**Title: HIV on the move: Gender differences in migration and HIV risk in South Africa**

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***Background.*** The role of migration in the spread of HIV/AIDS in South Africa is well-documented: infections in rural areas have been traced to those who had been in urban areas (Jochelson et al., 1991), and infection rates are higher along roads (Tanser et al., 2000). South Africa's migrant labor system has long been recognized (e.g. Kark, 1949) to produce social conditions that facilitate the spread of sexually transmitted disease. A cornerstone of colonial and apartheid-era economies (Feinstein, 2005), the system imposed a high level of mobility on the African population. Contrary to expectations that once apartheid restrictions were lifted migration would subside, both men's and women's mobility increased in the 1990s (Posel & Casale, 2003). However, previous research on the role of migration in the spread of HIV/AIDS in South Africa has almost exclusively focused on the patterns of male circular labor migration (e.g. Lurie et al., 2003), finding migration to be a risk factor for men and their non-migrant female partners. Few studies have interrogated the assumption that migration is predominantly circular, or examined the contribution of women's migration to HIV. Yet, recent studies suggest that women are more mobile than men, though their patterns are different: they migrate over shorter distances to several destinations (Collinson et al., 2003; Hunter, 2006). The first studies to depart from paradigms established in earlier research find migration to be a risk factor for HIV among women (Kishamawe et al., 2006; Zuma et al., 2003). To our knowledge, this study is the first to examine the degree to which the large sex differentials in HIV risk in South Africa are accounted for by differences in men's and women's patterns of migration.

***Objectives.*** The overall aims of this study were:1) to establish whether gender differences in patterns of migration in South Africa partially account for sex differences in HIV infection rates; and, if so, 2) to identify the causal mechanisms by which migration patterns explain men's and women's differential risks of HIV infection in the nation. As a first step, this paper examines whether utilizing detailed measures of mobility, rather than the standard demographic measure of migration as a permanent and long-distance change in residence, reveals gender differences in patterns of mobility and migration; and it examines whether the gender composition of migrants accounts in part for the different HIV infection risks associated with migration for men and women.

***Methods***. This study used data from a demographic surveillance system (DSS) site located in Umkanyakude District, a predominantly rural area of KwaZulu-Natal (KZN), about two hours north of the provincial capital of Durban. The research institution, the Africa Centre for Health and Population Studies, has since 2000 collected detailed demographic, social and behavioral data in a population of over 80,000 individuals (including approximately 50,000 adults). In 2003, the Africa Center launched an HIV surveillance project in the population, enabling the annual collection of HIV serological data for all participating adults, and the linking of these with other individual level data. Data analyses were carried out in stages. Chi-squared tests of independence were used to examine associations between measures of various population characteristics and prevalent HIV infection. Multiple logit regression and ordered logit models were used to identify gender differences in patterns of migration (to determine whether the migration-associated HIV risk for men and women is in part due to the sex composition of migrants). [Please note: Prior to PAA 2007 final deadlines, further analyses will be undertaken to identify the covariates of participation in HIV testing, in order to adjust for selection bias in HIV test participation—on the basis of known covariates— with the use of propensity score weighting methods. Data will also be adjusted for non-resident sampling effects. Further

multiple logistic regression modeling will also be undertaken, incorporating sexual behavior measures and migration-gender interaction terms, to complete objective 2) to identify the causal mechanisms by which migration patterns explain men's and women's differential risks of HIV infection.]

***Results.*** *Study population.* All resident members of households as of June 1, 2003 and a 12.5% random sample of non-resident household members, females aged 15-49 and males aged 15-54, were eligible for HIV testing. Eligibility rules and non-resident sampling yielded an eligible population of 33,500 individuals. Upon validation, 567 individuals were found to have died before the intended HIV testing visit, 263 were found to be younger than 15 or to have aged out of the cohort, and 2,591 were deemed to be "lost to follow up" (no data had been collected for these individuals in over one year before June 2003.) After these exclusions, the number of individuals found to be truly eligible was 30,179, of whom 28,647 were resident and 1,550 were non-resident at the date of eligibility list creation; 70.6% of these individuals were contacted by a fieldworker, and over 53% (12,406) of those contacted agreed to participate in HIV testing.

