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High levels of post-migration HIV acquisition within nine European countries.

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Abstract

Objective: We aimed to estimate the proportion of post-migration HIV acquisition among HIV-positive migrants in Europe.

Design: To reach HIV positive migrants we designed a cross sectional study performed in HIV clinics.

Methods: The study was conducted from July 2013-July 2015 in 57 clinics (9 European countries, targeting individuals over 18 years diagnosed in the preceding 5 years and born abroad. Electronic questionnaires supplemented with clinical data were completed in any of 15 languages. Post-migration HIV acquisition was estimated through Bayesian approaches combining extensive information on migration and patients' characteristics**.** CD4 counts and HIV-RNA trajectories from seroconversion were estimated by bivariate linear mixed models fitted to natural history data. Post-migration acquisition risk factors were investigated with weighted logistic regression.

Results: Of 2009 participants, 46% were men who have sex with men (MSM) and a third originated from Sub-Saharan Africa (SSA) and Latin America & Caribbean (LAC), respectively. Median time in host countries was 8 years. Post-migration HIV acquisition was 63% (95% CI: 57%-67%); 72% among MSM, 58% and 51% in heterosexual men and women, respectively. Post-migration HIV acquisition was 71% for LAC migrants and 45% for people from SSA. Factors associated with post-migration HIV acquisition among heterosexual women and MSM were age at migration, length of stay in host country and HIV diagnosis year and among heterosexual men, length of stay in host country, and HIV diagnosis year.

Conclusions: A substantial proportion of HIV-positive migrants living in Europe acquired HIV post-migration. This has important implications for European public health policies.

Keywords: HIV; Transients and Migrants; Europe

Introduction

Migrants most typically encompass a selected population of healthy young people[1] whose drivers are largely labour and education markets. Migration is also fuelled by economic and political instability[2]. Despite this, compared with native populations, migrants are at increased risk of many diseases, including HIV infection[3, 4]. This is attributable to individual behaviours, structural factors and social inequalities[3, 4] which increase the vulnerabilities of migrant populations through limited access to HIV prevention, testing and care[3, 5].

In 2015, 29,747 new HIV diagnoses were reported in the European Union (EU) and the European Economic Area (EEA), information on geographical origin was available for 25,785, and of these, 9,347 (37%) were in people from outside of the reporting country, migrants, and 3,768 (15%) from countries with generalized HIV epidemics[6]. Most EU countries consider migrants as a priority population in their national response to HIV[7]. In the past, most HIV infections in migrants in Europe, particularly among those from Sub-Saharan African (SSA), were assumed to have been imported[8, 9]. There is mounting evidence that HIV infections in migrants are being increasingly acquired post-migration[10-15]. This concerns the two populations most affected by HIV in Europe, African communities and men who have sex with men (MSM) from different geographical regions, but hardly any data are available from migrant MSM [16]. Knowing whether HIV acquisition occurs pre or post-migration is critical in designing adequate HIV prevention and testing strategies. Obtaining reliable estimates, though, requires a combination of behavioural and clinical data, as well as detailed information of migratory paths which is hard to implement on routine bases. There is no consensus on

how to best determine timing of HIV infection and different methodologies have adopted [12-15]. Further, all published studies to date have been confined to one city or one country and most have addressed heterosexually transmitted HIV among people from SSA[12, 15, 17].

In this article we estimate the proportion of post-migration HIV acquisition, and factors associated with it, among HIV-positive migrants diagnosed with HIV in the preceding 5 years from different geographic origins living in any of the nine EU/EEA countries participating in the aMASE (Advancing Migrant Access to Health Services in Europe) study[18].

Methods

Study design, setting and participants

We designed a multicenter cross-sectional study whose full methodology has been described elsewhere[18]. Participants' were over 18 years old, diagnosed with HIV in the preceding five years (to minimize recall bias), living outside their country of birth and residing in one of the nine following countries for at least six months: Belgium, Germany, Greece, Italy, The Netherlands, Portugal, Spain, Switzerland and the United Kingdom. Patients had to consent to participate and be able to complete alone or assisted an electronic survey in any of the 15 languages (Amharic, Arabic, Dutch, English, French, German, Greek, Italian, Polish, Portuguese, Russian, Turkish, Tigrinya, Spanish, Somali). In Switzerland, migrants from neighbouring Austria, France, Germany and Italy were excluded. A convenience sample was recruited within 57 HIV clinics (Appendix 1 ,

http://links.lww.com/QAD/B119) across the EuroCoord European Network of Excellence on HIV Research (www.eurocoord.net). Data collection took place July 2013-July 2015.

