oral fluid specimens were tested for HIV antibodies

using standard enzyme immunoassays (see the Supplement, Table S2, Page 3). For two sites, HIV infection status was based on self-reported HIV status (Portugal 2009-2010, Czech Republic 2002-2003).

Summary statistics and data imputation

Table 2 presents the summary statistics, which are expressed as counts and percentages for categorical variables and as the means and standard deviations for continuous variables. Figure 1 shows the data on HIV prevalence, proportion of people ever incarcerated, and age at and duration of injection among PWID by site.

Missing data resulted from either the entire variable missing from a site or data for that variable missing for a subset of the sample (the proportions of missing data by study and variable are provided in Supplementary Table S2 and the overall proportions for each variable in Figure S3). The proportion of missing data varied between studies (see Supplementary Table S2). We accounted for missing data in a two-staged imputation procedure, assuming that the probability of data being missing was random. [22] We applied multiple imputations for each country, using the variables that had at least some data available, which resulted in five imputed datasets for each country. After that, we combined imputed datasets (separately for each of the five imputations), which we then used for the second-level imputation. We performed five further imputations for each of the five datasets, resulting in 25 imputed datasets. We used two-level multiple imputation, with sites within the same country as the first level and between countries as the second, to make maximum use of country-specific information. See the Supplement, Statistical analysis, Pages 7-9 for further details on the imputation procedure (specific imputation methods, iterations to convergence).

Propensity score matching

Propensity score estimates for a history of incarceration, i.e., estimates of the probability that a PWID was ever incarcerated, were used to standardise the distribution of observed baseline covariates (including confounders) between the exposed (ever in prison) and unexposed (never in prison) subjects (a balancing weighting index).[23] For each of the 25 imputed datasets, the propensity scores were estimated using a logistic regression model that included country, site and year (as fixed effects) and all individual-level variables (except HIV status), based on the Akaike

and Bayesian information criteria (Table 2) (see the Supplement, Statistical analysis, Pages 7-9). We applied nearest neighbour matching, in which exposed subjects were matched to the nearest unexposed subjects based on the estimated propensity scores, using a variable ratio matching algorithm with replacement [24] with a 1:n variable ratio (distance tolerance equal to 1/100,000 and maximum number matches per exposed was set to n = 4).[25] The variable ratio matching algorithm controlled for additional bias by varying the number of never-incarcerated subjects matched to each ever-incarcerated subject according to a defined propensity score tolerance range. To address heterogeneity, we used 7 matching groups, defined by geographical and epidemiological similarities of sites (Group 1: studies from the UK (UK-EWnI, UK-S); Group 2: studies from Russia (RU-IN, RU-StP, RU-V, RU-5s); Group 3: a study from Greece (GR-A); Group 4: studies from Central Europe (CZ, HU, PL-G; PL-GK, PL-W, PL-Ms); Group 5: studies from Eastern Europe (EE-T, LV-5s, LV-R); Group 6: studies from western Europe LU, NL-A, FI-7); and Group 7: studies from Spain and Portugal (PT-P, SP-C, SP-MBS); for the description of the abbreviations see Table 1, Table S1). Based on the matching procedure, weights were assigned to individuals proportional to the number of 'never-incarcerated' PWID matched to each 'ever-incarcerated' subject. The weights were then used in a weighted generalised linear mixed model (GLMM) to estimate the association between a history of incarceration and HIV status.

Modelling

For each of the 25 matched datasets, we employed a GLMM to estimate the effect of incarceration on the probability of having a positive HIV status (Supplement, Page 7). We used a logistic mixed effects model with logit link, in which the variable "study" (indicating one data collection round/period within a site and to account for the calendar period effect) and matching group were considered as nested random effects. Due to discontinuity in calendar years between sites, we could not assess a separate longitudinal parameter across different time points. The weights from the propensity score matching algorithm were introduced using weighted least squares. The multivariable model of the probability of being HIV positive included all variables listed in Table 2 as covariates, except for recent needle/syringe sharing, which was omitted due to multicollinearity with ever needle/syringe sharing. Subsequently, we pooled the estimates of each of the 25 models, and we estimated odds ratios (ORs) and 95% confidence intervals (CIs)

for each variable. Finally, we estimated odds ratios for the association between HIV status and a history of incarceration.

The association between sociodemographic (age, sex), behavioural (duration of injection, frequency of injection, main drug injected, overdose, needle/syringe sharing, number of partners) and service use (OMT status, main source of clean needles/syringes) factors and HIV positivity at the individual level was assessed with univariable (both unmatched and propensity score matched) and multivariable (propensity score matched) regression models (Table 2). Structural-level variables were tested univariably and included in the model if they were statistically significant (Supplement, Statistical analysis, Page 8).

Associations were considered statistically significant at $p<0.05$. The results are presented for a full model (adjusted for all measured variables) and reduced models (the exact parameter estimates along with standard errors and p-values are presented in Supplementary Table S4).

Sensitivity analysis

In sensitivity analyses, first a reduced model was used to evaluate the effect of removing the UK data (sites: UK-EWnI; UK-S) on the measure of association (given that the UK data constituted 69.1% of the total sample and thus dominated the analysis).

Second, to understand exposure effect heterogeneity, we estimated propensity stratum-specific associations. For stratification on the propensity score of a history of incarceration, we ranked participants by estimated propensity score and then divided the sample into quintiles of the propensity score (from 1, lowest probability to 5, highest probability of ever-incarceration). We estimated the incarceration effect within each stratum using a similar GLMM as that for the matched data, with the exception of random effects being defined here as "study" and "country". Each of the stratum-specific effects described the HIV odds in the respective stratum, and to obtain the population-wide average (exposure) effect, we averaged the effects across the strata.

The models were estimated in R (version 3.5.1) using function glmer from the package lme4. (See additional details on the statistical analysis in the Supplement, Pages 7-9)

The analysis was not pre-registered and the results should be considered exploratory.

RESULTS

Characteristics of the study population

Data on 43,807 PWID from 22 sites within 13 countries were included in the analyses. Country-level sample sizes ranged from n=253 (Portugal) to 30,286 (UK).

The mean age of the participants was 32.81 years (range 13-78, SD 8.40). On average, they had injected drugs for 11.22 years (range 0.02-53.01, SD 8.02); 58.53% were injecting less than daily and 37.02% reported ever and 30.23% recent needle/syringe sharing. Across the 17 sites with data on number of sexual partners in the past 12 months, a small minority of the participants (5.32%) reported 10 or more sexual partners, three in ten (30.04%) had two to nine partners and 41.50% had one partner. Ever receiving OMT was reported by 75.23% of PWID. Opioids were reported as the main injection drug used by a majority (75.43%) of PWID, combined use of opioids and cocaine was reported by 7.77%, and cocaine only was reported by 6.91%.

Across the whole sample, 58.69% (n=24,857) had ever been in prison (range 15.08% in Voronezh, Russia, to 89.14% in Amsterdam, the Netherlands), and 7.16% (n=3,099) were HIV positive (range 0.19% in Hungary to 55.74% in Saint Petersburg, Russia). Among those who had ever been in prison, the HIV prevalence was 7.35% (95% CI 7.02-7.67%), and among those who had never been in prison, it was 7.28% (95% CI 6.90-7.66%). When excluding the UK data (UK-EWnI; UK-S), the HIV prevalence was 27.0% (95% CI 25.89-28.18%) among those who had ever been in prison and 16.7% (95% CI 15.83-17.69%) among those who had never been in prison. Univariable site-specific estimates for the association between ever incarceration and HIV positivity are given in Figure 2, and study-specific estimates are given in Figure S1 in the Supplement.

Insert Figure 1 here

Insert Figure 2 here

Association between a history of incarceration and HIV infection

After imputation and propensity score matching, an average of 25,752 ever-incarcerated PWID were matched to never-incarcerated PWID. In univariable analysis, a history of incarceration was significantly associated with a positive HIV status (OR 1.76, 95% CI 1.61-1.94). Univariable significant associations of HIV status with frequency of injection (less than daily vs. daily or more: OR 0.75, 95% CI 0.67-0.85), number of lifetime sexual partners (per partner: OR 1.04, 95% CI 1.02-1.07), having ever had an overdose (OR 1.56, 95% CI 1.23-1.97) and having ever received OMT (OR 1.47, 95% CI 1.27-1.70) became non-significant in the multivariable analysis (Table 2). Of the structural variables, only the Gini index was significantly associated with HIV status in univariable analysis (OR 1.25, 95% CI 1.16-1.34) and thus included in the multivariable model (Supplementary Table S3).

In multivariable analysis, the odds of a positive HIV status were approximately 30% higher among PWID with a history of incarceration than among those without (aOR 1.32, 95% CI 1.09-1.59). In addition, individuals with a longer duration of injecting drugs (aOR 1.31, 95% CI 1.16-1.48 per 8 years) or a history of (ever) needle/syringe sharing (aOR 1.91, 95% CI 1.59-2.28) had higher odds of a positive HIV status (Table 2). The main drug injected was also associated with a positive HIV status, with the highest odds for cocaine (aOR 2.70, 95% CI 1.73-4.22), followed by opioids together with cocaine (aOR 2.16, 95% CI 1.33-3.53) and only opioids (aOR 1.52, 95% 1.05-2.18), compared to those mainly injecting stimulants other than cocaine. Finally, older age (per 8-year increase in age: aOR 0.84, 95% CI 0.76-0.94), male sex (aOR 0.77, 95% CI 0.65-0.91), and obtaining new needles/syringes from pharmacies as opposed to NSPs and/or outreach programmes showed a protective association (aOR 0.72, 95% CI 0.59-0.88).

A negative association between a positive HIV status and age appeared after adjusting for the duration of injection (aOR 0.84, 95% CI 0.76-0.94 per 8 years). Given the strong correlation between age and years of injection, we performed a sensitivity analysis, omitting age from our final model. This did not change our findings (ever in prison: aOR 1.31 95% CI 1.09-1.59).

Insert Table 2 here

We found an inverse dose–response association between a history of incarceration and HIV status across the five propensity score strata for a history of incarceration (in other words, there was a weaker association among PWID with characteristics predicting a higher probability of having ever been in prison, and a stronger association among those with a lower probability of having ever been in prison) (see the characteristics of PWID across each of the 5 propensity score strata in Table S5). Thus, there was no statistically significant association among the PWID with the highest propensity scores for a history of incarceration: fifth stratum aOR 0.94, 95% CI 0.68-1.29 and fourth stratum aOR 1.15, 95% CI 0.83-1.58) while the association became increasingly stronger among the PWID with lower propensity scores for a history of incarceration: third stratum aOR 1.30, 95% CI 1.02-1.65; second stratum aOR 1.63, 95% CI 1.3-2.04, and first stratum aOR 1.78, 95% CI 1.47-2.16.

