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The influence of mobility among high-risk populations on HIV transmission in Western Kenya

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ABSTRACT

Western Kenya suffers a highly endemic and also very heterogeneous epidemic of human immunodeficiency virus (HIV). Although female sex workers (FSW) and their male clients are known to be at high risk for HIV, HIV prevalence across regions in Western Kenya is not strongly correlated with the fraction of women engaged in commercial sex. An agent-based network model of HIV transmission, geographically stratified at the county level, was fit to the HIV epidemic, scale-up of interventions, and populations of FSW in Western Kenya under two assumptions about the potential mobility of FSW clients. In the first, all clients were assumed to be resident in the same geographies as their interactions with FSW. In the second, some clients were considered non-resident and engaged only in interactions with FSW, but not in longer-term non-FSW partnerships in these geographies. Under both assumptions, the model successfully reconciled disparate geographic patterns of FSW and HIV prevalence. Transmission patterns in the model suggest a greater role for FSW in local transmission when clients were resident to the counties, with 30.0% of local HIV transmissions attributable to current and former FSW and clients, compared to 21.9% when mobility of clients was included. Nonetheless, the overall epidemic drivers remained similar, with risky behavior in the general population dominating transmission in high-prevalence counties. Our modeling suggests that co-location of high-risk populations and generalized epidemics can further amplify the spread of HIV, but that large numbers of formal FSW and clients are not required to observe or mechanistically explain high HIV prevalence in the general population.

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1. Introduction

Kenya is ranked among the countries with the greatest number of people living with HIV (PLHIV) in the world, with an estimated population of 1.5 million PLHIV (NASCOP, 2016). The country's most affected region is the former Nyanza province in Western Kenya, comprised of six counties – Siaya, Homa Bay, Kisumu, Migori, Nyamira, and Kisii. Of these six counties, the first four experience extremely high HIV prevalence. The 2012 AIDS Indicator Survey found that approximately 1 out 4 adults in Siaya and Homa Bay counties were living with HIV, as were 1 out of 5 adults in Kisumu and Migori counties (NASCOP, 2014a). Some studies attribute high HIV infection rates to high levels of risk in the general population (Blaizot et al., 2016; Wachira, Kimaiyo, Ndege, Mamlin, & Braitstein, 2012), especially youth (Alsallaq et al., 2017; Wachira et al., 2014) and those living in communities with historically low rates of male circumcision (Anderson et al., 2014), while others have reported that high-risk sub-populations such as female sex workers (FSW) contribute substantially to HIV transmission in this region (Gouws & Cuchi, 2012; Vandenhoudt et al., 2013).

The population of FSW has been quantified throughout Kenya using a two-stage approach with geographical mapping of locations identified by key informants, followed by enumeration of FSW at the identified locations (Odek et al., 2014). The enumeration study included street-based, home-based, venue-based, road (truck stop) based, sex den based, massage parlour based, and escort services-based FSW. In Nyanza, the highest proportion of FSW in any town or city was found in Kisii, where FSW comprised 21% of women ages 15–49 residing in Kisii town in 2012. Because Kisii County is largely rural, the proportion of FSW county-wide is similar to that of Kisumu County, where FSW comprise 4% of the population of Kisumu city, but the city itself contains a larger proportion of the county's population. Nonetheless, this remarkably high proportion of FSW was found despite Kisii having the lowest HIV prevalence in Nyanza (NASCOP, 2014a).

Mobility of high-risk populations could potentially explain the contrast between the high rates of FSW and relatively low HIV prevalence. Kisii town is situated at the intersection of two highways (Fig. 1) and experiences substantial through-migration. Since the early rise of HIV in the region, migrant populations such as long-distance truck drivers have contributed to HIV transmission in such areas (Mbugua et al., 1995). Household-based surveys may not capture populations that are not resident within the county, yet contribute to local HIV transmission.

We used an epidemiological model to investigate whether mobility of high-risk populations is necessary to explain the epidemic patterns observed in Nyanza, and the extent to which assumptions about mobility influence patterns of HIV transmission. To capture overall patterns of HIV transmission, we made use of an available agent-based HIV model, EMOD-HIV, which includes networks of relationships, HIV risk groups and risk factors such as medical male circumcision (MMC), age patterns of partnerships, and geography. By fitting the model under different assumptions about the mobility of sexual partners of FSW, we sought to gain insights into the influence of mobility on patterns of HIV transmission.

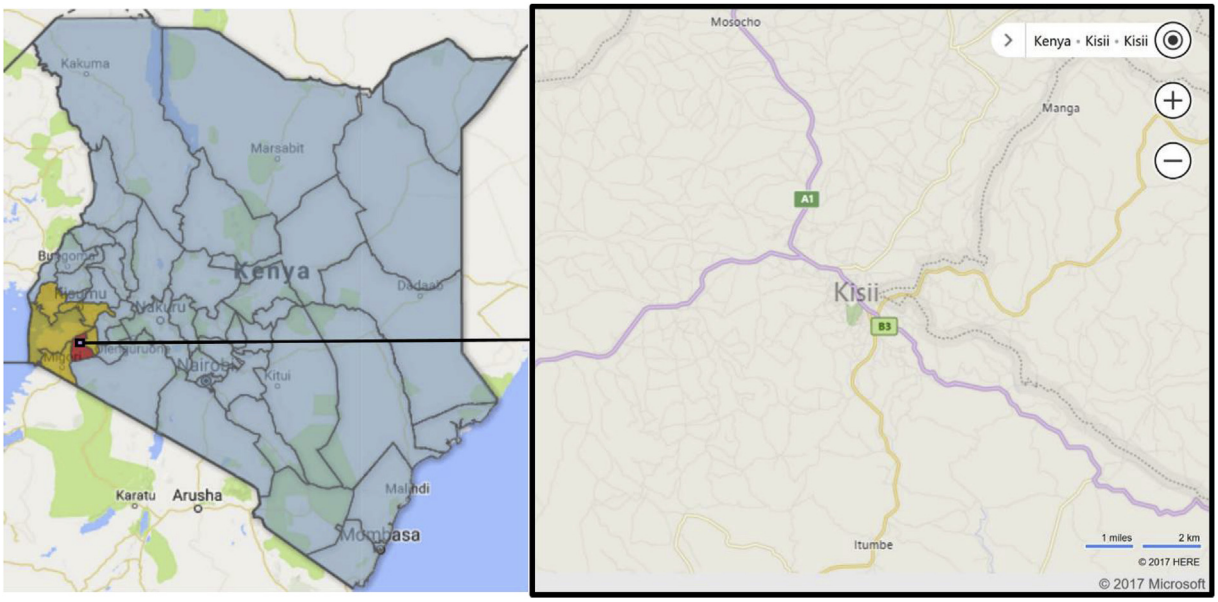

Fig. 1. Map showing Kisii County (red), the other five counties included in this modeling exercise (Homa Bay, Siaya, Kisumu, Migori, and Nyamira, orange), and the counties of Kenya not included in this modeling exercise (blue). Inset shows the location of Kisii town.