Mobility and Circular Migration in Lesotho: Implications for Transmission, Treatment, and Control of a Severe HIV Epidemic

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Abstract: We analyzed georeferenced data on mobility and HIV infection from the 2009 Demographic and Health Survey of Lesotho. We found ~50% of the population traveled in the preceding year. By constructing gender-specific mobility maps, we discovered that travel is highest in the urban areas bordering South Africa and in the mountainous interior of the country. For both genders, increased mobility was associated with increased levels of "recent" sexual behavior. Notably, mobility was only associated with an increased risk of HIV infection for men who traveled frequently. We discuss the implications of our results for designing effective treatment programs and HIV interventions.

Key Words: HIV, Lesotho, mobility, Africa, epidemiology, migration

(*J Acquir Immune Defic Syndr* 2015;68:604–608)

INTRODUCTION

Studies in Kenya, Tanzania, Burkina Faso, Zimbabwe, South Africa, and Cameroon have shown an association between increased mobility and increased levels of sexual behavior,[1–3] increased risk of HIV infection,[4,5] or both.[6–10] These studies indicate population mobility may have a significant effect on HIV transmission in these countries. Moreover, a recent study has shown the importance of travel in the early spread of the HIV epidemic in Sub-Saharan Africa.[11] Notably, the potential impact of mobility on HIV transmission in countries where the HIV prevalence is extremely high has not yet been investigated. Here, we assess the potential impact of mobility on the high-prevalence HIV epidemic in Lesotho, where 27% of women and 18% of men are infected with HIV.[12] In Lesotho, there is a high level of circular migration as many men and women have to travel for employment. Some travel within the country to work in agriculture and the textile industry,[13] and others travel between Lesotho and South Africa for employment as domestic and mine workers.[13,14] To evaluate the impact of mobility, we analyzed linked demographic, behavioral, and HIV infection data from the 2009 Demographic and Health Survey (DHS) of Lesotho.[15] We analyzed the DHS data to (1) quantitatively assess the mobility of the population, (2) identify the demographic and behavioral characteristics of individuals who travel, (3) determine whether there are geographic patterns in mobility, and (4) determine whether there is an association between mobility and increased levels of sexual behavior and/or risk of HIV infection.

Many of the previous epidemiological studies investigating the effect of mobility and migration on HIV epidemics have been based on small sample sizes and/or used poorly designed questionnaires to collect data on risk behaviors.[9,16,17] In contrast, in this study, we analyzed data collected from ~45,000 individuals living in ~9000 households. It has been suggested that concurrency is under reported in DHS surveys in Sub-Saharan Africa because of problems with the questionnaire design.[18,19] However, we note the questionnaire was changed for the 2009 Lesotho DHS and the levels of reported concurrency are high.[19]

METHODS

We used georeferenced demographic, behavioral, and HIV testing data that had been collected in the 2009 DHS in Lesotho. In this data set, an individual's HIV test results are linked to their demographic and behavioral data. The response rate for the DHS in Lesotho, unlike in many other African countries where DHS are conducted,[20] was very high: 98% for women and 95% for men. Participation in HIV testing was also high: 94% for women and 88% for men. Data were weighted to ensure they were representative of the population.[21] A detailed description of the DHS data can be found elsewhere.[12]

We quantified population mobility by stratifying the population into 3 travel categories according to the number of trips taken in the preceding year: (1) no travel, (2) 1–4 trips, and (3) 5 or more trips. A trip was defined as being away from home for at least one night. We defined individuals who had made 5 or more trips in the preceding year as frequent travelers. We compared demographic and behavioral characteristics of individuals in these 3 travel categories.

Received for publication May 30, 2014; accepted November 11, 2014.
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Supported by NIH Grant No. R01AI041935 and funding from the Semel Institute of Neuroscience and Human Behavior and the David Geffen School of Medicine at UCLA.

