The Effectiveness of Group-Based Comprehensive Risk-Reduction and Abstinence Education Interventions to Prevent or Reduce the Risk of Adolescent Pregnancy, Human Immunodeficiency Virus, and Sexually Transmitted Infections

Two Systematic Reviews for the Guide to Community Preventive Services

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Context: Adolescent pregnancy, HIV, and other sexually transmitted infections (STIs) are major public health problems in the U.S. Implementing group-based interventions that address the sexual behavior of adolescents may reduce the incidence of pregnancy, HIV, and other STIs in this group.

Evidence acquisition: Methods for conducting systematic reviews from the *Guide to Community Preventive Services* were used to synthesize scientific evidence on the effectiveness of two strategies for group-based behavioral interventions for adolescents: (1) comprehensive risk reduction and (2) abstinence education on preventing pregnancy, HIV, and other STIs. Effectiveness of these interventions was determined by reductions in sexual risk behaviors, pregnancy, HIV, and other STIs and increases in protective sexual behaviors. The literature search identified 6579 citations for comprehensive risk reduction and abstinence education. Of these, 66 studies of comprehensive risk reduction and 23 studies of abstinence education assessed the effects of group-based interventions that address the sexual behavior of adolescents, and were included in the respective reviews.

Evidence synthesis: Meta-analyses were conducted for each strategy on the seven key outcomes identified by the coordination team—current sexual activity; frequency of sexual activity; number of sex partners; frequency of unprotected sexual activity; use of protection (condoms and/or hormonal contraception); pregnancy; and STIs. The results of these meta-analyses for comprehensive risk reduction showed favorable effects for all of the outcomes reviewed. For abstinence education, the meta-analysis showed a small number of studies, with inconsistent findings across studies that varied by study design and follow-up time, leading to considerable uncertainty around effect estimates.

Conclusions: Based on these findings, group-based comprehensive risk reduction was found to be an effective strategy to reduce adolescent pregnancy, HIV, and STIs. No conclusions could be drawn on the effectiveness of group-based abstinence education.

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Context

This paper presents the results of systematic reviews of effectiveness in preventing pregnancy, HIV, and other sexually transmitted infections (STI) of two group-based behavioral interventions for adolescents: (1) comprehensive risk reduction and (2) abstinence education. Intervention effectiveness was assessed on sexual behaviors (such as delayed initiation of intercourse, or use of condoms by sexually active adolescents) and biologic outcomes (including incidence of pregnancy and STIs). The results of these reviews provide the basis for recommendations by the Community Preventive Services Task Force (Task Force),[1] an independent, nonfederal body of experts in public health research, practice, and policy. Task Force recommendations are compiled in the *Guide to Community Preventive Services* (*Community Guide*; www.thecommunityguide.org) and can inform decision making about effective interventions for meeting public health aims, including *Healthy People 2020* objectives.[2]

Background

Adolescent pregnancy, HIV, and other STIs are major public health problems in the U.S. The national teen birth rate (among women aged 15–19 years) decreased 37% (from 61.8 to 39.1 births per 1000) from 1991 to 2009.[3] Between 2008 and 2009 among non-Hispanic white teens there was a decrease in birth rate from 26.7 to 25.6 births per 1000 teenagers; among non-Hispanic black teens from 62.9 to 59.0 births per 1000 teenagers; and among Hispanic teens from 77.4 to 70.1 births per 1000 teenagers.[3,4] However, in younger adolescents, aged 10–14 years, there was a smaller decrease from 0.6 to 0.5 births per 1000.[3,4] Despite these declines, the teen birth rate is still high, with approximately 4% or 410,000 female teenagers aged 15–19 years giving birth in 2009.[3] In addition, the costs of teen pregnancy remain high: an estimated $9.1 billion a year for society[5] and lost opportunities and lifelong social and psychological consequences for teens.[6]

In 2006, more than one third (34%) of the estimated 54,230 new HIV infections in the U.S. were among people aged 13–29 years.[7] Among male adolescents and young adults, the rate of infection per 100,000 was seven times higher among African Americans than among whites (128.3 vs 18.1) and three times higher among African Americans than Hispanics (128.3 vs 42.8).[7] This disproportionate occurrence of new HIV infections was described in one recent commentary[8] as a "state of emergency" in the African-American community.

