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Multiple Behaviors Associated with HIV Risk Among Female Sex Workers and Men who have Sex with Men: Results from Pooled Respondent-driven Sampling (RDS) Surveys — Uganda, 2021–2023

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Abstract

Key populations (KP), such as female sex workers (FSW) and men who have sex with men (MSM) can engage in multiple behaviors associated with HIV risk, but they are typically categorized by a single defining behavior, i.e., selling sex and sex with a man, respectively. We estimated the prevalence of engaging in multiple KP defining behaviors such as buying/selling sex, receptive anal sex, and injection drug use (IDU) among KP in Uganda. Data were collected at survey offices in four sites (Kampala, Jinja, Mbarara, and Masaka) through respondent-driven sampling. Data across multiple sites were combined and reweighted based on the combined sample size for each population. We fitted weighted multinomial logistic models for additional KP defining behaviors using demographics as predictors, and the simplest plausible model was identified for each KP using the Bayesian Information Criterion. Among FSW and sexually exploited minors under 18 years of age, 21.8% (CI: 20.1–23.5%) ever engaged in anal sex and 12.0% (CI: 10.6–13.3%) ever engaged in IDU in our model. Among MSM, 54.8% (CI: 52.0–57.7%) ever engaged in buying/selling sex and 11.0% (CI: 9.3–12.8%) ever engaged in IDU in the model. While KP are generally viewed as independent groups, our findings demonstrate that KP defining behaviors such as buying/selling sex, anal sex with a man, and IDU are shared across populations, with buying/selling sex particularly common among MSM. Consideration of

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Declarations

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comprehensive behaviors by outreach and service providers may better inform HIV risk reduction and prevention services for key populations.

Keywords

HIV; Uganda; Key Populations; Sex work; Anal sex; Injection drug use

Introduction

Significant progress toward controlling the human immunodeficiency virus (HIV) epidemic has been made over the past 40 years. Increased emphasis on HIV testing and treatment has led to increased awareness of their positive HIV status among people living with HIV (PLHIV) thus reducing the likelihood of transmitting the virus due to viral suppression [1]. Despite this progress, HIV remains a significant global health challenge. As of 2022, the Joint United Nations Programme on HIV/AIDS (UNAIDS) estimated that 39 million people were living with HIV globally, of whom 86% knew their HIV status, 76% were on treatment, and 71% were virally suppressed (viral load less than 1,000 copies per mL) [2].

In Uganda, HIV prevalence among adults is estimated to be 5.8% overall [3]. Despite Uganda having a generalized HIV epidemic, in which HIV transmission is sustained in the general population, key populations (KP), such as female sex workers (FSW) (including sexually-exploited minors (SEM) – females age 15–17 years old), men who have sex with men (MSM), and people who inject drugs, are disproportionately affected by HIV. HIV prevalence is estimated to be as high as 33% depending on KP and location [4, 5]. The stark contrast between HIV prevalence in the general population as compared to KP highlights the need to better understand the unique needs and behaviors of these populations so that HIV prevention services can be appropriately tailored.

In Uganda, KP face stigma and strict laws that criminalize their behaviors and necessitate a high degree of secrecy [6–8]. As a result, KP may be reluctant to share their behaviors in a household setting and can be underrepresented in general population surveys. Although a single behavior is often used to define or categorize KP (sex work among FSW/SEM, sex with a man among MSM), the behaviors themselves are not isolated to a single KP [4, 5]. Engaging in multiple KP defining behaviors, such as injection drug use (IDU) among FSW/SEM or sex work among MSM, have been associated with increased HIV prevalence and may increase the number of possible exposures to HIV as well as an individual's vulnerability within their communities and the healthcare system [9–11]. While estimates for the proportion of KP engaged in multiple behaviours' are part of HIV biobehavioral surveillance survey (BBS) activities in Uganda, less is known about contributing or protective factors that may be associated with these behaviors.

The Crane Survey is a collaborative activity implemented by Makerere University and supported by the United States (US) Centers for Disease Control and Prevention and the Uganda Ministry of Health. BBSs were previously conducted by Crane Survey in various key and priority populations in Uganda. In 2008–2009, BBSs were conducted among FSW, partners and clients of FSW, MSM, and various other priority populations [12]. In 2012–

2013, BBSs were conducted among MSM and FSW in Kampala [4, 5]. In the third survey cycle (Crane 3, 2021–2023), data were collected among FSW/SEM in 12 sites, among MSM in 8 sites, and among people who inject drugs in 5 sites throughout Uganda. Using available Crane 3 BBS data among FSW/SEM and MSM from across Uganda, we explore the prevalence of behaviors commonly used to define KP among and across FSW/SEM and MSM (selling to or buying sex from a man among MSM, anal sex with a man among FSW/SEM, and IDU for both FSW/SEM and MSM) and explore other potential behaviors and demographics that correlate with these KP associated behaviors in weighted models.