The authors have no funding or conflicts of interest to disclose.
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TABLE 1. Characteristics of Individuals Who Travel (a) and Associations Between Travel, Risk Behavior and Risk of HIV Infection (b) Associations Are Shown by the Adjusted Odds Ratios (aOR)

	Number of Overnight Trips in the Past Year		
(a) Demographic and Behavioral Characteristics	**0**	**1–4**	**5 or More**
Women			
Number and percentage of total population, N (%)	1992 (51.8)	1158 (30.1)	699 (18.2)
Age, median (IQR)	25 (19–35)	28 (21–36)***	28 (21–36)***
Age of sexual debut, median (IQR)	17 (16–19)	18 (16–20)	18 (16–20)
Live in urban areas, n/N (%)	595/1992 (29.9)	336/1158 (29.0)	297/699 (42.5)***
Employed, n/N (%)	626/1992 (31.4)	495/1158 (42.7)***	350/699 (50.1)***
Ever married, n/N (%)	1241/1992 (62.3)	815/1158 (70.4)***	466/699 (66.7)*
Secondary or higher education, n/N (%)	965/1992 (48.4)	599/1158 (51.7)	413/699 (59.1)***
No. sex partners in last year, mean (SD)	0.74 (0.55)	0.87 (0.54)***	0.91 (0.56)***
Men			
Number and percentage of total population, N (%)	1467 (47.7)	971 (31.6)	638 (20.7)
Age, median (IQR)	26 (19–38)	25 (19–34)	29 (22–38)***
Age of sexual debut, median (IQR)	17 (15–20)	17 (15–19)	17 (15–20)
Live in urban areas, n/N (%)	342/1467 (23.3)	243/971 (25.0)	217/638 (34.0)***
Employed, n/N (%)	872/1467 (59.4)	602/971 (62.0)	470/638 (73.7)***
Ever married, n/N (%)	654/1467 (44.6)	436/971 (44.9)	375/638 (58.8)***
Secondary or higher education, n/N (%)	481/1467 (32.8)	366/971 (37.7)*	297/638 (46.6)***
No. sex partners in last year, mean (SD)	0.93 (1.17)	1.08 (0.80)***	1.26 (0.93)***

	Number of Overnight Trips in the Past Year		
(b) Adjusted Odds Ratios for Sexual Risk Behaviors and HIV Infection	**0**	**1–4**	**5 or More**
Women			
2 or more sex partners in last year			
n/N (%)	90/1910 (4.7)	99/1193 (8.3)	70/703 (10.0)
aOR (95% CI)	1 (Ref)	1.64 (1.22 to 2.21)**	1.97 (1.41 to 2.73)***
4 or more lifetime sex partners			
n/N (%)	240/1585 (15.1)	159/1059 (15.0)	119/616 (19.3)
aOR (95% CI)	1 (Ref)	0.97 (0.77 to 1.21)	1.20 (0.93 to 1.54)
Concurrent partnership in the last year			
n/N (%)	72/1333 (5.4)	88/921 (9.6)	64/556 (11.5)
aOR (95% CI)	1 (Ref)	1.79 (1.29 to 2.49)***	1.92 (1.33 to 2.77)***
HIV infected			
n/N (%)	484/1941 (24.9)	302/1202 (25.1)	211/706 (29.9)
aOR (95% CI)	1 (Ref)	0.91 (0.76 to 1.09)	1.13 (0.92 to 1.39)
Men			
2 or more sex partners in last year			
n/N (%)	236/1415 (16.7)	239/974 (24.5)	199/642 (31.0)
aOR (95% CI)	1 (Ref)	1.58 (1.29 to 1.94)***	2.00 (1.60 to 2.50)***
4 or more lifetime sex partners			
n/N (%)	564/1147 (49.2)	468/824 (56.8)	354/576 (61.5)
aOR (95% CI)	1 (Ref)	1.41 (1.18 to 1.70)***	1.46 (1.19 to 1.82)***
Concurrent partnership in the last year			
n/N (%)	184/995 (18.5)	180/765 (23.5)	169/557 (30.3)
aOR (95% CI)	1 (Ref)	1.33 (1.05 to 1.68)*	1.76 (1.38 to 2.25)***
Ever paid for sex			
n/N (%)	56/945 (5.9)	52/734 (7.1)	44/541 (8.1)
aOR (95% CI)	1 (Ref)	1.29 (0.87 to 1.93)	1.32 (0.86 to 2.02)
HIV infected			
n/N (%)	230/1445 (15.9)	171/982 (17.4)	142/648 (21.9)
aOR (95% CI)	1 (Ref)	1.17 (0.93 to 1.48)	1.31 (1.01 to 1.68)*

The demographic and behavioral characteristics for those that travel 1–4, or 5 or more times, are compared to those that do not travel. Odds ratios are calculated adjusting for age, employment status, marital status and education. Asteriks denote the significance according to the following P-values: *** $P < 0.001$, ** $0.001 \leq P < 0.01$, * $0.01 \leq P < 0.05$. Concurrent partnerships are calculated amongst those who had sex in the last 12 months.