Although young people aged 15–24 years account for only one quarter of the sexually experienced population, they contract nearly half of the 19 million new STIs diagnosed each year.[9] Data from 2009 show that people aged 15–19 years continue to have one of the highest rates of chlamydia (3329.3 per 100,000 for girls/women and 735.5 per 100,000 for boys/men) and gonorrhea (568.8 per 100,000 for girls/women and 568.8 per 100,000 for boys/men) of any age/gender group.[10] These adolescents are at greater risk for acquiring other infections, such as HIV. Inflammatory STIs, such as gonorrhea, are associated with a three- to five-fold increase in the risk of acquiring HIV.[11] In addition to disparities by age, racial disparities persist across all STIs. An example of this can be seen in the data from 2009,[10] which showed African-American women aged 15–19 years had the highest gonorrhea rate of any race/age group (2613.8 per 100,000).

Sexual activity patterns have changed among U.S. teens. Between 1991 and 2009, the percentage of high school students reporting ever having had sexual intercourse decreased from 54.1% to 46.0%.[12] Among high school students who were sexually active, condom use at last intercourse increased from 46.2% in 1991 to 61.0% in 2009.[12] Although these trends for the period between 1991 and 2009 show a decrease in the initiation of sexual activity and increase in protective sexual behaviors, all the improvements occurred before 2007.[12]

A widely used approach to address the problem of teen pregnancy and STIs has been group-based sex education.[13] From the early model of sex education as a didactic presentation about "our changing bodies" and reproductive health, sex education has evolved into a behavioral theory–based approach to increase adolescents' knowledge; influence attitudes and beliefs; create supportive norms; and build relevant communication, decision-making, and practical skills.[14] Despite these developments in the approach to group-based sex education over

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the years, there are multiple barriers to implementing these approaches, which are discussed later in this paper.

Behavioral interventions to promote adolescents' health protective behaviors and reduce sexual risk behaviors have been evaluated extensively.[15–17] However, important questions still remain about the effectiveness of different types of interventions—particularly abstinence education and comprehensive risk reduction. One recent narrative review[16] concluded that about two thirds of curriculum-based sexual behavior interventions for adolescents in schools or community settings had positive effects on teen sex behavior, such as delayed initiation of intercourse, increased condom use, or both.

The distinction between abstinence education and programs that teach sexual risk-reduction behaviors in addition to or instead of abstinence reflects a longstanding debate among parents, providers, and policymakers about the most appropriate goal and content of sexual behavior interventions for adolescents. Previous reviews[17,18] of the effectiveness of abstinence education have found minimal or inconclusive effects, which have been attributed to too few studies, weak designs, and the heterogeneity of program curricula and their implementation. In contrast, reviews[15,19] of the effects of comprehensive approaches have generally reported positive results.

Until 2010, federal funding was available for states to implement only abstinence education programs that follow the federal A–H guidelines (Table 1).[20] Currently, in addition to federal funding for abstinence education,[21,22] there is also federal funding for evidence-based programs that use curriculum-based sex education or youth development approaches to prevent teen pregnancy.[22,23] Thus federal funding to prevent teen pregnancy is now available for a broad range of programs, including those that use a comprehensive strategy. However, the funding requirements do not specify that the programs address STI or HIV prevention.

The goals of the present systematic reviews were to assess (1) the effectiveness of comprehensive risk-reduction and abstinence education interventions for reducing adolescent pregnancy, HIV, and other STIs and (2) the influence of moderator variables including delivery setting, type of deliverer, intervention focus (pregnancy or STIs), and targeting (adapting interventions for specific groups).[24] Comprehensive risk-reduction interventions promote behaviors that prevent or reduce risk of pregnancy, HIV, and other STIs; abstinence education interventions promote abstinence from sexual activity (either delayed initiation or abstinence until marriage). Studies were included if behavioral training was provided through personal interaction between a deliverer and a group of adolescents— either a school classroom setting during school hours or a community setting, which can be located outside of a school (e.g., runaway shelter or healthcare setting) or at a school but before or after traditional school hours.

