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## Awareness of and willingness to use oral HIV self-test kits among Kenyan young adults living in informal urban settlements: a cross-sectional survey

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### ABSTRACT

Self-administered HIV testing may be a promising strategy to improve testing in hard-to-reach young adults, provided they are aware of and willing to use oral HIV self-testing (HIVST). This study examined awareness of and willingness to use oral HIVST among 350 high-risk young adults, aged 18–22, living in Kenya's informal urban settlements. Bivariate and multivariate logistic regressions were used to examine differences in HIVST awareness and willingness by demographic and sexual risk factors. Findings showed that most participants were male (56%) and less than 20 years old (60%). Awareness of oral HIVST was low (19%). However, most participants (75%) were willing to use an oral HIV self-test in the future and ask their sex partner(s) to self-test before having sex (77%). Women (OR = 1.80, 95%CI:1.11, 2.92), older participants (aged 20+) (OR = 2.57, 95% CI:1.48, 4.46), and more educated participants (OR = 2.25, 95%CI:1.36, 3.70) were more willing to use HIVST as compared to men, teen-aged, and less educated participants, respectively. Young adults who reported recent engagement in high-risk sexual behaviors, such as unprotected sex, sex while high or drunk, or sex exchange, were significantly less likely to be willing to use an oral HIV self-test kit (OR = 0.34, 95%CI:0.13,0.86). Those with the highest monthly income (OR = 0.47, 95%CI: 0.25, 0.89) were also less willing to use HIVST. More community- and peer-based efforts are needed to highlight the range of benefits of HIVST (i.e., social, clinical, and structural) to appeal to various youth demographics, in addition to addressing concerns relating to HIVST.

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### KEYWORDS

HIV; rapid test; self-test; young adults; informal urban settlement; slum; respondent driven sampling; Kenya

## Introduction

With approximately 1.6 million people living with HIV (PLHIV), Kenya is estimated to have one of the largest HIV epidemics in sub-Saharan Africa (Joint United Nations Programme on HIV/AIDS, 2020). The prevalence of HIV among persons aged 15 years and older in Kenya is estimated as 4.8%, with the prevalence among girls and women (6.0%) being almost twice that of boys and men (3.6%) (Joint United Nations Programme on HIV/AIDS [UNAIDS], 2020). There is also a wide geographical variation in the prevalence of HIV in Kenya, with individuals residing in informal urban settlements estimated to have disproportionately higher rates (12%) of HIV than city dwellers residing outside of

informal urban settlements (5%) and higher rates than residents living in rural areas (6%) (Madise et al., 2012). Although Kenya has made significant progress in improving access to HIV testing services to meet the 95-95-95 target (e.g., 95% of people living with HIV knowing their HIV status; 95% of people who know their status receiving treatment; and 95% of people on treatment having a suppressed viral load) of ending the HIV epidemic by 2030 (UNAIDS, 2015), a significant proportion of PLHIV have not been tested and diagnosed (UNAIDS, 2020). This has limited enrollment into care and treatment for HIV (Cherutich et al., 2012). According to recent data, only 74% of PLHIV were receiving antiretroviral therapy (ART)

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(UNAIDS, 2020). Lack of awareness of HIV status has been found to be higher among adolescents and young adults (15–24 years), with 82% of adolescents and young adults reporting being unaware of their HIV status compared to approximately 40% to 50% in older age groups (Ng'ang'a et al., 2014).

HIV testing services (HTS) are a critical component of the response to the HIV epidemic in Kenya (National AIDS and STI Control Programme [NASCOP], Ministry of Health, 2015). HTS are often delivered through client-initiated testing and counseling (CITC) in which individuals voluntarily seek HTS either in the community or in health facility settings. HTS are also delivered through provider-initiated testing and counseling (PITC) approaches, whereby health care providers make routine recommendations to persons attending health care facilities (NASCOP, Ministry of Health, 2015). The Kenyan national guidelines recommend annual HIV testing among the general population (i.e., defined as people who are not at increased risk of HIV because of low-risk behaviors) and quarterly HIV testing for high-risk individuals who are frequently exposed to HIV (NASCOP, Ministry of Health, 2015). This includes vulnerable young adults who are at an increased risk of HIV because of specific high-risk behaviors, such as men who have sex with men, people who inject drugs, and people employed by sex work (NASCOP, Ministry of Health, 2015; National AIDS Control Council, 2015). However, there are numerous barriers to HTS among Kenyan young adults, including lack of social support, fear of positive results, stigma, and accessibility to HTS centers – resulting in less than optimal uptake of HTS among in this population (Cheruiyot et al., 2019; Kabiru et al., 2010; Nall et al., 2019; Tenkorang & Maticka-Tyndale, 2013). Only 70% of young Kenyan women and 57% of young Kenyan men have ever tested for HIV and received their test results (Kenya National Bureau of Statistics et al., 2015).

