How do HIV-negative individuals in sub-Saharan Africa change their sexual risk behaviour upon learning their serostatus? A systematic review

Sanjeev Ramachandran,¹ Sharmistha Mishra,¹,² Natalie Condie,¹ Michael Pickles¹

ABSTRACT

Objective To determine whether, and how, sexual behaviour of HIV-negative individuals in sub-Saharan Africa changes upon learning their serostatus. Methods We systematically reviewed the published literature using EMBASE and Medline to search for publications between 2004 and 2014. We included studies that quantified behaviour change (condom use, number of sexual partners or sex acts) following an HIV test in HIV-negative adults in SSA, and extracted relevant data including study characteristics and measurement type. Results From 2185 unique citations, n=14 studies representing 22 390 participants met our inclusion criteria. We did not pool data due to marked heterogeneity in study outcome measures. The proportion of participants reporting consistent condom use (n=6) post-testing ranged from 7.6% greater, to 10.6% fewer, while ‘no condom use’ (n=5) ranged from 40.0% less, to 0.7% more. Condom use in serodiscordant couples increased (n=3). Five studies measured the proportion reporting abstinence, finding an increase of 10.9% to a decrease of 5.3% post-testing. The post-testing change in the mean number of sex acts (n=3) ranged from a relative decrease of 15.7% to a relative increase of 9.4%. Two studies reported relative decreases in the mean number of sexual partners of 35.2% and 14.0%. Three studies examining serodiscordant primary relationships specifically all showed increases in extrarelational sex. Conclusions With the exception of serodiscordant couples, there is variable evidence that awareness of one’s serostatus leads to substantial changes in risk behaviour among HIV-negative individuals. Further research is needed to estimate the behavioural impact of learning one’s serostatus in SSA.

INTRODUCTION

Behavioural interventions remain important for HIV prevention in sub-Saharan Africa (SSA)—a region accounting for 70% of HIV cases worldwide.¹ HIV testing offers an opportunity to promote safer sexual behaviour through counseling. The potential for antiretroviral therapy (ART) to reduce transmission² has led to intensifying of HIV testing efforts,³ with a focus on positive prevention¹ where HIV-positive individuals are targeted for prevention efforts. However, it remains important to understand behavioural changes after individuals receive an HIV-negative test result.

Mathematical models suggest that universal testing and treatment, where all are offered HIV testing and counselling with immediate ART for those with HIV, could substantially reduce HIV incidence.⁵–⁹ However, these models rarely include potential behaviour changes of HIV-negative individuals post-testing⁵–⁷ and when they do the parameter inputs are either assumed,⁸ or are based on a few studies conducted before 2000.⁸ As more people become aware of their serostatus, it is important to understand how the awareness and associated counselling impact the larger HIV-negative population.

Three systematic reviews have previously examined the impact of voluntary counselling and testing (VCT) on the sexual behaviours of clinic attendees in low-income and middle-income countries.¹⁰–¹² Two estimated outcomes by serostatus, finding that the effects (change in condom use; number of sexual partners) were not statistically significant when restricted to HIV-negative persons.¹¹ ¹² When considering HIV-positive and HIV-negative individuals jointly, all three studies found that VCT positively influences risk behaviour, including increased condom use¹⁰–¹² and reduced number of sexual partners.¹¹ ¹² The reviews were all restricted to data collected between 1990 and 2005.¹⁰ ¹¹ or 2010.¹² To our knowledge, there have been no systematic reviews focused on HIV-negative populations in SSA in the era following the scale-up of HIV testing and ART, which began in 2003.¹³ Changes in HIV test delivery (such as opt-out systems), improved on-treatment survival among HIV-positive individuals, and increases in HIV awareness and knowledge all occurred around this time, and may have influenced how individuals perceived HIV severity and responded to HIV-negative test results.

We sought to determine how the sexual behaviour of HIV-negative individuals in SSA changes after learning their serostatus in this period after ART roll-out (post-2003).

METHODS

Study selection

We systematically reviewed the peer-reviewed, published literature according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.¹⁴ We searched two electronic databases using the search terms detailed in the online supplementary material: EMBASE and Medline for articles published between 1 January 2004 and 8 November 2014, with no language restrictions. Reference lists of included studies were not screened to identify further data.

After screening titles and abstracts, we performed a full-text review of remaining articles. The
screening and full-text review were conducted by two independent reviewers (SR and NC), with arbitration in case of disagreement (MP). We contacted authors for clarifications when consensus could not be reached after full-text review, or when appropriate data on pre-test and post-test behaviour was present but not stratified by serostatus.

