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Behavior Change Interventions to Prevent HIV Infection among Women Living in Low and Middle Income Countries: A Systematic Review

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Abstract We conducted a systematic review of behavioral change interventions to prevent the sexual transmission of HIV among women and girls living in low- and middle-income countries. PubMed/MEDLINE, Web of Science, the Cochrane Library, and other databases and bibliographies were systematically searched for trials using randomized or quasi-experimental designs to evaluate behavioral interventions with HIV infection as an outcome. We identified 11 analyses for inclusion reporting on eight unique interventions. Interventions varied widely in intensity, duration, and delivery as well as by target population. Only two analyses showed a significant protective effect on HIV incidence among women and only three of ten analyses that measured behavioral outcomes reduced any measure of HIV-related risk behavior. Ongoing research is needed to determine whether behavior change interventions can be incorporated as independent efficacious components in HIV prevention packages for women or simply as complements to biomedical prevention strategies.

Keywords HIV/AIDS prevention · Behavioral interventions · Women · Systematic review

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Introduction

Globally, women and girls are exceptionally vulnerable to HIV infection. Although women represent about half of all people living with HIV, in Sub-Saharan Africa where the pandemic is concentrated, women comprise 59 percent of people living with HIV infection [1]. Young women become susceptible to HIV at an early age—in some areas the prevalence of infection among women between 15 and 24 years is more than twice that of young men [1, 2]. Women living in lower income countries are particularly at risk, as extreme poverty and other structural factors such as gender inequities, lack of education, and violence reduce their ability to control health outcomes or access HIV-related information and services [3].

HIV prevention efforts in women have been hampered by the generally disappointing results of biomedical prevention trials. Candidate female-controlled biomedical prevention strategies, such as cervical barriers and microbicides, have not yet shown efficacy in randomized trials [4–7]. Thus, prevention focuses mainly on male-controlled prevention methods such as male circumcision and condoms. Male circumcision, although highly effective at preventing female-to-male sexual transmission, has yet to be shown to directly reduce women's risk of infection (although reductions in HIV prevalence will indirectly benefit women) [8, 9]. Male and female condoms are effective at preventing sexual transmission of HIV but both require male partner knowledge and consent [10, 11]. Finally, although improved diagnosis and treatment of sexually transmitted infections (STI) may be an important strategy to reduce HIV transmission and deleterious effects of other STIs [12], women in the poorest parts of the world may not have access to or utilize sexual and reproductive health services [13]. Thus, in the absence of an effective

vaccine or alternative female-controlled biomedical prevention method, HIV prevention efforts for women currently focus on the mainstay of prevention strategies—behavior change [14].

Behavioral strategies to prevent the sexual transmission of HIV include programs that aim to delay age of sexual debut, decrease the number of sexual partners and concurrent partnerships, increase the proportion of protected sexual acts, increase acceptance of voluntary counseling and testing (VCT), and improve adherence to successful biomedical prevention strategies, such as condom use [15]. These interventions can focus on the individual, peer, couple, group, family, institution, or the community. In addition, they vary widely in duration, intensity, and delivery. In order to produce measureable population-level changes in HIV infection, behavioral interventions need to produce change in enough people for a sufficient time to impact transmission dynamics [15]. Behavioral interventions targeting men who have sex with men [16], sexually transmitted disease clinic patients [17], heterosexual African Americans [18], sexually experienced adolescents in the United States [19], and people living with HIV [20] are effective in reducing self-reported sexual risk behaviors. In addition, meta-analytic reviews suggest that interventions that are targeted to specific race or gender groups, include skills training, and that are based on behavioral theory demonstrate efficacy, again, when measured by self-report (for review of meta-analyses, see Noar 2008) [21].

Despite numerous behavior change interventions that have been evaluated since the beginning of the HIV epidemic more than 25 years ago, there is a notable paucity of data on the direct effect of such interventions on HIV incidence. Examining HIV infection as the outcome in efficacy trials is critical for several reasons. Most obviously, because the ultimate objective of such interventions is to prevent new HIV infections, evaluating the effect on HIV incidence is the only way to measure program impact directly. Furthermore, reported sexual behaviors can be subject to reporting and recall bias and may be inconsistent with what is known about population-level HIV infection prevalence [22, 23]. Although greater resources are often needed to conduct evaluation trials with HIV infection as the endpoint, they are generally acceptable to study participants and have been utilized in several large randomized trails of behavioral interventions [24–27].

To date, no reviews have been conducted that summarize the effect of behavioral interventions for HIV prevention in women and girls in the developing world. Recently, the results of several large randomized trials of the effect of behavioral interventions on HIV incidence have been published, the data from which now permit a more focused review of these trials for HIV prevention in women [28–30]. Given the increased risk of HIV incidence among women and girls [1–3] our goal was to systematically review and summarize behavioral change interventions to prevent the sexual transmission of HIV among women and girls living in low- and middle-income countries.