Methods

Survey Setting

Among FSW/SEM, data collection took place in Jinja during April–August 2022, Kampala May–October 2021, Masaka March–June 2022, and Mbarara April–June 2022. Among MSM, data were collected in Jinja during September 2022–February 2023, Kampala January–December 2021, Masaka July–December 2022, and Mbarara July 2022–February 2023. Kampala, the capital, is characterized as a large urban area with an estimated population of 1.8 million in 2023 [13]. Other survey locations represent smaller cities and are colloquially referred to as up-country sites with estimated population sizes projected to be 258,700 in Jinja, 250,500 in Masaka, and 236,600 in Mbarara in 2023 [13]. Sites were selected based on parity across KP and data availability, i.e., data collection had concluded for both FSW/SEM and MSM at each site and all data had been cleaned and reviewed by the in-country data managers prior to analysis.

Survey Design

Participants were recruited using respondent-driven sampling (RDS) [14, 15]. RDS is a variant of link-tracing network sampling. An initial set of participants, called *seeds*, were selected purposively among the KP group of interest at each sampling location. Each seed was given three coupons for distribution to KP members they knew. Participants were KP members who received coupons and enrolled in the survey. Each participant was asked to report the number of their contacts in the KP group, also known as the *degree*. Each participant was then given up to three coupons which they could distribute to other KP members they knew. Sampling proceeded through several such waves.

Target sample size differed by KP and site but aimed to enroll a minimum number of participants with HIV to achieve statistical power to estimate viral load suppression (VLS) and/or HIV prevalence. Among FSW/SEM, sampling continued at each site until the target sample size was reached. Among MSM, target sample sizes were not reached, and sampling continued until funding was exhausted or was cut short due to a perceived lack of safety for staff and participants related to homophobia and the recently passed Anti-Homosexuality Act [16–18].

To participate in the survey, candidate participants presented their coupons at the local survey office within the catchment area (site). The screening was conducted by trained recruitment staff and took place in a private office to ensure confidentiality. Eligible

FSW/SEM participants were female, age 15–17 (SEM) or 18–49 (FSW) years, and sold sex in the last 6 months in the survey's sampling area. SEM were provided with additional counselling and referred to child protection services. Eligible MSM participants were male, age ≥ 18 years, had engaged in anal sex with a man in the last 6 months and resided in the survey's sampling area for the last 6 months. FSW/SEM and MSM were excluded from participation if they refused any part of the study, did not speak one of the offered survey languages, had previously been interviewed, had been recruited by a stranger, or did not reside in the catchment area. Survey languages included English and Luganda at all four sites, additional language options included Lusoga in Jinja and Runyankole in Mbarara.

Surveys were taken on a tablet in the participant's preferred language and participants were provided headphones, all instructions and interview questions were read aloud using audio-computer assisted self-interview software. Outcome variables included multiple KP defining behaviors other than the eligibility criteria for each population. For example, selling sex was part of the eligibility criteria for survey enrolment for FSW/SEM, so this behavior was not included as an outcome variable. Only additional KP defining behaviors, i.e., anal sex with a man and IDU, were considered as outcome variables in the FSW/SEM model. In the MSM model, anal sex with a man was part of the eligibility criteria, so our outcome variables for additional KP defining behaviors among MSM were buying/selling sex from a man and IDU. Our decision to include both buying and selling sex with a man in our MSM model was based on the literature, in which both behaviors demonstrate higher burdens of HIV [19].

Recall periods for KP eligibility behaviors, selling sex among FSW/SEM and anal sex with a man among MSM, were within the last 6 months. The recall period for IDU among both FSW/SEM and MSM included multiple timeframes, i.e., within the last 6 months, greater than 6 months ago, or never injected drugs. The recall periods for additional sexual behaviors, anal sex with a man among FSW/SEM and buying/selling sex with a man among MSM, also included multiple timeframes: within the last 12 months, greater than 12 months ago, or never. To account for variables with multiple and differing recall periods, additional KP defining behaviors were categorized as ever or never. However, it should be noted that behaviors associated with KP eligibility were fixed within the last 6 months and were therefore not able to be converted to ever or never.

Analysis

KP defining behaviors were evaluated for each KP as a mutually exclusive categorical variable with four outcome levels for each KP. FSW/SEM mutually exclusive outcome levels included FSW/SEM who reported never engaging in anal sex or IDU, FSW/SEM who reported ever having anal sex but never IDU, FSW/SEM who reported ever injecting drugs but never anal sex, and FSW/SEM who reported both ever having anal sex and IDU. MSM mutually exclusive outcome levels included MSM who reported never engaging in buying/selling sex from a man or IDU, MSM who reported ever buying/selling sex but never IDU, MSM who reported ever IDU but never buying/selling sex, and MSM who reported both ever buying/selling sex and IDU.

