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Prevalence and Incidence of HIV Infection among Fishermen along Lake Victoria Beaches in Kisumu County, Kenya

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Abstract

Background: Herpes simplex virus type-2 (HSV-2) and human papillomavirus (HPV) are common sexually transmitted infections (STIs) among fishing communities and are associated with high HIV prevalence in this underserved population. However, there is limited knowledge on HIV incidence among fishermen. This study aimed at determining prevalence, incidence and risk factors associated with HIV infection among fishermen in Kisumu Kenya. Methods: Three hundred fishermen were evaluated for baseline HIV, HSV-2, HPV infection and a structured questionnaire administered. HIV incidence was assessed after 12 months among those initially HIV negative. HIV incidence rate in person-years and prevalence were estimated. Multivariate logistic regression was used to determine factors independently associated with HIV acquisition. Results: HIV prevalence was 23.3% (95% CI: 18.5 - 28.1). Risk factors for baseline HIV prevalence were older age (aOR = 2.13; 95% CI: 1.25 - 5.07), history of STI (aOR 4.21; 95% CI: 2.07 - 9.34), baseline HPV infection (aOR 2.13; 95% CI: 1.05 - 4.77), number of lifetime sexual partners (>5) aOR = 5.76 (95% CI: 1.41 - 13.57) and transactional sex (aOR = 10.98; 95% CI: 1.86 - 19.34). Condom uses with new sexual partner (aOR 0.21, 95% CI: 0.08 - 0.55) and during most recent sexual act (aOR 0.09, 95% CI: 0.03 - 0.61), were negatively associated with HIV prevalence. HIV incidence was 4.2 (95% CI = 1.3 - 7.1) per 100 person-years with being single (aIRR = 8.32; 95% CI: 1.27 - 54.67) as an independent risk factor. Condom use with new sexual partner (aIRR = 0.11; 95% CI: 0.01 - 0.89) and recent sex with wife/regular girlfriend (compared to sex worker/casual partner; aIRR = 0.03; 95% CI: 0.01 - 0.35) were associated with reduced risk of HIV acquisition. Conclusion: Inconsistent condom use and transactional/casual sexual partnerships were the main high-risk sexual behaviors in addi-

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tion to marital status explaining the high HIV acquisition rate among fishermen. Intensified safer sex promotion is urgently needed in this subpopulation to avert new HIV infections.

Keywords

HIV, Incidence, Prevalence, Fishermen, Sexual Behavior

1. Introduction

The HIV-AIDS pandemic is currently in its fourth decade of existence since the first case was reported in 1981 [1]. However, the global distribution of the virus in the population is highly varied geographically, by age, gender, race, and occupation [1]-[3]. Socio-economic, behavioral characteristics and cultural practices are also thought to contribute to the spread of HIV [1] [4]. Generally, HIV prevalence is highest in countries located in Sub-Sahara Africa [1]. In the US and Europe, high HIV rates are observed among injection drug users (IDUs) and young men who have sex with men (MSM), particularly among young African American MSM [1] [5]. In Sub Saharan Africa, heterosexual transmission accounts for the majority of HIV infection [6]-[8]. Disparities in the distribution of HIV across different populations (subpopulations) suggest existence of variable risk factors predisposing individuals within these populations with varying levels of risk for HIV infection. Similarly, sex workers and long distance truck drivers have been reported to have higher prevalence of HIV when compared to the general population [9]-[11]. This observation may largely be due to modified sexual practices or/and rapidly expanding sexual networks associated with these occupations.

HIV prevalence (20% to 28%) among fishing communities is higher compared to the general population [12]-[16]. This has posed a serious threat to the fishing industry [13] [17]. Notably, access to care from public health facilities remains a challenge for this underserved population [18]. The fishing industry therefore presents an occupational risk for HIV infection, explained partially by the migratory nature of the fishing and fish trade activities [19]. Several studies and national survey in Kenya have documented high prevalence of HIV infection among the fishing communities including among fishermen [15] [16] [19]. However, HIV incidence and associated risk factors among this population remain largely unavailable. Quantification of HIV acquisition rates and exploring risk factors related to HIV incidence are crucial steps in characterizing the HIV epidemic among fishermen and designing specific intervention strategies suited to this highly migratory population.

