Coming home for faster treatment: antiretroviral treatment and in-migration patterns in rural South Africa

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Abstract

Background: The widespread expansion in delivery of antiretroviral treatment (ART) marks an unparalleled phenomenon in terms of means and public health infrastructure in settings of high HIV prevalence. There is plenty of evidence on the impact of large-scale treatment programs on health outcomes and certain social dynamics, but very little is known about the effect of ART roll-out on migration dynamics in South Africa, a country where migration is a primary source of livelihood.

Methods: We make use of the ability to match demographic surveillance data with ART records from an HIV Care and Treatment programme in rural South Africa to estimate hazard models of time to first CD4 count and time to initiation on ART for three types of individuals: Residents, returning migrants and new in-migrants (N=8,347).

Results: The risk of getting in touch with the programme is on average 60% larger for immigrants than for long-time residents. This excess intention to enroll is increased three-fold if the immigrant has access to a household member with previous experience with the programme, although this effect of social exposure is stronger for the early years of the programme when this was least well-known. Immigrants who did not live in the DSA between 2000 and the year of migration exhibit an increasing trend in intentions to enroll over time.

Conclusions: Immigrants are increasingly more likely to get in touch with the public HIV Care and Treatment Programme, and this trend seems to continue into the future. As the South African government moves forward with the expansion of its public HIV Care and Treatment Programme, it should consider otherwise unbudgeted immigrant flows that could risk crowding well-functioning clinics in the local allocation of resources.

Keywords: South Africa, Antiretroviral treatment, migration.

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1 Introduction

The widespread expansion in delivery of antiretroviral treatment (ART) marks an unparalleled phenomenon in terms of means and public health infrastructure in settings of high HIV prevalence. In South Africa universal rollout is a priority for the government, and more than three million people are expected to be on ART by 2020 (Cleary & McIntyre, 2010). At the end of 2010, 700,000 people had started on ART, making South Africa's the world largest ART program. However, while the government is committed to universal coverage, only 42% of all HIV-positive individuals in need of antiretroviral treatment (ART) at the end of 2008 were receiving treatment (Adam and Johnson, 2009). One of the reasons for this gap between people eligible and those accessing care is the long waiting lists that many eligible patients face (Wouters et al., 2010). This study examines to what extent individuals reallocate in their search for easy-to-access ART care.

There is plenty of evidence on the impact of large ART scale-ups on health outcomes, and some evidence on its effect on certain social dynamics. In South Africa, declines in infant mortality and improvements in adult survival have been shown to be comparable to those in Europe and the US (Herbst et al., 2009; Ndirangu et al., 2010; Wouters et al., 2010). Widely accessible ART care has also changed health behaviors, such as decreasing risky sexual practices, or increased uptake of voluntary testing and counseling (Venkatesh et al., 2010; Roura et al., 2009). Furthermore, important externalities on social dynamics within high HIV populations may include: improvements in insight of HIV (Cassell et al. 2006; Kennedy et al. 2007; Bechange et al. 2010) and stigmas attached to being infected (Wolfe et al. 2008); changes in patterns of employment (Larson et al. 2008; Rosen et al. 2008), expenditures (Beard et al. 2009; Wagner et al. 2009; Kaler et al. 2010), education (Graff Zivin et al. 2009); and social exposure (Bor et al. 2011).

Much less is known, however, about how migration patterns might have been affected as a consequence of the South African ART roll-out. This is surprising, as migration is one of the main sources of livelihood of the rural Black population (Bekker and Swart, 2002). In

other countries, some are concerned about the role of out-migration flows in patient retention and treatment adherence (Gill and Krentz, 2009). But with many programs actively tracking their patients, South Africa's retention rates rank among the highest in the continent. More importantly, the rapid expansion of ART care in rural clinics (Mutevedzi et al. 2010)—more visible and less crowded than in their urban counterparts— coupled with the fact that migrants seem to return home when sick in search of terminal care (Welaga et al., 2009; Clark et al. 2007) posits the question: are migrants returning home to get faster ART? Are new in-immigrants moving to areas where information is more accessible and waiting lists are shorter?

This analysis intends to answer these questions. In this study, we examine how fast residents of and in-migrants into a demographic surveillance area (DSA) in rural KwaZulu-Natal get in touch with the local government-run free ART programme in the same area. We make use of the ability to match data from the DSA with ART records to estimate hazard models of time to first CD4 count and time to initiation on ART for three types of individuals: Residents, returning migrants and new in-migrants. We look at both types of immigrants together to estimate the excess intention to enroll for non-residents. We then compare stayers, returnees and new in-migrants to get a sense of the extent to which this excess is driven by the Hlabisa HIV Care and Treatment program lack of waiting list and visibility in the DSA. We hypothesize that, if individuals reallocate in search of ART, returning migrants should get in touch with the program faster and, conditional on eligibility, should initiate treatment sooner than stayers and new in-immigrants given their previous knowledge of the programme's positive traits.