We examined associations between mutually exclusive categories for each KP with possible predictor variables, including categorical age (SEM age 15–17 years; FSW age 18–24, 25–34, and 35–49 years; and MSM age 18–24, 25–34, 35–49, and ≥ 50 years), nationality (Ugandan or other), educational level (never attended school; some primary; completed primary; some secondary; or completed secondary or higher), marital status (never married; currently married; or divorced, widowed or separated), HIV status (positive or negative) and site/location (Jinja, Kampala, Masaka, or Mbarara). Among FSW/SEM we also explored associations with sex work as primary income (yes/no), average number of clients per day (≤ 1 , 2–5, ≥ 6), and duration in sex work (≤ 1 , 2–4, ≥ 5 years). Among MSM, we further explored associations with ever reporting sex with a female partner (yes/no), age-at-first sex with a man (≤ 14 , 15–24, ≥ 25 years of age), and numbers of male sex partners in the past 3 months (≤ 1 , 2–5, ≥ 6 partners). The proportion of KP engaged in each behavior (anal sex with a man and IDU among FSW/SEM, and buying/selling sex with a man and IDU among MSM) and confidence intervals were then computed from mutually exclusive outcome levels using a classical large-sample confidence interval for the sum of two non-independent proportions.

To account for site-specific variation, analysis for this manuscript was limited to the four sites with available data from both FSW/SEM and MSM (Jinja, Kampala, Masaka, and Mbarara). Participants who were missing demographic or biomarker data (age, education, HIV status, etc.) or KP defining behavior data (anal sex with a man among FSW/SEM, buying or selling sex from a man among MSM, and IDU among both KP) were excluded from analysis. A total of 3,492 FSW/SEM and 2,920 MSM approached the four survey offices with interest in participating. Of these, 438 (12.5%) FSW/SEM and 776 (26.6%) MSM were found to be ineligible during initial screening. Among FSW/SEM, 73.3% ($n = 321$) were not the target KP, 4.6% ($n = 20$) were over the age of 49 years, 1.4% ($n = 6$) did not know the person who recruited them, 14.4% ($n = 63$) did not reside in the target area, and in 6.4% ($n = 28$) the reason for exclusion was not listed. In the MSM surveys, 93.2% ($n = 723$) were not the target KP, 3.7% ($n = 29$) were under the age of 18 years, 0.4% ($n = 3$) did not know the person who recruited them, 1.4% ($n = 11$) did not reside in the area, and in 1.3% ($n = 10$) the reason for exclusion was not listed. Among eligibles, 0.4% of FSW/SEM ($n = 12$ of the 3,054 in the eligible sample) and 0.8% of MSM ($n = 17$ of the 2,145 in the eligible sample) were dropped from analysis for missing responses to variables of interest. In total, 5,170 participants were included in our analysis (3,013 FSW, 29 SEM, and 2,128 MSM).

HIV status was determined based on the Ugandan Ministry of Health's (MOH) national testing algorithm: A Determine[®] HIV-1/2 AG/AB Combo [Abbott, Abbott Park, IL, USA] reactive rapid HIV test was confirmed with HIV 1/2 STAT PAK[®] Assay [Chembio Diagnostics, Medford, NY, USA]; participants with discordant results underwent further testing with SD Bioline[®] HIV 1/2 Ab Test [Standard Diagnostics, Inc., Gyeonggi-do, South Korea].

A key feature of RDS is that they are not simple random samples, and therefore specialized analytic methods are needed to provide statistically principled estimates of outcomes of interest from each sampled site and population [20, 21]. Therefore, data across multiple

sites were combined and RDS weights were rescaled from each survey so that the sum of the weights equalled the effective sample size for each KP across sites [22, 23]. The effective sample size was defined as the numbers of total participants divided by the design effect computed from Gile's successive sampling estimator of prevalence for the behavior outcomes of interest (selling or buying sex from a man among MSM, anal sex with a man among FSW/SEM, and IDU for both FSW/SEM and MSM) as implemented in the RDS package for R [24, 25]. The rescaled weights therefore have the effective sample sizes for each survey as their common basis, and the reweighted RDS survey data were combined for further analysis. R [25] (version 4.3.1) was used to compute the design effects of RDS estimates and rescale the RDS weights. STATA [26] (version IC 16.1) was used to combine datasets for analysis and to fit test weighted multinomial logistic models.

For each of the FSW/SEM and MSM behavior outcome of interest, we first tested a full model including all plausibly important covariates, which included categorical age, site, nationality, education, marital status, and HIV status across both KP. The full models also included variables that were unique to each KP, including sex work as their main income, average number of clients per day, and duration of sex work among FSW, and ever having had sex with a female, age at first sex with a man, and average number of male sex partners in the last 3 months among MSM. We then fitted a reduced model by removing covariates with p -values > 0.05 starting with the largest p -value. The decision to remove each covariate was confirmed if the differences between the Bayesian Information Criteria (BIC) from the larger and reduced model was at least 5. This process continued until the simplest plausible multivariable model was identified, and that model was used for inference. All covariates in the final fitted model had a p -value < 0.05 and were confirmed with BIC difference. As interpretation of the coefficients of multinomial logistic models is difficult, unlike conventional binary logistic models, we based inferences on the conditional probabilities of behavior outcomes of interest given the covariates.

Human Subjects Considerations

This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.[§] We obtained verbal informed consent; all personal identifiers collected during the survey were omitted from analysis. Recruits were compensated for their initial visit (~ USD \$5.40), peer recruitment (~ USD \$1.30 per successful recruitment), and return visit (~ USD \$2.70). Test results were returned to participants; all participants were offered initial HIV treatment and referred to service providers either for pre-exposure prophylaxis (HIV-negative) or treatment (HIV-positive) unless they were already using such services. SEM were counselled and referred to child protection services.