Sensitivity analyses

The effect size estimate and the corresponding standard error of incarceration regarding HIV positivity remained stable after excluding the UK data from the model (full model: aOR 1.58, 95% CI 1.32-1.89).

Both the original (full model aOR 1.32, 95% CI 1.09-1.59) and the propensity score stratification analysis (aOR 1.32, 95% CI 1.17-1.49) resulted in very similar effect sizes and standard error estimates, indicating that our analysis was not sensitive to the adjustment method.

DISCUSSION

To our knowledge this is the largest study to date confirming the association between a history of incarceration and HIV infection among PWID. This is also the first study suggesting an inverse dose–response relationship between a history of incarceration and HIV infection, by the propensity of PWID for having a history of incarceration – i.e. the association between a history of incarceration and HIV infection appears to be strongest among the PWID with characteristics associated with a lower likelihood of having ever been incarcerated. This novel finding may have been made possible by the large size of our sample, allowing for a wider range of likelihoods

(propensity scores) of a history of incarceration among PWID and greater statistical power in analysing that range.

For decades, incarceration has been a frequent occurrence for PWID.[6,14] For the majority of our sites, close to two-thirds of PWID reported having been incarcerated at some point in their lives. Relatively low lifetime incarceration rates in the Russian sites, in particular (<20%) Ivanovo and Voronezh, can likely be attributed to these sites having recruited a young population of PWID with short injection durations and a short time at risk for incarceration.[27]

Our results suggest that past incarceration among PWID is associated on average with a 30% higher odds of HIV infection. Our findings are in agreement with those of a recent systematic review[14] (mainly including studies from non-European countries) that found a 25% increase in HIV acquisition risk among those who had ever experienced incarceration. Our study covered PWID from 13 countries across Europe, including Eastern European countries with more recent injection drug use and a high prevalence of HIV, Central European countries with recent but a low prevalence of HIV and Western and Northern European countries with a much longer history of injection drug use and low to high rates of HIV among (older) injection drug users. Additionally, our results are in good agreement with those of a recent study that utilised aggregated data from 16 countries in Europe, where among PWID, the population attributable risk for the effect of incarceration on HIV was estimated at 26%.[6]

The inverse relationship between the likelihood that a PWID has a history of incarceration, and the strength of the association between an incarceration history and HIV infection, is potentially important for our understanding of the association between a history of incarceration and HIV infection. Here, a history of incarceration may act as a moderating variable in the relationship between injection drug use and HIV risk. For example, among PWID with a low risk of incarceration, being incarcerated might bring them in contact with high-risk injection PWID networks. High-risk networks might for example be larger (having more members), have higher rates of turnover, have higher HIV seroprevalence, potentially greater injection risk behaviours, and greater visibility to the police (perhaps from engaging in street-level drug distribution). This supports our finding that the association between a history of incarceration and HIV infection appears to be independent of self-reported injection and sexual risk behaviours and may be due to other additional factors linked to a history of incarceration.

In addition, HIV positivity was associated with cumulative exposure (injection duration), drug injection risks and risk behaviours (needle/syringe sharing, ever having an overdose), and sexual risk behaviours (greater number of sexual partners). These results are consistent with known HIV transmission risks. Obtaining new needles/syringes from sources other than NSPs/outreach services, i.e., using pharmacies as the main source of needles/syringes was protective for HIV infection. Buying or receiving new needles/syringes via pharmacies might be more characteristic for 'lighter/more infrequent injectors' (often with shorter injection careers) and those with a higher socioeconomic status, as opposed to frequent injectors.[28]

In multivariable analysis, OMT was not associated with HIV infection, despite being positively associated in the univariable analysis. This latter result may reflect selection bias linked to the cross-sectional nature of our data, e.g., PWID who have ever received OMT have a longer injection duration and have been at risk of HIV infection for longer and have a higher (cumulative) HIV prevalence.[29]

The higher risk of HIV infection among PWID who inject cocaine, due to the increase in injection frequency associated with cocaine injection warrants attention. Along with the historical evidence,[30] evidence from recently documented HIV outbreaks among people injecting cocaine in Glasgow (Scotland)[31] and Luxemburg[32] corroborate this finding. High rates of early HCV reinfection after treatment with direct-acting antivirals (DAAs) among people who inject heroin and/or cocaine in Madrid (Spain)[33] further confirm greater injection risks among PWID who inject cocaine. In recent years, other stimulants (e.g., new psychoactive substances (NPSs)) have become more widespread, and new HIV outbreaks have been linked to these substances.[34]

We found a lower risk of HIV infection among males in comparison to females who injected drugs. This result is consistent with those of earlier studies in Europe.[35] Differences in HIV prevalence between female and male PWID may be due to factors such as multilayer stigma (also limiting access to much-needed services), high-risk sex and injection partners, dependence on male partners for drugs and injections, and participation in sex work.[35]

Our finding that HIV prevalence was lower among older PWID, after adjusting for duration of injection, has, to our knowledge, not been reported before. This seems consistent with a recent finding that adjusted HIV incidence was not lower among young PWID in an HIV outbreak context, i.e. a positive association between HIV prevalence and age reported in many cross-sectional studies is largely due to cumulative risk exposure and does not reflect actual

risks, which may in fact be higher among young PWID, which our analysis approach and large sample size may have been able to better distinguish.[36] Indeed, multiple studies have reported greater HIV risk behaviours and/or HCV incidence among young PWID.[37] Due to the difficulty of adjusting both for injection duration and age, given the strong correlation between these variables, this result can only be observed in a very large sample such as that in the present study, although it also suggests that caution is warranted and further confirmation is needed.

Among structural factors (aggregate-level variables), our only statistically significant finding was the association of HIV positivity with the Gini index, a measure of the level of socioeconomic inequality in the general population. The Gini index has been found to be predictive of HIV outbreaks among PWID or substance misuse,[38] and a higher Gini index is associated with a higher HIV prevalence among PWID.[39]

Importantly, our finding of an association between a history of incarceration and HIV infection, after accounting for other known risk factors, may confirm the concept of incarceration as a high-risk environment in addition to known risk factors. For example, this could be due to a high prevalence of HIV among other people who are in prison or among other PWID in the period after release[6,11] or limited access to effective HIV risk reduction interventions (OMT, behavioural interventions).

Our study has several limitations. We used data from cross-sectional studies in which the temporality between the exposure (a history of incarceration) and outcome (HIV status) or other potential risk factors (e.g., injection risk markers) could not be established. A history of incarceration could just be a marker for a period in life of extremely high risk (a confounder), i.e., those who injected more frequently in the past may also just be more likely to have been ever incarcerated, in the absence of a causal relationship. With the available data, we were unable to disentangle the prison environment and the immediate period after release as related risk factors. Additionally, the data were derived from multiple studies with differences in the definitions of the behavioural measures (e.g. recall periods, wording of questions). However, the resulting errors would probably be non-differential for the PWID groups compared within sites and would therefore likely lead to underestimating their effects on our outcome variable. We could not exclude the possibility of a survival effect: since incarceration is a risk factor for both mortality (protective inside prison, but increased after release) and HIV infection, we likely

lacked data on some high-risk HIV-positive individuals who had been incarcerated and died after release, which might also lead to a (slight) underestimation of the association of interest. Approximately 2% of our total sample (Portugal 2009-2010, Czech Republic 2002-2003) was based on self-reported HIV status. This is a small proportion in our total dataset, and given that these sites had a stable HIV prevalence and high availability of harm reduction services, it seems likely that self-reported HIV status is an acceptable indicator of HIV infection in those sites.[40] The choice of variables used in the construction of the propensity scores was limited to those measured in source studies. Our propensity score analysis did include the variables most likely to be confounders in the relationship between incarceration and HIV. However, not having data on homelessness, ethnicity, or education might have caused residual confounding. A history of incarceration as the exposure variable was measured as a binary variable that should have captured both brief jail stays after arrest and longer periods of imprisonment. It may not be possible to generalise our results to all PWID in Europe given the limits of the venue-based ('convenience') and/or social network-based sampling used in the studies. Finally, there is a diversity of drug policy laws in the included countries, which for example included Russia, which has a highly punitive approach and where the provision of opioid maintenance programmes is prohibited, and Portugal, where drug possession is decriminalised and where extensive harm reduction programmes are in place.

The majority of PWID in this analysis were exposed to the high-risk environments of prison and the period following release,[6] highlighting ample opportunities for alternatives to incarceration. Alternative responses include various decriminalisation, diversion, and depenalisation schemes,[41] primarily by diverting people with nonviolent offences to alternatives for incarceration (in combination with treatment and harm reduction services in prison and after release or 'throughcare'). Importantly, apart from contributing to HIV transmission among PWID, incarceration is an expensive intervention.[42] Prisons are an extremely expensive location for treating substance use and other health problems. Negative health, economic and social well-being effects of incarceration and other health-related harms associated with prison, including tuberculosis, mental health and costs to families, coupled with the high public cost of current levels of incarceration, strengthen the argument for the decarceration of drug policies. A recent modelling study suggested that cost savings from the decriminalisation of drug use could greatly

reduce HIV transmission through increased coverage of opioid agonist therapy and ART in the context of the HIV epidemic driven by injection drug use (Eastern Europe and Central Asia).[43]

In conclusion, among community-recruited PWID in Europe, a history of incarceration was strongly and independently associated with HIV positivity, with a stronger association observed among PWID with a lower likelihood of having a history of incarceration. Given the high incarceration rates among PWID, drug policies that reduce incarceration rates of PWID and its associated risks, and that provide health and social services both in prison and upon release ('throughcare'), would likely have considerable public health impacts.

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Table and figure captions

Table 1. Characteristics of the research and data collection methods of the source data (22 sites across Europe).
Table 2. Univariable and multivariable risk factors associated with HIV among PWID in Europe.
Figure 1. HIV prevalence, proportion ever incarcerated, age and duration of injection among PWID by site.
Figure 2. Univariable site-specific estimates for the association of incarceration with HIV positivity (odds ratio, 95% CI).