The inclusion criteria were as follows: (1) studies conducted in SSA as defined by the United Nations Statistics Division;15 (2) participants enrolled after 1 January 2003; (3) serostatus defined by documented HIV test result (not self-report); (4) participants ≥15 years of age; (5) quantitative measurement on at least one behavioural outcome collected before and after HIV testing. Thus, inclusion criteria were restricted to ‘pre/post’, serial cross-sectional, prospective cohort and time series studies. During screening and full-text review, a study was excluded once it met any exclusion criterion. The exclusion criteria were always applied in the order given in the online supplementary material. Studies focused exclusively on persons who inject drugs were excluded.

Types of outcome

Outcomes were divided into three domains: condom use, number of sexual partners and number of sex acts (see online supplementary material for more detail). In the later two domains, zero partners or zero sex acts were defined as abstinence.

We give a descriptive analysis of the outcomes, and report the absolute change in outcomes between baseline and follow-up unless otherwise stated. In studies reporting outcomes over multiple follow-up periods, we report the latest recorded outcome to represent longer-term changes. Data over other periods are reported in the online supplementary material. The number of studies is indicated by n. We did not pool outcomes due to the reported in the online supplementary material. The number of sexual partners and number of sex acts (see online supplementary material). Studies focused exclusively on persons who inject drugs were excluded.

In seven studies, the primary purpose was to evaluate changes in sexual behaviour following HIV testing.20 23–25 27–31 32 Participants in all 14 studies underwent either individual19 20 22 24 26–32 or couples19 counselling, or a combination of both.23 25 Of studies specifying whether counselling was pre-testing or post-testing, two used post-test counselling only,20 32 while two used both.25 29

Description of participants

Six studies recruited sexually active adults from the general population19 22 28–31 (one recruited half the sample from bar and hotel workers, regarded as higher risk individuals28), four evaluated HIV-negative partners in serodiscordant relationships,21 23 25 26 one focused on STI clinic attendees,27 one on general outpatients,29 one on employees32 and one on non-spousal household members of those initiating ART.24 No study specifically enrolled key populations, aside from seronegative partners in serodiscordant partnerships, or reported data by risk factors such as formal sex work. The minimum age of recruitment ranged from 1519 22 to 18 years. Five studies did not set a maximum age limit,20 23 27 28 32 while in those that did it varied from 3521 to 6924 years.

One largely unexplored issue is participants’ prior testing history. Only three studies in this review reported how many participants had received prior VCT.19 20 22

Risk of potential bias

The majority of studies used face-to-face interviews, so were judged to be at risk of social desirability bias (n=12). The rest used audio-computer-assisted structured interview27 and computer-assisted personal interview26 to ascertain self-reported behavioural data, reflecting reduced risk of social desirability bias. All studies were at risk of sampling bias, due to the use of convenience sampling or recruitment from specific locations such as clinics. Nine studies were at risk of recall bias,19–22 24 26 29 31 32 while only one study24 was deemed at risk of attrition bias. A full list of the potential biases of each study is given in table 1. Six studies were at higher risk of confounding as the primary study outcome was not to measure changes in behaviour post-testing. All studies were at risk of temporal confounding, owing to the pre-post design used.

HIV testing and condom use

Thirteen studies presented data on condom use (table 2; additional time-points in online supplementary table S1). Six studies measured consistent condom use, reporting one of ‘always/100% using a condom’,20 21 28 ‘consistent condom use’19 22 and ‘no unprotected sex’.32 Baseline levels of consistent condom use were low (eg, 0.3%–33.7% reported consistent condom use in the last year, n=3). The post-testing change in the proportion of participants reporting consistent condom use ranged from 7.6% greater,20 to 10.6% fewer21 (median across studies: decrease of 0.2%; 2/6 studies showed an increase).

Between baseline and follow-up, the change in the proportion of participants reporting ‘no condom use’ ranged from 40.0% less21 to 0.7% more28 (median: decrease by 2.2%; 4/5 studies showed a decrease). Two studies found decreases of 19.8%20 and 16.6%,24 respectively in the proportion of participants engaging in condomless sex with an HIV-positive partner or a partner whose HIV status was unknown. In the proportion of participants not using a condom at last sex increased by 8% in the intervention arm, but decreased by 15% in the control arm.29

Four studies measured unprotected sex acts.20 26 27 30 Two reported absolute reductions of 23.0%20 to increase of 0.8%.20 A third reported a 24.2% relative decrease in the number of unprotected sex acts26 after testing. The condom use was assessed through a ‘sexual behaviour score’,26 approximating the likelihood of HIV acquisition using the frequencies of