Sample size calculation

Sample size calculations were estimated for the proportion of subjects with previous HIV-negative tests, as described in the methodology article by the aMASE study group[18]. The target sample size was 2000 HIV-positive migrants who were recruited from a minimum of two clinics in each country, with each clinic forming a discrete cluster. Within cluster correlation was estimated to be relatively weak (e.g. 0.005)[18]. This sample size (n=2000) was sufficient for the question addressed in this manuscript as the assumed proportion of post-migration HIV acquisition was 50% with a precision of 5%-10%.

Variables and definitions

A questionnaire was designed in collaboration with community partners to gather the following information: socio-economic and clinical data; sexual and drug use behaviour; migratory trajectories, including dates of arrival into the host country; and residency status. Whenever possible, items were adapted from existing survey instruments[18]. The survey was delivered using a computer assisted self- or personal-interview (CASI or CAPI) using a tablet or PC available on- and offline to minimize interviewer and interviewee bias, supplemented with clinical data from patient records within the participating clinics. Clinical data included: previous HIV tests, CD4 cell counts, viral load determinations, HIV-1 subtypes, clinical events and Antiretroviral Therapy (ART)

initiation. For the current analyses, our outcome of interest was the time of HIV-acquisition (pre or post-migration).

Statistical analyses

The probability of pre- or post-migration infection was estimated through a Bayesian approach that combined information on migration history, risk factors and patients' characteristics including CD4 cell count and HIV-RNA measurements**.** Full statistical methods were presented elsewhere [19] and in the Web appendix (see Text, Supplemental Digital Content 1 , http://links.lww.com/QAD/B120). We assumed subjects could have not been infected with HIV before: i) the age of ten years (since patients in this analysis were not vertically infected); ii) 1/1/1980 and iii) the date of a documented HIV negative test. Starting from a uniform prior distribution for the seroconversion date over time at risk, we incorporated information from available CD4 cells counts and HIV-RNA levels measurements before AIDS development and ART initiation. CD4 cell counts and HIV-RNA trajectories from HIV seroconversion were estimated by a bivariate linear mixed model (LMM) fitted to natural history data from the CASCADE collaboration[20]. CASCADE comprises data of over 30.000 HIV-positive persons with documented dates of HIV seroconversion from 29 cohorts across Europe, Canada and Australia. Demographic covariates such as sex, current age, mode of infection and region of birth along with calendar year of seroconversion were incorporated in the model as virulence may increase over the epidemic's course[21]. For individuals participating in aMASE, we derived the posterior distribution of the time between HIV seroconversion and HIV diagnosis applying the Bayes' rule assuming parameters obtained by the

bivariate LMM as known (see Text, Supplemental Digital Content 1, http://links.lww.com/QAD/B120). We further extended this method by considering absence or presence of AIDS at diagnosis, incorporating the distribution of time to AIDS obtained from CASCADE data (censored at 1996 due to the introduction of ART). Additionally, behavioral data were also considered by assigning prior probabilities of HIV acquisition pre or post-migration based on expert' opinion (HIV researchers with more than 15 years' experience in HIV epidemiology). Table 1 summarizes the assigned pre or post-migration probabilities for sexual and drug use behaviour data. In case of no agreement between experts, the figures closest to 0.5 (i.e. the less informative) were considered (bold in the Table). Analyses were also done removing these prior probabilities. The posterior probabilities of pre or post-migration infection were obtained through numerical integration over the posterior distribution of the time between HIV seroconversion and diagnosis dates (see Text, Supplemental Digital Content 1). For patients who were known to have been infected pre or post-migration (through a documented or self-reported HIV positive test pre-migration or a documented HIV negative test after migration followed by a positive one, respectively) the aforementioned Bayesian method was not applied but they were included in the final analysis assigning to them pre or post-migration probability equal to one as appropriate. The combination of behavioral, documented seroconversion and inferences from joint CD4 and VL modelling, allowed classifying 95% of all HIV infections as pre or post-migration acquisitions. To investigate the validity of our approach we applied it to individuals known to be infected pre or post-migration (based on their HIV testing history). The results of this analysis showed that our method was able to correctly identify post and

pre-migration infections (e.g. individuals with an estimated probability of post-migration infection >0.5 were classified as infected post-migration), in about 85% of the cases. Uncertainty in the estimation of the date of HIV seroconversion (and the resulting uncertainty in the classification of HIV acquisition as pre or post-migration) was taken into account using a multiple imputations approach. More specifically, after deriving the posterior distribution of unknown seroconversion time for each individual, 50 random samples were drawn for each participant (using rejection sampling). In each one of the resulting datasets (n=50), subjects were classified as being infected pre- or post-migration based on the imputed seroconversion time. Results for all subsequent analyses were based on the combination of results from the imputed datasets according to Rubin's rules [22]. Potential clinics and/or countries clustering effects were investigated and taken into account through multilevel logistic regression models. Initially, three-level logistic models (i.e. participants nested within clinics nested within countries) were fitted. However, the variance of the countries' random effects was approximately zero and non-significant given other significant prognostic factors. Thus, all subsequent analyses were based on two-level random effects logistic regression models with clinics as the clustering variable. Associated p-values were derived using Wald type tests.