2 Setting and Data

The data come from the Africa Centre for Health and Population Studies, which has collated information on approximately 11,000 households and 90,000 individuals bi-annually since 2000 in a demographic surveillance area in KwaZulu-Natal, South Africa. As of manuscript preparation the last date of follow up was April 2011. This community presents high overall levels of HIV prevalence in adults (21.4% in 2003-2004) and HIV incidence (3.4 per 100 person-years from

2003 through 2007) (Bärnighausen et al., 2009), but substantial geographic variation in HIV prevalence (Tanser et al., 2009) and incidence in sub-communities (Bärnighausen et al., 2010). As of 2009, life expectancy was 59 years for women and 50 for men (Herbst et al., 2011). Individuals may be residents in the DSA, or non-resident members of households that claim them as members. Approximately two-thirds of all persons under demographic surveillance are residents in the DSA at any one time. At six month intervals, every household is visited, and information about migration, health, HIV status and socioeconomic indicators of all its members (residents and not) is collected. Due to its detailed recording of events within the DSA, these demographic records have been widely used and tested in a number of studies of migration, health, gender and mortality (Camlin, 2008; Hosegood et al., 2004). (See Tanser et al. 2007 for details on the Africa Centre site and surveillance protocols. Also refer to the Africa Centre website: www.africacentre.com for full details updated regularly.)

In 2004, the Africa Centre and the South African Department of Health partnered to initiate an HIV Care and Treatment Programme in the Hlabisa sub-district. The Hlabisa HIV Care and Treatment Programme is an ART program executed by nurses at public health clinics (PHC) (Houlihan et al. 2010; Mutevedzi et al. 2010). The program was introduced in the PHC setting in 2004 and by 2011 it had initiated over 16,000 individuals on ART. Most of the programme emphasis has been on initiating patients onto treatment, and as of the end of 2008, coverage of eligible patients exceeded 84%. The retention rate is also quite high, with only 3.7% lost to follow-up during the first 12 months since initiation. The programme is highly visible, and nearly 40% of DSA individuals co-reside with someone that is either enrolled in ART or in pre-ART care. Furthermore, the district is better covered by participating clinics than other programs in the province, with one hospital or clinic every $112km^2$ (while the provincial average is one per $150km^2$).

Patient records (including visit dates, CD4 counts and regimen at ART initiation) are stored at the primary health clinics, but these are systematically entered into the Africa Centre's ART Evaluation and Monitoring System (ARTemis). While not all of those eligible for ART under

demographic surveillance are enrolled in the program, and not all of those in the programme are under demographic surveillance, the overlap is substantial: The DSA lies in the southern third of the Hlabisa health services catchment area and approximately 40% of patients in the Hlabisa HIV Care and Treatment Program live in the DSA (Houlihan et al. 2010). In 2008 it was estimated that 21% of HIV infected individuals residing in the DSA had initiated ART.

Our sample is composed out of the 8,347 patients on ART or pre-ART for whom we have migration and socio-demographic information, as well as information about the households they move into.

Migration

We classify individuals in three categories according to their residential mobility between August 2004 (when the HIV Care and Treatment Programme started) and April 2011 (the last date of follow-up). The first line in Table 1 reports the number of observations in each category.

Stayers are individuals who started their DSA residence (either began in 2000, were born into the DSA or immigrated into) before August 2004 and did not leave the surveillance area until contact with the ART programme or last date of follow up (N=6,025).

Returning migrants are individuals who started out as stayers but out-migrated before August 2004 and returned **after** the programme started (N=1,238).

New in-migrants are individuals who were never recorded as DSA residents before August 2004 and moved into the DSA for the first time after the programme started (N=1,083). We only focus on individual immigration episodes and, as such, all the new in-migrants move into an already established DSA household.

We follow all three groups up until the date of initiation, date of death or last surveillance visit. Residence episodes that took place after initiation or first CD4 count (for those who did not initiate) are not considered in the classification by immigration status. The prevalence of individuals with an in-migration episode in the sample is 27.8%.

