Kiwanuka, Noah; Ssetaala, Ali; Nalutaaya, Annet; Mpendo, Juliet; Wambuzi, Matthias; Nanvubya, Annet; Sigirenda, Simon; Kitandwe, Paul Kato; Nielsen, Leslie Elizabeth; Balyegisawa, Apolo; Kaleebu, Pontiano; Nalusiba, Josephine; Sewankambo, Nelson Kaulukusi (2014) High Incidence of HIV-1 Infection in a General Population of Fishing Communities around Lake Victoria, Uganda. PLOS ONE, 9 (5). ISSN 1932-6203 DOI: https://doi.org/10.1371/journal.pone.0094932

Downloaded from: http://researchonline.lshtm.ac.uk/4651923/

DOI: 10.1371/journal.pone.0094932

Usage Guidelines

Please refer to usage guidelines at http://researchonline.lshtm.ac.uk/policies.html or alternatively contact researchonline@lshtm.ac.uk.

Available under license: http://creativecommons.org/licenses/by/2.5/
High Incidence of HIV-1 Infection in a General Population of Fishing Communities around Lake Victoria, Uganda

Noah Kiwanuka¹,²*, Ali Ssetaala², Annet Nalutaaya², Juliet Mpendo², Matthias Wambuzi², Annet Nanvubya², Simon Sigirenda², Paul Kato Kitandwe², Leslie Elizabeth Nielsen³, Apolo Balyegisawa³, Pontiano Kaleebu⁴, Josephine Nalusiba⁵, Nelson Kaulukusi Sewankambo⁵

¹ Makerere University College of Health Sciences, School of Public Health, Kampala, Uganda, ² Uganda Virus Research Institute-International AIDS Vaccine Initiative HIV Vaccine Program, Entebbe, Uganda, ³ International AIDS Vaccine Initiative (IAVI), New York, New York, United States of America, ⁴ Medical Research Council/UGanda Virus Research Institute, Uganda Research Unit on AIDS, Entebbe, Uganda, ⁵ Makerere University College of Health Sciences, School of Medicine, Clinical Epidemiology Unit, Kampala, Uganda

Abstract

Background: High HIV-1 incidence rates were reported among persons in fisherfolk communities (FFC) in Uganda who were selected for high risk behaviour. We assessed the incidence of HIV-1 and associated risk factors in a general population FFC to determine population-wide HIV rates.

Methods: A community-based cohort study was conducted among a random sample of 2191 participants aged 18–49 years. At baseline and 12 months post-baseline, data were collected on socio-demographic characteristics and risky behaviors (including number of partners, new partners, condom use, use of alcohol and illicit drug use). Venous blood was collected for HIV serological testing. HIV incidence was calculated per 100 person years at-risk (pyar) and adjusted incidence rate ratios (Adj.IRR) were estimated by multivariable Poisson regression.

Results: Overall follow up at 12 months was 76.9% (1685/2191) and was significantly higher among HIV uninfected persons and those with at least 1 year duration of stay in community. Overall HIV-1 incidence was 3.39/100 pyar (95% CI: 2.55–4.49). Among the 25–29 years who drank alcohol, HIV incidence was 7.67/100pyar (95% CI:4.62–12.7) while it was 5.67/100pyar (95% CI:3.14–10.2) for 18–24 year olds who drank alcohol. The risk of HIV infection was higher among 25–29 years (adj.IRR = 3.36; 95% CI: 1.48–7.65) and 18–24 years (adj.IRR = 2.65; 95% CI: 1.05–6.70) relative to 30 years. Compared to non-drinkers, HIV incidence increased by frequency of alcohol drinking - occasional drinkers (adj.IRR = 3.18; 95% CI: 1.18–8.57) and regular drinkers (adj.IRR = 4.93; 95% CI: 1.91–12.8).

Conclusion: HIV-1 incidence in general fisherfolk population along L.Victoria, Uganda, is high and is mainly associated with young age and alcohol drinking. HIV prevention and control strategies are urgently needed in this population.

Background

The HIV epidemic in sub-Saharan Africa is generalized and stable or declining [1]. High risk sub-groups can co-exist within generalized epidemics giving rise to concentrated HIV sub-epidemics in generalized epidemic settings [2]. These high risk sub-groups, known as most-at-risk or key populations, tend to have consistently higher rates of new and existing infections than the general population [1,3]. A growing body of evidence from Uganda and other sub-Saharan African countries suggests that fisher folk communities (FFC) appear to have a much higher burden of HIV-1 infection than respective general populations [4–11]. This may not be surprising given that the first cases of HIV in Uganda were identified from a fishing community in Rakai district in 1982 [12] and since then FFC in East Africa have been disproportionately affected by the HIV epidemic [13–16]. However, most studies have reported findings on HIV prevalence in FFC but data on incidence are still very limited. HIV prevalence levels between 27–29% in Ugandan FFC and 16–25% among Kenyan FFC [4–6,9,10,17,18] and an incidence rate of 4.9/100 person-years among Ugandan FFC prescreened and identified as being at high-risk of HIV infection [4,11] have been reported. These figures are 3–4 times higher than respective national averages. Currently in Uganda, groups that have been identified as key populations include commercial sex workers, uniformed services, fishing communities, truck drivers and MSMs [18] but only commercial sex workers and long distance truck drivers have been well characterized [19–21]. However, emerging
Study sites definition

Methods

Study sites definition

A fishing community was defined as a group of persons living in a village or trading center that is adjacent to lake landing site where main economic activities and livelihood are derived directly or indirectly from fishing activities. Inhabitants of these communities are diverse and usually include fishers (boat crew), boat owners, boat makers and repairers, fish processors and traders, shop keepers, and owners and workers of bars/restaurants/lodges. These communities are typically densely populated with wooden temporary buildings that are densely concentrated in small spaces especially at landing sites and their proximal areas [17].

