Changes in sexual risk behavior among MSM participating in a research cohort in coastal Kenya

Lisanne M. Möller^{a,*}, Ineke G. Stolte^{a,f,*}, Ronald B. Geskus^{a,b},
Haile Selassie Okuku^c, Elizabeth Wahome^c, Matt A. Price^{d,e},
Maria Prins^{a,f}, Susan M. Graham^{c,g} and Eduard J. Sanders^{c,h,i}

Objective: To describe changes in sexual risk behavior among Kenyan MSM who received regular risk reduction counseling (RRC).

Design: Data were derived from two cohorts of HIV-1-negative and HIV-1-positive MSM in Kenya. Behavioral data were collected at enrollment and at monthly or quarterly scheduled follow-up visits. At each visit, RRC was provided to all men and HIV-1 testing to seronegative men.

Methods: Random effects logistic and Poisson regression models with time since study entry as main variable of interest were used to evaluate changes in number of sex partners and unprotected sex in the past week, and insertive, receptive, and unprotected anal intercourse in the past 3 months. Analyses were adjusted for HIV-1-status, calendar year of follow-up, and several baseline characteristics. Trends over follow-up time were allowed to differ by HIV-1-status. Men were censored when they seroconverted for HIV.

Results: Number of regular and casual sex partners and unprotected anal intercourse decreased in both HIV-1-negative and HIV-1-positive men. Unprotected sex with both regular and casual sex partners decreased more strongly early in follow-up in HIV-1-positive men than in HIV-1-negative men. Decreases in insertive anal intercourse were found for HIV-1-positive men only, whereas decreases in receptive anal intercourse were found for HIV-1-negative men only.

Conclusion: MSM who were regularly exposed to RRC showed some reductions in sexual risk behavior, but it is uncertain if these reductions are sustained over time. As HIV-1 incidences in Kenyan MSM are very high, RRC should be supported by comprehensive biomedical interventions.

Copyright © 2015 Wolters Kluwer Health, Inc. All rights reserved.

AIDS 2015, **29** (Suppl 3):S211–S219

Keywords: HIV-1, Kenya, MSM, risk reduction counseling, sexual behavior

^aDepartment of Infectious Diseases Research and Prevention, Public Health Service Amsterdam, the Netherlands, ^bDepartment of Clinical Epidemiology, Biostatistics and Bioinformatics, Academic Medical Center, Amsterdam, the Netherlands, ^cCentre for Geographic Medicine Research-Coast, Kenya Medical Research Institute, Kilifi, Kenya, ^dInternational AIDS Vaccine Initiative, New York City, New York, ^eDepartment of Epidemiology and Biostatistics, University of California, San Francisco, California, USA, ^fDepartment of Internal Medicine, Division of Infectious Diseases, Center for Infection and Immunity Amsterdam (CINIMA), Academic Medical Center, Amsterdam, the Netherlands, ^gDepartments of Medicine, Global Health, and Epidemiology, University of Washington, Seattle, Washington, USA, ^hNuffield Department of Medicine, Centre for Tropical Medicine and Global Health, University of Oxford, Headington, UK, and ⁱDepartment of Global Health, Academic Medical Centre, University of Amsterdam, Amsterdam, the Netherlands.

Correspondence to Ineke G. Stolte, Public Health Service Amsterdam, Nieuwe Achtergracht 100, 1018 WT, Amsterdam, the Netherlands.

Tel: +31 020 555 5229; e-mail: istolte@ggd.amsterdam.nl

* Lisanne M. Möller and Ineke G. Stolte contributed equally to the writing of this article.

DOI:10.1097/QAD.0000000000000890

ISSN 0269-9370 Copyright © 2015 Wolters Kluwer Health, Inc. All rights reserved. This is an open access article distributed under the Creative Commons Attribution License 4.0, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Introduction

Male same-sex behavior and HIV-1/sexually transmitted infections (STI) transmission among men who have sex with men (MSM) in sub-Saharan Africa (sSA) have been described recently [1–7], despite years of neglect of this population due to stigma and criminalization [1,8,9]. As a result of the belated recognition of African MSM as a key group for interventions, front-line health workers lack training that would enable them to communicate with MSM and provide education about HIV-1 transmission risk [10]. An important public health question concerns how best to promote HIV and STI screening and prevention services for MSM within diverse healthcare settings in sSA [8].