Time to first CD4 count

Even if individuals do not qualify or enroll into ART, they will get a patient record in the HIV Care and Treatment programme when they approach it for a CD4 count measurement. The CD4 count eligibility threshold is $CD4 < 200/\mu l$ (Department of Health, South Africa, 2003). We define first CD4 count as the first CD4 recorded by the programme, even though individuals may have had a previous count we do not observe. Panel A in Table 1 shows the CD4 count at first contact by immigration status. Stayers had, on average $284/\mu l$, returning migrants 274 and new in-migrant 278. On average, 49% of stayers and 46.5% of immigrants were found eligible to initiate treatment at first contact.

We take time to first CD4 count as our proxy variable for "immigrant interest" in the local programme. Even if individuals decide not to pursue further treatment, resources for these potential patients need to be in place. We measure time to CD4 count as days since the first in-migration episode for immigrants or since August 1 for stayers. The second panel of Table 1 shows the differential years to first CD4 count by immigration status. Since 2004 it has taken stayers on average 3.7 years to first contact the program, while only 1.8 years to both types of immigrants.

Time to ART Initiation

We measure time to initiation as number of days between August 1, 2004 or first in-migration episode and the first recorded date of treatment. The fifth line in Table 1 shows that stayers took on average 4.3 years to initiate treatment, while immigrants did it faster, about 2 years after immigration. Time to initiation for patients who never enrolled is measured as time to last follow-up. The sixth line in Table 1 shows the years to enrollment for those who actually initiated. Again, immigrants are about twice as fast as stayers, enrolling 1.9 (versus 3.8) years after immigration. Finally, the fifth line in Table 1 shows that conditional on being eligible at first CD4 count, immigrants are also twice as fast (1.9 years).

Socio-demographic characteristics

We augment the patient records and immigration status with socio-demographic information collected between January 2003 and June 2004. We use sex, age at immigration (age in 2004 for stayers), education, and co-residence in the host household with someone who has accessed the programme before the immigration epoisode as control variables in our analysis. [1] For this last measure, stayers are assigned one if a household member had a CD4 count before the stayer's count or initiation (or last follow up if not initiated). Following Bor et al. (2011), we call this last variable "social exposure", although in truth it is a measure of household-level exposure (i.e. stayers may not co-reside with people who has been in touch with the programme, but they have had exposed just by living in the DSA). Panel B in Table 1 reports these characteristics by immigration status. Twenty-seven percent of stayers are male, while 26% of returning migrants and 30% of new in-migrants are. All three groups are very similar in terms of age, about 28 years old each. The returning migrants have the most years of education (8.9), followed by new in-migrants (8.1) and stayers (7.5). As expected, stayers are the ones with most social exposure, with 40% co-residing with someone who had a CD4 count with the programme. As expected, these are followed by returning migrants (13%) and new in-migrants (9.2%).

Statistical Analyses

Because we want to obtain an estimate of the excess intention to enroll in ART for migrants, a simple way to go about this would be to model the probabilities of contacting the programme and initiating ART upon arrival (i.e. using a logit specification). However, we have much more detailed data on enrollment dates and CD4 count measurements. Accordingly, we model instead the *hazards* of enrollment and first CD4 count with a Cox proportional hazards model, where time is measured in days.

Individuals who directly enrolled into ART without having a CD4 count are right censored

[1] In results not shown we also included co-residence with someone who initiated ART. In models where both were included simultaneously only co-residence with someone who had had a CD4 count measurement was statistically significant.

at the date of initiation in the model for first CD4 count. Individuals who had a CD4 count but never enrolled are right censored in the model for ART initiation. Survival analyses predicting hazards of first contact and enrollment were conducted in four steps: (i) a dummy indicator taking the value of one if the individuals is an immigrant (returning and new) and zero if not as the only independent variable, (ii) the dummy for immigrant and socio-demographics as independent variables, (iii) an indicator for returning immigrant and an indicator for new immigrant as independent variables, and (iv) the two immigrant indicators and socio-demographics as independent variables. In the model for ART initiation we further control for eligibility to enroll in ART based on the individual's first CD4 count. To better account for trends in migration flows we include time of immigration fixed effects in all the specifications (the year is set to 2004 for stayers).

Because the HIV Care and Treatment program had a slow start, we might find that immigrants enroll faster simply because we start measuring their time to access/initiation at later dates, while the stayers have a fixed left-censoring point, in August 2004. In lieu of controlling for cumulative monthly initiations as a time-varying covariate, we reproduce steps (ii) and (iv) for each calendar year between 2004 and 2010. This way, we can estimate the evolution of the annual "intention to enroll of non-residents" over time and offer concise implications for the future. In this exercise, we left-censor stayers on January 1st. of the corresponding year.

