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Gendered dimensions of population mobility associated with HIV across three epidemics in rural Eastern Africa

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Abstract

Mobility in sub-Saharan Africa links geographically-separate HIV epidemics, intensifies transmission by enabling higher-risk sexual behavior, and disrupts care. This population-based observational cohort study measured complex dimensions of mobility in rural Uganda and Kenya.

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Contributors

CSC, AA, EDC, TBN made substantial contributions to the conception or design of the work and the analysis and interpretation of data for the work. MGe, SS, IM, PE were responsible for the overall project coordination and made substantial contributions to the acquisition and interpretation of data for the work. DVH, MLP oversaw the parent clinical trial and along with MRK, EAB, CRC were responsible for the clinical sites with biological samples of the study participants in the cohort. AA, CSC, EDC wrote the manuscript. MRK, EAB, EG, MGa, MLP, DVH, AB, TBN revised drafts critically for important intellectual content. All authors gave final approval of the version to be published and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Declaration of interests

All authors declare no competing interests.

Survey data were collected every 6 months beginning in 2016 from a random sample of 2,308 adults in 12 communities across three regions, stratified by intervention arm, baseline residential stability and HIV status. Analyses were survey-weighted and stratified by sex, region, and HIV status. In this study, there were large differences in the forms and magnitude of mobility across regions, between men and women, and by HIV status.

We found that adult migration varied widely by region, higher proportions of men than women migrated within the past one and five years, and men predominated across all but the most localized scales of migration: a higher proportion of women than men migrated within county of origin. Labor-related mobility was more common among men than women, while women were more likely to travel for non-labor reasons. Labor-related mobility was associated with HIV positive status for both men and women, adjusting for age and region, but the association was especially pronounced in women. The forms, drivers, and correlates of mobility in eastern Africa are complex and highly gendered. An in-depth understanding of mobility may help improve implementation and address gaps in the HIV prevention and care continua.

Keywords

HIV; mobility; migration; gender; Kenya; Uganda; population-based

Introduction

High levels of geographic mobility of populations in sub-Saharan Africa present a widespread challenge to the global HIV response. Population mobility in the region takes on many forms, including permanent resettling (not only from rural to urban areas, but also reverse and alternative migration flows), circular mobility (in which individuals move back and forth between multiple residences), and other forms (Collinson et al., 2006; Zlotnick, 2006). The complex and novel forms of mobility in sub-Saharan Africa are driven by labor-related forces, environmental pressures, and cultural practices (including women's migration for nuptiality in the region's patrilineal marriage systems)(Camlin et al., 2014b; Collinson et al., 2006; Zlotnick, 2006). Mobility can disrupt bonds between individuals and HIV care systems (Taylor et al., 2011), leading to poor health outcomes at all steps of the HIV care cascade (Tanser et al., 2015). Short-term mobility and recent migration present an additional challenge to the plethora of barriers people living with HIV (PLWH) experience when attempting to engage in care (Phillips et al., 2018; Taylor et al., 2014).

Mobility also links geographically separate epidemics (Isdory et al., 2015) and intensifies transmission by enabling higher-risk sexual behavior (Andrews et al., 2012; Camlin et al., 2018a) and diffusing higher-risk behavioral norms across social networks (Cassels et al., 2014; Lippman et al., 2007). There is accumulating evidence for what we have termed the *behavioral consequences of mobility* (Camlin et al., 2014a) to explain: 1) how mobile populations often experience life disruptions such as separation from spouses (Vissers et al., 2008), and 2) exposure to social environments featuring anonymity and riskier sexual norms (Lippman et al., 2007). Male labor migrants, for example, report more frequent visits to commercial sex workers (Weine and Kashuba, 2012), and engagement in commercial and

transactional sex by many migrant and highly mobile women for livelihoods is common (Camlin et al., 2017; Camlin et al., 2013a; Camlin et al., 2014a).

The promise of antiretroviral therapy (ART) for population-level HIV prevention through a "treatment as prevention" strategy (Granich et al., 2009) requires high levels of engagement in care, especially among those most likely to transmit HIV. Occupations with high HIV risk and low care engagement are often the most mobile – including fisherfolk (Bogart et al., 2016) and those involved in transportation, trucking, and tourism (Bwayo et al., 1994; Ramjee and Gouws, 2002). Because mobile populations are thought to contribute substantially to community-level HIV transmission in sub-Saharan Africa (Coffee et al., 2005; Garin et al., 1993; Grabowski et al., 2014; Jochelson et al., 1991), and often face barriers to care engagement, there are now renewed calls for HIV treatment as prevention to place special efforts on harder-to-reach mobile populations (Akullian et al., 2017).

Although geographic mobility has long been known to be a key driver of HIV epidemics in Africa (Garin et al., 1993; Jochelson et al., 1991), the existing literature on links between mobility and HIV has been hampered by broad and incompatible measures (Deane et al., 2010), gender biases in measures and data sources (Camlin et al., 2014b) and inadequate attention to the complex and dynamic nature of mobility and its setting-specific contexts (Bershteyn et al., 2018; Deane et al., 2010). This has led to discordant findings and possible under-measurement of women's mobility (Camlin et al., 2014b) and has precluded meta-analytical summaries of links between mobility and HIV (Deane et al., 2010). Here, we address these limitations by advancing new methods and metrics for the measurement of mobility across three regions of east Africa with unique HIV epidemiology. This study sought to measure complex dimensions of mobility, over multiple temporal and geographic scales in these regions, by HIV status and gender. We characterize migrations (permanent changes of residence over national and subnational boundaries) over recent time periods (past one and five years), recent mobility (movements to and from primary residences requiring overnight stays), reasons for migration and mobility (including specific labor-related and non-labor-related reasons), and the geographic origin and destination of these movements. In doing so, this study responds to calls to consider population mobility in its many forms, in order to inform strategies to reach high-risk populations for HIV prevention and treatment interventions (Camlin et al., 2018b; Deane et al., 2010; Taylor et al., 2011) .

Methods

Study design and participants

We conducted a cross-sectional analysis of regional and gender-specific population mobility in eastern African communities participating in the Sustainable East Africa Research in Community Health (SEARCH) trial (NCT01864603), a study in 32 communities of approximately 10,000 persons each in Uganda and Kenya investigating the effect of a multi-disease approach to universal HIV "test and treat" on HIV incidence and health outcomes (Perriat et al., 2018; Petersen et al., 2017). We collected survey data at 6-month intervals with a single random sample of 2,308 adults from 12 of the SEARCH communities (6 control, 6 intervention) followed longitudinally (Figure 1), with individual-level sampling within community stratified by sex, baseline HIV status, and baseline residential stability

(stable vs. mobile). Communities were selected purposively for a range of levels and types of mobility using the ethnographic data collected for SEARCH study community matching and randomization. Inclusion was restricted to individuals living in these 12 SEARCH communities, aged 16 and older at baseline, for whom baseline HIV serostatus and census-defined mobility status was ascertained. As described elsewhere (Chamie et al., 2016), the SEARCH trial ascertained individuals' HIV status via rapid, finger-prick blood based HIV antibody testing and Ministry of Health-based test-and-treat algorithms were followed.

Procedures

A stratified random sampling design was used to select the sample, ~200 individuals from each of 12 SEARCH communities, composed of eight roughly equally-sized groups of sex-specific, HIV positive and HIV negative, mobile (away from household six months or more in past 12 months, and fewer than half of nights spent in household in past four months) and residentially stable (non-mobile), men and women. HIV positive individuals and mobile individuals were oversampled to achieve the desired sample size in each stratum. In communities with low total numbers within a strata, all individuals were sampled in the stratum, a scenario that was common in communities with low HIV prevalence or low proportion of mobile participants.