Behavior change interventions conducted in North-America or Western Europe have been efficacious in reducing the frequency of unprotected anal intercourse among MSM in the early years of the epidemic, but have not been sufficient to stop the HIV-epidemic in the era of combination antiretroviral therapy [10]. Typically, behavioral interventions focused on reducing unprotected anal intercourse, or numbers of sexual partners. The vast majority of these studies have taken place in settings with good access to tailored information. Given the difficulties African MSM face in accessing prevention interventions, an important question remains whether regular risk reduction counseling (RRC) with tailored health information can influence men's sexual risk behavior in sSA.

Since 2005 in Mtwapa, Kenya, we have followed HIV-1-negative MSM in an HIV-1 vaccine preparedness cohort study, and HIV-1-positive men who enrolled in a parallel cohort for care. Our objective was to evaluate whether participation in a study with regular RRC led to changes in partner numbers, unprotected sex, and insertive (IAI), receptive (RAI), or unprotected anal intercourse (UAI) reported by either HIV-1-negative or HIV-1-positive MSM.

Methods

Study population

In July 2005, a prospective cohort study of adult men and women at high risk for HIV-1 acquisition was initiated by the Key Populations Studies cluster of the Kenya Medical Research Institute-Wellcome Trust Research Programme (KEMRI-WTRP) in Kilifi, Kenya [11]. Participants were identified and recruited by a team of trained peer mobilizers who approached individuals via personal networks and at venues where they met with their partners and clients. HIV-1-negative adults aged 18 to 49 years were eligible for enrollment if they met any of the following criteria: any report of transactional sex,

recent STI, multiple sexual partners, anal sex, or regular sex with an HIV-1-infected partner in the previous 3 months. Individuals who had prevalent HIV-1 at screening could enroll in a parallel cohort for HIV-1-infected participants. The present study focuses on MSM only, and includes all eligible men who enrolled in either cohort between July 2005 and December 2011 and who reported having had anal sex with another man at any point during follow-up. Only men with at least one follow-up visit were included in the analyses. Men who reported no sex during the past week ($n = 61$) on all of their study visits were excluded.

Study procedures

Eligible individuals were offered confidential HIV-1 counseling and testing at baseline. HIV-1-negative participants underwent HIV-1 testing at each study visit. Participants were followed monthly or quarterly, depending on their reported risk behavior and HIV-1 status (i.e., monthly for most HIV-1-negative men who reported RAI and otherwise quarterly). At enrollment and follow-up visits, participants completed face-to-face interviews with counselors to collect information on their sexual behavior, with data recorded on paper questionnaires (prior to 2009) or directly captured into a computer database (2009 onwards). A physical examination was performed at each visit. Participants who acquired HIV-1 during follow-up ($n = 69$) were excluded from this study from their first HIV-1-positive visit onwards, as they were enrolled into a separate protocol without detailed risk behavior assessments.

At each scheduled follow-up visit, brief RRC was conducted for all participants. These sessions lasted 20 minutes on average and included assessment of HIV-1 knowledge, risk behavior, and substance use; identification of what supports and hinders use of condoms and other strategies to reduce risk, and negotiation of a realistic and incremental plan for reducing risk of HIV-1 and other STIs. All clinic counselors attended regular supervisory meetings that discussed challenges of RRC in the context of research, and attending to MSM in a society that largely rejects same-sex practices [12]. At each scheduled visit, condoms and water-based lubricants were provided. The studies were approved by the ethical review boards at KEMRI and, for the HIV-1-positive cohort, at the University of Washington. All participants provided written informed consent.

Variables

Seven primary sexual risk behavior outcomes were investigated. First, number of sexual partners in the past week was studied separately for regular partners (defined as 'boyfriend', 'girlfriend', or a spouse) and casual partners (defined as an occasional or new sex partner). Second, we studied unprotected sex in the past week during any type of sex separately for regular and casual partners. Sex was considered to be protected when the number of sexual

acts where a condom was used was equal to the number of reported sexual acts, or when no sex in the past week was reported. Third, UAI (both insertive or receptive), any RAI (both protected and unprotected), and any IAI (both protected and unprotected) in the past 3 months were studied. UAI was dichotomized; men reporting 'never', 'sometimes' or 'frequently' using condoms during anal sex were considered as having UAI, and were compared to men reporting 'always' using condoms or not having had anal sex, as a marker of behavior that reduces the risk of HIV transmission.