Proportionality for all predictors was examined using scaled Schoenfeld residuals (Grambsch and Therneau, 1994). The global tests showed no departures from proportionality (p-values were 0.13 and 0.14 for first-time contact and ART initiation respectively. The detailed tests showed slight departures for sex and the immigration categories.

All analyses were conducted in STATA SE, version 11 (StataCorp, 2005).

3 Main Results

Table 2 shows the Cox proportional hazards results for models predicting time to first CD4 count. We first discuss the socio-demographic determinants of programme access. Men are less

likely to contact the programme than women (adjusted hazard ratio (aHR) 0.9; 95% Confidence Interval (95% CI) 0.9-1.0), possibly reflecting the large prevalence of women in the sample. Older individuals are one percent more likely to approach the clinics, while a additional year of education reduces the risk of approaching the public programme also by one percent.

Immigrants have hazards of attending a clinic for a CD4 count that are three times larger than stayers (column 1). The hazard ratio falls once socio-demographic characteristics are accounted for, but remains significantly larger than one. Column 2 shows that even immigrants who move into a household where no one had accessed the programme have hazards of approaching it for a CD4 count that are 62% larger than stayers who did not have household exposure either (95% confidence interval (95% CI 1.5-1.8). Immigrants who move into a household in which someone had had a CD4 count before the immigration episode have hazards of approaching the programme that are three times higher than immigrants without social exposure (95% CI 2.6-3.9). The group of stayers with household exposure has the *lowest* hazards of programme access (aHR 0.6; 95%CI 0.57-0.63).

Columns (3) and (4) in Table 1 show the hazard model's result when we disaggregate the immigrant variable into returning and new immigrants. Both groups behave similarly, with hazards of approaching the programme that are 2.5 times larger than stayers when neither groups is exposed to the programme, and hazards that are 3.5 (3.2 for new in-migrants) times larger than stayers with all groups co-reside with someone that has had a CD4 count in one of the programme's clinics.

Table 2 replicates the analysis for initiation into ART and includes eligibility at first CD4 count as a control. While women are more likely to approach the programme for a CD4 count, men have hazards of initiation that are 9% larger than women's (95% CI 1.0-1.2). As expected, individuals who are eligible are faster to initiate (aHR 3.6; 95% CI 3.4 - 3.9). When we group both types of immigrants into a single category (columns 1 and 2), the aHRs are very similar to those in the models for first CD4 count. When we disaggregate the immigration categories (columns 3 and 4), we find that unexposed returning immigrants have aHR of initiation that

are 85% (95% CI 1.6-2.2) higher than those for the socially unexposed stayers, but that socially unexposed new in-migrants have aHR that are almost three times as higher (aHR 2.7; 95% CI 2.3-3.2). The association between social exposure and initiation into ART is not significantly different across immigration groups: their aHR are about three times as large as that for stayers who co-reside with someone who approached the programme.

Figure 1 graphs the evolution over time in the adjusted hazard ratios of immigration for the models predicting time to first CD4 count and time to ART initiation for immigrants with (triangle markers, left axes) and without (solid lines, right axes) social exposure. Stayers are the omitted category. The dashed lines represent confidence intervals. For both returning migrants and new in-migrants the effect of social exposure on programme access tends to zero with time. Co-residing with someone who had experience with the programme is associated with adjusted hazard ratios between 8.8 (CD4, returning immigrants 95% CI 4.3-18.0) and 80.7 (CD4, new in-migrants 95% CI 35.0-186.3) in 2004. These fall to a range between 1.44 (ART, new in-migrants 95% CI 0.8-2.7) and 2.84 (CD4, returning immigrants 95% CI 1.8-4.5) in 2007 and become statistically insignificant in all models thereafter. Returning migrants without any social exposure have kept their intentions to approach the programme fairly constant over time (CD4: aHR 1.6; 95% CI 1.3-1.8 in 2004, aHR 1.7; 95% CI 0.9-3.0 in 2010. ART: aHR 1.6; 95% CI 1.3-2.0 in 2004, aHR 1.6; 95% CI 0.8-3.0 in 2010). This, coupled with the high aHRs in the initial years for those socially exposed has resulted in stagnant or declining (albeit positive) intentions to enroll for returning migrants over time. New in-migrants who move into a household where no one had previous programme experience are increasingly more likely to get in touch with the clinics (CD4: aHR 1.5; 95% CI 1.3-1.7 in 2004, aHR 2.5; 95% CI 1.4-4.4 in 2010. ART: aHR 1.4; 95% CI 1.1-1.7 in 2004, aHR 2.7; 95% CI 1.3-5.4 in 2010). Coupled with the aHRs for the new in-migrants with social exposure, this implies a U-shaped or increasing trend in intentions to enroll for immigrants who did not live in the DSA between 2000 and the year of migration.

