

HIV Voluntary Counseling and Testing and Behavioral Risk Reduction in Developing Countries: A Meta-analysis, 1990–2005

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Abstract The effectiveness of HIV voluntary counseling and testing (VCT) in reducing HIV risk behaviors in developing countries was assessed using meta-analytic methods. A standardized protocol was used for searching, acquiring, and extracting study data and meta-analyzing the results. Seven studies met the inclusion criteria. VCT recipients were significantly less likely to engage in unprotected sex when compared to behaviors before receiving VCT, or as compared to participants who had not received VCT [OR 1.69; 95%CI 1.25–2.31]. VCT had no significant effect on the number of sex partners [OR 1.22; 95%CI 0.89–1.67]. While these findings provide only moderate evidence in support of VCT as an effective prevention strategy, neither do they negate the need to expand access to HIV testing and counseling services. Such expansion, however, must be accompanied by rigorous evaluation in order to test, refine and maximize the preventive benefits of learning one's HIV infection status through HIV testing and counseling.

Keywords Meta-analysis · Developing countries · HIV voluntary counseling and testing · Behavioral risk reduction

Introduction

HIV voluntary counseling and testing (VCT) is an integral component of HIV prevention and care strategies worldwide. By combining personalized counseling with knowledge of one's HIV status, VCT is believed to motivate people to change their behaviors to prevent the transmission of the virus. In an earlier review synthesizing VCT data published between 1986 and 1990, Higgins et al. (1991) found the strongest evidence of behavior change among discordant heterosexual couples who received VCT. The effect of VCT on sexual risk behaviors among other groups, such as men who have sex with men and injecting drug users, was inconclusive. Similarly, another review of VCT studies from 1990 to 1996 showed that the effect of VCT on risk behaviors often varied by research population and design, with the most consistent behavior change evidence found in studies among discordant couples (Wolitski et al. 1997). Results from a meta-analysis of VCT efficacy data also supported the intervention as an effective behavior change strategy for persons infected with HIV (Weinhardt et al. 1999). Few studies from developing countries were either available or matched the inclusion criteria for these reviews. As a result, the majority of studies included in these reviews were conducted in developed countries in North America and Europe.

Providing VCT in resource-constrained settings is substantively different than in developed countries (De Zoysa et al. 1995). Delivering labor intensive counseling and high

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quality testing may strain already weak health care infrastructures. The lack of HIV care and treatment, including antiretroviral therapy (ART), prophylaxis for the prevention of mother to child HIV transmission (PMTCT), access to condoms, and treatment for opportunistic infections, may also hinder the acceptance and effectiveness of VCT. Despite these challenges, several advances have occurred since the 2001 UN Special Assembly's commitment to expanded access to VCT (UN 2001). The estimated number of people using HIV testing and counseling services in more than 70 surveyed countries increased from four million persons in 2001 to 16.5 million in 2005. During that time, the number of ART recipients also increased from 240,000 to 1.3 million (UNAIDS 2006). While these trends represent great progress, an estimated 80% of people living with the HIV virus remain unaware of their infection status (WHO, UNAIDS and UNICEF 2007). The emphasis placed on HIV testing as an entry point for treatment and care has also tended to overshadow the need to examine VCT as a behavioral risk reduction program. However, in 2006, the UN General Assembly reaffirmed their commitment to VCT specifically as an HIV prevention strategy (UN 2006). As the movement to scale up different HIV testing models in developing countries gathers greater support it is crucial to examine the existing data to determine if VCT services are achieving the goal of behavioral risk reduction. This meta-analysis examines the evidence on the effectiveness of VCT in developing countries in reducing recipients' numbers of sex partners and the occurrence of unprotected sex.

Methods

We utilized standard methods for conducting systematic reviews and meta-analysis (Copper and Hedges 1994). First, we defined VCT and established the minimum design characteristics for study inclusion. We then systematically searched for studies that met the inclusion criteria, extracted data from each eligible study using a standard method and forms, and compared and meta-analyzed the results across studies.