Results

Most (97.7% FSW/SEM and 97.2% MSM) participants in both populations were Ugandan nationals (Table 1). The age distribution among FSW/SEM was largely symmetric and

[§]See e.g., 45 C.F.R. part 46.102(l)(2), 21 C.F.R. part 56; 42 U.S.C. § 241(d); 5 U.S.C. § 552a; 44 U.S.C. § 3501 et seq.

skewed younger in MSM. Educational attainment was lower among FSW/SEM compared to MSM, with 33.4% of FSW/SEM and 77.4% of MSM reporting some secondary school or higher. Over half of FSW/SEM (53.1%) were divorced, widowed, or separated, but the majority of MSM (79.1%) had never married. Among the sample population, the percent of PLHIV differed by site and was 30.9–55.2% among FSW/SEM and 3.9–7.2% among MSM. Among FSW/SEM, the majority (88.0%) of the sample reported that sex work was their main income, more than half (51.0%) reported more than 6 clients per day, and 56.8% had been selling sex for 2 or more years. Among MSM, 61.0% of the sample reported ever having had sex with a woman and 78.5% reported multiple male sex partners in the past 3 months. The median age when MSM reported their first sexual encounter with a man was 18 years with an interquartile range (IQR) of 17–20 years.

Mutually Exclusive KP Defining Behavior Categories Among FSW/SEM

Among FSW/SEM, site, marital status, and average number of clients per day were retained as independent variables in our weighted models following fit testing. Proportions and confidence intervals were calculated for mutually exclusive risk categories with weighted multivariable multinomial logistic regression. When results of the fit-tested, weighted model were considered as mutually exclusive outcome levels, FSW/SEM most frequently had never engaged in anal sex or IDU (71.0%, 95% confidence interval (CI): 69.1–72.8%), followed by ever engaged in anal sex with a man but never injected drugs (17.1%, CI: 15.5–18.6%), ever injected drugs but never engaged in anal sex (7.2%, CI: 6.2–8.2%), and finally ever engaged in both anal sex and IDU (4.7%, CI: 3.9–5.6%) (Table 2). Despite being significant in our model, CI for site, marital status, and average number of clients per day overlapped between predictor variable values, or covariates, for FSW/SEM.

Mutually Exclusive KP Defining Behavior Categories Among MSM

Among MSM, site, education, and the average number of male sex partners in the past 3 months were retained as independent variables in our weighted model following fit testing. When results were considered as mutually exclusive categories, MSM most frequently had ever bought/sold sex with a man but never IDU (46.1%, CI: 43.5–48.6%), followed by never engaged in either buying/selling sex or IDU (42.9%, CI: 40.3–45.4%), ever engaged in both buying/selling sex and IDU (8.8%, CI: 7.2–10.4%), and finally ever injecting drugs but never buying/selling sex (2.3%, CI: 1.4–3.1%) (Table 2). Despite being significant in our fit-tested model, CI for site, education status, and average number of male sex partners in the past three months overlapped between covariates for MSM.

The four mutually exclusive KP defining behavior categories presented in Table 2 were collapsed to produce prevalence estimates for each KP defining behavior of interest (Table 3). Prevalence estimates for KP defining risk behaviors are based on the same fit-tested and weighted model but are not mutually exclusive. For example, MSM who engaged in IDU and buying/selling sex will be included in prevalence estimates for each behavior.

KP Defining Behavior Prevalence Among FSW/SEM

Among FSW/SEM, 21.8% (CI: 20.1–23.5%) of FSW/SEM ever had anal sex with a man; 12.0% (CI: 10.6–13.3%) had ever used injection drugs (Table 3). The prevalence of KP

defining behaviors differed by site, e.g., ever injecting drugs was highest in Jinja (16.4%, CI: 13.1–19.7%) and lowest in Mbarara (7.7%, CI: 5.0–10.3%), whereas ever engaging in anal sex with a man was lowest in Jinja (19.7%, CI: 16.1–23.4%) and highest in Masaka (28.0%, CI: 23.4–32.7%). While marital status and average number of sex work clients per day demonstrated statistical significance in our model, these differences should be interpreted carefully since CI overlapped across all covariates.

KP Defining Behavior Prevalence Among MSM

In total, 54.8% (CI: 52.0–57.7%) of MSM ever bought or sold sex from a man; 11.0% (CI: 9.3–12.8%) ever injected drugs. Prevalence of KP defining behavior differed by site; ever buying or selling sex with a man was most prevalent in Jinja (63.9%, CI: 56.4–71.4%) and least prevalent in Kampala (51.8%, CI: 48.5–55.1%), whereas ever injecting drugs was most prevalent in Mbarara (13.7%, CI: 8.7–18.7%) and least prevalent in Kampala (9.3%, CI: 7.5–11.2%). Prevalence of ever engaging in buying/selling sex and IDU also differed by educational attainment level, but results were non-linear. Prevalence of both KP defining behaviors increased with number of male sex partners in the past 3 months.