Sampling weights were generated to ensure accurate proportional representation of eight gender/mobility/HIV strata within each of the 12 SEARCH communities, while keeping the influence of each community similar, regardless of overall community size. Sampling weights for stratum i in community j ($W_{i,j}$) were calculated by dividing the expected number of individuals within each stratum (based on population proportions) by the observed number of individuals actually sampled in each stratum, as follows:

$$w_{ij} = \frac{Expected_{ij}}{Sampled_{ij}} = \frac{\left(\frac{N_{ij}}{N_j} \times n_j\right)}{n_{ij}}$$

where N_{ij} is the population size of stratum i in community j, N_j is the total population size of community j, n_j is the sample size of community j, and n_{ij} is the sample size of stratum i in community j.

Data collection

Mobility survey data were collected using programmed tablets during one visit with study participants between February and November 2016. Data were collected in households or in another location preferred by the participant. Research assistants, trained in research ethics and qualitative and survey interview techniques, conducted data collection in the participants' preferred local language. Research teams were gender-balanced and gender-matched to participants, to maximize rapport and reduce social desirability bias.

Metrics of geographic mobility

We developed new high resolution, multi-dimensional typologies of mobility, not yet applied in HIV research, to better understand the social and demographic context of HIV risk and

HIV care cascade outcomes. These metrics are informed by theoretical and empirical advances in demography (Bell et al., 2002; Taylor and Bell, 2012) and prior qualitative research (Camlin et al., 2014a). We collected migration history data using a novel lifeline method, recording all childhood and adulthood changes of residence, locations of all places (including geographic designations to the district (Uganda) and sub-county (Kenya) level), reasons for moves, and ages during moves. Migration was defined in this study as a permanent change of primary residence over both national and subnational geopolitical boundaries (district and sub-county are low level geopolitical units in Uganda and Kenya, respectively, that most closely approximate one another in area and size); internal (within-country) migrations were categorized by whether they were within (intra-) or across (inter-) district/subcounty. We also collected detailed data on mobility (defined as travel that requires sleeping away from one's main residence) in the past month and past six months, including places and their geopolitical designation (subcounty/district), reasons for mobility, and detailed data on numbers of trips and average numbers of nights spent away from home on these trips, for both labor/livelihoods and other purposes. These data were used to establish a comprehensive set of metrics to characterize mobile populations and forms of mobility, including flows, types, and temporicity (numbers of circuits to and from households, by their duration and frequency)(Taylor and Bell, 2012).

Statistical analysis

Descriptive statistics were weighted by individual-level survey weights and chi-square tests of association and two sample t-tests (assuming unequal variances) were used to examine differences in mobility/migration by region, sex, and HIV status. Generalized linear models with a quasi-binomial family and survey weights were used to estimate relative risk of mobility metric by HIV status. All statistical analyses adjusted standard errors for clustering by community in the survey design. Data management and cleaning was performed using Stata version 14.2 (StataCorp, College Station, TX, USA), and analyses were conducted using the R software and survey packages (R Development Core Team, Vienna, Austria) (Lumley, 2004).

Ethical approval

Ethical approvals for this research were received from the University of California San Francisco Committee on Human Research (14-15058), Ethical Review Committee of the Kenya Medical Research Institute (KEMRI/SERU/CMR/3052), Makerere University School of Medicine Research and Ethics Committee (2015-040), and Uganda National Council for Science and Technology (HS 1834).

Role of the funding source

The funder of the study had no role in study design, data collection, analysis, or interpretation, or manuscript writing. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

Sample characteristics

The overall consent rate was 98.3% among those successfully contacted for data collection. The sample included 2,308 adults; 1,187 from western Kenya (51.4%), 544 from eastern Uganda (23.6%), and 577 from southwestern Uganda (25.0%) (Table 1). The weighted sample included 43.3% men and 56.7% women, with a mean age of 37.9 years; 23.4% were under age 25. HIV prevalence was 13.2% overall and varied widely across region – 20.9% in Kenya, 2.7% in eastern Uganda and 7.1% in southwestern Uganda ($p<0.001$). The majority (69.5%) was currently married. Women were more commonly divorced, separated, or widowed than men (24.7% versus 5.6%, $p<0.001$). The majority of individuals in these largely rural communities had completed primary or secondary levels of schooling (82.3%), and most (58.0%) worked exclusively in farming or with livestock as a livelihood; smaller proportions had other informal sector occupations as indicated in Table 1. Work in the fish trade was more common in Kenya (16.6%), while farming predominated in eastern Uganda (84.0%).

Typologies of recent migration, by region and sex

Ever having migrated as an adult was common (46.7%) among both men (49.5%) and women (44.5%), but varied widely by region (69.8% in western Kenya, 9.2% in eastern Uganda, 34.5% in southwestern Uganda, $p<0.001$) (Table 1). Most adult migration was internal (45.5% overall; 67.9% in western Kenya, 9.1% in eastern Uganda, 33.9% in southwestern Uganda). Migration in the previous five years also varied by region. Overall, 6.5% had migrated in the past year (8.7% in western Kenya, 2.6% in eastern Uganda, 7.7% in southwestern Uganda, $p<0.001$); 17.1% migrated in the past five years (24.6% in western Kenya, 1.6% in eastern Uganda, 16.6% in southwestern Uganda ($p<0.001$). Higher proportions of men than women undertook migration within the past year (8.5% versus 5.0%, $p=0.003$) and past five years (19.6% versus 14.9%, $p=0.010$). Sex differences in migration persisted across all geographic scales of migration except the most localized: a higher proportion of women (24.6%) than men (18.8%) undertook intra-county (Kenya) or sub-district (Uganda) moves as an adult ($p<0.001$)(Table 1). Median age was lower among mobile compared to non-mobile individuals using several metrics; for example, the median age was 23 among men and 25 among women among past year migrants, compared to a median age of 35 among non-migrants of both sexes ($p<0.001$).

Short-term mobility for labor-related and other reasons

Almost 9% of the community population regularly spent at least one night away from home for labor-related purposes in the last six months (5% in the last month). Men traveled more for labor-related reasons than women (17.2% versus 2.3%, respectively, $p<0.001$) and labor-related travel was more common in western Kenya (11.5%) and southwestern Uganda (10.2%) than in eastern Uganda (1.1%, $p=0.005$). Labor-related temporicity (number of trips for labor-related reasons, as well as number of nights away per trip) over the previous six months was greatest in southwestern Uganda (4.4 nights/person) and western Kenya (2.9 nights/person) compared to eastern Uganda (0.4 nights/person), $p=0.011$, and higher in men (5.0 nights/person) than women (0.9 nights/person) ($p=0.009$). Market-trading was the most

common reason to spend time away from home for work (44.8%), and predominated among women, followed by artisanal labor (21.7%) exclusively among men. Fishing was a more common reason to travel for work in western Kenya (23.7%) compared to the two regions in Uganda (~2%) and predominated among men.

Women, on the other hand, were more likely to report spending time away from home for non-labor-reasons, such as care-giving or seeking, attending a funeral, visiting family, holiday, or schooling. More than half of women (54%) reported spending at least one night away from home for non-labor-related reasons in the previous six months compared to 31% of men ($p<0.001$). Women also took more non-labor-related trips compared to men (2.2 trips per person compared to 1.4 trips per person, $p=0.006$) over the previous six months and spent almost double the amount of time away from home as men (5.8 nights versus 3.0 nights, respectively, $p=0.012$). The most common reason reported for spending time away from home for non-labor-related activities was attending a funeral (39.0% overall) followed by visiting family (33.7%). Funeral attendance over a six-month period was more common in western Kenya (48.7%) than eastern Uganda (21.9%) or southwestern Uganda (19.8%), $p<0.001$ and was more common among women (43.8%) compared to men (30.9%), $p=0.045$.

