Determinants of migration in a hyper-endemic rural community: evidence from a population-based study 2000-2015

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Abstract

To reassess whether characteristics of migration identified as risk factors in the early phases of the HIV epidemic are still important in the ART era, we examined migration levels, trends and patterns in rural KwaZulu-Natal, South Africa, using data from the Africa Health Research Institute between 2000 and 2015. Further, we followed 60 203 adult participants aged 20-49 at baseline and recorded their migration events to estimate the time to each migration event for participants, adjusting for socio-demographic covariates; age, sex, marital status, HIV and ART status. 55% of the population experienced at least one migration event over the observation period. At peak, women had over 35 events per 100 PY compared to men with 26 events per 100 PY. Controlling for factors above, the risk of migration increased 18 times among young adults 20-24 years compared to =40 years (aHR = 18.62, 95% CI 11.51 – 30.11); single compared to married (aHR 3.11, 95% CI: 1.57-6.16) and on ART (aHR 1.91, 95% CI: 1.46-2.51) compared to those not on ART. Being on ART almost doubled the odds of migration compared to those not, with significant HRs above 77% in both men and women across separate models. While the ability to migrate among PLHIV may suggest health benefits of successful engagement to care in local clinics, mobile individuals remain at high risk of acquiring HIV. Thus, novel public health interventions tailored to reduce HIV risk and sustain care for this highly vulnerable population are urgently needed.

Keywords: Risk of HIV acquisition, Migrants, Migration intensity, ART scale-up, Migration incidence, Universal test and treat, South Africa

Introduction

In recent decades, geographic mobility and migration has rapidly increased among adults in SSA in accordance to emerging social transitions. In South Africa, the long history of male dominated temporary labour migration as a legacy of apartheid is shifting with the democratic dispensation in which women are increasingly participating in mobility [1,2]. Newer forms of livelihood migration for example, frequent movements to non-traditional destinations and non-metropolitan destinations such as informal settlements and regional towns [3,4], including circulation between rural areas, semi-urban towns and the rural perimeters of cities persist. In rural communities in South Africa, formal employment attracts migrant men to semi-skilled occupations in the mining sector, construction, security and agricultural work and women in largely informal activities such as domestic work and on fruit or game farms, sale of fruit, cooked food and cheap snacks . The reduced difficulty to move and availability of more efficient means of keeping contact with people left behind is effectively loosening the conventional links between migrant motivations and migrant characteristics [5], reflecting an evolution of factors shaping migration intentions and behaviors [6]. Remarkably, an HIV diagnosis can contribute to greater mobility as HIV-infected (HIV positive) individuals move to seek care and away from stigma [7]. In hyper-endemic settings such as in KwaZulu-Natal where the impact of expanded ART scale-up program has been monitored on an ongoing basis, geographic mobility is associated with patterns of accessing and receiving HIV care [8,9]

Identifying the causal, temporal and spatial dimensions of migration and person-level and community characteristics associated with migrants has not been properly undertaken [10,11]. Earlier perspectives from demography, economics and epidemiology have examined the prevalence, nature, determinants and extent of migration including consequences of mobility on both sending and receiving regions communities based on cross-sectional designs [12–14]. In tandem with increasingly available follow-up data, the levels and trends of labour migration in South Africa were examined with individual, household and community-level effects being highlighted [2,15,17]. Unprecedentedly, long-term impact on socio-economic measures (i.e. income/remittances and education) and health such as effects

on the well-being of children left behind, chronic diseases such as TB and HIV including injuries etc. and mortality have been described [3,18–20]. Despite more than two decades worth of follow-up data from population-specific surveys, analysis of migration decision-making and positive selection for incident migration are rare. In a recent study on internal migration in sub-Saharan Africa, correlates of migration showed no clear evidence whether education was positively associated with either in- or out-migration for South Africa [21], highlighting that whether migration decision-making predicts actual migration is less understood. This region has one of the Sub-Saharan highest migration rates and frequent geographic mobility yet little is known about the predictors of migration events trajectories which is crucially important in the context of a hyper-endemic rural African community.

