PREVENTION OF SEXUALLY TRANSMITTED HIV INFECTION: A META-ANALYTIC REVIEW OF THE BEHAVIORAL OUTCOME LITERATURE[1,2]

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ABSTRACT

Social learning theory-based models have recently provided the foundation for a series of twelve controlled human immunodeficiency virus (HIV) risk reduction intervention studies that have examined sexual behavior change. These interventions have been tested with adolescents, gay and bisexual men, inner-city women, college students, and seriously mentally ill adults. We report the first meta-analysis of these intervention studies. We found that, as expected, the mean weighted effect of HIV-risk reduction interventions on behavioral outcomes was positive and strongly significant ($d_+ = 0.25$). Moreover, the studies' effect sizes were consistently positive, ranging from 0.11 to 0.53, and were largest when the outcomes were measured close in time to the intervention. We discuss other methodological challenges that, if solved, should enhance the success of future HIV-risk reduction interventions.

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INTRODUCTION

Human immunodeficiency virus (HIV), the cause of acquired immunodeficiency syndrome (AIDS), is transmitted from person-to-person through direct contact with HIV-infected blood, semen, or vaginal fluids, chiefly through sexual and injection drug using behaviors. Thus, the AIDS epidemic is driven principally by intimate and private interpersonal interactions. The North American AIDS epidemic has occurred primarily among gay and bisexual men (53% of cases), injection drug users (25%), and heterosexuals with high-risk partners (7%). Recent data indicate that infection rates are rising fastest among heterosexual women (1). Preventing the spread of HIV infection demands the cessation of behaviors that permit efficient transmission of HIV in populations with high rates of infection.

To date, attempts to control the spread of HIV infection include educational programs, HIV counseling and testing programs, medical interventions, and public health policies. Educational programs, including information dissemination campaigns, are known to raise individual awareness and knowledge about the epidemiology, transmission, and prevention of HIV. Unfortunately, knowledge alone has not been sufficient to reduce HIV risk behaviors (2). Studies show that HIV counseling and testing helps people who are HIV-infected to receive medical care but does little to change high-risk behaviors, particularly among people who test negative (3,4). Medical interventions have focused on developing HIV-preventive vaccines. Although vaccine programs have made relatively great strides in a short period of time, a prophylactic vaccine against HIV is not likely to be available for some time (5).

Public health policy interventions have been among the most difficult to establish because HIV transmission occurs within private and intimate relationships. One exception has been needle exchange programs, which provide clean injection equipment to drug users and have been shown to prevent the spread of HIV (6,7). A second policy intervention that has averted countless HIV infections is mandatory screening of the nation's blood supply. However, it is difficult to conceive of public policies that could thwart sexually transmitted HIV infections without seriously breaching individual civil liberties. Educational, counseling and testing, medical, and policy interventions have played important roles in the HIV epidemic but have had little impact on sexual behaviors relevant to HIV transmission. However, a fifth category of interventions differs from those discussed thus far. Theory-based behavior change interventions have been heralded as having successfully reduced HIV risk behaviors (8,9).

An inspection of the HIV-risk reduction (HIV-RR) research literature reveals that many programs have established curricula and activities to guide individuals toward behavior change, but most have not been explicitly based on theoretical principles (9–13). However, there are now twelve published HIV-RR interventions that have been evaluated in controlled studies while measuring sexual behavior change (14–25). In this article, we introduce the theoretical underpinnings of these inventions, evaluate the success of these HIV prevention interventions in the first meta-analysis of these studies, and provide recommendations for future HIV-RR studies based on our results. As our meta-analysis reveals, there is cause for guarded optimism about the prospects of reducing risk for HIV infection via these theory-based interventions.

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THEORY-BASED HIV-RISK REDUCTION INTERVENTIONS

For the most part, theory-based HIV-RR studies have been grounded in principles derived from social learning theory or related models. Social learning theory emphasizes observation, modeling, behavioral rehearsal, outcome expectancies, self-efficacy beliefs, and social reinforcement for instituting behavior changes (26–28). Specifically, social learning theory posits that modeling and behavioral rehearsal result in increased positive outcome expectancies, increased self-efficacy, and increased probability of receiving reinforcement for initial behavioral changes. Health-related behavioral programs based on social learning theory generally target four interactive determinants of behavior (31). First, behavior change requires accurate information to increase awareness and knowledge of risks associated with specific risk-producing practices. Second, people must possess social and self-management skills to allow for effective action implementation. Third, preventive behavior changes require enhancement of skills and the development of self-efficacy, usually accomplished through guided practice and corrective feedback of skills performance. Finally, behavior change entails creating social supports and reinforcements for behavior changes.