Table 1. Federal A–H guidelines for abstinence education

A–H definition (Title V Section 510 (b)(2)(A–H) of the Social Security Act)
(A) Have as its exclusive purpose teaching the social, psychological, and health gains to be realized by abstaining from sexual activity
(B) Teach abstinence from sexual activity outside marriage as the expected standard for all school-age children
(C) Teach that abstinence from sexual activity is the only certain way to avoid out-of-wedlock pregnancy, sexually transmitted diseases, and other associated health problems
(D) Teach that a mutually faithful, monogamous relationship in the context of marriage is the expected standard of sexual activity
(E) Teach that sexual activity outside the context of marriage is likely to have harmful psychological and physical effects
(F) Teach that bearing children out of wedlock is likely to have harmful consequences for the child, the child's parents, and society
(G) Teach young people how to reject sexual advances and how alcohol and drug use increases vulnerability to sexual advances
(H) Teach the importance of attaining self-sufficiency before engaging in sexual activity

Source: www.ssa.gov/OP_Home/ssact/title05/0510.htm.

Recommendations from Other Advisory Groups

Several other groups have made recommendations on the use of sex education for adolescents. The American Academy of Pediatrics[25] recommends that pediatricians "encourage sexual abstinence as part of comprehensive sexuality education and services offered to their adolescent patients." The American Academy of Family Physicians[26] has similar recommendations, which promote an evidence-based comprehensive approach to sex education to prevent adolescent pregnancy and STI transmission. Specifically, their recommendations define an effective sexuality education program as one that includes medically accurate information on contraception and abstinence. The recommendations[26] include both abstinence and responsible sexual behavior as effective methods to prevent pregnancy and STIs, while stressing abstinence as the most effective method. The American

Medical Association[27] provides similar guidance and states that comprehensive sex education is currently the most effective strategy to address the public health problems of increasing sexually transmitted disease and HIV transmission rates among youth, as well as a recent increase in the national teen pregnancy rate.

Evidence Acquisition

The general methods for conducting a *Community Guide* systematic review are described elsewhere.[28,29] Specific methods used for this review are described in depth in the accompanying article.[30] Oversight for all stages of the systematic review was provided by a Coordination Team (the team) of 20 members—including systematic review methodologists and individuals with relevant research, policy, and programmatic expertise in comprehensive risk-reduction and abstinence education interventions and other issues related to adolescent sexual behavior.

Search Period and Data Abstraction

The search period for these reviews was from 1988 to August 2007. Data from relevant papers were abstracted and assessed for study design suitability and quality of execution by two reviewers. Discrepancies in abstraction were resolved by consensus. Inadequate interpretation of the study results by authors was the most common type of limitation found during the quality of execution assessment. Studies with five or more limitations (of a potential of nine limitations) were categorized as limited in their quality of execution[28] and excluded from the analysis. Authors were contacted for missing or inconsistently reported data. In these reviews, 24 authors were contacted for additional information, 17 responded, and 11 provided additional data.

Intervention Descriptions and Study Variables

Comprehensive risk-reduction interventions promote behaviors that prevent or reduce the risk of pregnancy, HIV, and other STIs. These interventions (1) suggest a hierarchy of recommended behaviors, identifying abstinence as the "best" or "preferred" method, but also provide information about sexual risk-reduction strategies; (2) promote abstinence and sexual risk reduction without placing one strategy above the other; or (3) primarily or solely promote sexual risk-reduction strategies. These reviews evaluated comprehensive risk-reduction interventions delivered in school or community settings to groups of adolescents. Some comprehensive risk-reduction interventions in these reviews also included additional components that ranged from condom distribution to STI screening and others used a more comprehensive youth development approach.