Table 1 describes the characteristics of included studies. Settings included southern and eastern Africa, primarily Uganda,19 26 South Africa23–26 28–30 and Tanzania.21 24 26 Five studies covered multiple countries.23 25 28–30 The recruitment setting was community-based (n=5),19 22 24 28 30 clinic-based (n=3),20 21 27 a combination of community-based and clinic-based (n=5)24 25 26 29 31 and workplace-based in one study.12 The majority of studies were prospective cohorts (n=9),20 21 24 26–28 31 while the remainder were randomised controlled trials(n=5).19 22 25 29 30

RESULTS

Of 2185 unique records, we excluded 1960 by abstract/title screening, and 210 by full-text review (see online supplementary figure S1). Fourteen studies met inclusion criteria, and provided outcomes on 22 390 HIV-negative adults in SSA.

Description of studies

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different types of unprotected sex acts. It found that HIV-negative persons in serodiscordant and seroconcordant relationships underwent relative decreases in their scores of 100% and 25%, respectively (representing increased condom use and/or reduced sexual activity).

With respect to population-specific findings, three studies assessed the general population recruited from the community. Two found negligible changes (≤1%) in consistent or zero condom use after testing, while the third saw an overall decrease of 3.0% in consistent condom use post-testing. Two studies examined condom use in serodiscordant partnerships. One found a reduction in consistent condom use of 10.6% but 40.0% more people reported using condoms at least once (ie, reduction in zero condom use) while the second, a randomised controlled trial examining behaviour change post-testing in the context of HIV pre-exposure prophylaxis, found an 18%

Table 1 Characteristics of studies included for qualitative synthesis

| Study | Data | No. of partners | Sex acts | Study design | Geographic setting | Study population characteristics | Age range and gender | Potential biases* |
|-------|------|-----------------|----------|--------------|-------------------|---------------------------------|---------------------|------------------|
| Gray et al | Y | Y | No | RCT | Rakai, Uganda (R) | General population | 15–49, male | SD, sampling, recall |
| Kiene et al | Y | N | Yes | Prospective cohort | Mpigi District, Uganda (R) | Outpatients | 18+, male and female | SD, sampling, recall |
| Ruzagira et al | Y | Y | No | Prospective cohort | Masaka, Uganda (R) | HIV partners in serodiscordant relationships | 18–60, male and female | SD, sampling, recall |
| Wawer et al | Y | Y | No | RCT | Rakai, Uganda (R) | General population | 15–49, female | SD, sampling, recall |
| Ndase et al | N | Y | Yes | Prospective cohort | Botswana, Kenya, Rwanda, SA, Tanzania, Uganda and Zambia (14 sites) | HIV partners in serodiscordant relationships | 18+, male and female | SD, sampling, recall |
| Bechange et al | Y | N | Yes | Prospective cohort | Tororo and Busia districts, Uganda (R) | Non-spousal household members of those commencing ART | 18–69, male and female | SD, sampling, recall |
| Mugwanya et al | Y | N | Yes | RCT | Kenya: Eldoret, Kisumu, Nairobi and Thika (U) Uganda: Jinja, Kabwohe, Kampala, Mbane, Tororo (U) | HIV partners in serodiscordant relationships | 18–65, male and female | SD, sampling, recall |
| Ritchie et al | Y | N | Yes | Prospective cohort | Entebbe, Uganda (U) | HIV partners in serodiscordant and seroconcordant relationships | 18+, male and female | SD, sampling, recall |
| Kalichman et al | Y | Y | Yes | Prospective cohort | Cape Town, SA (U) | STI clinic attendees | Unspecified, male and female | Sampling |
| Ramjee et al | Y | Y | No | Prospective cohort | Durban, SA (U); Hlabisa, SA (R); Lusaka, Zambia (U); Moshi, Tanzania (U+R) | Sexually active women, largely from general population | Tanzania and Zambia: 16+, female SA: 18+, female | SD, sampling, recall |
| Padian et al | Y | N | No | RCT | Durban, SA (U); Johannesburg, SA (U); Harare, Zimbabwe (U) | Sexually active women from general population | 18–49, female | SD, sampling, recall |
| Van Damme et al | Y | Y | No | RCT | Bondo, Kenya (U); Pretoria, SA (U); Bloemfontein, SA (U); Arusha, Tanzania (U) | High risk members from general population | 18–35, female | SD, sampling, recall |
| Djomand et al | Y | Y | Yes | Prospective cohort | Gaborone, Botswana (U) | High risk heterosexual men and women | Employees | SD, sampling, recall |
| Matambo et al | Y | N | Yes | Prospective cohort | Harare, Zimbabwe (U) | | Unspecified, mostly male | SD, sampling, recall |