Published models of HIV-RR have typically integrated social learning principles as necessary components for risk behavior change. For example, the AIDS Risk Reduction Model (29) specifies information and behavioral skills necessary for risk behavior reduction. Fisher and Fisher's (11) Information–Motivation–Behavioral Skills model consists of accurate information about HIV transmission and prevention, motivation to change risk-related behaviors, and behavioral skills for performing specific HIV-preventive actions. Other models also evoke social, cognitive, and behavioral determinants in order to predict HIV risk behaviors and guide prevention intervention development (30,31). Thus, HIV-RR interventions integrate information, attitudinal change to enhance motivation, development and reinforcement of risk reduction behavioral skills, and self-efficacy to implement behavioral changes. Interventions have also been derived from other theoretical models, such as the Conservation of Resources approach (32) combined with skills training.

Because twelve studies (14–25) have examined the efficacy of theory-based interventions for HIV-RR and because the findings of these studies range across a wide array of outcome measures and methods (see Table 1), it is valuable to know the size, significance, and consistency of the intervention effects. Therefore, we provide a meta-analytic review of these studies, coding their important methodological features as well as their effect sizes. Overall, we expected that these studies would yield a significant risk reduction effect. However, we also investigated whether the risk reduction effect generalizes across varying intervention dosages, attrition rates, and the interval at which risk reduction was assessed. We expected that risk reduction would improve with greater intervention dosage and decay as time passes between the end of the intervention and the assessment. We had no predictions regarding the influence of attrition on effect size.

META-ANALYSIS OF INTERVENTION OUTCOMES

Design of the Meta-Analysis

Sample of Studies: We obtained the studies for the meta-analysis by searching the literature via computerized data bases and hand searches of relevant journals. We restricted our review to studies that: (a) employed an HIV-RR intervention based on psychological theories of behavior change; (b) used group-based or face-to-face models of intervention delivery; (c) included a comparison group; (d) examined a behavioral HIV-RR outcome; and (e) provided summary data or inferential statistics sufficient to calculate the relevant effect size. Studies that presented open treatment trials (e.g. 33,34) or community level interventions (e.g. 35) were excluded from the review.

Methodological Features Coded: For the purpose of describing studies, we coded the following methodological dimensions: (a) population sampled (gay and bisexual men, women, adolescents, college students, adults with serious mental illness); (b) geographical site; (c) gender composition of sample; (d) mean age (in years) of participants in sample; (e) race of participants (African–American, Caribbean, Hispanic, White, Other); (f) study design (randomized versus non-randomized field trial); (g) dosage or amount of intervention; (h) number and sex of session leaders; (i) components of intervention (see Table 1 for details); (j) type of control group (waiting list, non-HIV-related health education, career opportunities, counseling, didactic AIDS education, educational games); (k) amount of control group information, where relevant; (l) outcome measures assessed (see Table 1 for a listing); (m) attrition for intervention and follow-up assessments, where reported; and (n) intervals, in months, for follow-up assessments.

Effect Size Calculations and Analyses: The effect size we calculated was g, defined as the difference between the means of the intervention and control groups on the behavioral outcome measure, divided by the pooled standard deviation (37,38). We calculated these effect sizes based on means and standard deviations if available, or with F- or t-statistics (and associated error terms, where necessary). When an intervention reduced risk, we gave the effect size a positive sign. Thus, for example, if an intervention improved condom use, its effect size carried a positive sign. When only repeated measures data were available (18), or when a non-randomized control group was employed (20), we calculated the difference between the preintervention and postintervention means for the treatment group.

So that analyses of the intervention outcomes would not violate the meta-analytic assumption of non-independence (36,37), it was necessary that only one effect size for each intervention study be calculated. Therefore, when studies reported outcomes at more than one interval, the data from the first (earliest) reported period were employed, an operation that made the studies' results more comparable. Similarly, if a study reported results for more than one behavior, an effect size was computed for each dimension and the effect sizes were then averaged to form a composite effect size estimate. To reduce computational error, two of the authors calculated effect sizes independently and met to resolve discrepancies.