VCT Definition and Intervention Components

Prior to searching for citations, we defined VCT as consisting of pre- and post-test counseling and having learned one's HIV status. This definition corresponds to the international standards for VCT as initially set forth by the US Centers for Disease Control and Prevention (CDC) and the Joint United Nations Programme on HIV/AIDS

(UNAIDS) (CDC 2001; UNAIDS 2000). CDC/UNAIDS guidelines recommend that during pre-test counseling the counselor and client discuss the test process, assess the client's risk behaviors, discuss coping strategies related to receipt of test results, review prevention options, and reaffirm the decision to test for HIV. In the post-test counseling session clients receive their HIV status, discuss risk reduction strategies and disclosure of test results, and receive appropriate referrals for care and support. These VCT intervention components are hypothesized to influence several intermediate outcomes, including enhancing the client's HIV risk reduction knowledge, attitudes, beliefs and behaviors (Fig. 1). These intermediate outcomes in turn are believed to affect health outcomes by reducing HIV transmission and improving the psychological and physical health status of clients and their partners.

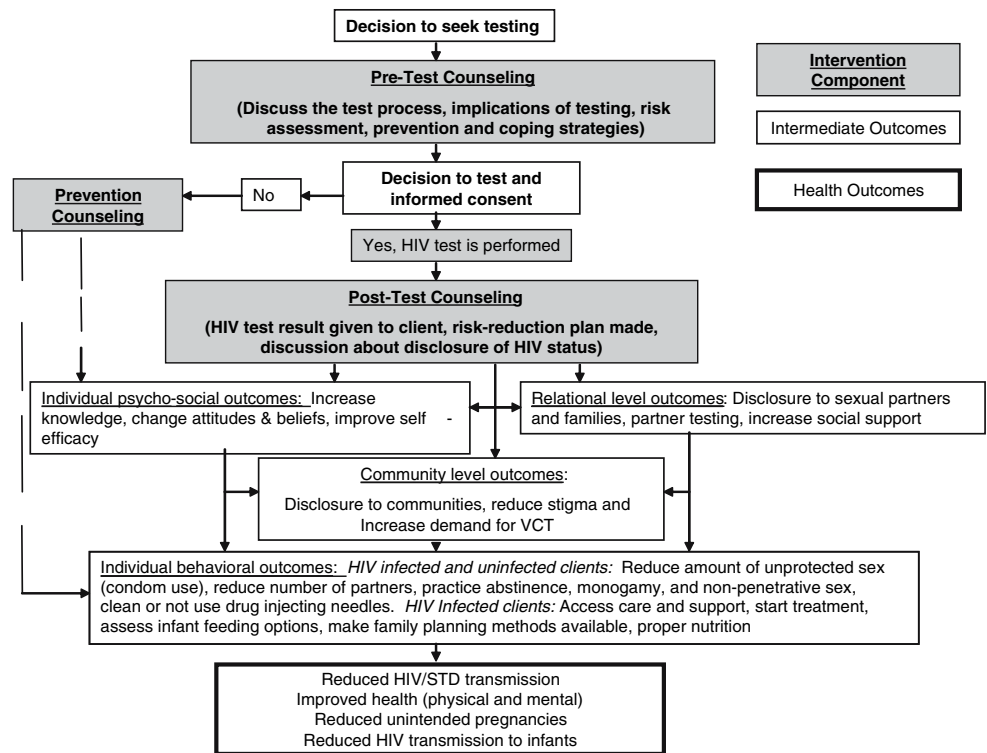
Inclusion Criteria

Study citations were included based on five criteria: (1) the study was conducted in a developing country or emerging economy as defined by the World Bank (World Bank 2005); (2) the study evaluated VCT interventions that adhered to the CDC/UNAIDS guidelines as described above; (3) results presented were from pre- and post-VCT assessments, or compared persons who received VCT to those who did not receive VCT (including intensive/less intensive versions of VCT); (4) the study measured HIV-related outcomes such as knowledge and HIV-risk behaviors; and (5) the study was published between January 1990 and April 2005. Published articles in any language that met the criteria were eligible for inclusion. Unpublished material and conference abstracts were excluded from the review as they lacked the necessary detail needed for the synthesis. Previous reviews, meta-analyses and seminal reports were also identified and coded less intensively as background information. For the meta-analysis presented in this paper, only studies that met these criteria and presented outcome data on number of sex partners or unprotected sex were included.

Search and Acquisition

Trained staff searched for citations on five computer-based search engines: the National Library of Medicine's Gateway database (which includes Medline and AIDSline), Psych INFO, Sociological Abstracts, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), and EMBASE. Staff then hand searched

Fig. 1 VCT intervention components and outcomes



five HIV-related journals: AIDS Care, AIDS, AIDS and Behavior, AIDS Education and Prevention and the Journal of AIDS. Any citation appearing to meet the inclusion criteria based on the title and abstract was retrieved. An iterative process was used to generate a final list of search terms, which were HIV counseling and testing, HIV VCT, HIV voluntary counseling and testing, HIV anonymous counseling and testing, HIV ACT, HIV testing and counseling and evaluation, HIV testing and counseling and interventions, HIV counseling and efficacy. The references of the eligible papers were also searched, a process that was iterated until no new papers were identified. We also carefully reviewed the references from previous review papers and meta-analyses for possible citations.