* Biases refer to biases in our outcomes of interest, not necessarily the primary purpose of the given study.
†Non-spousal household member includes any individual aged 18–69 living in the household, except the spouse of the individual receiving ART.
‡High risk defined as “one or more vaginal sex acts in the previous 2 weeks or more than one sex partner in the previous month”.
§High risk defined as police officers.
ART, antiretroviral therapy; R, rural; RCT, randomised controlled trial; SA, South Africa; SD, social desirability; U, urban.
Among individuals in serodiscordant partnerships, the ‘sexual behaviour score’ decreased to zero, meaning no unprotected sex acts were reported post-testing. With the exception of the two studies among serodiscordant couples, overall there was no pattern observed between the direction of condom use and study factors such as sample size, risk of bias, study population characteristics, purpose of study, provision of free condoms during HIV testing and the nature or number of risk reduction counselling sessions involved. This was assessed through counting the proportion of positive outcomes. In all studies reporting multiple follow-ups, post-test condom use appeared stable over different lengths of follow-up (see online supplementary material).

### HIV testing and number of sex partners
The effects of HIV testing on the number of sex partners were variable (n=8, table 3; additional time-points in online supplementary material).

## Table 2: Summary of results for studies assessing condom use before and after testing for HIV

| Study                        | Consistent condom use | No condom use | Unprotected sex | Measures of unprotected acts |
|------------------------------|-----------------------|---------------|-----------------|-----------------------------|
| **Baseline value of outcome** |                       |               |                 |                             |
| Gray et al\(^{19}\)          | Consistent use in year | Not used in year | % did not use condoms at any time in last 3 months | % of risky acts* that were unprotected in the last 3 months |
| Ruzagira et al\(^{21}\)      | Always used in year   | Not used in year | % did not use condoms at any time in last 3 months | % of risky acts* that were unprotected in the last 3 months |
| Wawer et al\(^{22}\)         | Consistent use in year | Not used in year | % did not use condoms at any time in last 3 months | % of risky acts* that were unprotected in the last 3 months |
| Kiene et al\(^{10}\)         | 100% with risky partner* in last 3 months | Not used in last week | % did not use condoms at any time in last 3 months | % of risky acts* that were unprotected in the last 3 months |
| Ramjee et al\(^{18}\)        | 100% in last week     | % did not use condoms at any time in last 3 months | % of risky acts* that were unprotected in the last 3 months | % of risky acts* that were unprotected in the last 3 months |
| Matambo et al\(^{22}\)       | No unprotected sex in last 3 months | % did not use condoms at any time in last 3 months | % of risky acts* that were unprotected in the last 3 months | % of risky acts* that were unprotected in the last 3 months |

Baseline percentages are calculated as the percentage of people reporting a given outcome. Changes after testing represent absolute changes unless explicitly reported as relative.

* Kiene et al\(^{10}\). Risky sex is sex with a partner who is HIV-positive or of unknown serostatus.
† In Padian et al\(^{29}\), intervention participants received a diaphragm, lubricant and male condoms, while control arm participants received only male condoms.
‡ In Ritchie et al\(^{26}\), defined risky sex as “risky sex as intercourse with inconsistent condom use with an HIV-infected partner or a partner of unknown serostatus during the prior 3 months.”
§ Additional data obtained from Baeten et al\(^{20}\).
¶ Unprotected acts are defined as those reported by individuals in the risky groups in the sexually active cohort relative to those reported by the non-risky group in the sexually active cohort.

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574 Ramachandran S, et al. Sex Transm Infect 2016;92:571–578. doi:10.1136/sextrans-2015-052354
supplement table S2). Four of eight studies noted decreases in partner numbers, and two reported more partners after HIV testing. One found changes of <1% for all outcomes,22 as with studies of condom use, there was no discernible pattern underlying the variability.