The gs were converted to ds by correcting them for bias [i.e. g's overestimate of the population effect size, which occurs especially for small samples (36,37)]. To obtain an overall estimate of the effects reported in the original studies, we combined the study outcomes by averaging the ds using a procedure that gives greater weight to effect sizes that are more reliably estimated (i.e. are based on larger sample sizes). To determine whether the effect sizes were consistent across the studies, we calculated a homogeneity statistic, Q, which has an approximate χ^2 distribution with $k - 1$ degrees of freedom, where k is the number of effect sizes (38). Moderator analyses of effect size

TABLE 1

Summary of HIV-Risk Reduction Intervention Studies' HIV Methodologies and Effect Sizes

Authors/Site	Sample	Study Design	Intervention	Control Group	Outcome Measure(s)	Effect Size (d)	Attrition	Follow-up
Gay and Bisexual Men								
Kelly et al. (14) Community based for gay/bisexual men; Jackson, MS	N = 104 men Age: 31 Race: 87% W	Randomized field trial	Twelve 75–90 min (16.5 hr) sessions led by 1 male or 1 female Components: AIDS risk education, behavior self-management, assertion training, relationship skills	Waiting list	Number of casual sex partners; unprotected anal intercourse; condom-protected anal intercourse; oral/anal activity; digital/anal activity; oral/genital intercourse; condom use (%)	0.39	20% total	Immediate post; 8 months from baseline
Valdiserri et al. (15) Community based for gay/bisexual men; Pittsburgh, PA	N = 584 men Age: 33 Race: 95% W	Group randomized field trial	One 140-min (2.3 hr) session with 2 leaders Components: education, role playing, psychodrama, group process	One 60–90 min session with 1 leader Components: education	Sex partners for mutual masturbation, insertive anal or oral intercourse, receptive anal or oral intercourse, and protected insertive or receptive anal intercourse	0.11	23% at FU 1 50% at FU 2	6 and 12 months from session
Women								
Hobfoll et al. (16) Prenatal care clinic; Akron, OH	N = 206 pregnant women Age: 21 Race: 57% AA, 40% W	Randomized field trial	Four 90–120 min (7.0 hr) sessions led by 1 of 2 females Components: assertiveness, negotiating skills, planning skills, socialized skills, aversive conditioning, role playing, cognitive rehearsal	Two controls: (a) 4-session health–behavior skills group led by 1 of 2 same females; (b) no intervention	Discuss HIV with sex partners; number of sex partners; protected vaginal intercourse; condom acquisitions; spermicide acquisitions	0.38†	15% total	Immediate post; 6 months from last session
Kelly et al. (17) Women's health clinics; Milwaukee, WI	N = 197 women Age: 29 Race: 87% AA, 6% W, 3% H, 4% Native American	Randomized field trial	Four 90-min sessions (6.0 hr) with 2 leaders Components: education, risk sensitization, role play, communication skills, condom use, problem solving	Three 90-min sessions Components: general health and nutrition	Number of sex partners; unprotected vaginal intercourse; condom-protected vaginal intercourse; number using condoms at any time; male partners with whom condoms were used	0.26	46% intervention; 56% control	3 months from last session
Adolescents								
Jemmott et al. (19) Health care clinic; Philadelphia, PA	N = 157 males Age: 14 Race: 100% AA	Randomized field trial, stratified by age prior to randomization	One 5-hour session (5.0 hr) led by 1 male or female AA adult Components: information, educational games, role playing, condom use	Five-hour career opportunities control group	Abstinence; number of days with coitus; number of partners; number of high-risk partners; frequency of condom use; number of days unprotected coitus; heterosexual anal sex; number of days of heterosexual anal sex; number of female anal sex partners	0.43†[a]	4% at FU	3 months from last session