Using time to event assumptions based on the Andersen-Gill Cox regression model, we quantified socio-demographic level covariates of migration from a hyper-endemic rural community in South Africa between 2000-2015. Specifically, we used one of Africa's largest population-based cohorts to measure time to migration events of each individual over the 15-year follow-up period and examined the key pre-migration characteristics. The Africa Health Research Institute has collected comprehensive socio-demographic information since 2000 – surveillance data on residential histories, mobility patterns, migration including HIV surveillance and ART usage. In our previous study in this setting, we demonstrated significantly increased risk of HIV acquisition among women with high migration intensity when compared with low migration intensity (HR = 2.88, 95% CI: 1.56–5.53). This large increase in HIV risk acquisition disappeared when ART coverage was included in the analysis such that women with high annual migration intensity had significantly lower risk of HIV acquisition in the post-ART period (aHR = 0.18, 95% CI 0.04–0.83) compared to the pre-ART scale-up period [22]. Building on this analysis, our study estimates migration incidence and covariate factors for migration among adult men and women in an effort to add literature on mobility and HIV risk in SSA.

Methods: Overview

Study Design

Data emerged from the population-based longitudinal surveillance system conducted by the Africa Health Research Institute (AHRI). This integrated platform for population data collection and analysis is located in the Umkhanyakude district of northern KwaZulu-Natal, which is predominantly rural. The Africa Health Research Institute has collected comprehensive socio-demographic information since 2000 – surveillance data on household residencies, mobility patterns, migration including HIV testing and antiretroviral therapy status are available from 2003 and 2004 respectively. The surveillance includes all members of all households located in the 432-km^2 surveillance area, with a population of approximately 100 000 resident and non-resident members from 11 000 households [23].

This community is characterized by frequent migration (38% of men and 32% of women were nonresident in 2008), and high levels of residential instability as 33% of those regarded as household members in the surveillance area do not reside within it [17]. Local employment is scarce, and residents often migrate for work outside the area. Levels of mobility in the region have risen dramatically in recent decades, aligned with rapid socio-economic transformations, including feminization of the labour market (working age economically active women increased from 38% to 51% of women of working age between 1995 and 2001). Circulatory migration predominate in this setting, with individuals migrating repeatedly between rural areas, semi-urban towns and the rural perimeters of cities on an ongoing basis. Around 17% of the study population makes this kind of move each year [4]. Women are somewhat more likely than men to undertake any form of migration although sex differentials in migration trends differ by migration distances [4].

Other characteristics of the surveillance area include low marital rates (only 23% of men and 31% of women have ever been married) [19], late marriage especially for men, polygamous marriages (about 14% of all marriages for men and 12% of all marriages for women) [19] and multiple sexual partnerships, as well as by poor knowledge and disclosure of HIV status [24]. KwaZulu-Natal is the province is home to the largest HIV burden in South Africa [25]. Adult HIV prevalence in this region is 30% [26] and ART coverage of all HIV-infected people increased rapidly since 2004, primarily via

nurse-led public sector ART programs. The expanded scale-up of ART doubled coverage from 27.2% (25.4%-29.0%) to 45.5% (43.7%-47.3%) between 2009 and 2012 [27].

Study design and data collection

We used prospective population-based cohort data available from the AHRI surveillance system from 2000 through 2015. Surveys capturing demographic events that can change the structure of the household, such as births, deaths and migrations from key household informants every 4–6 months were conducted by trained field-workers. Data on other socio-economic and health exposures and outcomes such as education, HIV and ART status were collected annually since 2003. Household and individual surveys are linked longitudinally to each other and over time through unique individual and household identification. The various surveys are described in detail elsewhere. Eligible participants aged 15-years and older are interviewed in private by the same fieldworkers, who also extract blood from consenting participants by finger-prick for HIV testing. The Biomedical Research Ethics Committee of the University of KwaZulu-Natal (BREC) Durban, South Africa, gave full ethics approval for this study.