Study design and Procedures

A community-based cohort study was conducted in 8 fishing communities (1 lakeshore and 7 islands) in 3 Uganda districts of Wakiso, Mukono, and Kalangala. Study procedures have been previously described [5] but briefly, we conducted a community-wide household enumeration census in each community after which a proportion to size random sample of 2200 participants aged 18–49 years was selected using Stata 12 (StataCorp, College Station, TX) software. Of the 2200 selected, 2191 provided written informed consent and were interviewed in privacy by same sex interviewers at baseline and 1685 at the 12 months post-baseline visit. Data on socio-demographic characteristics and risky behaviors (including number of partners, new partners, condom use, use of alcohol and illicit drugs) were collected using semi-structured questionnaires. Participants were asked if they drank any alcoholic drink and if they responded in affirmation, they were further asked the frequency of consumption. Assessments were done for 3 and 12 months preceding the date of interview. Venous blood samples were collected for HIV-1 serological testing and participants got voluntary counseling and testing from certified HIV counselors. Participants were encouraged to share their HIV results with their sexual partners but no involuntary disclosure of HIV results to third parties was done as per the Ugandan Ministry of Health AIDS Control Program policy on HIV testing [27]. HIV infected participants were referred to HIV/AIDS care centres for further management and encouraged to seek care. HIV prevention services including health education, counseling, treatment of sexually transmitted infections (STIs) and voluntary medical male circumcision were provided to community members (participants and non-participants) at no cost. Institutional Review Board approvals were obtained from the Uganda Virus Research Institute’s Science and Ethics Committee (UVRI SEC) and the Uganda National Council for Science and Technology (UNCST). All participants were enrolled in the study after providing written informed consent.

Laboratory testing

HIV-1 serology was determined by rapid HIV tests performed in the community by certified laboratory technologists and EIA confirmation in the laboratory at Uganda Virus Research Institute. In the rapid HIV testing algorithm blood samples were first tested with Determine HIV assay (Alere Medical Co., Ltd., Chiba, Japan), and if negative, results were reported as negative. Determine positive samples were then tested with HIV 1/2 Stat-Pak assay (Chembio Diagnostic Systems, Inc. Medford, NY, USA), and if positive too, results were reported as positive. But if negative on Stat-Pak, Uni-Gold HIV test (Trinity Biotech plc, Bray, Ireland) was used as a tie-breaker. All positive rapid results were confirmed using 2 parallel enzymelinked immunosorbent assay (EIA) tests: Vironostika (HIV Uni-Form II plus 0 microelisa system, Biomerieux, SA, Marcy l’Etoile, France); and Murex HIV-1.2.O (Diasorin S.P.A, Dartford, United Kingdom). Concordant EIA positives were taken as positive but discordant EIA results were confirmed using HIV RNA PCR (COBAS AmpliPrep/COBAS TaqMan HIV-1 Test, v2.0 from Roche Molecular Diagnostics, Pleasanton, CA, USA).

Statistical Analysis

Participants’ characteristics were summarised and compared using t-tests for continuous variables and chi-square and Fisher Exact tests for categorical variables. Bivariate analyses were used to estimated unadjusted (crude) associations between outcome variables and potential predictors. Adjusted associations were estimated using multivariable regression models. All models were constructed using stepwise logical model building method (purposeful selection of covariates) [28] and the most persimmonous model was selected as the final one. Covariates were selected for inclusion in multivariable models based on a bivariate statistical significance at an alpha (α) of <0.15 and biological plausibility (clinical and intuitive relationship to outcome variable). To account for potential correlation at household level (where more than 1 participant from a given household were selected) we used the empirical variance estimator to estimate robust standard errors [29]. All statistical analyses were performed using Stata 12 (StataCorp, College Station, TX) software.

The main outcome was incident HIV infection among previously uninfected individuals at baseline. HIV seroconversion was estimated to have occurred at the midpoint between the last
negative and first positive serologic tests, approximately 12 months apart. Person years at-risk (pyar) were calculated as (date of last HIV seronegative result, or estimated date of HIV seroconversion minus date of enrollment) divided by 365.25. HIV incidence rate per 100 pyar was calculated as number of events of seroconversion divided by pyar, multiplied by 100. Adjusted incidence rate ratios (Adj.IRR) of HIV acquisition with corresponding 95% confidence intervals were estimated by multivariable Poisson regression using the natural logarithm of pyar as the offset term. The final model on HIV acquisition included sex, age, religion, marital status, new sexual partners in past 12 months, and frequency of alcohol drinking. Alcohol consumption was defined as occasional if the participants reported consumption at least once a week or less, and regular if they drank daily or at least 3 days every week. Covariates that dropped from the final model include ethnicity/tribe, duration of stay in fishing communities, occupation, marital status, condom use, male circumcision status, and use of marijuana.

Results

Of the 2191 participants enrolled at baseline, 1685 were interviewed during the 12 months post-baseline visit giving a follow up rate of 76.9% (Table 1). Follow up rates did not statistically differ by sex, education status and religion but were significantly lower among those aged 18-24 years, non-Baganda, never married, bar/odge/restaurant workers, those with less than one year’s stay in fishing communities, and HIV positives at baseline. Among the 1288 participants included in incidence analysis, the mean (SD) and median (IQR) age in years were 29.7 (7.5) and 29 (24-35) respectively. Fifty four percent (54.1%) were males, 20.4% Moslems, 40.2% Protestants/Evangelical, and 39.4% Catholics. Only 35.9% had attained post primary education, 49.5% had been residing in their community for less than 5 years, and 69.2% were married. Fifty percent (50.3%) were involved in fishing and fishing related activities, 10.5% in small scale businesses, 5.8% were farmers, and 9.5% were bar/odge/restaurant workers (not shown).