CI, confidence interval; IQR, interquartile range; SD, standard deviation.

We constructed mobility maps, using the georeferenced DHS data, to determine whether there are geographic patterns in mobility. The maps show (1) the percentage of individuals (living at a specific geographic location) who traveled in the preceding year and (2) where the frequent travelers live. We constructed gender-specific maps. The maps were constructed using kriging,[22–24] which was implemented using the R package geoR.[25]

To determine whether mobility was associated with increased risk behavior and/or increased risk of HIV infection, we used logistic regression. For both genders, risk behavior was defined in terms of (1) the number of sex partners reported in the preceding year and in the respondents lifetime, (2) concurrency (defined as 2 or more sexual partnerships that overlapped in time), and (3) condom usage (defined as using a condom for the last sex act). For men, we analyzed a further measure of risk behavior whether they had ever paid for sex. In separate analyses, the measures of risk behavior and HIV infection were used as response variables; analyses were gender specific. Mobility (adjusting for age, education level, marital, and employment status) was assessed as an explanatory variable.

RESULTS

Demographic statistics, stratified by gender and travel category (ie, number of overnight trips in the last year), are given in Table 1. It can be seen that the population of Lesotho is highly mobile: 30% of women and 32% of men made 1–4 trips in the preceding year, 18% of women and 21% of men made 5 or more. For a high percentage of individuals who traveled (37% women and 39% men), one or more of their trips lasted for at least a month. Men and women who traveled were slightly older than those who did not travel. They were also more likely to be married, employed, live in urban areas, and have a higher level of education. The age of sexual debut was not significantly different between those who traveled and those who did not. Notably, individuals who traveled reported having had a greater number of sex partners in the preceding year than those who did not; those who were frequent travelers (ie, made 5 or more trips in the last year) reported the highest numbers. A greater percentage of men who traveled reported paying for sex; however, the numbers are low, only ~8% of men who traveled frequently reported paying for sex.

The mobility maps (for men) are shown in Figure 1. Figure 1A shows the percentage of men (living at a specific geographic location) who traveled in the preceding year; Figure 1B shows where the frequent travelers live. Figure 1A shows that the level of mobility is high throughout the country, but geographic patterns are apparent. In some parts of the country, ~40% of men traveled (green data), whereas in other parts ~70% of men traveled (red data). The highest concentration of frequent travelers (shown by the red data) is in several of the urban areas that border South Africa and also in the mountainous interior of the country (Fig. 1B). For a map of the mountainous areas and urban centers in Lesotho, see Ref. 23. The mobility maps for women are similar to those for men (results not shown).

Adjusted odds ratios from the logistic regression analyses are presented in Table 1. We found men and women who traveled (regardless of the number of trips they made) were more likely to have had multiple partners in the preceding year (ie, recent partners) than those who did not travel; odds increased with the frequency of travel. Men and women who made 5 or more trips were almost twice as likely to have 2 or more recent partners than those who did not travel. In addition, men and women who traveled (regardless of the number of trips they made) were more likely to have concurrent partners than those who did not travel; odds increased with frequency of travel. Furthermore, men who traveled (regardless of the number of trips they made) were more likely to have a greater number of lifetime sex partners than men who did not travel. However, no association was found between travel and the number of lifetime partners for women; and no association was found, for either gender, between mobility and condom usage. Men who traveled, regardless of the number of trips they made, were not more likely to have paid for sex than men who did not travel.

Notably, only men who traveled frequently (ie, made 5 or more trips in the past year) had an increased risk of HIV infection: they were 1.31 (95% CI: 1.01 to 1.68) times more likely to be infected than men who did not travel (Table 1). Men who traveled infrequently (ie, made 1–4 trips in the preceding year), and women who traveled (regardless of the number of trips) did not have an increased risk of HIV infection in comparison with individuals who did not travel.