The probabilities of post-migration HIV acquisition, and their 95% Confidence Intervals (CI), were estimated by geographical origin, transmission categories and destination country. Separate analyses were conducted for HIV transmitted heterosexually in men and in women (only reported heterosexual sex and never injected drugs), for MSM (MSM who never injected drugs) and for people who inject drugs (PWID). Socio-

demographic factors associated with post-migration HIV acquisition were investigated for each transmission category through multivariable random effects logistic regression as described above. We specified the following a priori variables which could be associated with post-migration HIV acquisition: age at arrival to host country, age at HIV diagnosis, geographical origin (Europe, SSA, Latin-America & The Caribbean, other), length of stay in host country (< six years, six to ten years, > ten years), residency status (EU/EEA nationals/with residency permit, visa/asylum/refugee status, uncertain/unknown status), civil status (married/living with couple, single, divorced/separated/widowed), has children (yes/no), educational level (primary or less, secondary, university), employment status (working, unemployed, not allowed to work due to immigration reasons, student, retired/long term disability, family care/voluntary work and unknown), salary (less that minimum wage (MW), does not earn his/her own wage, above or similar to MW, rather not say). The final model was constructed through a backward stepwise procedure with the removal p-value equal to 0.15 whereas area of origin was included irrespective of its significance due to its importance in the specific study.

Statistical analyses were performed by using Stata software (Version 13.1; College Station, TX USA) and R (Version 3.4.0; R Foundation for Statistical Computing, Vienna, Austria)

Ethics

Ethical approval for aMASE was received separately in each country [18].

Results

Of 3794 patients registered on enrolment logs, 3251 HIV-positive migrants were invited to participate of whom 3152 were eligible and 2209 (70%) accepted and completed the survey. Participation was higher in men (74%) than in women (62%), decreased with age (83% in people aged 18-24 and 70% in those aged 55-64) and was higher in migrants from Latin America (86%) and Eastern Europe (82%) and lower in those from Sub-Saharan Africa (59%). Out of these 2209, 2117 (96%) had supplementary clinical data. Recruitment was as follows: Belgium (256), Germany (31), Greece (175), Italy (64), The Netherlands (119), Portugal (182), Spain (710), Switzerland (178) and United Kingdom (402).

Overall, 68% were men , the proportion of transgender men or women was low (1%, n=24). Median age was 36 years (Interquartile Range, IR: 30-44). A third were from SSA and Latin America & Caribbean, respectively, followed by Western (11%), Central (10%) and Eastern (5%). Almost half of participants were MSM (46%). The median time in host countries was 8 years (IR: 4-13). Heterosexually transmitted cases were largely from SSA (61%), the proportion of women was 65%, educational level was the lowest (32% with primary education or less) and 26% did not have permanent resident status. MSM were mainly from Latin America and Caribbean (47%) and Europe (35%) and their socio-economic profile was more favourable than heterosexually transmitted cases. PWID were largely from Europe (50%) and predominantly men (88%) (Table 2).

Of the 2117 study participants with clinical data, 2009 (95%) had enough information to estimate time of HIV acquisition. Of them, 129 (6.4%) and 624 (31.1%) were classified as definitely infected pre or post-migration through a documented or self-reported HIV

positive test pre-migration or a documented HIV negative test after migration, respectively. Taking into account all available data, the overall proportion of post-migration HIV acquisition was 63% (95% CI: 57%-67%). Post-migration HIV acquisition was higher among MSM (72%) and PWID (75%) compared to heterosexual men (58%) and women (51%). Post-migration HIV acquisition was higher in migrants from Europe (71%) and Latin America & Caribbean (71%) compared to migrants from SSA (45%) (Figure 1a). Estimated probabilities of post-migration HIV acquisition in the nine participating countries are shown in Figure 1b with Netherlands, Spain and UK having the highest ones (72%, 71% and 67%, respectively) and Italy, Belgium and Switzerland the lowest estimates (27%, 42% and 46%, respectively). Overall differences by country were statistically significant ($p<0.001$) but became non significant after adjustment for transmission category and length of stay ($p=0.430$). Analyses without assigning prior probabilities yielded similar results: the estimated overall probability (95% CI) of post-migration infection became 61% (56, 65) instead of 63% (57, 67). Similar differences were observed when estimating the same probability by region of origin [e.g. European migrants 69% (63, 74) instead of 71% (65, 76), SSA migrants 44% (38, 50) instead of 45% (39, 52)].