Methods

Search Strategy

We searched PubMed/MEDLINE, PsycInfo, the Cochrane Library including the Cochrane Central Register of Controlled Trials (CENTRAL), Web of Science, Sociological Abstracts, the National Library of Medicine Gateway, African Index Medicus, the Regional Index for Latin America and the Caribbean (Virtual Health Library) and IndMed (the regional database for Indian biomedical journals) for articles and abstracts meeting our inclusion criteria as of March 2, 2009. There were no language restrictions to the search. We developed a customized search strategy for each database relying on the database's controlled vocabulary or index (e.g., medical subject headings (MeSH)) or free text terms. In most cases, search strategies combined terms for (1) HIV infection, (2) behavior or counseling, (3) prevention, and (4) study design restrictions (randomized controlled designs or quasi-experimental). In PubMed/MEDLINE, we searched for clinical trials using an adapted version of Cochrane's "Highly Sensitive Search Strategy" for identifying randomized controlled trials [31]. Search strategies for each database are available from the authors.

To limit publication bias and identify unpublished studies, we searched the Current Controlled Trials Register, the International Clinical Trials Registry Platform Search Portal, clinicaltrials.gov, and Computer Retrieval of Information on Scientific Projects (CRISP) to identify unpublished studies meeting the inclusion criteria. We conducted a cited reference search with key articles, scanned reference lists of eligible articles and reviews, and searched the electronic conference proceedings of recent HIV/AIDS-related conferences (Conference on Retroviruses and Opportunistic Infections, International Society for STD Research annual meetings, and International AIDS Society annual meetings). We contacted three study authors who provided additional information about the trials (including effect estimates among women [27, 29]).

Trial Selection

Eligible trials were those that (1) were published in 1990 or after; (2) used randomized controlled designs (individual or community) or quasi-experimental prospective designs with

a control group; (3) evaluated behavioral interventions focusing on sexual transmission of HIV; (4) were conducted in low- and middle-income countries as defined by the World Bank; (5) were conducted either entirely in women or reported gender-stratified effect estimates (either in the manuscript or shared by study authors); and (6) reported HIV incidence or cumulative risk in the intervention and comparison arms or an overall relative measure of effect (e.g., incidence rate ratios (IRR), risk ratios (RR)). Although effect estimates adjusted for confounders were preferred, analyses with only unadjusted ("crude") estimates were eligible for inclusion.

We first examined the citations from the literature search to eliminate obviously ineligible studies (e.g., those conducted in men, in high-income countries, pertaining to intravenous transmission, or inappropriate article types such as reviews or commentaries). Abstracts were specifically searched for mention of a behavioral intervention tested against a control intervention with biological outcomes. Report of any sexually transmitted disease outcome in the abstract such as incident gonorrhea or chlamydia infections automatically warranted a full length review of the article to determine if HIV testing was conducted. We then conducted a detailed manual review of full length articles to determine eligibility. As we wanted to estimate the effect of interventions on HIV incidence, repeated cross-sectional studies [32] or studies only reporting prevalence were not considered eligible [33].

In two instances, results from individual-level analyses in a community randomized trial were considered separately from the primary community-level analysis. Although such individual-level analyses are subject to selection bias and could potentially negate the benefits of randomization, these reports allow examination of the direct effect of the interventions on the individuals who actually received them in contrast to the general effect on residents residing in communities where the interventions took place. Furthermore, the individual analyses independently meet study inclusion criteria as they are prospective in nature and have control groups. In these cases, we present the community- and individual-level analyses as single interventions with two methods of analyses. We refer to the community-level analysis as the primary analysis and to the individual-level analysis as a secondary analysis.

Quality Assessment

We assessed trial quality using a "component approach" after completion of the literature search; to prevent exclusion of potentially valid information study quality was not part of the inclusion criteria [34]. We assessed dimensions of internal validity such as allocation method, type of control group, participation rate, attrition bias, and type and appropriateness of statistical analyses (e.g., intent to treat). We also considered the role of selection bias for each study.

Data Extraction

For each eligible article or abstract, a single investigator (SM) abstracted the most adjusted measure of effect on the primary outcome of HIV incidence (e.g., IRR, RR). In cases where only the incidence rates in each study arm were presented, we computed IRRs and 95% confidence intervals using standard methods [35]. Although the incidence rate ratio was the preferred measure of effect; one study reported a RR [30, 36], which we assumed approximated the IRR given the rarity of the outcome and that the "exposure" to the intervention should only negligibly affect the person-time at risk [37]. Alternatively, if the exposure did affect the average time at risk, we would expect the RR to be closer to the null than the IRR in which case the RR would be more conservative [37]. In one study, no events were reported in the intervention arm so we computed an exact *P*-value for the intervention effect with person-time information obtained from the study authors [34, 38].

We also examined the effect of the interventions on incident STIs as secondary outcomes as well as the effect of the interventions on HIV-related risk behavior such as number of partners and condom use. In cases where multiple behavioral measurements were assessed in a single study over time, we examined the effect with the longest follow-up period. We also abstracted data including trial year, location, and population as well as details about the intervention (e.g., type, length, audience, behavioral theory (if specified), and nature of the control group).

Descriptive Analysis

We anticipated that few studies would meet the inclusion criteria and that the study populations and interventions would be substantially variable, precluding consideration of summary measures of effect. Given the wide variation in intervention type and intensity, we decided not to proceed with meta-analytic methods. Thus, we present descriptive information about each unique intervention as well as a forest plot of measures of effect generated with Stata software (StataCorp, College Station, TX, USA).