In this prospective cohort study, the incidence rate of HIV infection among fishermen working on beaches around Lake Victoria in Kisumu County, Kenya was estimated. Additionally, factors associated with HIV prevalence and risk of HIV acquisition in this subpopulation, were explored. Potentially, these would rationalize and inform development of well-targeted interventions against new HIV infections among fishermen and the fishing communities at large.

2. Methods

2.1. Study Design and Clinical Procedures

Three hundred fishermen aged 18 - 47 years were recruited for evaluation of baseline HIV prevalence and prospective HIV acquisition over a period of one year. At enrolment, infection with Herpes simples virus type 2 (HSV-2) and human papillomavirus (HPV) were determined as potential baseline risk factors for HIV infection. Participants provided written informed consent prior to screening and enrollment. Structured interviews were conducted at baseline and repeated at study exit (month 12) to gather socio-demographic characteristics and risky sexual behavior. Genital examination for clinical STIs and collection of genital swabs (from the glans, head, shaft, scrotum and perineum) for HPV testing was performed at baseline and at every 3 months. Blood samples were collected for serological testing of HIV and HSV-2. All participants were offered free HIV counseling and testing, health education and condoms at each visit. Participants found to be HIV-positive were referred for free HIV care at patient support center nearest to their residence. The study was approved by Kenya Medical Research Institutes Scientific and Ethical Review Committees (SSC No. 2014).

2.2. Laboratory Detection of HIV, HPV and HSV-2

HIV serostatus was assessed by two rapid test kits in parallel: Determine (ABBOTT Laboratories, Diagnostic

division, Chicago IL, USA) and UniGold HIV 1/2 rapid kit (Trinity Biotech, Ireland USA) with all concordant HIV positive or HIV discordant results confirmed by enzyme immunoassays: Vironostika ELISA (Bio Merieux Vironostika HIV Uni-Form II plus O Antigen/Antibody ELISA, Marcy l'Etoile, France) and Murex HIV 1/2 Combo (Murex Biotech Limited, Dartford, UK). Men with concordant negative results were evaluated for HIV incidence at the study exit. Baseline HPV infection was determined by polymerase chain reaction (PCR) using PGMY11/09 primer set and detection by genotype-specific probes multiples Luminex assay for 33 important genital HPV genotypes (HR: 16, 18, 26, 31, 33, 35, 39, 45, 51, 52, 53, 55, 56, 58, 59, 66, 68, 73, 82, 83 and LR: 6, 11, 40, 42, 54, 61, 62, 67, 70, 72, 81, 84, CP6108). Baseline HSV-2 infection was determined by HSV-2 enzyme-linked immunosorbent assay (ELISA) (Kalon Biological Ltd., Guilford, UK), as per manufacturer's instructions.

2.3. Statistical Analysis

HIV incidence and person-time calculations were performed with the assumption that HIV infection occurred at any time between baseline HIV negative serology test and study exit (after 12 months) positive serological test. HIV incidence was estimated per 100 person-years. For prevalence of HIV analyses, associations with fixed covariates such as age, marital status, and HPV/HSV-2 status at enrollment, as well as sexual risk behavior (number of partners, sexual relationships and condom use) reported at baseline and exit of the study were assessed by chi square, logistic regression and Fisher's exact for smaller numbers (<6). Risk factors with a p-value less than 0.10 in bivariate logistic regression analysis were entered into a multivariate multiple logistic regression model to estimate adjusted measures of association for HIV prevalence (aOR) and incidence rate ratio (aIRR) at 95% confidence intervals (95% CIs) for HIV acquisition. SPSS version 18 (SPSS, Chicago, IL) and Stata version 12 (StataCorp LP 4905 Lakeway Drive College Station, Texas 77845 USA) were used.

3. Results

3.1. Baseline Background Characteristics of Sampled Fishermen

Of the 326 eligible fishermen, 300 (92.0%) aged 18 - 47 years who provided written informed consent, were enrolled in the study and followed up for one year between September 2011 and December 2012. Of the 26 who did not consent to the study, 25 (96%) declined due to blood draws and 1 (4%) was not willing to be followed up. Of the 300 men, 70 were HIV positive at baseline. **Table 1** shows background characteristics of fishermen enrolled in the study. The study population had a mean (SD) age of 27.7 (6.4). The mean (SD) age at sexual debut was 15 (3.7) years. The majority of men, 77% (232/300) were married and 57% had attained primary education. Among married men, 135 (57%) had multiple partners with at least one new partnership formation in the year prior to the study compared to 53 (83%) among single men who were 3.6 times as likely as married men to report multiple sexual partners in this period; OR = 3.60 (95% CI: 1.72 - 7.73). Additionally, single men were significantly younger with a mean (SD) age of 22.6 (3.39) compared to married men who had a mean age of 29.0 (6.34); $P < 0.001$. A significant number of men; 183 (61%) $P < 0.01$ and 118 (39%) $P < 0.05$ never used condoms with frequent sexual partners and new sexual partners respectively. Seventy seven men (25.8%) reported a history of STI and the majority (81.3%) reported having ever had an HIV test.

