HIV, Marital Dissolution and Migration: A longitudinal analysis of differential risk of migration by sero-status in rural Uganda

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ABSTRACT

Migration is regarded as a key element in the transmission of HIV in sub-Saharan Africa. This paper investigates an under-explored causal mechanism; hypothesizing that HIV-positive individuals are more likely to migrate than HIV-negative individuals, with marital dissolution as the mediating mechanism. Using 10 years of longitudinal data from an open-population cohort in rural Uganda, discrete-time event-history analysis is used to determine event-sequencing. Marital dissolution is examined not as a single event, but rather as a dynamic process overlapping with migration. HIV-positive women, but not men, were more likely to migrate than their HIV-negative counterparts. While previous research has shown an association between HIV and marital dissolution, and marital dissolution and migration, this analysis shows a distinct gendered phenomenon, where HIV-positive women have a large and significant increased risk of experiencing the combined events.

INTRODUCTION

Migration is regarded a key element in the transmission of HIV in sub-Saharan Africa. Initial research focused on the role of migrant population movements facilitating the transmission of HIV from low to high prevalence areas. A shift in migration and HIV research occurred in 1995 following a review of migration and HIV/AIDS in The Lancet, which drew off several studies from Uganda and Senegal to highlight the statistically significant relationship between migration and HIV sero-status (Decosas, Kane, Anarfi, et al. 1995a). Drawing from these results, the prevailing consensus was that migration was an independent risk factor in the acquisition of HIV. Subsequent research has emphasized the mechanisms through which migration increases vulnerabilities towards HIV infection. Male professions that were based on migrant labor, or necessitated high-levels of mobility have been thoroughly studied in conjunction with HIV and sexual risk behavior.

The dominating hypothesis linking migration to HIV infection is that absences from home lead to the development of new (and concurrent) sexual partnerships and elevated sexual risk taking. Lagarde et al (2003) found evidence supporting this hypothesis; short term migrants were more likely to engage in higher-risk sexual behaviors, including women reporting casual partners in the city in the past 12 months (OR 5.61; 95% CI 1.56-20.2) Partnerships with commercial sex workers have been identified as very prevalent in male-dominated professions such as truck drivers (Gysels, Pool, and Bwanika 2001; Bwayo et al. 1994) and migrant fisherman (Kissling, Allison, JA Seeley, et al. 2005b; Decosas, Kane, JK Anarfi, et al. 1995a).

Migrants increased vulnerability to contracting HIV is then compounded by their increased likelihood of transmitting the virus on to their other sexual partners in both home and migrant-destination communities. Internal or regional migration patterns that involve mobility between work and home communities supports this mechanism: seasonal migration has been identified as an important epidemiological pathway whereby migrant laborers become infected while away from home and bring the virus back to their rural communities through patterns of circular migration (M Lurie et al. 2004; Pison et al. 1993). Partners remaining in home communities may also have changes in sexual behaviors following migration. Lurie et al. (2003) in a study of migrant men in sero-discordant relationships found that over 1/3 of sero-positive individuals were women who had stayed remained at home. However, the study was not able to determine if infection occurred during men's absence from the home.

The challenging in parsing out event-sequencing between migration and sero-conversion plague the majority of analyses undertaken. Causal inferences are drawn from cross-sectional studies, assuming that results validate the dominant proposed mechanisms, even when pre-migration sero-status is unknown (MN Lurie, Williams, Zuma, Mkaya-Mwamburi, Garnett, Sturm, et al. 2003; Bwayo et al. 1994; Decosas, Kane, JK Anarfi, et al. 1995a; Lagarde et al. 2003;. Nunn et al. 1995; Pison et al. 1993). While the wealth of research does suggest that migration increases HIV vulnerabilities, alternative mechanisms and causal pathways that may also be linking HIV and migration are infrequently explored.

This paper investigates an alternative causal-mechanism; hypothesizing that HIV-positive individuals are more likely to migrate than their HIV negative counterparts. Using 10 years of

longitudinal data from an open population cohort in rural South-Western Uganda, discrete time event history analysis is used to determine the extent to which sero-status increases the risk of migration. First, this paper asks whether HIV positive men and women in Uganda are more at risk of migration than those who are HIV negative. Event-sequencing between migration and HIV infection are determined using longitudinal data and an assortment of robustness checks. Second, mediating mechanisms between migration and HIV are explored, with emphasis on marriage-related factors, and specifically marital dissolution, in leading to increased migration among HIV-positive individuals. Differential mechanisms by gender are also examined. Third, this paper asks whether the length of HIV-infection has a duration effect on the risk of migration, and how these trends may differ by marriage-related factors.

In undertaking this analysis, this paper seeks to enhance our understanding of migration and HIV infection, and identify underexplored and alternative causal mechanisms. Understanding the sequencing between life-events such as these can serve to highlight new points for prevention policy. This paper serves to further out knowledge on how HIV interacts with important life-events, such as marital dissolution and migration. In developing HIV policy targeted for migrants it is important to identify if HIV infection occurs pre or post migration, as well as how these sequences may differ by gender, duration, and other salient socio-demographic characteristics. Determining if HIV can trigger migration in rural settings opens up new doors for future research and potential avenues to mitigate future transmission of the virus.

THEORETICAL BACKGROUND

In examining the relationship between migration and HIV, this paper will speak to the broader theories of migration and health. This theoretical framework takes into account the complex and interactive relationship that exists between migration and health: "a health perspective treats population movement as a dynamic process by which individuals are related to specific locations by reasons of their participation in human networks" (Evans 1987, v). As such, any analysis of migration events has to take into account the multiple episodes of migration across one's life, the varying factors that will influence migration outcomes, and the myriad of ways that HIV may interact with migration at different points in time.

I will draw off of three of the primary areas of examination laid out by Evans (1987) in his review of migration and health: (1) the relationship between migration and public health (2) the relationship between migration and individual health and (3) the relationship between migration and health services.[1] In thinking of migration as a dynamic process, I will be expanding on Evans analysis that examined the ways in which migration impacted health, by applying his framework to the impact of health on migration.

Regardless of the causal association between migration and HIV, the movement of individuals who have a higher likelihood of being HIV-positive will have an impact on public health through

[1] Evans (1987) has two additional areas of inquiry he discusses in his introduction of health and migration which are not relevant to this paper. The first is what health status tells us about the migration process, whereby health status is used as a means of assessing migrant integration. Second Evans' also address the relationship between health and migration policy, but this aspect of the migration-health relationship is centered around international migration policy only.

the resulting changes to HIV transmission. In the current literature, emphasis has been on the role of migrants acquiring HIV away from the home, and transmitting the virus to their home communities. A study using the same data from south-western Uganda employed in this paper found that in-migrants to this rural community contributed substantially to overall HIV prevalence, and were found to have a higher rate of infection than permanent residents (Dermot Maher et al. 2009). In this paper, the impact of migration on public health will be determined by whether HIV positive individuals are more likely to be migrating to other areas. If so, the characteristics and sexual behaviors of these migrants may be important in determining potential risk for transmission. Results confirming that HIV-positive individuals are more likely to migrate would confirm the hypothesis that migrants impact public health through their role in potential transmission of the virus. However, Qualitative research in Uganda and Nigeria has suggested that HIV-positive individuals seek out other HIV-positive individuals as sexual partners (Seeley et al. 2009; Rhine et al. 2009), which would in face limit future transmission.