HIV incidence rate and associated factors

There were 48 incident HIV infections among 1288 participants followed over 1416.8 person years at risk (pyar) yielding an overall cumulative incidence of 3.72% (95% CI, 2.74–4.94) and an incidence rate of 3.39/100 pyar (95% CI, 2.55–4.49). Table 2 shows absolute incidence rates individual and combined by socio-demographic characteristics and risky behaviours. The absolute HIV incidence rate (AR) was 3.40 (2.31–4.99) in men, 3.37 (2.22–5.13) in women, 3.68 (2.22–6.11) among those aged 18-24 years, 4.77 (2.96–7.67) in 25-29 years, and 2.45 (1.50–4.00) in those aged 30 years or more. The AR was 5.44 (3.80–7.73) among Roman Catholics, 2.09 (1.18–3.67) in Protestants/Evangelicals and 2.06 (0.93–4.60) in Muslins. Unmarried participants had an AR of 5.04/100 pyar while it was 2.65/100 pyar among the married ones [not shown]. High ARs were observed among Roman Catholics [3.44 (95% CI; 3.80–7.73)], those involved in fishing-related activities [3.46 (95% CI; 3.02–9.86)], participants previously married but not married at the time of the study [3.62 (95% CI; 3.44–9.18)], those who reported 2 or more new sexual partners in past 12 months [5.67 (95% CI; 3.14–10.23)], and regular alcohol drinkers [6.44 (95% CI; 4.38–9.45)]. But the highest incidence was observed among alcohol drinkers aged 25–29 years [7.67 (95% CI; 4.62–12.7)]. It is noteworthy that involvement in fishing per se did not increase the absolute risk of HIV as long as one was young (less than 30 years) and consumed alcohol.

Table 3 shows unadjusted and adjusted incident rate ratios (IRRs) of HIV and associated 95% confidence intervals. At bivariate analysis, the unadjusted (crude) risk of HIV infection was 2.6 times higher among Roman Catholics relative to Moslems (crude IRR = 2.63, 95% CI, 1.10–6.33), and 2 times higher among participants with 2 or more new sex partners in past 12 months compared to those with none (crude IRR = 2.13, 95% CI, 1.03–4.39). Compared to those who reported no alcohol consumption, the risk of HIV infection was twice as high among occasional drinkers and four times higher among regular drinkers - IRR = 2.33(95% CI, 1.01–5.39) and 4.30 (95% CI, 2.07–8.92), respectively. The unadjusted risk was 2 times higher among those aged 25–29 years compared to those aged 30 or more years but the difference was of borderline statistical significance [IRR = 1.94 (95% CI, 0.90–3.85)].

At multivariable analysis, the risk of HIV infection was statistically significantly associated with age and alcohol consumption, and there was a borderline association with those previously married but not currently married. Compared to participants aged 30 or more years, the adjusted HIV incidence rate ratios were 3.36 (95% CI, 1.48–7.65) and 2.63 (95 CI, 1.03–6.70) for participants aged 25–29 years and 18–24 years respectively.

The risk of HIV infection increased with increasing frequency of alcohol consumption. Compared to non-drinkers, the adjusted risk was 3 times higher in occasional drinkers and 5 times higher in regular drinkers - adj.IRR = 3.18 (95% CI, 1.18–8.57) and 4.93 (95% CI, 1.91–12.8), respectively. The effect of alcohol on HIV risk was more pronounced in the age group of 25-29 years (Table 4). Without considering frequency of alcohol consumption, the incident rate ratio of HIV acquisition among alcohol drinkers compared to non-drinkers was 2.45 (95% CI, 0.79–7.61), 6.18 (95% CI, 1.41–27.0), and 3.03 (95% CI, 0.96–9.51) for age years 30+, 25-29 and 18-24 respectively. Compared to non-drinkers, the risk of HIV increased with increasing frequency of alcohol consumption in each age group. Across age groups, the risk was higher among those aged 25-29 years, followed by 18-24 years and lowest among those aged 30 or more years for both occasional and regular drinkers. The most pronounced effect of alcohol on HIV risk was observed among regular drinkers aged 25–29 years, IRR = 8.44 (95% CI, 1.85–38.5).

Although the risk of HIV infection was significantly higher among Catholics than Moslems at bivariate analysis (crude IRR = 2.63 (95% CI, 1.10–6.33)], the association lost statistical significance after multivariable adjustment [adj. IRR = 1.65 (95% CI; 0.62–4.38)]. Nevertheless, we assessed whether the association between incident HIV infection and religion was confounded by alcohol consumption and male circumcision. Alcohol consumption was higher among Catholics (51.0%), than Protestants (41.5%) and Moslems (27.5%) [trend p<0.0001]. As expected male circumcision higher among Moslems (96.7%) than Protestants (32.5%) and Catholics (28.9%) [trend p<0.0001]. For all the religious groups, the absolute incidence of HIV was higher among those who reported alcohol drinking (any frequency) than their counterparts who reported no alcohol consumption in past 12 months; rates were 3.11 (95% CI; 1.00–9.67) versus 1.54 (95% CI; 0.49–4.79) among Moslems, 3.47 (95% CI; 1.87–6.43) versus 0.70 (95% CI; 0.17–2.79) in Protestants/Evangelicals, and 6.86 (95% CI; 4.64–10.16) versus 2.67 (95% CI; 1.11–6.42) for Catholics. When Catholics and Moslems who drink alcohol were compared, adjusting for circumcision, the IRR of HIV acquisition was 2.56.
Table 1. Baseline Socio-demographic Characteristics of Study Population by Enrolment Status.