*HIV prevalence and socio-demographic characteristics*. The burden of HIV infection in this population is disproportionately borne by women, in whom prevalence was 27.7% vs. 14.3% among men. HIV prevalence was highest among those living in peri-urban (29.6%) followed by urban areas (27.0%), in contrast to relatively lower prevalence (18.6%) in rural areas. Prevalence peaked at 41.0% among adults aged 30-39; by sex, prevalence peaked at 51.7% among women aged 25-29 and 43.4% among men aged 30-34. A large majority (75.1%) was never married and is not "engaged to be married". The process of marriage is lengthy in KZN, and a relatively large proportion of those unmarried – 7.5% – indicate they are engaged; prevalence of HIV has highest in this marital status category (31.2%). Most individuals (46.3%) are, however, in a stable, regular partnership: the partnership category highest in HIV prevalence (35.7%). Reflecting South Africa's relatively advanced literacy level, the largest proportion of individuals had completed at least some secondary education (33.9%), followed by almost all or all of secondary education (27.8%). Involvement in secondary education is prolonged, in a local context of high unemployment: some 53.6% reported they were currently in full-time study, virtually all in secondary education (n=8,164, of 15,228; 91% of whom were under age 25). The data demonstrate high poverty conditions for households in the surveillance area, as described elsewhere (e.g. Case & Ardington, 2004.). Unemployment is high, and only 34.8% of individuals do anything to earn money.

*HIV prevalence and patterns of mobility and migration.* Various measures of mobility and migration, from the global and general to more recent movement patterns, were consistently associated with prevalent HIV infection in chi-squared tests of independence. Rates of infection were some 7 to 10 percentage points higher among more mobile than among less mobile individuals. Most (58.7%) were quite stable, in that they had never changed their household residence since the start of the DSS (January 2000); HIV prevalence was 18.9% in this group compared to a prevalence of 28.7% among individuals who had ever been a migrant (41.3%). HIV prevalence is highest (34.4%) among those who have moved in and out (or out and in) of the area in the past two years, relative to those who only in-migrated (28.4% HIV-positive), only out-migrated (27.9%), migrated only internally (26.9%), and did not move at all in the past 2 years (20.7%). The pattern of presence in the household (which is used to classify individuals as resident and non-resident household members) suggests a quasi-linear relationship between the degree of mobility and prevalent infection: the more absent from the household, the higher the level of HIV infection. For example, HIV infection is 21.7% among those who are present most or all nights compared to 36.1% among those who spend at least some time away from the home; in the past 4 months prior to the HIV test visit, prevalence ranged from 18.7% among those who had

spent every night at home, to 36.8% among those who spent few or no nights in the household.

*Patterns of migration and mobility and HIV status by gender.* While it is commonly assumed that migrants tend to be male, in this population of men and women who participated in HIV testing, patterns of migration were strikingly similar: 35.2% of women and 32.5% of men had changed their residence at least once since January 2000; since that time, 17.5% of women and 17.1% of men had in-migrated from outside the DSA, and 8.3% of women and 8.4% of men had migrated out of the area, at least once.[1] Moreoever, a greater proportion of women (16.7%) than men (13.0%) had internally migrated at least once since January 2000. However, a significantly greater percentage of men (4.0%) than women (3.2%) had been classified as non-resident household members as of June 1, 2003, and a greater percentage of men than women (4.5% vs. 3.4%, respectively) were generally not present on most or all nights in the household of which they were a member in the DSA.

In the two years prior to the HIV test date, women appeared to be as likely as men (9.5%) to have in-migrated, and were almost as likely as men (5.6% vs. 5.7%) to have out-migrated, at least once. Again, a larger proportion of women than men had internally migrated (9.0 vs. 7.1%, respectively.) A slightly smaller percentage of women than men (86.3% vs. 88.4%, respectively) had been present in the household on the night before the HIV test visit. HIV prevalence among men and women increased in tandem with their degree of recent mobility: a measure of the past four-month household presence pattern shows that rates of HIV infection increased with the number of nights an individual spent outside of the home, for both men and women.