From initial searches, 538 references were identified as potentially eligible and imported into a database for additional screening (Fig. 2). Two senior staff separately screened the citations for eligibility based on the title and abstract (if available) and classified each citation as either: (a) eligible for coding; (b) suitable background material; or (c) excluded. The screened citations of each senior staff were then merged for comparison, and any differences were resolved through discussion. From this process a list of citations for acquisition was derived, the citations were obtained, and an additional screening of the full citation was conducted by two independent coders.

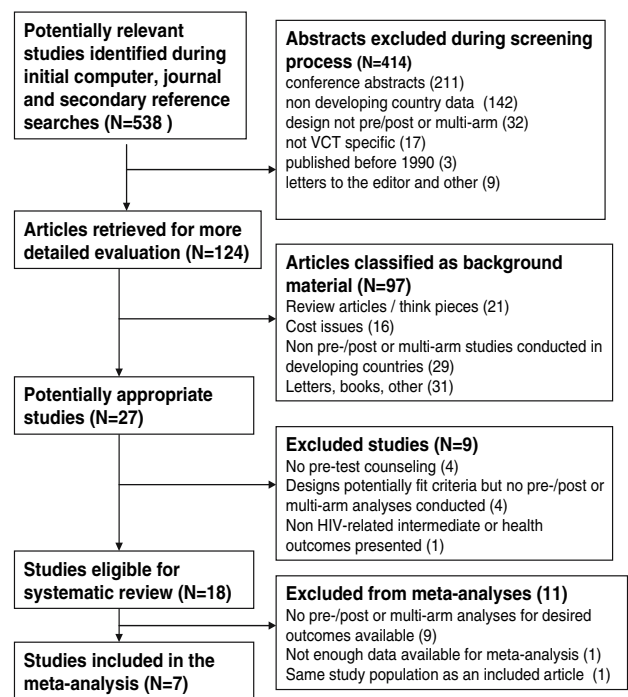


Fig. 2 Disposition of citations in search process

Coding

Two coders extracted data from each eligible citation independently using a highly detailed coding form with 15

content areas: (1) citation information, (2) synthesis inclusion criteria, (3) study methods, (4) study population characteristics, (5) setting, (6) sampling, (7) study design, (8) unit of analysis, (9) loss to follow up rates, (10) study group (arms or comparison groups) characteristics, (11) intervention characteristics, (12) intervention topic specific questions, (13) outcome measures, (14) outcome results, and (15) additional information (e.g. costs, limitations).

All outcome variables reported in a study were noted, but detailed results were only recorded for those outcomes with either a pre/post or between study group arm comparisons. Eligible outcome results were coded in a structured format which included: (1) the statistical analysis used, (2) the effect size and base rate, (3) the independent variables analyzed, (4) catchments and/or follow-up times, (5) the confidence interval and/or *P*-value, (6) the page number where the results are located, and (7) any additional brief information deemed important by the coder. All eligible outcome results were coded, including sub-group presentation of results (such as by gender) even when aggregated results were presented. After the two coders independently coded the citation the data were transferred to a statistical database (using SPSS Data Entry software; SPSS™, Chicago, IL.). A resolution report, highlighting any differences between coders, was generated from the SPSS™ quantitative database and resolved by senior staff in consultation with the study Principal Investigators.

Assessing Study Rigor

An eight-point rigor scale developed for the synthesis project was used to generate a standard comparison of rigor across analyses. The scale is additive, with one point given for each item and no point given when data were not available to assess the criterion. The rigor scale items and definitions included: *Prospective cohort* analyses presented data from the same study subjects followed over time. *Control or comparison groups* compared those who received VCT to those who did not (including more- versus less-intensive intervention). *Pre/Post intervention outcome data* assessed behaviors before and after participants received VCT. *Random assignment to treatment groups* assessed random assignment of study subjects as individual or groups. *Random selection of subjects* for assessment. *Attrition* determined if the follow up rate was 80% or more. *Comparison group matching* assessed if there were statistically significant differences in socio-demographic measures (such as age) across study arms. *Comparison group matching on outcome measures* assessed whether studies had a statistically significant baseline difference in study outcomes.