In addition to transmission of the virus, HIV will also affect public health outcomes if there is selection migration by sero-status. Depending on net-migration, the migration of those with worse health status (sero-positive) out of a population will also lead to a selection of more healthy people remaining in the population. By examining destination of migrants by sero-status I will be able to determine if HIV positive people are largely moving away from rural areas, or within them.

On the individual level, healthy individuals are thought to be more likely to migrate than unhealthy individuals as a result of their capacity to do so. However, the hypothesis proposed in

this paper is that less healthy individuals, those infected with HIV, are more likely to migrate than their HIV-negative counterparts. If HIV is the causal factor, then poor health would indeed be motivation migration, in opposition to the healthy migrant hypothesis.

The third intersection, between migration and health services, encompasses the range of ways in which migrants health needs may differ from those of the general population. In the context of HIV, however, research has emphasized the role of HIV-positive migrants returning to their home community with the onset of AIDS to seek care from family members. This pattern fits within the broader literature on migration that identifies kin and community ties as a key determinant of migration patterns (Ritchey 1976). Care can also be conceptualized more broadly, whereby HIV-positive individuals migrate to join family to receive economic and social, as well as health, support. If migration is occurring to seek access to health care then those with a longer duration infected, at the point in their illness when care is most required, would be expected to have an increased risk of migration.

Marriage as a Mediating Mechanism

Recent research of migrants in Malawi found that HIV-status was associated with future migration (Anglewicz, forthcoming). Using sero-status data from a 2004 survey round and conducting a post-migration autopsy three years later, Anglewicz found that those who were HIV positive in 2004 were more likely to have migrated in 2007, a finding that was significant for both male and female migrants. The increased migration of HIV positive individuals was attributed to marital instability and change, including divorce, widowhood and remarriage.

Marriage represents an important life transition which has been clearly linked to migration patterns (Lee 1966). In addition to shaping individual life trajectories, marital change also represents important points of household formation and dissolution. Changes to household formation will also affect the political economy of the household, such that decisions to migrate may be different as a result of marital change. Based on differential land rights and wealth, men and women may experience marriage-related migration in different ways. In particular, marital dissolution may make it more likely that women will need to migrate in order to ensure social and economic security.

That marriage-related migration may serve as a potential mediating mechanism between HIV and future migration fits within the broader literature that finds a strong association between both HIV and marital dissolution and remarriage, as well as between marital dissolution and remarriage and migration. Porter et al. (2004) found that women's HIV status was significantly associated with a greater likelihood of divorce or separation, and an even larger likelihood of widowhood. Similarly, Reniers (2008) examined union-based risk avoidance strategies among couples in Malawi, and found evidence of negative partner selection, whereby factors associated with HIV risk were seen to increase union instability.

Marrital dissolution and HIV is highly gendered phenomenon, however, dependent on patterns of matrilocal and patrilocal residency. Porter et al. (2004) found that among sero-discordant couples, union dissolution was more likely if the woman was sero-positive, than if the man was (RR 4.28 for sero-positive women and RR 1.31 for sero-positive men). However, they found that widowhood was most likely in sero-discordant couples with a sero-positive man, or in sero-

positive concordant couples. Research on marital instability and HIV in this region has also shown that HIV prevalence is greater among those widowed or separated (de Walque and Kline 2009; Nabaitu, Bachengana, and Seeley 1994).

Research from rural Tanzania confirmed similar findings on the common occurrence of marital dissolution in East Africa, but they also found common patterns of remarriage following divorce (Boerma et al. 2002). Ntozi (1997) also found remarriage was common following widowhood, however widowers were more likely to remarry (56.1%, Chi-2=12.2) than widows (27.3%, Chi-2=35.0). de Walque and Kline (2009) also examined remarriage patterns based for 13 African countries, and found that remarriage was very common, and that those who remarried had higher HIV prevalence rates than the general population. They also found that remarried women in particular were significantly more likely to be HIV positive, even after adjusting for an array of individual characteristics. These studies suggest that alongside trends of marital dissolution, new partner selection and remarriage is also common.

Some research has begun to link marital patterns to migration and mobility trends. Research in Uganda has also shown evidence of widowhood being associated with patterns of migration (Ntozi 1997). However, contrary to traditional hypothesis surrounding a healthy-migrant effect, Ntozi also found that unhealthy widows and widowers were more likely to migrate than healthy ones. Research in Tanzania also examined migration and marriage trends, with respondents reporting marriage or divorce as the most important reasons for moving (Boerma et al. 2002). However, the majority of those moving households for marriage-related reasons moved within the same village.

Anglewicz (2010) found that marriage-related reasons made up 30% of stated reason for migration, which was more common among women (41%) than men (25%). Both male and female respondents who were HIV positive in 2004 were significantly more likely to migrate after 2004, and respondents moving for marriage-related reasons are significantly more likely to be HIV positive. Despite evidence on the relationship between HIV and migration, and HIV and marital instability, previous research in Uganda has not combined these two fields to determine the relationship of HIV, migration and marriage.

To determine whether HIV infection leads to an increased risk of migration, this paper tests the following hypotheses:

	Hypothesis	*Migration and Transmission*	*Healthy Migrants*	*Migration and Health Care*
H1	HIV infection occurs sequentially prior to migration, and increases the likelihood of migration compared to HIV-negative individuals.	Supports	Opposes	----------
H2	Marital dissolution is the primary mediating mechanism leading to a higher risk of migration among HIV-positive individuals as compared to HIV-negative individuals.	----------	----------	----------
H3	With increased duration positive, the risk of migration will go up as individuals are more likely to be migrating to seek HIV-related care.	----------	Opposes	Supports

DATA

Data for this analysis comes from the General Population Cohort (GPC) study conducted by the Medical Research Council of Uganda and the Uganda Virus Research Institute (MRC/UVRI). The GPC is an annual population census and sero-survey that has been conducted in the area

since 1989. It is comprised of a rural population cohort in south-western Uganda with approximately 20,000 respondents from the 25 villages in the study site. Details of the population cohort study and methodology have been described elsewhere (Nakibinge et al. 2009; A. J Nunn et al. 1997). This paper draws on annual data from 2000-2009 (Round 10-20). The dataset includes information on household composition and characteristics, individual demographics, sexual behavior and marriage histories, and sero-status. The adult survey has response rate of 69%, and of those who take the survey, 83% also participate in the sero-survey. Using unique respondent identification numbers, individuals are followed within households, including migration out of the study site, and follow-up surveys if migrating to other households within the study site. Analyses were undertaken on all ever-married adults aged 15 and older who were included in at least one census round from 2000-2009. The sample did not include never married individuals, as it would be impossible for them to have ever been exposed to marital dissolution. Never married respondents who then marry were then included in the sample in the survey round at which they first reported being married. The longitudinal nature of this data set allows for discrete event sequencing between migration and HIV infection to be determined.