Supplement

Table S1. List source data: Cross-sectional studies among PWID in Europe by country, study (site-year), and number of study subjects
Table S2. Measure availability and recall times by site in the source data (22 sites across Europe)
Table S3. Univariable estimates of the association between structural-level variables and HIV positivity (odds ratio, 95% CI)
Table S4. Exact parameter estimates with standard errors and p values
Table S5. Characteristics of PWID across each of the 5 propensity score strata (quintiles - from 1, lowest probability to 5, highest probability of ever incarceration)
Figure S1. Univariable study-specific estimates of the association between ever incarceration and HIV positivity (odds ratio, 95% CI)
Figure S2. Propensity score balance and distributional balance plots (adjusted and unadjusted samples)
Figure S3. Proportion of missing data points in the combined dataset

Table 1.Characteristics of research methods and data collection for source data (22 sites across Europe)

Country	Czech Republic (CZ)	Estonia (EE-T)	Finland (FI-7)	Greece (GR-A)	Hungary (HU)	Latvia (LV-5s)	Latvia (LV-R)	Luxembourg (LU)	Netherlands (NL-A)	Poland (PL-G)	Poland (PL-GK)	Poland (PL-Ms)	Poland (PL-W)	Portugal (PT-P)	Russia (RU-5s)	Russia (RU-IN)	Russia (RU-StP)	Russia (RU-V)	Spain (SP-C)	Spain (SP-MBS)	UK (UK-EWnI)	UK (UK-S)
City / Region	National	Tallinn	Seven cities in Southern Finland	Athens	National	5 geographical areas of Latvia	Riga / surrounding areas	Luxembourg	Amsterdam	Gdańsk	Gdańsk, Kraków	Multiple sites	Warszawa	Regional (Porto)	5 cities	Ivanovo, Novosibirsk	Saint Petersburg	Voronezh	Catalonia	Madrid, Barcelone, Seville	England, Wales & Northern Ireland	Scotland (national)
Year of data collection	2002-2003	2009, 2011, 2013	2014	2012-2013	2014-2015	2014, 2016	2012	2015-2017	2010-2014	2002	2008-2009	2004-2005	2013	2009-2010	2014	2010	2012-2013	2011	2014-2015	2001-2003	2000-08	2013-14
Place of recruitment	Low-threshold center	NSP [1]	Low threshold center (NSP)	Site for community based testing and linkage to care	NSP, OST, low threshold center (without NSP)	NSP	NSP	NSP, drug treatment center	Public Health Service	Drug treatment center; street	Research center	Drug treatment center; research center	Research center	Drug treatment centers; Infectious diseases hospitals	NSP	HIV treatment center	NSP, street, mobile van	HIV treatment center	Harm reduction centers	Street	NSP, drug treatment center	NSP
Sampling method	Convenience	RDS [2]	Convenience	RDS	Convenience	Convenience	RDS	Convenience	Convenience	Convenience	RDS	Convenience + snowball	RDS	Convenience	RDS	RDS	RDS	RDS	Convenience [5]	Targeted + snowball	Purposive	Purposive
Sample size (N)	760	1031	600	3320	1054	666	290	420	262	200	193	776	95	253	520 (105 from each city)	593 (Ivanovo 300; Novosibirsk 293)	811	310	730	637	27823	2463
Inclusion criteria (definition of recent injection drug use [3])	Drug injecting in the last 12 months	Drugs injecting in the last 2 months	Current	Drug injecting in the last 12 months	Drug injecting in the last 4 weeks	Drug injecting in the last 4 weeks	Drug injecting in the last 4 weeks	Current	Drug injecting in the last 6 months	Drug injecting in the last 4 weeks	Drug injecting in the last 4 weeks	Drug injecting in the last 4 weeks	Drug injecting in the last 4 weeks	Drug injecting in the last 6 months	Drug injecting in the last 4 weeks	Drug injecting in the last 4 weeks	Drug injecting in the last 4 weeks	Drug injecting in the last 4 weeks	Drug injecting in the last 6 months	Using heroin in the last 3 months	Active PWID [3]	Active PWID
Inclusion criteria (other) [4]	Age > 15 years; not in OST	Age >= 18 years;	None	Age >= 18 years	Drug injecting ever	Age >= 18 years	Age >= 18 years	Adults having taken once any illegal drug	Using drugs	Age >= 18 years	Age >= 18 years	Age >= 18 years	Age >= 18 years	Age >= 18 years;, who had been diagnosed with HIV within five years of the date of the interview or HIV negative with a last negative test within 12 months of the date of the interview	Age >= 15 years	Age >= 18 years	Age >= 16 years	Age >= 16 years	Age >= 18 years	Used heroin at least 12 days in the last 12 months and at least once in the past 3 months; age between 18 and 30 years;	Active PWID	Active PWID
Type of sample taken	Venous blood	Venous blood	Finger prick blood	Venous blood	Dry blood spot	Finger prick testing	Venous blood;	Venous blood	Venous blood	Venous blood	Venous blood	Venous blood	Venous blood	None	Venous blood	Venous blood	Saliva	Venous blood	Saliva	Dry blood spot	Oral Fuid/ Dried Blod Spot	Dry blood spot
Measurement to detect HIV	Self-report	HIV-1/HIV-2 III Plus from Abbott Laboratories, Abbott Park,	Abbott ARCHITECT HIV Ag/Ab Combo	anti–HIV-1/2 (AxSYM HIV-1/2 gO; Abbott)	HIV Ab: Vironostika HIV Ag/Ab ELISA (bioMérieux)	Rapid test (CHIV-201	Vironostika HIV Uniform II Ag/Ab (BioMerieux), Genscreen Plus HIV Ag Ab,	Cobas roche Combo HIV Combi PT	INNO-LIA HIV-1 HIV-2 assay, Innogenetics	Ab commercial EIA	Ab commercial EIA	Ab commercial EIA	Ab commercial EIA	Self-report	EIA test certified in Russia	EIA test certified in Russia	Rapid test (OraQuick)	Genscreen ULTRA HIV Ag-Ab, NEW LAV-BLOT	Genscreen HIV-1/2 Version 2.0 assay fromBio-Rad	ELISA Genscreen HIV1/2 version 2, Bio-Rad, Marnes La Coquette, France	Various tests	Ortho Save 3.0 EIA

		Illinois, USA					(BioRad, France);)															

[1] Needle and syringes programm

[2] Respondent driven sampling

[3] People who inject drugs

[4] Main inclusion criteria only

[5] A stratified convenience sample of PWID was selected according to the type of centre and country of origin using proportional allocation

Note: CZ = Czech Republic; EE-T = Tallinn, Estonia; FI-7 = seven cities (Helsinki, Vantaa, Espoo, Tampere, Turku, Lahti, Hämeenlinna), Finland; GR-A = Athens, Greece; HU = Hungary; LV-5s = five geographical areas (Riga, Jurmala, Ogre, Liepaja, Bauska), Latvia; LV-R = Riga and surrounding areas, Latvia; LU = Luxembourg; NL-A = Amsterdam, Netherlands; PL-G = Gdańsk, Poland; PL-GK = Gdańsk, Kraków, Poland; PL-Ms = in six regions: mazowieckie (Warszawa), lubuskie (Zielona Góra, Gorzów Wlkp., Cibórz, Nowy Dworek), śląskie (Katowice, Chorzów, Sosnowiec), dolnośląskie (Wrocław – 2 locations), lubelskie (Lublin, Puławy), warmińsko-mazurskie (Olsztyn, Elbląg, Barczewo), Poland; PL-W = Warszawa, Poland; PT-P = Porto, Portugal; RU-5s = five cities (Barnaul, Volgograd, Naberezhnye, Chelny, Perm, Abakan), Russia; RU-IN = Ivanovo, Novosibirsk, Russia; RU-StP = Saint Petersburg, Russia; RU-V = Voronezh, Russia; SP-C = Catalonia, Spain; SP-MBS = Madrid, Barcelone, Seville, Spain; UK-EWnI = England, Wales & Northern Ireland, United Kingdom; UK-S = Scotland, United Kingdom

GR-ANote: CZ = Czech Republic; Tallin, EE-T = Estonia; SP-MBS = Madrid-Barcelona-Seville; SP-C = Catalonia, Spain; FI-7 = seven cities in Finland (list them all here); ...ss

Table 2. Univariable and multivariable risk factors associated with HIV among PWID in Europe.

	Unimputed data			**Imputed data**					
	HIV+/total	**% HIV+**		**Univariable models**		**Univariable propensity score matched models**		**Multivariable propensity score matched models**	
				OR	95% CI	OR	95% CI	OR	95% CI
Socio-demographic characteristics									
Age (years; mean, range, SD) (all PWID)	32.77, 13-78, 8.42			1.16	1.10-1.22 **	1.03	0.95-1.11	0.84	0.76-0.94 **
Age (years; mean, range, SD) (HIV+ PWID)	33.61, 17-64, 7.61								
Gender									
Men	2378/32251	7.37%		0.97	0.88-1.07	0.74	0.63-0.87 **	0.77	0.65-0.91 **
Female	710/11165	6.36%		1		1		1	
Drug use characteristics									
Duration of injecting (years; mean, range, SD) (all PWID)	11.19, 0.02-53, 8.04			1.35	1.28-1.41 **	1.21	1.11-1.33 **	1.31	1.16-1.48 **
Duration of injecting (years; mean, range, SD) (HIV+ PWID)	14.02, 0.33-40, 7.44								
Frequency of injecting (recent)[ǁ] (yes, n %)									
Less than daily	1701/17551	9.69%		0.75	0.67-0.85 **	0.86	0.73-1.01	0.9	0.76-1.07
Daily or more	1016/12449	8.16%		1		1		1	
Main drug injected (recent)[ǁ] (yes, n %)									
Stimulants other than cocaine	171/1597	10.71%		1		1		1	
Cocaine	230/2030	11.33%		3.26	2.26-4.71 **	3.42	2.22-5.29 **	2.70	1.73-4.22 **
Opioids	1796/22143	8.11%		1.93	1.56-2.39 **	1.87	1.35-2.59 **	1.52	1.05-2.18 *
Opioid & Cocaine	264/2282	11.57%		3.28	2.33-4.63 **	2.74	1.73-4.34 **	2.16	1.33-3.53 **

Other	83/1304	6.37%		1.76	1.33-2.33 **	1.64	0.94-2.88	1.55	0.88-2.72
Overdose (ever)[§] (yes, n. %)									
Yes	1039/2432	42.72%		1.56	1.23-1.97 **	1.42	1.10-1.83 *	1.21	0.97-1.51
No	681/2928	23.26%		1		1		1	
Sharing needles/syringes (recent)[‖] (yes, n. %)									
Yes	608/6357	9.56%		1.46	1.30-1.63 **	-		-	
No	596/14684	4.06%		1		-		-	
Sharing needles/syringes (ever)[§] (yes, n. %)									
Yes	1697/11619	14.61%		1.88	1.70-2.09 **	2.05	1.73-2.44 **	1.91	1.59-2.28 **
No	1119/19702	5.68%		1		1		1	
Sexual behaviour									
Number of partners (lifetime)[§] (mean, range, SD) (all PWID)	3.36, 0-2400, 25.38			1.04	1.02-1.07 **	1.04	1.002-1.07 *	1.03	0.96-1.06
Number of partners (lifetime)[§] (mean, range, SD) (HIV+ PWID)	7.85, 0-2400, 72.92								
Number of partners (lifetime)[§] (yes, n %)									
>=10	207/1916	10.80%		1		-		-	
2-9	871/11385	7.65%		0.82	0.70-0.97 *	-		-	
1	1102/15743	7.00%		0.87	0.75-1.02	-		-	
0	675/8883	7.60%		1.23	1.04-1.45 *	-		-	
Environmental factors									
Opioid maintenance therapy (ever)[§] (yes, n %)									
Yes	1075/27047	3.97%		1.47	1.27-1.70 **	1.39	1.11-1.74 **	1.22	0.96-1.56
No	632/8915	7.09%		1		1		1	
Main source of clean syringes (ever)[§] (yes, n %)									