Mobility flows: origin-destination pairs

Figure 2 shows the magnitude of sex-specific short-term mobility (overall and stratified on labor versus non-labor mobility) by origin-destination pairs at the county/district level. In men, travel most commonly originated from Migori County, Kenya (5.2 trips per person), Mitooma District, Uganda (3.5 trips per person) and Homa Bay County, Kenya (2.4 trips per person). In women, travel most commonly originated in Migori County (2.9 trips per person), Homa Bay County (2.9 trips per person), and Bushenyi District, Uganda (1.4 trips per person). In southwest Uganda, Mitooma and Bushenyi Districts border one another, as do Migori and Homa Bay Counties in western Kenya. Although primarily rural, these areas contain corridors to regional capitals and bordering countries (Democratic Republic of the Congo, Rwanda, and Tanzania). In Uganda, Bushenyi sits on the major route to Mbarara, and neighboring Mitooma contains no major truck routes but draws traders and workers to its coffee, tea, and banana plantations. In Kenya, a major route through Migori connects north to the regional capital Kisumu (and onward to Eldoret) and south to Tanzania (Mwanza), and Homa Bay contributes the largest source of fish catch of all of the five Kenyan counties bordering Lake Victoria (Fisheries, 2016), and thus is an area with high circulation of fishermen and traders.

Short-term mobility occurred predominantly within counties or districts of origin. Overnight trips from Migori were mostly within that county (76% of male trips and 71% of female trips) or to neighboring Homa Bay (20% of male trips and 22% of female trips). Similarly, travel from Homa Bay occurred primarily within the county (84% of male trips and 77% of female trips), or to nearby Siaya (5% of male trips and 3% of female trips), Migori (3% of male trips and 5% of female trips), and Kisumu County, Kenya (3% of male trips and 6% of female trips). Travel from Mitooma was also primarily within the District (59% of male trips

and 47% of female trips) and to neighboring Bushenyi (21% of male trips and 25% of female trips).

Not all local travel requiring overnight stays was related to livelihoods, however, and this was especially true among women; work-related travel accounted for a smaller proportion of overall mobility for women compared to men. Women travelling from Homa Bay took the most work-related trips (average of 0.8 trips per person over a six-month period, reflecting women's participation in the fish trade), followed by women travelling from Bushenyi (0.2 trips per person over a six-month period), and Mitooma (0.06 trips per person). Very little work-related travel among women was reported from Migori and other counties/districts. Work-related travel among men was most common among those originating from Migori (4.9 trips per person, reflecting its rural conditions with fewer opportunities for livelihoods other than farming), followed by Mitooma (3 trips per person), and Homa Bay (1.6 trips per person).

Mobility and HIV status

Community-level measures of mobility, migration and HIV prevalence tended to correlate regionally. Kenyan communities had both the highest HIV prevalence and the greatest proportion of recent migrants and mobile individuals, followed by communities in southwestern Uganda, and eastern Uganda. First-order ecological associations between HIV prevalence and community-level mobility metrics were observed in both men and women (Figure 3). Communities with higher HIV prevalence in women (>10% female prevalence) tended to also have the greatest proportion of women reporting non-work-related mobility. In men, levels of both forms of mobility were highest in communities with the greatest male HIV prevalence. These associations appear to be driven by regional differences in mobility and HIV prevalence; whereby western Kenyan communities tend to have the highest levels of HIV prevalence and mobility followed by southwestern Uganda and eastern Uganda.

At an individual level, HIV negative men and women differed from HIV positive men and women, respectively, by metrics of mobility and socio-demographic characteristics (Table 2). Compared to HIV negative men, HIV positive men tended to be older, currently married and more likely to be fishermen. HIV positive women were also more likely to work in the fish trade (16%) compared to HIV negative women (6%), $p<0.001$. HIV negative women tended to have a lower level of educational attainment, but there was no difference in poverty levels between HIV positive and HIV negative men and women, respectively.

HIV positive men were almost twice as likely to report travel for work in the previous six months compared to HIV negative men (29% versus 16%, $p=0.005$). HIV positive men also reported spending more nights away in the previous 6 months, on average, than HIV negative men (mean=9.2 nights, SD=30.3 versus 4.6 nights, SD=19.5, $p=0.012$). Alhough we observed differences in the probability of having attended a funeral in the past six months by HIV status, with HIV positive women and men reporting more funeral attendance than HIV negative men and women, respectively, that result was explained entirely by higher funeral attendance and HIV prevalence in western Kenya. Differences in work-related mobility between HIV positive and HIV negative men were especially large (40% vs 20%) among men 25-34 years (Figure 4). HIV positive women were also more likely than HIV

negative women to report work-related mobility (5% versus 2%, p=0.004) and non-work-related mobility in the past 6 months (71% versus 51%, p=0.007). Similarly, HIV positive women tended to travel more for both work-related and non-work-related reasons than did HIV negative women, though differences were not significant.

In multivariable analysis the higher probability of work-related mobility (past 6 months) among HIV positive men and women, compared to HIV negative men and women, held in sex-stratified models adjusting for age and region, [aRR in men=1.65, 95% CI (1.07–2.55), aRR in women=2.32, 95% CI (1.27–4.22)] (Figure 5). The amount of time spent away from home was also associated with being HIV positive in men, adjusting for age and region. There was no evidence that recent migration was associated with HIV in either men or women in adjusted analyses (Figure 5).

Discussion

We conducted a population-based study of mobility across three regions of eastern Africa to characterize and quantify dimensionally complex, gendered forms of population movement within the context of differing HIV epidemics. Our results suggest overwhelming differences in the forms and magnitude of mobility across regions, by sex, and by HIV status. We found the largest magnitude of mobility in communities from western Kenya, followed by southwestern Uganda – regions with the greatest HIV burden. Short-term mobility occurred primarily within counties or districts of origin and was common among men for work-related reasons and among women for non-work-related reasons, such as caring for a family member, attending a funeral, or attending school. Men and women living with HIV tended to be more mobile and more likely to have recently migrated.

Our finding that mobility in rural communities bordering Lake Victoria in Kenya is higher than in rural communities in the two regions of Uganda reflects the diversity of structural drivers of mobility across the regions. Among the drivers of mobility in western Kenya are that livelihoods are more varied (beyond farming), that mobility is inherent to livelihoods in the wild catch fishing sector in the communities, that networks of roads for commerce and transport are more developed than in some of the areas in Uganda, and that these communities have been heavily burdened by high HIV prevalence for many years. These factors are inter-related: we (Camlin et al., 2013b) and other scholars (e.g. (Mojola, 2011)) have highlighted how labor market declines have converged with environmental deterioration to facilitate mobility as well as a sexual economy known as “sex-for-fish” in Kenya’s lakeshore communities, a key pathway through which mobility increases HIV risks in Kenya. This phenomenon is an example of what Cassels and colleagues have termed the ‘intrinsic risk pathway’, which posits that mobile persons are at higher risk of HIV due to any mechanism that independently causes both disease exposure and outcome (Cassels et al., 2014); i.e., the structural drivers of mobility in western Kenya influence both mobility and higher risk behavior (Camlin et al., 2014a). The pathway is also subject to reverse causation, as when HIV infection triggers marital dissolution (Anglewicz, 2012) or migration to seek medical care or family care-giving (Welaga et al., 2009). The ecological associations between community-level HIV prevalence and community-level prevalence of multiple

forms of mobility in men and women is likely the consequence of this bi-directional relationship.

The findings presented here highlight how better high-resolution mobility measures and methods can elucidate the complex dynamics of mobility in specific settings. First, the study adds new evidence that not only conventional measures of mobility, including measures of migration that typically capture longer-distance, permanent changes of residence, but also shorter-term, localized forms of mobility, are associated with prevalent HIV infection. A measure of mobility restricted to those who have undertaken permanent changes in residence over wide geopolitical boundaries (i.e. to those conventionally defined as international or even internal migrants), would 'miss' a large and disproportionately female proportion of the population with local mobility, which is significantly associated with prevalent HIV infection.