To address challenges in access to and uptake of HTS among young adults, Kenya has adopted HIV self-testing (HIVST) to supplement CITC and PITC approaches (NASCOP, Ministry of Health, 2017; UNAIDS, 2017). By encouraging individuals to perform an HIV test privately and conveniently at home, studies have shown that HIVST can reduce the social and structural barriers associated with facility- and community-based testing and generate demand among those unreachable by existing facility- and community-based testing services (Johnson et al., 2017; Katz et al., 2018; Pettifor et al., 2020; World Health Organization [WHO], 2016). HIVST can be performed using oral fluid (e.g., Saliva and gum particles) or blood (Indravudh et al., 2018; WHO, 2016). However,

unlike blood-based HIVST, which involves pricking the finger with a lancet to collect blood, oral-based HIVST involves swabbing the gums with the test device for oral fluid and is less invasive, easier to use, and potentially more preferable to users (Balán et al., 2017; Krause et al., 2013; Stevens et al., 2018).

However, despite these potential benefits, little is known about the awareness of and willingness to use HIVST in vulnerable young adults (Johnson et al., 2020). While studies among key populations, older adults, and health care providers (Gichangi et al., 2018; Kalibala et al., 2014; Kelvin et al., 2018, 2019; Kurth et al., 2016; Ochako et al., 2014; Pintye et al., 2019; Vrana-Diaz et al., 2019) in Kenya have found high willingness and acceptability of HIVST (Masters et al., 2016; Pintye et al., 2019), there is a paucity of evidence specific to HIVST willingness in Kenyan young adults. Previous HIVST studies in African young adults have not included impoverished youth such as those living in informal urban settlements (Hector et al., 2018; Iliyasu et al., 2020; Izizag et al., 2018; Mokgatle & Madiba, 2017; Nwaozuru et al., 2019; Ritchwood et al., 2019; Smith et al., 2016; Tonen-Wolyec et al., 2019).

This study examined awareness of and willingness to use oral HIVST among high-risk young adults living in Kenya's informal urban settlements. We also examined differences in HIVST awareness and willingness by young adults' demographic and sexual risk factors. Insights into preferred usage of HIVST among high-risk young adults can inform the scale-up of HIV testing services in Kenya and other similar settings.

## Methods

### Design

A cross-sectional survey was administered among young adults, aged 18–22 years old, using respondent-driven sampling (RDS) within two informal urban settlements in Nairobi, Kenya: Korogocho and Kawangware (Jennings Mayo-Wilson et al., 2020). RDS is a sampling method that operates as a chain-referral sampling process that is driven by peers and used to estimate characteristics of hidden groups that public health services do not well reach (Heckathorn, 2002). The survey was administered in-person in English or the local language (Kiswahili) by nine trained Kenyan interviewers.

### Setting

Korogocho is one Nairobi's northeast informal urban settlements, and Kawangware is one the city's western

informal urban settlements. Both are located within 6–9 miles from the city center. According to the most recent Population and Housing Census, each settlement's population is approximately 130,000–200,000 people, the majority of whom are children and young adults. There is little infrastructure serving Korogocho and Kawangware's residents, including limited safe drinking water, sanitation, durable housing, and access to electricity.

## Eligibility

Study eligibility was determined using a paper-based screening tool. Individuals were eligible if at the time of enrollment they self-reported that they: were Kenyan, had primary residence within the Korogocho or Kawangware informal urban settlements, and were aged 18–22 years. Self-report was used given that

**Table 1.** Crude and RDS-weighted estimates of demographic characteristics, sexual risk behaviors, and awareness of and willingness to use oral HIV self-test kits in Kenyan young adults ( $N = 350$ ).

| Demographic characteristics                                             | Crude    |                | RDS-weighted   |          |
|-------------------------------------------------------------------------|----------|----------------|----------------|----------|
|                                                                         | <i>N</i> | % <sup>a</sup> | % <sup>a</sup> | (95% CI) |
| Gender                                                                  |          |                |                |          |
| Male                                                                    | 196      | 56             | 50             | (43, 57) |
| Female                                                                  | 154      | 44             | 50             | (43, 57) |
| Age (in years)                                                          |          |                |                |          |
| 18–19                                                                   | 209      | 60             | 61             | (54, 67) |
| 20–22                                                                   | 106      | 40             | 38             | (31, 45) |
| Highest level of education                                              |          |                |                |          |
| Primary                                                                 | 175      | 50             | 53             | (46, 60) |
| Secondary or higher                                                     | 174      | 50             | 47             | (40, 54) |
| Marital status                                                          |          |                |                |          |
| Married/Cohabiting                                                      | 19       | 5              | 6              | (3, 10)  |
| Single <sup>b</sup>                                                     | 330      | 94             | 94             | (90, 97) |
| Monthly Income <sup>c</sup>                                             |          |                |                |          |
| < KSh 5,000                                                             | 165      | 47             | 48             | (42, 55) |
| KSh 5,000–9,999                                                         | 69       | 20             | 19             | (14, 24) |
| ≥ KSh 10,000                                                            | 78       | 22             | 20             | (15, 26) |
| Tribal Ethnicity                                                        |          |                |                |          |
| Luo                                                                     | 22       | 6              | 5              | (3, 9)   |
| Luhya                                                                   | 43       | 12             | 13             | (9, 19)  |
| Kikuyu                                                                  | 163      | 47             | 45             | (38, 52) |
| Garre                                                                   | 40       | 11             | 14             | (9, 20)  |
| Borana                                                                  | 18       | 5              | 5              | (3, 9)   |
| Mixed/Other                                                             | 62       | 18             | 18             | (13, 24) |
| Sexual behaviors                                                        |          |                |                |          |
| Ever had sex ( $n = 350$ )                                              | 231      | 66             | 60             | (53, 67) |
| Recent high-risk sexual behavior <sup>d</sup> ( $n = 231$ )             | 180      | 78             | 76             | (68, 83) |
| HIV self-testing                                                        |          |                |                |          |
| Awareness of oral HIV self-testing ( $n = 350$ )                        | 67       | 19             | 19             | (14, 25) |
| Willing to use oral HIV self-test ( $n = 349$ )                         | 263      | 75             | 74             | (67, 79) |
| Willing to ask a sexual partner to use oral HIV self-test ( $n = 299$ ) | 231      | 77             | 75             | (68, 81) |