In the two studies reporting mean number of sexual partners, both found statistically significant relative decreases of 35.2%27 and 14.0%.10 Four studies assessed changes in the proportion of participants with more than one current partner. Three studies found a decrease of 1.0% to an increase of 1.1%,19 22 28 but two of them had few participants reporting multiple partnerships at baseline (3.6%22 and 1.7%28). The fourth recorded a large decrease of 58.0% in the proportion of women reporting no sex acts from 7.6% to 10.9%,20 23 while a third study reported a 7.1% reduction in individuals reporting no sex acts: two reported increases in individuals reporting no sex acts 7.6% to 10.9%,20 23 while a third study reported a 7.1% reduction in individuals reporting sexual activity in the past week.25 Three studies reported on changes in the number of sex acts (table 4; additional time-points in online supplementary table S3).20 23 25 28 30 Three studies reported on changes in individuals reporting no sex acts: two reported increases in individuals reporting no sex acts from 7.6% to 10.9%,20 23 while a third study reported a 7.1% reduction in individuals reporting sexual activity in the past week.25 Three studies reported on changes in the number of sex acts (table 4; additional time-points in online supplementary table S3).20 23 25 28 30 Three studies reported on changes in individuals reporting no sex acts: two reported increases in individuals reporting no sex acts from 7.6% to 10.9%,20 23 while a third study reported a 7.1% reduction in individuals reporting sexual activity in the past week.25 Three studies reported on changes in the number of sex acts (table 4; additional time-points in online supplementary table S3).20 23 25 28 30 Three studies reported on changes in individuals reporting no sex acts: two reported increases in individuals reporting no sex acts from 7.6% to 10.9%,20 23 while a third study reported a 7.1% reduction in individuals reporting sexual activity in the past week.25 Three studies reported on changes in the number of sex acts (table 4; additional time-points in online supplementary table S3).20 23 25 28 30 Three studies reported on changes in individuals reporting no sex acts: two reported increases in individuals reporting no sex acts from 7.6% to 10.9%,20 23 while a third study reported a 7.1% reduction in individuals reporting sexual activity in the past week.25 Three studies reported on changes in the number of sex acts (table 4; additional time-points in online supplementary table S3).20 23 25 28 30 Three studies reported on changes in individuals reporting no sex acts: two reported increases in individuals reporting no sex acts from 7.6% to 10.9%,20 23 while a third study reported a 7.1% reduction in individuals reporting sexual activity in the past week.25 Three studies reported on changes in the number of sex acts (table 4; additional time-points in online supplementary table S3).20 23 25 28 30 Three studies reported on changes in individuals reporting no sex acts: two reported increases in individuals reporting no sex acts from 7.6% to 10.9%,20 23 while a third study reported a 7.1% reduction in individuals reporting sexual activity in the past week.25 Three studies reported on changes in the number of sex acts (table 4; additional time-points in online supplementary table S3).20 23 25 28 30 Three studies reported on changes in individuals reporting no sex acts: two reported increases in individuals reporting no sex acts from 7.6% to 10.9%,20 23 while a third study reported a 7.1% reduction in individuals reporting sexual activity in the past week.25 Three studies reported on changes in the number of sex acts (table 4; additional time-points in online supplementary table S3).20 23 25 28 30 Three studies reported on changes in individuals reporting no sex acts: two reported increases in individuals reporting no sex acts from 7.6% to 10.9%,20 23 while a third study reported a 7.1% reduction in individuals reporting sexual activity in the past week.25 Three studies reported on changes in the number of sex acts (table 4; additional time-points in online supplementary table S3).20 23 25 28 30 Three studies reported on changes in individuals reporting no sex acts: two reported increases in individuals reporting no sex acts from 7.6% to 10.9%,20 23 while a third study reported a 7.1% reduction in individuals reporting sexual activity in the past week.25
Table 4  Summary of results for studies assessing frequency of sex acts before and after testing for HIV

| Study | Outcome measure | Sample size | Baseline value of outcome | Change after testing | Follow-up time (months) | p Value |
|-------|----------------|-------------|---------------------------|----------------------|-------------------------|---------|
| Had sex/was abstinent | 28 | 958 | 70.9% | 7.1% decrease | 12 | NR |
| Ramjee et al | Became abstinent* | 131 (risky participants only) | NR | 7.6% increase | 3 | NR |
| Kiene et al | No sex in last month | 2284 (males) | 5.6% | 9.1% increase | 24 | NR |
| Number of sex acts | 20 | 213 (all participants) | 18.1 | Relative increase by 9.4% | 3 | NR |
| 30 | Number of vaginal sex acts in past week | 2120 | 3.7 | Relative decrease of 15.7% | 12 | <0.001 |
| Average of number of sex acts per month outside primary relationship | 0.67 | 0.67 | Relative increase of 25.6% | 0.006 |

Baseline percentages are calculated as the percentage of people reporting a given outcome. Changes after testing represent absolute changes unless explicitly reported as relative.

*No timescale specified for abstinence. NR, not reported.