Abstinence education interventions promote abstinence from sexual activity (either delayed initiation or abstinence until marriage) and mention condoms or other birth control methods only to highlight their failure rates, if at all. These interventions generally include messages about the psychological and health benefits of abstinence as well as the harms of sexual activity. Most of the interventions adhered to the eight federal guidelines required to obtain Title V federal funding (Table 1).[20] This review evaluated abstinence education interventions delivered in school or community settings to groups of adolescents. These interventions could also include other components (such as media campaigns and community service events), and others used a more comprehensive youth development approach.

The four broad research questions were:

1. Are group-based comprehensive risk-reduction interventions for adolescents effective in reducing sexual activity and sexual risk behaviors, to prevent HIV, other STIs, and pregnancy?
2. Are group-based abstinence education interventions for adolescents effective in reducing sexual activity, to prevent HIV, other STIs, and pregnancy?
3. Does intervention effectiveness vary by:
   population characteristics (age, gender, or race/ethnicity, virginity status at baseline);
   intervention characteristics (setting, dosage, focus, deliverer, multicomponent, targeting); or
   study characteristics (study design, type of comparison group)?
4. Are adverse effects associated with these interventions?

The analytic framework for these reviews (Figure 1) identifies the ways in which abstinence education and comprehensive risk reduction are expected to influence pregnancy and HIV/STI rates. Abstinence education is expected solely to increase the number of adolescents who abstain from sexual activity. Therefore, the primary outcomes for the abstinence education interventions are reduced sexual activity and reduced frequency of sexual activity, as well as reductions in the biologic outcomes of pregnancy, HIV, and other STIs. Comprehensive risk reduction is expected to reduce both sexual activity and sexual risk behaviors among youth who become or remain sexually active.

The team examined all of the aforementioned behavioral and biologic outcomes plus number of sex partners, frequency of unprotected sexual activity, and use of protection (barrier, hormonal, or dual use). Abstinence education and comprehensive risk-reduction interventions influence changes in these sexual behaviors through changes in the relevant knowledge, attitudes, skills, and other psychosocial mediators for each intervention strategy. Both intervention strategies influence these proximal outcomes, but the specific knowledge, attitudes, skills, intentions, and other mediators influenced is specific to the outcome category being targeted (e.g., refusal skills are relevant to abstinence education and comprehensive risk reduction for reducing sexual activity, but condom use skills are relevant only for comprehensive risk reduction to change sexual risk behaviors).

The team also looked at the distribution of 12 effect-modifier variables across all studies: population characteristics (gender, virginity status, age, and race/ethnicity); intervention characteristics (setting, dosage, focus, deliverer, multicomponent, and targeting); and study characteristics (study design and comparison group type). Dosage was examined as a continuous variable, race/ethnicity as a categoric variable, and the remaining variables as dichotomous.[30]

Analyses

Outcome data were reported as proportions, Ms, and ORs in the studies reviewed. When enough information was provided, the data were transformed into OR effect estimates to place effect estimates for each study on a common scale for meta-analysis. Heterogeneity testing included analyses with the Q statistic and the I^2 statistic. Only I^2 will be discussed because it is not sensitive to the number of studies included nor to the metric of the effect size index.[31] An $I^2 > 50\%$ represents a substantial amount of between-study variation in the outcome beyond what would be expected

from sampling variation and is therefore of concern in meta-analysis.[32] To assist with interpretation of results, risk ratios for each outcome variable were also estimated. Additional details on the methods of the meta-analysis are provided in the accompanying paper.[30]

Univariate analyses on each of the moderator variables were conducted to (1) assess whether they are associated with intervention effects and (2) explore potential sources of heterogeneity in the overall mean effect size. Similar to the meta-analyses, ORs and CIs were calculated for each category of the moderator variable. Between-study analyses were conducted on all of the moderator variables where overall results were reported and not stratified by the variable categories presented in Table 2. When authors reported results stratified by a moderator variable of interest, within-study analyses were performed.