Discussion

Using population-based survey data collected among FSW/SEM and MSM at four sites in Uganda, we found that multiple KP defining behaviors were common in both KP but displayed heterogeneity by KP, place, and other traits. The distribution of behaviors differed by KP group and by key demographics in our models.

Our results indicate that the proportion of FSW/SEM in our study who have ever engaged in anal sex (21.8%) is similar to the 19% previously reported in Uganda [4] but slightly higher than global estimates of 2.4–15.9% from a meta-analysis of publications from 1980–2018 [27]. Furthermore, the proportion of FSW/SEM in this study who ever engaged in anal sex increased with respect to the average number of clients per day. Our findings suggest the importance of considering HIV anal transmission in FSW/SEM and designing effective prevention interventions that address anal sex as potential behavior associated with HIV risk among women.

Additionally, prior research in Uganda has highlighted high proportions of MSM who report buying or selling sex and to a lesser extent IDU, which aligns with our current findings [10]. However, few studies have explored the potential relationship between MSM who buy or sell sex to men and IDU, especially within Africa. That being said, the high proportion of MSM who had ever bought or sold sex among those who injected drugs (80.0%) is higher in our survey than reported elsewhere in the literature from the United States (68.0%) and Europe (13.6%) [10]. Our findings indicate that behavior profiles among MSM, particularly among MSM who may be engaged in sex work or transactional sex with other men, are complex; therefore, these men may benefit from comprehensive services.

Sample site also correlated to differences in KP defining behaviors across both FSW/SEM and MSM. For example, we report lower proportions of ever buying or selling sex and IDU among MSM in Kampala as compared to MSM in up-country sites. The proportion of

FSW/SEM who ever engaged in anal sex or IDU also differed by site, but factors driving such site-level differences could not be determined by this analysis. These findings may reflect regional differences in the availability of KP-specific outreach and service provision depending on what organizations or programming exists in a given area, or KP may utilize services at different rates regardless of availability. For example, Johnston et al. indicates that women may be less likely than men to seek IDU-related services such as needle exchange and methadone treatment [28]. Additionally, our study sites fall along high-volume transportation corridors, which are associated elsewhere in the literature with increased risk of forced labour and sexual exploitation [29]. Economic and cultural differences may also contribute to site-level differences across KP (e.g., tourism, transportation, and rapid population growth) [30]. Our findings indicate that additional research is needed to determine and address the underlying cause of differences in lifetime IDU and sex work by site and across KP groups at the same site.

Marital status was not correlated with engaging in multiple KP defining behaviors in MSM, although this KP group skewed into the never-married group. However, FSW/SEM who had ever been married had lower proportions of ever engaging in anal sex and in IDU than those who had never married. The lower rate of anal sex and IDU among FSW/SEM who had ever been married, is surprising since it includes those who are no longer married, but similar findings among currently and previously married women have been reported elsewhere in the literature [29]. Therefore, our findings may represent differences in social status or access to resources that may be unique to FSW/SEM.

Among FSW/SEM, the proportion of IDU also increased with respect to the average number of clients per day. Similarly, among MSM, both ever having engaged in buying or selling sex and IDU increased with the average number of male sex partners in the last three months. These higher rates of ever injecting drugs among FSW/SEM with more clients and MSM with more partners indicate a relationship between sex work and IDU. This is consistent with a recent meta-analysis that reported the pooled prevalence of lifetime illicit drug use among sex workers was 35% (95% CI: 30–41%) across 86 studies in 46 countries [31]. Some potential explanations may include a reduction in sexual behavior inhibition following IDU, IDU as a mechanism to cope with external and internalized stigma, or sex work as a means to pay for drugs. Additionally, a separate meta-analysis reported a high prevalence of depression, anxiety, psychological distress, and violence among sex workers [32]. For MSM, this relationship between sex work and anxiety/depression may be exacerbated by the stigma and mental health effects related to being MSM; such as rejection by family, community, and country (e.g., legal environment). Considered holistically, FSW/SEM and MSM might be best served by differentiated services or person-centered services that are tailored to the needs of the individual, including interventions that consider IDU and other substance use, mental health, and violence in addition to HIV biomedical prevention. It is critical to explore and respond to barriers that may exacerbate mental health breakdown and limit resiliency among KP. For example, availability and quality of mental health services, provider bias and stigma regarding KP behaviors, and legal barriers that may prohibit access to care. All of which may negatively impact mental health and overwhelm an individual's coping mechanisms.

Strengths of our analysis include that we report on issues that are underrepresented in the literature, such as sex work among MSM and the distribution of IDU across FSW/SEM and MSM in Uganda. We highlight that both FSW/SEM and MSM shared behaviors across KP groups. Although we found differences across sites, similar findings across multiple contexts suggest the importance of these findings. In addition, the results of our analysis allow for comparisons of the proportion of KP defining behaviors across KP groups within and across sites that may aid in tailoring HIV treatment and prevention services by KP and location.