Meta-analytic Methods

We standardized effect size estimates from study reports to the common metric of an odds ratio since all studies reported dichotomous outcomes and compared two groups (either intervention/comparison groups or before/after groups). We utilized standard meta-analytic methods to derive standardized effect size estimates (Copper and Hedges 1994), and used the software package Comprehensive Meta-Analysis V.2.2 to conduct statistical analyses. For the outcome number of sex partners, all studies presented results as a dichotomous proportion. Two studies compared participants with none or one partner, to two or more partners; while the third study compared having one partner, to more than one partner. For the outcome unprotected sex, variables were the dichotomous proportion of respondents who either (a) did versus did not use condoms or (b) did versus did not have unprotected sex. Thus, we first computed the Chi-squared statistic from contingency tables, then converted this to the standardized mean difference, “d”, and then converted “d” to an odds ratio using readily available and widely accepted formulas (Copper and Hedges 1994). We pooled the odds ratios using a random effects model.

Selection of Study Endpoints

Two studies reported multiple measures of unprotected sex, the VCT Efficacy trial (VCT Efficacy Study Group 2000) and a study conducted in Thailand by Kawichai et al. (2004). In the VCT Efficacy Trial those enrolling as individuals and those enrolling as couples in the study each had two unique measures of unprotected sex assessed. Participants enrolling as couples were asked about unprotected sex with their enrollment partner, and also with non-enrollment partners. Participants enrolling as individuals were asked about unprotected sex with primary and non-primary partners. In the Kawichai study, participants were asked about condom use with casual partners, their spouse, and with girlfriends/boyfriends. Within each study we calculated an average effect size across these various measures of condom use. The average effect size measures were then used in the meta-analysis. Average within study effect sizes were estimated by converting odds ratios to a standard Hedges-G statistic. The arithmetic average of the Hedges-G statistics, and average associated standard errors, were calculated across measures, and this composite effect size estimate was utilized in the overall across study meta-analysis. Selected measures for each study are described in the left column of Table 1.

Table 1 Study descriptions

Author and outcome measure	Setting/target group	Intervention	Study design	N (I = intervention arm) C = comparison arm)	Age	% Female	Length of follow-up
Allen et al. 1992 <i>Unprotected sex:</i> proportion of couples using condoms	Kigali, Rwanda Women attending antenatal or pediatric clinics and their partners	Couples watched an AIDS education video and attended a group discussion led by a social worker. Condoms and spermicide provided free of charge. HIV results given individually in sealed envelopes. Couples were encouraged to receive their results together.	Pre-post design. Couple unit of analysis. Non-random selection of participants.	60 couples	Mean Males: 35 Females: 29	50%	12 months (1988)
Farquhar et al. 2004 <i>Unprotected sex:</i> reported condom use	Nairobi, Kenya Women attending antenatal clinic	Partner testing, couple VCT and partner notification were discussed individually with women. All participants were invited back 1 week later for counseling and testing. Women who returned with their partner were offered either couple or individual counseling and testing.	Pre-post design. Individual unit of analysis. Non-random selection of participants.	Baseline: 2104 (n = 871 females for the analysis)	Mean: 24	100% (for the included analysis)	2 weeks (2001–2002)
VCT Efficacy Study Group 2000 <i>Unprotected sex:</i> an average of amount of unprotected intercourse with primary and primary partners for individuals and non-enrollment and enrollment partners for couples.	Nairobi, Kenya; Dar es salaam, Tanzania; and Port of Spain, Trinidad. General population	VCT arm received CDC client centered counseling (personalized risk assessment, development of a personalized risk-reduction plan, role plays and condom demonstrations). Test results available 2 weeks after the blood draw. The participants in the health information (HI) arm watched a 15-min video and participated in a group discussion about HIV transmission and condom use. At the first follow-up HI participants were offered VCT.	Randomized controlled pre/post trial design. Participants randomly assigned to the study arms as individuals or couples. Data pooled across countries for all analyses. Individual unit of analysis. Non-random selection of participants.	<i>Individuals</i> Baseline: 3,120 (I: 1563; C: 1557) 1st follow-up: 2,550 (I: 1281; C: 1269) <i>Couples</i> Baseline: 1,174 (I: 589; C: 584) 1st follow up: 1,001 (I: 508; C: 493)	<i>Individuals</i> Mean ages ranged from 28.5 to 28.1 <i>Couples</i> Mean ages ranged from 25.9 to 32.1	<i>Individuals</i> 51% <i>Couples</i> 50%	7.3 months (1995–1998)