TABLE 1
Continued

Authors/Site	Sample	Study Design	Intervention	Control Group	Outcome Measure(s)	Effect Size (d)	Attrition	Follow-up
Rotheram-Borus et al. (20) Runaway adolescents; New York City, NY	N = 52 male, 93 female Age: 15 Race: 63% AA, 22% H	Non-randomized; intervention and non-intervention youth shelters	Up to twenty 90- to 120-min (20.0 hr)[a] sessions over 3 wks led by 1 male and 1 female Components: general knowledge, coping skills, health care and resources, safer sex barriers	Non-intervention shelter provided counseling but no HIV intervention	Abstinence; consistent condom use; high-risk pattern; number of sex partners; number of sexual encounters	0.32†	26% lost at FUs	3 and 6 months from baseline
St. Lawrence et al. (22) Health care clinic; Jackson, MS	N = 69 female, 177 male Age: 15 Race: 100% AA	Randomized field trial	Eight 90- to 120-min weekly sessions (14.0 hr) with 2 leaders Components: AIDS education, sexual decisions and values, condom use skills, social skills, cognitive skills, social support, personal empowerment	One 120-min didactic AIDS education session	Number of different sexual partners; unprotected vaginal intercourse; condom-protected vaginal intercourse; unprotected oral or anal intercourse; condom-protected anal or vaginal intercourse	0.32†	8.5% lost at FUs	Immediate post; 6 and 12 months from last session
St. Lawrence et al. (21) Substance abuse treatment center; Jackson, MS	N = 25 male, 9 female Age: 15 Race: 84% W, 16% AA	Randomized field trial	Six 90-min sessions (9.0 hr) with 3 leaders matched to sex of participants Components: HIV education, condom use, abstinence, assertion, partner information, educational negotiation, communication games skills	Six 90-min sessions with the same 3 leaders Components: didactic information, educational games	Coercions into unwanted sexual activity; exchanging sex for money or drugs; engaging in casual sex; engaging in sex with a high-risk partner; number of STDs treated	0.53†	No attrition	Immediate post
Schinke et al. (23) Job training program; New York, NY	N = 34 female, 26 male Age: 16 Race: 37% AA, 27% H, 15% Caribbean	Randomized field trial	Three 60-min sessions (3.0 hr) Components: self-instruction risk reduction guide, cognitive problem solving group	Two controls: (a) received self-instruction guide without problem solving; (b) brief information only	Talk with friends about sex	0.31	NR	1 month from baseline
Walter and Vaughan (25) High school setting; New York, NY	N = 498 male, 703 female Age: 15.7 Race: 36.7% AA, 35.4% H, 27.9% Other	Non-randomized: 2 intervention and 2 non-intervention schools matched for demographics	Six 1-hr class period lessons (6.0 hr) led by teachers Components: HIV education, role play rehearsals for negotiation skills	Non-intervention schools provided regular education but no HIV intervention	Number of sexual partners; consistency of condom use; engaging in sex with a high-risk partner; number of STDs diagnosed	0.19†	—	3 months from intervention

TABLE 1
Continued

Authors/Site	Sample	Study Design	Intervention	Control Group	Outcome Measure(s)	Effect Size (d)	Attrition	Follow-up
College Students								
Sikemma et al. (24) College campus setting; Blacksburg, VA	N = 43 female Age: 20.14 Race: 95.35% W, 4.65% AA	Randomized field trial	Four 75- to 90-min (5.5 hr) sessions over 4 weeks led by 1 female Components: risk behavior education, behavioral self-management, assertiveness training, decision making, safer-sex negotiation, condom use, and maintenance of risk-reduction behavior	One 90-min session using a didactic educational approach to risk-related behaviors	Condom-protected vaginal intercourse; oral/genital sex without condom; sexual intercourse without birth control	0.25	14% lost at FU	1 month from intervention
Adults with Serious Mental Illnesses								
Kalichman et al. (18) Psychiatric clinics; Milwaukee, WI	N = 27 men, 25 women Age: 39 Race: 73% W, 19% AA	Randomized field trial	Four 90-min sessions (6.0 hr) with 2 leaders matched to participant sex Components: education, risk sensitization, role play communication skills training, condom use, problem solving	Waiting list	Discuss HIV with sex partners, unprotected intercourse; condom-protected intercourse; condom-protected intercourse occasions	0.49	15% total from last session	1 and 2 months

Note: Effect sizes are positive when the intervention reduced behavioral risk of HIV infection relative to the control group (or baseline). AA = African–American. FU = Follow-Up. H = Hispanic. NA = Not available. NR = Not reported. STD = Sexually transmitted disease. W = White.
† 95% Confidence interval does not include zero, indicating that effect of intervention is significant ($p < .05$).
[a] Estimate collapses across levels of intervention received (see 19, p. 1239).

magnitude followed Hedges and Olkin's (36) procedures and yielded a test of the significance of each moderator. These models are weighted least squares regressions, with weights equal to the reciprocal of the variance of each effect size. Therefore, moderator analyses also give greater weight to effect sizes that are more reliably estimated.