Limitations include, the timing of data collection, which took place during the COVID-19 pandemic and during a period of heightened anti-homosexuality political and media attention [16]. Both factors likely slowed sampling, potentially reduced participation, and may have impacted participants' responses. The Anti-Homosexuality Act, passed on May 26, 2023, stipulates up to life imprisonment or the death penalty for certain offences involving same-sex intercourse [17]. It also opens the door for reduced access to care and may reduce the likelihood of patient risk disclosure for fear that health and research records may be subject to government seizure and criminal charges [17]. The heightened anti-homosexuality attention also impacted the number of sites included in our investigation, as several MSM surveys that were originally planned at up-country sites as part of Uganda's HIV surveillance were never started due to safety and feasibility concerns.

Second, given the relatively small number of MSM over the age of 35 years, older MSM were likely underrepresented in our samples. Third, the variation for recall periods in our analysis is a potential weakness. For example, behaviors associated with KP eligibility must have been current (within the last 6 months), whereas other KP defining behaviors could have occurred at any point in the past. Therefore, we cannot determine whether KP in our investigation engaged in multiple KP defining behaviors simultaneously or if they switched from one KP category to another throughout their lives. Third, only formal RDS estimation provides principled estimates of standard errors and uncertainty intervals, whereas this analysis recalculated weights across multiple sites. Therefore, the results of our analyses are likely to provide reasonably accurate estimates of the probabilities of occurrence of the risk categories, but the standard errors are likely to be too small and uncertainty intervals too narrow. However, this is the best analysis that can be done given the currently available methods. Fourth, convergence was not achieved in attempts to analyze buying and selling sex as separate variables in our model; therefore, buying and selling sex among MSM were collapsed into a single variable. This collapsing of buying/selling sex limits our ability to speak to differences between MSM who buy sex from men but do not sell sex to men and vice versa. However, we feel that combining buying and selling sex to men was appropriate in this analysis, because both behaviors have demonstrated a higher risk of HIV in the literature [19].

This work may help to inform HIV-related estimation and modelling, as globally, data on overlapping KP defining behaviors is sparse, thus impeding insight into changes in KP behavior overtime [33]. Our analysis serves as a reminder that individuals often fall into more than one behavior category, and we provide empirical data to support screening for multiple KP defining behaviors as part of comprehensive HIV treatment and prevention services. We also found differences between behavior profiles across demographics and

between KP at each site, which indicates that this or similar analyses may be used to inform HIV harm reduction and prevention services. Furthermore, we highlight several areas where additional research is needed to better understand underlying factors that contribute to KP defining behavior such as high rates of buying or selling sex among MSM and possible relationships between transactional sex and IDU in Uganda.

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Table 1

Sample demographic percentages are calculated from unweighted Crane III data from FSW and MSM in Jinja, Kampala, Masaka, and Mbarara, Uganda, collected from May 2021–February 2023. Range across sites represents the lowest and highest percentages across all sites for a given demographic variable

Sample demographics by key population															
Total FSW/SEM population		FSW total		Range across sites		Total MSM population		MSM total		Range across sites					
n=		%		Lowest (%) Highest (%)				n= %		Lowest (%) Highest (%)					
3,042		100.0%		N/A N/A				2,128 100.0		N/A N/A					
Key population by site															
Jinja		607		20.0		N/A		N/A		272 12.8		N/A N/A			
Kampala		1,581		52.0		N/A		N/A		1,417		66.6		N/A N/A	
Masaka		441		14.5		N/A		N/A		209		9.8		N/A N/A	
Mbarara		413		13.6		N/A		N/A		230		10.8		N/A N/A	
HIV prevalence among sample population *															
Jinja		200		32.9		N/A		N/A		12		4.4		N/A N/A	
Kampala		488		30.9		N/A		N/A		102		7.2		N/A N/A	
Masaka		206		46.7		N/A		N/A		10		4.8		N/A N/A	
Mbarara		228		55.2		N/A		N/A		9		3.9		N/A N/A	
Age								Age							
15–17		29		1.0		0.2		1.5		18–24		1,509		70.9 65.8 82.6	
18–24		831		27.3		24.6		30.3		25–34		532		25.0 15.2 29.1	
25–34		1,333		43.8		41.6		49.0		35^19		83		3.9 1.4 4.9	
35–49		849		27.9		22.0		31.3		50+		4		0.2 0.0 0.4	
Nationality										Nationality					
Uganda		2,973		97.7		96.6		89.3		Uganda		2,068		97.2 96.8 98.5	
Other		69		2.3		1.7		3.4		Other		60		2.8 1.5 3.3	
Education										Education					
Never went to school		437		14.4		12.9		17.6		Never went to school		66		3.1 2.2 7.4	
Some primary		1,092		35.9		33.2		44.8		Some primary		265		12.5 10.4 22.5	
Completed primary		498		16.4		13.5		19.1		Completed primary		151		7.1 6.1 12.9	