Ascertainment of the outcome variable

Migration events

The primary outcome of the study was the risk of migration among adult men and women. All participants with one or more migrations for whom the first episode of migration started with residency within the AHRI surveillance area were included in the cohort. In the current study, we defined migration as change of residency (i.e. both internal and external migration) during the observation period, categorised as: migrant ≥1 events and non-migrant ≤0 event. Overall, migration events per individual ranges from 0 to 9 and the average follow-up time per individual is 3.8 years. Fieldworkers routinely collect residential histories data for resident and non-resident individuals from key household informants, such that information such as the destination place of residence, and the date of the move for every migration event at the time of their visit are recorded.

Covariates

Time-varying potential confounders included response data for age (20-24 years; 25-29 years; 30-34 years; 35-39 years; ≥ 40 years), marital status categorised as single; married (monogamous/polygamous); separated or divorced, HIV status, i.e. either HIV positive; HIV negative and ART status (whether on and/or presumed to be on ART and not on ART). In addition, sex at baseline was also included.

Statistical analysis

In order to identify individual characteristics associated with repeat migration events from the AHRI surveillance area, we performed three standard sets of analyses. First, we measured trends of residential instability and migration among adults between 2000 and 2015, i.e. calculating; frequencies and percentages for residency status (resident or non-resident), annual migration rates and associated person-years, including incidence rates by sex. We further estimated migration incidence rates per the following socio-demographic and health factors: sex, age, marital status, HIV and ART status.

Thirdly, we fitted Anderson – Gill models to estimate hazard ratios for the association between abovementioned covariates and the risk of repeated migration events or censoring. We repeated the same analysis to generate hazard ratios stratified by sex. All models (bivariate and multivariate) were fitted employing a counting process notation as described in Therneau & Grambsh, and the dataset was thusly prepared [28]. To account for clustering of observations within each individual and to control for follow-up time of individuals, we estimated robust SEs in the analysis. The underlying risk of migration was treated as independent for each event within an individual such that the number previous migration events did not induce subsequent events. For models considering the effect of HIV status and ART status on multiple migration events, the reference categories were 'HIV negative' and having 'no ART' treatment respectively. However, with the exception of marital status (reference being married), models for other covariates used the most frequent values as the reference category against which other

categories were compared. Analyses were performed using Stata 14.0 software (StataCorp, College Station, Texas, USA).

Results

Residency

Table 1 presents data for resident and non-resident adult study participants between 2000 and 2015. For each year of observation after 2002, greater than 40% of both men were not resident in the surveillance area. The proportion of non-residents was lower for women than men, however non-resident women increased constantly from 25%-30%.

Migration rates: 2000-2015

Crude annual migration rates for the observation period are presented in Table 2 and Fig 1, ranging from from 26 to about 347 per 100 PY for both males and females. Migration rates sharply increased from 2000 to 2002 and remained largely unchanged until 2007, after which increased steadily to peak in 2010 and 2012, beyond this point migration rates have been declining.

Highlighting other important data, the sex-specific trends of migration rates showed a bimodal pattern (see Figure 2) with the distribution of rate values being similar for all the years under observation. However, primary peaks for women were sharper and steeper compared to those for men with a gradual slope.

Incidence migration: socio-demographic and health factors

30% of the population experienced at least one migration event over the period of observation and mean number of migration events was 9.66. Over the duration of the study (2000–2015), the crude migration incidence rate was 159.26 events [95% confidence interval (CI) 157.68-160.85] per 100 person-years (38 899 events in 24 425.55 person-years of follow-up). However, for men, the rate was 157.39 cases [95% confidence interval (CI) 155.09-159.74] per 100 person-years (17 597 migration

events in 11 180. 22 person-years of follow- up) while for women, the migration incidence rate was 160.83 events (95% CI 158.68-163.00) per 100 person-years (21 302 migration events in 13 245. 33 person-years of follow-up) see Table 3. Other results show that the incidence rate for migration among those HIV positive was 33% higher (215.80 per 100 person-years) compared to those HIV negative (172.27 per 529.39 person-years).