[a] Percentages may not add up to 100% due to rounding and/or missing or don't know responses; [b] Includes widowed, divorced, or separated; [c] 1 US Dollar (USD) ≈ 103 Kenyan Shillings (KSh); [d] Includes report of one or more of the following in the last six months among respondents who reported having had sex: unprotected sex, sex while high/drunk, sex exchange, and sex with three or more partners.

young adults in this population commonly lacked government-issued identification or postal mail. Therefore, to minimize sample biases, in addition to self-report, a community health worker from the informal urban settlement was present during enrollment to affirm residence and age. In addition, participant names and birth dates were used to avoid duplication. All three eligibility criteria had to be met to be included in the study. The screening process took approximately two minutes to complete and was conducted by the field supervisor who then assigned the participant to an on-site interviewer (Jennings Mayo-Wilson et al., 2020).

## Data collection

Interviews were conducted at community centers within each of the informal urban settlements using a structured questionnaire developed by the research team, translated, and pre-tested. The survey questionnaire included the following 5 questions relating to HIVST: (1) Have you heard of an oral HIV self-test? Followed by a definition of HIVST that described HIVST as a “test a person can do themselves at home using their saliva and receive the results in 20 min”; (2) Would you be willing to use an oral HIV self-test in the future? (3) If yes, what would be some possible reasons to use the oral HIV self-test, and if no, what would be some possible reasons to not use the oral HIV self-test? (4) Would you be comfortable asking your sexual partner(s) to use an oral HIV self-test before you had sex? and (5) Where would you prefer to go and collect an oral HIV self-test kit? The study also obtained: (a) demographic data relating to age, gender, education, marital status, monthly income, and tribal ethnicity as well as (b) sexual behavioral data relating to ever having sex (yes or no) and recent engagement in high-risk sexual behavior (yes or no), defined as reporting one of more of the following risk behaviors in last six months – unprotected sex, sex while high or drunk, sex exchange, or sex with three or more partners. A more detail description of the study's methodology is previously published (Jennings Mayo-Wilson et al., 2020).

## Analysis

We calculated crude and RDS-weighted descriptive statistics to summarize the descriptive data. The RDS weights were generated using the RDS-II estimator in the Respondent Driven Sampling Analysis Tool (RDSAT), Version 7.146 (Cornell University, Ithaca, NY, U.S., <http://www.respondentdrivensampling.org>), based on the inverse of each participant's personal network size, rescaled to sum to the total sample size. We

also estimated the crude odds ratios (OR) and adjusted odds ratio (AOR) with their respective 95% confidence intervals (CIs) using bivariate and multivariate logistic regression analyses to assess associations of demographic and sexual risk behaviors with awareness of and willingness to use HIVST. Data were analyzed using SPSS (Version 26). In the adjusted models, we controlled for age, gender, and education. Analyses were considered statistically significant at  $p < 0.05$ .

## Ethics

This study received ethics approval from the Johns Hopkins Bloomberg School of Public Health Institutional Review Board (IRB#0007421) and the Kenyatta National Hospital, University of Nairobi Ethics and Research Review Committee. Written informed consent was obtained from all participants prior to data collection.

## Results

### Sample demographics and sexual risk behaviors

Table 1 describes the sample's distribution of demographic and sexual risk behaviors. A total of 350 young adults were enrolled in the study. Most participants were male (56%) and under the age of 20 years old (60%) (Table 1). Approximately 50% of participants had completed secondary education or higher. Most (94%) were unmarried/single. The largest ethnic group was Kikuyu (47%). Approximately two-thirds (66%) of participants reported ever having sex and, among those who had sexually debuted, 78% reported having engaged in one or more high-risk sexual behaviors in the past six months, such as unprotected sex, sex while high or drunk, sex exchange, and sex with three or more sex partners (Table 1). Trends were similar among RDS-weighted measures.

### Prevalence of HIVST awareness and willingness to use

Awareness of oral HIV self-testing was low. Nineteen percent (19%) of participants stated that they had heard of an oral HIVST kit compared to 81% who had not (Table 1). However, willingness to use HIVST in the future was comparatively high. Most participants (75%) indicated that they would be willing to use an oral HIV self-test in the future, and 77% reported feeling comfortable in asking their sexual partner(s) to use an oral HIV self-test kit before having sex (Table 1).