Table 1 continued

Author and outcome measure	Setting/target group	Intervention	Study design	N (I = intervention arm) C = comparison arm)	Age	% Female	Length of follow-up
Xu et al. 2002 <i>Unprotected sex</i> : 100% condom use with husband prior 6 months or until husbands tested negative for HIV	Chiang Rai Province, Thailand Women attending family planning and post-partum clinics	Trained nurse counselors provided pre- and post-test counseling (20–40 min each). Condom use was recommended if husband's HIV status was positive or unknown. Women were shown how to use condoms and were given condoms to take home. Partner HIV testing was recommended and the cost reimbursed.	Time series design among HIV negative women with steady partners. Individual unit of analysis. Non-random selection of participants.	Baseline: 779 (<i>n</i> = 629 for the analysis)	Median; 27	100%	12 months (1998–1999).
Muller et al. 1995 <i>Unprotected sex</i> : proportion who used condoms during each of the last three incidences of sexual intercourse <i>Number of partners</i> : in the last 12 months for the comparison arm, and on average past 23 months for the intervention arm (none or one partner versus more than one partner)	Bangkok, Thailand General population	HIV positive patients, who received their test result at the anonymous clinic (AC), were referred to the immune clinic (IC) for care and treatment after the post-test counseling. New patients receive counseling by specially trained Red Cross health workers.	Non-randomized cross-sectional trial among HIV-infected participants who had previously sought VCT on average 23 months earlier and were attending an immune clinic versus HIV infected age and gender-matched controls receiving VCT for the first time. Individual unit of analysis. Non-random selection of participants.	600 (I: 300; C: 300)	Range: 15–66	17%	NA (1993)
Kawichai et al. 2004 <i>Unprotected sex</i> : an average of consistent condom use with casual partners, their spouse, and with girlfriends/boyfriends in previous 6 months Number of partners: in the 6 months before the baseline interview (none or one partner versus more than one partner)	Chiang Mai city, Thailand General population	Group pre-test counseling provided by trained counselors at community study sites covered HIV/STDs, routes of infection, risk assessment, risk reduction and the meaning of an HIV test. After blood draw the questionnaire was administered. Participants received confidential post-test counseling individually 2–3 weeks later at health clinics or hospitals.	Prospective cohort data for condom use. Cross sectional analysis for number of sex partners comparing I = previously tested participants vs. C = untested participants, measured at baseline. Individual unit of analysis. Non-random selection of participants.	Baseline: 2251 6 month follow-up: NR (<i>n</i> = 37 for males and 7 for females for condom use analysis) Males: I = 531; C = 391 Females: I = 648; C = 642 (for the number of sex partner analysis)	Mean males: 28 Mean females: 29	59%	6 months (1999)

Table 1 continued

Author and outcome measure	Setting/target group	Intervention	Study design	N (I = intervention arm) C = comparison arm)	Age	% Female	Length of follow-up
Matovu et al. 2005 <i>Unprotected sex:</i> condom use during all sexual encounters in the previous 6 months. <i>Number of partners:</i> in the 6 months before the baseline interview (one partner versus more than one partner)	Rakai, Uganda General population	Participants were interviewed and had a blood draw, followed by pre-test counseling. VCT provided in the home or another venue of the respondents choosing. Participants could request free VCT as individuals or couples, either at the time of the interview or during the inter-survey period. Participants who choose to learn their HIV status received post-test counseling and verbally told their HIV test result.	Prospective HIV-negative cohort who completed the 1999 baseline and the 2000 follow-up interviews. All participants received pre-test counseling and had their blood drawn. Analysis compared respondents who I = accepted VCT (received their VCT test result) versus C = did not accept VCT (did not receive their VCT test result). Census sampling.	Follow-up = 6088 I: Received HIV test result = 3158 C: Did not receive HIV test result = 2930	Range: 15–49	57%	12 months (1999 and 2000)

Results

Description of Studies and VCT Intervention Characteristics

Seven studies met the inclusion criteria, the characteristics of which are detailed in Table 1 Three studies took place in Africa, three in Asia and one had study sites in both Africa and the Caribbean. The majority of the studies ($n = 4$) assessed the impact of VCT on the behaviors of those who either sought the service at free-standing VCT centers, or were offered VCT through community-based approaches. The remaining studies examined the effectiveness of VCT when offered to women who attended antenatal care (ANC), pediatric, obstetric, or family planning (FP) clinics. The number of participants in the studies ranged from 120 to 6,088.