Results of the Meta-Analysis

Summary of HIV-RR Studies' Methodological Features: Prior to evaluating the success of HIV-RR intervention studies, it is important to consider the methodological features that produced these studies' outcomes. A consideration of the methods, which appear in Table 1, provides a context from which to interpret the results of the studies.

Study Participant Features: Theory-based HIV-RR interventions usually have targeted adolescents but have also examined homosexually-active men, inner-city women, runaway youth, college students, and chronic mentally ill adults. The studies usually sampled males and females in roughly equal proportions (51% versus 49%, respectively); considered populations whose mean ages ranged from 14 to 39; and used samples that were 41% African–American, 25% White, 16% Hispanic, and 18% other.

Intervention Features: Ten of the twelve studies employed randomized field trial designs, sometimes stratifying for age prior to randomization; in the other two instances, studies employed non-randomized designs. As the "Intervention" column in Table 1 shows, HIV-RR interventions shared a core of central components that included such features as risk education, risk sensitization, self-efficacy building, and skills training. The interventions have varied widely regarding the amount of information delivered, ranging from 2.3 to 20.0 hours. However, most HIV-RR interventions delivered between four and eight one- to two-hour sessions; the mean was 8.36 total hours. The intervention sessions were usually led by two or more adults.

Outcome Measures: To evaluate the effectiveness of the studies' interventions, ten of the twelve studies assessed: (a) number of sexual partners; (b) number of protected and unprotected occasions of oral, anal, and vaginal intercourse; (c) percentage of time that condoms are used; and/or (d) engaging in sex with a high-risk partner. In individual instances, studies assessed: (a) recently diagnosed sexually transmitted diseases (STDs), (b) coercions into unwanted sexual activity, (c) exchanging sex for money or drugs, or (d) discussions with friends about sex. Six of the studies assessed outcomes once, five of the studies assessed outcomes at two time intervals, and one study included

three assessments. The studies' initial assessments usually were taken within one month of the interventions but one was taken six months after the intervention. Finally, attrition varied from none to 56%; overall, only about 15% of participants were lost to attrition (this estimate assumes that there was no attrition for the two studies that did not report it).

Empirical Success of HIV-RR Interventions: Table 1 also shows the risk reduction effect sizes of the twelve studies. Note that, despite the methodological variations in this literature, all of the effect sizes are positive, ranging from a low of d = 0.11 to a high of d = 0.53. Thus, ignoring considerations of statistical significance, the direction of effect in all twelve studies favors the HIV-RR interventions. Our calculation of 95% confidence intervals for each individual d showed that six of the studies achieved statistically significant reductions of risk behaviors. Importantly, when the effect sizes are averaged together, the mean weighted effect size is highly significant (d_+ = 0.25, 95% CI = 0.18 to 0.33), indicating that the interventions had a significant positive effect on risk behaviors relative to the comparison. This calculation is based on 2,583 study participants, an average of 215 per study. Interestingly, the mean unweighted effect size was 0.33, a somewhat larger value, implying that studies based on larger samples obtained smaller effect sizes. However, the homogeneity statistic for the twelve effect sizes indicates that the studies share a common effect size, Q(11) = 7.78, p > .50. This high degree of homogeneity implies that it is statistically improbable for moderator analyses to reach significance. In other words, the success of HIV-RR interventions is relatively constant across the methodological variations in the literature. Yet one should note that the homogeneity statistic is based only on twelve studies and, therefore, has relatively low power to reject the null hypothesis of no differences among studies.

Because it was still possible to obtain significant moderators (38), we proceeded to examine whether effect size magnitude was related to: (a) intervention dose, (b) attrition rate, or (c) the timing of the first postintervention assessment. Dose (expressed in hours) and attrition were unrelated to intervention success, B = .51 and −.04, ps > .15. However, assessment interval was significantly related to intervention success, B = −.79, p < .05. As Figure 1 shows, as the interval between the intervention and the assessment increased, intervention success tended to decrease.