| Table 1. Baseline Socio-demographic Characteristics of Study Population by Enrolment Status. | Enrolment | Follow-up Status | Not Followed No. (%) |
| --- | --- | --- | --- |
| | Enrolled No. (%) | Followed No. (%) | |
| All Participants | 2191 (99.5) | 1685 (76.9) | 506 (23.1) |
| Sex | | | |
| Male | 1106 (50.5) | 865 (78.2) | 241 (21.8) |
| Female | 1085 (49.5) | 820 (75.6) | 265 (24.4) |
| Age at enrolment (years) | | | |
| 18–24 | 616 (28.1) | 429 (69.6) | 187 (30.4) |
| 25–29 | 566 (25.8) | 434 (76.7) | 132 (23.3) |
| 30–39 | 733 (33.5) | 591 (80.6) | 142 (19.8) |
| 40–49 | 276 (12.6) | 231 (83.7) | 45 (16.3) |
| Highest Education level* | | | |
| None | 186 (8.5) | 138 (74.2) | 48 (25.8) |
| Primary | 1294 (59.1) | 987 (76.3) | 307 (23.7) |
| Post primary | 708 (32.4) | 557 (78.7) | 151 (21.3) |
| Religion | | | |
| Roman Catholic | 890 (40.6) | 681 (76.5) | 209 (23.5) |
| Protestant/Anglican | 600 (27.4) | 451 (75.2) | 149 (24.8) |
| Moslem | 421 (19.2) | 329 (78.2) | 92 (21.8) |
| Pentecostal/Evangelical | 197 (9.0) | 160 (81.2) | 37 (18.8) |
| Other† | 83 (3.8) | 64 (77.1) | 19 (22.9) |
| Ethnicity/tribe | | | |
| Non-Muganda | 1197 (54.6) | 881 (73.6) | 316 (26.4) |
| Muganda | 994 (45.4) | 804 (80.9) | 190 (19.1) |
| Occupation | | | |
| Fishing/Fishing related | 1038 (47.4) | 817 (78.7) | 221 (21.3) |
| Trade/Business | 223 (10.2) | 176 (78.9) | 47 (21.9) |
| Bar/Lodge/Restaurant | 257 (11.7) | 170 (66.2) | 87 (33.8) |
| Farming | 130 (5.9) | 111 (85.4) | 19 (14.6) |
| Others§ | 353 (16.1) | 272 (77.0) | 81 (22.9) |
| Housewife | 190 (8.7) | 139 (73.2) | 51 (26.8) |
| Marital status | | | |
| Never married | 340 (15.5) | 233 (68.5) | 107 (31.5) |
| Not currently married | 505 (23.1) | 376 (74.5) | 129 (25.5) |
| Married monogamous | 923 (42.1) | 743 (80.5) | 180 (19.5) |
| Married polygamous | 423 (19.3) | 333 (78.7) | 90 (21.3) |
| Duration in community (years) | | | |
| Less than 1 | 394 (17.9) | 213 (54.1) | 181 (45.9) |
| 1 to 4 | 823 (37.6) | 609 (74.0) | 214 (26.0) |
| 5 to 10 | 668 (30.5) | 589 (88.0) | 80 (12.0) |
| More than 10 | 305 (13.9) | 274 (88.8) | 31 (10.2) |
| Alcohol consumption | | | |
| No | 1031 (47.1) | 799 (77.5) | 232 (22.5) |
| Yes | 1160 (52.9) | 886 (76.4) | 274 (23.6) |
| Use of Marijuana | | | |
| No | 1889 (86.2) | 1460 (77.3) | 429 (22.7) |
| Yes | 302 (13.8) | 225 (74.5) | 77 (25.5) |
| HIV status (Baseline) | | | |
| Positive | 584 (26.6) | 396 (67.8) | 188 (32.2) |
| Negative | 1607 (73.3) | 1289 (80.2) | 318 (19.8) |

*3 missing education,
†Seventh Day Advent/Traditionist,
§Construction/Mechanic/Government/Clerical,
P < 0.05.
Table 2. HIV Incidence Rate by Socio-demographic Characteristics and Risky Behaviours.