### Demographic and sexual factors associated with awareness of and willingness to use HIVST

Table 2 reports the unadjusted odds ratios and 95% confidence intervals of demographic and sexual behavioral factors associated with awareness of HIVST, willingness to use HIVST, and willingness to ask a sex partner to use HIVST. No demographic or sexual risk behaviors were significantly associated with awareness of HIVST. However, gender, age, education, and recent engagement in one or more high-risk sexual behaviors was significantly associated with willingness to use an oral HIV self-test kit. Women had significantly greater odds of willingness to use an oral HIV self-test kit (OR = 1.80, 95% CI: 1.11, 2.92) as compared to young men. Older young adults (aged 20+) were also significantly more willing to use an oral HIV self-test kit (OR = 2.57, 95% CI: 1.48, 4.46) and ask a sex partner to use an oral HIV self-test kit (OR = 2.66, 95% CI: 1.47, 4.83) as compared to teen-aged young adults (aged 18–19). The odds of willingness to use an oral HIV self-test kit was also significantly higher in more educated participants as compared to those with primary education or less (OR = 2.25, 95% CI: 1.36, 3.70). Marital status was not associated with willingness to use an oral HIV self-test kit (i.e., self or partner) (OR = 0.40, 95% CI: 0.10, 1.60), potentially due in part to the limited convergence and variability of this variable. Monthly income was also largely not found to be associated with willingness to use an oral HIV self-test kit. However, participants with the highest income were consistently less likely to be willing to use an oral HIV self-test kit as compared to participants with lower monthly income. Specifically, higher-income participants were 53% significantly less likely (OR = 0.47, 95% CI: 0.25, 0.89) to be willing to ask a sex partner to use an oral HIV self-test kit than lower-income participants.

Among sexual risk behaviors, having sexually debuted was not significantly associated with willingness to use an oral HIV self-test kit (OR = 1.48, 95% CI: 0.91, 2.40) or ask one's partners to use a kit (OR = 1.04, 95% CI: 0.58, 1.84). However, engagement in one or more high-risk sexual behaviors was significantly associated with being less willing to use an oral HIV self-test kit (OR = 0.34, 95% CI: 0.13, 0.86) – although this relationship was not significant relative to willingness to ask sex partners (OR = 0.54, 95% CI: 0.23, 1.27). Findings were comparable in the adjusted analyses after controlling for age, gender, and education (Table 3). Of note in adjusted analyses is that awareness of HIVST was significantly associated with being less likely to be willing to use HIVST (OR = 0.33, 95% CI:

**Table 2.** Bivariate logistic regression analyses of demographic and sexual risk behaviors associated with awareness of oral HIV self-testing (HIVST), willingness to use oral HIVST, and willingness to ask a sexual partner to use oral HIVST before sex in Kenyan young adults (N = 350)