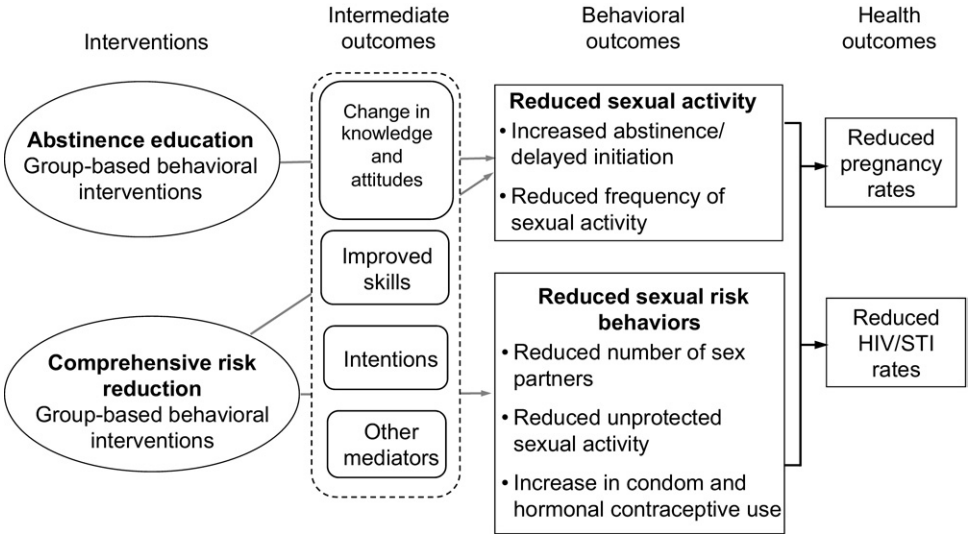

Figure 1. Analytic framework showing the effects of group-based abstinence education and comprehensive risk-reduction interventions

Note: Figure shows changes in adolescent sexual behavior, reductions in the prevalence of adolescent pregnancy, HIV, and STIs. Abstinence education interventions are expected to lead to reductions in sexual activity only and comprehensive risk-reduction interventions are expected to lead to reductions in sexual activity and sexual risk behaviors among adolescents. Changes in these outcomes occur through changes in the proximal outcomes relevant to each intervention strategy. Both interventions are expected to lead to reductions in the biologic outcomes of pregnancy and HIV/STIs.

STI, sexually transmitted infection

Orwin's fail-safe N and visually inspected funnel plots were used to detect publication bias on all outcomes that had a significant overall effect estimate.[33] A one-study-removed analysis was performed to test how sensitive the overall effect estimates were to any one study.[33] Correlations between intervention effectiveness and follow-up time were also assessed.

Additional Information on the Interventions

As with all *Community Guide* reviews, additional information on the interventions was also considered—applicability, economic efficiency, potential benefits and harms, barriers to implementation, and research gaps. The team drew conclusions about the applicability of the results to various populations and settings after considering the conceptual basis for the interventions, examining data on participant and intervention characteristics, and robustness of results across studies.

For the evaluation of economic efficiency, the intervention definition and characteristics defined for the effectiveness review were adopted as primary inclusion and exclusion criteria. Economic keywords such as cost, cost-benefit, cost-effectiveness, and cost-utility were then added to the original search strategy for the effectiveness review to find relevant economic evaluations.

Potential benefits of the interventions, in addition to those examined as primary and secondary outcomes of the review, were identified from studies included in the effectiveness review, a review of background literature on adolescent behavior, or by team members. The great number of concerns about the potential harms that surround this topic area could not all be addressed. Therefore, the discussion of potential harms is limited to those for which data were available from the studies included in these reviews.

Identification of barriers to implementation of comprehensive risk-reduction and abstinence education interventions was similar to the approach used for potential benefits and harms. The team examined qualifying studies, as well as relevant related literature, for information on barriers to intervention implementation. Also, during the course of conducting these systematic reviews, areas in which information about the effectiveness of the interventions was lacking or of poor quality were identified and noted as research gaps.