DISCUSSION

Previous epidemiologic studies that have looked for associations between mobility and increased levels of sexual behavior and/or risk of HIV infection have focused on specific "risk groups" living in particular locations.[2,4–8,10] In contrast, we have focused on an entire population and (by using georeferenced data) evaluated mobility within a large-scale geographic context. By constructing mobility maps, we have discovered that, although the entire population of Lesotho is very mobile, there is an observable geographic pattern. We have found 2 "types" of areas where a very high proportion of the population travel: (1) Maseru (the capital of Lesotho) and smaller urban areas that border South Africa and (2) the remote mountainous interior of the country. Notably, this geographic pattern holds for both men and women. Unfortunately, the DHS did not collect data that enabled us to determine where, or why, individuals traveled. It is possible that the destinations individuals traveled to may differ for those who live in urban areas versus those who live in the mountains. Our results suggest that travel (for both genders) may be necessary for employment, as we found that those who traveled were more likely to be employed than those who did not travel. Notably, in the mountainous areas, there are few employment opportunities. Future studies of migration would be improved by collecting detailed data to determine where individuals travel and why they travel.

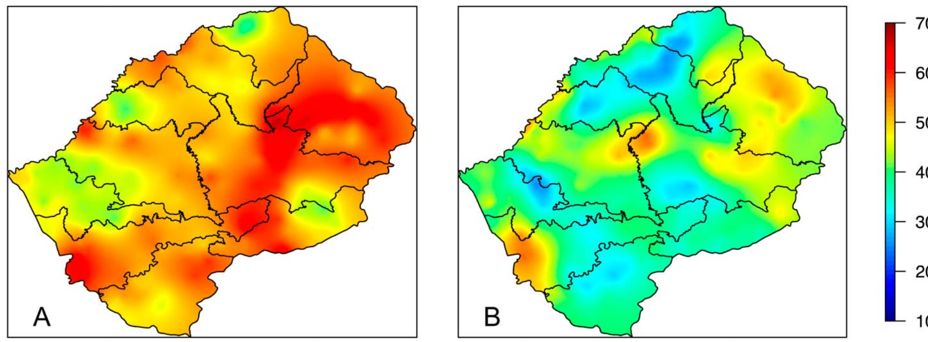

FIGURE 1. Mobility maps for men in Lesotho. The maps are constructed using the 2009 Demographic Health Survey data from Lesotho and plotted using kriging: (A) shows the percentage of men (living at a specific geographic location) who travel; men who travel are defined as those who made 1 or more trips in the last year and (B) shows the percentage of men (among those who traveled last year) who were frequent travelers and who live at that specific geographic location; frequent travelers are defined as those who made 5 or more trips in the last year.

Our results show, as suggested by social scientists,[16] that the effect of mobility and circular migration on HIV epidemics is complex and dynamic. For both men and women, we found that increased mobility was associated with increased levels of "recent" sexual behavior (ie, in the preceding year). However, it was only for men that we found an association between increased mobility and increased numbers of lifetime sex partners. Notably, it was only for men who were frequent travelers that we found an association between increased mobility and an increased risk of HIV infection. Whether mobility increases an individuals' risk of infection depends on multiple interacting factors: for example, the baseline risk of infection, the magnitude of increase in risk behavior, and the travel destination. There is a need to develop a greater understanding of the causal pathways through which migration can increase vulnerability to HIV.[16] There is also a need to develop complex transmission models that can be used to gain insights into the dynamic effect of mobility and migration on sexual networks and HIV epidemics.[26,27]

Our results have significant implications for the design of effective treatment programs and interventions for reducing HIV transmission in Lesotho. As many individuals travel, it may be very difficult to ensure high adherence to treatment.[28] Our mobility maps can be used to identify the geographic regions where attaining high levels of adherence may be the most challenging. We recommend that treatment programs in Lesotho should collect travel data from patients and use these data as a basis for developing strategies to enhance adherence. It is generally assumed that implementing interventions in 1 geographic region will reduce transmission in that region. However, this may not be the case in Lesotho where the highly mobile population can link many "localized" HIV epidemics both within the country and in the bordering provinces of South Africa. For example, miners who live in Lesotho may become infected in South Africa and then infect their partners when they return home. Under these conditions, it is essential to design interventions that are specifically targeted to migrant workers and frequent travelers. Our mobility maps can be used to identify where there is the greatest need for such interventions. Taken together, our results imply that in Lesotho and in other countries (such as Zimbabwe, Cameroon, and Kenya) that have high levels of mobility and circular migration, it may be more difficult to control HIV epidemics than currently appears.

ACKNOWLEDGMENTS

The authors thank Dr. Brian Coburn and Justin Okano for their insightful comments.

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