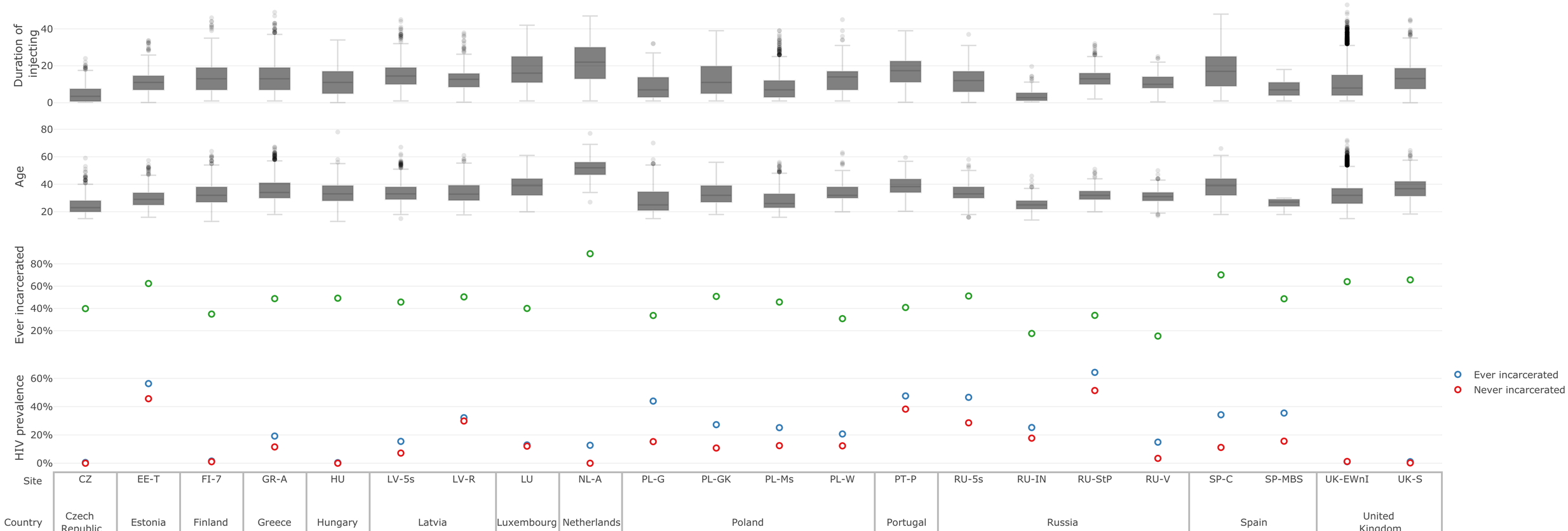
NSP and/or outreach	773/2451	31.54%		1		1		1	
Other	91/559	16.28%		0.74	0.54-1.02	0.8	0.54-1.17	0.88	0.59-1.31
Pharmacy	745/2368	31.46%		0.7	0.57-0.86 **	0.73	0.59-0.90 **	0.72	0.59-0.88 **
Ever in prison (yes, n %)[§†]									
Yes	1803/24857	7.25%		1.76	1.61-1.94 **	1.27	1.05-1.53 *	1.32	1.09-1.59 **
No	1239/17491	7.08%		1		1		1	
Study level measures									
GINI index[‡] (mean, range, SD)	33.54, 25.4-44, 4.76			1.25	1.16-1.34 **	1.35	1.19-1.51 **	1.34	1.18-1.51 **
* p<0.05 ** p<0.01									

[ǀ] Recall times up to 12 months were categorized as 'recent'.

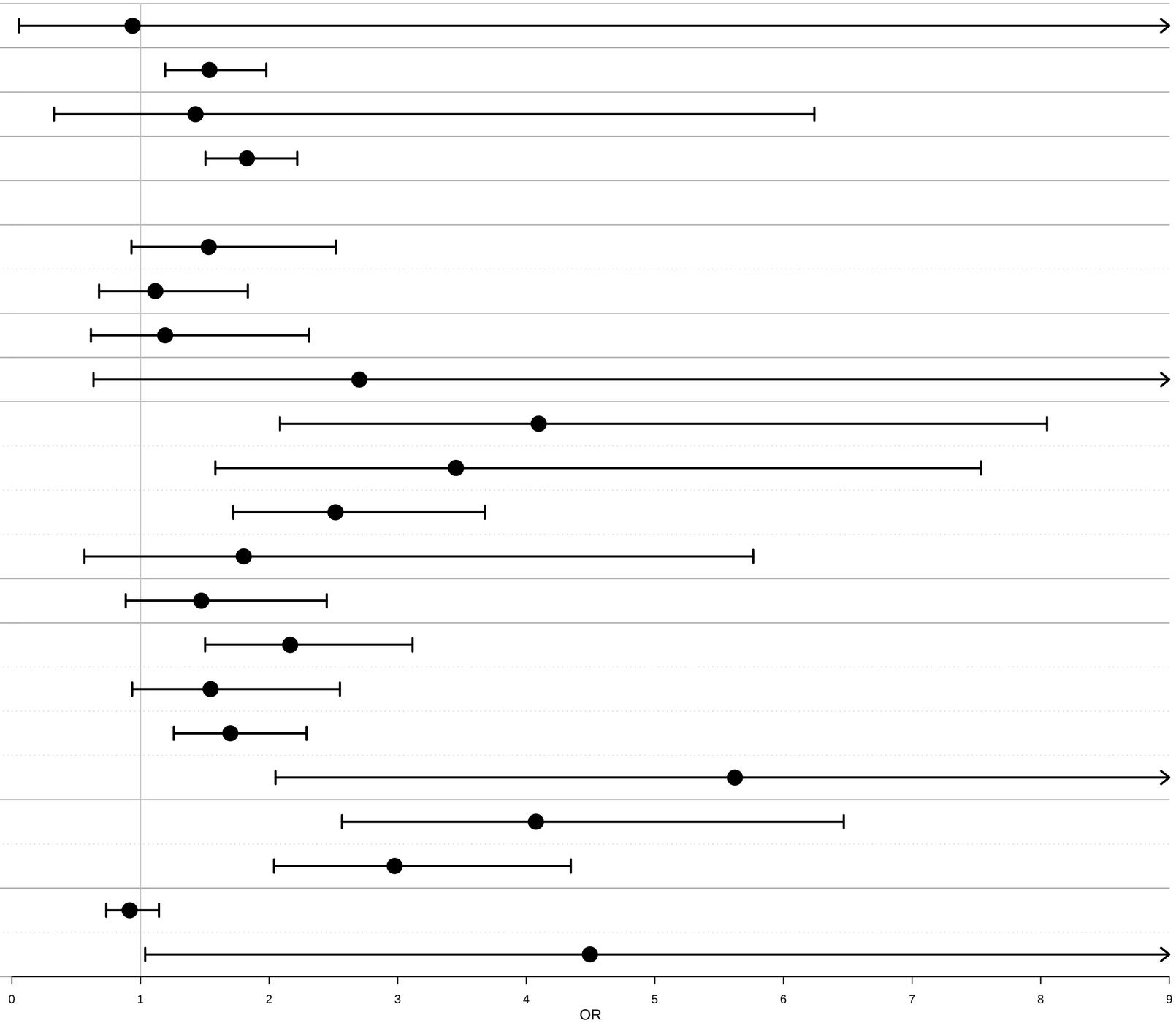
§ Recall periods vary by sites and variables (see Supplement Table S2). For variables where lifetime and recent had to be combined recall was categorized as 'ever'

† A total of 24,857 (58.69%) study subjects reported a history of incarceration (46.7% when excluding the data for UK-EW-NI and UK-S, which constitutes 69.14% of the total sample size)

‡ Data derived from publicly available sources, and for the same years or closest available years to the respective site data collection period (Eurostat: ES, FI, FR, GR, HU, LU, LV, NL, PL, PT, RO, UK; https://data.europa.eu/data/datasets/dvrrgg5nu7galdtl3xsyq?locale=en); Worldbank: PL, PT; http://iresearch.worldbank.org/PovcalNet/index.htm); Knoema: RU; https://knoema.com/atlas/Russian-Federation/GINI-index)


Duration of injecting
0
20
40
Age
20
40
60
80
Ever incarcerated
20%
40%
60%
80%
HIV prevalence
0%
20%
40%
60%
Site
CZ
EE-T
FI-7
GR-A
HU
LV-5s
LV-R
LU
NL-A
PL-G
PL-GK
PL-Ms
PL-W
PT-P
RU-5s
RU-IN
RU-StP
RU-V
SP-C
SP-MBS
UK-EWnI
UK-S
Country
Czech Republic
Estonia
Finland
Greece
Hungary
Latvia
Luxembourg
Netherlands
Poland
Portugal
Russia
Spain
United Kingdom
Ever incarcerated
Never incarcerated