Andersen-Gill Model results

Survival data description and summary

Over the course of the study (2000–2015), a total of 32 328 migration events were accrued in 225 896. 99 person-years of follow-up for all 60 263 participants in the cohort. Nearly 53% of all study participants had at least one migration events. The mean follow-up time was 3.8 years per each individual (not shown). Migration is very common such that there were an average of 0.5 events per-person over the 15 year period.

Andersen-Gill Model results

Table 2 shows the Andersen-Gill Model regression results for predictors of multiple external migration events. In the univariate and multivariate analyses (column 2), several socio-demographic factors were significant. Increased odds of recurrent migration was associated with being aged 20–24 years (aHR = 18.62, 95% CI 11.51 – 30.11), 25-29 years (aHR=2.31, 95% CI 1.32-4.04) compared to 40 years and above and single (aHR=2.51, 95% CI 1.60- 3.92) compared to married. ART status covariates were among the most important factors associated with migration when considering results from both unadjusted and adjusted models. The risk of migration was high, among those on ART (aHR=1.75, 95% CI 1.41-2.19); compared to not on ART, with excess risk of above 75% in both models (see Table 4).

Table 5 shows results for the same analyses stratified by gender. Migration was 16 times higher among women aged 20-24 years (aHR=16.90, 95% CI 10.00-28.54) compared to those aged ≥40 years, while for men, those aged 20-24 years 3 times likely to migrate compared to those aged ≥40 years. All

covariates categories in the models by sex (i.e. age, marital status, HIV Status (i.e. except in women) and ART status significantly associated with migration, demonstrating the importance of independent characteristics in explaining repeat migrations among adults among men and women. The effect of HIV status on migration either disappeared and/or failed to reach significance among both men and women across the unadjusted and adjusted analyses. For example, men who were HIV positive were 12% less likely to migrate (HR=0.88, 95% CI 0.78-0.99) compared to those HIV negative while the hazard to migrate increase by more than 4 times in the multivariate model, results were not significant. Importantly, the hazard of migration was significant by ART status; among women on ART an additional 77% risk for migration was conferred (aHR=1.77, 95% CI 1.38-2.26) compared to those not on ART while for men there was an 86% increase in risk among those on ART (aHR=1.86, 95% CI 1.12-3.08) compared to not on ART.

Discussion

It is important to study external migration due to its role in the rapid spread of HIV in sub-Saharan Africa including the ongoing effects on HIV care engagement, and on effectiveness of ART as treatment and prevention programs in sub-Saharan Africa. Based on results from a rural South African community between 2000-2015 we found that migration rates remain high and fluctuating, characterised by rapidly increasing female residential instability. The risk of migration (migration ≥1 event) was 18 times higher among young adults (20-24 years) compared to old i.e. ≥40 years and unmarried compared to married men and women. Highlighting some important similarities and differences by sex; age, marital status and ART status were independently associated with a higher risk of migration in all, while in women the risk of migration was higher among those unmarried and among men, those divorced/separated compared to married. Notably, being on ART almost doubled the odds of migration when compared to those not, contributing to large mobility risk, with significant HRs above 77% among both men and women.

The socio-demographic profiles of migrants in our study fits prior research in sub-Saharan Africa. The over-representation of young unmarried adults of working age among migrants compared to older and

married individuals reflect the persistence of historical labour related mobility from rural to urban settings for greater opportunities of employment as demonstrated in past literature [3,29,30]. Other less dominant motivations include identity formation [31], gaining familial and societal respect, and household formation or transitions, especially among women [17,32]. Additionally, being single/unmarried (as is often the case with young adults and low marriage rates being common in our study area) is an important life-course marker associated with a higher probability of external migration [33]. This trend may be partially explained by reduced familial responsibility – unmarried men and women may have fewer dependents, i.e. (children and spouses) and have weaker ties to home [19,34]. Comparably, we demonstrated increased migration odds associated with marital status among men and women in keeping with the stereotypical popular image of adult non-residents.