4 Robustness checks

The sample used in this analysis corresponds to an overlap between individuals under demographic surveillance and those who contacted the Hlabisa HIV Care and Treatment programme. The matched sample is representative of neither. For one, we do not have information on migration status of individuals undergoing ART not under surveillance. In particular, if we look at the uptake rates for the programme as a whole as compared to those in the matched sample, we find that while 38% of those in ARTemis are eligible and on ART, more than 41% of those in our analysis sample belong to this category. These three percentage points of difference are reflected in 15% of those in ARTemis being eligible but not on ART, but only 12% in the analysis sample. In other words, the individuals in our sample are more likely to initiate conditional on eligibility. For instance, those under surveillance may trust those programs sponsored by the Africa Centre and are more willing to enroll because of this. In this sense, migrants into the DSA might be substantially different from those who are not under surveillance. Our first robustness test, then, is to simulate everyone on ARTemis without migration information as a) a migrant; or b) a non-migrant.

The first two columns in Table 4 present the results from such an exercise. We only have monthly initiation rates for the bulk of the HIV Care and Treatment programme and thus, we only focus on the models predicting ART initiation. Furthermore, we do not have socio-demographic or household information for these patients. In lieu of simulating the entire distribution of SES characteristics, we opt for the simplicity of an unadjusted specification. In addition, we group both type of immigrants into the single dummy variable. Imputing all patients not under demographic surveillance as immigrants (aHR 1.8; 95%CI 1.76-1.91) or as stayers (aHR 2.3; 95%CI 2.2-2.5) still yield aHR that are significantly larger than one, albeit smaller that in the matched sample. Because the reality is bound to be within these two scenarios, our conclusions are robust to this selection effect.

A different selectivity issue is brought about by the whereabouts of HIV+ immigrants who do not contact the program. We have about 5,100 HIV-positive individuals under surveillance

who have not even had a CD4 count with the HIV Care and Treatment Programme. Out of these, about 42% (N= 2,200) are HIV-positive individuals with at least one in-migration episode between 2004 and 2010. In this sense, the immigrants who do contact the programme may not be a random subsample of the immigrant population. If they are, for instance, particularly driven in their intentions to initiate treatment, we would estimate a higher bound in the intentions to enroll for non residents.

We offer a lower bound on this estimate by imputing every HIV-positive immigrants who has not contacted this programme as someone who has not contacted *any* program, and every HIV-positive stayer who has not contacted it as getting their first CD4 count or initiating at the median date of those for whom we do have access dates. Under this imputation strategy the times to first CD4 count fall from 3.7 to 3.3 years for stayers and increase from 1.8 to 2.7 years for immigrants. Similarly, the times to ART initiation increase fall from 4.3 to 3.9 years for stayers and increase from 2.1 (2.0) to 2.8 (3.0) years for returning (new) immigrants.

Table 4 also replicates the analyses predicting time to first CD4 count and time to initiation where we impute the CD4 and ART behaviors of HIV-positive individuals who are not patients in the HIV Care and Treatment programme. In all specifications we control for gender, age, education and social exposure. We also control for CD4 count eligibility at first contact in the ART Initiation models. Under this conservative imputation strategy, the immigrant's excess risk of first contact disappears (aHR 0.96; 95%CI 0.9-1.1) or becomes negative (aHR 0.6; 95%CI 0.55-0.65 for returning migrants and aHR 0.8; 95%CI 0.77-0.92 for new in-migrants) depending on whether we group the two immigrant categories (column 3) or not (column 4). Conversely, the hazard ratios for ART initiation remain larger than one and significant albeit —expectedly— smaller in size than in the original sample.

5 Discussion

The socio-economic impact of the recent antiretroviral treatment scale-up in Sub-Saharan Africa in general and in South Africa in particular is now beginning to be assessed. We examine for the

first time the intention to enroll of non-residents of a community in rural South Africa where a highly successful ART programme has been operating since 2004.