Evidence Synthesis

Comprehensive Risk Reduction

Effectiveness. The review identified 66 studies[34–96] (88 study arms) that used a comprehensive risk-reduction strategy, including one paper[64] that provided information on two studies and another paper[55] that provided information on three studies. Of these 66 studies, four[45,78,84,96] (five study arms) had limited quality of study execution[30] and were removed from further analysis. The remaining qualifying 62 studies[34–44,46–77,79–83,85–95] (83 study arms) were of greatest study design suitability.[30] Of these, 12 studies[39,43,51–54,69,70,76,89,91,92] (19 study arms) had good quality of execution and 50 studies[34–44,46–50,55–68,71–75,77,79–83,85–88,90,93–95] (64 study arms) had fair quality of execution.[30] Most of the outcome measures were self-report, with the STI outcome

Table 2. Characteristics of the included studies for comprehensive risk reduction

Characteristics	No. of study arms	% of total or M (min, max)
No. of components		
Single	58	70.7
Multiple	24	29.3
Focus		
HIV/STI only or multi (HIV/STI and pregnancy)	74	90.2
Pregnancy only	8	9.8
Deliverer		
Adult only (no peer)	66	80.5
Adult plus peer	16	19.5
Setting		
School	38	46.3
Community	44	53.7
Targeting		
No	29	35.4
Yes	53	64.6
Dosage		
Mean hours of contact with deliverer	63	14.5 (1, 54)
School level and age of recipients		
Middle (10–14 years)	29	35.4
High (15–19 years)	53	64.6
Gender		
Female only	9	11.0
Male only	3	3.7
Co-ed	60	73.2
Not reported	10	12.2
Majority race/ethnicity		
African-American	41	50.0
White	15	18.3
Hispanic	7	8.5
Asian	1	1.2
Mixed samples	7	8.5
Not reported	11	13.4
Virginity status		
Mean baseline percentage	53	56.5 (0, 96)
Comparison group		
Untreated and minimal treatment	74	90.2
Treated	8	9.8
Study design		
RCT	50	61.0
Non-RCT	32	39.0

sometimes confirmed with laboratory testing. Summary evidence tables that provide further information on the details of each study can be found at www.thecommunityguide.org/hiv/supportingmaterials/SETcrr.pdf.

Characteristics of the interventions, sample demographics, and study design. The characteristics of the evidence base for comprehensive risk reduction by number of study arms are detailed in Table 2. Most comprehensive risk-reduction intervention arms were single component (i.e., provided group-based education only, many curriculum-based); focused on the prevention of HIV/STIs and pregnancy; and were delivered solely by a trained adult without including a peer deliverer. Interventions were distributed almost equally between school and community settings and between targeted and untargeted approaches.[97] Intervention dosage varied across studies. Participants in comprehensive risk-reduction interventions included representation across age, gender, race/ethnicity, and virginity status at baseline. Most comparison groups were untreated or minimally treated and more than half of the studies used an RCT study design.

Outcomes for comprehensive risk reduction. All of the outcomes for comprehensive risk reduction demonstrated effectiveness (Table 3). There were reductions in sexual activity (sexual activity OR=0.84, frequency of sexual activity OR=0.81); sexual risk behaviors (number of sex partners OR=0.83, unprotected sexual activity OR=0.70); and the biologic outcomes (STIs OR=0.65, pregnancy OR=0.88), as well as increases in protective sexual behaviors (use of protection OR=1.39). The effect estimates for all outcomes for comprehensive risk reduction, except pregnancy, were significant. Stratification of the protection outcome by type—condom, oral contraception, or dual use—showed favorable effects for all three but significance for condom use only. Additionally, when examining the effects of comprehensive risk reduc-

Table 3. Meta-analysis results and estimated RRs for all review outcomes for comprehensive risk-reduction interventions