Beyond the associations between HIV and specific aspects of mobility, there is a synergy across the dimensions of mobility measured in this study, encompassing both spatial and temporal aspects of mobility as well as its underlying drivers. Data on the key origins and destinations of mobility in specific settings provide opportunities for selecting appropriate locations for HIV interventions; data on the characteristics of mobile populations (including livelihoods and sexual risk behaviors) provide opportunities for targeting interventions to the 'right' populations. Understanding the drivers of mobility— or more proximally, as we have done, measuring people's reported reasons for mobility — along with knowing *where* people are moving (origins and destinations), seasonality and patterns of circulation (temporality), and *who* these mobile people are (characteristics of mobile populations) provides the in-depth understanding of population mobility in specific settings that enables us to identify and appropriately target the full set of solutions that will be needed to end the epidemic.

Further, a key finding is that short-term mobility for purposes related to livelihoods (rather than reasons unrelated to labor) is highly associated with HIV infection, particularly for women. We had previously found in the study population that both longer-distance/ permanent, and localized/shorter-term forms of mobility were associated with higher-risk sexual behavior, and that these associations were more pronounced for women (Camlin et al., 2018a). We and others have found that women in this and similar settings who migrate or travel away from home communities for their livelihoods are (relative to their more residentially stable counterparts) more able to pursue opportunities for transactional sex in exchange for money, goods, transportation or housing to supplement their low, sporadic earnings (Camlin et al., 2013a; Camlin et al., 2014a; Desmond et al., 2005; Hunter, 2007). These findings suggest that economic interventions targeted to mobile women that are designed to expand their range of behavioral choices, i.e., to 'empower' them and reduce their financial pressures to engage in transactional sex, could bolster, in a sustained way, efforts to prevent ongoing transmission of HIV.

The relationship between population mobility and risk of HIV is highly complex. The goal of this analysis was not to establish a causal relationship between mobility and HIV risk; rather, it was to advance an understanding of the complex and highly gendered nature of

mobility and its association with HIV in eastern African settings. Few studies to date have been able to provide evidence of specific causal pathways linking mobility and HIV, which requires correctly assessing the timing of exposure and outcomes; the few longitudinal studies to date have been subject to high loss to follow up (Cassels et al., 2014). The cross-sectional nature of our data did not permit assessment of directionality of any individual-level associations between mobility and HIV status.

Notwithstanding this limitation, the present analysis fills a crucial gap, where previous studies on mobility in sub-Saharan African populations have not adequately characterized the full dimensions of migration and short-term mobility, and their occurrence over multiple temporal and geographic scales. Moreover, regardless of the mechanism, the higher level of mobility among HIV-infected individuals has major implications for the global HIV response. Higher levels of mobility in regions with greater burden of HIV presents a major challenge to the promise of test and treat. Despite high levels of mobility in SEARCH, its approach to community-based testing and treatment led to an increased proportion of HIV positive adults who achieved viral suppression, along with increased HIV diagnosis and initiation of antiretroviral therapy, exceeding the UNAIDS population-level viral suppression target within two years (Petersen et al., 2017). Yet the limited population-level effectiveness of test and treat strategies for decreasing HIV incidence in several trials to date suggest that population mobility may impede the ability of current models of ‘test and treat’ to find, test, and treat those most at risk of sustaining local transmission. Innovation is needed, including interventions, policies, and health systems improvements to maximize the engagement of mobile individuals in HIV care and prevention. These could include new models of differentiated service delivery to simplify and adapt HIV services to better meet the needs of mobile women and men living with HIV, and new therapeutic technologies that permit mobile individuals to visit clinics less often, including longer-acting formulations of ART and of Pre-Exposure Prophylaxis (PrEP)(Camlin et al., 2018b). Expanding the delivery of these technologies beyond clinic settings into communities and key destinations and transit hubs where mobile populations are found, and offering economic interventions to reduce financial pressures and facilitate individuals’ ability to prioritize health, could facilitate the full inclusion of mobile populations in the global effort to end HIV/AIDS.

The different forms of mobility among women and men revealed by sex-stratified analyses reflect the highly gendered nature of mobility and its drivers, whether related to gendered structure of labor markets and livelihood opportunities, to cultural practices, or to broader geopolitical and environmental forces. These gendered forms of mobility have helped to shape the current HIV epidemic, and must be understood in order to improve the coverage and effectiveness of strategies to address gaps in the HIV prevention and care continua.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- This study measured complex and dynamic forms of mobility in rural eastern Africa
- Migration and short-term, localized mobility associated with prevalent HIV infection
- Findings highlight value of ascertaining reasons for mobility, and sex-specific forms
- Mobility for livelihoods is particularly associated with HIV infection in women
- Understanding of mobility necessary to address gaps in HIV prevention and care continua