DISCUSSION

Fourteen primary studies carried out in SSA measured various sexual risk behaviour outcomes before and after HIV testing. Findings suggest that awareness of one’s serostatus does not increase consistent condom use, but there were increases in the proportion of acts protected by a condom. Furthermore, in 3/4 studies there were increases in the proportion ever using a condom, suggesting that awareness of one’s serostatus can shift HIV-negative individuals who never use condoms to start using them, although inconsistently. Condom use in serodiscordant partnerships generally increased: 2/3 studies reported reduced risky sex, while in the third there was an increase in the proportion ever using a condom, although consistent condom use declined. While overall there was variability in the effects of HIV testing on the number of sex partners or sex acts among HIV-negative individuals, there was an increase in individuals reporting no sex acts in 3/3 studies, and 2/3 studies reported increases in individuals reporting no sexual partners. Two studies saw significant decreases in the mean number of reported sexual partners. While a few studies reported large changes, the effect sizes observed were generally moderate. There was also little evidence of consistently increased risk behaviour following a negative HIV test, which may thus be reinforcing past behaviours and not increasing risk. In general, we could not identify any factors predicting behaviour modification. However, a notable exception was seen in HIV-negative partners in serodiscordant relationships, who appear to engage in more extrarelational sex after testing and counselling in studies examining this population, although they may reduce condomless sex with their positive partner.

Our results complement those from the two systematic reviews and meta-analyses of HIV-negative individuals in low and middle-income countries (LMICs), although they did not examine serodiscordant couples. However, our review is more relevant to the present situation in SSA, since only 3 out of 17 studies were included, and no studies began enrolment after 2002.

Our findings, combined with results from other LMICs, may allow mathematical modellers to assume, with reasonable confidence, that risk behaviour among the HIV-negative majority does not markedly change post-testing. However, incorporating a sensitivity analysis to changes in risk behaviour is advisable, given the variability in our findings. Furthermore, findings among serodiscordant couples suggest that HIV testing may lead to changes in the sexual network due to partner switching by the seronegative partner.

The results also have implications for universal testing and treatment. Across three studies assessing the general population recruited from the community, results suggest that although VCT does little to improve risk behaviour among individuals...
testing HIV-negative in that population, it importantly also does not increase risk behaviour. However, the lack of consistent evidence in either direction points to the need to incorporate suitable indicators in HIV surveillance to detect local increases in risk behaviour of HIV-negative individuals as HIV testing efforts intensify, so that additional risk reduction interventions may be put in place where necessary. In addition, few studies examined the effectiveness of different testing strategies. For instance, home-based counselling and testing has been shown to be highly acceptable in SSA, but our review failed to identify any studies evaluating its effectiveness in altering HIV-negative individuals’ risk behaviour. Therefore, it is important to investigate the impact of new testing modalities on behaviour. More information is also needed on the impact of repeated testing, particularly in the long term, when individuals who have received multiple negative tests may perceive themselves to be at low risk of HIV acquisition.

Identification of serodiscordant couples is a high priority for global public health, as it allows provision of HIV prevention services including counselling about condoms and ART provision. However, this study highlights the need for more understanding of how the HIV risk behaviour of the seronegative partner may change. In particular, ART initiation and viral suppression of the HIV-positive partner may not mitigate HIV risk for the seronegative partner, who may be exposed through other partnerships after a negative HIV test result.

Limitations

There are limitations to this review. First, grey literature and programme data were not included. Second, other important behaviour changes associated with HIV testing, such as propensity to repeat test in the future, were not included. Third, only one study was a randomised controlled trial examining post-testing behaviour change; most data were subject to high risk of sampling and social desirability bias as they came from studies where post-testing behaviour was not the primary aim. Fourth, the quality and type of HIV counselling received when testing may differ. Fifth, no study in this review measured pre-test intention. As individuals may resolve to reduce risky behaviour as part of the decision-making process to get tested, the behaviour change may differ if study recruitment removes the active decision to test. Finally, both the study populations and the outcome measures varied widely, precluding our ability to pool data, and highlighting the need to more consistently measure pre-test and post-test behaviour.

CONCLUSIONS

Awareness of one’s serostatus generally has a small effect on risk behaviour of HIV-negative individuals, although seronegative partners in serodiscordant partnerships may engage in more extrarelational sex. Additional research specifically examining behavioural change is needed in SSA, including in key populations and serodiscordant partnerships.

Acknowledgements

We would like to thank the following who responded to our inquiries with additional study information and study clarifications: Adam Ritchie (University of Oxford) and the CHAVI 002 study team; Ashley Clayton (Fred Hutchinson Cancer Research Center), the HIV Vaccine Trials Network and the HVTN 903 study team. MP thanks the National Institutes of Health for funding through the NIAID cooperative agreement UM1AI088619. SM is supported by a Canadian Institutes of Health Research and Ontario HIV Treatment Network New Investigator Award. We thank Jacqueline Cousins, Imperial College Library Information Specialist, in supporting the generation of search terms.