METHODS

A discrete time hazard models was developed to estimate the effect of HIV on migration. The complementary-log-log link was used, which takes the logarithm of the negative logarithm of the complement probability (the probability of event-non occurrence). This model was used over the logit link for two primary reasons: (1) it takes into account the continuous nature of time under

analysis despite the measurement of data occurring in discrete time intervals, and (2) it allows for the estimation of risk of migration, rather than odds, which provides for clearer interpretation of risk of event occurrence. Individual-level random effects were included to take into account the non-independence of observations across individuals. Only first episodes of migration since initial observation in the sample were included for analysis. That is after time t_m when an individual first migrates, they are removed from the sample to remove some potential for reverse causality.

$$clog - \log(h(t_{ij})) = \beta_1 HIV_{ij-1} + \beta_2 \gamma_i + \beta_3 Age_{ij} + \sum_{j=12}^{20} \alpha_j R_{ij} + \delta_i + e_{ij}$$

$t = time\ period$
$i = individual$
$h(t_{ij}) = hazard\ of\ migration$
$R_{ij} = dummy\ variables\ for\ round\ number\ 12 - 20$
$HIV_{ij-1} = dummy\ variable\ for\ one\ year\ lagged\ HIV\ status$
$\gamma_i = vector\ of\ control\ variables$
$\delta_i = individual - level\ random\ effect$
$e_{ij} = error\ term$

Left-censoring still limits the ability to make strong causal claims using the above model. The sample under analysis is left truncated at the first found of observation in the sample. The duration of time of residence prior to 2000 is unknown, as is past experiences of migration. To assess the potential bias left-censoring may introduce in estimates for the risk of migration, robustness checks are run using alternative model specifications. First, a separate model is run for sero-converters, those who become HIV-positive after their first round of observation and prior to any migration events. Despite the small number of sero-converters in the sample, the direction of this association is important to estimate to confirm event-sequencing between HIV and migration.

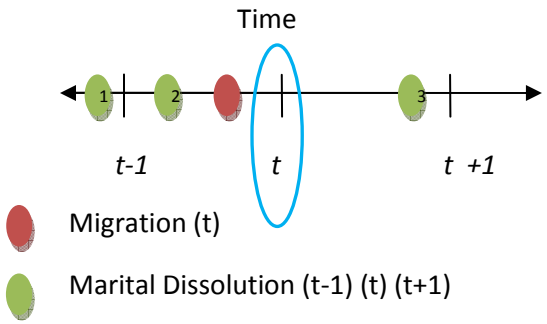
Outcome Variable

A dummy variable for migration is the primary outcome of analysis. However, in order to determine if marriage-related factors are driving the hypothesized association, four additional outcome measures were developed.

First, the model was run to compare the outcome of labor-related migration to a model of non-labor related migration. Reasons for migration were either self-reported or reported by a head of household. These were classified into work/school reasons, marriage-related reasons, to join relatives, and other reasons. Despite a category for marriage-related migrations, it is also possible that those migrating following marital dissolution were migrating to join their relatives, or that some marriage-related migrations were coded as "other" if marriage was not seen as the primary reason for migration. In order to capture all migrations related to marital dissolution, or remarriage, migrations were classified as either labor-related migrations or non-labor related migrations.

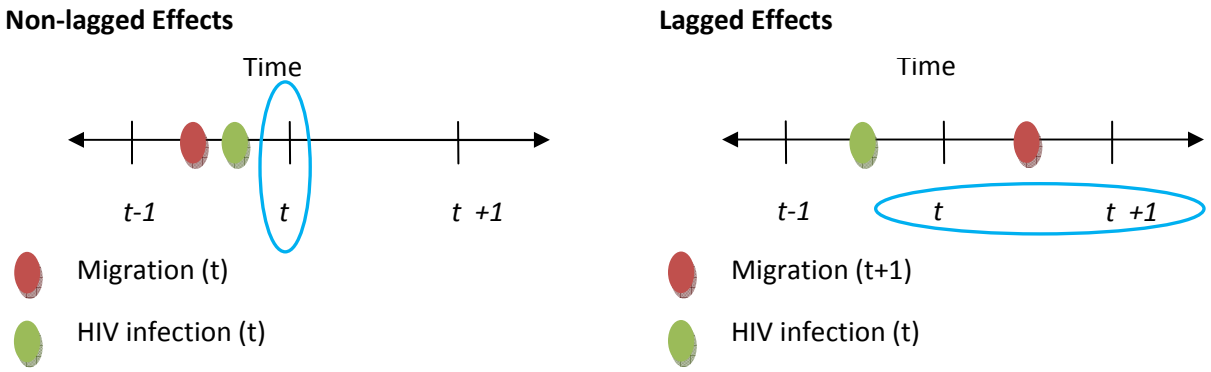
More challenging to measure is the relationship between changes in marital status and migration outcomes. While research on marital formation has moved away form thinking of marriage as a discrete event, to marriage as a process, research on marital dissolution has not followed suite. In reality, is unclear whether one first reports their marriage has dissolved or their partner has died, and then later migrates, or whether one migrates as a marriage is moving towards dissolution, and then declares marital dissolutions in later rounds of the survey. To take into account the dynamic process that is marital dissolution, a purposeful 'fuzzy' variable was created for migration with and migration without dissolution. An individual is recorded as having a

marital dissolution and migration if migration in time *t* occurs in conjunction with a marital dissolution in time *t-1*, *t* or *t+1*. (See diagram) Individuals moving outside the study site and experiencing marital dissolution at time *t+1* would be censored from this analysis, and recorded as a migration without dissolution. The right censoring of dissolution and migration would lead to a downward bias in the estimated effect of HIV on migration with marital dissolution. The effect of HIV status on migration with marital dissolution is compared to the effect on migration without marital dissolution.



Predictor Variable

The time-varying covariate of HIV-status is the primary predictor variable of interest. Determining event sequencing with discrete-time measurements is problematic as reported events at time *t* will have occurred anytime within the previous year between time *t* and time *t-1*. To isolate sequencing between HIV and migration, HIV status is lagged by one year such that HIV status in time *t-1* is used to predict migration at time *t*.



Control Variables

All models were adjusted for age, included as a continuous variable in the model. Age-intervals, and non-linearity's were also modeled, but did not provide a better fit for the data. Demographic characteristics including religion, tribe and education were also added into the model. Finally, two sexual behavior variables, age at first sex (AFS) and age at first marriage (AFM) were also included as dichotomous variable for below or above the median reported age (median AFS for men was 18 and 16 for women; median AFM for men was 22 and 18 for women).