The rigor score for the studies ranged from 1 to 6 out of a possible 8 points, with 8 representing more rigorous methodologies (Table 2). The two studies with the strongest designs were a randomized controlled trial and a community-based cohort trial. Of the remaining five studies, three presented pre–post cohort data, one presented cross-sectional group comparison data, and one presented both pre–post and cross-sectional analyses that met the inclusion criteria. Only one study randomly assigned participants to the intervention, one randomly selected participants for assessment, and two had follow-up rates of 80% or more. The follow-up time period ranged from 2 weeks to 1 year. While all the study results were published between 1990 and 2005, the actual dates of study implementation occurred between 1988 and 2002.

Information on the counseling provided during these studies varied. Two studies provided group pre-test counseling, and four provided opportunities for couple counseling. One study also incorporated HIV positive peer counselors to augment the counseling provided by trained nurse counselors. The majority of studies had VCT counselors trained in social work, nursing or medicine. The waiting period between a participant’s blood being drawn and receiving post-test counseling, reported by only four studies, ranged from 30 min to 4 weeks.

The Impact of VCT on Behavior

Number of Sex Partners

Three studies, with a combined study population of 8,803, generated six discrete effect size estimates on number of sex partners (Table 3). Pooled, these data show that VCT had no effect on this outcome [random-effects pooled effect size OR 1.22 (95%CI 0.89–1.67); $P > 0.05$]. The Q-statistic

Table 2 Study quality assessment (rigor)

Study	Cohort	Control or comparison group	Pre/post intervention data	Random assignment of participants to the intervention	Random selection of participants for assessment	Follow-up rate of 80% or more	Comparison groups equivalent on sociodemographics	Comparison groups equivalent at baseline on outcome measure	Final score out of 8
Allen et al. 1992	1	0	1	0	0	0	0	0	2
Xu et al. 2002	1	0	1	0	0	1	0	0	3
Farquhar et al. 2004	1	0	1	0	0	0	0	0	2
Muller et al. 1995	0	1	0	0	0	0	1	0	2
Kawichai et al. 2004	0	1	0	0	0	0	0	0	1
(1) Number of partners	1	0	1	0	0	0	0	0	2
(2) Condom use									
Matovu et al. 2005	1	1	1	0	1	0	0	1	5
VCT Efficacy Group 2000	1	1	1	1	0	1	1	0	6

for heterogeneity of 26.50 is statistically significant ($P < 0.005$) indicating that the findings across studies were not consistent and that factors other than sampling errors may explain the variability among these effects.

When examining the six discrete random effect size estimates individually, only one study showed a statistically significant and positive effect. In a study in Thailand, Muller et al. found that reports of one or fewer sexual partners was more common among HIV-infected participants attending an HIV post-test clinic than among matched controls receiving VCT for the first time (males = 66% vs. 46%; OR 2.3 (95%CI 1.57–3.46); females = 92% vs. 68%; OR 2.3 (95%CI 1.51–18.37). This result was mainly driven by the number of participants reporting not having any sex partners. The other two studies, from Thailand and Uganda, found no relationship between VCT and number of sex partners.

Unprotected Sex

All seven studies presented data on unprotected sex and generated 13 discrete effect size estimates with a combined sample size of 12,348 (Table 4). The pooled effect size from these studies show that the odds of VCT recipients engaging in unprotected sex were significantly less when compared to their behaviors before the test or to participants who had not receive VCT [random-effects pooled effect size OR 1.69 (95%CI 1.25–2.31; $P < 0.01$)]. The statistically significant Q-statistic for heterogeneity of 176 ($P < 0.001$) indicates that, as with the outcome of number of sexual partners, the findings across studies were not consistent, and factors other than sampling errors may explain the variability among these effects.