| Characteristic                          | Incidence/100 | Rate (95% CI) |
|----------------------------------------|---------------|---------------|
|                                        | Cases | PYAR          |                |
| All Participants                       | 48    | 1416.8        | 3.39 (2.55–4.49) |
| **INDIVIDUAL VARIABLES**               |       |               |                |
| Sex                                    |       |               |                |
| Male                                   | 26    | 756.2         | 3.40 (2.31–4.99) |
| Female                                 | 22    | 651.5         | 3.37 (2.22–5.13) |
| Age at enrolment (years)               |       |               |                |
| 30+                                    | 16    | 652.8         | 2.45 (1.50–4.00) |
| 25–29                                  | 17    | 356.5         | 4.77 (2.96–7.67) |
| 18–24                                  | 15    | 407.4         | 3.68 (2.22–6.11) |
| Religion                               |       |               |                |
| Moslem                                 | 6     | 290.5         | 2.06 (0.93–4.60) |
| Protestant/Evangelical                 | 12    | 575.0         | 2.09 (1.18–3.67) |
| Roman Catholic                         | 30    | 551.3         | 5.44 (3.80–7.78) |
| Ethnicity/tribe                         |       |               |                |
| Muganda                                | 17    | 675.5         | 2.52 (1.56–4.05) |
| Non-Muganda                            | 31    | 741.2         | 4.18 (2.94–5.95) |
| Occupation                              |       |               |                |
| Trade/Business                          | 2     | 153.0         | 1.31 (0.33–5.22) |
| Fishing                                | 16    | 504.9         | 3.17 (1.94–5.17) |
| Fishing related activities^1            | 11    | 201.4         | 5.46 (3.02–9.86) |
| Bar/Lodge/Restaurant                   | 5     | 136.7         | 3.66 (1.52–8.79) |
| Farming                                | 3     | 79.8          | 3.76 (1.21–11.6) |
| Housewife                              | 3     | 110.6         | 2.71 (0.87–8.41) |
| Others^1+                               | 8     | 230.3         | 3.47 (1.74–6.95) |
| Duration in community at enrolment (years) |       |               |                |
| 5+                                     | 21    | 713.4         | 2.94 (1.91–4.51) |
| 2–4                                    | 11    | 366.1         | 3.00 (1.66–5.42) |
| Less than 2                            | 16    | 337.2         | 4.75 (2.91–7.74) |
| Marital status                         |       |               |                |
| Married monogamous                      | 18    | 632.8         | 2.84 (1.79–4.51) |
| Married polygamous                      | 7     | 260.2         | 2.84 (1.79–4.51) |
| Not currently married                   | 16    | 284.5         | 5.62 (3.44–9.18) |
| Never married                          | 7     | 239.2         | 2.93 (1.39–6.14) |
| New sex partners in past 12 months      |       |               |                |
| None                                   | 22    | 827.5         | 2.66 (1.75–4.04) |
| 1                                      | 7     | 251.9         | 2.78 (1.32–5.82) |
| 2+                                     | 11    | 194.1         | 5.67 (3.14–10.23) |
| Condom use in past 12 months           |       |               |                |
| Always                                 | 4     | 191.0         | 2.09 (0.78–5.58) |
| Inconsistent                           | 15    | 319.4         | 4.69 (2.83–7.79) |
| No use                                 | 29    | 769.7         | 3.77 (2.62–5.42) |
| Circumcised (men only)                 |       |               |                |
| Yes                                    | 8     | 355.2         | 2.25 (1.13–4.50) |
| No                                     | 18    | 408.5         | 4.40 (2.77–6.99) |
| Frequency of Alcohol consumption       |       |               |                |
| No                                     | 10    | 668.4         | 1.50 (0.80–2.78) |
| Occasional                             | 12    | 344.5         | 3.48 (1.98–6.13) |
| Regular                                | 26    | 403.9         | 6.44 (4.38–9.45) |
Table 2. Cont.

| Characteristic | Incidence/100 | PYAR | Rate (95% CI) |
|----------------|--------------|------|---------------|
| **Use of Marijuana** | | | |
| No | 44 | 1299.3 | 3.39 (2.52–4.55) |
| Yes | 4 | 104.5 | 3.83 (1.44–10.20) |
| **COMBINED VARIABLES** | | | |
| Age and fishing | | | |
| 30+ and involved in fishing | 11 | 336.9 | 3.26 (1.80–5.90) |
| 25–29 and involved in fishing | 9 | 195.4 | 4.61 (2.40–8.85) |
| 18–24 and involved in fishing | 7 | 174.1 | 4.02 (1.92–8.43) |
| Age and alcohol drinking | | | |
| 30+ and drinks alcohol | 12 | 359.0 | 3.34 (1.89–5.89) |
| 25–29 and drinks alcohol | 15 | 195.5 | 7.67 (4.62–12.7) |
| 18–24 and drinks alcohol | 11 | 193.8 | 5.67 (3.14–10.2) |
| Age, fishing and alcohol drinking | | | |
| 30+, fishing and alcohol use | 7 | 196.1 | 3.57 (1.70–7.49) |
| 25–29, fishing and alcohol use | 8 | 118.1 | 6.77 (3.39–13.5) |
| 18–24, fishing and alcohol use | 4 | 80.2 | 4.99 (1.87–13.3) |

*PYAR-person years at risk.

(95% CI; 0.29–22.54), \( p = 0.398 \). Results were similar when non-alcohol drinkers were compared - adj.IRR = 2.44 (95% CI; 0.22–26.94), \( p = 0.466 \) [Not shown].

**Discussion**

In a general population cohort study in fishing communities around Lake Victoria, Uganda, we found an overall HIV-1 incidence rate of 3.39/100 pyar (95% CI, 2.55–4.49) with the highest incidence of 7.67 (95% CI; 4.62–12.7) observed among alcohol drinkers aged 25–29 years. The risk of HIV infection was mainly associated with young age (less than 30 years) and alcohol consumption.

The incidence of HIV that we observed in this general FFC population study was lower than that found in fisherfolk that were screened for high risk behaviour in a previous study that was conducted in Entebbe and Masaka communities (3.4 /100 vs 4.9/100 pyar, \( p = 0.059 \)) [11]. However, the general FFC population rate in this study conducted in Entebbe site communities was not different from that observed among high risk FFC from the same side of the lake (3.4/100 vs 3.8/100 pyar, \( p = 0.588 \)) [11]. Our data seems to suggest that for adult sexually active persons, living in a fishing community is generally associated with increased risk for HIV infection. But strong conclusions on this observation can be better made from studies that involve both fishing and non fishing communities in which direct comparisons of HIV rates could be done. However, findings from Rakai district, Southwestern Uganda, indicate that HIV rates are highest in lake shore communities, followed by adjacent communities and are lowest in agrarian non fishing communities (pc Dr. David Serwadda). Our finding of similar risk of HIV infection between general population of fisherfolk and those screened for high risk implies that HIV prevention and control programs as well as intervention studies should target the fisherfolk community as a whole without pre-screening for “high risk”. It is noteworthy that the overall risk of HIV infection of 3.39/100 pyar that we found among general population of fishing communities is about 4 times higher than the estimated national incidence among adults in general population in Uganda [30]. However, the risk among persons in fishing communities who are considered to be “high risk” is about 5–8 times higher than the estimated national rate among adults. This underscores the need for urgent interventions to prevent and control the spread of HIV in fishing communities which tend to be socially marginalized and under served. Furthermore, there is need for more studies in fishing communities to concretize the evidence that these communities are key HIV populations. With such high risks of HIV infection in fishing communities, sexual inter-mixing and interactions between persons in these communities and the general populations may lead to an upsurge of HIV incidence in general population.