Other health related covariates provide details important for understanding the dynamics of population movement in light of a mature HIV epidemic in South Africa. Being on antiretroviral treatment did not restrict migration in both our independent and more aggregated models possibly highlighting health benefits ('healthy migrant', i.e. migrants are selected on health at origin) [35] from the wider availability of ART, enabling seamless movement of people across space. In 2010, large scale-treatment-as-prevention interventions in KwaZulu-Natal and elsewhere were implemented. Among the many challenges associated with widespread access to clinic-based HIV care system in rural communities, the provision of treatment and care to mobile populations posed particular challenges. The possibility of migration affecting antiretroviral adherence was suggested in previous research, with others raising concerns about treatment interruptions likely resulting in poor outcomes, and generation and transmission of drug-resistant strains of HIV. Our study results echoes the paradox that from a treatment perspective, migration is at odds with community based ART programs, yet it remains a potent livelihood strategy for communities highly dependent on remittances from migrant household members for survival.

Our study is not without limitations. That participants were not always available at each successive round for individual surveillance and HIV data collection (i.e. attrition) is a challenge in the AHRI

surveillance area. This issue has been closely investigated by Larmarange and others finding that over a five-year period in the study area, more than two-thirds participated at least once, 48% at least 2 times and 31% at least three times [36], raising concerns about biases in incidence estimation. However, given our large sample size and consistently high response rates in the AHRI household data collection surveys (>99%), our results indicate a fairly balanced picture of the motivations of migration events trajectories among adults in rural KZN. A strength of our study was our use of Andersen-Gill models to capture migratory events (i.e. which are frequent and recurrent in the study area) of each individual through the follow-up period including controlling for known demographic and health factors, with some of which being treated as time-varying.

Our findings highlight the need to intensify engagement and retaining of migrants to effective combinations of HIV prevention and care programs in the era of ART. Given that ART uptake is risk factor of migration, we note that ability to migrate among adults living with HIV may be illustrative of health benefits from successful engagement, mobile individuals remain at high HIV risk. Moreover, we echo recommendations in Camlin and colleagues that mobile populations may benefit more from novel models of differentiated care or differentiated service delivery, which not only simplify and adapt HIV services across the cascade for PLHIV but also reduce burdens on health systems. These models include patient-led community adherence groups, healthcare worker-managed groups i.e. adherence clubs, fast-track or multi-month drug scripting, mobile outreach, and community drug distribution points (e.g pharmacy-based refills). Importantly, these models can be informed by an acute awareness of the needs of mobile women and men living with HIV, holding the promise for engaging and retaining these populations who struggle to fit their needs to the requirements of community/clinic-based HIV care systems. Beyond social and structural interventions, mobile populations may benefit from improved therapeutic technologies such as long-acting ART variations of biomedical prevention technologies such as Pre-Exposure Prophylaxis (PrEP), and extending coverage of these technologies further than clinic settings into communities and key migration destinations and transit hubs [37]. Recognising that

migrants are increasingly young, unmarried and female, approaches sensitive to age and privacy such as self-testing kits should be scaled-up.

Conclusions

Our study provides evidence of the diverse pre-migration characteristics of mobile men and women from a hyper endemic community in South Africa. Migration positively associated with being single, unmarried age and on ART. Novel prevention and care interventions customised to the unique HIV risks and needs of mobile individuals are needed to reduce the risk of HIV acquisition and onward transmission among this highly vulnerable group.