Results

Literature Search

The results of the literature search are presented in Fig. 1. We identified 3,864 citations from electronic databases of

which 3,265 were excluded based on title examination and 551 were excluded based on abstract-level review. Forty-eight full-length articles were reviewed in detail. During the entire process, we excluded nearly 200 evaluations of behavioral interventions in women and girls in low- and middle-income countries that did not evaluate HIV infection. One report with no HIV seroconversions in either study arm was excluded [39]. Eight articles from the literature search met the inclusion criteria; addition of another three articles from reference list examinations yielded 11 analyses for inclusion in the review reporting on eight unique interventions (Table 1). All but one [36] of the reports were published in peer-reviewed journals.

Several of the interventions were described in multiple articles from which we abstracted information. For example, the female-only estimate of the intervention described in Pronyk et al. was obtained from a separate article because the estimate in the original article was combined for men and women [30, 40]. For two interventions, we included both the individual-level and community-level analysis in the review [27, 29, 41]. In one case (Gregson et al.) the individual-level estimate was from the same article as the community-level estimate [29]. We also included two estimates from the *MEMA kwa Vijana* study in Tanzania, one was after 3 years of follow-up and the other was after 6–8 years of follow-up [36, 42]. Information on the long-term follow-up of the *MEMA kwa Vijana* trial was also abstracted from a technical briefing paper available on the study website with a more detailed presentation of the long-term results [43].

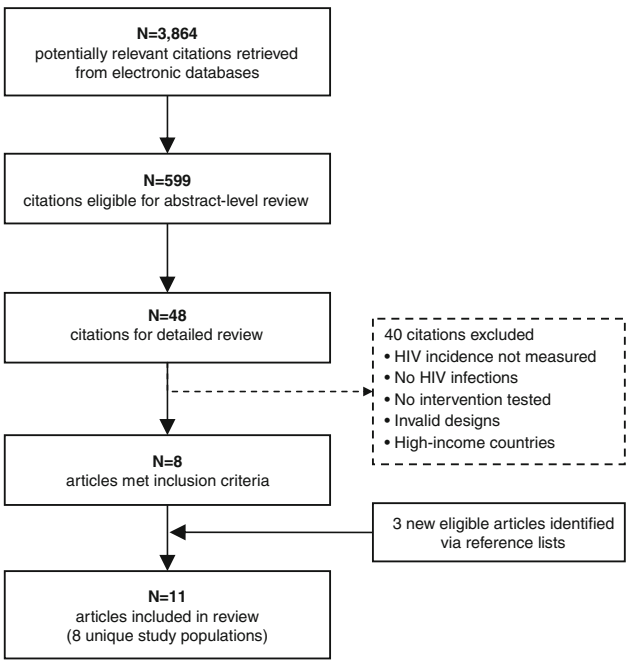

Fig. 1 Study selection process

Study Characteristics

Of the eight unique interventions, six (75%) were conducted in Africa, one was conducted in India, and one was conducted in Mexico. Community randomized controlled trials (C-RCT) were the most common study design (five of eight trials), and together the trials enrolled 42,053 participants. Two trials were targeted toward female sex workers (FSWs) [38, 44], and two were targeted toward adolescents or young adults aged 15–26 years [28, 36, 42]. With one exception, study participants were followed for at least a year and on average for approximately 2.6 years. A study evaluating a brief counseling session for sex workers in Mexico followed participants for 6 months [38].

Most studies used randomized designs, reported participation rates over 70%, and had active control groups receiving a separate prevention intervention (Table 2). Retention rates varied from more than 90% over 1 year in Indian female sex workers to 21–24% over three to 4 years among men and women in Uganda [27, 44]. Two reports had significant methodological limitations. The first, Bhave et al. examined the effect of an educational and motivational intervention for female sex workers and brothel madams in two red light districts in Mumbai [44]. The red light districts were assigned to the intervention or control by convenience (although the authors note similarities between the areas in reported behaviors and STI prevalence) and there was no adjustment for this clustering in the analysis. Another study evaluated the effect of VCT in Uganda by allowing participants the choice to receive testing results and therefore self-selection into the study arms [45]. Participants were subsequently followed for a year to determine the effect of receiving testing results on HIV incidence. Despite these limitations, these reports were included in the review for completeness.

Types of Interventions

The types of interventions were highly variable (Table 3). They ranged from a single enhanced counseling session in FSWs to the intensive 50-h *Stepping Stones* program, which used a participatory learning approach among young men and women ages 15–26 [28, 38]. Only two interventions were targeted towards individuals, one was a study of VCT where individuals could choose to receive their testing results alone or as a couple and the other was among FSWs in Mexico (*Mujer Segura*) [38, 45]. The remaining six interventions were targeted towards groups or combinations of individuals, groups, and/or communities. The study among FSWs in India targeted sex workers as well as brothel madams—each participated in a separate educational and motivational program over 6 months [44]. Two interventions were targeted towards adolescents or young

Table 1 Characteristics of 8 trials (11 reports) evaluating the effect of behavior change interventions to prevent HIV infection in women and girls in low- and middle-income countries