At enrollment, we collected information on socio-demographic factors. Educational level was divided into two categories: primary school or lower vs. secondary school or higher. Married monogamous, polygamous, separated/divorced and widowed men were categorized as ever married, and other men as never married. Religion was categorized into Christian (Catholic, Protestant, other Christian), Muslim, and none/other. Employment was categorized into none, self, and formal employment. Men were asked at enrollment whether they had been previously tested for HIV-1. At every visit, questions on sex with women, group sex, receiving payment for sex, and paying for sex in the past 3 months were asked, and these variables were dichotomized. Information on alcohol use in the past month was also collected at every visit, and dichotomized as no vs. any use.

Statistical analyses

Participants were censored at the last study visit before December 2011 (end of study date), date of last study visit if lost to follow-up, or date of last HIV-1-negative study visit if they seroconverted during follow-up. Changes in sexual risk behavior over follow-up years after cohort enrollment were evaluated using multivariable random effects logistic regression for the five binary outcomes and multivariable random effects Poisson regression for the two count outcomes, allowing for smoothly varying trends via restricted cubic splines. The intercept and linear time trend were allowed to differ per individual via the random effects. Time since study entry was the principal covariable. To allow for differential trends in sexual risk behavior for HIV-1-positive and HIV-1-negative men, an interaction term between time and HIV-1-status was included a priori in the models. Additionally, analyses were corrected for calendar year of study entry and for enrollment characteristics that changed significantly over calendar year of entry (age at recruitment, HIV-1 testing prior to study enrollment, paying for sex, receiving payment for sex, and alcohol use in the past month), to adjust for changes in cohort make-up over the years. A marker indicating whether the visit was an enrollment or follow-up visit was also included in all models, as men may have over-reported risk behavior at enrollment in order to be included in the study and to benefit from access to healthcare and research services

[13]. For the RAI model, a three-way interaction between follow-up years, HIV-1-status, and receiving payment for sex was included, as we hypothesized that men who were paid for sex had more RAI than other men and reduced their risk behavior to a lesser extent, because they might be paid more for RAI. Likewise, a three-way interaction between follow-up years, HIV-1-status, and having paid for sex was included in the IAI model.

Trends are presented graphically as probabilities of engaging in a specific sexual behavior over time for dichotomous outcomes, and as counts for number of partners. As reference values for the other variables, we chose the median value of continuous covariates and most common values of categorical covariates (age 25.4 years, calendar year 2009, being paid for sex, not paying for sex, alcohol use in the past month, and no prior HIV-1 testing). The effect of overreporting of sexual risk behavior on the first visit was discounted in the analyses. Additionally, odds ratios for the effect of follow-up time were calculated for dichotomous outcomes, comparing baseline (0 years of follow-up) and 4 years of follow-up to 1 year of follow-up, to consider possible rebounding of reported sexual behaviors. All statistical analyses were performed using Stata version 11.2 (StataCorp, College Station, Texas, USA), and the R statistical computing environment version 3.1.1 [14].

Results

Study population

Of the 776 MSM enrolled in either of the two cohorts, 215 (27.7%) did not return for any follow-up visits. Baseline characteristics from men with and without follow-up visits are presented in Supplementary Table 1, <http://links.lww.com/QAD/A779>. Men without follow-up tended to be younger than men with follow-up, had more casual sex partners in the past week, and more often had unprotected sex with casual partners.

In total, 561 MSM returned for at least one follow-up visit and were included in this study, of which 92 (16%) were HIV-1-positive and 469 (84%) were HIV-1-negative. The median number of follow-up visits per participant was 9 [interquartile range (IQR) 4–16] for HIV-1-negative and 8 (IQR 4–14) for HIV-1-positive men. The median follow-up time was 1.2 years (IQR 0.5–2.3), with a median of 1.1 years for HIV-1-negative and 1.8 years for HIV-1-positive men. Baseline demographic and sexual behavior characteristics of the 561 study participants are presented in Table 1, overall and by HIV-1-status. HIV-1-positive men were generally older than HIV-1-negative men, and less often had HIV-1 testing prior to study enrollment. Compared with HIV-1-negative men, HIV-1-positive men were less likely to

Table 1.. Baseline characteristics of 561 men who have sex with men, Kilifi, Kenya, 2006–2011.