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Table 1: Residency status by sex and exposure year 2000-2015

Year			Women				Men	
		Non-residents		Residents		Non-residents		Residents
	N	%	N	%	N	%	N	%
2000	9, 593	25.61%	27, 866	74.39%	11, 756	39.27%	18, 183	60.73%
2001	9, 482	25.08%	28, 331	74.92%	12, 021	39.44%	18, 457	60.56%
2002	9, 544	25.59%	27, 745	74.41%	12, 320	40. 63%	18, 004	59.37%
2003	9, 487	26.60%	26, 178	73.40%	12, 102	41.63%	16, 968	58.37%
2004	9, 300	27.00%	25, 146	73.00%	12, 902	42.88%	16, 105	57.12%
2005	9, 477	27.58%	24, 880	72.42%	12, 304	43.83%	15, 768	56.17%
2006	9, 855	28.32%	24, 939	71.68%	12, 760	44.78%	15, 735	55.22%
2007	9, 936	28.58%	24, 834	71.42%	12, 906	45.28%	15, 594	54.72%
2008	9, 802	28.40%	24, 714	71.60%	12, 673	44.79%	15, 619	55.21%
2009	9, 881	28.46%	24, 835	71.87%	12, 729	44.74%	15, 720	55.26%
2010	10, 031	28.84%	24, 745	72.23%	12, 794	44.80%	15, 763	55.20%
2011	9, 911	28.87%	24, 422	71.13%	12, 768	45.12%	15, 533	54.88%
2012	9, 770	28.94%	23, 993	71.06%	12, 578	44.85%	15, 467	55.15%
2013	9, 522	29.44%	22, 818	70.56%	12, 111	45.65%	15, 016	55.35%
2014	9, 354	30.03%	21, 800	69.97%	11, 879	45.26%	14, 370	54.74%
2015	8, 099	30.24%	18, 686	69.76%	10, 347	46.05%	12, 124	53.95%

Table 2: Trends of migration rates by exposure year: 2000-2015

Exposure year	Out migrations	Person-years	Migration rate per 100 PY
2000	1402	2633.61	38.58
2001	2909	2831.58	102.73
2002	3729	1441.30	258.72
2003	3037	1170.88	259.38
2004	2576	944.81	271.65
2005	2414	943.76	255.79
2006	2396	896.67	267.21
2007	2399	972.08	246.80
2008	2309	790.38	292.14
2009	2446	862.10	283.73
2010	2717	782.73	347.12
2011	2445	734.84	332.72
2012	2389	692.73	344.87
2013	2101	662.65	317.06
2014	2001	860.82	232.45
2015	1629	6204.60	26.25