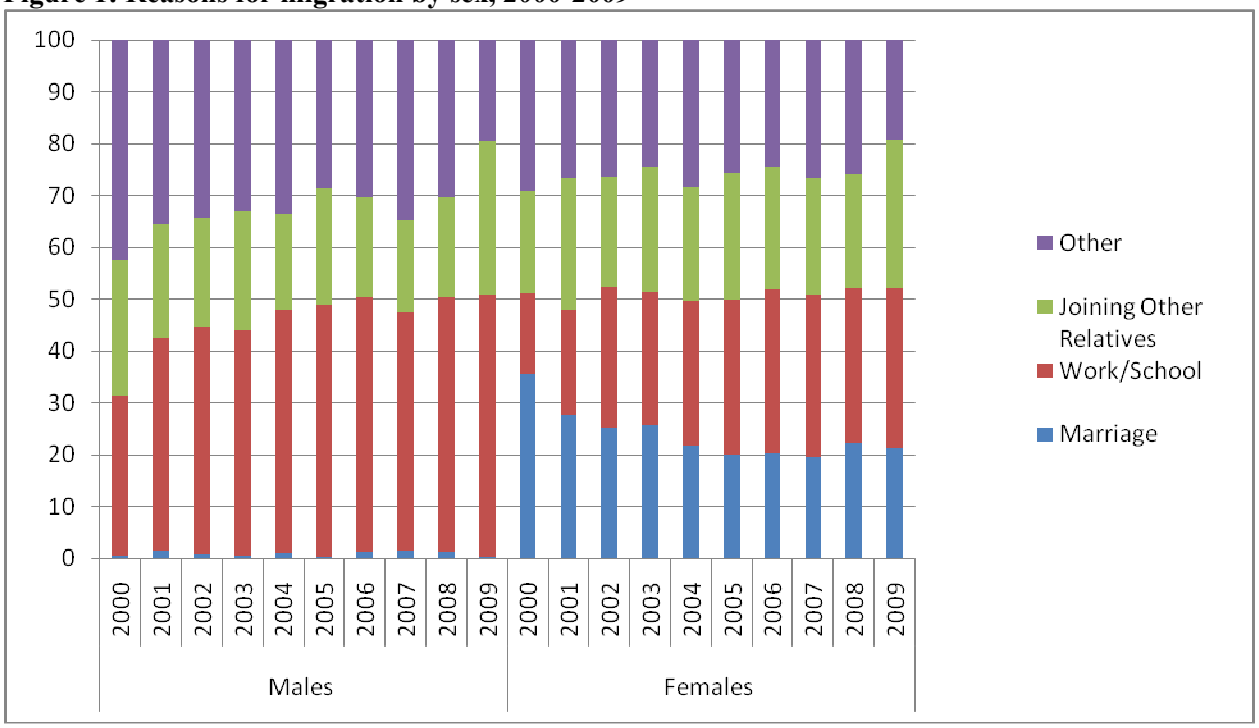
Additional model specifications include controls for mobility. While left-censoring limits controlling for previous migration experiences, non-migration mobility which may be correlated with past migration, is included to try to limit potential bias from left-censoring. A mobility control variable for whether an individual had spent greater than one month away from the household in the last year, was included.[2]

[2] To qualify as a household resident to being with, however, an individual must have spent a minimum of 3 months in the previous year residing in the household.

RESULTS

Analysis was limited to participants 15 years or older who had participated in at least one census or survey from 2000-2009. Table 1 provides basic demographic characteristics for survey respondents in 2000-2009, as well as sero-prevalence rates which range from 7-11%. Overall 8-11% of respondents migrated within a given year. Over the course the 10-year period, at least half of respondents reporting migrating at least once (49 %, results not shown). Women were much more likely to report migrating for marriage-related reasons: 19-35% of migrations among women in each year were marriage-related (Figure 1). Marriage-related reasons were much less common among men, constituting only 0.5-1.5% of reported reasons for migration. While men make up the majority of labor migrants each year, marriage-related migrations almost exclusively occur among women. Between 94-99% of marriage-related migrants each year are women (Figure 2). Given that the Buganda ethnic groups follow a patrilineal system of descent with patrilocal residence at marriage, it is the women who join their husbands at marriage, and again move out in case the marriage dissolves (widows may continue to live in their husband's homestead) indicating a gendered process of marriage-related mobility in rural Uganda.

Figure 1: Reasons for migration by sex, 2000-2009



Notes: Figure excludes those never married in each survey round. Reasons of migration are self-reported, or reported by household hold completing census.

Figure 2: Absolute number of marriage-related migrations by sex, 2000-2009

Notes: Figure excludes those never married in each survey round. Reasons of migration are self-reported, or reported by household hold completing census.

Table 1: Demographic Characteristics, 2000-2009

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
N	9,348	10,120	10,367	10,497	10,637	10,594	10,693	10,741	10,908	11,065
Migrated	701 (8%)	1,150 (11%)	1,322 (13%)	1,323 (13%)	1,444 (14%)	1,460 (14%)	1,300 (12%)	1,208 (11%)	1,169 (11%)	1,198 (11%)
Age										
15-29	4,873 (52%)	5,394 (53%)	5,506 (53%)	5,527 (53%)	5,511 (52%)	5,393 (51%)	5,400 (51%)	5,333 (50%)	5,407 (50%)	5,496 (50%)
30-39	1,589 (17%)	1,721 (17%)	1,742 (17%)	1,778 (17%)	1,804 (17%)	1,815 (17%)	1,835 (17%)	1,883 (18%)	1,903 (18%)	1,915 (17%)
40-49	1,002 (11%)	1,042 (10%)	1,112 (11%)	1,145 (11%)	1,229 (12%)	1,251 (12%)	1,312 (12%)	1,362 (13%)	1,396 (13%)	1,422 (13%)
50-59	697 (7%)	718 (7%)	748 (7%)	760 (7%)	777 (7%)	797 (8%)	832 (8%)	849 (8%)	896 (8%)	906 (8%)
60-69	620 (7%)	639 (6%)	666 (6%)	679 (6%)	673 (6%)	670 (6%	655 (6%)	654 (6%)	635 (6%)	611 (6%)
70 +	567 (6%)	606 (6%)	593 (6%)	608 (6%)	643 (6%)	668 (6%)	659 (6%)	660 (6%)	671 (6%)	715 (6%)
Sex										
Male	4,502 (48%)	4,854 (48%)	4,985 (48%)	5,026 (48%)	5,047 (47%)	5,044 (48%)	5,039 (47%)	5,048 (47%)	5,112 (47%)	5,208 (47%)
Female	4,846 (52%)	5,266 (52 %)	5,382 (52%)	5,471 (52%)	5,590 (53%)	5,550 (52%)	5,654 (53%)	5,692 (53%)	5,795 (53%)	5,855 (53%)
HIV										
Negative	7,013 (93%)	7,294 (93%)	6,992 (93%)	7,049 (93%)	7,036 (92%)	6,746 (92%)	6,839 (92%)	6,634 (91%)	6,232 (90%)	5,781 (89%)
Positive	499 (7%)	540 (7%)	547 (7%)	555 (7%)	590 (8%)	590 (8%)	601 (8%)	621 (9%)	671 (10%)	713 (11%)
N	7,512	7,834	7,539	7,604	7,336	7,336	7,440	7,255	6,903	6,494
Marital Status										
Never married	1,959 (35%)	2,250 (36%)	1,784 (29%)	2,053 (35%)	2,141 (34%)	1,776 (31%)	1,780 (32%)	1,797 (32%)	1,716 (32%)	1,103 (22%)
Married	2,657 (47%)	2,809 (45%)	3,015 (50%)	2,705 (46%)	2,883 (46%)	2,704 (48%)	2,717 (48%)	2,666 (48%)	2,597(48%)	2,829 (56%)
Widowed	424 (7%)	446 (7%)	491 (8%)	459 (8%)	530 (9%)	523 (9%)	481 (8%)	454 (8%)	426 (8%)	478 (9%)
Divorced/ Separated	630 (11%)	703 (11%)	773 (13%)	660 (11%)	662 (11%)	660 (12%)	648 (12%)	655 (12%)	639 (12%)	634 (13%)
N	5,670	6,208	6,063	5,877	6,216	5,663	5,626	5,572	5,378	5,044
Tribe										
Muganda	2,392 (74%)	2,909 (73%)	3,104 (72%)	3,279 (72%)	3,427 (73%)	3,439 (73%)	3,492 (72%)	3,546 (72%)	3,761 (72%)	3,912 (73%)
Munyanrwanda	440 (14%)	571 (14%)	642 (15%)	680 (15%)	699 (15%)	709 (15%)	754 (16%)	767 (16%)	795 (15%)	830 (15%)
Other	400 (12%)	525 (13%)	550 (13%	570 (13%)	591 (13%)	582 (12%)	608 (13%)	614 (12%)	648 (12%)	641 (12%)
N	3,232	4,005	4,297	4,529	4,717	4,730	4,854	4,927	5,204	5,383
Religion										
Christian	5,005 (76%)	5,716 (77%)	6,048 (77%)	6,311 (76%)	6,601 (76%)	6,832 (76%)	7,206 (76%)	7,453 (75%)	7,956 (75%)	8,117 (75%)
Muslim	1,750 (24%)	1,750 (23%)	1,853 (23%)	1,968 (24%)	2,082 (24%)	2,126 (24%)	2,290 (24%)	2,453 (25%)	2,709 (25%)	2,770 (25%)
N	6,552	7,466	7,901	8,279	8,683	8,958	9,496	9,996	10,665	10,887
Education										
No Education	3,482 (37%)	3,565 (35%)	3,263 (31%)	3,008 (29%)	2,811 (26%)	2,539 (24%)	2,465 (23%)	2,449 (23%)	2,593 (24%)	3,094 (28%)
Some Primary	4,269 (46%)	4,705 (47%)	5,022 (48%)	5,223 (50%)	5,409 (51%)	5,543 (52%)	5,661 (53%)	5,726 (53%)	5,800 (53%)	5,628 (51%)
Some Secondary	1,597 (17%)	1,850 (18%)	2,082 (20%)	2,266 (22%)	2,417 (23%)	2,512 (24%)	2,567 (24%)	2,566 (24%)	2,515 (23%)	2,343 (21%)