	Overall, <i>n</i> (%)	HIV-1-negative, <i>n</i> (%)	HIV-1-positive, <i>n</i> (%)
Total	561 (100)	469 (83.6)	92 (16.4)
Median age (years) (IQR)	25.2 (21.5–29.7)	24.7 (21.3–29.2)	27.7 (24.7–31.7)
Education			
None or primary	302 (53.8)	248 (52.9)	54 (58.7)
Secondary and higher	259 (46.2)	221 (47.1)	38 (41.3)
Marital status			
Never married	459 (81.8)	382 (81.5)	77 (83.7)
Ever married	102 (18.2)	87 (18.6)	15 (16.3)
Religion			
Christian	269 (48.0)	225 (48.0)	44 (47.8)
Muslim	187 (33.3)	154 (32.8)	33 (35.9)
Other/none	105 (18.7)	90 (19.2)	15 (16.3)
Employment			
None	250 (44.6)	210 (44.8)	40 (43.5)
Self	221 (39.4)	190 (40.5)	31 (33.7)
Formal	90 (16.0)	69 (14.7)	21 (22.8)
Had been tested for HIV-1 prior to study enrollment			
No	295 (52.6)	230 (49.0)	65 (70.7)
Yes	266 (47.4)	239 (51.0)	27 (29.4)
Sexual activity with regular partner in past week ^a			
Mean number of sex partners (SD)	0.8 (1.0)	0.8 (1.1)	0.7 (0.7)
Unprotected sex			
No	338 (60.4)	281 (60.0)	57 (62.0)
Yes	222 (39.6)	187 (40.0)	35 (38.0)
Sexual activity with casual partner in past week ^a			
Mean number of sex partners (SD)	1.6 (2.2)	1.6 (2.1)	1.6 (2.6)
Unprotected sex			
No	305 (56.8)	252 (56.4)	53 (58.9)
Yes	232 (43.2)	195 (43.6)	37 (41.1)
Anal intercourse in past 3 months ^a			
Insertive anal intercourse ^b			
No	160 (30.3)	123 (28.2)	37 (40.2)
Yes	369 (69.8)	314 (71.9)	55 (59.8)
Receptive anal intercourse ^b			
No	167 (31.6)	153 (35.0)	14 (15.2)
Yes	362 (68.4)	284 (65.0)	78 (84.8)
Unprotected anal intercourse			
No	89 (16.8)	75 (17.2)	14 (15.2)
Yes	440 (83.2)	362 (82.8)	78 (84.8)
Sex with women in past 3 months			
No	227 (40.5)	169 (36.0)	58 (63.0)
Yes	334 (59.5)	300 (64.0)	34 (37.0)
Received payment for sex with cash, living expenses, or goods in past 3 months			
No	160 (28.5)	135 (28.8)	25 (27.2)
Yes	401 (71.5)	334 (71.2)	67 (72.8)
Paid for sex with cash, living expenses, or goods in past 3 months			
No	376 (67.0)	305 (65.0)	71 (77.2)
Yes	185 (33.0)	164 (35.0)	21 (22.8)
Participated in group sex in past 3 months			
No	470 (83.8)	393 (83.8)	77 (83.7)
Yes	91 (16.2)	76 (16.2)	15 (16.3)
Alcohol use in past month			
No	195 (34.8)	163 (34.8)	32 (34.8)
Yes	366 (65.2)	306 (65.3)	60 (65.2)

IQR, interquartile range; SD, standard deviation.

^aBased on a subset of participants due to missing values (1 missing for number of regular partners and unprotected sex with regular partner, 97 missing for number of casual partners, 24 missing for unprotected sex with casual partner, and 32 missing for variables on anal intercourse).

^bInsertive and receptive anal intercourse were not exclusive.

have had IAI, more likely to have had RAI, less likely to have had sex with women, and less likely to have paid for sex.

Changes in sexual risk behavior

Number of sex partners in the past week

HIV-1-negative and HIV-1-positive men showed a similar decrease in number of regular sex partners (P

interaction = 0.72), but the time trend itself was only significant for HIV-negative men, most likely due to the differences in sample size ($P < 0.001$ for HIV-1-negative men and $P = 0.14$ for HIV-1-positive men; Fig. 1a). There was a borderline significant difference in trend between HIV-1-negative and HIV-1-positive men for number of casual sex partners ($P = 0.09$). The number of casual partners seemed to decrease earlier in follow-up for

Fig. 1. Trends in number of partners in the past week over follow-up time, among men who have sex with men, Kilifi, Kenya, 2006–2011. (a) Number of regular sex partners in the past week. (b) Number of casual sex partners in the past week.