3.2. Baseline HIV Infection

Among the 300 fishermen, HIV prevalence was 23% (95% CI: 18.5 - 28.1). As shown in **Table 2**, the number of sexual partners in 6 months prior to study participation did not differ significantly by HIV status. Unlike among HIV positive men, the majority of HIV negative men were significantly of younger age (70%), had multiple sexual partners in the year prior to study participation (65%) and reported no history of STI (82%); p-values as shown in **Table 2**. Conversely, proportions of baseline HSV-2 (76% vs. 50%) and HPV (69% vs. 44%) infection were significantly higher among HIV positive men compared to HIV negative men ($P < 0.001$). HIV negative men were younger ($P < 0.001$), had a higher number of sexual partners lifetime ($P < 0.001$) and reported higher condom use with a new partner ($P < 0.001$) compared to HIV positive men (**Table 2**).

In bivariate logistic regression (**Table 3**), history of STI, HPV and HSV-2 infection at enrolment were significantly associated with baseline HIV infection ($P < 0.001$). HIV prevalence in the studied population increased with age. A unit increase in age was significantly associated with a one-fold increase in odds of being HIV in-

Table 1. Baseline background characteristics of sampled fishermen.

Characteristic (N = 300)	Category	N (%)
Age	Mean age (SD)	27.7 (6.4)
	Median age (IQR)	26.5 (21 - 32)
School years	Mean number of years (SD)	8.8 (3.1)
Ethnicity	Luo	283 (94.3%)
	Other	17 (5.7%)
Monthly income	Income ≤ 115 US$ (10,000 KShs)	273 (91.0%)
	Income > 115 US$ (10,000 KShs)	27 (9.0%)
Religion	Mainline Protestant	75 (25.0%)
	Catholic	46 (15.3%)
	Independent African churches	131 (43.7%)
	Other	48 (16.0%)
Duration of vocational training	Less than 1 year	22 (32.4%)
	1 - 2 years	33 (48.5%)
	More than 2 years	13 (19.1%)
Sexual History:		
Age of sexual debut	Mean age (SD)	13.5 (3.7)
	Median age (IQR)	13 (5)
Condom use at sexual debut	Yes	20 (6.7%)
	No	280 (93.3%)
History of HIV test:	Ever tested for HIV	243 (81.3%)
Immunologic parameters, N = 287; (mean, SD):	Baseline CD4 (HIV Positive)	518.9 (297.31) cells/µl
	Baseline CD4 (HIV Negative)	922.7 (304.32) cells/µl
	Baseline CD4 (overall)	829.8 (346.82) cells/µl
	White blood cells ($\times 10^9$/L)	5.6 (1.53)

Table 2. Characteristics of fishermen by HIV status at study enrollment.

Characteristic	HIV Positive (N = 70)		HIV Negative (N = 230)		Total (N = 300)	
	n (%)	P-Value	n (%)	P-Value	n (%)	P-Value/(95% CI)
Age		**0.396**		**<0.001**		**<0.001**
18 - 28 years	33 (47.1)		161 (70)		194 (64.7)	(59.2 - 70.1)
29 - 47 years	37 (52.9)		69 (30)		106 (35.3)	(29.9 - 40.8)
Marital status		**<0.001**		**<0.001**		**<0.001**
single	9 (12.9)		55 (23.9)		64 (21.3)	(16.7 - 26.0)
Ever married	61 (87.1)		175 (76.1)		236 (78.7)	(74.0 - 83.3)
Circumcised		**<0.001**		**<0.001**		**<0.001**
Yes	11 (15.7)		61 (26.5)		72 (24.0)	(19.1 - 28.9)
No	59 (84.3)		169 (73.5)		228 (76.0)	(71.1 - 80.7)
Sexual partners in 6 months		**0.090**		**0.777**		**0.777**
≤1 partner	39 (55.7)		113 (49.1)		152 (50.7)	(45.0 - 56.4)