Notes: Number of observations reported for categories where data was no available for the full sample.

Looking at Table 2, it is clear that HIV-positive individuals have a significantly highly risk of migrating in future years than those who are HIV-negative, holding all else equal. For women, the risk of migration is 66% higher for those who are HIV-positive, a highly significant difference. HIV-positive men on the other hand have only a 0.4% increase in the risk of migrating compared to their HIV negative counterparts, a small and insignificant result. These results are robust to alternative model specifications.

Table 2: Hazard ratio of migration for men and women in rural Uganda, 2000-2009

	Females	Males
Lagged HIV status	1.660***	1.004
	(1.305 - 2.111)	(0.625 - 1.612)
Demographics		
Age	0.921***	0.896***
	(0.916 - 0.927)	(0.887 - 0.906)
Christian (ref)		
Muslim	0.677***	0.910
	(0.565 - 0.811)	(0.808 - 1.025)
Muganda (ref)		
Munyarwanda	1.389**	4.241***
	(1.078 - 1.791)	(2.762 - 6.513)
Other	1.720***	4.855***
	(1.289 - 2.294)	(3.071 - 7.677)
Education		
None (ref)		
Some Primary	0.357***	0.173***
	(0.294 - 0.433)	(0.120 - 0.248)
Some Secondary	0.347***	0.109***
	(0.274 - 0.439)	(0.0706 - 0.167)
Mobility		
≥ 1 month away	0.444***	0.163***
	(0.361 - 0.547)	(0.117 - 0.228)
Sexual Behavior		
AFM < 18 (f) 22(m) (ref)		
AFM ≥ 18 (f) 22(m)	0.900	0.720*
	(0.754 - 1.075)	(0.513 - 1.012)
AFS < 16 (f) 18(m) (ref)		
AFS ≥ 16 (f) 18(m)	1.230**	2.025***
	(1.047 - 1.445)	(1.481 - 2.770)
Constant	6.914***	44.55***
	(5.563 - 8.592)	(21.86 - 90.81)
First Migrations Only	Yes	Yes
Random Effects	Yes	Yes
Observations	23,832	16,119

*** p<0.01, ** p<0.05, * p<0.1

Notes: All models control for census round

Even when looking at just those who sero-converted over the course of observation period, we still see a large and positive effect of HIV on the risk of migration, with a 92.7% increase in the hazard. Due to the small number of sero-converters, male and females were combined together in one model to reduce inflated standard-errors as a result of smaller variance in the outcome variable. In the female-only model, the hazard was 33.4% higher, but the standard errors were very large.

Table 3: Hazard Ratios among all participants and women originally negative in first round of observation, 2000-2009

	HIV negative in first round	
	All	Females
HIV (lagged)	**1.927****	**1.334**
	(1.090 - 3.408)	**(0.673 - 2.644)**
Demographics		
Age	0.913***	0.920***
	(0.907 - 0.919)	(0.914 - 0.925)
Christian (ref)		
Muslim	0.665***	0.485***
	(0.559 - 0.791)	(0.372 - 0.632)
Muganda (ref)		
Munyarwanda	2.051***	1.393**
	(1.611 - 2.612)	(1.053 - 1.841)
Other	2.667***	1.933***
	(2.045 - 3.480)	(1.410 - 2.649)
Education		
None (ref)		
Some Primary	0.277***	0.338***
	(0.226 - 0.340)	(0.274 - 0.416)
Some Secondary	0.222***	0.334***
	(0.173 - 0.284)	(0.259 - 0.430)
Sexual Behavior		
AFM < 18 (f) 22(m) (ref)		
AFM ≥ 18 (f) 22(m)	0.787***	0.886
	(0.659 - 0.940)	(0.731 - 1.074)
AFS < 16 (f) 18(m) (ref)		
AFS ≥ 16 (f) 18(m)	1.426***	1.220**
	(1.215 - 1.673)	(1.026 - 1.451)
Constant	12.05***	7.312***
	(8.913 - 16.30)	(5.726 - 9.337)
First Migrations Only	Yes	Yes
Random Effects	Yes	Yes
Observations	37,449	22,303

*** p<0.01, ** p<0.05, * p<0.1

Notes: All models control for census round

To isolate the mechanisms through which HIV increases the risk of migration, labor-related migration compared to non-labor related migration models were run, with a control added for whether or not marital dissolution had occurred within a three year time window. For men, marital dissolution was only significantly associated with non-labor related migration. Moreover, by dividing the outcome between labor and non-labor related migration, one can see that while the effect of HIV still remains very small and insignificant, the size of the coefficient is slightly larger for non-labor related migration, as the marriage-related mechanism would suggest. For labor-related migration, neither HIV-status nor marital dissolution were predictive.

For women, on the other hand, Table 4 shows some striking gender differences. First, the effect of marital dissolution on both labor and non-labor related migration is very strong. HIV no longer has a significant effect on women's labor related migrations. However, marital dissolution is associated with close to two and a half times the risk of labor-related migration compared to those not experiencing marital dissolution. Among non-labor related migrants, even though marital dissolution increases the risk of migration by 33%, there is still a strong and significant association between HIV-status and risk of migration after controlling for marital dissolution. Taking into account marital dissolution, the risk of migrating for HIV-positive women is of the same magnitude as the results found in Table 2. This suggests that regardless of marital dissolution occurring, HIV still leads to a higher risk of future migration. Along with marital dissolution as a mediating mechanism, other mechanisms may also be leading to HIV status to increase the risk of migration.