We found a higher rate of HIV infection among young people (aged 18–29 years) which is consistent with an earlier study [11] but differs from the observation of higher rates of infection among older people in the general population in Uganda [1]. This difference highlights the potential variations in HIV risk profiles (risk factors and drivers) between general population and key populations within the same regional/geographical HIV sub-epidemic.

Alcohol consumption was a very strong predictor of risk of HIV infection in this study; regular drinkers were 5 times more likely to get infected with HIV compared to non-drinkers. This finding too is consistent with previous studies among FFC in Uganda that reported higher risk of HIV infection among regular alcohol drinkers and a strong correlation between alcohol consumption and risky behaviours such as having multiple sexual partners, sex with non-regular partner and transactional sex [4,11,31]. In this study we explored the association between HIV incidence and alcohol consumption stratified by religion and found that in all
| Characteristic                        | Incidence Rate Ratio (95% CI) | Unadjusted | Adjusted | P-value |
|--------------------------------------|------------------------------|------------|----------|---------|
| **Sex**                              |                              |            |          |         |
| Male                                 | 1 (Reference)                | 1 (Ref)    |          |         |
| Female                               | 0.99 (0.56–1.75)             | 1.15 (0.58–2.29) | 0.68    |
| **Age (years)**                      |                              |            |          |         |
| 30+                                  | 1 (Ref)                      | 1 (Ref)    |          |         |
| 25–29                                | 1.94 (0.98–3.85)             | 3.36 (1.48–7.65) | 0.004   |
| 18–24                                | 1.50 (0.74–3.04)             | 2.65 (1.05–6.70) | 0.039   |
| **Religion**                         |                              |            |          |         |
| Moslem                               | 1 (Ref)                      | 1 (Ref)    |          |         |
| Protestant/Evangelical               | 1.01 (0.38–2.69)             | 0.78 (0.26–2.27) | 0.645   |
| Roman Catholic                       | 2.63 (1.10–6.33)             | 1.65 (0.62–4.38) | 0.317   |
| **Ethnicity/tribe**                  |                              |            |          |         |
| Muganda                              | 1 (Ref)                      | -          |          |         |
| Non-Muganda                          | 1.66 (0.92–3.00)             | -          |          |         |
| **Occupation**                       |                              |            |          |         |
| Trade/Business                       | 1 (Ref)                      | -          |          |         |
| Fishing                              | 2.42 (0.56–10.5)             | -          |          |         |
| Fishing related activities¹          | 4.18 (0.93–18.8)             | -          |          |         |
| Bar/Lodge/Restaurant                 | 2.80 (0.54–14.4)             | -          |          |         |
| Farming                              | 2.88 (0.48–17.2)             | -          |          |         |
| Housewife                            | 2.07 (0.35–12.4)             | -          |          |         |
| Others¹                              | 2.66 (0.56–12.5)             | -          |          |         |
| **Duration in community at enrolment (years)** |  |  |  |         |
| 5+                                   | 1 (Ref)                      | -          |          |         |
| 2–4                                  | 1.02 (0.49–2.12)             | -          |          |         |
| Less than 2                          | 1.61 (0.84–3.09)             | -          |          |         |
| **Marital status**                   |                              |            |          |         |
| Married monogamous                   | 1 (Ref)                      | -          |          |         |
| Married polygamous                   | 0.94 (0.39–2.26)             | 1.20 (0.46–3.11) | 0.712   |
| Not currently married                | 1.98 (1.01–3.87)             | 2.06 (0.92–4.61) | 0.079   |
| Never married                        | 1.03 (0.43–2.46)             | 0.84 (0.28–2.50) | 0.749   |
| **New sex partners in past 12 months** |                              |            |          |         |
| None                                 | 1 (Ref)                      | 1 (Ref)    |          |         |
| 1                                    | 1.04 (0.45–2.45)             | 0.89 (0.37–2.14) | 0.793   |
| 2+                                   | 2.13 (1.03–4.39)             | 1.31 (0.58–2.99) | 0.513   |
| **Condom use in past 12 months**     |                              |            |          |         |
| Always                               | 1 (Ref)                      | -          |          |         |
| Inconsistent                         | 2.24 (0.74–6.75)             | -          |          |         |
| No use                               | 1.80 (0.63–5.11)             | -          |          |         |
| **Circumcised (men only)**           |                              |            |          |         |
| Yes                                  | 1 (Ref)                      | -          |          |         |
| No                                   | 1.96 (0.85–4.50)             | -          |          |         |
| **Frequency of Alcohol consumption** |                              |            |          |         |
| No                                   | 1 (Ref)                      | 1 (Ref)    |          |         |
| Occasional                           | 2.33 (1.01–5.39)             | 3.18 (1.18–8.57) | 0.022   |
| Regular                              | 4.30 (2.07–8.92)             | 4.93 (1.91–12.8) | 0.001   |
| **Use of Marijuana**                 |                              |            |          |         |
| No                                   | 1 (Ref)                      | -          |          |         |
| Yes                                  | 1.13 (0.41–3.15)             | -          |          |         |

doi:10.1371/journal.pone.0094932.t003
Referencing sex which might result in reduced risk of HIV acquisition and a strong association with risk of HIV infection but also in its own studying. In general, the problem of alcohol consumption in preventing HIV spread but this hypothesis warrants further studying. In general, the problem of alcohol consumption in fishing communities needs to be addressed not only due to its strong association with risk of HIV infection but also in its own entity as a psychosocial problem. Interventions to reduce hazardous alcohol use have been shown to lower unprotected sex [32] which might result in reduced risk of HIV acquisition and transmission.