Continued

>1 partners	**31 (44.3)**		**117 (50.9)**		**148 (49.3)**	**(43.6 - 55.0)**
Sexual partners in 12 months		**0.090**		**<0.001**		**<0.001**
<2 partner	31 (44.3)		81 (35.2)		112 (37.3)	(31.8 - 42.8)
≥2 partners	39 (55.7)		149 (64.8)		188 (62.7)	(57.2 - 68.2)
Sexual partners in lifetime		**<0.001**		**<0.001**		**<0.001**
≤5 partners	10 (14.3)		48 (20.9)		108 (36.0)	(30.5 - 41.5)
>5 partners	60 (85.7)		182 (79.1)		192 (64.0)	(58.5 - 69.5)
Commercial sex		**<0.001**		**<0.001**		**<0.001**
No	1 (1.4)		33 (14.3)		34 (11.3)	(7.7 - 14.9)
Yes	69 (98.6)		197 (85.7)		266 (88.7)	85.1 - 92.3)
Most recent sexual partner						
Regular Girlfriend/Wife	43 (61.4)	Reference	128 (71.7)	Reference	167 (69.3)	(50.0 - 61.3)
Casual partner/Sex worker	27 (38.6)	<0.001	65 (28.3)	<0.001	92 (30.7)	(25.4 - 35.9)
Condom use on last sexual act		**<0.001**		**<0.001**		**<0.001**
No	69 (98.6)		189 (82.2)		258 (86.0)	(82.1 - 90.0)
Yes	1 (1.4)		41 (17.8)		42 (14.0)	(10.1 - 18.0)
Condom use with new partner						
Rarely (<25%)	44 (62.9)	Reference	63 (27.4)	Reference	107 (35.7)	Ref
Some of the time (25% - 75%)	17 (24.3)	0.011	48 (20.9)	0.221	65 (21.7)	0.003
Most of the time (>75%)	9 (12.9)	<0.001	119 (51.7)	<0.001	128 (42.7)	0.265
Ever use of Condom		**<0.001**		**<0.001**		**<0.001**
Ever used condom	48 (68.6)		195 (84.8)		243 (81.0)	(76.5 - 85.5)
Never used condom	22 (31.4)		35 (15.2)		57 (19.0)	
History of STI		**0.777**		**<0.001**		**<0.001**
No	34 (48.6)		189 (82.2)		223 (74.3)	(69.3 - 79.2)
Yes	36 (51.4)		41 (17.8)		77 (25.7)	(20.8 - 30.7)
Baseline HSV-2		**<0.001**		**1.000**		**0.090**
Negative	17 (24.3)		114 (49.6)		131 (43.7)	(38.0 - 49.3)
Positive	53 (75.7)		116 (50.4)		169 (56.3)	(50.7 - 62.0)
Baseline HPV		**<0.001**		**0.090**		**1.000**
Negative	22 (31.4)		129 (56.1)		151 (50.3)	(44.6 - 56.0)
Positive	48 (68.6)		101 (43.9)		149 (49.7)	(44.0 - 55.4)

fected at baseline; OR = 1.08 (95% CI: 1.04 - 1.13). Older men (>28 years old) were 2.6 times more likely to test positive for HIV at baseline compared to younger men (≤28 years old); OR = 2.62 (95% CI: 1.46 - 4.69) as shown in **Table 3**. Men who reported ever being married were 2 times more likely to be HIV positive at baseline in bivariate analysis OR = 2.13 (95% CI: 1.02 - 4.93). Men in this study reported very low condom use: 7% at sexual debut, 10% with new sexual partner (at a frequency >75% of the time), 14% at most recent sexual act and 43% with new sexual partner (at frequency >75% of the time). However, those who reported ever using a condom OR = 0.39 (95% CI: 0.20 - 0.76), condom use with a frequency greater than 75% of the time with a new sexual partner OR = 0.18 (95% CI: 0.06 - 0.51) or used condom on the most recent sexual act OR = 0.07 (95% CI: 0.01 - 0.50), were less likely to test HIV positive at baseline. Circumcision status and/or the number of sexual partners at enrolment were not associated with baseline HIV status (**Table 3**). Married men who reported

Table 3. Bivariate logistic regression of factors associated with baseline HIV infection.