| Characteristics                               | Awareness of oral HIV self-test<br>OR (95%CI) | Willingness to use oral HIV self-test<br>OR (95%CI) | Willingness to ask a sexual partner to use oral HIV self-test before sex<br>OR (95%CI) |
|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------------|----------------------------------------------------------------------------------------|
| Gender                                        |                                               |                                                     |                                                                                        |
| Male                                          | 1.0                                           | 1.0                                                 | 1.0                                                                                    |
| Female                                        | 1.29 (0.76, 2.22)                             | <b>1.80 (1.11, 2.92)*</b>                           | 1.55 (0.91, 2.64)                                                                      |
| Age (in years)                                |                                               |                                                     |                                                                                        |
| 18–19                                         | 1.0                                           | 1.0                                                 | 1.0                                                                                    |
| 20–22                                         | 1.05 (0.61, 1.82)                             | <b>2.57 (1.48, 4.46)**</b>                          | <b>2.66 (1.47, 4.83)**</b>                                                             |
| Highest level of education                    |                                               |                                                     |                                                                                        |
| Primary                                       | 1.0                                           | 1.0                                                 | 1.0                                                                                    |
| Secondary or higher                           | 0.60 (0.34, 1.04)                             | <b>2.25 (1.36, 3.70)**</b>                          | 1.63 (0.95, 2.82)                                                                      |
| Marital status                                |                                               |                                                     |                                                                                        |
| Married/Cohabiting                            | 1.0                                           | 1.0                                                 | 1.0                                                                                    |
| Single <sup>a</sup>                           | 0.52 (0.19, 1.44)                             | 0.04 (<0.01, 1.41)                                  | 0.40 (0.10, 1.60)                                                                      |
| Monthly Income <sup>b</sup>                   |                                               |                                                     |                                                                                        |
| < KSh 5,000                                   | 1.0                                           | 1.0                                                 | 1.0                                                                                    |
| KSh 5,000–9,999                               | 0.93 (0.45, 1.94)                             | 1.37 (0.68, 2.79)                                   | 0.93 (0.43, 1.99)                                                                      |
| ≥ KSh 10,000                                  | 0.76 (0.36, 1.60)                             | 0.80 (0.43, 1.48)                                   | <b>0.47 (0.25, 0.89)*</b>                                                              |
| Tribal Ethnicity                              |                                               |                                                     |                                                                                        |
| Luo                                           | 1.0                                           | 1.0                                                 | 1.0                                                                                    |
| Luhya                                         | 2.58 (0.47, 14.14)                            | 0.26 (0.05, 1.32)                                   | 0.20 (0.03, 1.52)                                                                      |
| Kikuyu                                        | 2.65 (0.54, 13.08)                            | 0.35 (0.07, 1.63)                                   | 0.21 (0.03, 1.45)                                                                      |
| Garre                                         | 0.54 (0.08, 3.90)                             | 0.23 (0.05, 1.15)                                   | 0.14 (0.02, 1.03)                                                                      |
| Borana                                        | 0.77 (0.06, 7.92)                             | <b>0.12 (0.02, 0.73)*</b>                           | <b>0.09 (0.01, 0.93)*</b>                                                              |
| Mixed/Other                                   | 2.66 (0.51, 13.98)                            | 0.55 (0.11, 2.82)                                   | 0.39 (0.05, 2.97)                                                                      |
| Ever had sex                                  |                                               |                                                     |                                                                                        |
| No                                            | 1.0                                           | 1.0                                                 | 1.0                                                                                    |
| Yes                                           | 1.70 (0.94, 3.06)                             | 1.48 (0.91, 2.40)                                   | 1.04 (0.58, 1.84)                                                                      |
| Recent high-risk sexual behavior <sup>c</sup> |                                               |                                                     |                                                                                        |
| No                                            | 1.0                                           | 1.0                                                 | 1.0                                                                                    |
| Yes                                           | 0.82 (0.39, 1.76)                             | <b>0.34 (0.13, 0.86)*</b>                           | 0.54 (0.23, 1.27)                                                                      |
| Awareness of oral HIV self-test               |                                               |                                                     |                                                                                        |
| No                                            | N/A                                           | 1.0                                                 | 1.0                                                                                    |
| Yes                                           |                                               | 0.58 (0.32, 1.02)                                   | 1.14 (0.58, 2.25)                                                                      |
| Willingness to use oral HIV self-test         |                                               |                                                     |                                                                                        |
| No                                            | N/A                                           | N/A                                                 | 1.0                                                                                    |
| Yes                                           |                                               |                                                     | <b>21.19 (10.91, 41.17)***</b>                                                         |

[a] Includes widowed, divorced, or separated; [b] 1 US Dollar (USD) ≈ 103 Kenyan Shillings (KSh); [c] Includes report of one or more of the following in the last six months among respondents who reported having had sex: unprotected sex, sex while high/drunken, sex exchange, and sex with three or more partners; \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ . Statistically significant findings are starred and bolded to facilitate identification.

0.120.90), while willingness to use HIVST oneself was significantly and strongly associated with being more willing to ask one's sex partner to use HIVST (OR = 21.19, 95%CI: 10.91, 41.17) (Table 3).

### Reasons for willingness to use or not to use HIVST

Table 4 presents reported reasons for willingness to use (or not use) oral HIV self-test kits. The three most commonly cited reasons in favor of HIVST were knowing one's HIV status (76%), having increased confidentiality (38%), increased convenience (21%), and lower risk of unintended disclosure (also 21%) (Table 4). The three most commonly cited reasons against HIVST were possible inaccurate test results (53%), possible self-harm (23%), and lack of pre- and post-test counselling (17%).

### Preferred points-of-access for HIV self-test kits

Table 5 describes participant preferences for places to access HIV self-test kits. The three most frequently preferred venues were a hospital (59%), HIV clinic (19%), and pharmacy/laboratory (12%) (Table 5). The least preferred places were within a community center (4%) or within a school/university (2%).

### Discussion

This study examined awareness of and willingness to use oral HIVST among high-risk young adults living in Kenya's informal urban settlements. We also examined differences in HIVST awareness and willingness by demographic and sexual risk factors. We found that awareness of oral HIV self-testing was low (19%) but willingness to use a self-test kit was high (75%).

**Table 3.** Adjusted logistic regression analyses of demographic and sexual risk behaviors associated with awareness of oral HIVST, willingness to use oral HIVST, and willingness to ask a sexual partner to use oral HIVST before sex in Kenyan young adults ( $N = 350$ ).