Table 3 shows the percentages of post-migration HIV acquisition (i.e. the proportion of individuals with an estimated probability of post-migration infection >0.5) by mode of transmission for each sociodemographic characteristic. In the multivariate regression analyses, among heterosexual women and among MSM, the factors associated with the probability of acquiring HIV post-migration were length of stay and age at arrival in the host country and year of HIV diagnosis (Table 4). For heterosexual men, factors

associated with post-migration HIV acquisition were length of stay in the host country and the year of HIV diagnosis (Table 4). Additionally, among MSMs, those in visa/asylum or refugee status and those with unknown status were less likely to be infected post-migration compared to those of EU nationalities or with residence permit. Geographical region of origin did not remaine a significant risk factor in the multivariate analyses apart from some weak indications for lower probabilities of post-migration HIV acquisition in heterosexual men from Sub-Saharan Africa compared to migrants from Europe [OR: 0.4 (95% CI: 0.1-1.4; p=0.144.

Numbers were too low to perform multivariate analyses in PWID.

Discussion

Our study suggests that 63% of HIV-positive migrants in aMASE – who were diagnosed within the preceding 5 years - acquired HIV after migrating into Europe. The proportion of post-migration HIV acquisition varies by patients' origin which is closely linked to the mode of HIV transmission. Latin-America & Caribbean MSM appear to be particularly at risk, 79% of all HIV infections in this group were acquired most likely post-migration. Among heterosexual migrants from SSA more than 40% of all HIV infections seem to be acquired post-migration. Although numbers are considerably lower among PWID, the probability of post-migration HIV acquisition exceeded 74% for all geographical origins. Length of stay and age at arrival in the host country were associated with post-migration HIV acquisition of sexually transmitted HIV; the longer the duration of residence and the younger the age at migration, the higher the probability of becoming HIV infected after migration. Post-migration HIV acquisition was more common in recent periods for the

sexually transmitted cases and only for MSM was commoner for those with secure immigration status.

Migrants included in this study are not representative of migrants living with HIV in the 9 participating countries, but rather a convenience sample from large HIV testing sites of migrants diagnosed with HIV in the preceding 5 years. Indeed, this selection bias needs to be taken into account when comparing our findings with other studies. Whereas the restriction to HIV diagnoses within preceding 5 years may hamper comparisons with other studies, this was a deliberate decision to minimize recall bias given the extensive information on migration and risk behaviour history we aimed to collect.

Our results are consistent with previous publications but provide new information to guide public health policy and practice. Fakoya et al.[13] described in a systematic review that HIV acquisition after migration could range from 2% in Switzerland among people from countries with a generalized epidemic[23] to 62% among migrant black Caribbean MSM in the UK[24]. Overall differences between countries were highly significant, but after adjustment for differences in the distribution of transmission category and length of stay, differences became clearly non-significant.

Rice et al. estimated that 31% of HIV-positive black Africans reported through national surveillance had become infected after arrival to the UK between 2004-2010[15]. Desgrees et al. in the PARCOUR study which looked at a representative sample of Sub-Saharan Africans in the Paris Area from 2012-13 published that from one third to half (depending on the assumptions made) of HIV-positive Africans were infected post-migration[12]. Brannstrom et al. showed that 19% of those diagnosed with HIV-1 infection in the period 1983−2013 acquired HIV after migrate to Sweden[10]. Migrants

can suffer an increased risk of acquiring HIV in destination countries related to the socioeconomic and structural inequalities they may have to endure[25, 26]. The probability of post-migration HIV acquisition increased overtime for migrant MSM and for men and women from SSA and this is consistent with the dynamics of sexually transmitted infections and the convergence of health patterns of migrant populations with those of native populations from host countries. Similar trends have been observed in HIV reports from surveillance data from UK [15] and in a random sample of migrants from SSA in France [12].

Our study shows that post-migration HIV acquisition in Europe in migrant MSM is very frequent, irrespective of their geographical origin even if our estimates are not population-based. Many MSM migrate to be able to live in less homophobic environments[27]; this can place them at higher risk of HIV as many EU cities have higher HIV prevalence among MSM than the reported for MSM in their countries of origin[28, 29]. Further, many migrant MSM have to deal with deep-rooted stigma and some studies show that migrant MSM are reluctant to disclose their sexual orientation to members of their communities[30]. Consequently, many live their sexuality under cover, creating challenges for preventive interventions. The process of migration itself can influence sexual behaviors with data suggesting disconnection from the traditional systems of social control and a greater frequentation of gay venues which results in increased sexual activity, particularly in the first phases of migration[27]. Sexual mixing, the use of commercial sex and changing perceptions of risk behaviors in origin versus destination countries are all contributing factors to high-risk behaviors. Our data are concordant with Diez et al. in Spain[16] and Dougan et al. in UK[24] and highlight the

need to develop specific health promotion interventions targeting MSM from all migrant groups, soon after arrival to Europe, as previously stated by Elford et al.[31].