Characteristic	OR	95% CI	P-value
Age: 18 - 28 years		Reference	
29 - 47 years	2.62	1.46 - 4.69	0.001
Marital status: Single		Reference	
Ever married	2.13	1.02 - 4.93	0.048
Circumcision: Yes		Reference	
No	1.94	0.95 - 3.93	0.067
Sexual partners in 6 months: <2 partner		Reference	
≥2 partners	1.19	0.68 - 2.08	0.523
Sexual partners in 12 months: ≤2 partner		Reference	
>2 partners	1.04	0.58 - 1.85	0.897
Sexual partners in lifetime: ≤5 partners		Reference	
>5 partners	4.45	2.17 - 9.14	<0.001
Commercial sex: No		Reference	
Yes	11.56	1.65 - 23.12	0.017
Baseline HSV-2: Negative		Reference	
Positive	3.06	1.67 - 5.61	<0.001
Baseline HPV: Negative		Reference	
Positive	2.79	1.58 - 4.92	<0.001
Relation with recent partner			
All men: Girlfriend	1.00	0.59 - 1.72	0.993
Casual partner/Sex worker	2.23	0.36 - 13.59	0.386
Wife	0.32	0.11 - 0.92	0.035
Single men: Girlfriend		Reference	
Casual partner/Sex worker	0.80	0.15 - 4.50	0.761
Married men: Wife		Reference	
Girlfriend	3.52	1.08 - 12.69	0.020
Casual partner/Sex worker	4.44	1.30 - 16.59	0.007
Ever use of Condom: Yes	0.39	0.20 - 0.76	0.002
No	2.55	1.31 - 4.96	0.002
Condom use on recent sexual act:			
No	14.97	2.15 - 29.82	0.005
Yes	0.07	0.01 - 0.50	0.005
Condom use with new partner:			
Most of the time (>75%)	0.18	0.06 - 0.51	0.001
Some of the time (>25%)	1.71	0.66 - 4.43	0.266
Rarely (<25%)	4.14	2.35 - 7.29	0.001
Ever had STI: No		Reference	
Yes	4.86	2.72 - 8.65	<0.001

having their most recent sexual act with a girlfriend OR = 3.52 (95% CI: 1.08 - 12.69) or sex worker/casual partner OR = 4.44 (95% CI: 1.30 - 16.59) were more likely to be HIV positive at baseline compared to those who reported having the most recent sexual act with their wife. In stratified analysis, men infected with both HPV and HSV-2 at baseline were 6 times at increased risk of being detected with HIV infection at baseline

compared to men negative for both HPV and HSV-2infections at baseline; OR = 6.19 (2.55 - 15.03). Only 6.7% (5/75) and 38.7% (36/93) were detected with HIV at baseline among those negative for both HPV/HSV-2 and those positive for both HPV/HSV-2infections respectively.

In multivariate logistic regression, age was significantly associated with baseline HIV infection (aOR = 1.05; 95% CI: 1.02 - 1.11), with older men being more likely to test positive for HIV at baseline compared to younger men; aOR = 2.13 (95% CI: 1.25 - 5.07) as shown in **Table 4**. However, marital status and circumcision were not associated with baseline HIV infections (P > 0.05). History of STI (aOR: 4.21; 95% CI: 2.07 - 9.34) and baseline HPV infection (aOR: 2.13 (95% CI: 1.05 - 4.77) were positively associated with HIV infection. Higher number (>5) of lifetime sexual partners (aOR: 5.76; 95% CI: 1.41 - 13.57) and engaging in transactional sex (exchange of fish, money and other favors for sex) (aOR: 10.98; 95% CI: 1.86 - 19.34) were more likely to have HIV infection at baseline. However, consistent condom use over 75% of the time with new sexual partner, ever using condom and condom use on the most recent sexual act was protective with regards to HIV infection (p < 0.01 as shown in **Table 4**). Conversely men who reported consistent use of condom (>75% of the time) were 2.6 times more likely to test HIV positive at baseline compared to those who rarely or inconsistently used condom (less than 25% of the time) with a regular sexual partner (aOR = 2.60; 95% CI: 1.17 - 7.77).

3.3. Incident HIV Infection

Of the 300 fishermen enrolled, 230 men were HIV negative at baseline of which 191 (83%) returned for the scheduled study exit follow-up visit after 12 months. This represented a crude total of 191 person-years (PY) of follow-up. During the 1 year period, 8 of the 191 (4.2%) seroconverted, indicating an HIV incidence rate of 4.2 (95% CI: 1.3 - 7.1) per 100 person-years. Men who seroconverted hada mean (SD) age of 22 (2.19) years, which was significantly lower compared to the mean (SD) age 27.0 (6.05) years of those men that remained negative at study exit, (P<0.001)… Seven (87.5%) of seroconverters were below 25 years.