Table 4: Hazard Ratios for labor and non-labor related migration, 2000-2009

	Females Migration		Male Migration	
	Labor	*Non-Labor*	*Labor*	*Non-Labor*
Lagged HIV status	**1.342**	**1.676*** **	**1.068**	**1.129**
	(0.837 - 2.153)	(1.308 - 2.147)	(0.403 - 2.830)	(0.836 - 1.525)
Marital Dissolution	2.540***	1.327***	1.001	1.479***
	(1.748 - 3.691)	(1.105 - 1.594)	(0.545 - 1.840)	(1.198 - 1.825)
First Migration	Yes	Yes	Yes	Yes
Random Effects	Yes	Yes	Yes	Yes
N	23,832	23,832	16,119	16,119

*** p<0.01, ** p<0.05, * p<0.1

Note: Controls include age, survey round, religion, tribe, education, AFS and AFM

To check the robustness of the classification of the dependent variable into labor and non-labor related migrations, never-married respondents who married and then migrated were examined for reported reason of migration. Among those who married and migrated, 36% reported their migration as marriage-related, while 58% reported that their migration was "Other". The multiple ways respondents classified what would easily be considered a marriage related migration justifies collapsing the non-labor related categories in Table 4 to capture marriage-related migrations.

Interacting marital dissolution and HIV-status provides further evidence that the relationship between HIV-status and migration differs by whether or not one has experiences a marital dissolution. For those not reporting marital dissolution, HIV-positive individuals are much more likely to migrate than HIV-negative individuals. Among those experiencing a marital dissolution

there is little difference in non-labor migration risk by sero-status. The effect of marital dissolution leads to a 50% higher risk of non-labor migration among both HIV-positive and HIV-negative women. However, the marriage-related mechanism hypothesized in this paper is not about comparing whether marital dissolution impacts HIV-positive individuals differently than HIV-negative individuals. Rather, it is determining whether HIV positive individuals are more likely to have both a marital dissolution and a migration. Models presented in Table 5 take into account the joint events of migration and marital dissolution to better test the hypothesized marriage mechanism, taking into account the dynamic temporal nature between these two combined outcomes. This additional analysis was only done for women, as HIV was not found to be a determinant of men's non-labor related migration.

Figure 3: Interaction effect of dissolution and lagged HIV status on women, 2000-2009

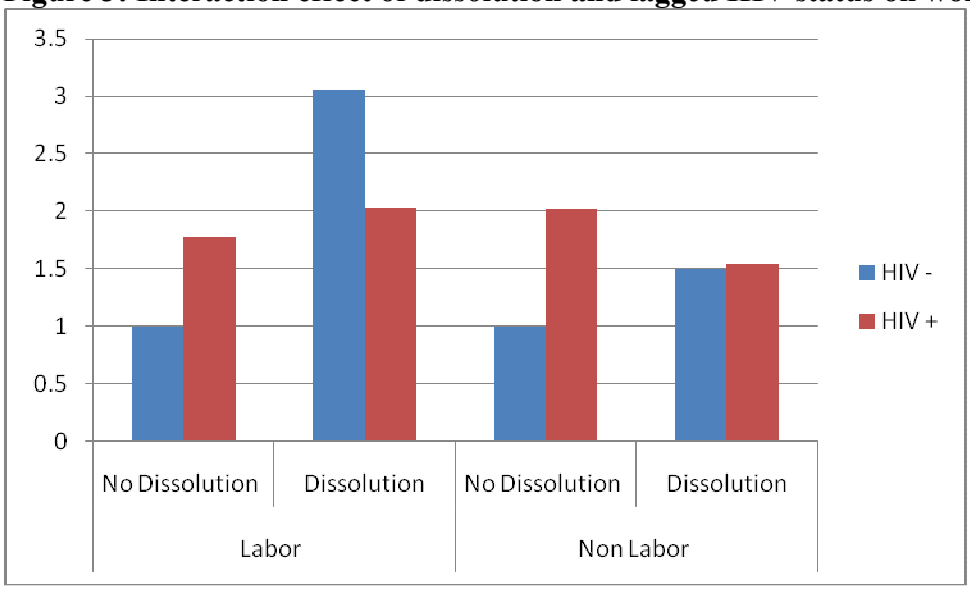


Table 5: Hazard Ratios for migration and marital dissolution

	Females	
	Migration with Dissolution	*Migration withtout Dissolution*
Lagged HIV status		
	2.485* **	**1.229*** **
	(1.889 - 3.269)	(1.055 - 1.432)
First Migration	Yes	Yes
Random Effects	No	No
N	23,832	23,832

*** p<0.01, ** p<0.05, * p<0.1

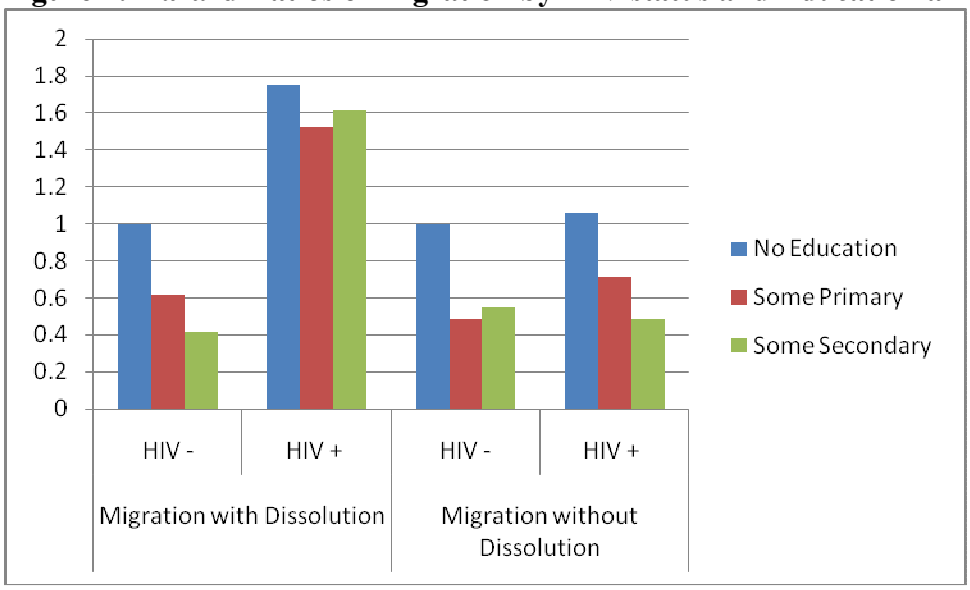
Notes: Controls for survey round, age, religion, tribe, education, AFS, and AFM were included

As can be seen by the results in Table 5, being HIV-positive is associated with a 23% higher risk of migration without marital dissolution among women but is predictive of a 149% higher risk of migration combined with marital dissolution. While being HIV-positive increases the risk of all types of migration compared to those who are HIV-negative, this relationship is drastically larger when looking at migration occurring in conjunction with marital dissolution.

To isolate the mechanism that leads those with HIV to have an increased risk of migration, even without marital dissolution, an interaction term between HIV and education was added to the model. Using education as a proxy of socio-economic status we can see that taking into account socio-economic status differences those who are HIV-positive are no longer at an increased risk of experiencing a migration without a marital dissolution. This suggests that socio-economic status may account for the other mechanism through which HIV leads to migration. Among those experiencing a marital dissolution and a migration, however, socio-economic status did not change the increased risk among those who are HIV-positive. Regardless of socio-economic

status, being HIV-positive leads to an increased risk of experiencing a migration with a marital dissolution.