| Characteristics                                | Awareness of oral HIV self-test<br>AOR <sup>a</sup> (95%CI) | Willingness to use oral HIV self-test<br>AOR <sup>a</sup> (95%CI) | Willingness to ask a sexual partner to use oral HIV self-test before sex<br>AOR <sup>a</sup> (95%CI) |
|------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| Gender                                         |                                                             |                                                                   |                                                                                                      |
| Male                                           | 1.0                                                         | 1.0                                                               | 1.0                                                                                                  |
| Female                                         | 1.21 (0.69, 2.11)                                           | <b>1.99 (1.18, 3.33)**</b>                                        | 1.55 (0.88, 2.74)                                                                                    |
| Age (in years)                                 |                                                             |                                                                   |                                                                                                      |
| 18–19                                          | 1.0                                                         | 1.0                                                               | 1.0                                                                                                  |
| 20–22                                          | 1.13 (0.63, 2.03)                                           | <b>2.00 (1.13, 3.56)*</b>                                         | <b>2.28 (1.22, 4.25)**</b>                                                                           |
| Highest level of education                     |                                                             |                                                                   |                                                                                                      |
| Primary                                        | 1.0                                                         | 1.0                                                               | 1.0                                                                                                  |
| Secondary or higher                            | 0.59 (0.33, 1.05)                                           | <b>2.02 (1.18, 3.45)*</b>                                         | 1.45 (0.80, 2.63)                                                                                    |
| Marital status                                 |                                                             |                                                                   |                                                                                                      |
| Married/Cohabiting                             | 1.0                                                         | 1.0                                                               | 1.0                                                                                                  |
| Single <sup>b</sup>                            | 0.58 (0.20, 1.71)                                           | 0.07 (<0.01, 2.43)                                                | 0.67 (0.16, 2.90)                                                                                    |
| Monthly Income <sup>c</sup>                    |                                                             |                                                                   |                                                                                                      |
| < KSh 5,000                                    | 1.0                                                         | 1.0                                                               | 1.0                                                                                                  |
| KSh 5,000–9,999                                | 1.00 (0.47, 2.13)                                           | 1.38 (0.65, 2.93)                                                 | 0.88 (0.39, 1.95)                                                                                    |
| ≥ KSh 10,000                                   | 0.94 (0.42, 2.11)                                           | 0.67 (0.33, 1.36)                                                 | <b>0.38 (0.18, 0.81)*</b>                                                                            |
| Tribal ethnicity                               |                                                             |                                                                   |                                                                                                      |
| Luo                                            | 1.0                                                         | 1.0                                                               | 1.0                                                                                                  |
| Luhya                                          | 2.18 (0.39, 12.25)                                          | 0.27 (0.06, 1.50)                                                 | 0.21 (0.03, 1.62)                                                                                    |
| Kikuyu                                         | 2.73 (0.54, 13.70)                                          | 0.48 (0.10, 2.34)                                                 | 0.27 (0.04, 1.92)                                                                                    |
| Garre                                          | 0.52 (0.07, 3.87)                                           | 0.36 (0.07, 1.91)                                                 | 0.20 (0.03, 1.59)                                                                                    |
| Borana                                         | 0.58 (0.05, 6.73)                                           | 0.21 (0.03, 1.28)                                                 | 0.13 (0.01, 1.35)                                                                                    |
| Mixed/Other                                    | 2.71 (0.51, 14.38)                                          | 0.64 (0.12, 3.39)                                                 | 0.40 (0.05, 3.11)                                                                                    |
| Ever had sex                                   |                                                             |                                                                   |                                                                                                      |
| No                                             | 1.0                                                         | 1.0                                                               | 1.0                                                                                                  |
| Yes                                            | 1.86 (0.97, 3.54)                                           | 1.19 (0.69, 2.04)                                                 | 0.78 (0.41, 1.47)                                                                                    |
| Recent high-risk sexual behaviors <sup>d</sup> |                                                             |                                                                   |                                                                                                      |
| No                                             | 1.0                                                         | 1.0                                                               | 1.0                                                                                                  |
| Yes                                            | 0.93 (0.43, 2.05)                                           | <b>0.33 (0.12, 0.90)*</b>                                         | 0.55 (0.22, 1.34)                                                                                    |
| Awareness of oral HIV self-test                |                                                             |                                                                   |                                                                                                      |
| No                                             | N/A                                                         | 1.0                                                               | 1.0                                                                                                  |
| Yes                                            |                                                             | <b>0.53 (0.29, 0.97)*</b>                                         | 1.16 (0.58, 2.34)                                                                                    |
| Willingness to use oral HIV self-test          |                                                             |                                                                   |                                                                                                      |
| No                                             | N/A                                                         | N/A                                                               | 1.0                                                                                                  |
| Yes                                            |                                                             |                                                                   | <b>21.70 (10.57, 44.55)***</b>                                                                       |

[a] Adjusts for age, gender, and education; [b] Adjusts for age, gender, and education; [b] Includes widowed, divorced, or separated; [c] 1 US Dollar (USD) ≈ 103 Kenyan Shillings (KSh); [d] Includes report of one or more of the following in the last six months among respondents who reported having had sex: unprotected sex, sex while high/drunken, sex exchange, and sex with three or more partners; \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ . Statistically significant findings are starred and bolded to facilitate identification.

Women, older, and more educated more participants were more willing to use HIVST as compared to men, teen-aged, and less educated participants. Those who were willing to use HIVST themselves were also more likely to be willing to ask a sex partner to use HIVST before sex. However, participants who reported recent engagement in high-risk sexual behaviors were significantly less likely to be willing to use an oral HIV self-test kit. Willingness to self-test appeared largely driven by the desire to know one's HIV status confidentially and conveniently. Hospitals and HIV clinics were the most preferred point-of-access for self-test kits. Among those who opposed HIVST, possible inaccurate test results, limited counseling support, and risk of self-harm were key concerns. These findings point to several important considerations for promotion and implementation of HIVST in this population.