As shown in **Table 5**, the majority of men with incident HIV infection were uncircumcised, single (never married), engaged in commercial sex, never used condom in their latest sexual act, reported multiples partners in

Table 4. Multivariate logistic regression of factors associated with baseline HIV infection.

Characteristic	aOR	95% CI	P-value
Age: 18 - 28 years		Reference	
29 - 47 years	2.13	1.25 - 5.07	0.001
Marital status: Single		Reference	
Ever married	1.57	0.15 - 2.17	0.409
Circumcision: Yes		Reference	
No	1.82	0.55 - 5.98	0.325
Sexual partners in lifetime: ≤5 partners		Reference	
>5 partners	5.76	2.41 - 11.57	<0.001
Commercial sex: No		Reference	
Yes	10.98	1.86 - 19.34	0.021
Baseline HSV: Negative		Reference	
Positive	1.54	0.67 - 3.57	0.312
Baseline HPV: Negative		Reference	
Positive	2.13	1.05 - 4.77	0.047
Ever use of Condom: Ever used condom		Reference	
Never used condom	2.67	1.19 - 5.99	0.017
Condom use on recent sexual act: No		Reference	
Yes	0.09	0.03 - 0.61	0.009
Condom use with new partner:			
Rarely (<25%)		Reference	
Most of the time (>75%)	0.21	0.08 - 0.55	0.002
Ever had STI: No		Reference	
Yes	4.21	2.07 - 9.34	<0.001

Table 5. Factors associated with incident HIV infection among fishermen.

Factors	n	Incidence (Rate %)	IRR (95% CI)	P-Value	aIRR (95% CI)	P-Value
Age						
18 - 25 years	88	7 (8.0)	8.19 (1.03 - 65.32)	0.025	5.57 (0.89 - 34.64)	0.066
26 - 47 years	103	1 (1.0)	Reference			
Marital status						
Single	45	5 (11.1)	5.41 (1.34 - 21.75)	0.019	8.32 (1.27 - 54.67)	0.027
Ever married	146	3 (2.1)	Reference			
Circumcised						
Yes	51	1 (2.0)	0.39 (0.05 - 3.11)	0.092	0.99 (0.09 - 10.68)	0.991
No	140	7 (5.0)	Reference			
Sexual partners in 6 months						
≤1 partner	94	4 (4.3)	0.95 (0.24 - 3.68)	1.00	Not included	-
>1 partners	93	4 (4.3)	Reference			
Sexual partners in 12 months						
≤1 partner	70	1 (1.4)	0.25 (0.03 - 1.97)	0.102	0.87 (0.07 - 10.92)	0.913
>1partners	121	7 (5.8)	Reference			
Sexual partners in lifetime						
≤5 partners	78	1 (1.3)	0.21 (0.03 - 1.65)	0.101	0.65 (0.05 - 8.93)	0.747
>5 partners	113	7 (6.2)	Reference			
Commercial sex						
No	25	0 (0.0)	0.00 (0.00 - 4.58)	0.600	Not included	-
Yes	166	8 (4.8)	Reference			
Most recent sexual partner						
Wife/regular girlfriend	139	1 (0.7)	0.05 (0.00 - 0.39)	0.001	0.03 (0.01 - 0.35)	0.004
Casual partner/Sex worker	53	7 (13.2)	Reference			
Condom use on last sexual act						
No	162	7 (4.3)	1.25 (0.16 - 9.81)	1.000	Not included	-
Yes	29	1 (3.4)	Reference			
Condom use with regular partner						
≥ 50% of the time	14	0 (0.0)	0.00 (0.00 - 9.17)	1.000	Not included	-
< 50% of the time	177	8 (4.5)	Reference			
Condom use with new partner						
≥50% of the time	108	1 (0.9)	0.10 (0.00 - 0.85)	0.022	0.08 (0.01 - 0.89)	0.039
<50% of the time	83	7 (8.4)	Reference			
Ever use of Condom						
Ever used condom	**164**	8 (4.9)	Reference			
Never used condom	**27**	0 (0.0)	0.00 (0.00 - 4.17)	0.603	Not included	-
History of STI						
No	157	5 (3.2)	Reference			
Yes	33	3 (9.1)	3.04 (0.54 -15.74)	0.104	2.10 (0.28 - 15.84)	0.470
Baseline HSV-2						
Negative	94	5 (5.3)	0.57 (0.10 - 2.83)	0.493	Not included	-
Positive	97	3 (3.1)	Reference			
Baseline HPV						
Negative	106	3 (2.8)	Reference			
Positive	85	5 (5.9)	2.15 (0.43 - 11.73)	0.470	Not included	-