Sample demographics by key population									
Total FSW/SEM population	FSW total		Range across sites		Total MSM population	MSM total		Range across sites	
	n=	%	Lowest (%)	Highest (%)		n=	%	Lowest (%)	Highest (%)
	3,042	100.0%	N/A	N/A		2,128	100.0	N/A	N/A
Some secondary	747	24.6	15.5	28.0	Some secondary	767	36.0	12.0	43.8
Completed secondary or higher	268	8.8	6.1	9.8	Completed secondary or higher	879	41.3	27.3	45.2
Marital status					Marital status				
Never married	1,113	36.6	32.9	38.1	Never married	1,684	79.1	77.8	87.1
Currently married	314	10.3	6.1	11.8	Currently married	275	12.9	7.7	15.7
Divorced, widowed, or separated	1,615	53.1	50.0	61.0	Divorced, widowed, or separated	169	7.9	5.2	8.6
Sex work is main income	2,677	88.0	87.3	88.3	Ever sex with a female partner	1,299	61.0	49.6	68.9
Duration of sex work					Age at first sex with a man				
1 year or less	1,313	43.2	40.2	45.4	Age 14 years or less	149	7.0	3.5	13.6
2–4 years	882	29.0	2.6	32.3	Age 15–24 years	1,824	85.7	82.4	94.4
5 years or more	847	27.8	27.0	31.5	Age 25 years or more	155	7.3	2.2	9.4
FSW average number of clients per day					MSM average number of male sex partners in last 3 months				
1 or fewer	78	2.6	1.8	6.3	1 or fewer	457	21.5	15.7	26.8
2–5	1,414	46.5	37.0	52.1	2–5	1,128	53.0	46.7	63.5
6 or more	1,550	51.0	41.7	61.2	6 or more	543	25.5	19.1	27.1

* HIV prevalence estimates for each site do not represent a distribution across sites

Weighted proportion of FSW/SEM and MSM populations engaged in each mutually exclusive risk category by independent variables

Total FSW population	FSW only (neither anal sex or IDU)				FSW IDU (but not anal sex)				FSW anal sex (but not IDU)				FSW both (IDU and anal sex)			
	Std error		95% CI		Std error		95% CI		Std error		95% CI		Std error		95% CI	
	%		Lower	Upper	%		Lower	Upper	%		Lower	Upper	%		Lower	Upper
	71.0	0.9%	69.1%	72.8%	7.2	0.5%	6.2%	8.2%	17.1	0.8%	15.5%	18.6%	4.7	0.4%	3.9%	5.6%
Key population by site																
Jinja	70.6	2.0%	66.6%	74.6%	9.7	1.3%	7.2%	12.1%	13.0	1.5%	10.0%	15.9%	6.8	1.1%	4.6%	9.0%
Kampala	72.9	1.3%	70.3%	75.5%	6.7	0.7%	5.3%	8.1%	16.6	1.2%	14.4%	18.9%	3.8	0.6%	2.6%	4.9%
Masaka	64.0	2.4%	59.3%	68.8%	7.9	1.4%	5.2%	10.7%	22.4	2.1%	18.4%	26.5%	5.6	1.2%	3.3%	7.9%
Mbarara	73.9	2.3%	69.4%	78.4%	4.2	1.0%	2.3%	6.1%	18.4	2.1%	14.3%	22.5%	3.5	0.9%	1.7%	5.3%
Marital status																
Never married	67.6	1.6%	64.5%	70.8%	8.3	0.9%	6.6%	10.1%	17.5	1.3%	14.9%	20.1%	6.5	0.9%	4.8%	8.2%
Currently married	72.4	2.9%	66.7%	78.2%	7.9	1.7%	4.6%	11.2%	15.8	2.5%	10.9%	20.7%	3.9	1.2%	1.6%	6.2%
Divorced, widowed, or separated	72.9	1.2%	70.5%	75.3%	6.4	0.7%	5.1%	7.6%	17.0	1.0%	15.0%	19.1%	3.7	0.5%	2.7%	4.8%
FSW average number of clients per day																
1 or fewer	79.5	5.2%	69.2%	89.7%	3.2	2.0%	0.0%	7.2%	13.9	4.8%	4.5%	23.3%	3.4	2.0%	0.0%	7.3%
2–5	75.9	1.3%	73.3%	78.4%	6.4	0.7%	5.0%	7.7%	14.8	1.1%	12.7%	16.9%	2.9	0.5%	1.9%	4.0%
6 or more	65.8	1.4%	63.1%	68.5%	8.2	0.8%	6.7%	9.7%	19.4	1.2%	17.2%	21.7%	6.5	0.7%	5.1%	7.9%
Total MSM population	MSM only (neither buy/sell sex or IDU)				MSM IDU (but not buy/sell sex)				MSM buy/sell sex (but not IDU)				MSM both (IDU and buy/sell sex)			
	Std error		95% CI		Std error		95% CI		Std error		95% CI		Std error		95% CI	
	%		Lower	Upper	%		Lower	Upper	%		Lower	Upper	%		Lower	Upper