Among heterosexuals in aMASE, post-migration HIV acquisition is less common in people from SSA compared to people from other regions. It accounts, nevertheless, for more than 40% of all HIV infections and highlights prevention gaps in the migrant group with the largest burden of HIV in Europe[15, 19, 21]., Length of stay in the host country, age at arrival and year of HIV diagnosis confounded associations observed in univariate analyses and after taking these into account geographical origin was no longer a risk factor for post-migration acquisition. Post-migration HIV acquisition among PWID was also high irrespective of geographical origin. Similar to previous analyses, the younger the age at migration and the longer the duration of stay in the host country, the higher was the probability of having become HIV infected after migration. However, contrary to sexually transmitted HIV, statistical significance of differences seen in PWID, according to the year of HIV diagnosis, could not be determined in a multivariable analysis.

Our study has a number of limitations to acknowledge. The most important one stems from the lack of a clear sampling frame for the HIV-positive migrant population within the nine EU/EEA participating countries leading to a potential selection bias of our convenience sample. Because response rates were lower in women and migrants from SSA, where the probability of post-migration HIV acquisition is lower, the proportion of post-migration HIV acquisition in the study may be overestimated. However, the distribution of the HIV-positive migrants participating in aMASE is consistent with the epidemiology of new HIV diagnoses in each of the 9 countries thus supporting the external validity of our findings. Among most relevant differences is the larger

proportion of migrant MSM in our study due to the nature of the participating clinics; migrant and gay friendly sites. [18]. We collected data only from people followed-up in HIV clinics therefore selecting those who have been linked to and retained in care, thus excluding those migrants who are not within the health system. Though most of the post-migration HIV acquisition is likely to have occurred in the host country, we cannot exclude that circular migrations or visits to travel countries may account for some of these[32].

To our knowledge, this is the first pan-European study that has estimated the proportion of post-migration HIV acquisition among people diagnosed in the preceding 5 years across all transmission categories and irrespective of geographical origin. The high level of post-migration HIV acquisition provides strong evidence of inadequate HIV prevention for migrants across Europe and helps to further identify which sub-groups are more at risk. Interventions – soon after migration into host countries - need to tackle migrants' vulnerabilities to HIV infection and recognise them as a priority group within primary and secondary HIV prevention strategies.

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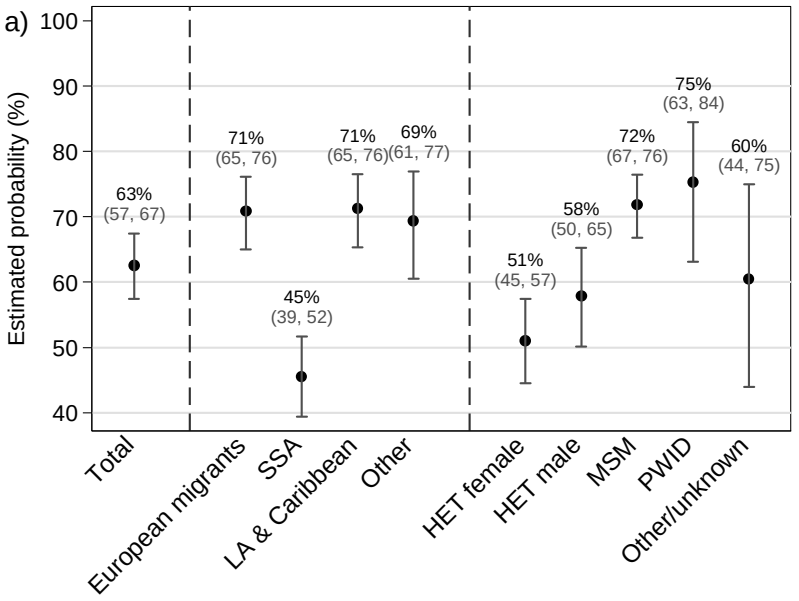
Figure 1. Estimated post-migration HIV acquisition probability (95% CI) by a) mode of transmission and geographical origin and b) destination country (numbers on top of bars denote sample size per country)