HIV-1-positive men, but the trend itself was not significant ($P=0.36$), whereas it was significant for HIV-1-negative men ($P<0.001$; Fig. 1b).

Unprotected sex in the past week

Patterns in unprotected sex with regular partners seemed to differ between HIV-1-negative and HIV-1-positive men (P interaction = 0.07), with a decrease early in follow-up for HIV-1-positive men ($P=0.005$; Fig. 2a). For HIV-1-negative men, there was a more smoothly decreasing trend, but this was overall not statistically significant ($P=0.13$). Similar trends were seen for unprotected sex with casual partners ($P=0.03$ for HIV-1-positive men and $P=0.18$ for HIV-1-negative men, P interaction = 0.04; Fig. 2b). Using 1 year of follow-up as reference time point, the odds of engaging in unprotected sex with regular partners were higher at entry for HIV-1-positive men [adjusted odds ratio (aOR) 2.84, 95% confidence interval (CI) 1.37–5.96]. A similar, but slightly weaker effect was seen for unprotected sex with casual partners at baseline (aOR 2.12, 95% CI 0.97–4.64). There was no further decrease observed in unprotected sex with regular or casual partners between 1 and 4 years of follow-up for HIV-1-positive men. For HIV-1-negative men, no significant decrease between baseline and 1 year of follow-up was seen for unprotected sex with regular or casual partners. We did see a decrease between 1 and 4 years of follow-up; HIV-1-negative men at 4 years of follow-up were less likely to have unprotected sex with regular partners than at 1 year of follow-up (aOR 0.52, 95% CI 0.28–0.94), and a similar trend was shown for unprotected sex with casual partners (aOR 0.53, 95%

CI 0.28–1.01 for HIV-1-negative men at 4 years of follow-up).

Unprotected anal intercourse in the past 3 months

There was no significant interaction between HIV-1-status and follow-up years for UAI in the past 3 months ($P=0.10$). Both HIV-1-negative and HIV-1-positive men showed a significant decrease in UAI over follow-up years ($P=0.05$ for HIV-1-negative men and $P=0.01$ for HIV-1-positive men; Fig. 3), with the largest change observed in the first 12 months. In accordance, the odds of engaging in UAI were higher at baseline compared to 1 year of follow-up for both HIV-1-negative and HIV-1-positive men (aOR 2.07, 95% CI 1.19–3.61 and aOR 2.63, 95% CI 1.12–6.20, respectively), but there was no significant further decline at 4 years of follow-up compared to 1 year of follow-up for either group (aOR 0.56, 95% CI 0.22–1.41 and aOR 0.61, 95% CI 0.20–1.93, respectively).

Insertive and receptive intercourse in the past 3 months

There was a significant difference in time trend between HIV-1-positive and HIV-1-negative men in IAI ($P<0.001$). For both HIV-1-negative and HIV-1-positive men, there was no significant difference in time trend in IAI between men who paid for sex and men who did not ($P=0.36$ for HIV-1-negative and $P=0.67$ for HIV-1-positive; Figs. 4a and b). As can be seen in Fig. 4b, there was a strong decline in IAI early in follow-up for HIV-1-positive men, but this decline was not statistically significant (aOR at baseline compared with 1 year of follow-up 2.27, 95% CI 0.83–6.18 for men who did not

Fig. 2. Trends in unprotected sex in the past week over follow-up time among men who have sex with men, Kilifi, Kenya, 2006–2011. (a) Unprotected sex with regular sex partner in the past week. (b) Unprotected sex with casual sex partner in the past week.

pay for sex and aOR 3.89, 95% CI 0.37–41.07 for men who paid for sex). Between 1 and 4 years of follow-up, a further decline was seen for both groups, but only statistically significant for men who did not pay for sex (aOR at 4 years compared with 1 year of follow-up 0.23, 95% CI 0.06–0.86 for men who did not pay for sex and aOR 0.02, 95% CI 0.00–2.73 for men who paid for sex).

Fig. 3. Trends in unprotected anal intercourse in the past 3 months over follow-up time among men who have sex with men, Kilifi, Kenya, 2006–2011.

For HIV-1-negative men, no clear decline in IAI was seen (Fig. 4a).