Only 4 of the 13 effect size estimates showed positive impacts with the largest effects seen among HIV positive individuals or discordant couples (Allen et al. 1992; Muller et al. 1995). Data from Muller et al. show higher odds of consistent condom use during the last three sex acts among HIV positive participants who had undergone testing 23 months earlier compared to matched controls attending VCT for the first time (Males: 46% vs. 15%; OR 5 (95%CI 3.13–7.85); Females: 35% vs. 3.3%; OR 15.6 (95%CI 1.92–127.0). In Rwanda, Allen et al. also found that discordant couples increased condom use from 4% at baseline to 57% 1 year after VCT OR = 31.4 (95%CI 7.83–125.8). While both of these studies have statistically significant odds ratios, their confidence intervals are large, reflecting their small sample sizes. Two other studies with positive effects were conducted among women attending FP, ANC or post-partum clinics. Xu et al. found that consistent condom use with husbands of unknown HIV status, or until the husband tested negative, increased from 2% at baseline to 5% 1 year after VCT among women attending FP and post-partum clinics in Thailand (OR 2.46, 95%CI 1.27–4.7). In Kenya, Farquhar found an increase in condom use among sexually active pregnant women comparing pre-VCT to a 2-week follow-up (14% vs. 38%; OR 3.76; 95%CI 2.97–4.76).

The study with the strongest design, a randomized control trial, compared a VCT intervention arm to a health information comparison arm (VCT Efficacy Study Group 2000). For this study we averaged the frequency of unprotected sex that individuals had with their non-primary and primary partners; and couples had with their enrollment and non-enrollment partners. These averaged data show no effect of VCT on the amount of unprotected sex reported. The remaining two studies, a community based

Table 3 Meta-analysis: random effects model: number of partners

Study name	Subgroup	Outcome	Statistics for each study					Odds ratio and 95% CI	
			Odds ratio	Lower limit	Upper limit	Z-value	P-value	Enhanced Risk	Reduced Risk
Muller 1995 Males	Individuals	Number of partners	2.335	1.574	3.463	4.214	0.000		
Muller 1995 Females	Individuals	Number of partners	5.261	1.506	18.373	2.602	0.009		
Matovu 2005 Females	Individuals	Number of partners	0.950	0.843	1.072	-0.827	0.408		
Matovu 2005 Males	Individuals	Number of partners	0.991	0.862	1.139	-0.133	0.894		
Kawichai 2004 Males	Individuals	Number of partners	0.615	0.273	1.388	-1.170	0.242		
Kawichai 2004 Females	Individuals	Number of partners	1.009	0.063	16.172	0.007	0.995		
			1.224	0.894	1.674	1.261	0.207		

Table 4 Meta-analysis: random effects model: unprotected sex

Study name	Subgroup	Outcome	Statistics for each study					Odds ratio 95% CI	
			Odds ratio	Lower limit	Upper limit	Z-value	P-value	Enhanced Risk	Reduced Risk
Muller 1995 Males	Individuals	Condom use	4.958	3.130	7.854	6.823	0.000		
Muller 1995 Females	Individuals	Condom use	15.615	1.919	127.095	2.569	0.010		
Matovu 2005 Females	Individuals	Condom use	1.028	0.901	1.175	0.414	0.679		
Matovu 2005 Males	Individuals	Condom use	0.984	0.846	1.144	-0.211	0.833		
VCT Efficacy Females	Couples	Unprotected sex	1.091	0.812	1.466	0.578	0.563		
VCT Efficacy Males	Individuals	Unprotected sex	1.103	0.923	1.318	1.080	0.280		
VCT Efficacy Males	Couples	Unprotected sex	0.937	0.697	1.259	-0.434	0.664		
VCT Efficacy Males	Individuals	Unprotected sex	1.158	0.966	1.389	1.588	0.112		
Xu 2002	Individuals	Condom use	2.456	1.273	4.740	2.680	0.007		
Farquhar 2004	Individuals	Condom use	3.763	2.974	4.761	11.042	0.000		
Kawichai 2004 Males	Individuals	Condom use	1.878	0.439	8.031	0.850	0.395		
Kawichai 2004 Females	Individuals	Condom use	0.851	0.460	1.574	-0.514	0.607		
Allen 1992	Couples	Condom use	31.385	7.829	125.820	4.865	0.000		
			1.694	1.245	2.306	3.354	0.001		

trial in Uganda that examined consistent condom use during all sex acts in the previous 6 months, and a prospective cohort study in Thailand that examined condom use with casual sex partners in 6 months, also found non-significant differences in these outcomes over time (Kawichai et al. 2004; Matovu et al. 2005).

Discussion

This article presents the first meta-analysis that focuses solely on VCT efficacy data from developing countries. Overall, the pooled data from the seven studies we identified showed a moderate effect of VCT on unprotected sex, and inconclusive evidence, based on only three studies, regarding the effect of VCT on recipients' number of sex partners. Similar to past meta-analyses and syntheses (Higgins et al. 1991; Weinhardt et al. 1999; Wolitski et al. 1997), the significant effect on unprotected sex is found primarily in studies conducted among HIV-infected persons or discordant couples.