We find that the risk of getting in touch with the programme is on average 60% larger for immigrants than for long-time residents of the demographic surveillance area, even accounting for the differential length of exposure to the programme that we impose on both groups. This excess intention to enroll is increased three-fold if the immigrant has access to a household member with previous experience with the programme. This effect of social exposure, however, was stronger in the early years, when the programme was least known. We find that from 2007 onwards co-residence with someone who had accessed the programme did not modify the hazards of approaching it for migrants, still (between 29% and 141%) larger than for residents. We take this reduction over time on the effect of social exposure together with the consistent excess intention to access the programme of immigrants as indication that it is indeed the ex-ante well-known traits of the programme, such as visibility and lack of waiting lists, and not the ex-post access to household level information, that are acting as drivers of both return and new immigration into the DSA.

We find very similar patterns if we focus on the intention to actually initiate ART, although new in-migrants have larger risks both on average and over time. Social exposure "helps" returning migrants access the programme well into 2007, while co-residence with someone that had experience with the programme conveys an additional risk of initiation only in 2004. Furthermore, we find a marked increase in the hazards of initiation over time for new in-migrants, suggesting that individuals seem to respond to the availability of high quality ART in their reallocation decisions.

Research on the costs of ART access frequently cites lack of means of or money for transportation, lost income (Vearey, 2008), stigma (Babalola, 2007), limited information about the programmes (Posse et al., 2008) or need of caretaking (Rosen et al. 2007) as barriers to initiation. We do not find it surprising that immigrants present an excess intention to enroll given that, compared to their living conditions in urban areas, the HIV Care and Treatment pro-

gramme under study reduces travel time and costs and the presence of family members provides home based-care, alternative sources of income and, at least initially, information regarding the programme.

Among potential weaknesses of this study is the large non-response rate in the HIV surveillance. Our study mainly borrows socio-economic variables and migration history from the population-based surveillance, and in this sense, the levels of participation should not concern us. Although we would no longer be able to provide a lower bound for the intention to enroll of returning non-residents if all of the non-responses came from HIV-positive migrants who have never initiated ART, our results for first contacts with the programme (i.e. first CD4 count) should still be a good reference, as both HIV-positive and HIV-negative individuals may want to get tested. Even in the most conservative of scenarios, our study indicates a need to prepare the ART system for returning and new immigrants.

In addition, by focusing on first in-migration episodes we lose perspective of the extent to which ART may be contributing to circular migration flows. If individuals temporarily immigrate to the DSA to access ART and out-migrate in search of work once their health is restored, the excess intention to initiate would become a public health problem if, for instance, upon out-migration individuals were to discontinue treatment. Not only would this be a misuse of public resources, but it would also translate into a public health threat, as treatment interruption has been shown to increase resistance (Bansberg et al., 2000). Further research on the effect of ART roll-out on circular migration patterns would be needed to understand the magnitude of this issue.

Our results highlight the need to take into account migration flows in the planning of ART scale up. As the South African government moves forward with the expansion of its public HIV Care and Treatment Programme, it should consider otherwise unbudgeted immigrant flows that could risk crowding well-functioning clinics in the local allocation of resources.

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Table 1: **Descriptive statistics, individuals under demographic surveillance who contacted HIV Care and Treatment Programme**

	Stayers	Returning immigrants	New In-migrants
N. obs	**6,025**	**1,238**	**1,083**
Panel A: HIV Care and Treatment Programme			
CD4 count at first contact	284	274**	278
	(377)	(224)	(265)
% Eligible at first contact	48.7	46.0***	47.1**
	(0.5)	(0.5)	(0.5)
Time to CD4 count (in years)	3.7	1.8***	1.8***
	(1.4)	(1.5)	(1.4)
Time to ART Initiation (in years)	4.3	2.1***	2.0***
	(1.6)	(1.6)	(1.5)
Time to ART Init. *conditional on initiation*	3.8	1.9***	1.9***
	(1.6)	(1.6)	(1.5)
Time to ART Init. *if elig. at first contact*	3.7	1.8***	1.9***
	(1.6)	(1.5)	(1.5)
Panel B: Demographic and socioeconomic information			
% Male	26.6	26.1	29.9***
	(0.43)	(0.43)	(0.46)
Mean age at immigration	29.2	27.5***	28.7*
	(12.9)	(9.8)	(12.6)
Years of education	7.5	8.9***	8.1***
	(4.7)	(4.8)	(4.6)
% Co-resident with someone that has had CD4 count	38.8	20***	14.5***
	(42.4)	(36.1)	(33.4)

$***p < 0.01, **p < 0.05, *p < 0.1$ for null hypothesis of no differences with stayer's averages

Table 2: **Hazard ratios for immigration categories for models predicting first contact with HIV Care and Treatment programme between August 2004 and April 2011**