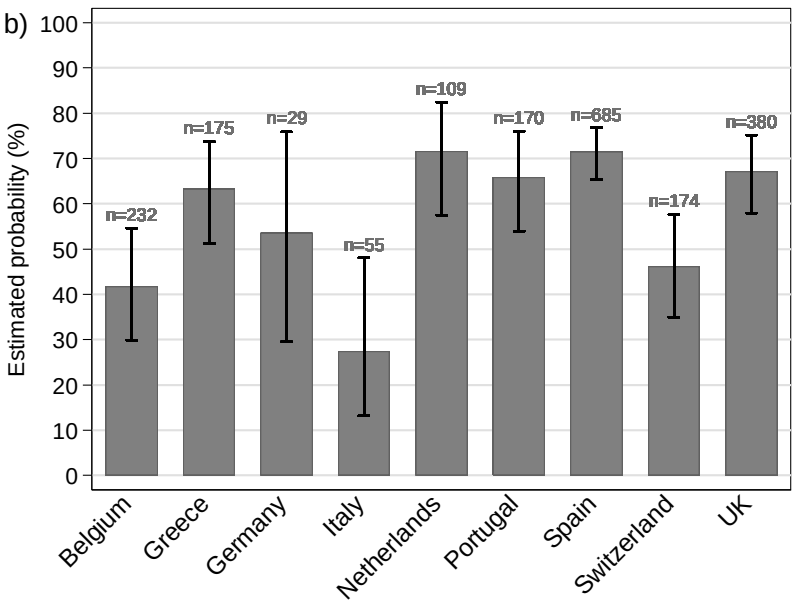


Table 1. Assigned pre- and post- migration prior probabilities based on behavioural data as evaluated by 5 members of the research team. In bold the prior probabilities applied in data.

	Condition	Probability of **pre-migration** HIV acquisition	Probability of **post-migration** HIV acquisition
1	Has an AIDS diagnosis within 3 months of HIV diagnosis and arrived in the same year of diagnosis and has no evidence of seroconversion	**70%**	**30%**
		80%	20%
		80%	20%
		70%	30%
		80%	20%
2	Has not had sex in the country of destination and has never injected drugs	65%	35%
		60%	**40%**
		70%	20%
		85%	15%
		85%	15%
3	Has only injected drugs in country of origin	**80%**	**20%**
		80%	20%
		80%	20%
		80%	20%
		80%	20%
4	Patient with negative self-reported HIV test after year of arrival	20%	80%
		20%	80%
		20%	80%
		30%	**70%**
		20%	80%
5	Has only injected drugs in country of destination	20%	80%
		20%	80%
		20%	80%
		25%	**75%**
		25%	75%
6	Has had unprotected sex only in country of destination and has never injected drugs	35%	65%
		40%	**60%**
		30%	60%
		30%	70%
		40%	60%

Table 2. Socio-demographic characteristics of the study population (n=2117)

Sample characteristics	HET female (n=643)	HET male (n=344)	MSM (n=967)	PWID (n=98)	Other /unknown (n=65)
Geographical area of origin					
European migrants	98 (15%)	58 (17%)	335 (35%)	49 (50%)	7 (11%)
Sub-Saharan African	401 (62%)	204 (59%)	59 (6%)	9 (9%)	26 (40%)
Latin America & Caribbean	119 (19%)	49 (14%)	453 (47%)	17 (17%)	28 (43%)
Other	25 (4%)	33 (10%)	120 (12%)	23 (23%)	4 (6%)
Gender					
Female	643 (100%)	-	-	11 (11%)	4 (6%)
Male	-	344 (100%)	967 (100%)	86 (88%)	38 (58%)
Transgender Male	-	-	-	1 (1%)	18 (28%)
Transgender Female	-	-	-	-	5 (8%)
Age at interview					
18-30 years old	162 (25%)	39 (11%)	304 (31%)	19 (19%)	18 (28%)
31-50 years old	401 (62%)	240 (70%)	595 (62%)	70 (71%)	39 (60%)
51 and more years old	80 (12%)	65 (19%)	68 (7%)	9 (9%)	8 (12%)
Educational level					
Primary education or less	207 (32%)	110 (32%)	81 (8%)	14 (14%)	23 (35%)
Secondary education	279 (43%)	145 (42%)	347 (36%)	38 (39%)	33 (51%)
University degree	157 (24%)	89 (26%)	539 (56%)	46 (47%)	9 (14%)
Administrative status					
EU nationals/with residence permit	470 (73%)	263 (76%)	855 (88%)	78 (80%)	44 (68%)
In temporary visa/asylum/refugee status	74 (12%)	42 (12%)	44 (5%)	10 (10%)	10 (15%)
Uncertain status and unknown	99 (15%)	39 (11%)	68 (7%)	10 (10%)	11 (17%)
Employment					
Working (full and part time)	269 (42%)	170 (49%)	641 (66%)	57 (58%)	35 (54%)
Unemployed	200 (31%)	120 (35%)	204 (21%)	26 (27%)	16 (25%)
Other	174 (27%)	54 (16%)	122 (13%)	15 (15%)	14 (22%)
Salary					
Less than minimum wage (MW)	210 (33%)	99 (29%)	191 (20%)	16 (16%)	21 (32%)
Do not earn his/her own wage	230 (36%)	115 (33%)	137 (14%)	33 (34%)	14 (22%)
More/about the same MW	144 (22%)	101 (29%)	576 (60%)	44 (45%)	19 (29%)
Rather not say	59 (9%)	29 (8%)	63 (7%)	5 (5%)	11 (17%)
Civil status					
Married or living as a couple	292 (45%)	200 (58%)	367 (38%)	35 (36%)	33 (51%)
Single	221 (34%)	96 (28%)	513 (53%)	48 (49%)	23 (35%)
Divorced/separated/widowed	130 (20%)	48 (14%)	87 (9%)	15 (15%)	9 (14%)