No.	Authors	Location	Design	Population	Follow-up	Intervention and Comparison
1	Bhave [44]	Mumbai, India	Individual quasi-experimental	541 female sex workers (FSW) and 37 brothel madams in red-light districts	1 year	*Intervention*: Educational and motivational videos, small group discussions, pictorial educational materials, and free condoms for FSWs[a]; small group sessions for madams *Comparison:* VCT[a] including pre- and post-test counseling. No condoms provided
2	Kamali [27]	Masaka, Uganda	C-RCT[a]	9,767 men and women residing in study communities	3–4 years	*Intervention*: Information, education, and communication (IEC), social marketing of male condoms, and VCT
	Quigley [41]		C-RCT (individual-level analysisl)	1,836 sexually active women residing in study communities	3–4 years	*Comparison:* Community development and general health-related issues chosen by communities. Social marketing of male condoms and VCT
3	Matovu [45]	Rakai, Uganda	Prospective cohort	6,088 men and women residing in study communities	1 year	*Intervention*: Acceptance of HIV VCT and post-test counseling and risk reduction planning *Comparison:* Pre-test counseling only; no post-test counseling or risk-reduction planning. Community promotion of VCT, condom promotion, community HIV/AIDS education
4	Pronyk [30]	Limpopo Province, South Africa	C-RCT	2,858 men and women residing in study communities	3 years	*Intervention*: *IMAGE*—microfinance and Sisters for Life (SFL) gender and HIV training program *Comparison:* Standard government services
5	Gregson [29]	Manicaland Province, Zimbabwe	C-RCT	9,454 men and women residing in study communities	3 years	*Intervention*: Peer education and condom distribution amongst sex workers and clients, income generating projects (microcredit component not implemented), strengthened management of STIs, and IEC at heath centers. Social marketing of male and female condoms
	Gregson [29]		C-RCT (individual-level analysisl)			*Comparison:* Standard government services, social marketing of male and female condoms
6	Ross [42]	Mwanza, Tanzania	C-RCT	9,645 male and female adolescents in years 4–6 of primary school	3 years	*Intervention*: *MEMA kwa Vijana*—in-school program, youth friendly sexual and reproductive health services, condom promotion and distribution (2000–2002 only) and community-activities
	Doyle [36, 43]		C-RCT (long term follow-up)	13,814 male and female adolescents in years 4–6 of primary school	6–8 years	*Comparison:* Standard family planning services and improved case management of STI

Table 1 continued

No.	Authors	Location	Design	Population	Follow-up	Intervention and Comparison
7	Jewkes [28]	Eastern Cape Province, South Africa	C-RCT	2,776 young men and women residing in study communities	2 years	*Intervention: Stepping Stones*—participatory learning including critical reflection, role play, and drama *Comparison:* Single 3-h session on HIV, safer sex, and condoms
8	Patterson [38]	Tijuana and Ciudad Juarez, Mexico	I-RCT[a]	924 female sex workers	6 months	*Intervention: Mujer Segura*—brief counseling session using motivational interviewing techniques and role playing *Comparison:* Face-to-face didactic presentation of prevention materials and counseling on personal risk assessment, cultural identity assessment, and strategies for reducing personal risk

[a] C-RCT, community randomized controlled trial; I-RCT, individual randomized controlled trial; FSW, female sex workers; VCT, HIV voluntary counseling and testing; STI, sexually transmitted infections

adults, *MEMA kwa Vijana* in Tanzania (adolescents in years 5–7 of primary school) and *Stepping Stones* (men and women 15–26 years old) [28, 42].

All of the interventions directly addressed HIV-related risk with some combination of education, motivational counseling, skills building, condom promotion, risk reduction planning, and/or improved sexual and reproductive health services. However, Pronyk et al. added a microfinance component to the *Sisters for Life* gender and HIV curriculum; Gregson et al. also planned to implement microcredit income generating projects but they could not do so due to the economic climate in Zimbabwe [29, 30]. In general, the community randomized trials implemented a diverse suite of targeted and community activities including small and large group discussions, community events such as drama and video shows for community residents, and social marketing of condoms. Communication and condom skills-building or role-playing activities were a component of all but two of the interventions [29, 45].

Effect on HIV Infection

Only 2 of 11 analyses showed a significant effect on HIV incidence among women (Fig. 2). Note that the Patterson et al. estimate among FSWs in Mexico is not shown on the plot because there were no seroconversions in the intervention arm and only four seroconversions in the control arm ($P = 0.07$) [38]. A 6 month program of group educational and motivational sessions for FSWs and brothel madams in two red-light districts in Mumbai (Bombay) was successful at reducing HIV incidence over the 1 year follow-up period (IRR = 0.33, 95% CI: 0.15, 0.72) [44]. The intervention for FSWs consisted of educational and motivational videos, small group discussions, and the use of pictorial educational materials focusing on STIs, AIDS, and condom use. Women were instructed on correct use of the male condom and were encouraged to educate their clients about the importance of condom use, as well as refuse clients who did not use condoms. The intervention for madams focused on the importance and economic benefits of maintaining the health of sex workers. Lubricated condoms were only given to the intervention group and were not available to FSWs in the control arm. Use of condoms was extremely low at baseline—only 1–2% of FSWs asked clients to use condoms—and less than 1% knew not to use oil-based lubricants (e.g., hair oil), which was a common practice. The intervention also significantly affected condom use (discussed below).