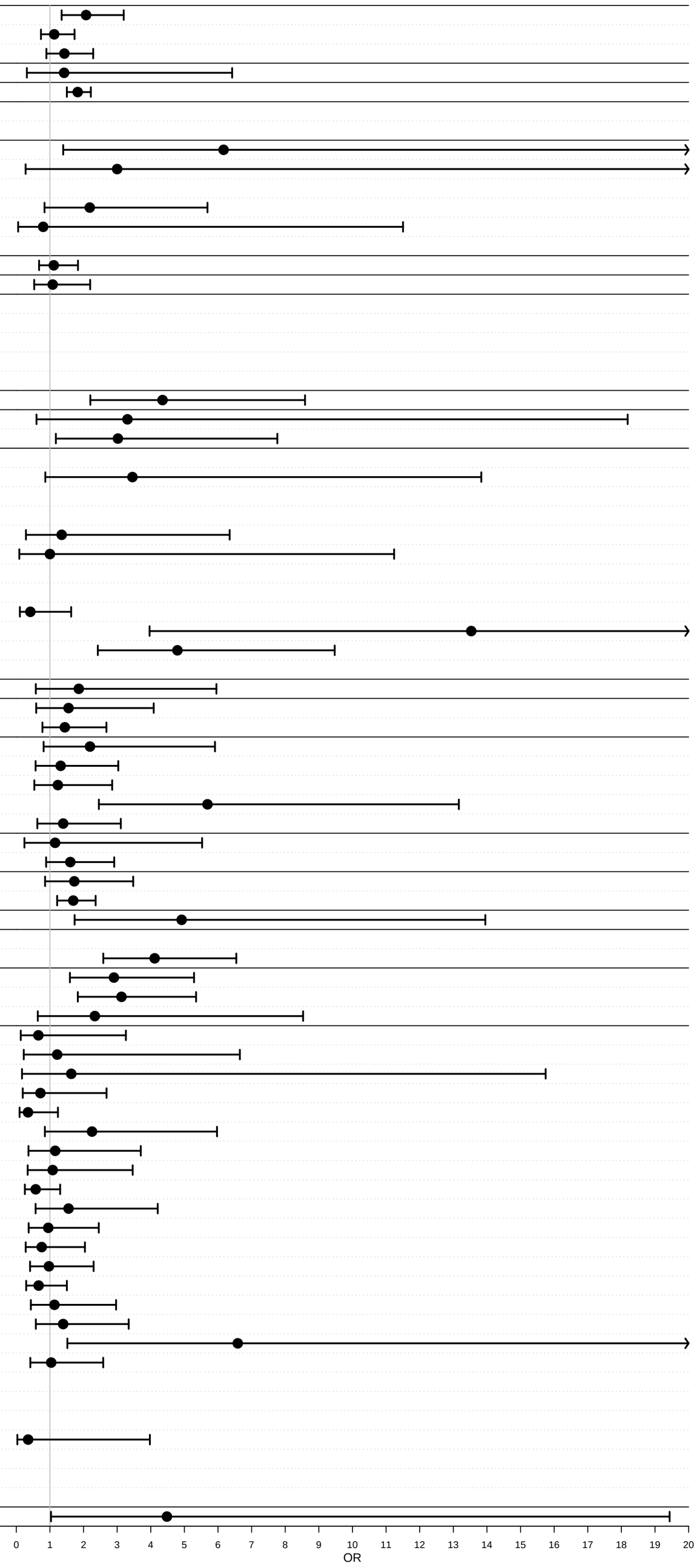
Country	Site	OR	95% CI
Czech Republic	CZ	0.94	0.1−15.9
Estonia	EE−T	1.54	1.2−2
Finland	FI−7	1.43	0.3−6.2
Greece	GR−A	1.83	1.5−2.2
Hungary	HU		
Latvia	LV−5s	1.53	0.9−2.5
	LV−R	1.12	0.7−1.8
Luxembourg	LU	1.19	0.6−2.3
Netherlands	NL−A	2.7	0.6−11.5
Poland	PL−G	4.1	2.1−8
	PL−GK	3.45	1.6−7.5
	PL−Ms	2.52	1.7−3.7
	PL−W	1.8	0.6−5.8
Portugal	PT−P	1.47	0.9−2.4
Russia	RU−5s	2.16	1.5−3.1
	RU−IN	1.55	0.9−2.6
	RU−StP	1.7	1.3−2.3
	RU−V	5.62	2−15.4
Spain	SP−C	4.07	2.6−6.5
	SP−MBS	2.98	2−4.3
United Kingdom	UK−EWnI	0.92	0.7−1.1
	UK−S	4.5	1−19.5



** Not estimated OR's are due to scarcity of data on HIV status*

** Note: CZ = Czech Republic; EE-T = Tallinn, Kohtla-Järve, Estonia; FI-7 = seven cities (Helsinki, Vantaa, Espoo, Tampere, Turku, Lahti, Hämeenlinna), Finland; GR-A = Athens, Greece; HU = Hungary; LV-5s = five geographical areas (Riga, Jurmala, Ogre, Liepaja, Bauska), Latvia; LV-R = Riga and surrounding areas, Latvia; LU = Luxembourg; NL-A = Amsterdam,Netherlands; PL-G = Gdańsk, Poland; PL-GK = Gdańsk, Kraków, Poland; PL-Ms = in six regions: mazowieckie (Warszawa), lubuskie (Zielona Góra, Gorzów Wlkp., Cibórz, Nowy Dworek), śląskie (Katowice, Chorzów, Sosnowiec), dolnośląskie (Wrocław – 2 locations), lubelskie (Lublin, Puławy), warmińsko-mazurskie (Olsztyn, Elbląg, Barczewo), Poland; PL-W = Warszawa, Poland; PT-P = Porto, Portugal; RU-5s = five cities (Barnaul, Volgograd, Naberezhnye, Chelny, Perm, Abakan), Russia; RU-IN = Ivanovo, Novosibirsk, Russia; RU-StP = Saint Petersburg, Russia; RU-V =Voronezh, Russia; SP-C = Catalonia, Spain; SP-MBS = Madrid, Barcelone, Seville, Spain; UK-EWnI = England, Wales & Northern Ireland, United Kingdom; UK-S = Scotland, United Kingdom*

Country	Site	Study	OR	95% CI
Czech Republic	CZ	Northern Bohemia_2002−2003		
		Other Czech Republic_2002−2003		
		Prague_2002−2003		
Estonia	EE−T	Tallinn_2009	2.08	1.3−3.2
		Tallinn_2011	1.13	0.7−1.7
		Tallinn_2013	1.43	0.9−2.3
Finland	FI−7	Southern Finland_2014	1.42	0.3−6.4
Greece	GR−A	Athens_2012−2013	1.83	1.5−2.2
Hungary	HU	Hungary_2014		
		Hungary_2015		
Latvia	LV−5s	Outside Riga_2014	6.17	1.4−27.2
		Outside Riga_2016	3	0.3−32.5
		Outside Riga_2017		
		Riga_2014	2.18	0.8−5.7
		Riga_2016	0.8	0.1−11.5
		Riga_2017		
	LV−R	Riga_2012	1.12	0.7−1.8
Luxembourg	LU	Luxembourg_2015−2017	1.08	0.5−2.2
Netherlands	NL−A	Amsterdam_2010		
		Amsterdam_2011		
		Amsterdam_2012		
		Amsterdam_2013		
		Amsterdam_2014		
Poland	PL−G	Gdansk_2002	4.35	2.2−8.6
	PL−GK	Gdańsk_2009	3.31	0.6−18.2
		Kraków_2009	3.02	1.2−7.8
	PL−Ms	Barczewo_2005		
		Cibórz_2004	3.45	0.9−13.8
		Elbląg_2005		
		GorzówWlkp_2004		
		Katowice/Chorzów_2004	1.35	0.3−6.3
		Lublin_2005	1	0.1−11.2
		NowyDworek_2004		
		Olsztyn_2005		
		Puławy_2005	0.42	0.1−1.6
		Warszawa_2004	13.53	4−46.2
		Wrocław_2005	4.79	2.4−9.5
		ZielonaGóra_2004		
	PL−W	Warszawa_2013	1.86	0.6−6
Portugal	PT−P	Central Portugal_2009−2010	1.55	0.6−4.1
		Northern Portugal_2009−2010	1.44	0.8−2.7
Russia	RU−5s	Abakan_2014	2.19	0.8−5.9
		Barnaul_2014	1.32	0.6−3
		Naberezhnye Chelny_2014	1.24	0.5−2.9
		Permian_2014	5.69	2.5−13.2
		Volgograd_2014	1.39	0.6−3.1
	RU−IN	Ivanovo_2010	1.16	0.2−5.5
		Novosibirsk_2010	1.61	0.9−2.9
	RU−StP	St Petersburg_2012	1.73	0.9−3.5
		St Petersburg_2013	1.69	1.2−2.4
	RU−V	Voronezh_2011	4.92	1.7−14
Spain	SP−C	Catalonia_2014		
		Catalonia_2015	4.12	2.6−6.5
	SP−MBS	Barcelona_2001−2003	2.9	1.6−5.3
		Madrid_2001−2003	3.13	1.8−5.3
		Seville_2001−2003	2.34	0.6−8.5
United Kingdom	UK−EWnI	England & Wales outside London_2000	0.66	0.1−3.3
		England & Wales outside London_2001	1.22	0.2−6.7
		England & Wales outside London_2002	1.64	0.2−15.7
		England & Wales outside London_2003	0.72	0.2−2.7
		England & Wales outside London_2004	0.35	0.1−1.2
		England & Wales outside London_2005	2.25	0.8−6
		England & Wales outside London_2006	1.16	0.4−3.7
		England & Wales outside London_2007	1.08	0.3−3.5
		England & Wales outside London_2008	0.58	0.3−1.3
		London_2000	1.55	0.6−4.2
		London_2001	0.95	0.4−2.5
		London_2002	0.76	0.3−2
		London_2003	0.97	0.4−2.3
		London_2004	0.66	0.3−1.5
		London_2005	1.13	0.4−3
		London_2006	1.39	0.6−3.3
		London_2007	6.59	1.5−28.6
		London_2008	1.04	0.4−2.6
		Northern Ireland_2002		
		Northern Ireland_2003		
		Northern Ireland_2004		
		Northern Ireland_2005	0.35	0−4
		Northern Ireland_2006		
		Northern Ireland_2007		
		Northern Ireland_2008		
	UK−S	Scotland_2013−2014	4.48	1−19.4



** Not estimated OR's are due to scarcity of data on HIV status and/or imprisonment*

** Note: CZ = Czech Republic; EE-T = Tallinn, Kohtla-Järve, Estonia; FI-7 = seven cities (Helsinki, Vantaa, Espoo, Tampere, Turku, Lahti, Hämeenlinna), Finland; GR-A = Athens, Greece; HU = Hungary; LV-5s = five geographical areas (Riga, Jurmala, Ogre, Liepaja, Bauska), Latvia; LV-R = Riga and surrounding areas, Latvia; LU = Luxembourg; NL-A = Amsterdam, Netherlands; PL-G = Gdańsk, Poland; PL-GK = Gdańsk, Kraków, Poland; PL-Ms = in six regions: mazowieckie (Warszawa), lubuskie (Zielona Góra, Gorzów Wlkp., Cibórz, Nowy Dworek), śląskie (Katowice, Chorzów, Sosnowiec), dolnośląskie (Wrocław - 2 locations), lubelskie (Lublin, Puławy), warmińsko-mazurskie (Olsztyn, Elbląg, Barczewo), Poland; PL-W = Warszawa, Poland; PT-P = Porto, Portugal; RU-5s = five cities (Barnaul, Volgograd, Naberezhnye, Chelny, Perm, Abakan), Russia; RU-IN = Ivanovo, Novosibirsk, Russia; RU-StP = Saint Petersburg, Russia; RU-V = Voronezh, Russia; SP-C = Catalonia, Spain; SP-MBS = Madrid, Barcelone, Seville, Spain; UK-EWnI = England, Wales & Northern Ireland, United Kingdom; UK-S = Scotland, United Kingdom*