Has a child/children					
Yes	461 (72%)	253 (74%)	106 (11%)	26 (27%)	26 (40%)
No	178 (28%)	84 (24%)	854 (88%)	71 (72%)	34 (52%)
Rather not say	4 (1%)	7 (2%)	7 (1%)	1 (1%)	5 (8%)
Age at arrival					
Duration of residence in host country					
5 years or less	263 (41%)	95 (28%)	312 (32%)	27 (28%)	19 (29%)
Between 6 and 10 years	175 (27%)	92 (27%)	282 (29%)	34 (35%)	18 (28%)
More than 10 years	205 (32%)	157 (46%)	373 (39%)	37 (38%)	28 (43%)
Year of HIV diagnosis					
2008-2009	95 (15%)	58 (17%)	105 (11%)	16 (16%)	11 (17%)
2010-2012	359 (56%)	174 (51%)	464 (48%)	48 (49%)	34 (52%)
2013-2015	189 (29%)	112 (33%)	398 (41%)	34 (35%)	20 (31%)
TOTAL	**643 (100%)**	**344 (100%)**	**967 (100%)**	**98 (100%)**	**65 (100%)**

HET: Heterosexuals; MSM: Men who have sex with men; PWID: People who inject drugs

Table 3. Post-migration HIV acquisition by mode of HIV transmission, sex and socioeconomic characteristics [n/N (%); n number of participants with estimated probability of post-migration infection > 0.5; N: total number of participants].

Characteristics	HET female (N=588)	HET male (N=326)	MSM (N=938)	PWID (N=94)	Other/ unknown (N=63)
Area of origin					
European migrants	53/92 (58%)	47/57 (82%)	242/324 (75%)	35/47 (74%)	6/7 (86%)
Sub-Saharan African	145/360 (40%)	82/188 (44%)	30/58 (52%)	8/9 (89%)	8/24 (33%)
Latin America & Caribbean	75/112 (67%)	31/48 (65%)	349/442 (79%)	12/16 (75%)	20/28 (71%)
Other	11/24 (46%)	22/33 (67%)	82/114 (72%)	20/22 (91%)	4/4 (100%)
Gender					
Female	284/588 (48%)	-	-	8/10 (80%)	1/4 (25%)
Male	-	182/326 (56%)	703/938 (75%)	67/83 (81%)	21/36 (58%)
Transgender Male	-	-	-	0/1 (0%)	12/18 (67%)
Transgender Female	-	-	-	-	4/5 (80%)
Age					
18-30 years old	62/146 (42%)	18/37 (49%)	184/293 (63%)	12/19 (63%)	9/18 (50%)
31-50 years old	175/369 (47%)	120/227 (53%)	460/578 (80%)	56/67 (84%)	23/38 (61%)
51 and more years old	47/73 (64%)	44/62 (71%)	59/67 (88%)	7/8 (88%)	6/7 (86%)
Educational level					
Primary education or less	83/186 (45%)	54/105 (51%)	50/81 (62%)	10/14 (71%)	12/23 (52%)
Secondary education	126/253 (50%)	82/137 (60%)	265/335 (79%)	26/35 (74%)	20/31 (65%)
University degree	75/149 (50%)	46/84 (55%)	388/522 (74%)	39/45 (87%)	6/9 (67%)
Legal status					
EU nationals/with residence permit	237/436 (54%)	159/252 (63%)	650/829 (78%)	62/75 (83%)	31/43 (72%)
In visa/asylum/refugee status	15/63 (24%)	9/38 (24%)	18/43 (42%)	6/9 (67%)	2/9 (22%)
Uncertain status and unknown	32/89 (36%)	14/36 (39%)	35/66 (53%)	7/10 (70%)	5/11 (45%)
Employment					
Working	145/253 (57%)	95/165 (58%)	482/624 (77%)	50/56 (89%)	22/35 (63%)
Unemployed	83/177 (47%)	68/110 (62%)	151/196 (77%)	15/24 (63%)	9/16 (56%)
Other	56/158 (35%)	19/51 (37%)	70/118 (59%)	10/14 (71%)	7/12 (58%)
Salary					
Less than MW	99/193 (51%)	53/97 (55%)	125/185 (68%)	10/15 (67%)	13/21 (62%)
Do not earn his/her own wage	73/205 (36%)	45/104 (43%)	82/132 (62%)	25/32 (78%)	7/13 (54%)
More/about the same MW	86/135 (64%)	69/97 (71%)	457/561 (81%)	39/43 (91%)	14/18 (78%)
Rather not say	26/55 (47%)	15/28 (54%)	39/60 (65%)	1/4 (25%)	4/11 (36%)
Civil status					
Married or living with a couple	124/267 (46%)	112/191 (59%)	253/358 (71%)	27/34 (79%)	19/32 (59%)
Single	97/200 (49%)	46/90 (51%)	383/495 (77%)	35/46 (76%)	15/23 (65%)
Divorced/separated/widow	63/121 (52%)	24/45 (53%)	67/85 (79%)	13/14 (93%)	4/8 (50%)
Has child					
Yes	207/421 (49%)	139/238 (58%)	78/102 (76%)	18/25 (72%)	11/24 (46%)
No	74/163 (45%)	40/81 (49%)	619/829 (75%)	56/68 (82%)	25/34 (74%)
Rather not say	3/4 (75%)	3/7 (43%)	6/7 (86%)	1/1 (100%)	2/5 (40%)
Age at arrival					
36 and more years old	41/124 (33%)	38/100 (38%)	68/114 (60%)	9/14 (64%)	4/11 (36%)
26-35 years old	107/260 (41%)	67/127 (53%)	258/371 (70%)	27/37 (73%)	17/25 (68%)
18-25 years old	85/149 (57%)	58/80 (73%)	276/350 (79%)	30/34 (88%)	12/22 (55%)
17 years old or less	51/55 (93%)	19/19 (100%)	101/103 (98%)	9/9 (100%)	5/5 (100%)