The individual-level secondary analysis of sexually active, initially HIV-seronegative women in the Masaka, Uganda trial showed that attendance at any study-related activity in the past year reduced HIV incidence (IRR = 0.41, 95% CI: 0.19, 0.89) [41]. Intervention

Table 2 Characteristics associated with methodological quality of 11 reports evaluating the effect of behavior change interventions to prevent HIV infection in women and girls in low- and middle-income countries

Authors	Allocation method	Control group	Participation rate	Retention[a] (control/ intervention)	Statistical analysis	Powered for HIV infection
Bhave [44]	Convenience	Inactive	NR[b]	92%/100%	Not adjusted for clustering	No
Kamali [27]	Random by community	Active	71%[c]	24%/21%[c]	Intention to treat (communities)	Yes
Quigley [41]	Random by community	Active	NR	NR	Individual-level analysis of C-RCT	Yes
Matovu [45]	Self-selection	Active	77.7%	N/A	Unadjusted	No
Pronyk [30]	Random by community	Inactive	74%	63%/58%	Per protocol	Yes
Gregson [29]	Random by community	Active	78.9%	56%/55%	Intention to treat (communities)	Yes
Gregson [29]	Random by community	Active	78.9%	56%/55%	Individual-level analysis of C-RCT	Yes
Ross [42]	Random by community	Active	99.8%	74%/72%	NR	Yes
Doyle [36, 43]	Random by community	Active	99.9%	NR	NR	Yes
Jewkes [28]	Random by community	Active	NR	73%/68%	Intention to treat	Yes
Patterson [38]	Random	Active	NR	80%/83%	NR	No

[a] Retention refers to the people with follow-up data minus those lost to out-migration, absenteeism, refusal, or incomplete information

[b] NR not reported, N/A not applicable

[c] Percent of those consenting to providing blood samples at baseline and of those, percent consenting to providing blood samples at round 3

activities included meetings, videos, and dramas focusing on information, education, and communication [27]. The effect was diluted when those who reported not being sexually active were included (IRR = 0.53, 95% CI: 0.24–1.14), and the community-level analysis of women living in study communities failed to show any effect [27, 41]. The remaining analyses clustered near the null value of no effect on HIV incidence.

Effect on Secondary Outcomes: STIs and HIV-Related Risk Behavior

Six of the 11 analyses reported outcomes in STIs other than HIV and 10 assessed self-reported HIV-related risk behavior (Table 4). Only one analysis (Bhave et al. among FSWs in India) reduced the incidence of HIV and STIs, and reduced reported risk behavior. This intervention significantly reduced the incidence of syphilis antibodies and hepatitis B surface antigen (unadjusted IRRs 0.35 (95% CI: 0.17, 0.72) and 0.30 (95% CI: 0.14, 0.66), respectively) and the percentage of FSWs reporting always using a condom with clients increased from 3 to 28 percent after the intervention, compared to a decrease in the control group (from 3 to 0 percent) [44].

The information, education, and communication intervention in Masaka, Uganda had mixed results on STIs and no effect on behavior [27, 41]. Although the individual-level analysis among sexually active women demonstrated reduced HIV incidence, the effect on STIs was not available in this sub-group [41]. In the community-level analysis, the intervention reduced herpes simplex virus type 2 (HSV-2) incidence (IRR = 0.65, 95% CI: 0.43–0.97), although no effect was found for active syphilis, gonorrhea or chlamydia prevalence [27]. This study also included a third study arm combining the same behavioral intervention plus improved management of STIs, which did not detect a similar effect on HSV-2 [27]. Significant behavior changes were not observed in either the individual-level analysis among women or the community-level analysis among both men and women.

The remaining analyses, none of which had an effect on HIV, had inconsistent effects on STIs and self-reported behavior. Three analyses did not reduce self-reported risk behavior and did not measure STIs other than HIV [29, 30, 45]. In the *MEMA kwa Vijana* trial, there was no reduction of HSV-2, syphilis, chlamydia or gonorrhea prevalence among women either after 3 years of follow-up or after 6–8 years of follow-up [36, 42, 43]. Although the intervention had no effect on most behavioral outcomes in either follow-up period, in the long term follow-up, condom use at the last sex with a non-regular partner in the past year among female adolescents increased (prevalence ratio = 1.34, 95% CI: 1.07, 1.69). The *Stepping Stones* intervention reduced HSV-2 incidence overall (adjusted IRR = 0.67, 95% CI: 0.47, 0.97) but among women the effect was not statistically significant (unadjusted IRR = 0.69, 95% CI: 0.47, 1.03) [28]. There was no effect on reported sexual risk behaviors. Finally, the *Mujer Segura* intervention in FSWs in Mexico did not reduce the incidence of syphilis, gonorrhea, or chlamydia individually, but did have an effect on a composite STI measure, including HIV infection (unadjusted IRR = 0.55, 95% CI: 0.32, 0.95). Condom use increased 27% among FSWs in Mexico after the *Mujer Segura* intervention, compared to 17.5% among controls ($P < 0.01$).