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Key population by site										
	42.9	1.3%	40.3%	45.4%	2.3	0.4%	1.4%	3.1%	46.1	1.3%
								8.8	43.5%	48.6%
								0.8%	7.2%	10.4%
Jinja	34.8	3.1%	28.8%	40.9%	1.3	0.6%	0.1%	2.4%	53.2	3.3%
Kampala	46.6	1.5%	43.7%	49.6%	1.6	0.4%	0.8%	2.3%	44.1	1.5%
Masaka	39.3	3.8%	31.8%	46.9%	2.8	1.3%	0.3%	5.3%	48.9	3.8%
Mbarara	40.9	3.5%	34.1%	47.8%	4.0	1.3%	1.4%	6.6%	45.4	3.5%
Education										
Never went to school	61.3	7.5%	46.6%	76.0%	2.5	2.0%	0.0%	6.4%	30.1	6.7%
Some primary	32.2	3.8%	24.8%	39.6%	2.8	1.5%	0.0%	5.7%	47.1	3.8%
Completed primary	31.6	4.6%	22.5%	40.7%	1.5	1.5%	0.0%	4.5%	60.4	5.0%
Some secondary	39.2	2.2%	34.9%	43.5%	2.1	0.6%	0.9%	3.3%	49.4	2.2%
Completed secondary or higher	49.4	2.1%	45.3%	53.5%	2.4	0.7%	1.0%	3.8%	42.1	2.1%
MSM average number of male sex partners in last 3 months										
Single sex partner	61.8	2.9%	56.1%	67.5%	3.2	1.1%	1.1%	5.3%	28.3	2.7%
2-5	40.9	1.7%	37.5%	44.3%	2.1	0.5%	1.0%	3.2%	48.9	1.8%
6 or more	30.2	2.7%	24.9%	35.5%	1.9	0.8%	0.4%	3.3%	56.0	2.7%
								11.9	50.6%	61.3%
								1.8%	8.4%	15.5%

Table 3

Prevalence of additional KP defining risk behaviors calculated as the proportion of each key population to report ever engaging in the behavior as determined by weighted multivariable multinomial logistic regression. Risk behaviors are not mutually exclusive, and individuals engaged in multiple risk behaviors will be included in the prevalence estimates for all risk categories that they reported

Proportion of FSW/SEM and MSM populations engaged in each risk behavior by independent variables									
Total FSW population	FSW who ever injected drugs			FSW who ever engaged in anal sex					
	%	Std error	95% CI		%	Std error	95% CI		
			Lower	Upper			Lower	Upper	
	12.0	0.7%	10.6%	13.3%	21.8	0.9%	20.1%	23.5%	
Key population by site									
Jinja	16.4	1.7%	13.1%	19.7%	19.7	1.9%	16.1%	23.4%	
Kampala	10.5	0.9%	8.7%	12.3%	20.4	1.3%	17.9%	22.9%	
Masaka	13.6	1.8%	10.0%	17.1%	28.0	2.4%	23.4%	32.7%	
Mbarara	7.7	1.3%	5.0%	10.3%	21.9	2.3%	17.4%	26.4%	
Marital status									
Never married	14.9	1.3%	12.4%	17.3%	24.0	1.6%	20.9%	27.1%	
Currently married	11.8	2.0%	7.8%	15.8%	19.7	2.8%	14.3%	25.1%	
Divorced, widowed, or separated	10.1	0.8%	8.4%	11.7%	20.8	1.2%	18.5%	23.0%	
FSW average number of clients per day									
1 or fewer	6.7	2.8%	1.1%	12.2%	17.3	5.2%	7.2%	27.5%	
2–5	9.3	0.9%	7.5%	11.0%	17.8	1.2%	15.4%	20.1%	
6 or more	14.8	1.0%	12.7%	16.8%	25.9	1.4%	23.3%	28.6%	
MSM who ever injected drugs									
MSM who ever bought/sold sex									
Total MSM population	%	Std error	95% CI		%	Std error	95% CI		
			Lower	Upper			Lower	Upper	
	11.0	0.9%	9.3%	12.8%	54.8	1.5%	52.0%	57.7%	
Key population by site									

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Jinja	11.9	2.1%	7.8%	16.1%	63.9	3.8%	56.4%	71.4%
Kampala	9.3	0.9%	7.5%	11.2%	51.8	1.7%	48.5%	55.1%
Masaka	11.8	2.5%	6.8%	16.8%	57.9	4.3%	49.4%	66.4%
Mbarara	13.7	2.6%	8.7%	18.7%	55.1	4.1%	47.1%	63.1%
Education								
Never went to school	8.6	3.4%	1.8%	15.3%	36.2	7.2%	22.0%	50.3%
Some primary	20.7	3.5%	13.8%	27.6%	65.0	4.9%	55.4%	74.6%
Completed primary	8.0	2.9%	2.2%	13.7%	66.9	5.6%	56.0%	77.8%
Some secondary	11.4	1.5%	8.4%	14.4%	58.8	2.6%	53.7%	63.8%
Completed secondary or higher	8.5	1.3%	5.9%	11.1%	48.2	2.3%	43.7%	52.8%
MSM average number of male sex partners in last 3 months								
Single sex partner	9.9	1.9%	6.1%	13.7%	34.9	3.1%	28.9%	41.0%
2–5	10.2	1.2%	7.9%	12.5%	57.0	2.0%	53.0%	61.0%
6 or more	13.8	2.0%	10.0%	17.7%	67.9	3.2%	61.6%	74.2%