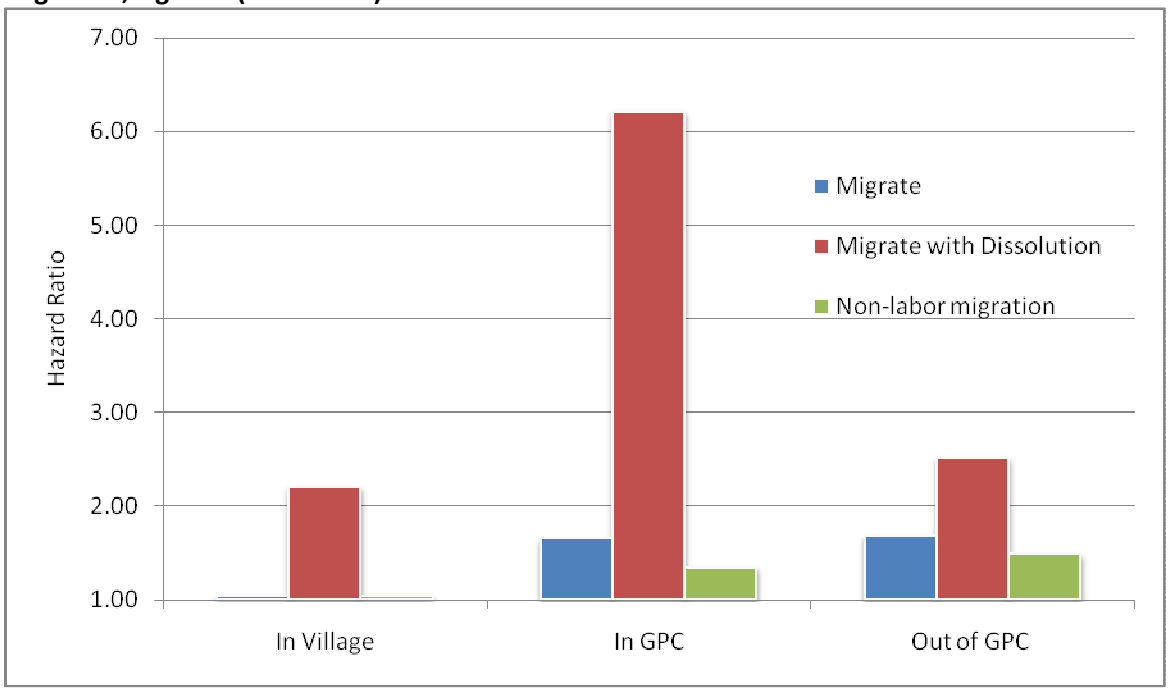
Figure 4: Hazard Ratios of migration by HIV status and Education among women, 2000-2009



In examining where women are migrating to, hazard ratios were predicted for moving within the same village, moving to another village in the GPC study-site, and moving outside the study site. The first columns in Figure 3 show the hazard ratio of migration by lagged-HIV status. Overall, being HIV-positive has no effect on the risk of moving within the same village, but is associated with nearly a 65% higher risk of moving within the study site, and a 68% higher risk of moving outside the study site, compared to those who are HIV-negative. The second column, highlighting the risk of migration with marital dissolution, shows the effect of HIV when marital dissolution is the mediating mechanism. While being HIV-positive increases the risk of migrating with dissolution regardless of location, this risk is much higher for those moving within the study site, compared to their HIV-negative counterparts. This suggests that rural-rural migration is the dominating pattern of migration for women experiencing marriage-related

migration as a result of their HIV status. Finally, the third column in Figure 3 suggests how destination is impacted by the direct effect of HIV-status on non-labor related migrations, once marital dissolution has been controlled for. In this instance, being HIV-positive is only associated with an increased risk of migration among those moving within the study site or outside the study site, but this risk does not differ much between these two destinations (a 35% higher risk of migrating within the study site vs. a 49% higher risk of migrating outside the study site, compared to those who are HIV negative).

Figure 5: Hazard of Migration of lagged HIV status by Destination among females for first spells of migration, Uganda (2000-2009)

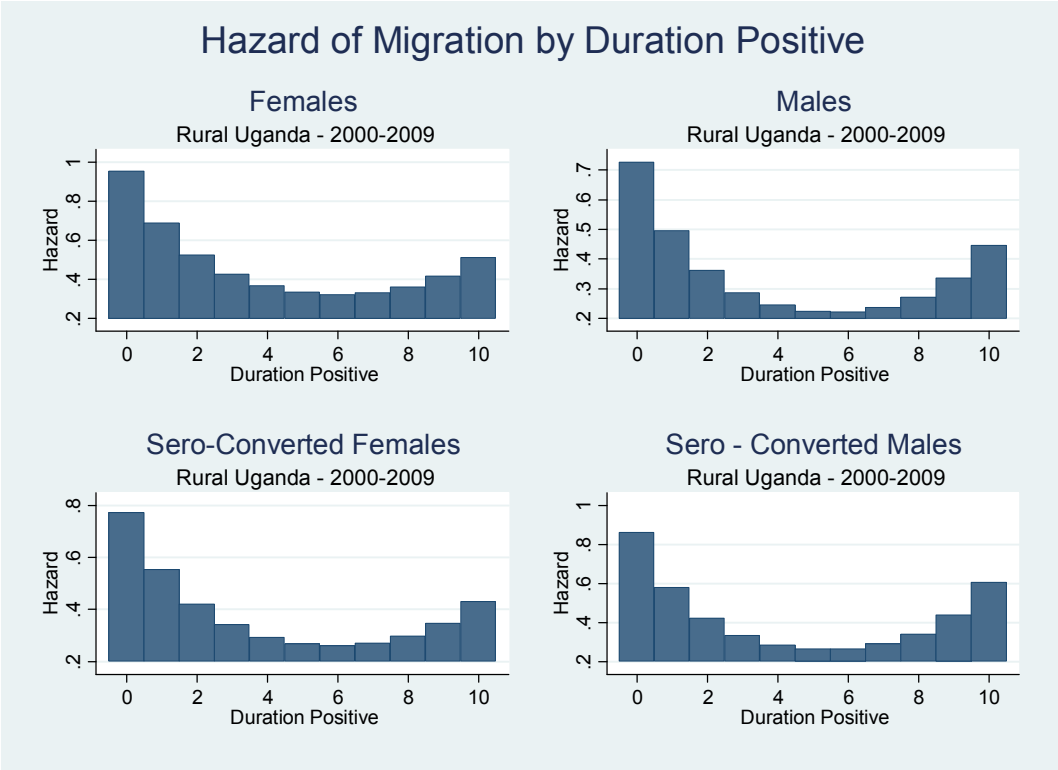


Notes: Coefficients were estimated controlling for survey round, age, religion, tribe, education, AFM and AFS, and if they had spent greater than one month away from the household in the last year.

Finally, the duration positive for men and women was examined to see how the risk of migration is affected by different stages of HIV infection. What emerges is a clear u-shaped duration effect of HIV-infection, whereby the risk is highest during the initial stages of infection, and decreases

over time. However, after approximately 6 years, the risk of migration begins to increases again. Since left-censorship is more problematic for estimating duration effects, two additional models were run only among those who sero-converted after 2000. The similar u-shaped pattern suggests that these findings are robust and not biased due to left-censorship.

Figure 6



Notes: Figure was estimated for a hypothetical HIV positive individual who has the mean age of the population (34.3), is Christian and from the Muganda tribe, has a AFM and AFS below the median value, and has not been away for more than a month in the previous year or have a past event of migration reported. The horizontal red line indicates a hazard ratio of 1, or where duration has no effect on the hazard of migration.