For RAI, there was also a significant difference in time trend between HIV-1-positive and HIV-1-negative men ($P=0.01$). For both HIV-1-negative and HIV-1-positive men, there was no statistically significant difference in time trend for RAI between men who received payment for sex and men who did not ($P=0.22$ for HIV-1-negative and $P=0.11$ for HIV-1-positive; Figs. 4c and d). RAI was very common among HIV-1-positive men; in those who were paid for sex it was close to 100%, and it did not significantly decline over time for either men who did or did not pay for sex. For HIV-1-negative men, there was an initial decline in RAI, both for men who did not receive payment for sex (aOR at baseline compared with 1 year of follow-up 9.24, 95% CI 3.06–27.92), and for men who did receive payment (aOR 2.98, 95% CI 1.02–8.70). For both groups, this decline continued between 1 and 4 years of follow-up (aOR at 4 years compared with 1 year of follow-up 0.04, 95% CI 0.00–0.30 for men who did not receive payment for sex and aOR 0.03, 95% CI 0.00–0.25 for men who did receive payment).

Discussion

This unique, longitudinal study on trends in sexual risk behavior among African MSM shows that it is possible to engage, enroll, and follow-up a relatively large number of MSM in a setting unsupportive of same-sex practices.

Fig. 4. Trends in insertive and receptive anal intercourse in the past 3 months over follow-up time among men who have sex with men, Kilifi, Kenya, 2006–2011. (a, b) Insertive anal intercourse in the past 3 months among MSM who paid (dashed line) or not paid (solid line) for sex. (c, d) Receptive anal intercourse in the past 3 months among MSM who received payment (dashed line) or not received payment (solid line) for sex.

MSM enrolled in this study received regular RRC and, for seronegative men, HIV-1 testing, and reductions in sexual risk behavior were observed. Reductions were found in number of partners and any type of unprotected sex in the past week, and UAI in the past 3 months. In addition, HIV-1-positive men showed decreases in IAI, and HIV-1-negative men in RAI.

We found reductions in number of regular and casual sex partners and UAI for both HIV-1-positive and HIV-1-

negative men. Reductions in number of partners were only statistically significant for HIV-1-negative men, but as trends in number of regular and casual sex partners were similar for HIV-1-negative and HIV-1-positive men, the lack of significance for HIV-1-positive men may be due to limited power for analyses in this smaller group. These decreases in partner numbers and UAI may be the effect of regular exposure to counseling. Elsewhere, studies have shown that behavioral interventions can result in reducing the number of partners and UAI [15–17], although most

behavioral interventions have only had modest effects on self-reported behaviors and little or no impact on HIV-1 incidence [10]. However, as this is an observational study in which all men were counseled, we were not able to assess the effect of RRC on its own.

HIV-1-positive men showed stronger decreases in unprotected sex with both regular and casual sex partners in the past week early in follow-up than HIV-1-negative men. This may be due to the fact that 85% of HIV-1-positive men enrolled were not previously aware of their HIV-1-status. Several studies have shown that MSM decrease their sexual risk behavior immediately after becoming aware of their HIV-positive status [18–21].

We found reductions in IAI among HIV-1-positive men only, and significant reductions in RAI among HIV-1-negative men only. Because counseling conveys the message that risk of transmission is greatest with the HIV-positive ‘top’ (i.e., insertive) partner and risk of acquisition greatest for the HIV-negative ‘bottom’ (i.e., receptive) partner, these findings could suggest that counseling messages have been heeded, and men may be translating this knowledge into behavior to avoid transmission or acquisition of HIV. It is possible that ‘strategic positioning’, a risk reduction strategy in which men exclusively have unprotected RAI if they are HIV-positive and unprotected IAI if they are HIV-negative [22], is being employed by the men in this study. Qualitative data on the use of strategic positioning and other harm reduction strategies among Kenyan MSM are currently lacking.

There are several limitations to these findings. First, data on sexual behavior are self-reported, and may therefore be subject to social desirability bias. Decreases in self-reported risk behavior do not definitely equal decreases in actual behavior, nor directly translate into a reduction in HIV or STI acquisition risk. The use of direct biomarkers (e.g., prostate-specific antigen) of sexual activity among MSM could be explored in future studies. HIV-1 or STI acquisition outcomes would also help assess the impact of behavior changes objectively. Second, only data from men with at least two study visits were included in this study, and over a quarter of our volunteers did not return for follow-up. Men with only one study visit reported more casual sex partners and more unprotected sex with casual sex partners at their enrollment visit when compared with men who had follow-up visits. This suggests that our study population may represent a somewhat less risky group. However, HIV-1 incidences reported in this study population have been very high [5], especially in the first 3 months following cohort enrolment compared to the remainder of cohort follow-up (16.0 per 100 person-years in the first 3 months vs. 5.2 per 100 person-years in the remainder of follow-up), suggesting that risk of HIV-1 acquisition was very high in this group of MSM, and dropped along