previous 12 months and >5 sexual partners lifetime at baseline. Six of 8 men (75%) with incident HIV infection were HSV-2 positive at exit. However, only 3 (37.5%) of these men had HSV-2 at baseline. Of the men with new HIV infection 63% (5/8) had HPV infection at baseline. Moreover, 88% (7/8) were detected with at least one new HPV genotype (different from those detected at baseline) in the course of study follow-up and 71% (5/7) of these men had multiple new HPV genotypes. All these men had a baseline CD4 > 700 (mean = 852, SD = 162.5; median = 809, IQR = 744.8 - 938.3) cells/μl of blood before getting HIV infection but by the time of exit their CD4 had significantly ($P < 0.001$) dropped to mean (SD) CD4 of 516 (277.5); median (IQR) 461 (391.5 - 658.3) cells/μl of blood. Five (62.5%) already had their CD4 dropped to <500 cells/μl of blood.

Multivariate logistic regression (**Table 5**) strengthened the association between marital status and HIV incidence. Single men were independently at a greater risk for HIV acquisition compared to married men, aIRR = 8.32 (95% CI: 1.27 - 54.67). Young age had a borderline association with HIV acquisition; aIRR = 5.57 (95% CI: 0.89 - 34.64). Men who had most recent sexual act with their wife/regular girlfriend and those who used condom (≥50% of the time) with new sexual partners were protected from acquiring HIV compared to men whose most recent sexual act was with a sex worker/casual partner and those who consistently used condom (<50% of the time) with new sexual partners; aIRR = 0.03 (95% CI: 0.01 - 0.35) and aIRR = 0.11 (95% CI: 0.01 - 0.89) respectively.

4. Discussion

4.1. HIV Prevalence

This study presents data from a one-year longitudinal follow-up of fishermen on the Kenyan beaches of Lake Victoria. It is one of the very few studies that have evaluated risk factors for HIV acquisition among fishermen. With a baseline HIV prevalence of 23.3%, fishermen remain a subpopulation that is highly burdened by HIV compared to the general population. This was 4 times the national HIV prevalence of 5.6% [19]. Similar high HIV prevalence (20% - 28%) among fishermen, have been previously reported in Kenya and Uganda [16] [20]-[22]. In comparison to other high-risk groups such as MSM, the HIV prevalence in this study was twice that observed in bisexual MSM in Mombasa, Kenya [23]. However, the HIV prevalence in this study was lower than 43% observed among exclusive MSM in Mombasa, Kenya [23] and 37% among women with high-risk sexual behavior in Uganda [24]. The independent risk factors (older age, a higher number of lifetime sexual partners, commercial sex, HPV infection and history of STI) associated with HIV prevalence in this study, were also observed in previous studies [20] [21] [24].

4.2. HIV Incidence Rate

The HIV incidence rate of 4.2 per 100 person-years among fishermen in this study was similar to rates found in previous studies among male subpopulations considered at higher risk for HIV infection. Seeley *et al*. (2012) found an HIV incidence rate of 4.9 person-years among fishing communities (with 5.2 person-years among men) on the shores of Lake Victoria in Uganda [25]. New HIV infection rate of 3.9 per 100 person-years was observed among men reporting high-risk sexual behavior [26] and 5.8 per 100 person-years among bisexual MSM [27] in Costal Kenya. Similarly, HIV incidence of 6.1 per 100 person-years was found among exclusive MSM in Mombasa, Kenya [28], while 3.4 per 100 person-years [29] and 5.4 per 100 person-years [30] observed among MSM in China. Moreover, HIV acquisition rate of 5.8 per 100 person-years was shown among patients and commercial sex workers attending STI clinics in Pune, India [31] and 3.66 per 100 person-years observed among female sex workers in Kampala, Uganda [32].