Figure 1: Trends of migration rates from a rural area in South Africa: 2000-2015

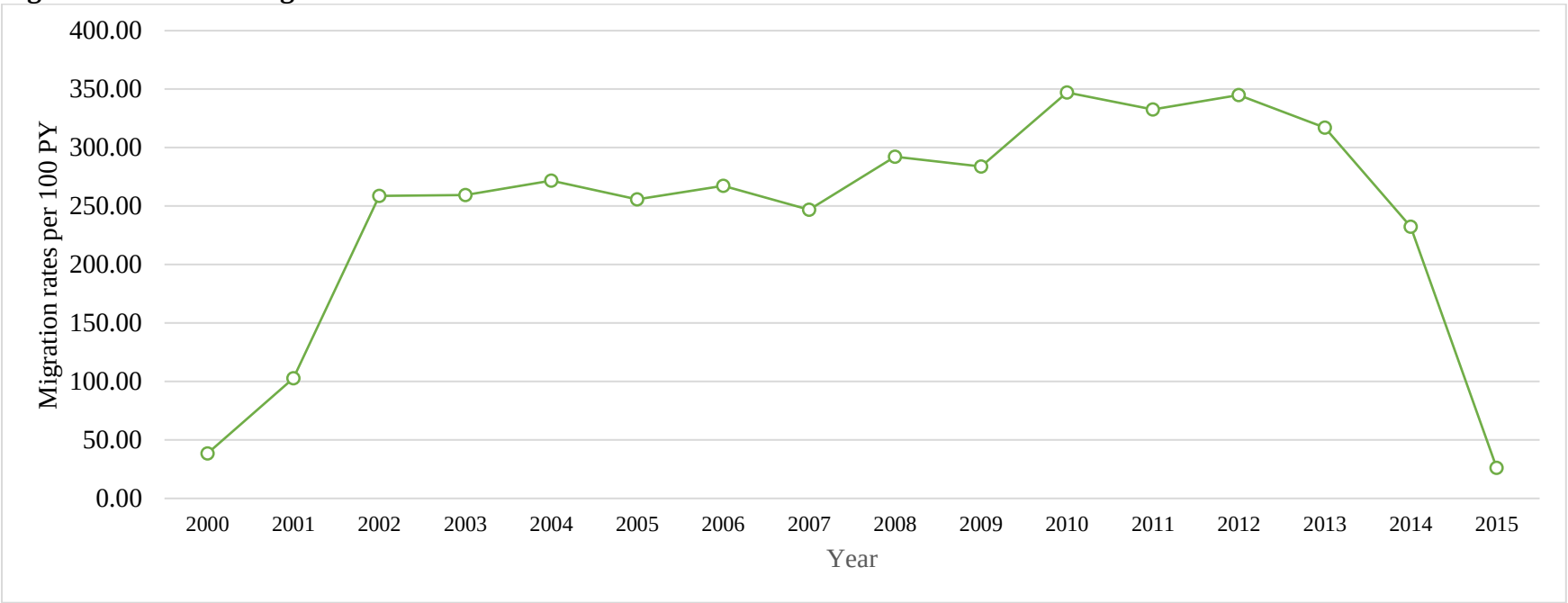
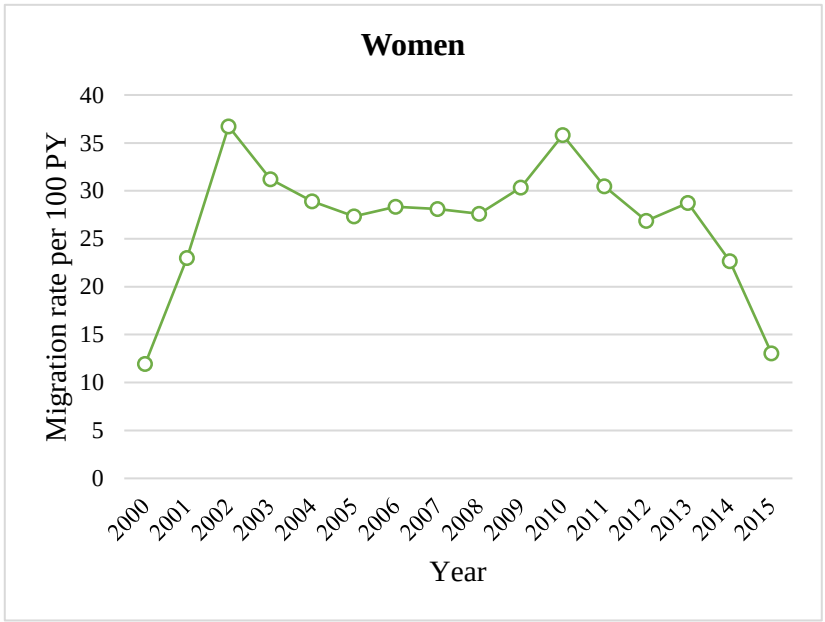