SUPPLEMENT

Table S1. The list source data: cross-sectional studies among PWID in Europe by country, study, site, year, and number of study subjects

country/study/site year	n
Czech Republic	**760**
CZ	**760**
Northern Bohemia_2002−2003	129
Other Czech Republic_2002−2003	416
Prague_2002−2003	215
Estonia	**1031**
EE-T	**1031**
Tallinn_2009	353
Tallinn_2011	350
Tallinn_2013	328
Finland	**600**
FI-7	**600**
Southern Finland_2014	600
Greece	**3320**
GR-A	**3320**
Athens_2012−2013	3320
Hungary	**1054**
HU	**1054**
Hungary_2014	591
Hungary_2015	463
Latvia	**956**
LV-5s	**666**
Outside Riga_2014	110
Outside Riga_2016	37
Outside Riga_2017	31
Riga_2014	443
Riga_2016	37
Riga_2017	8
LV-R	**290**
Riga_2012	290
Luxembourg	**420**
LU	**420**
Luxembourg_2015−2017	420
Netherlands	**262**
NL-A	**262**
Amsterdam_2010	32
Amsterdam_2011	29
Amsterdam_2012	36
Amsterdam_2013	85
Amsterdam_2014	80
Poland	**1264**
PL-G	**200**
Gdansk_2002	200
PL-GK	**193**
Gdansk_2009	81
Kraków_2009	112
PL-Ms	**776**
Barczewo_2005	14
Cibórz_2004	87
Elblag_2005	23
GorzówWlkp_2004	38
Katowice/Chorzów_2004	60
Lublin_2005	42
NowyDworek_2004	21
Olsztyn_2005	46
Puławy_2005	50
Warszawa_2004	200
Wrocław_2005	178
ZielonaGóra_2004	17
PL-W	**95**
Warszawa_2013	95
Portugal	**253**
PT-P	**253**
Central Portugal_2009−2010	86
Northern Portugal_2009−2010	167
Russian Federation	**2234**
RU-5s	**520**
Abakan_2014	105
Barnaul_2014	105
Naberezhnye Chelny_2014	100
Permian_2014	105
Volgograd_2014	105
RU-IN	**593**
Ivanovo_2010	293
Novosibirsk_2010	300
RU-St P	**811**
St Petersburg_2012	144
St Petersburg_2013	667
RU-V	**310**
Voronezh_2011	310
Spain	**1367**
SP-C	**730**
Catalonia_2014	12
Catalonia_2015	718
SP-MBS	**637**
Barcelona_2001−2003	293
Madrid_2001−2003	278
Seville_2001−2003	66
United Kingdom	**30286**
UK-EWnI	**27823**
England & Wales outside London_2000	2866
England & Wales outside London_2001	2448
England & Wales outside London_2002	2157
England & Wales outside London_2003	1848
England & Wales outside London_2004	1941
England & Wales outside London_2005	2400
England & Wales outside London_2006	2483
England & Wales outside London_2007	2821
England & Wales outside London_2008	2511
London_2000	559
London_2001	515
London_2002	608
London_2003	801
London_2004	645
London_2005	628
London_2006	593
London_2007	594
London_2008	546
Northern Ireland_2002	77
Northern Ireland_2003	53
Northern Ireland_2004	100
Northern Ireland_2005	148
Northern Ireland_2006	164
Northern Ireland_2007	165
Northern Ireland_2008	152
UK-S	**2463**
Scotland_2013−2014	2463

TABLE S2: Measures availability and recall times by sites in source data (22 sites across Europe).

Study / Variable	Czech Republic (CZ)	Estonia (EE-T)	Finland (FI-7)	Greece (GR-A)	Hungary (HU)	Latvia (LV-5s)	Latvia (LV-R)	Luxembourg (LU)	Netherlands (NL-A)	Poland (PL-G)	Poland (PL-GK)	Poland (PL-Ms)	Poland (PL-W)	Portugal (PT-P)	Russia (RU-5s)	Russia (RU-IN)	Russia (RU-StP)	Russia (RU-V)	Spain (SP-C)	Spain (SP-MBS)	UK (UK-EWnI)	UK (UK-S)
Incarceration (history based on self-report)	ever (0.3) ‡	ever (0.0)	last 5 years (3.2)	ever; last 12 months (0.4)	ever (0.7)	ever (1.8)	ever (0.0)	ever (31.0)	ever (5.3)	last 12 months (0.5)	last 12 months (2.1)	last 12 months (1.9)	last 12 months (1.1)	ever (0.4)	ever (0.8)	ever (0.8)	ever (0.0)	ever (0.3)	ever; last 12 months (0.0)	ever (0.0)	ever (4.3)	ever (0.9)
Duration of injecting (years)	(+; categorised) (1.1)	(+) (1.3)	(+) (20.7)	(+) (2.9)	(+) (2.8)	(+) (3.3)	(+) (0.3)	(+) (63.1)	(+) (3.4)	(+) (30.5)	(+) (3.1)	(+) (15.5)	(+) (2.1)	(+) (3.2)	(+) (0.6)	(+) (85.7)	(+) (0.1)	(+) (0.0)	(+) (2.9)	(+) (8.0)	(+) (24.5)	(+) (0.4)
Frequency of injecting	recent (0.0)	1 month (2.5)	4 weeks (89.0)	12 months (0.0)	4 weeks (0.0)	4 weeks (83.2)	4 weeks (0.0)	recent (0.0)	1 month (85.9)	30 days (1.5)	recent (58.5)	recent (58.1)	NA (100)	6 months (74.3)	4 weeks (0.2)	30 days (0.0)	30 days (0.0)	30 days (0.0)	6 months (0.3)	12 months (1.6)	28 days (41.7)	recent (0.0)
Sharing needles/syringes	ever (2.2)	ever (3.0)	1 month; ever (5.0)	12 months; last time injected (0.5)	4 weeks (37.7)	1; 6 months; ever (2.1)	1; 6 months; ever (0.0)	recall period not specified (100.0)	6 months (85.5)	6 months; ever (22.0)	12 months; ever (3.6)	12 months; ever (5.5)	12 months; ever (2.1)	ever (24.9)	30 days (0.2)	last time injected (1.5)	30 days (1.6)	30 days (0.3)	6 months; ever (0.4)	1; 12 months; ever (8.3)	28 days / ever (39.9)	6; 12 months; ever (1.3)
Number of sexual partners	lifetime (0.5)	12 months (0.7)	nr* (100.0)	12 months (1.6)	12 months (9.6)	has had sex (yes/no) (4.4)	nr (100.0)	nr (100.0)	ever (casual partners only) (7.3)	12 months (3.0)	12 months (2.1)	12 months (3.0)	nr (100.0)	6 months (0.0)	12 months (1.0)	12 months (0.3)	6 months (0.0)	12 months (0.3)	12 months (2.6)	12 months (0.2)	12 months (6.2)	nr (100.0)
Opioid maintenance therapy	nr (100.0)	ever (53.0)	nr (100.0)	ever; 12 months, recent (1.4)	4 weeks (0.9)	12 months (91.7)	12 months (1.0)	recent (32.4)	ever (0.0)	nr (100.0)	12 months (0.0)	nr (100.0)	recent; 12 months (4.2)	ever (2.0)	na † (100.0)	na (100.0)	na (100.0)	na (100.0)	6 months (48.1)	recent; 12 months; ever (1.3)	Ever (5.6)	Ever (0.2)
Source of sterile needles/syringes	6 months (7.4)	1; 6 months (17.9)	nr (100.0)	12 months (100.0)	nr (100.0)	4 weeks (94.1)	4 weeks (2.1)	recall period not specified (0.0)	6 months (86.6)	ever (only NSP ‡) (94.0)	(+) (56.0)	nr (100.0)	ever (only NSP) (69.5)	recall time not reported (70.8)	recall time not reported (35.2)	12 months (12.8)	4 weeks (5.8)	nr (100.0)	6 months (0.0)	12 months (21.2)	nr (100.0)	6 months (NSP contact only) (100.0)
Main injection drug used	recall period not specified (7.2)	1 month (4.7)	1 month (52.8)	recent (0.7)	recall period not specified (0.7)	4 weeks (83.5)	4 weeks (2.8)	recent (46.0)	recent (85.9)	recent (2.0)	recent (42.5)	recent (6.2)	recent (30.5)	1 month (54.2)	nr (100.0)	30 days (1.0)	4 weeks (0.0)	30 days (0.0)	6 months (0.7)	12 months (0.0)	28 days (42.3)	recent (16.9)
Antiretroviral therapy §	nr (100.0)	recent (74.7)	nr (100.0)	recent (96.2)	nr (100.0)	recent (95.6)	recent (93.4)	recall period not specified (31.0)	recent (85.9)	nr (100.0)	nr (100.0)	nr (100.0)	nr (100.0)	nr (100.0)	recent (75.4)	recent (95.8)	recent (92.2)	nr (100.0)	6 months (75.8)	recent; ever (88.2)	nr (100.0)	nr (100.0)
Experiencing overdose	nr (100.0)	ever (0.0)	nr (100.0)	nr (100.0)	nr (100.0)	30 days; 6, 12 months; > 12 months (2.1)	nr (100.0)	nr (100.0)	recall period not specified (100.0)	nr (100)	recall period not specified (100.0)	nr (100.0)	12 months (2.1)	nr (100.0)	12 months (0.2)	12 months (2.0)	12 months (0.0)	12 months (0.0)	12 months; ever (0.5)	12 months; ever (0.0)	nr (100.0)	nr (100.0)

‡ The numbers in the parentheses represent the proportions of missing values (in percentages) for the specific study and variable; (+) availability of this variable in the data set; * nr not reported; † na not available; ‡ needle/syringe programme; § variable not used in the analysis due to missing data (not reported) (50% of sites);

Note: CZ = Czech Republic; EE-T = Tallinn, Estonia; FI-7 = seven cities (Helsinki, Vantaa, Espoo, Tampere, Turku, Lahti, Hämeenlinna), Finland; GR-A = Athens, Greece; HU = Hungary; LV-5s = five geographical areas (Riga, Jurmala, Ogre, Liepaja, Bauska), Latvia; LV-R = Riga and surrounding areas, Latvia; LU = Luxembourg; NL-A = Amsterdam, Netherlands; PL-G = Gdańsk, Poland; PL-GK = Gdańsk, Kraków, Poland; PL-Ms = in six regions: mazowieckie (Warszawa), lubuskie (Zielona Góra, Gorzów Wlkp., Cibórz, Nowy Dworek), śląskie (Katowice, Chorzów, Sosnowiec), dolnośląskie (Wrocław – 2 locations), lubelskie (Lublin, Puławy), warmińsko-mazurskie (Olsztyn, Elbląg, Barczewo), Poland; PL-W = Warszawa, Poland; PT-P = Porto, Portugal; RU-5s = five cities (Barnaul, Volgograd, Naberezhnye, Chelny, Perm, Abakan), Russia; RU-IN = Ivanovo, Novosibirsk, Russia; RU-StP = Saint Petersburg, Russia; RU-V = Voronezh, Russia; SP-C = Catalonia, Spain; SP-MBS = Madrid, Barcelone, Seville, Spain; UK-EWnI = England, Wales & Northern Ireland, United Kingdom; UK-S = Scotland, United Kingdom

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Estonia

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Spain

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Statistical analysis

Source of the data

For this work, traditional methodology (via systematic review) for selecting studies into this analysis was not used. Our data originates from a collaborative project 'European study group for mathematical modelling and epidemiological analysis of drug related infectious diseases' established by the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA), that compiles data from sero-behavioural surveillance and research studies across Europe. National studies from France and Germany could not be included due to procedural requirements (institutional agreements for use of the data could not be obtained in time).