First, given the reported low awareness of HIVST among the sample, a significant level of HIVST promotional effort is needed among young adults in similar settings. Low awareness of HIVST may be the consequence of limited access to resources and information in impoverished settings in Kenya. It may also be attributed to home-based self-test kits being a relatively new HIV prevention technology. Recruiting and training peers to lead HIVST awareness campaigns could be an acceptable and feasible strategy to improve awareness since peers share common characteristics and experiences. Peers could also serve as models and provide post-test support for self-testers in their social networks. By providing detailed demonstrations of how the HIV self-testing kit work, they can also show their peers that others like themselves can do it. Studies in sub-Saharan Africa have demonstrated the importance of peers in increasing HIV testing uptake among men

**Table 4.** Crude and RDS-weighted estimates of reported reasons among Kenyan Young adults for willingness to use or not to use an oral HIV self-test kit ( $N = 350$ ).

| Reasons for willingness to use an oral HIVST kit ( $n = 262$ ) <sup>a</sup>    | Crude    |    | RDS-weighted |          |
|--------------------------------------------------------------------------------|----------|----|--------------|----------|
|                                                                                | <i>N</i> | %  | %            | (95% CI) |
| Knowledge of HIV status                                                        | 198      | 76 | 74           | (67, 80) |
| Increased confidentiality                                                      | 99       | 38 | 38           | (30, 46) |
| Increased convenience                                                          | 56       | 21 | 23           | (17, 31) |
| Autonomy or ability to do it one's self                                        | 15       | 6  | 4            | (2, 8)   |
| Less stigma                                                                    | 22       | 8  | 10           | (6, 17)  |
| Less risk of status disclosure                                                 | 21       | 8  | 11           | (7, 17)  |
| Saves time                                                                     | 55       | 21 | 23           | (16, 31) |
| Saves money                                                                    | 12       | 5  | 6            | (3, 12)  |
| Easier to repeat                                                               | 26       | 10 | 9            | (6, 14)  |
| Accessed through more outlets                                                  | 1        | 0  | 0            | (0, 3)   |
| Other reasons                                                                  | 6        | 2  | 2            | (1, 5)   |
| Reasons for non-willingness to use an oral HIVST kit ( $n = 79$ ) <sup>a</sup> | <i>N</i> | %  | %            | %        |
| Too costly or expensive                                                        | 1        | 1  | 5            | (1, 27)  |
| Possible inaccurate results                                                    | 42       | 53 | 59           | (45, 72) |
| Lack of counselling                                                            | 13       | 17 | 24           | (13, 41) |
| Difficulty with referral to care and treatment                                 | 1        | 1  | 2            | (0, 14)  |
| Facility-based HIV testing is free                                             | 3        | 4  | 4            | (1, 13)  |
| Unsafe disposal                                                                | 3        | 4  | 3            | (1, 12)  |
| Possible self-harm                                                             | 18       | 23 | 27           | (16, 42) |
| Used with coercion                                                             | 1        | 1  | 1            | (0, 7)   |
| Ill-omened use of money                                                        | 0        | 0  | 0            | (0, 0)   |
| Encourages unprotected sex                                                     | 2        | 3  | 3            | (1, 14)  |
| Other reasons                                                                  | 29       | 37 | 25           | (16, 38) |

[a] Excludes participants who reported no reason ( $n = 9$ ).

(Choko et al., 2011; Conserve et al., 2018; Hatzold et al., 2019; Matovu et al., 2020). Other studies in developing countries have also shown the efficacy of peer interventions for HIV prevention with demonstrated effects on HIV knowledge, condom use, and less equipment sharing among injection drug users (Simoni et al., 2011).

Secondly, despite the low HIVST awareness, it is promising that many participants were willing to use HIV self-testing kits. Consistent with other studies, willingness to self-test was favored because of ease of delivery, confidentiality, and the desire to know one's status (Harichund et al., 2019; Makusha et al., 2015). This may not be surprising given that most of the deterrents to HIV testing in sub-Saharan Africa are related to the mode of delivery including inconvenience to accessing

HIV testing facilities, direct and indirect costs related with HIV testing and the stigma attached to showing up at HIV testing clinics (Musheke et al., 2013). Consequently, the potential of HIVST to remove the aforementioned barriers can facilitate HIV self-testing uptake among the youth.

However, some challenges to promotion of HIVST in vulnerable young adults may need to be addressed. One is that women were significantly more likely to be willing to self-test for HIV than men. In fact, young men's unwillingness to show up at HIV testing clinics have been demonstrated in other studies (Camlin et al., 2016; Masters et al., 2016; Conserve et al., 2018). Low uptake of HIV testing in men has been attributed to several factors including masculinity norms and economic and structural barriers limiting men from accessing testing centers (Camlin et al., 2016). Conversely, we have seen encouraging studies in sub-Saharan where women were instrumental in increasing the uptake of HIV testing among male sex partners (Masters et al., 2016). A recent study in Tanzania also demonstrated the importance of men's social networks with other men in encouraging uptake of HIV prevention services (Conserve et al., 2018). HIVST lessons learned in these settings may also be applicable for use among settlement-based young men in Kenya.