DISCUSSION

Discrete time analysis is able to parse out event sequencing between HIV and migration, indicating that HIV infection does trigger future migration among women, but not among men. Overall, this paper finds evidence supporting all three hypotheses: HIV-positive individuals are more likely to migrate than HIV-negative individuals (but only among women), and marriage is one of the primary mechanisms driving this relationship. In examining whether marriage-related factor explain this association, as the two-round analysis by Anglewicz suggested, this paper shows that the relationship between HIV-status, marriage and migration is very different for men and women. These results suggest that HIV is differentially impacting the lives of men and women in rural Uganda, leading to increased migration and potential insecurity, among women but not men. While risk of migration increases with duration of disease, this relationship is not linear as predicted, but rather follows a u-shaped relationship, indicating that infection is also a key point of insecurity in the disease progression.

Marital dissolution was found to be associated with non-labor migration among both men and women, but not labor-migration among men. These results support the previous evidence in the literature on the role of marital dissolution leading to migration as a result of changing household dynamics. However, the impact of marital dissolution on both labor and non-labor related migration among women suggests that marital dissolution impacts women differently, necessitating moving for both economic and non-economic reasons. What is not evident from this analysis, however, is whether women first migrate for labor, and then have their marriage dissolve, or if marital dissolution requires them to move elsewhere to look for work and economic security.

Through analyzing the impact of sero-status on the combined events of migration and marital dissolution, marriage was identified as the primary mediating mechanism through which HIV leads to migration. While previous research has shown an association between HIV and marital dissolution, and marital dissolution and migration, this analysis shows how being HIV-positive leads to a large and significant increase in the risk of experiencing the combined events. This paper contributes to the literature on migration and marriage by considering marriage not as a single event but as a dynamic process that overlaps with migration.

A second mechanism through which HIV leads to migration was identified as socio-economic status. HIV-positive individuals were more likely to experience migration without marital dissolution as well, but this main effect was no longer found to be significant when an interaction between education and HIV was added to the model. These findings suggest that socio-economic status largely drives the difference in non-marriage related migrations between HIV-positive and HIV-negative individuals. The socio-economic gradient across both sero-status groups highlights that those with higher socio-economic status are less likely to migrate. This provides further evidence for the theory that socio-economic insecurity is a driving determinant of migration. Through the socio-economic status mechanisms those at higher levels of insecurity have a higher risk of migration. Through the marriage-mechanism, those women experiencing marital dissolution are at heightened insecurity, regardless of socio-economic status, again necessitating migration. Using wealth may be a better means of assessing socio-economic status, though education and wealth are likely highly correlated in rural Uganda where access to education is largely determined by wealth.

Social and economic insecurity resulting from both identified mechanisms may in part explain the large gender differential observed in risk of migration by sero-status. If men experience less social and economic shocks as a result of their sero-status, they may be less likely to need to migrate. Women, on the other hand, may have different capacities to absorb social and economic shocks resulting from HIV-infection. While one's ability to withstand shocks associated with HIV-infection will be mediated by socio-economic status, this paper argues that marital dissolution provides increases insecurity among all women, regardless of socio-economic status. Women overall are faced with a triple burden of HIV-infection, marital instability, and socio-economic insecurity. Migration becomes a potential strategy of women in addressing these challenges.

Rural-rural migration within the study site was the most common migration route taken by HIV-positive women experiencing marriage-related migration. If women are moving as a result of insecurity, it may be that migration is a means of accessing kin or community ties to gain support. Support may be both in terms of health care from family members, as well as socio-economic support. Without post-migration autopsies to determine where these women move, what households they join, and how their economic livelihoods are effected, no definitive conclusions can be drawn as to what drives rural-rural migration among this group.

HIV status is strongly associated with the risk of migrating in future years. The effect of migrating is high just after sero-conversion, as well as during the later stages of this illness. If this duration risk is largely driven by marital dissolution, this suggests that marital dissolution is high (1) shortly after the test, and possibly disclosure of the results, and (2) as men/women start

to become visibly sick. This would fit with other literature that shows that HIV disclosure following testing is associated with separation or divorce. In addition, widowhood may be the dominating effect later on in the disease progression. Other research has indicted that following widowhood, one is also likely to be quite sick with HIV, and may therefore need to seek out care, no longer having a marital partner to look after them.

This analysis provides an important contribution to the literature on health and migration, identifying a health condition as a primary motivation to migrate, and the importance of marriage as a mediating mechanism. The increased risk of migration among HIV-positive women counteracts the healthy migrant hypothesis, indicating that in the case of HIV those infected and particularly those infected at the later stages of the disease are likely to be migrating. Rather than health status alone driving migration, the analysis of HIV reveals how HIV interacts with social factors, including marriage and socio-economic insecurity, to shape migration outcomes. While healthy individuals may be better able to physically migrate, less health individuals in this case are facing a necessity to migrate as a result of health and social factors.

The duration analysis provides further evidence for the relationship between health and migrating to access health care. Those individuals at the later stage of the disease are more likely to migrate. In the case of HIV/AIDS, care will only be needed in the later stages of the disease when one will either need to access anti-retroviral therapy, or if not, will need end of life care and support.

The potential to apply these findings to other rural areas in sub-Saharan Africa may be limited by the differing social conditions that mediate this relationship. For example, Angelwicz (forthcoming) found an increased odds of migration among both men and women who were HIV positive. This paper's results from rural Uganda, however, suggest vast gender differences in this relationship. Differential access to resources and land by gender, as well as local culture, will modify the way in which HIV leads to migration.

Whether other health conditions may similarly lead to migration remains to be further explored. Other diseases that affect working aged adults and alter the political economy of the household will necessarily have an impact on socio-economic insecurity, which may effect risk of migration. Transmission through sexual intercourse, however, also makes HIV unique in how the disease impacts households and partnerships. For other diseases to also lead to migration through a marriage mechanism would require the disease to have important repercussions on marital dynamics in a similar way to HIV.

CONCLUSION

Using discrete time analysis to determine event-sequencing, HIV-status was found to be a strong and significant predictor of migration in future years among women. Though examining marriage-related factors for migration, marital dissolution was identified as a mediating mechanism through which HIV leads to migration. Socio-economic insecurity was identified as second mechanism through which HIV leads to increased migration among HIV-positive women.

From a policy perspective, this paper highlights the importance of rural-rural migration among women, which may be ignored among the overarching emphasis within HIV and migration policy that focuses on rural-urban migration pathways among men. Attention also needs to be drawn to the combined impact of HIV-infection, marital dissolution and socio-economic insecurity on women's wellbeing. With much of the migration literature focused on male migrants, female migration as a health seeking behavior and means of improving socio-economic security needs to be given greater attention. The analysis of duration indicates the importance of initial infection, and the latter progression to AIDS as two critical points in the diseases progression where migration risk is elevated. While HIV programming largely focuses on HIV testing and treatment, these results suggest that when individuals are at these key points in the disease progression, they are also the least likely to be remaining in one location and near the same source of health services. Finally, marital dissolution also emerges as a key life-event that is associated with both being HIV-positive and migrating. What remains to be seen, however, is the resulting impact this may have on future HIV transmission. Conclusions should be withheld until more is understood about future partnerships patterns, sexual behaviors and remarriage among these individuals - only if these individuals are more likely to partner with HIV-negative individuals in risky sexual behavior, will this be important to increase transmission of the virus.

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