Ethical review and approval was not required for this work based on completely and robustly anonymised secondary data from the EMCDDA collaborative project.

Missing data[1]

We presumed that the probability of being missing is the same within groups defined by the observed,[2] and therefore assumed that the data were missing at random. We applied multiple imputations (MI) using built-in predictive mean matching (semi-parametric), logistic regression (for imputing binary variables) and polytomous regression (for imputing categorical variables) methods. The MI procedure was first implemented using five imputations within each country, as ignoring the country-level clustering may lead to additional bias.[3] After that, each imputed country-level dataset was combined at each imputation, leaving five datasets with missing values for the variables that would otherwise have been completely missing at country level. In order to impute those final missing values, on the five datasets, the MI procedure was once again performed using five imputations, resulting in 25 unique datasets. The MI algorithm was implemented in R (version 3·5·1) using package MICE.[4]

Statistical analysis

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Propensity scores were estimated using a logistic regression model that included country, site-year (as fixed effects) and all individual-level variables (except HIV status) (Table 2). In addition, higher-order terms of Duration of injecting, Age and Number of partners and interactions between site-year, Duration of injecting and Age, between Main drug injected, Duration of injecting and Gender and between Main drug injected and Frequency of injecting were taken into account based on the Akaike and Bayesian information criteria. The propensity score model was developed to obtain the best possible predictive model within this data set. The model selection was conducted using stepwise forward-selection procedure using Akaike and Bayesian information criteria. Firstly, we added each of the variables linearly in the model to minimise information criteria. Secondly, we added in the same stepwise fashion higher-order terms (up to the 4th degree polynomial) for Duration of injecting, Age and Number of partners. Finally, we added in the same stepwise fashion pairwise interactions between site-year, Duration of injecting and Age, between Main drug injected, Duration of injecting and Gender and between Main drug injected and Frequency of injecting, maximising the information criteria.

The propensity-matched groups revealed a relatively small imbalance between the covariates. Across 25 imputed data sets, 7 matching groups and 15 variables (total of 2625 set of variables), after propensity score matching, 97% of all absolute standardised mean differences were below the threshold of 25%, and 77% of these differences were below the threshold of 10%. Although this does not result in standardised mean differences below 10% for some cases, the vast majority of the absolute standardised mean differences still lie below 25%. Further, it has been indicated that for modest sample sizes one could expect standardized differences that exceed 20% even when the propensity-score model was correctly specified.[5] Given previous and that the variance ratios for the variables lie between 0.5 and 2, we believe that propensity score fits well the data.

For the propensity score matched data, a GLMM was applied, in order to estimate the effect of incarceration on the probability of being infected with HIV. To guarantee the convergence of the model, we used bound-constrained optimization by quadratic approximation. As the number of random effects was larger than one, the number of points per axis for evaluating the adaptive Gauss-Hermite approximation to the log-likelihood was set to 1 which corresponds to Laplace approximation of the integrand.[6] Recent needle/syringe sharing was omitted due to multicollinearity with ever needle/syringe

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sharing (ever sharing included all individuals recently sharing). Age and years of injecting drug use were strongly correlated, above r = 0·6 in 13 of the 22 sites. Both of these variables measured "time at risk" for acquiring HIV through needle/syringe sharing, though years injecting is a more direct measure. We therefore conducted an additional sensitivity analysis by omitting age from the multivariable model. This did not affect the association between incarceration experience and HIV (aOR 1·31 95%CI 1·09-1·59).

The potential contribution of a number of structural level variables was assessed. However, as the structural level variables did not improve the fit of the models (except for Gini index that was also accounted for in the final analysis) it was decided to omit those from the analysis (results not shown). The aggregate level variables included: "OMT coverage of opioid users in community", "NSP coverage of PWID in community", "HIV prevalence among PWID in community", "PWID prevalence in community", "ART coverage among PWID in community", "incarceration rate in general population", "incarceration rate in PWID", "Gini index", "unemployment in general population", "OMT coverage in prisons", "NSP in prisons", "HIV prevalence in PWID in prisons", "PWID prevalence in prisons", "condom coverage in prisons"

Table S3. Univariable estimates for structural level variables and HIV positivity status association (odds ratios, 95%CI).

Aggregated level characteristics	**OR**	**95% CI**	**p-value**
OMT_coverage_of_opioid_users_in_community	0.97	0.54-1.74	0.91095
NSP_coverage_of_PWID_in_community	0.99	0.55-1.76	0.96567
HIV_prevalence_among_PWID_in_community	1.56	0.90-2.70	0.11698
PWID_prevalence_in_community	0.90	0.41-1.97	0.79806
ART_coverage_among_HIV_infected_PWID_in_community	0.65	0.24-1.74	0.39428
Incarceration_rate_general_population	0.54	0.25-1.15	0.10931
Incarceration_rate_among_PWID	1.00	0.62-1.62	0.98519
Gini_index	1.97	1.17-3.31	0.01059
Unemployment_general_population	0.89	0.55-1.46	0.65344
OMT_Prison	0.93	0.61-1.41	0.72249
NSP_Prisonnot provided in prisons	0.35	0.07-1.69	0.19218
HIV_prevalence_among_PWID_Prison	1.40	0.45-4.41	0.56578
PWID_prevalence_Prison	0.44	0.06-3.46	0.43931
Condom_coverage_PWID_Prisonyes	0.90	0.09-8.84	0.92879

Table S4. Exact parameter estimates along with standard errors and p-values. Estimates are on the scale of log odds ratios.

	Univariable models			**Univariable propensity score matched models**			**Multivariable propensity score matched models**		
	estimate	std.error	p-value	estimate	std.error	p-value	estimate	std.error	p-value
Socio-demographic characteristics									
Age (years)	0.149255	0.025999	<0.00001	0.029821	0.039164	0.44805	-0.16879	0.055315	0.00261
Gender									
Male	-0.02973	0.051923	0.56701	-0.30445	0.084127	0.00037	-0.26023	0.084573	0.00228
Female									
Drug use characteristics									
Duration of injecting (years)	0.297712	0.024149	<0.00001	0.193792	0.045109	0.00008	0.266698	0.062435	0.00006
Frequency of injecting (recent)[i]									
Less than daily	-0.2837	0.059292	<0.00001	-0.15275	0.082939	0.06943	-0.10141	0.086215	0.24289
Daily or more									
Main drug injected (recent)[j]									
Stimulants other than cocaine									
Cocaine	1.183048	0.186553	<0.00001	1.230646	0.222065	<0.00001	0.994668	0.227448	0.00004
Opioids	0.659891	0.108455	<0.00001	0.624935	0.166039	0.00031	0.416978	0.185563	0.02782
Opioid & Cocaine	1.188181	0.175326	<0.00001	1.007634	0.235071	0.00007	0.772078	0.249483	0.00305
Other	0.563555	0.143506	0.00011	0.497524	0.286117	0.0883	0.439302	0.287172	0.13202
Overdose (ever)[k]									
Yes	0.443733	0.11889	0.00074	0.349554	0.129926	0.01089	0.189962	0.113329	0.10081

No									
Sharing (recent)[¶]									
Yes	0.37584	0.058907	<0.00001	-	-	-	-	-	-
No									
Sharing (ever)[§]									
Yes	0.633568	0.053188	<0.00001	0.719512	0.088166	<0.00001	0.644623	0.091122	<0.00001
No									
Sexual behaviour									
Number of partners (lifetime)[§]	0.042421	0.012007	0.00041	0.035986	0.017209	0.03822	0.028092	0.016215	0.08508
Number of partners (lifetime)[§]									
>=10									
2-9	-0.20307	0.08587	0.01816	-	-	-	-	-	-
0	0.204199	0.083887	0.01503	-	-	-	-	-	-
1	-0.13428	0.079887	0.09301	-	-	-	-	-	-
Environmental factors									
Opioid maintenance therapy (ever)[§]									
Yes	0.384496	0.075232	<0.00001	0.331779	0.114558	0.00533	0.20044	0.125443	0.11582
No									
Main source of clean syringes (ever)[§]									
NSP and/or outreach									
Other	-0.2994	0.160524	0.07091	-0.22607	0.197462	0.26018	-0.13267	0.205512	0.52279
Pharmacy	-0.35577	0.103016	0.00124	-0.3157	0.107367	0.00465	-0.33072	0.102173	0.00176

Ever in prison§†									
Yes	0.567497	0.047753	<0.00001	0.237849	0.095456	0.01602	0.275384	0.095353	0.00553
No									
Study level measures									
GINI index‡	-	-	-	-	-	-	0.289494	0.062788	<0.00001

† Recall times up to 12 months were categorized as 'recent'.
§ Recall periods vary by sites and variables (see Supplement Table S2). For variables where lifetime and recent had to be combined recall was categorized as 'ever'
† A total of 24,857 (58.69%) study subjects reported a history of incarceration (46.7% when excluding the data for UK-EW-NI and UK-S, which constitutes 69.14% of the total sample size)
‡ Data derived from publicly available sources, and for the same years or closest available years to the respective site data collection period (Eurostat: ES, FI, FR, GR, HU, LU, LV, NL, PL, PT, RO, UK; https://data.europa.eu/data/datasets/dvrrgg5nu7galdtl3xsyq?locale=en); Worldbank: PL, PT; http://iresearch.worldbank.org/PovcalNet/index.htm); Knoema: RU; https://knoema.com/atlas/Russian-Federation/GINI-index)

Table S5. Characteristics of PWID across each of the 5 propensity score strata (quintiles - from 1, lowest probability to 5, highest probability of ever incarceration)