Contributors

MP and SM designed the study. SR and NC carried out the screening, full-text review and data extraction. SR, SM and MP undertook the analysis and interpretation of results. SR, SM and MP wrote the first draft of the report. All authors contributed to subsequent drafts of the report and reviewed the final version before submission.

Competing interests

None declared.

Provenance and peer review

Not commissioned; externally peer reviewed.

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REFERENCES

1 World Health Organization. Data on the size of the HIV/AIDS epidemic: Data by WHO region. Secondary Data on the size of the HIV/AIDS epidemic: Data by WHO region. http://apps.who.int/gho/data/node.main.619?lang=en
2 Cohen MS, Chen YQ, McGoey M, et al. Prevention of HIV-1 infection with early antiretroviral therapy. N Engl J Med 2011;365:493–505.
3 UNAIDS. 90–90–90—An ambitious treatment target to help end the AIDS epidemic. Geneva: UNAIDS, 2014.
4 Auerbach JD. Principles of positive prevention. J Acquir Immune Defic Syndr 2004;37(Suppl 2):S122–5.
5 Granich RM, Gilks CF, Dye C, et al. Universal voluntary HIV testing with immediate antiretroviral therapy as a strategy for elimination of HIV transmission: a mathematical model. Lancet 2009;373:48–57.
6 Dodd PJ, Garnett GP, Hallett TB. Examining the promise of HIV elimination by ‘test and treat’ in hyperendemic settings. AIDS 2010;24:729–35.
7 Baggaley RF, Fraser C. Modelling sexual transmission of HIV: testing the assumptions, validating the predictions. Curr Opin HIV AIDS 2010;5:269–76.
8 Hallett TB, DuBe S, Cremin I, et al. The role of testing and counselling for HIV prevention and care in the era of scaling up antiretroviral therapy. Epidemics 2009;1:77–82.
9 Cori A, Ayles H, Begg Y, et al. HPTN 071 (PopART): a cluster-randomized trial of the population impact of an HIV combination prevention intervention including universal testing and treatment: mathematical model. PLoS ONE 2014;9:e84511.
10 Denison JA, O’Reilly KR, Schmid GP, et al. HIV voluntary counselling and testing and behavioural risk reduction in developing countries: a meta-analysis, 1990–2005. AIDS Behav 2008;12:363–73.
11 Kennedy CE, Medley AM, Sweat MD, et al. Behavioural interventions for HIV positive prevention in developing countries: a systematic review and meta-analysis. Bull World Health Organ 2010;88:615–23.
12 Fonner VA, Denison J, Kennedy CE, et al. Voluntary counselling and testing (VCT) for changing HIV-related risk behavior in developing countries. Cochrane Database Syst Rev 2012;9:CD001224.
13 World Health Organization, UNAIDS, UNICEF. Towards universal access: scaling up priority HIV/AIDS interventions in the health sector: progress report, April 2007. Geneva: WHO, 2007.
14 Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med 2009;6:e1000097.

Key messages

- Further primary evidence with the primary purpose of examining behavioural change in HIV-negative individuals after testing is needed in sub-Saharan Africa (SSA), including in key populations.
- Additional research is needed to specifically investigate the behaviour of seronegative individuals in serodiscordant partnerships.
- As was previously found, there remains a need to standardise sexual behavioural outcomes to facilitate valid comparisons across studies and programmes.
- Future studies should aim to use methodologies that minimise sampling and social desirability biases. More qualitative evidence exploring the psychological determinants of behavioural change, or lack thereof, among HIV-negative individuals may help elucidate causal mechanisms underlying our observations.
Review

15 United Nations Statistics Division. Composition of macro geographical (continental) regions, sub-regions, and selected economic and other groupings. Secondary Composition of macro geographical (continental) regions, geographical sub-regions, and selected economic and other groupings. https://unstats.un.org/unsd/methods/m49/m49regin.htm

16 Napper LE, Fisher DG, Reynolds GL, et al. HIV risk behavior self-report reliability at different recall periods. AIDS Behav 2010;14:152–61.

17 Schroder KE, Carey MP, Vanable PA. Methodological challenges in research on sexual risk behavior. II. Accuracy of self-reports. Ann Behav Med 2003;26:104–23.

18 Higgins JPT, Green S, Cochrane Collaboration. Cochrane handbook for systematic reviews of interventions. Chichester, England; Hoboken, NJ: Wiley-Blackwell, 2008.

19 Gray RH, Kigozi G, Serwadda D, et al. Male circumcision for HIV prevention in men in Rakai, Uganda: a randomised trial. Lancet 2007;369:657–66.