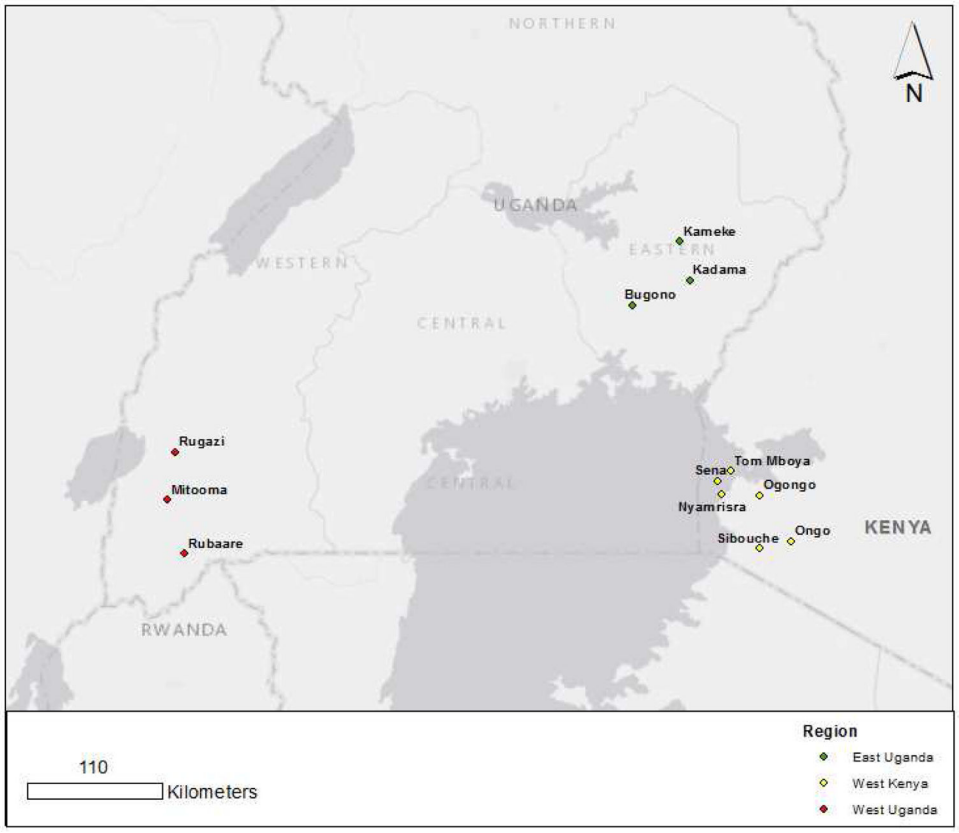

Figure 1. Map of the study communities in Kenya and Uganda

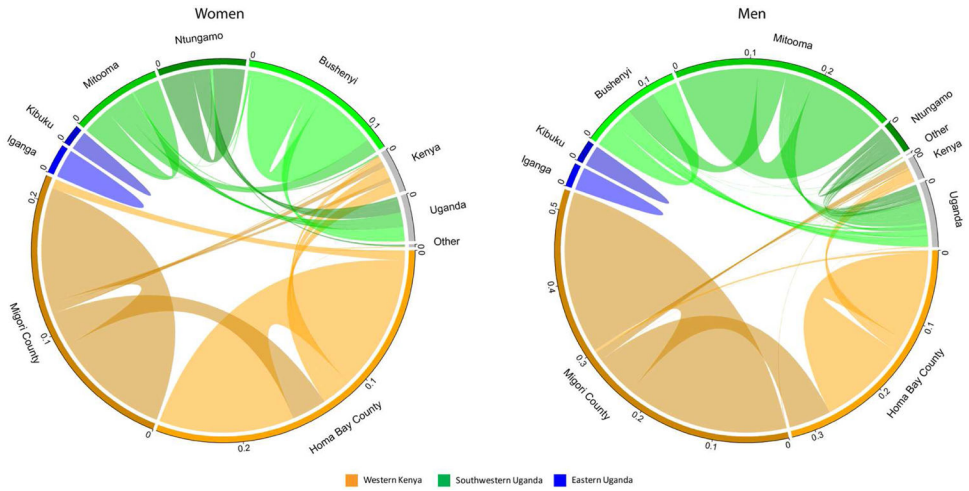

Figure 2. Magnitude of mobility flows: weighted number of overnight trips per person between origin-destination (county/district-level) pairs, by region and sex

notes: Origin-destination (county/district-level) pairs showing magnitude of mobility (labor and non-labor related trips requiring an overnight stay). Units are the weighted number of trips per person in the six-months prior to interview. Travel to non-study counties is represented at the country level. Origin counties grouped by western Kenya (orange), southwestern Uganda (green), and eastern Uganda (blue).

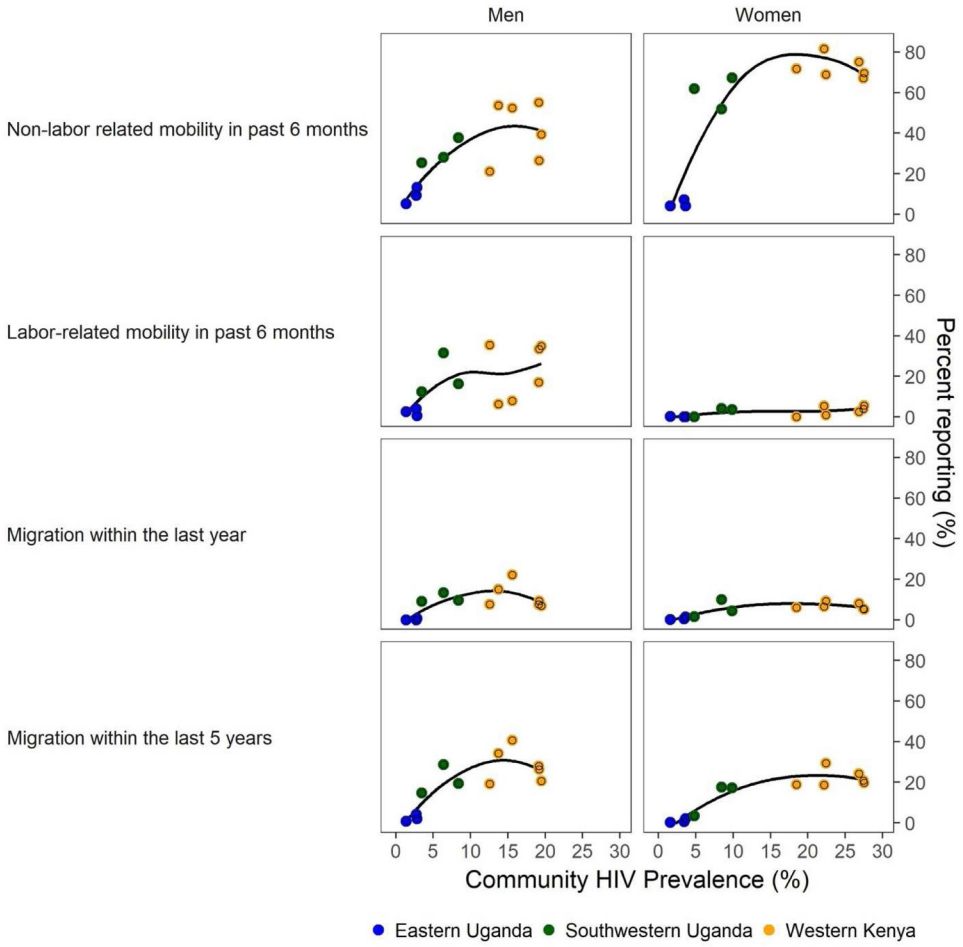

Figure 3. Ecological associations between community-level HIV prevalence and community-level prevalence of selected metrics of mobility

notes: Scatter plot showing ecological associations between community-level HIV prevalence and community-level prevalence of mobility (past six months) and migration (past one and five years) for men and women. Loess curves overlaid in black. All metrics adjusted for sampling design.

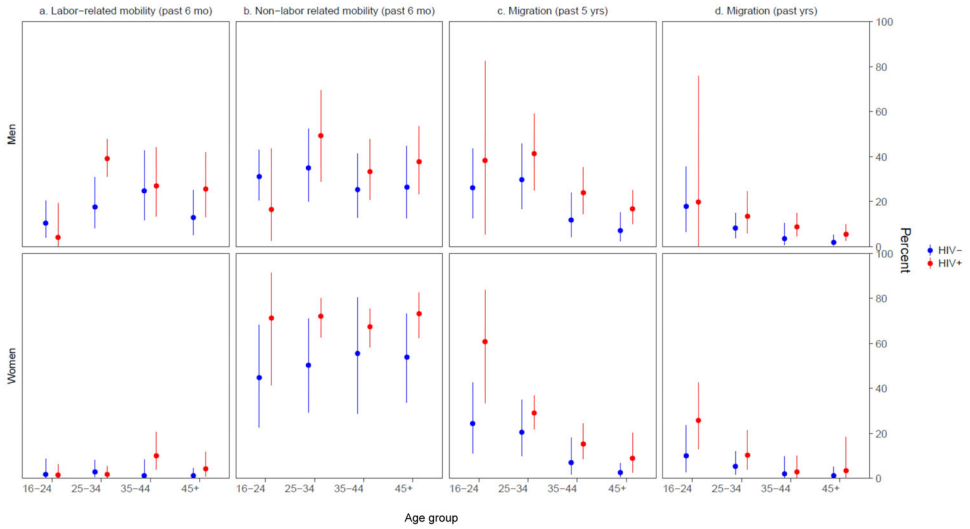

Figure 4. Proportions reporting mobility metrics by HIV status, age, and sex
notes: All metrics adjusted for sampling design.

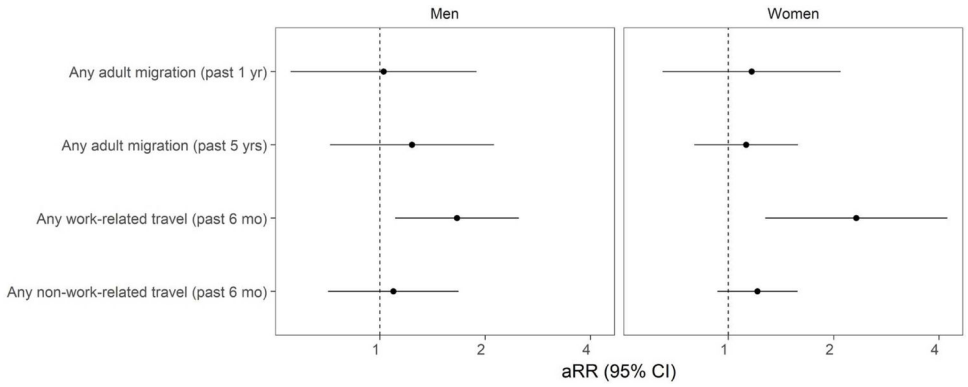

Figure 5. Adjusted relative risks (aRR) of associations between HIV status and mobility metrics by sex

notes: Adjusted relative risks (aRR) of associations between HIV status and mobility metrics among men and women, adjusted for age and region. Logarithmic aRR scale used. Standard errors are adjusted for clustering by community (N=12).