Socio-demographic characteristics	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Age (standardized years; mean, range, SD)	-0.50; -2.4-3.7; 0.94	-0.11; -2.1-4.7; 0.98	0.06; -2.1-4.7; 0.98	0.18; -2.1-4.5; 0.94	0.38; -2.1-5.4; 0.93
Age (years*; mean, range, SD)	28.6; 12.6-63.9; 7.91	31.8; 15.1-72.3; 8.25	33.3; 15.1-72.3; 8.25	34.3; 15.1-70.7; 7.91	36.0; 15.1-78.2; 7.83
***Gender* (%)**					
Men	39	59	82	94	98
Female	61	41	18	6	2
HIV positive (%)					
Yes	12	8	7	6	7
No	88	92	93	94	93
Ever in prison (%)§†					
Yes	27	49	62	72	84
No	73	51	38	28	16
Drug use characteristics					
Duration of injecting (standardized years; mean, range, SD) (all PWID)	(-0.58, -1.4-4.2, 0.75)	(-0.23, -1.4-4.3, 0.88)	(-0.08, -1.3-4.7, 0.94)	(0.16, -1.3-5.2, 0.93)	(0.73, -1.3-5.2, 0.97)
Frequency of injecting (recent)[ǁ] (%)					
Less than daily	72	62	58	53	39
Daily or more	28	38	42	47	61
Main drug injected (recent)[ǁ] (%)					
Stimulants other than cocaine	11	4	3	2	3

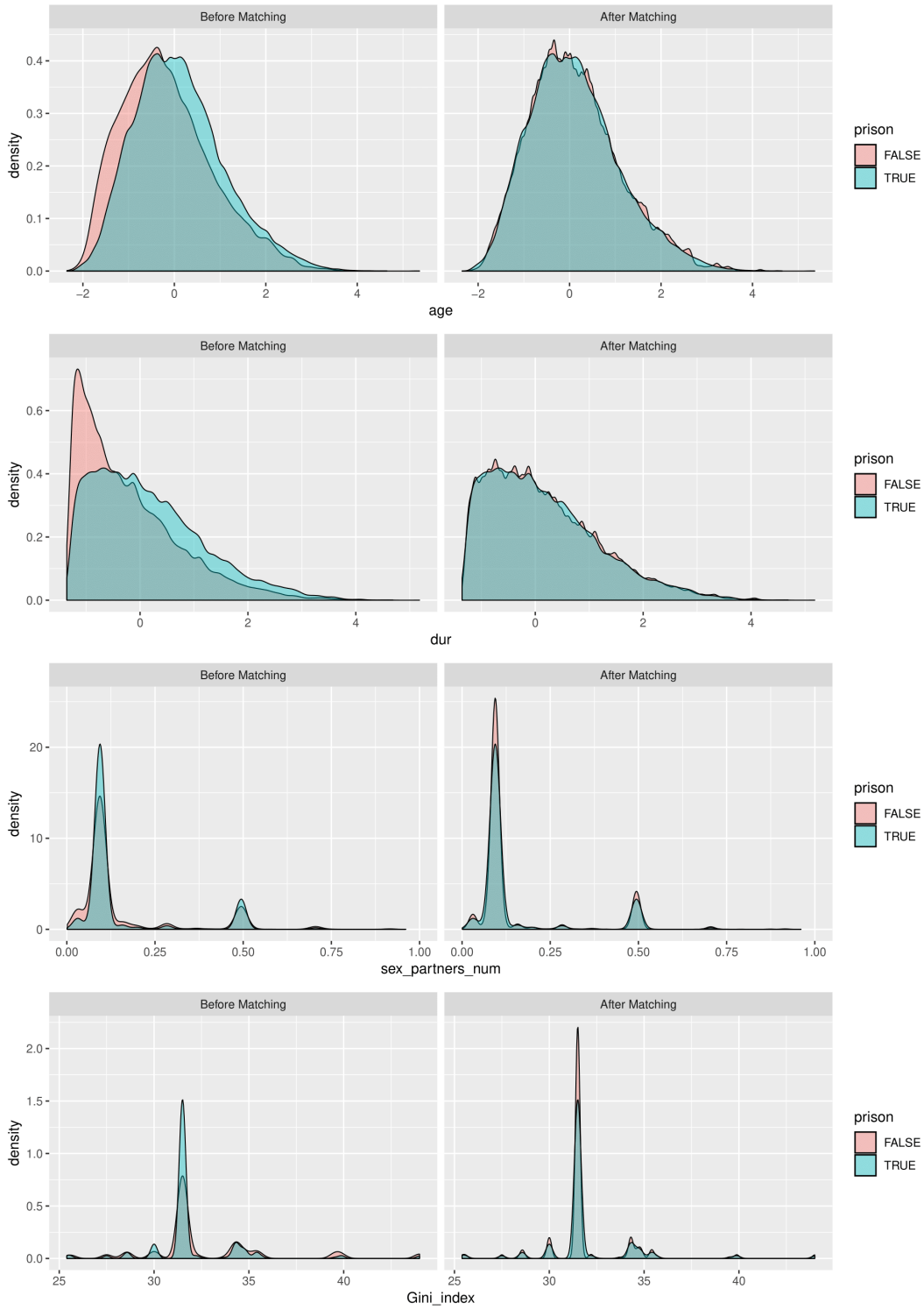
Cocaine	5	7	7	8	9
Opioids	70	79	81	80	69
Opioid & Cocaine	3	5	6	9	17
Other	11	4	3	2	2
Overdose (ever)[§] (%)					
Yes	31	38	44	51	67
No	69	62	56	49	33
Sharing needles/syringes (recent)[‖] (%)					
Yes	31	28	28	29	38
No	69	72	72	71	62
Sharing needles/syringes (ever)[§] (%)					
Yes	37	32	32	31	41
No	63	68	68	69	59
Sexual behaviour					
Standardized number of partners (lifetime)[§] (mean, range, SD) (all PWID)	(0.02, -0.1-63.3, 1.33)	(-0.02, -0.1-25.3, 0.39)	(-0.01, -0.1-70.8, 0.7)	(-0.01, -0.1-70.8, 0.75)	(0.02, -0.1-101.3, 1.42)
Number of partners (lifetime)[§] (%)					
>=10	17	22	26	29	36
2-9	21	12	8	5	4
1	45	44	41	39	36
0	16	22	25	26	24
Environmental factors					
Opioid maintenance therapy (ever)[§] (%)					
Yes	47	63	73	82	90
No	53	37	27	18	10

Main source of clean syringes (ever)§ (%)					
NSP and/or outreach	30	39	45	54	69
Other	25	26	22	20	14
Pharmacy	45	35	32	27	17

* Original scale age summary statistics are calculated by multiplying the standardized scale summary statistics with observed standard deviation (before imputation) and adding means (before imputation);
‖ Recall times up to 12 months were categorized as 'recent';
§ Recall periods vary by sites and variables (see Supplement Table S2). For variables where lifetime and recent had to be combined recall was categorized as 'ever';
† A total of 24,857 (58.69%) study subjects reported a history of incarceration (46.7% when excluding the data for UK-EW-NI and UK-S, which constitutes 69.14% of the total sample size);
‡ Data derived from publicly available sources, and for the same years or closest available years to the respective site data collection period; (Eurostat: ES, FI, FR, GR, HU, LU, LV, NL, PL, PT, RO, UK; https://data.europa.eu/data/datasets/dvrrgg5nu7galdtl3xsyq?locale=en); Worldbank: PL, PT; http://iresearch.worldbank.org/PovcalNet/index.htm); Knoema: RU; https://knoema.com/atlas/Russian-Federation/GINI-index)

Figure S2. Propensity score balance - distributional balance plot (adjusted and unadjusted samples)

S2.1 Distributional balance plot (numeric variables).



S2.2 Distributional balance plot (categorical variables).

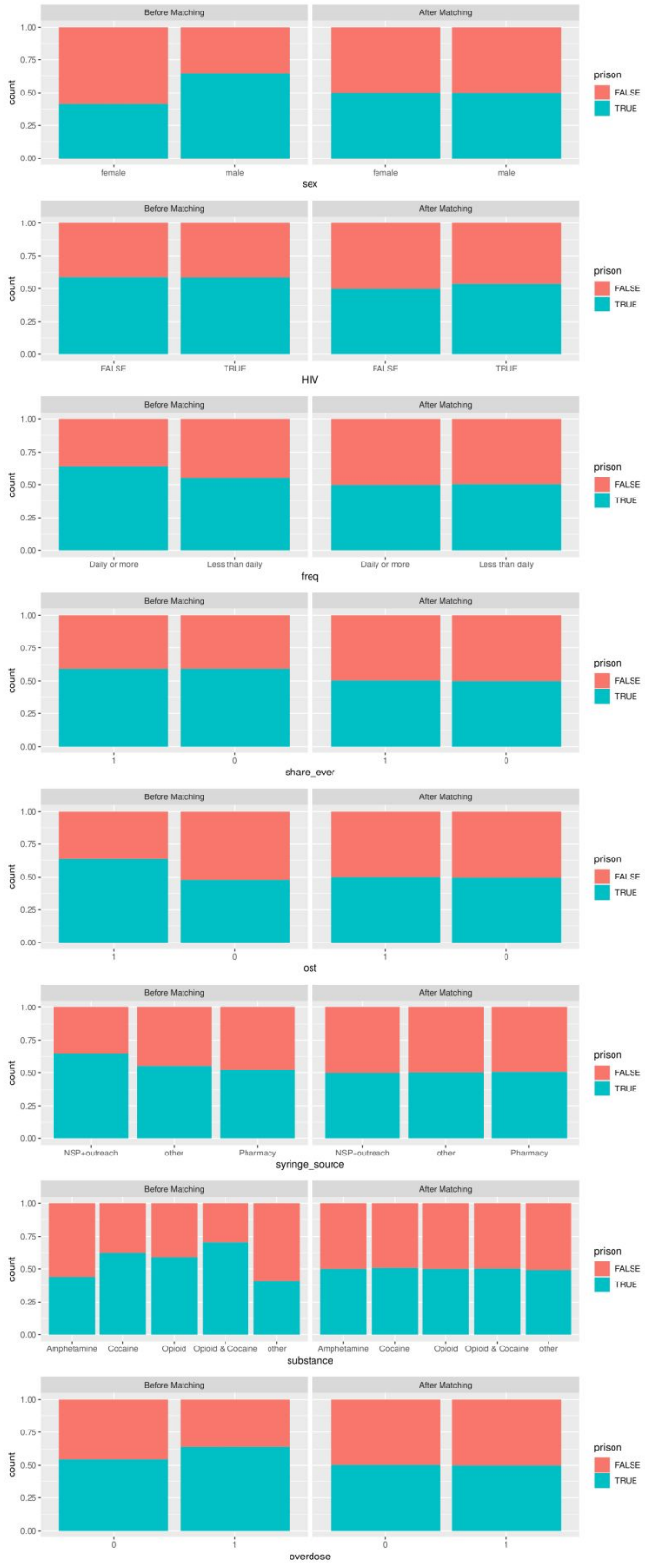


Figure S3. Proportion of missing (red) and observed (blue) data points in the combined data set