Length of stay					
5 years or less	21/228 (9%)	6/85 (7%)	111/290 (38%)	11/24 (46%)	3/18 (17%)
Between 6 and 10 years	89/164 (54%)	42/91 (46%)	228/279 (82%)	29/34 (85%)	11/18 (61%)
More than 10 years	174/196 (89%)	134/150 (89%)	364/369 (99%)	35/36 (97%)	24/27 (89%)
Year of HIV diagnosis					
2008-2009	36/85 (42%)	25/54 (46%)	69/103 (67%)	12/15 (80%)	4/11 (36%)
2010-2012	150/329 (46%)	89/164 (54%)	323/452 (71%)	34/46 (74%)	21/32 (66%)
2013-2015	98/174 (56%)	68/108 (63%)	311/383 (81%)	29/33 (88%)	13/20 (65%)

HET: Heterosexuals; MSM: Men who have sex with men; PWID: People who inject drugs

Table 4. Factors associated with HIV post-migration acquisition by mode of transmission and sex: results from mixed-effects logistic regression analyses [adjusted OR (95% Confidence Intervals - CI)]. Results, including CIs and p-values, based on multiple imputations (n=50) of unknown HIV infection times

	Heterosexual women N=588 aOR (95% CI)	Heterosexual men N=326 aOR (95% CI)	MSM N=938 aOR (95% CI)
Area of origin	p*=0.611	p*=0.390	p*=0.728
European migrants	Referent	Referent	Referent
Sub-Saharan African	1.0 (0.5-2.2)	0.4 (0.1-1.4)	0.6 (0.2-1.6)
Latin America & Caribbean	1.7 (0.6-4.3)	0.7 (0.2-2.8)	1.0 (0.6-1.8)
Other	1.0 (0.2-4.7)	0.5 (0.1-2.4)	0.9 (0.4-1.9)
Length of stay	p*<0.001	p*<0.001	p*<0.001
5 years or less	Referent	Referent	Referent
Between 6 and 10 years	7.5 (3.7-15.4)	6.4 (2.2-18.1)	7.4 (4.2-13.2)
More than 10 years	34.7 (15.7-76.8)	47.0 (14.0-157.6)	54.3 (21.6-136.6)
Age at arrival	p*=0.117		p*=0.121
36 and more years old	Referent		Referent
26-35 years old	1.3 (0.6-2.6)		1.5 (0.8-2.9)
18-25 years old	1.6 (0.7-3.5)		2.1 (1.0-4.4)
17 years old or less	4.9 (1.2-20.2)		4.0 (0.7-21.8)
Year of HIV diagnosis	p*=0.032	p*=0.046	p*<0.001
2008-2009	Referent	Referent	Referent
2010-2012	1.8 (0.8-4.0)	2.3 (0.8-6.4)	2.3 (1.1-4.7)
2013-2015	3.4 (1.3-9.1)	4.2 (1.4-12.9)	6.9 (3.0-15.7)
Legal status			p*=0.056
EU nationals/with residence permit			1
In visa/asylum/refugee status			0.4 (0.2-1.1)
Uncertain status and unknown			0.4 (0.2-1.1)

*p-values from global Wald tests