A second challenge to be addressed relates to youth-focused education and promotion HIVST. Our study found that concerns and misconceptions relating to HIVST (i.e., inaccurate results, harmful, ill-omened) were reasons for non-use HIVST. In fact, young adults who stated that they had heard of HIVST prior to the study were also significantly less likely to be willingness to use HIVST because of their prior knowledge of self-test kits. Participants with the lowest levels of education were also less likely to endorse HIVST. Surprising, participants with the highest monthly income were also less likely to be willing to use HIVST. While more research is needed, it is plausible that higher-income individuals are less adversely impacted by the economic and structural costs of facility-based HIV testing – and, therefore, less sensitive to the added convenience of home-based self-testing. As such, these findings suggest that significant efforts are needed to highlight the range of benefits of HIVST (i.e., economic, social, structural, clinical) that appeal to various youth demographics, in addition to addressing concerns and misinformation relating to HIVST (Choko et al., 2011; NASCOP, Ministry of Health, 2015). Studies have shown that increased education enhances the ability of individuals to adopt innovations and change behaviors in response to health behavior campaigns (Pampel et al., 2010). Designing HIVST outreach programs that address limited access

**Table 5.** Crude and RDS-weighted estimates of reported most preferred point-of-access to acquire oral HIV self-test kits among Kenyan young adults who were willing to use HIVST ( $N = 263$ ).

| Most preferred point-of-access ( $N = 263$ ) | Crude                 |    | RDS-weighted |          |
|----------------------------------------------|-----------------------|----|--------------|----------|
|                                              | <i>N</i> <sup>a</sup> | %  | %            | (95% CI) |
| General hospital                             | 152                   | 59 | 59           | (51, 66) |
| Specialized HIV clinic                       | 48                    | 19 | 19           | (13, 26) |
| Pharmacy or laboratory                       | 31                    | 12 | 13           | (9, 19)  |
| Community center                             | 10                    | 4  | 4            | (2, 8)   |
| School or university                         | 4                     | 2  | 1            | (0, 4)   |
| Other place                                  | 13                    | 5  | 4            | (2, 7)   |

[a] Excludes participants ( $n = 5$ ) with erred multiple responses.

to resources and information in impoverished settings may prove vital to HIV prevention in settlement-based youth. In fact, in Ethiopia, community conversations were found to positively change misconceptions about HIV in young adults (Esma'el et al., 2015). A similar model may be important for HIVST in Kenya's informal urban settlements.

### Limitations

The study's results should be interpreted with consideration of its limitations. First, the cross-sectional design limited our ability to assess causality. Observed associations may be a consequence and/or cause of other factors. All data are also based on self-report and reflect participants' preferences in a hypothetical future. Social desirability bias may have influenced endorsements of HIVST. More research is needed to assess actual use of HIVST as self-test kits, education, and support become more available. Lastly, given our use of respondent driven sampling, the results of this study are most representative of networked young adults living in informal urban settlements. Findings may be less generalizable to disconnected settlement-based youth.

### Conclusion

HIV testing services are a cornerstone of prevention, care, and treatment of HIV. Implementation of self-initiated home-based testing of HIV may be a promising strategy to improve testing in hard-to-reach young adults, provided they are aware of and willing to use oral HIV self-test kits. This study found that while awareness of HIVST was low, young adults were willing to use HIVST themselves and to ask their sex partners to self-test. However, more community- and peer-based efforts are needed to promote HIVST in teen-aged, male, and less educated youth, in addition to addressing concerns of test accuracy, self-harm, and limited support. As HIV self-testing increases in popularity, tailored approaches will be needed for equitable increases in uptake.

### List of abbreviations

AOR: Adjusted odds ratio; ART: Antiretroviral therapy; CI: Confidence interval; CITC: Client-initiated testing and counseling; HIV: Human Immunodeficiency Virus; HIVST: HIV self-testing; HTS: HIV testing services; KSH: Kenya Shillings; NAHEDO: National Health and Development Organization; NASCOP: National AID and STI Control Programme; OR: Odds ratio; PITC: Provider-initiated testing and counseling;

PLHIV: People living with HIV; RDS: Respondent-driven sampling; UNAIDS: Joint United Nations Programme on HIV/AIDS; USD: United States dollar; WHO: World Health Organization.

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### Availability of data and material

The dataset analyzed during the current study is available in the Data. Mendeley repository, <https://data.mendeley.com/datasets/xdk2frn44k>; doi:10.17632/xdk2frn44k.1.

### Authors' contributions

LJMW and MM are the co-principal investigators of the study (U.S. and Kenya, respectively). LJMW, MM, and MOM planned and implemented the research. DFC also assisted in planning the research relating to HIVST. LJMW and DFC developed the plan for analysis. BOB cleaned the data and conducted the analysis with assistance from DA. BOB, DA, DFC, and LJMW prepared the first draft of the manuscript. MM and MOM provided additional scientific and technical inputs. All authors contributed to editing the manuscript. All authors have read and approved the final manuscript.

### Disclosure statement

No potential conflict of interest was reported by the author(s).

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