Limitations to the meta-analysis and the included studies should be considered when interpreting these findings. The average rigor score of the included studies was three out of eight points, highlighting the lack of rigorous behavioral research being conducted in regions hardest hit by the HIV epidemic. The length of follow-up also varied among the studies and none reported outcome measures beyond 1 year after baseline. Thus, the extant data does not provide information on the long-term impact of VCT. The majority of studies also took place before the availability of rapid tests and increased access to ART, factors that may influence outcomes related to the service. Finally, all seven studies focused on adults, mainly in urban locations. Data on VCT among other groups, such as adolescents and drug-using populations, as well as in more diverse settings, including peri-urban and rural areas, are needed.

Another issue that influences interpretation is the measurement of outcome variables. The definitions of unprotected sex and condom use varied across studies. Two studies also stratified condom use and unprotected sex by type of partner. In order to fully utilize the data we averaged the results across the different sub-groups within these two studies. While averaging provides a succinct composite measure it also alters the interpretation of the results. For example, the authors of the VCT Efficacy Trial stated that the proportional reduction in unprotected sex with non-primary partners was greater among men and women randomly assigned to VCT compared to those assigned to a health information arm (men, 35% vs. 13%; women, 39% vs. 17% [VCT versus health information]) (VCT Efficacy Study Group 2000). When the unprotected sex data were averaged for the meta-analysis, combining information on

primary and non-primary partners, the VCT effect disappears. This issue illustrates how the power of meta-analysis to combine data may also hide important differences in effects among sub-groups.

Implementation of VCT across the studies also varied greatly. For example recruitment strategies included researcher-, provider- and client-initiated methods in clinic, community and home settings; the counseling provided included couple, individual and group approaches. Such differences may affect study outcomes as found in the Weinhardt meta-analysis in which more behavior change occurred among participants who actively sought HIV counseling and testing compared to those who were approached by researchers (Weinhardt et al. 1999). The discussion around volitional testing and behavioral effects has emerged more strongly as programs adopt a provider-initiated approach to HIV testing and counseling to reach the estimated 80% of people living with HIV who are unaware of their status (WHO and UNAIDS 2007). Provider initiated testing and counseling is a new and rapidly expanding approach and its impact on sexual risk behaviors has not yet been evaluated. Several of the studies included in this meta-analysis, however, used research-initiated approaches in clinics and one study recruited participants' in their homes. The limited number of studies that met the inclusion criteria did not allow us to conduct more detailed moderator analyses to explore these differences. A better understanding of how such variations in the implementation of VCT impacts behavioral outcomes warrant further consideration, especially as new models of HIV testing and counseling evolve and expand.

Despite these variations in research designs, outcome measurements, and service delivery components, the pooled data provide objective evidence that VCT has a moderate and significant effect on increasing protected sex. As well, it is reassuring that none of the included studies found a significant increase in risk taking behaviors among VCT participants. These data contribute valuable information regarding the effects and potential harms attributable to VCT. While this meta-analysis did not examine social harms as an outcome, studies have found that violence, abandonment and other negative consequences related to VCT, occur infrequently and the majority of VCT clients report positive life events associated with learning and disclosing their HIV status (Grinstead et al. 2001; Maman 2003). To minimize the potential for social harms, WHO recommends that testing and counseling involve informed consent, confidentiality, post-test counseling and appropriate referrals (WHO and UNAIDS 2007). WHO has also published recommendations on how to address violence against women in the context of expanding HIV testing and counseling programs (WHO 2006).

In conclusion, while this meta-analysis provides only moderate evidence in support of VCT as an effective HIV prevention strategy, neither does the evidence negate the need to expand access to the service. As different HIV testing and counseling service delivery models evolve, efforts to rigorously evaluate outcomes among diverse populations are needed to test, refine and maximize the preventive benefits of learning one's HIV status. Such evaluations should be theoretically driven to assess the intervention components that have the strongest influence on behaviors. A set of standardized measures of unprotected sex and other behavioral outcomes, based on two-decades of research, should also be agreed upon to help facilitate comparisons across studies and to utilize resources efficiently. We believe that having access to HIV testing and counseling services to enable people to learn their HIV infection status is a human right. Evaluation and critical examination of such services, however, are needed in order to strengthen the impact that VCT and other HIV testing and counseling models have on changing sexual risk behaviors.

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