with reports of higher risk behaviors [23]. Third, some HIV-1-positive men were treated with antiretroviral therapy (ART) during the study, which may have influenced sexual risk behavior. To exclude a possible influence of treatment on sexual behavior, we conducted sensitivity analyses excluding visits by HIV-1-positive individuals on ART (results not shown), and found comparable trends to those reported here. Fourth, HIV-seroconverters were censored at their last HIV-negative visit. This may have had a downward impact on the reported trends for HIV-negative men, as we miss information about the time period immediately leading up to seroconversion, generally a time period with higher rates of risk behavior. However, as men visited the study clinic at least every 3 months, the largest part of the time period before seroconversion is included in analyses, and we expect the downward effect to be limited. Last, the median follow-up time in this study was only 1.2 years. This may be too short to be able to show long-term effects of counseling, as we only have long-term follow-up data for a small group of men.

Participation in this study with regular exposure to RRC seems to have had some effects on reducing sexual risk behavior in both HIV-1 negative and positive MSM in coastal Kenya, but its lasting effect on sexual behavior, or its impact on HIV-1 and STI transmission remains unclear. Future research may consider evaluating comprehensive HIV interventions, including peer support, structural changes, and improved access to care for MSM. Given that HIV-1 incidences remain very high in MSM populations in Africa, biomedical interventions including both early ART and PrEP are urgently needed to mitigate the effect of ongoing HIV-1 transmission.

In conclusion, we were able to study longitudinal changes in sexual risk behavior among African MSM. These unique data indicated that participation in a study with regular exposure to counseling may have led to some reductions in self-reported sexual risk behavior. Importantly, this study shows that MSM can be engaged to participate in longitudinal research in Africa.

Acknowledgements

We are grateful to the study participants and staff in the HIV/STI project of the Kenya Medical Research Institute (KEMRI) in Kilifi, whose commitment and cooperation made this study possible. We thank the Director, KEMRI, for permission to publish this manuscript, and the International AIDS Vaccine Initiative (IAVI) for their support of the ongoing cohort studies and for sharing data on HIV-1 acquisition.

Author contributions: L.M.M. and I.G.S. performed data analyses, interpreted the data, and wrote the draft article.

R.B.G. performed data analyses and contributed to the interpretation of the data. H.S.O. ensured data quality and performed initial data analysis. E.W. performed data acquisition and quality assurance. M.A.P., S.M.G., and E.S. designed the cohort studies and contributed to interpretation of the data. All authors have contributed to and approved the final version of the manuscript.

Meetings: Presented in part as a poster presentation at the 18th International Workshop on HIV Observational Databases (IWHOD), March 28, 2014, Sitges, Spain.

Source of funding: This study was funded through grants from: the International AIDS Vaccine Initiative (IAVI) including the generous support of the American people from the United States Agency for International Development (USAID); and the University of Washington Centre for AIDS Research (CFAR), an NIH funded program (P30 AI027757), which is supported by the following NIH Institutes and Centers (NIAID, NCI, NIMH, NIDA, NICHD, NHLBI, NCCAM). A full list of IAVI donors is available at www.iavi.org. SMG was supported by NIH grant 1R34MH099946-01. The KWTRP at the Centre for Geographical Medicine Research-Kilifi is supported by core funding from the Wellcome Trust (grant number #077092). The views expressed in this publication are those of the researchers, and not necessarily of the mentioned sponsoring institutions.

Conflicts of interest

There are no conflicts of interest.