Table 1.

Population characteristics and mobility metrics by region and sex

	Full sample	Western Kenya	Eastern Uganda	South western Uganda	p value	Men	Women	p value
N / Weighted n	**2308**	**1187**	**544**	**577**		**998.8**	**1309.2**	
HIV prevalence (%)	304.2 (13.2)	248.3 (20.9)	14.8 (2.7)	41.1 (7.1)	<0.001	105.7 (10.6)	198.5 (15.2)	<0.001
Region (%)					NA			0.121
Western Kenya	1187.0 (51.4)	1187.0 (100.0)	0.0 (0.0)	0.0 (0.0)		509.5 (51.0)	677.5 (51.7)	
Eastern Uganda	544.0 (23.6)	0.0 (0.0)	544.0 (100.0)	0.0 (0.0)		244.0 (24.4)	300.0 (22.9)	
South western Uganda	577.0 (25.0)	0.0 (0.0)	0.0 (0.0)	577.0 (100.0)		245.3 (24.6)	331.7 (25.3)	
Age (Mean (SD))	37.87 (16.87)	38.71 (16.38)	34.80 (16.19)	39.03 (18.14)	0.011	37.61 (17.21)	38.06 (16.61)	0.615
10-year Age Band (%)					0.048			0.273
16-24	540.1 (23.4)	248.5 (20.9)	171.0 (31.4)	120.6 (20.9)		254.1 (25.4)	286.0 (21.8)	
25-34	639.6 (27.7)	328.1 (27.6)	143.0 (26.3)	168.5 (29.2)		262.2 (26.2)	377.4 (28.8)	
35-44	474.3 (20.6)	251.4 (21.2)	106.1 (19.5)	116.9 (20.3)		214.5 (21.5)	259.9 (19.8)	
45-54	254.5 (11.0)	129.4 (10.9)	62.9 (11.6)	62.3 (10.8)		94.7 (9.5)	159.8 (12.2)	
55-64	200.3 (8.7)	122.2 (10.3)	29.6 (5.4)	48.5 (8.4)		85.7 (8.6)	114.6 (8.8)	
65 and older	199.2 (8.6)	107.5 (9.1)	31.4 (5.8)	60.2 (10.4)		87.6 (8.8)	111.5 (8.5)	
Sex (Women (%))	1309.2 (56.7)	677.5 (57.1)	300.0 (55.1)	331.7 (57.5)	0.121	0.0 (0.0)	1309.2 (100.0)	<0.001
Marital Status (%)					0.193			<0.001
Divorced, Separated, Widowed, Missing	379.4 (16.4)	210.6 (17.7)	63.2 (11.6)	105.5 (18.3)		56.1 (5.6)	323.3 (24.7)	
Currently married	1604.4 (69.5)	827.0 (69.7)	389.1 (71.5)	388.3 (67.3)		757.3 (75.8)	847.1 (64.7)	
Currently single	324.2 (14.0)	149.4 (12.6)	91.7 (16.9)	83.1 (14.4)		185.4 (18.6)	138.8 (10.6)	
Education level					<0.001			<0.001
No Schooling	315.2 (13.7)	91.9 (7.8)	95.5 (17.7)	127.9 (22.2)		75.4 (7.6)	239.8 (18.4)	
Primary/Secondary	1890.4 (82.3)	1057.0 (89.6)	428.4 (79.2)	405.0 (70.2)		870.2 (87.8)	1020.2 (78.1)	
Post-secondary	91.5 (4.0)	30.5 (2.6)	16.9 (3.1)	44.1 (7.6)		45.1 (4.6)	46.5 (3.6)	
Household wealth: Poorest quantile (%)	331.8 (14.4)	122.6 (10.3)	100.2 (18.4)	109.0 (18.9)	0.007	163.1 (16.3)	168.8 (12.9)	0.13
Occupation (%)					0.246			<0.001
(Informal low risk)								
Farming/livestock (exclusively)	1338.4 (58.0)	549.4 (46.3)	457.1 (84.0)	331.8 (57.5)		538.5 (53.9)	799.9 (61.1)	

	Full sample	Western Kenya	Eastern Uganda	South western Uganda	p value	Men	Women	p value
Student	29.7 (1.3)	29.7 (2.5)	0.0 (0.0)	0.0 (0.0)		28.8 (2.9)	0.9 (0.1)	
Construction/artisanal labor	66.2 (2.9)	41.9 (3.5)	0.0 (0.0)	24.3 (4.2)		65.4 (6.6)	0.7 (0.1)	
Shopkeeper/market vendor	290.6 (12.6)	174.2 (14.7)	24.9 (4.6)	91.4 (15.8)		89.2 (8.9)	201.3 (15.4)	
Household worker/housewife	6.1 (0.3)	5.5 (0.5)	0.0 (0.0)	0.6 (0.1)		3.5 (0.4)	2.6 (0.2)	
Other/Missing	185.0 (8.0)	95.1 (8.0)	29.7 (5.5)	60.2 (10.4)		68.5 (6.9)	116.5 (8.9)	
(Formal)								
Government/military/teacher/healthcare	104.4 (4.5)	45.6 (3.8)	20.1 (3.7)	38.6 (6.7)		44.1 (4.4)	60.3 (4.6)	
Factory worker/mining	5.3 (0.2)	4.6 (0.4)	0.0 (0.0)	0.8 (0.1)		3.1 (0.3)	2.2 (0.2)	
(Informal high risk)								
Fishing/fish trade	201.0 (8.7)	196.5 (16.6)	3.1 (0.6)	1.4 (0.2)		99.3 (9.9)	101.7 (7.8)	
Hotel/restaurant/bar worker	38.5 (1.7)	13.7 (1.2)	9.0 (1.7)	15.8 (2.7)		17.5 (1.8)	21.0 (1.6)	
Transport driver/tourism	42.7 (1.9)	30.6 (2.6)	0.0 (0.0)	12.1 (2.1)		40.6 (4.1)	2.1 (0.2)	
Short-term mobility (travel to and from residences)								
Past 6 months mobility (>=1 nights away)								
Any labor-related travel, past 6 mo.(%)	201.7 (8.7)	136.8 (11.5)	5.9 (1.1)	59.0 (10.2)	0.005	171.7 (17.2)	30.1 (2.3)	<0.001
No. labor-related trips (mean (SD))	0.9 (8.4)	1.4 (11.2)	0.1 (1.1)	0.7 (4.6)	0.031	1.6 (11.3)	0.3 (5.1)	0.044
No. nights away, labor-related travel (mean (SD))	2.7 (15.4)	2.9 (15.9)	0.4 (5.9)	4.4 (19.7)	0.011	5.0 (20.9)	0.9 (8.8)	0.009
Any other travel, past 6 mo.(%)	1013.4 (43.9)	700.2 (59.0)	38.6 (7.1)	274.6 (47.6)	<0.001	307.5 (30.8)	705.9 (53.9)	0.001
No. non-work trips (mean (SD))	1.0 (1.9)	1.4 (2.3)	0.2 (0.7)	0.8 (1.5)	<0.001	0.58 (1.39)	1.2 (2.2)	0.006
No. nights away, non-work travel (mean (SD))	4.6 (13.4)	5.8 (13.2)	1.5 (9.2)	5.0 (16.4)	<0.001	3.0 (11.68)	5.8 (14.5)	0.012
Past 1 month: Recent mobility (>=1 nights away)								
Any labor-related travel, past 1 mo.(%)	112.8 (4.9)	80.4 (6.8)	5.9 (1.1)	26.5 (4.6)	0.013	95.2 (9.5)	17.7 (1.3)	<0.001
No. labor-related trips (mean (SD))	0.2 (1.5)	0.3 (2.0)	0.0 (0.3)	0.1 (0.8)	0.042	0.3 (2.1)	0.01 (0.8)	0.036
No. nights away, labor-related travel (mean (SD))	0.4 (2.9)	0.5 (3.1)	0.1 (1.3)	0.6 (3.3)	0.02	0.9 (4.0)	0.1 (1.5)	0.02
Any other travel, past 1 mo.(%)	483.5 (20.9)	299.1 (25.2)	38.5 (7.1)	145.9 (25.3)	<0.001	146.4 (14.7)	337.1 (25.7)	0.002
No. non-work trips (mean (SD))	0.3 (0.6)	0.3 (0.7)	0.1 (0.5)	0.3 (0.56)	<0.001	0.2 (0.5)	0.3 (0.7)	0.032
No. nights away, non-work travel (mean (SD))	1.0 (3.5)	1.1 (3.5)	0.6 (3.2)	1.1 (3.9)	0.054	0.9 (3.8)	1.0 (3.3)	0.625
Reasons for travelling (among those reporting travel)								
Most common reason for labor-related travel (%)					0.006			0.123
Artisanal labor (e.g. construction)	28.9 (21.7)	21.4 (26.0)	1.0 (16.9)	6.5 (14.5)		28.9 (28.0)	0.0 (0.0)	