	(1) Dummy Migration	(2) Dummy Migration + Socio-demographics	(3) Returning immigrants + New In-migrants	(4) Two migration dummies + Socio-demographics
=1 if Immigrant	2.95	1.62		
	[2.76 - 3.16]	[1.47 - 1.77]		
=1 if Returning immigrant			3.29	2.49
			[3.08 - 3.51]	[2.29 - 2.71]
=1 if New In-migrant			3.43	2.54
			[3.20 - 3.67]	[2.30 - 2.80]
=1 if male		0.92		0.92
		[0.88 - 0.97]		[0.81 - 0.96]
Age at immigration		1.01		1.01
		[1.00 - 1.01]		[1.01 - 1.01]
Years of Education		0.99		0.99
		[0.99 - 1.00]		[0.98 - 0.99]
=1 if co-residence with someone who had		0.60		0.65
a CD4 count within the programme		[0.57 - 0.63]		[0.62 - 0.69]
Social Exposure X Immigrant		3.21		
		[2.62 - 3.93]		
Social Exposure X Returning Immigrant				3.46
				[2.92 - 4.10]
Social Exposure X New In-migrant				3.16
				[2.58 - 3.88]
N. Observations	8,347	8,347	8,347	8,347

All especifications include a full set of time fixed effects indicating year of immigration for immigrants and year 2004 for stayers.

Table 3: **Hazard ratios for immigration categories for models predicting ART Initiation with HIV Care and Treatment programme between August 2004 and April 2011**

	(1) Dummy Migration	(2) Dummy Migration + Socio-demographics	(3) Returning immigrants + New In-migrants	(4) Two migration dummies + Socio-demographics
=1 if Immigrant	2.79	1.66		
	[2.56 - 3.05]	[1.41 - 1.95]		
=1 if Returning immigrant			2.66	1.85
			[2.44 - 2.91]	[1.56 - 2.19]
=1 if New In-migrant			3.21	2.71
			[2.94 - 3.51]	[2.28 - 3.21]
=1 if male		1.09		1.08
		[1.02 - 1.16]		[1.01 - 1.15]
Age at immigration		1.00		1.00
		[1.00 - 1.00]		[1.00 - 1.01]
Years of Education		0.98		0.98
		[0.97 - 0.99]		[0.97 - 0.98]
=1 if eligible at first CD4 count		3.52		3.62
		[3.31 - 3.75]		[3.40 - 3.85]
=1 if co-residence with someone who had		0.65		0.63
a CD4 count within the programme		[0.61 - 0.70]		[0.58 - 0.67]
Social Exposure X Immigrant		2.46		
		[1.91 - 3.18]		
Social Exposure X Returning Immigrant				3.13
				[2.50 - 3.91]
Social Exposure X New In-migrant				2.56
				[1.98 - 3.31]
N. Observations	8,347	8,347	8,347	8,347

All especifications include a full set of time fixed effects indicating year of immigration for immigrants and year 2004 for stayers.

Figure 1: Figure 1. Adjusted hazard ratios for immigration categories predicting first CD4 count and ART Initiation by year. 2004-2011. Stayers omitted.