References

1. Beyrer C, Baral SD, van Griensven F, et al. **Global epidemiology of HIV infection in men who have sex with men.** *Lancet* 2012; **380**:367–377.
2. Hladik W, Barker J, Ssenkusu JM, et al. **HIV infection among men who have sex with men in Kampala, Uganda: a respondent driven sampling survey.** *PLoS One* 2012; **7**:e38145.
3. Smith AD, Tapsoba P, Peshu N, et al. **Men who have sex with men and HIV/AIDS in sub-Saharan Africa.** *Lancet* 2009; **374**:416–422.
4. Okuku HS, Sanders EJ, Nyiro J, et al. **Factors associated with herpes simplex virus type 2 incidence in a cohort of human immunodeficiency virus type 1-seronegative Kenyan men and women reporting high-risk sexual behavior.** *Sex Transm Dis* 2011; **38**:837–844.
5. Sanders EJ, Okuku HS, Smith AD, et al. **High HIV-1 incidence, correlates of HIV-1 acquisition, and high viral loads following seroconversion among MSM.** *AIDS* 2013; **27**:437–446.
6. Price MA, Rida W, Mwangome M, et al. **Identifying at-risk populations in Kenya and South Africa: HIV incidence in cohorts of men who report sex with men, sex workers, and youth.** *J Acquir Immune Defic Syndr* 2012; **59**:185–193.
7. Wade AS, Kane CT, Diallo PA, et al. **HIV infection and sexually transmitted infections among men who have sex with men in Senegal.** *AIDS* 2005; **19**:2133–2140.
8. Beyrer C, Sullivan PS, Sanchez J, et al. **A call to action for comprehensive HIV services for men who have sex with men.** *Lancet* 2012; **380**:424–438.
9. Semugoma P, Nemande S, Baral SD. **The irony of homophobia in Africa.** *Lancet* 2012; **380**:312–314.
10. Sullivan PS, Carballo-Diequez A, Coates T, et al. **Successes and challenges of HIV prevention in men who have sex with men.** *Lancet* 2012; **380**:388–399.
11. Sanders EJ, Graham SM, Okuku HS, et al. **HIV-1 infection in high risk men who have sex with men in Mombasa.** *Kenya AIDS* 2007; **21**:2513–2520.
12. Taegtmeyer M, Davies A, Mwangome M, et al. **Challenges in providing counselling to MSM in highly stigmatized contexts: results of a qualitative study from Kenya.** *PLoS One* 2013; **8**:e5340.
13. van der Elst EM, Okuku HS, Nakamya P, et al. **Is audio computer-assisted self-interview (ACASI) useful in risk behaviour assessment of female and male sex workers, Mombasa, Kenya?** *PLoS One* 2009; **4**:e5340.
14. R Core Team. **R: A language and environment for statistical computing.** Vienna, Austria: R Foundation for Statistical Computing; 2014.
15. Johnson WD, Diaz RM, Flanders WD, et al. **Behavioral interventions to reduce risk for sexual transmission of HIV among men who have sex with men.** *Cochrane Database Syst Rev* 2008; **3**:CD001230.
16. Herbst JH, Sherba RT, Crepaz N, et al. **A meta-analytic review of HIV behavioral interventions for reducing sexual risk behavior of men who have sex with men.** *J Acquir Immune Defic Syndr* 2005; **39**:228–241.
17. Huan X, Tang W, Babu GR, et al. **HIV risk-reduction counseling and testing on behavior change of MSM.** *PLoS One* 2013; **8**:e69740.
18. Marks G, Crepaz N, Senterfitt JW, et al. **Meta-analysis of high-risk sexual behavior in persons aware and unaware they are infected with HIV in the United States: implications for HIV prevention programs.** *J Acquir Immune Defic Syndr* 2005; **39**:446–453.
19. Heijman T, Geskus RB, Davidovich U, et al. **Less decrease in risk behaviour from pre-HIV to post-HIV seroconversion among MSM in the combination antiretroviral therapy era compared with the precombination antiretroviral therapy era.** *AIDS* 2012; **26**:489–495.
20. Fox J, White PJ, Macdonald N, et al. **Reductions in HIV transmission risk behaviour following diagnosis of primary HIV infection: a cohort of high-risk men who have sex with men.** *HIV Med* 2009; **10**:432–438.
21. Gorbach PM, Weiss RE, Jeffries R, et al. **Behaviors of recently HIV-infected men who have sex with men in the year post-diagnosis: effects of drug use and partner types.** *J Acquir Immune Defic Syndr* 2011; **56**:176–182.
22. Van de Ven P, Kippax S, Crawford J, et al. **In a minority of gay men, sexual risk practice indicates strategic positioning for perceived risk reduction rather than unbridled sex.** *AIDS Care* 2002; **14**:471–480.
23. Kamali A, Price MA, Lakhi S, et al. **Creating an African HIV clinical research and prevention trials network: HIV prevalence, incidence and transmission.** *PLoS One* 2015; **10**:e0116100.