Table 3 Characteristics of behavioral interventions to prevent HIV infection in women and girls in low- and middle-income countries included in the review

Authors	Intervention description/name	Target group	Type	Unit of delivery	Intervention duration	Behavioral theory
Bhave [44]	Group educational and motivational sessions	FSWs and madams	Educational and motivational videos and discussions, pictorial educational materials, and condom promotion	Group	6 months; 3–4 video viewing groups, 3–4 group discussions, 2 sessions for madams	Not specified
Kamali [27] Quigley [41]	IEC[a]	Adult men and women	IEC and social marketing of male condoms; large and small group meetings, one-to-one discussions, information leaflets, and local drama and video shows	Individual and group	Activities implemented throughout the 3–4 year study period, including monthly video shows.	Behavior change for interventions model
Matovu [45]	VCT[a]	Adult men and women	Pre-test HIV counseling with option to receive results with post-test counseling and risk reduction planning	Individual or couples	One session	None specified, VCT offered in accordance with Ugandan Ministry of Health policies
Pronyk [30]	*IMAGE*	(1) Women in the program, (2) household co-residents, (3) community residents	Microfinance, Sisters for Life (SFL) gender and HIV training program including leadership training and community mobilization activities for "natural leaders"	Individual, group, and community	15–21 months[b]; loan center meetings every 2 weeks, 12–15 month SFL curriculum with meetings every 2 weeks	Guided by an ecological framework [61] with community mobilization
Gregson [29] Gregson [29]	Diverse community activities	Sex workers and adult men and women	Peer education and condom distribution amongst female sex workers and male clients, income generating projects (microcredit component not implemented), strengthened STI services, and IEC activities at health centers	Individual, group, and community	Activities implemented throughout the 3 year study period	Not specified
Ross [42] Doyle [36]	*MEMA kwa Vijana*	Male and female adolescents in years 5–7 of primary school	Participatory, teacher-led, peer-assisted in-school program, youth friendly sexual and reproductive health services, condom promotion and distribution (2000–2002 only) and community activities	Individual, group, and community	Activities implemented throughout the study period; 12 40-min school-based sessions per year, annual youth health weeks, twice yearly youth health days, and quarterly video shows	Not specified [62]

Table 3 continued

Authors	Intervention description/name	Target group	Type	Unit of delivery	Intervention duration	Behavioral theory
Jewkes [28]	*Stepping Stones*	Men and women 15–26 years	Participatory learning approaches including critical reflection, roleplay, and drama, held on school premises	Group and community	6–8 weeks; 13 3-h single sex groups, 3 meetings of peer groups, and a community meeting	Adult education theory, Freirian models of critical reflection, use of theater, and assertiveness training [63]
Patterson [38]	*Mujer Segura*	Female sex workers	Individual counseling using motivational interviewing techniques and role playing	Individual	Single 35-min counseling session	Social cognitive theory, theory of reasoned action [64]

[a] IEC, information, education, communication; VCT, voluntary HIV counseling and testing

[b] Based on information in the report stating that the SFL curriculum began 3–6 months after loan centers were assembled followed by the 12–15 month SFL curriculum

Discussion

This review suggests that behavioral interventions to prevent HIV infection in women and girls in low- and middle-income countries have been limited in their success. Of the interventions we identified, only two had statistically significant effects on HIV incidence and only one, which had significant methodological shortcomings, simultaneously reduced risk behavior, HIV incidence, and STIs [44]. It is challenging to determine specific features of these two successful interventions given the dramatic variability in the intensity, duration, and delivery of the interventions. The intervention among FSWs in India may have been successful because both FSWs and brothel madams were targeted [44]. However, the unavailability of free lubricated male condoms in the control group, the frequency of inappropriate lubricant use at baseline, and other methodological limitations suggest that the success of the intervention may have been at least partially attributed simply to the availability of quality lubricated condoms. The successful study in Uganda examined self-reported attendance at intervention activities among sexually active women [41]. There were no effects of intervention activities on sexual behavior or any effect on HIV in the community-level analysis, although the effect on sexually active women was statistically significant even when subdivided by type of activity (e.g., meeting, video, drama). In both cases, elements of the successful interventions were similar to those in other unsuccessful interventions.

Despite several summary reports finding that behavioral interventions were effective in changing self-reported risk behavior in a variety of other populations [16–19, 19, 21, 46], the interventions for women and girls in low- and middle income countries included in this review did not have large impacts on behavior. Only three of ten reports in this review that measured behavioral outcomes reduced any measure of HIV risk behavior; in one case (the long term evaluation of *MEMA kwa Vijana*) only one of 10 behavioral markers in women showed any improvement (condom use with a non-regular partner) [36, 43]. However, it is important to note that our review did not include all studies of behavioral interventions for women and girls in lower income countries only those that measured the effect on HIV incidence were included. Regardless, the reliability of self-reported sexual behavior is unknown.