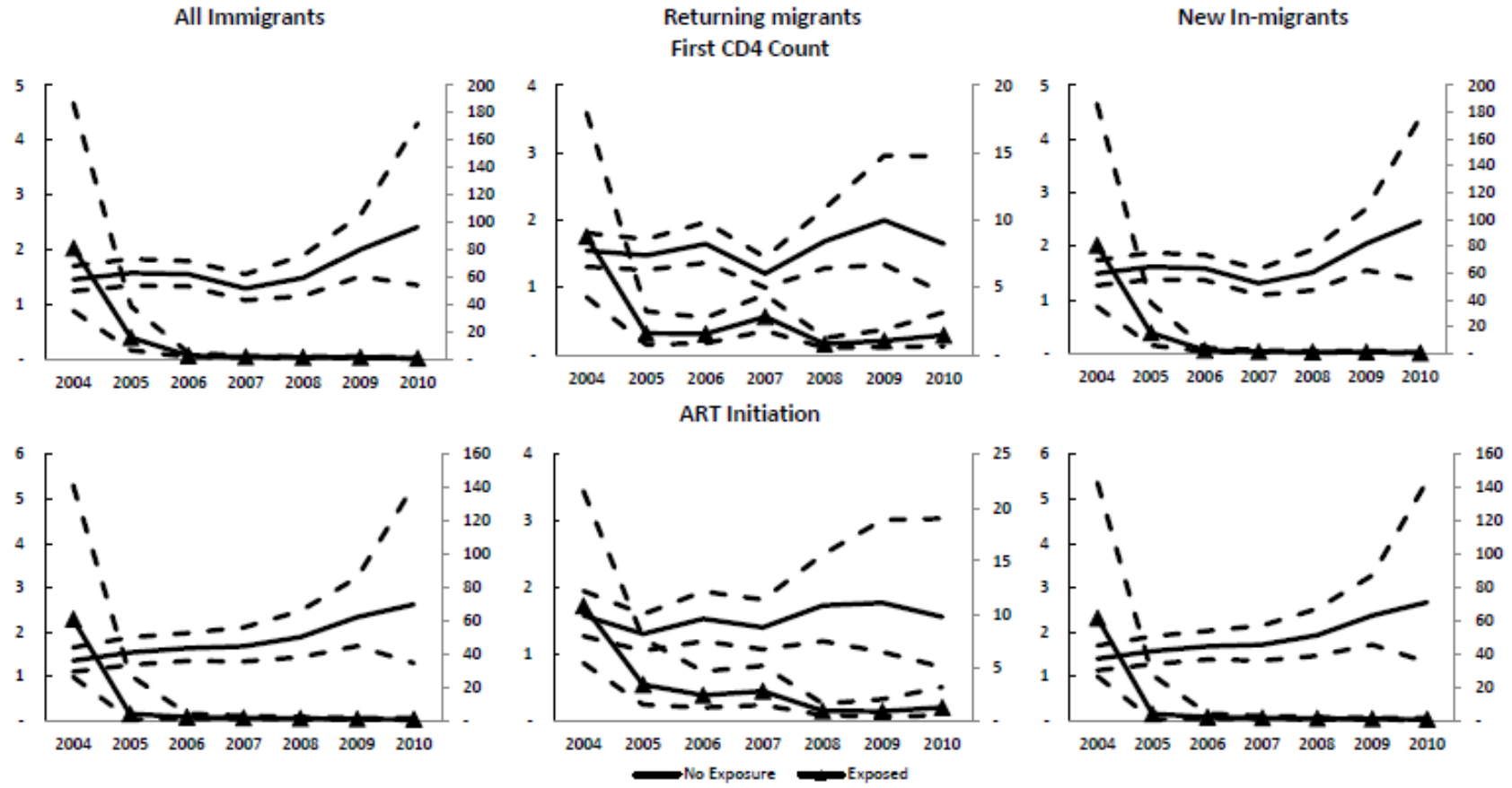

Table 4: **Hazard ratios for immigration categories for *Imputation* models predicting first CD4 count and ART Initiation between August 2004 and April 2011**

	Impute migration events for ART patients		Impute ART behavior for HIV+ DSA members			
	. = migrant	. = stayer	First CD4 count		ART Initiation	
	(1)	(2)	(3)	(4)	(5)	(6)
=1 if Immigrant	1.83	2.33	0.96		1.61	
	[1.76 - 1.91]	[2.18 - 2.48]	[0.88 - 1.05]		[1.46 - 1.78]	
=1 if Returning immigrant				0.60		1.38
				[0.55 - 0.65]		[1.26 - 1.52]
=1 if New In-migrant				0.84		1.74
				[0.77 - 0.92]		[1.57 - 1.92]
=1 if male			0.85	0.85	0.98	0.97
			[0.80 - 0.90]	[0.81 - 0.90]	[0.92 - 1.05]	[0.92 - 1.03]
Age at immigration			1.01	1.00	1.00	1.00
			[1.00 - 1.01]	[1.00 - 1.01]	[1.00 - 1.00]	[1.00 - 1.00]
Years of Education			0.97	0.97	0.97	0.97
			[0.97 - 0.98]	[0.97 - 0.98]	[0.97 - 0.98]	[0.97 - 0.98]
=1 if co-residence with someone who had			0.89	0.76	0.72	0.69
a CD4 count within the programme			[0.84 - 0.95]	[0.71 - 0.81]	[0.68 - 0.77]	[0.64 - 0.74]
Social Exposure X Immigrant			2.84		3.77	
			[2.21 - 3.65]		[2.88 - 4.93]	
Social Exposure X Returning Immigrant				3.04		3.91
				[2.49 - 3.71]		[3.17 - 4.81]
Social Exposure X New In-migrant				3.45		4.08
				[2.68 - 4.43]		[3.12 - 5.34]
=1 if eligible at first CD4 count					5.61	6.09
					[5.28 - 5.97]	[5.71 - 6.49]
N. Observations			13,442	13,442	13,509	13,509

All especifications include a full set of time fixed effects indicating year of immigration for immigrants and year 2004 for stayers.