	Full sample	Western Kenya	Eastern Uganda	South western Uganda	p value	Men	Women	p value
Farming (own plot or others' plots)	11.2 (8.4)	3.2 (3.9)	0.2 (4.2)	7.7 (17.2)		8.8 (8.5)	2.4 (8.1)	
Fishing	20.6 (15.5)	19.5 (23.7)	0.1 (1.8)	1.0 (2.2)		18.3 (17.7)	2.3 (7.6)	
Looking for work	12.8 (9.6)	2.8 (3.4)	3.2 (54.2)	6.8 (15.1)		5.7 (5.5)	7.1 (23.7)	
Market trading (including buying stock to sell)	59.6 (44.8)	35.4 (43.0)	1.4 (22.9)	22.9 (51.0)		41.6 (40.3)	18.0 (60.6)	
Most common reason for non-work travel (%)					<0.001			0.045
Care-giving / Care-seeking	105.1 (10.4)	50.1 (7.2)	13.9 (35.9)	41.1 (15.0)		38.0 (12.3)	67.1 (9.5)	
Funeral	404.2 (39.8)	341.5 (48.7)	8.5 (21.9)	54.2 (19.8)		95.3 (30.9)	308.9 (43.8)	
Holiday / Visiting family	339.3 (33.5)	187.4 (26.7)	4.6 (11.9)	147.3 (53.6)		120.1 (38.9)	219.2 (31.1)	
Other	137.7 (13.6)	108.6 (15.5)	6.8 (17.5)	22.4 (8.1)		38.0 (12.3)	99.7 (14.1)	
Schooling	28.1 (2.8)	13.5 (1.9)	4.9 (12.8)	9.6 (3.5)		17.0 (5.5)	11.0 (1.6)	
Any funeral attendance in past six months	485.0 (21.0)	418.3 (35.2)	8.5 (1.6)	58.3 (10.1)	<0.001	117.8 (11.8)	367.2 (28.1)	<0.001
Migration (permanent changes of residence over geopolitical boundaries)								
Any adult migration	1077.6 (46.7)	828.5 (69.8)	49.8 (9.2)	199.3 (34.5)	<0.001	495.3 (49.6)	582.3 (44.5)	0.259
Any adult internal migration	1051.2 (45.5)	805.7 (67.9)	49.8 (9.1)	195.8 (33.9)	<0.001	473.7 (47.4)	577.5 (44.1)	0.496
Intra-District/Sub-county	509.8 (22.1)	507.2 (42.7)	0.2 (0.0)	2.4 (0.4)	<0.001	188.2 (18.8)	321.6 (24.6)	<0.001
Inter-District/Sub-county	803.7 (34.8)	559.2 (47.1)	49.7 (9.1)	194.8 (33.8)	<0.001	419.3 (42.0)	384.5 (29.4)	0.003
Past 5 years: Any migration	395.3 (17.1)	291.2 (24.5)	8.5 (1.6)	95.6 (16.6)	<0.001	200.3 (20.0)	195.0 (14.9)	0.005
Past 5 years: Any internal migration	390.8 (16.9)	289.4 (24.4)	8.5 (1.6)	93.0 (16.1)	<0.001	195.8 (19.6)	195.0 (14.9)	0.010
5-year Intra-District/Sub-county	197.9 (8.6)	196.8 (16.6)	0.0 (0.0)	1.1 (0.2)	0.043	78.7 (7.9)	119.2 (9.1)	0.211
5-year Inter-District/Sub-county	232.9 (10.1)	132.4 (11.2)	8.5 (1.6)	92.0 (15.9)	<0.001	142.2 (14.2)	90.7 (6.9)	0.002
Past 1 year: Any migration	150.4 (6.5)	103.5 (8.7)	2.6 (0.5)	44.4 (7.7)	0.001	84.5 (8.5)	66.0 (5.0)	0.003
Past 1 year: Any internal migration	147.0 (6.4)	103.5 (8.7)	2.6 (0.5)	40.9 (7.1)	<0.001	81.0 (8.1)	66.0 (5.0)	0.008
Past year Intra-District/Sub-county	68.7 (3.0)	67.7 (5.7)	0.0 (0.0)	1.0 (0.2)	0.090	27.8 (2.8)	40.9 (3.1)	0.644
Past year Inter-District/Sub-county	80.3 (3.5)	37.8 (3.2)	2.6 (0.5)	40.0 (6.9)	<0.001	54.7 (5.5)	25.6 (2.0)	0.015

Notes: All metrics adjusted for sampling design.

Table 2.