HIV incidence in this study was higher compared to 2 per 100 person-years and 1.4 per 100 person-years observed among uncircumcised men drawn from the general population in Kisumu, Kenya [33] and Rakai, Uganda [34] respectively, 0.9 among heterosexual men in Mombasa, Kenya. Similar contrasting lower incidence rates were observed among high risk men in low HIV prevalence countries of: 1.24 per 100 person-years among MSM in Victoria, Australia [35] and 1.9 per 100 person-years among MSM in six US cities [36]. This suggests that the sexual behavior of fishermen in this study is comparable to that of men and women with high-risk sexual behavior living in high HIV prevalence communities.

4.3. Risk Factors for Incidence

Independent risk factors for HIV acquisition from this study were similar to those of previous studies assessing

factors associated with incident HIV infection. Young age [25] [32], being single [27] [34], recent sexual intercourse with sex worker/casual partner [35] [37] and unprotected sex with new sexual partners [27] [32] [35] [36] were significantly associated with new HIV infection. Surprisingly, incident HIV infection was not associated with baseline HSV-2 infection in this study. This finding was largely unexpected given the high baseline HSV-2 (56.3%) prevalence in this study of men with high risk sexual behavior, and the strong association between HIV and HSV-2 at baseline. However, similar results were documented by Supriya *et al*. (2012) in their Kisumu circumcision trial [33]. In contrast, other previous studies found baseline HSV-2 infection, a significant risk factor for HIV acquisition in men [34] [36] [38].

Although, evaluation of risk factors for HIV incidence had study power limitations which confined analysis to the eight seroconversion events that occurred in the study, the observed increased risk for new HIV acquisition among young single men was not surprising. In this study, single men were 3 times as likely as married men to report a new sexual partner(s) in the past 12 months. In the effort to provide explanation to why MSM are at increased risk for HIV compared to heterosexual men, Sara *et al*. (2012) found that 86% of young MSM (18 - 24 years) compared to 56% of young heterosexual men (18 - 24 years) acquired a new sexual partner in the previous year [39]. This was similar to 83% observed in this study among younger single men compared to 57% among married men who formed a new sexual partnership in the same period of time. This similarity in addition to low condom use with new sexual partners may partially explain the higher risk for HIV incidence among young single fishermen.

STIs that induce the activation and recruitment of CD4+ T lymphocytes into clinical (subclinical) mucosal lesions associated with disrupted mucosal membrane likely increase HIV acquisition [40] [41]. Earlier studies observed that HIV seroconversion was associated with incident STI infections: syphilis [30] [35], HSV-2 [31] [33] [34] [42], *Mycoplasma genitalium* [32] and gonorrhea [27]. This suggests that these infections potentially increase susceptibility to HIV infection, but more importantly that they share a mode of transmission and thus are biological markers for exposure to unprotected sexual behavior. New, current, or history of STI is strong indicators of previous or current exposure to unsafe sexual practice; which is the primary major risk factor for HIV acquisition and transmission. Subramanian *et al*. (2013) documented a significant decline in STI prevalence and stable HIV prevalence in India. This was due to a large scale HIV prevention program targeting safer sexual practices among high-risk MSM in high-prevalence state of Tamil Nadu [43]. Two recent randomized clinical trials successfully demonstrated that antiretroviral drugs can be used for HIV prevention. The Partners Pre-exposure prophylaxis (PrEP) trial showed that tenofovir-emtricitabine (TDF-FTC) conferred 75% protection against HIV acquisition by HIV negative spouses among HIV discordant heterosexual couples [44]. Cohen *et al*. demonstrated a 96% reduction in linked HIV transmission due to the effect of early antiretroviral therapy (ART) compared to delayed therapy administered to HIV positive spouses among heterosexual HIV discordant couples [45]. A global rollout of a multipronged program integrating PrEP, treatment for prevention (early ART) and safer sexual practices in groups with high-risk sexual behavior may reduce the incidence of HIV and other STIs.

5. Conclusion

Fishermen experience a high burden of HIV infection. Due to compounding and overlapping behavioral and sexual risk factors for STIs and HIV, the findings of this study suggest that high-risk unsafe sex could be the most important predisposing factor for HIV acquisition. The success in mitigating the HIV epidemic potentially lies in a renewed call for innovative revamping and strengthening of safer sex HIV preventions strategies fortified with the use of antiretroviral drugs. Well-targeted risk reduction interventions for high risk groups such as fishermen are urgently needed to prevent new HIV infections among most at risk subpopulations and the general population.

Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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