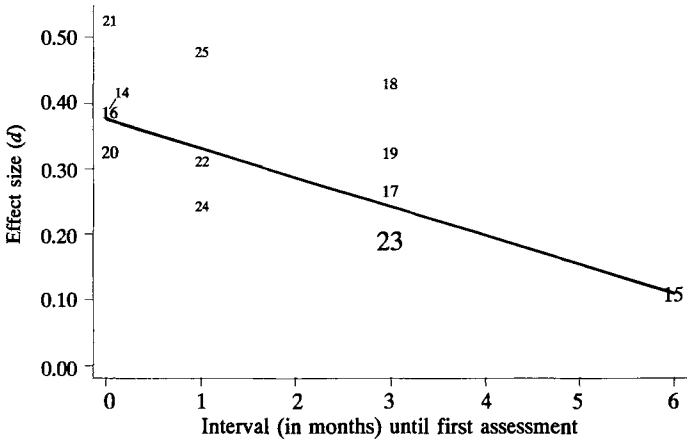

FIGURE 1: HIV-intervention effect sizes as a function of first assessment interval (in months). (*Note:* Plotted numbers refer to reference numbers; the size of each reference number is proportional to its weight in the analysis.)

DISCUSSION

Our meta-analytic review of the HIV-RR literature showed that the methods employed to study risk reduction were diverse, ranging across many populations, ages, settings, intervention doses, various outcome measures, attrition rates, and intervals of assessment. The effect sizes for the interventions ranged from small, d = 0.11, to moderate, d = 0.53, in size. These effects are greater than or equal to behavior change interventions targeting smoking (39), weight loss (40), and alcohol use (41), as well as medical interventions such as AZT for neonates (42) and adults (43), chemotherapy for cancer (44), and a cholesterol-lowering regimen for coronary status (45). The HIV-RR intervention studies consistently reported findings that favored the interventions over control groups on sexual behavioral outcomes, particularly when these outcomes were assessed close in time to the intervention. We discuss this pattern below (see **Behavior Change Follow-Up**).

In interpreting the overall effect size that was obtained for the literature of HIV-RR studies, it is necessary to keep the assumptions of meta-analysis in mind. First, it is important to note that the calculation of effect sizes examined the influence of the intervention relative to a control group. It is false to assume that the control groups showed absolutely no improvement over the period of time examined in the respective studies; indeed, some of the studies documented that the control groups showed reductions in risk behaviors (e.g. 16), although to a lesser degree than the interventions. Such results may reflect increased sensitization to risk as a function of completing lengthy sexual risk and behavioral assessments. The overall impact of such treatment versus control comparisons would be to underestimate actual effect sizes. Second, note that the meta-analysis collapsed across the diverse behavioral assessments present in most studies. It is possible that some measures might have larger effects than others, a possibility that we consider below (see **Outcome Measures**). Finally, it is also possible that the observed effect sizes were attenuated, overall, by methodological limitations in the intervention studies; however, due to the relatively small number of studies that have been completed thus far, our meta-analytic moderator analyses could not detect these patterns. Therefore, for the purposes of advising future theory-based HIV-RR studies, we review and suggest improvements regarding four key methodological aspects: (a) dose of intervention; (b) outcome measures; (c) behavior change follow-up; and (d) attrition.

Intervention Dose

As we documented in our meta-analytic review, although HIV-RR interventions have shared a core of central components (viz. risk education, risk sensitization, self-efficacy building, and skills training; cf. Table 1), these interventions have varied widely regarding the amount of intervention delivered. For example, Rotheram-Borus et al. (20) designed an HIV-RR intervention that consisted of up to twenty, 90- to 120-minute sessions delivered over a three-week period. In order to meet the difficult constraints of enrolling and retaining runaway adolescents in a prevention study, the sessions were rotated such that partici-

pants could join the intervention at any point in its delivery. Participants who did not complete the intervention received different components depending on when they entered the study. Dose effects were examined by comparing participants who completed different numbers of sessions. At the other end of the dose continuum, Valdiserri et al. (15) employed a single-session, 140-minute group intervention. Although AIDS education and risk reduction instructions were delivered in a cognitive–behavioral skills training paradigm, the single-session format abbreviated the amount of practice and in vivo experiences included in the intervention.

There are two simultaneous and competing demands regarding the amount of intervention provided in HIV-RR programs. On the one hand, longer interventions provide greater exposure time and more opportunities to practice new skills; on the other hand, single-session interventions are more feasible for use in public health settings. The majority of HIV-RR interventions have delivered between four (16–18) and eight (21,22) one- to two-hour sessions. Multiple sessions allow one to space intervention components, use homework assignments, self-monitor target behaviors, and provide guided practice. Multiple sessions also afford more opportunities for social supports and social reinforcements for behavior change efforts than do single-session interventions (30,31).