The strengths of this study include: 1) it was conducted in a general FFC population that was randomly selected which enabled estimation of population-wide HIV rates, 2) study communities included islands and lakeshores unlike previous studies that were conducted exclusively in lakeshore communities, 3) none of the religious groups (Moslems, Protestants/Evangelicals, and Catholics) the absolute incidence of HIV infection was 2–5 times higher among alcohol drinkers compared to non-drinkers. Despite the 97% circumcision level among Moslems, those who drank alcohol had a 2 times absolute risk of HIV infection relative to their non-drinking counterparts. The increased risk of HIV infection in Moslems who drink alcohol raises the question whether alcohol consumption might diminish the impact of circumcision in preventing HIV spread but this hypothesis warrants further studying. In general, the problem of alcohol consumption in fishing communities needs to be addressed not only due to its strong association with risk of HIV infection but also in its own entity as a psychosocial problem. Interventions to reduce hazardous alcohol use have been shown to lower unprotected sex [32] which might result in reduced risk of HIV acquisition and transmission.

The strengths of this study include: 1) it was conducted in a general FFC population that was randomly selected which enabled estimation of population-wide HIV rates, 2) study communities included islands and lakeshores unlike previous studies that were conducted exclusively in lakeshore communities, 3) none of the religious groups (Moslems, Protestants/Evangelicals, and Catholics) the absolute incidence of HIV infection was 2–5 times higher among alcohol drinkers compared to non-drinkers. Despite the 97% circumcision level among Moslems, those who drank alcohol had a 2 times absolute risk of HIV infection relative to their non-drinking counterparts. The increased risk of HIV infection in Moslems who drink alcohol raises the question whether alcohol consumption might diminish the impact of circumcision in preventing HIV spread but this hypothesis warrants further studying. In general, the problem of alcohol consumption in fishing communities needs to be addressed not only due to its strong association with risk of HIV infection but also in its own entity as a psychosocial problem. Interventions to reduce hazardous alcohol use have been shown to lower unprotected sex [32] which might result in reduced risk of HIV acquisition and transmission.

The strengths of this study include: 1) it was conducted in a general FFC population that was randomly selected which enabled estimation of population-wide HIV rates, 2) study communities included islands and lakeshores unlike previous studies that were conducted exclusively in lakeshore communities, 3) none of the religious groups (Moslems, Protestants/Evangelicals, and Catholics) the absolute incidence of HIV infection was 2–5 times higher among alcohol drinkers compared to non-drinkers. Despite the 97% circumcision level among Moslems, those who drank alcohol had a 2 times absolute risk of HIV infection relative to their non-drinking counterparts. The increased risk of HIV infection in Moslems who drink alcohol raises the question whether alcohol consumption might diminish the impact of circumcision in preventing HIV spread but this hypothesis warrants further studying. In general, the problem of alcohol consumption in fishing communities needs to be addressed not only due to its strong association with risk of HIV infection but also in its own entity as a psychosocial problem. Interventions to reduce hazardous alcohol use have been shown to lower unprotected sex [32] which might result in reduced risk of HIV acquisition and transmission.

The strengths of this study include: 1) it was conducted in a general FFC population that was randomly selected which enabled estimation of population-wide HIV rates, 2) study communities included islands and lakeshores unlike previous studies that were conducted exclusively in lakeshore communities, 3) none of the religious groups (Moslems, Protestants/Evangelicals, and Catholics) the absolute incidence of HIV infection was 2–5 times higher among alcohol drinkers compared to non-drinkers. Despite the 97% circumcision level among Moslems, those who drank alcohol had a 2 times absolute risk of HIV infection relative to their non-drinking counterparts. The increased risk of HIV infection in Moslems who drink alcohol raises the question whether alcohol consumption might diminish the impact of circumcision in preventing HIV spread but this hypothesis warrants further studying. In general, the problem of alcohol consumption in fishing communities needs to be addressed not only due to its strong association with risk of HIV infection but also in its own entity as a psychosocial problem. Interventions to reduce hazardous alcohol use have been shown to lower unprotected sex [32] which might result in reduced risk of HIV acquisition and transmission.

The strengths of this study include: 1) it was conducted in a general FFC population that was randomly selected which enabled estimation of population-wide HIV rates, 2) study communities included islands and lakeshores unlike previous studies that were conducted exclusively in lakeshore communities, 3) none of the religious groups (Moslems, Protestants/Evangelicals, and Catholics) the absolute incidence of HIV infection was 2–5 times higher among alcohol drinkers compared to non-drinkers. Despite the 97% circumcision level among Moslems, those who drank alcohol had a 2 times absolute risk of HIV infection relative to their non-drinking counterparts. The increased risk of HIV infection in Moslems who drink alcohol raises the question whether alcohol consumption might diminish the impact of circumcision in preventing HIV spread but this hypothesis warrants further studying. In general, the problem of alcohol consumption in fishing communities needs to be addressed not only due to its strong association with risk of HIV infection but also in its own entity as a psychosocial problem. Interventions to reduce hazardous alcohol use have been shown to lower unprotected sex [32] which might result in reduced risk of HIV acquisition and transmission.