20 Kiene SM, Bateganya M, Wanyenze R, et al. Initial outcomes of provider-initiated routine HIV testing and counseling during outpatient care at a rural Ugandan hospital: risky sexual behavior, partner HIV testing, disclosure, and HIV care seeking. AIDS Patient Care STDS 2010;24:117–26.

21 Ruzagira E, Wandiembe S, Abaasa A, et al. HIV incidence and risk factors for acquisition in HIV discordant couples in Masaka, Uganda: an HIV vaccine preparedness study. Plos ONE 2011;6:e24037.

22 Wawer MJ, Tobian AA, Kigozi G, et al. Effect of circumcision of HIV-negative men on transmission of human papillomavirus to HIV-negative women: a randomised trial in Rakai, Uganda. Lancet 2011;377:209–18.

23 Ndase P, Celum C, Thomas K, et al. Outside sexual partnerships and risk of HIV acquisition for HIV uninfected partners in African HIV serodiscordant partnerships. J Acquir Immune Defic Syndr 2012;59:65–71.

24 Bechange S, Bunnell R, Awor A, et al. Two-year follow-up of sexual behavior among HIV-uninfected household members of adults taking antiretroviral therapy in Moshi, Tanzania. AIDS Behav 2010;14:816–23.

25 Mugwanya KK, Donnell D, Celum C, et al. Sexual behaviour of heterosexual men and women receiving antiretroviral pre-exposure prophylaxis for HIV prevention: a longitudinal analysis. Lancet Infect Dis 2013;13:1021–8.

26 Ritchie AJ, Kuldanek K, Moodie Z, et al. Comparison of sexual behavior and HIV risk between two HIV-1 serodiscordant couple cohorts: the CHAVI 002 study. Plos ONE 2012;7:e37727.

27 Kalichman SC, Cain D, Simbayi LC. Behavioral changes associated with testing HIV-positive among sexually transmitted infection clinic patients in Cape Town, South Africa. Am J Public Health 2010;100:714–19.

28 Ramjee G, Kapiga S, Weiss S, et al. The value of site preparedness studies for future implementation of phase 2b/iii HIV prevention trials: experience from the HPTN 055 study. J Acquir Immune Defic Syndr 2008;47:93–100.

29 Padian NS, van der Straten A, Ramjee G, et al. Diaphragm and lubricant gel for prevention of HIV acquisition in southern African women: a randomised controlled trial. Lancet 2007;370:251–61.

30 Van Damme L, Corneli A, Ahmed K, et al. Preexposure prophylaxis for HIV infection among African women. N Engl J Med 2012:367:411–22.

31 Djomand G, Metch B, Zornilla CD, et al. The HVTN protocol 903 vaccine preparedness study: lessons learned in preparation for HIV vaccine efficacy trials. J Acquir Immune Defic Syndr 2008;48:82–9.

32 Matambo R, Dauya E, Mutswanga J, et al. Voluntary counseling and testing by nurse counselors: what is the role of routine repeated testing after a negative result? Clin Infect Dis 2006;42:569–71.

33 Sabapathy K, Van den Bergh R, Fidler S, et al. Uptake of home-based voluntary HIV testing in sub-Saharan Africa: a systematic review and meta-analysis. Plos Med 2012;9:e1001351.

34 Curran K, Baeten JM, Coates TJ, et al. HIV-1 prevention for HIV-1 serodiscordant couples. Curr HIV/AIDS Rep 2012;9:160–70.

35 Holtgrave D, McGuire J. Impact of counseling in voluntary counseling and testing programs for persons at risk for or living with HIV infection. Clin Infect Dis 2007;45(Suppl 4):S240–3.

36 Ngure K, Mugo N, Celum C, et al. A qualitative study of barriers to consistent condom use among HIV-1 serodiscordant couples in Kenya. AIDS care 2012;24:509–16.

37 Sikesote J, Grant L, Chinn DJ, et al. Voluntary counselling and testing for HIV in a Zambian mining community: serial interviews with people testing negative. Sex Transm Infect 2011;87:433–8.

38 Fiorillo SP, Landman KZ, Tribble AC, et al. Changes in HIV risk behavior and seroincidence among clients presenting for repeat HIV counseling and testing in Moshio, Tanzania. AIDS care 2012;24:1264–71.

39 Baeten JM, Donnell D, Ndase P, et al. Antiretroviral prophylaxis for HIV prevention in heterosexual men and women. N Engl J Med 2012;367:399–410.

578 Ramachandran S, et al. Sex Transm Infect 2016;92:571–578. doi:10.1136/sextrans-2015-052354