There are several possible explanations for the inability of the interventions in this review to reduce sexual risk behavior in women and girls. First, it is possible that the interventions did not change risk behavior at all or that short term effects were not sustained over the follow-up period. Second, women's individual behavior is not always high-risk, and their individual susceptibility may be entirely driven by their partner or husband's behavior,

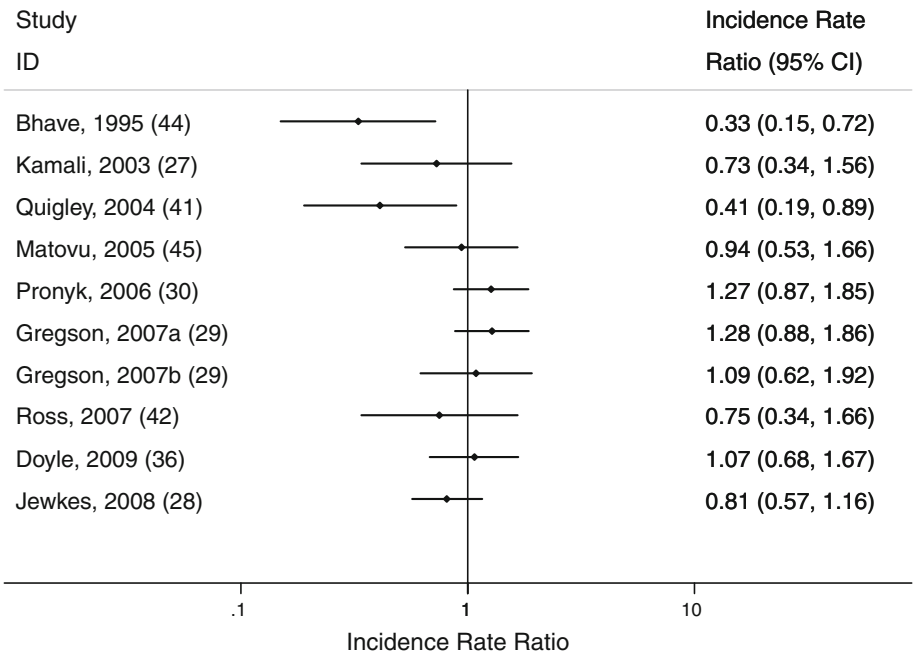

Fig. 2 Forest plot of study specific estimates of reduction in HIV incidence in women following implementation of a behavioral intervention. Patterson [38] not shown. Quigley [41] and Gregson [29] are individual-level analyses of community randomized trials described in Kamali [27] and Gregson [29], respectively. The estimate of HIV incidence for Pronyk [30] among women was presented in a separate article, Hargreaves et al. [40]. The estimate for HIV incidence among women for Kamali [27] and Gregson [29] was provided by study authors. The estimate presented in Doyle [36] is the 6–8 year follow-up analysis of the study described in Ross [42]. This study presented a relative risk; we assumed that the relative risk approximated the incidence rate ratio (see methods)

which is often out of their immediate control. Behavioral interventions targeting individual behavior change may be ineffective in these situations as women may not perceive themselves to be at risk [15]. Similarly, sexual network and group-level determinants may be more important drivers of transmission in a population [47]. The time between the end of one sexual partnership and the beginning of the next (the "gap") is gaining attention for its importance in facilitating the spread of STIs, especially when one partnership begins prior to the end of an STI's infectious period or when partnerships overlap in concurrency [48, 49]. Finally, perhaps structural factors such as gender inequities further up the causal chain that drive risk behavior are more important to address than individual behavior to incite population-level behavior change [3]. These reasons, and undoubtedly others, may explain why the reports in this review had limited efficacy changing sexual behavior.

The effect of the interventions on HIV, STIs and reported risk behavior were often inconsistent. However, the expectation that behavioral change interventions should consistently reduce both HIV and other STIs may be an oversimplification of complex pathogen transmission dynamics. Modeling studies have suggested that behavioral strategies have different impacts on HIV and STIs—reducing the number of partners may be more important for highly infectious STIs such as gonorrhea, whereas condom use may be more effective than reducing the number of partners at reducing HIV transmission risk [50]. The variability of infectivity across STIs as well as the variability of HIV infectivity given disease stage and cofactors like circumcision and the presence of STI co-infections [51] suggests that all sexual risk behaviors are not the same in terms of HIV/STI transmission, and that a more focused selection of "targeted" behaviors for a specific pathogen may increase the chances of success for behavioral interventions.

This review, like all systematic reviews, is subject to important limitations. All analyses that reported any biological outcome (e.g., HIV, gonorrhea, *Chlamydia*) in the abstract were selected for detailed review. However, if HIV incidence was measured but HIV or other biological outcomes were not mentioned in the abstract, they would have been excluded at the abstract review phase. We may have also missed relevant studies from databases not searched. We included one meeting abstract which had not yet been peer-reviewed, and we included both individual- and community-level analyses from the same interventions as well as both the short and long-term follow-up from one study: the *MEMA kwa Vijana* study. Although multiple estimates from the same study are typically not included in systematic reviews, we included them for completeness and because they met the inclusion criteria. We allow the

Table 4 Impact of 11 studies evaluating the effect of behavior change interventions on HIV incidence, behavior change and reduction of STIs in women and girls in low- and middle-income countries