Population characteristics and mobility metrics by sex and HIV serostatus

Characteristic	Women			Men		
	HIV−	HIV+	p value	HIV−	HIV+	p value
Weighted n	**1110.7**	**198.5**		**893.1**	**105.7**	
Region (%)			<0.001			<0.001
Western Kenya	514.1 (46.3)	163.4 (82.3)		424.6 (47.5)	84.9 (80.3)	
Eastern Uganda	291.0 (26.2)	9.0 (4.5)		238.2 (26.7)	5.8 (5.5)	
South western Uganda	305.5 (27.5)	26.2 (13.2)		230.3 (25.8)	14.9 (14.1)	
Age (Mean (SD))	38.0 (17.3)	38.6 (11.9)	0.550	35.0 (5.7)	34.8 (7.3)	0.011
10-year Age Band (%)			<0.001			<0.001
16-24	272.0 (24.5)	13.9 (7.0)		251.2 (28.1)	2.9 (2.8)	
25-34	308.3 (27.8)	69.2 (34.8)		233.3 (26.1)	28.9 (27.3)	
35-44	193.3 (17.4)	66.6 (33.6)		177.7 (19.9)	36.7 (34.8)	
45-54	134.8 (12.1)	25.0 (12.6)		75.5 (8.4)	19.3 (18.2)	
55-64	98.7 (8.9)	15.9 (8.0)		71.9 (8.0)	13.9 (13.1)	
65 and older	103.7 (9.3)	7.9 (4.0)		83.6 (9.4)	4.0 (3.8)	
Marital Status (%)			0.001			<0.001
Divorced, Separated, Widowed, Missing	247.5 (22.3)	75.7 (38.1)		50.5 (5.7)	5.6 (5.3)	
Currently married	732.5 (66.0)	114.6 (57.8)		659.6 (73.9)	97.7 (92.4)	
Currently single	130.6 (11.8)	8.1 (4.1)		183.0 (20.5)	2.4 (2.3)	
Education level			0.033			0.380
No Schooling	217.6 (19.6)	22.2 (11.2)		69.7 (7.9)	5.7 (5.4)	
Primary/Secondary	849.5 (76.6)	170.7 (86.4)		775.2 (87.6)	94.9 (90.1)	
Post-secondary	41.7 (3.8)	4.7 (2.4)		40.3 (4.6)	4.8 (4.5)	
Household wealth: Poorest quantile (%)	145.9 (13.1)	22.8 (11.5)	0.617	145.5 (16.3)	17.5 (16.6)	0.932
Occupation (%)			<0.001			<0.001
(Informal low risk)						
Farming/livestock (exclusively)	706.4 (63.6)	93.5 (47.1)		489.4 (54.8)	49.1 (46.5)	
Student	0.0 (0.0)	0.9 (0.4)		28.8 (3.2)	0.1 (0.1)	
Construction/artisanal labor	0.0 (0.0)	0.7 (0.4)		59.2 (6.6)	6.2 (5.9)	
Shopkeeper/market vendor	156.0 (14.0)	45.3 (22.8)		84.2 (9.4)	5.0 (4.8)	
Household worker/housewife	0.4 (0.0)	2.1 (1.1)		2.3 (0.3)	1.2 (1.2)	
Other/Missing	109.1 (9.8)	7.4 (3.7)		64.6 (7.2)	3.9 (3.7)	
(Formal)						
Government/military/teacher/healthcare	50.2 (4.5)	10.1 (5.1)		39.2 (4.4)	4.9 (4.7)	
Factory worker/mining	1.5 (0.1)	0.7 (0.4)		0.8 (0.1)	2.3 (2.2)	
(Informal high risk)						
Fishing/fish trade	69.5 (6.3)	32.2 (16.2)		72.0 (8.1)	27.2 (25.8)	
Hotel/restaurant/bar worker	17.5 (1.6)	3.5 (1.8)		16.3 (1.8)	1.2 (1.1)	
Transport driver/tourism	0.0 (0.0)	2.1 (1.0)		36.2 (4.1)	4.4 (4.2)	
Short-term mobility (travel to and from residences)						

Characteristic	Women			Men		
	HIV−	HIV+	p value	HIV−	HIV+	p value
Past 6 months mobility (>=1 nights away)						
Any labor-related travel, past 6 mo.(%)	19.9 (1.8)	10.2 (5.1)	0.004	141.3 (15.8)	30.4 (28.8)	0.003
No. labor-related trips (mean (SD))	0.2 (4.3)	0.9 (8.4)	0.068	1.4 (10.3)	3.3 (17.3)	0.065
No. nights away, labor-related travel (mean (SD))	0.6 (7.2)	2.3 (14.8)	0.069	4.6 (19.5)	9.1 (30.1)	0.012
Any other travel, past 6 mo.(%)	565.6 (50.9)	140.3 (70.7)	0.006	266.2 (29.8)	41.3 (39.1)	0.091
No. non-work trips (mean (SD))	1.2 (2.1)	1.7 (2.5)	0.059	0.6 (1.4)	0.7 (1.5)	0.199
No. nights away, non-work travel (mean (SD))	5.6 (14.4)	7.1 (14.9)	0.138	3.1 (12.1)	2.0 (7.0)	0.173
Past 1 month mobility (>=1 nights away)						
Any labor-related travel, past 1 mo.(%)	11.6 (1.0)	6.1 (3.1)	0.020	77.9 (8.7)	17.3 (16.4)	0.039
No. labor-related trips (mean (SD))	0.0 (0.7)	0.1 (1.2)	0.044	0.3 (1.9)	0.7 (3.5)	0.027
No. nights away, labor-related travel (mean (SD))	0.1 (0.9)	0.4 (3.1)	0.060	0.8 (3.7)	1.4 (5.5)	0.007
Any other travel, past 1 mo.(%)	277.2 (25.0)	59.9 (30.2)	0.230	126.3 (14.1)	20.1 (19.0)	0.069
No. non-work trips (mean (SD))	0.3 (0.6)	0.4 (0.8)	0.102	0.2 (0.5)	0.3 (0.6)	0.224
No. nights away, non-work travel (mean (SD))	1.0 (3.4)	1.0 (2.7)	0.918	0.9 (4.0)	0.6 (2.3)	0.061
Reasons for travel (among those reporting travel)						
Most common reason for labor-related travel (%)			0.176			0.014
Artisanal labor (e.g. construction)	0 (0.0)	0 (0.0)		25.3 (29.0)	3.6 (22.2)	
Farming (own plot or others' plots)	0.9 (4.6)	1.5 (15.1)		5.4 (6.2)	3.4 (20.8)	
Fishing	0.8 (4.1)	1.5 (14.8)		13.6 (15.6)	4.7 (29.1)	
Looking for work	6.1 (30.5)	1.0 (9.9)		5.6 (6.4)	0.1 (0.7)	
Market trading (including buying stock to sell)	12.1 (60.8)	5.9 (60.2)		37.2 (42.7)	4.4 (27.2)	
Most common reason for non-work travel (%)			0.234			0.189
Care-giving / Care-seeking	49.6 (8.8)	17.5 (12.5)		35.2 (13.2)	2.7 (6.6)	
Funeral	242.2 (42.8)	66.7 (47.5)		77.8 (29.1)	17.5 (42.3)	
Holiday / Visiting family	181.3 (32.1)	37.9 (27.0)		108.2 (40.5)	12.0 (29.0)	
Other	81.7 (14.4)	18.0 (12.8)		30.2 (11.3)	7.8 (18.9)	
Schooling	10.7 (1.9)	0.3 (0.2)		15.6 (5.9)	1.4 (3.3)	
Any funeral attendance in past six months	287.0 (25.8)	80.3 (40.4)	0.023	97.6 (10.9)	20.2 (19.1)	0.023
Migration (permanent changes of residence over geopolitical boundaries)						
Any adult migration	442.5 (39.8)	139.8 (70.4)	<0.001	414.7 (46.4)	80.6 (76.3)	<0.001
Any adult internal migration	438.4 (39.5)	139.1 (70.1)	<0.001	395.6 (44.3)	78.2 (74.0)	<0.001
Intra-District/Sub-county	228.1 (20.5)	93.5 (47.1)	0.001	151.0 (16.9)	37.2 (35.2)	0.004
Inter-District/Sub-county	295.2 (26.6)	89.3 (45.0)	0.005	353.8 (39.6)	65.5 (62.0)	0.001
Past 5 years: Any migration	152.0 (13.7)	43.0 (21.7)	0.038	172.5 (19.3)	27.7 (26.3)	0.198
Past 5 years: Any internal migration	152.0 (13.7)	43.0 (21.7)	0.038	169.7 (19.0)	26.1 (24.7)	0.250
5-year Intra-District/Sub-county	88.4 (8.0)	30.8 (15.5)	0.039	66.8 (7.5)	11.8 (11.2)	0.334
5-year Inter-District/Sub-county	74.1 (6.7)	16.6 (8.4)	0.483	124.6 (14.0)	17.6 (16.6)	0.469
Past 1 year: Any migration	51.7 (4.7)	14.3 (7.2)	0.190	74.8 (8.4)	9.6 (9.1)	0.780
Past 1 year: Any internal migration	51.7 (4.7)	14.3 (7.2)	0.190	71.6 (8.0)	9.4 (8.9)	0.756
Past year Intra-District/Sub-county	29.7 (2.7)	11.2 (5.6)	0.086	22.8 (2.6)	5.1 (4.8)	0.230

Characteristic	Women			Men		
	HIV−	HIV+	p value	HIV−	HIV+	p value
Past year Inter-District/Sub-county	22.4 (2.0)	3.1 (1.6)	0.672	50.0 (5.6)	4.7 (4.4)	0.549

Notes: All metrics adjusted for sampling design.