Despite the apparent importance of dose, our meta-analysis failed to show that this moderator was related to effect sizes, possibly due to a lack of statistical power to detect an effect. That is, our moderater relation of B = .51 would reach significance if more studies were available and the slope remained constant once the studies were included. Alternatively, the effects of dose could be examined within a single original study, which would involve carefully controlling intervention components across numbers of sessions so as to not confound components with contact time.

Outcome Measures

To evaluate the effectiveness of an intervention, investigators have assessed one or more of the following behavioral outcome variables: (a) number of sexual partners; (b) number of protected and unprotected occasions of oral, anal, and vaginal intercourse; (c) percentage of time that condoms are used; and, less often, (d) recently diagnosed STDs (cf. Table 1). To our knowledge, no one has yet assessed HIV-antibody status as an index of change, primarily because of inadequate statistical power due to low base rates of infection; that is, even in areas of high HIV seroprevalence, seroconversion rates rarely exceed 2–3% of population, requiring extremely large samples to obtain adequate statistical power for detecting differences. Therefore, researchers assume that an intervention is effective when it can be demonstrated that participants reduced the number of partners; the number of occasions of unprotected oral, anal, or vaginal intercourse; and incidence of STDs; and/or increased the number of occasions of protected sexual intercourse as well as the percentage of occasions that condoms were used. Because no single index of risk reduction contains all relevant information, most studies collect multiple measures. Most authors report each of the indices separately (20), although a few investigators have created composite indices reflective of overall risk reduction (14).

Two important concerns have been raised regarding the measurement of intervention outcomes. First, some authors (46,47) have argued that self-reports of sexual behavior, especially socially proscribed behavior such as anal sex, are unreliable due to social desirability, demand, and other biases. Other investigators have demonstrated that such assessments are indeed difficult to conduct but can yield reliable information (48,49). Research documenting the conditions that influence the reliability of self-report has been reviewed elsewhere (50).

Second, and of greater concern, is the observation that the same behavior may be safe for one person but risky for the next; for example, unprotected vaginal intercourse is safe in a monogamous relationship with an uninfected partner but unsafe with anonymous or casual partners whose HIV-antibody status is unknown. Thus, unlike risk assessment associated with smoking or dietary behavior where a person who is smoking or eating high-fat foods is assumed to be at greater risk for pulmonary or vascular disease, risk assessment for HIV infection is inherently idiosyncratic. A participant in an HIV-risk reduction program who engages in unprotected intercourse only after knowing their partner has tested HIV negative is at less risk than is the participant who uses condoms with a partner of unknown (i.e. possibly infected) HIV-antibody status; however, the former would be seen as a treatment failure whereas the latter would be counted as a success. Despite nearly universal recognition of this problem, investigators assume that unprotected sexual activities confer greater risk than do protected ones, due to difficulties in obtaining reliable antibody status for partners.

Use of non-reactive measures, such as a reduced incidence of diagnosed STDs following an intervention (22,25), can provide a useful supplement to self-report measures, but may be less sensitive to intervention effects due to relatively low base rates of STDs. Other creative evaluation strategies, such as monitoring condom acquisition, also provide an indirect and corroborative index of treatment effectiveness. For example, HIV-RR intervention studies have used opportunities to redeem coupons or vouchers for condoms as proxy measures of condom use (16). In addition, use of theoretical mediators of behavior change, such as knowledge or attitudes, can provide additional evidence of successful outcomes and are commonly employed in HIV-RR research. As researchers discover the dimensions that mediate behavioral change, there will be the potential to streamline interventions so that maximum impact is gained with minimal response burden to the intervention recipients.

Despite the fact that almost all studies assessed many dimensions of HIV risk behavior, our meta-analysis collapsed across the sometimes numerous dependent variables available in each study. Although it may be that some dimensions might have larger effects than others, our meta-analysis was not designed to assess this possibility. We collapsed across outcomes so that we would not violate the meta-analytic assumption of independence of effect sizes (i.e. so that the studies' subjects would appear only once in analyses). Future meta-analytic work might separate outcomes for each behavioral measure to determine whether some behaviors are easier to change than others.