For further modeling of gender differences in the HIV risk attributed to migration, we first empirically test whether there are gender differences in patterns of migration, and if so, where those differences lie. We carried out logistic regression modeling of gender and age (independent variables), on various dichotomous measures of migration and mobility (dependent variables), and also derived ordered logit estimates of past four-month presence patterns by gender (with and without integer-scored age as a control measure). From the ordered logit model we derived the predicted probabilities of each mobility pattern for each gender. All models were run on the total eligible population, not restricted to those who participated in HIV testing. From these analyses, males had 13% lower age-adjusted odds than females (0R=0.87) of having ever been a migrant, and 32% lower odds of have ever internally migrated (OR=0.68, and OR=0.73 for any internal migration in the past two years.) There were no statistically significant differences in the age-adjusted odds of in-migration for males and females, but males had 11-12% higher odds of out-migrating relative to females (OR=1.11, and OR=1.12 for past 2-year out-migration.) Males had almost 30% higher odds of being *not present* in the household most or all nights (OR=1.27) in general, but had 11% higher odds of being *present* on the night before the visit (OR=1.11). The ordered logit modeling showed that past four-month household presence pattern does significantly vary by gender (at $p = 0.034$), however, when age is added to the model the probability approaches marginal insignificance ($p = 0.048$); indeed the predicted age-adjusted probabilities show similar probabilities of having been in the household every night or most nights, while females were slightly more likely than males (5.1% vs. 5.1%, respectively) to be away approximately half of those nights and also to be away on most or all nights in the past four months (4.9% vs. 4.7% respectively.)

[1] Note: as these analyses use the population who participated in testing, and thus remained household members as of June 2003, this measure does not capture overall out-migration since the start of the DSS. Rather, it captures out-migration among those who remain members of households within the DSA, and thus were eligible to participate in testing. Men were more likely to out-migrate overall, but women who out-migrate were proportionately more likely than male out-migrants to remain a member of a household within the DSA; this presents a (female) sex-selection bias in any measures of association between out-migration and prevalent HIV infection.

When the same analyses were carried out on the population who participated in testing, effect sizes, levels of significance and direction of association are overall very similar to the findings described above, with the exception of one measure: (ever or recent) out-migration. Gender differences in rates of out-migration disappear when the population is restricted to those who have participated in HIV testing. The findings show that despite the fact that males were more likely than females to out-migrate, female out-migrants were more likely than male out-migrants to have participated in HIV testing. They may have been more likely than males to have in-migrated again to the DSA following an out-migration, to have been captured in the random sample of non-residents, or to have been more easily contacted as a non-resident sample member. They are over-represented in the category of out-migrants, thus, we can expect that the effect of out-migration on HIV risk would contain a female-gender bias.

These analyses set the stage for the further set of analyses of gender differences in the effect of migration on HIV risk. From these findings we may conclude that females were much more likely than males to have internally migrated, thus by our definition to have ever been a migrant. Males and females were equally likely to have in-migrated, but males were more likely than females to have out-migrated. When the data are restricted to testers, however, males and females appear equally likely to have out-migrated. More recent measures appear to better capture women's patterns of movement: women were less likely to have been in the home on the night prior to the visit, and had a higher probability than men did of having been away from the home for about half of the time or more in the past four months prior to the visit. Thus, in subsequent analyses, the degree to which gender differences are seen in the effect of migration on risk of HIV will in part be due to the gender composition of certain categories of individuals: 'ever migrants', 'internal migrants', and the 'recently mobile'. Any gender differences seen in the effect of migration on risk of HIV using measures of in- and out- (or, long-distance) migration will not be due to the gender composition of these categories of migrants (with the caveat that measures of out-migration are biased towards a 'female' gender effect.) Further analyses will quantify the gender-composition effects for ever migrants, internal migrants, and recently mobile individuals, and we anticipate no compositional effects for in- and out- (or long-distance) migrants. Additional data, including measures of sexual behavior, will be utilized in subsequent logistic regression modelling to ascertain whether behavioral differences between men and women vary by their patterns of mobility. Ultimately, we will test the hypotheses that, net of compositional effects, migration confers a greater risk to women than to men, and that the behavioral consequences of the decision to migrate vary by gender (i.e. that female migrants may be disproportionately more likely than male migrants to engage in higher risk sexual behavior).

*Conclusions.* The findings of this study underscore the high rates of migration and mobility- among women as well as men- in a primarily rural area of South Africa. Detailed measures of mobility, rather than standard definitions of migration as long-distant and permanent, reveal gender differences and highlight the associations between mobility and heightened HIV risk among women. The study also highlights the vulnerability of South Africa's migrant populations, particularly female migrants, to HIV infection.

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