Authors	Reduced HIV incidence		Reduced risk behavior		Reduced other STIs	
	IRR (95% CI)		Behavior		IRR (95% CI)	
Bhave [44]	Yes:	0.33 (0.15, 0.72)	Yes:	↑ Condom use with clients	Yes:	Syphilis: 0.35 (0.17, 0.72)
						HBsAG[a]: 0.30 (0.14, 0.66)
Kamali [27]	No:	0.73 (0.34, 1.56)[b]	No		Yes:	HSV-2[a]: 0.65 (0.43-0.97)[b]
						No effect on active syphilis, CT, or GC
Quigley [41]	Yes:	0.41 (0.19, 0.89)	No		NR[c]	
Matovu [45]	No:	0.94 (0.53, 1.66)	No		NR	
Pronyk [30, 40]	No:	1.27 (0.87, 1.85)	No		NR	
Gregson [29]	No:	1.28 (0.88, 1.86)[b]	No[e]		NR	
Gregson [29]	No:	1.09 (0.62, 1.92)	NR		NR	
Ross [42]	No:	0.75 (0.34, 1.66)	No[f]		No:	No effect on HSV-2, syphilis, CT, or GC
Jewkes [28]	No:	0.81 (0.57, 1.16)	No		Possibly[g]:	HSV-2: 0.69 (0.47, 1.03)
Patterson [38]	No:	NR ($P = 0.07$)	Yes:	↑ Condom use and total protected sex	Yes:	Any STI: 0.55 (0.32, 0.95)
Doyle [36, 43]	No:	1.07 (0.68, 1.67)[d]	Yes:	↑ Condom use with non-regular partner	No:	No effect on HSV-2, syphilis, CT, or GC

[a] HBsAG, hepatitis B surface antigen; HSV-2, Herpes simplex virus type 2; CT, chlamydia; GC, gonorrhea

[b] Estimate obtained from study authors

[c] NR not reported

[d] Risk ratio

[e] Risk behavior may have increased in women in the intervention arm

[f] One measure of risk behavior was reduced, first use of condom during follow-up

[g] HSV-2 was reduced significantly in the overall estimate, but not in women alone based on calculations by review authors

reader to determine the weight of the evidence they provide. We focused only on HIV incidence, so studies using repeated cross-sectional designs with prevalence estimates were excluded. Finally, not all of the included reports were powered to detect an effect on HIV incidence, so the precision of the effect estimates varies dramatically, and some reports only provided unadjusted measures of effect. Despite these shortcomings, this review is the first, to our knowledge, to summarize the effect of behavioral interventions to prevent HIV infection in women and girls in the developing world.

At least two large studies of behavioral interventions with HIV incidence as an outcome are currently in progress. The community population opinion leader (C-POL) program was evaluated in five countries (China, India, Russia, Peru, Zimbabwe) and has completed data collection. Although the HIV results had not been released at the time of this writing there was no effect of the intervention on a combined sexually transmitted infection outcome (including HIV) [52]. In addition, Project Accept is a trial of community based VCT versus standard clinic based VCT for the prevention of HIV infection in South Africa, Tanzania, Zimbabwe and Thailand [53]. Results are expected in 2011. In addition to these two trials, the *Regai Dzive Shiri* community randomized trial in Zimbabwe, which evaluated a multi-component prevention intervention for adolescents based on peer education, was recently completed [54, 55]. Although the community randomized study design was modified midway to serial cross-sectional assessments of prevalence (which precluded it from inclusion in this review), they found that the intervention had no effect on HIV prevalence in young men or women residing in study communities [55]—adding to the growing body of literature reporting on trials of behavioral interventions with no effect on HIV infection.

Given these findings, important research and prevention gaps remain for HIV prevention programmers. The diminishing hope that a single behavioral or biomedical prevention intervention will be sufficient to address the growing HIV pandemic has heralded a programmatic shift towards combination HIV prevention programming [56–59]. By combining interventions with partial effectiveness targeted to populations most at risk, combination intervention packages should address *both* the biological and behavioral factors associated with transmission as well as the social and structural determinants that can aid or impede the success of HIV prevention programming [56–59]. Under this new paradigm, behavioral approaches to HIV prevention are critical components of prevention packages for both women and men, as a strategy to reduce high-risk sexual behavior and inform and educate the community, but also as a mechanism to improve the uptake, adherence, and proper use of biomedical intervention methods.

This review has highlighted the reality that current behavior change interventions, by themselves, have been limited in their ability to control HIV infection in women and girls in low- and middle-income countries, at least over short follow-up periods of 1–3 years. However, there is an ethical responsibility to educate women about HIV infection and offer accurate prevention and risk reduction information even in the absence of clear data on effectiveness. Yet how to incorporate behavioral change programs into HIV prevention packages is unclear. Clearly, elements of behavior change (e.g., information, motivation, skills) are necessary to complement biomedical prevention strategies to ensure their successful scale up and prevent risk compensation [60]. However, ongoing studies are needed to determine whether behavior change interventions can be incorporated as efficacious components in a prevention package for women or, more conservatively, simply as supportive programs for biomedical prevention strategies.

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