Figure 2: Migration rates by sex: 2000-2015



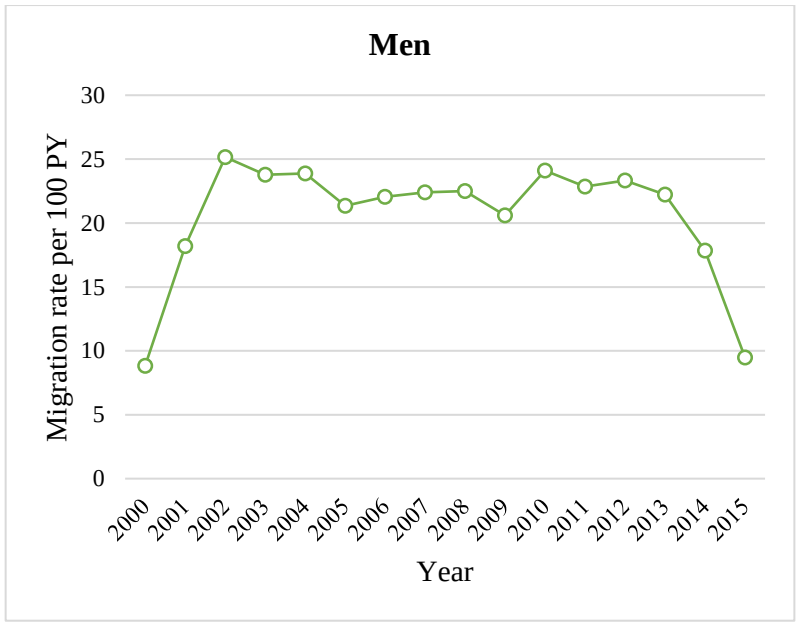


Table 3: Incidence of migration among resident adults from a rural South African cohort study

		Events	Person years at risk	IR (per 100 person years)
Age category:	20-24	10161	8244.41	123.25
	25-29	6999	4353.78	160.76
	30-34	5095	2960.37	172.11
	35-39	4065	2206.40	184.24
	40+	12579	6660.60	188.86
Sex:	Female	21302	13245.33	155.09
	Male	17597	11180.22	157.39
Marital status:	Single	33000	18592.86	177.49
	Married	1649	1575.68	104.65
	Divorced/Separated	105	61.63	170.38
HIV status:	HIV Positive	386	178.87	215.80
	HIV Negative	912	529.39	172.27
ART status:	On ART	712	402.66	176.82
	No ART	140	97.50	143.60

Table 4: Determinants of multiple migration events in a rural South African cohort study

	Category	HR	aHR	SE	95%	CI
Sex: [Female]	Male	0.99	0.85	0.09	0.68	1.02
Age category: [≥40y]	20-24y	3.30***	18.62***	4.57	11.51	30.11
	25-29y	1.78***	2.31***	0.66	1.32	4.04
	30-34y	1.27***	1.10	0.19	0.80	1.54
	35-39y	1.11***	1.04	0.15	0.79	1.38
Marital status: [Married]	Single	2.67***	2.51***	0.57	1.60	3.92
	Separated/Divorced	1.45***	2.92	2.14	0.69	12.32
HIV status: [Negative]	Positive	1.01	1.53	0.41	0.66	2.37
ART status: [No ART]	On ART	1.87***	1.75***	0.20	1.41	2.19

*** p<0.05. Reference category in bracket.

Table 5: Determinants of migration in a rural area in South Africa stratified by gender

	Category	HR	aHR	SE	95%	CI	HR	aHR	SE	95%	CI
				Men					Women		
Age category: [≥40y]	20-24y	3.64***	-	-	-	-	3.06***	16.90***	4.52	10.00	28.54
	25-29y	1.86***	2.61	1.12	1.13	6.08	1.72***	2.18***	0.70	1.16	4.09
	30-34y	1.32***	1.41	0.48	0.72	2.74	1.24***	1.03	0.19	0.71	1.48
	35-39y	1.10***	1.27	0.36	0.72	2.22	1.13***	0.99	0.16	0.72	1.35
Marital status: [Married]	Single	2.62***	2.02	0.80	0.94	4.38	2.71***	2.65***	0.74	1.53	4.58
	Separated/Divorced	1.38***	6.60***	3.01	2.70	16.16	1.51***	1.82	1.90	0.24	14.01
HIV status: [Negative]	Positive	0.88***	4.60	-	-	-	1.06	0.77	0.24	0.43	1.41
ART status: [No ART]	On ART	1.87***	1.86***	0.48	1.12	3.08	1.90***	1.77***	0.22	1.38	2.26

*** p<0.05, Reference category in brackets.