The strengths of this study include: 1) it was conducted in a general FFC population that was randomly selected which enabled estimation of population-wide HIV rates, 2) study communities included islands and lakeshores unlike previous studies that were conducted exclusively in lakeshore communities, 3) none of the religious groups (Moslems, Protestants/Evangelicals, and Catholics) the absolute incidence of HIV infection was 2–5 times higher among alcohol drinkers compared to non-drinkers. Despite the 97% circumcision level among Moslems, those who drank alcohol had a 2 times absolute risk of HIV infection relative to their non-drinking counterparts. The increased risk of HIV infection in Moslems who drink alcohol raises the question whether alcohol consumption might diminish the impact of circumcision in preventing HIV spread but this hypothesis warrants further studying. In general, the problem of alcohol consumption in fishing communities needs to be addressed not only due to its strong association with risk of HIV infection but also in its own entity as a psychosocial problem. Interventions to reduce hazardous alcohol use have been shown to lower unprotected sex [32] which might result in reduced risk of HIV acquisition and transmission.
15. Mojola SA (2011) Fishing in dangerous waters: Ecology, gender and economy in HIV risk. Soc Sci Med 72: 149–156. S0277-9536(10)00787-2 [pii];10.1016/j.socscimed.2010.11.006 [doi].

16. Seeley JA, Allison EH (2003) HIV/AIDS in fishing communities: challenges to delivering antiretroviral therapy to vulnerable groups. AIDS Care 17: 689–697. U46627K6714X203T [pii];10.1080/0954012012331336098 [doi].

17. Opio A, Muyonga M, Mulumba N (2013) HIV Infection in Fishing Communities of Lake Victoria Basin of Uganda - A Cross-Sectional Sero-Behavioral Survey. PLoS One 8: e70770. 10.1371/journal.pone.0070770 [doi];PONE-D-13-10671 [pii].

18. Uganda AIDS Commission (2008) The Modes of Transmission Study. The Uganda Country Synthesis Report. Kampala, Uganda.

19. Chersich MF, Luhrers S, Nteagana I, Gerbase A, Lo YR, et al. (2013) Priority interventions to reduce HIV transmission in sex work settings in sub-Saharan Africa and delivery of these services. J Int AIDS Soc 16: 17800. 17800 [pii].

20. Gysels M, Pool R, Bwanika K (2003) Truck drivers, middlemen and commercial sex workers: AIDS and the mediation of sex in south west Uganda. AIDS Care 13: 373–383. 10.1080/09540120120040426 [doi];6T4UYNNP9M6UX2GN [pii].

21. Bwayo J, Plummer F, Omari M, Mutere A, Moses S, et al. (1994) Human immunodeficiency virus infection in long-distance truck drivers in east Africa. Arch Intern Med 154: 1391–1396.

22. Hladik W, Barker J, Ssenkusu JM, Opio A, Tappero JW, et al. (2012) HIV infection among men who have sex with men in Kampala, Uganda-a respondent driven sampling survey. PLoS One 7: e30143. 10.1371/journal.pone.0030143 [doi];PONE-D-11-04705 [pii].

23. McArthur M, Birthistle I, Seeley J, Mpendo J, Auki G (2013) How HIV Diagnosis and Disclosure Affect Sexual Behavior and Relationships in Ugandan Fishing Communities. Qual Health Res 23: 1125–1137. 1049732313495327 [pii];10.1177/1049732313495327 [doi].

24. Smolak A (2014) A meta-analysis and systematic review of HIV risk behavior among fishermen. AIDS Care 26: 282–291. 10.1080/09540121.2013.824541 [doi].

25. Nsanu F, Luomba J, Lwenya C, Yonge E, Odongkara K, et al. (2012) Finding space for participation: fisherfolk mobility and co-management of Lake Victoria fisheries. Environ Manage 50: 204–216. 10.1007/s00267-012-0881-y [doi].

26. Gazi R, Mercer A, Wansorn T, Kabah H, Saha NC, et al. (2008) An assessment of vulnerability to HIV infection of boatmen in Teknaf, Bangladesh. Coastal Health 2: 3. 1752-1505-2-5 [pii];10.1186/1752-1505-2-5 [doi].

27. Uganda Ministry of Health (2003) Uganda National Policy Guidelines on HIV Voluntary Counseling and Testing.

28. Hosmer DW, Lemeshow S (1999) Applied Survival Analysis: Regression modeling of Time to Event Data. 1st Ed; John Wiley & Sons, Inc.

29. Zeger SL, Liang KY (1986) Longitudinal data: a generalized estimating equation approach. Biometrics 44: 1049–1060.

30. Kim AA, Halliet T, Stover J, Grives E, Musangu J, et al. (2011) Estimating HIV incidence among adults in Kenya and Uganda: a systematic comparison of multiple methods. PLoS One 6: e17535. 10.1371/journal.pone.0017535 [doi].

31. Tumwebisey NM, Anyambe L, Wayenze RR, Kabira SP, Li Q, et al. (2012) Alcohol consumption and risky sexual behaviour in the fishing communities: evidence from two fish landing sites on Lake Victoria in Uganda. BMC Public Health 12: 1069. 1471-2458-12-1069 [pii];10.1186/1471-2458-12-1069 [doi].

32. Chersich MF, Rees HV, Scorgie F, Martin G (2009) Enhancing global control of alcohol to reduce unsafe sex and HIV in sub-Saharan Africa. Global Health 5: 16. 1744-8603-5-16 [pii];10.1186/1744-8603-5-16 [doi].