Attrition

A third methodological factor that may disparately affect an effect size, significance of an effect size, or the validity of a finding is dropout during the intervention or follow-up. Our analysis detected no tendency for attrition to relate to effect size, B = −.04, ns, which suggests that effect size is relatively constant across variations in attrition. However, as the number of study participants drops, so does the statistical power to

detect the presence of an intervention effect. Moreover, if attrition occurs at a greater rate in either the intervention or the control group due to a risk-related factor, this confound provides a reason to question the validity of the observed differences. Therefore, as in all clinical trials, it is highly important for studies to keep attrition as low as possible.

As we documented in our meta-analytic review (see Table 1), studies with the least attrition are those that have the shortest-term follow-up. For example, St. Lawrence et al. (21) reported no attrition immediately following the intervention, Kalichman et al. (18) lost 15% of participants one month after the intervention, and Valdiserri et al. (15) reported 50% attrition at twelve months follow-up. There are exceptions to this rule; for example, St. Lawrence et al. (22) reported only 8.5% attrition at twelve months follow-up.

Studies vary with respect to how attrition is handled in outcome analyses. It is most common for intervention outcomes to be based on those participants who completed all aspects of the study. In most cases, dropouts and incompleters are compared to participants who completed the intervention on relevant measures collected at baseline (14,16,32). Methods for analyzing data from all enrolled participants usually fall under the rubric of intent-to-treat and data imputation models. These methods involve replacing missing values with estimates derived from existing values in the data set (51,52). There are a number of methods for analytically dealing with attrition and all are controversial. For example, Kelly et al. (17) used a multiple imputation procedure to replace missing assessments with data from retained participants matched on key demographic characteristics, including age, education, and sexually transmitted disease history. This method increased the within-subject variability and therefore increased the error term in the analyses, yielding a conservative test of intervention effects. Imputing data can also involve using regression models to estimate values or other means of modeling lost data (51). These procedures, however, pose problems as well, including difficulty interpreting findings from values that were not observed outcomes.

Based on need and the epidemic itself, HIV-RR interventions target difficult-to-reach (and retain) populations. Loss of intervention participants occurs when people move, lose access to a telephone, become displaced, or even when they gain employment. Therefore, interventions must provide incentives for both participation and retention. Monetary incentives in HIV-RR prevention interventions have been shown to reduce attrition relative to non-monetary incentives, at least among inner-city adults (53). Paying participants is relatively unique to funded research studies, however, and may reduce the external validity of intervention implementation in community-based service settings. More ecologically valid incentives may be attached to access other services, such as employment placement programs, training opportunities, and child care.

Behavior Change Follow-Up

Almost all HIV-RR interventions have reported behavioral changes immediately following the intervention, which is why our effect size calculations employed these measures (rather than delayed measures, if available). However, as the significant moderator analysis indicated (see Figure 1), relapse to baseline following behavioral interventions is common in the HIV-RR literature. That is, the effects of the HIV-RR interventions diminished substantially at longer intervals. It is important to note that this pattern also occurs in other intervention literatures, including weight reduction, substance use, and smoking cessation (40,54–56). Therefore, it is important to measure and report behavior change at follow-up assessments. Although most studies do not report assessments that are delayed long enough to assess maintenance of intervention effects, some have done so; for example, Kelly, St. Lawrence, and Brasfield (57) collected 16-month follow-up assessments from 68 gay and bisexual men who had completed their HIV prevention intervention (14). They found that 41 (60%) of the men maintained safer sexual practices. Measures taken 16 months earlier, intervention baseline assessments, showed that baseline risk behavior, younger age, and substance use proximal to sexual behavior best predicted high-risk practices at the follow-up.

CONCLUSIONS

The behavioral interventions reviewed and quantitatively synthesized here have shown substantial promise for altering sexual behaviors associated with HIV transmission. The effect sizes observed were small to moderate in size, but should be considered conservative estimates of intervention effects for several reasons, including moderate intervention doses and challenges to outcome measurement and subject retention. Moreover, comparison groups in these studies that were used to formulate the effect sizes tended to show reductions in risk behaviors, although to a lesser degree than the interventions. Even so, the effect sizes observed are comparable to other health behavior change and medical interventions. Given the challenges virologists face in developing HIV preventive vaccines, behavior change interventions such as those reviewed here remain the greatest hope for curtailing the spread of HIV.

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