Outcomes[a]	*k*	*n* (studies)	*n* (study arms)	OR (95% CI)	Q statistic *p*-value	I^2	Estimated RR
Sexual activity	57	38	54	0.84 (0.75, 0.95)	0.00	67.67	0.88
Frequency of sexual activity	14	13	14	0.81 (0.72, 0.90)	0.73	0.00	—[b]
Number of sex partners	28	23	27	0.83 (0.74, 0.93)	0.04	34.36	0.86
Unprotected sexual activity	29	22	28	0.70 (0.60, 0.82)	0.00	56.39	0.75
Protection[c]	63	38	50	1.39 (1.19, 1.62)	0.00	76.25	1.13
Condoms[c]	48	33	44	1.45 (1.20, 1.74)	0.00	78.26	1.12
Oral contraceptives[c]	10	9	10	1.29 (0.89, 1.85)	0.02	55.69	1.22
Dual use[c]	5	4	4	1.21 (0.70, 2.12)	0.01	72.24	1.17
Pregnancy	11	9	11	0.88 (0.60, 1.30)	0.02	53.35	0.89
STI	8	6	8	0.65 (0.47, 0.90)	0.34	11.15	0.69
HIV	0	0	0	—	—	—	—

[a]All of these outcomes were self-reported, with the exception of STIs, which were either self-reported or clinically documented.
[b]Unable to calculate
[c]ORs >1.0 indicate beneficial effects.
RR, risk ratio; STI, sexually transmitted infection

tion on consistent condom use, a subset of the condom use outcome, results were in the favorable direction but not significant (19 study arms, OR=1.24, 95% CI=0.96, 1.62).

Heterogeneity. Four of the main comprehensive risk-reduction outcomes—sexual activity, unprotected sexual activity, use of protection, and pregnancy—had I^2 statistics greater than the 50% threshold. In addition, all protection outcomes when examined by type (i.e., condom use, oral contraceptive use, or dual use) had I^2 statistics >50%. The forest plots for each depicted a substantial amount of variation of the individual study effect estimates around the overall weighted mean OR (see Figure 2 for an example).

Subgroup Analyses

Between-study analyses were conducted on the moderator variables age, race/ethnicity, setting, dosage, focus, deliverer, multicomponent, targeting, study design, and comparison group type. Within-study analyses were conducted by gender and virginity status. Within-study analyses could not be performed on the other moderator variables because either no or too few studies reported outcomes stratified by these variables.

Between-study analyses. No consistent pattern was found across the moderator variables examined in the meta-analysis for the dichotomous variables or in the meta-regression for the continuous variable of dosage (data not shown). All included studies were RCTs or controlled before–after (CBA) designs, and effects were similar for RCTs and CBA studies. Stratification of the STI analyses by community setting (five study arms[42,52,85,88]) versus school setting (three study arms[56,83]) showed effect magnitudes similar for school and community settings but CIs around the estimates were wider for studies in school settings (OR for community=0.64, 95% CI=0.43, 0.95; OR for school=0.71, 95% CI=0.24, 2.10; p=0.86), where STIs were rare events. Most of the evidence on the STI outcome is from samples of adolescents who were recruited in clinical settings (e.g., an adolescent health clinic).

Within-study analyses. Individual studies provided sufficient data to enable examination of two of ten moderator variables using within-study analyses. Ten study arms[34,35,40,48,56,60,73] reported sexual activity outcome by gender. The effect magnitude was larger for boys than girls (OR for boys=0.61, 95% CI=0.46, 0.81; OR for girls=0.90, 95% CI=0.69, 1.19; p=0.054). Similar results were found for the six study arms that reported results for condom use by gender (OR for boys=2.08, 95% CI=0.97, 4.48; OR for girls=0.88, 95% CI=0.40, 1.92; p=0.132). Four study arms[51,69] reported sexual activity outcome by virginity status at baseline. The analysis produced a similar effect magnitude for virgins and nonvirgins (OR for virgins=0.63, 95% CI= 0.46, 0.87; OR for nonvirgins=0.75, 95% CI=0.53, 1.06; p=0.47).

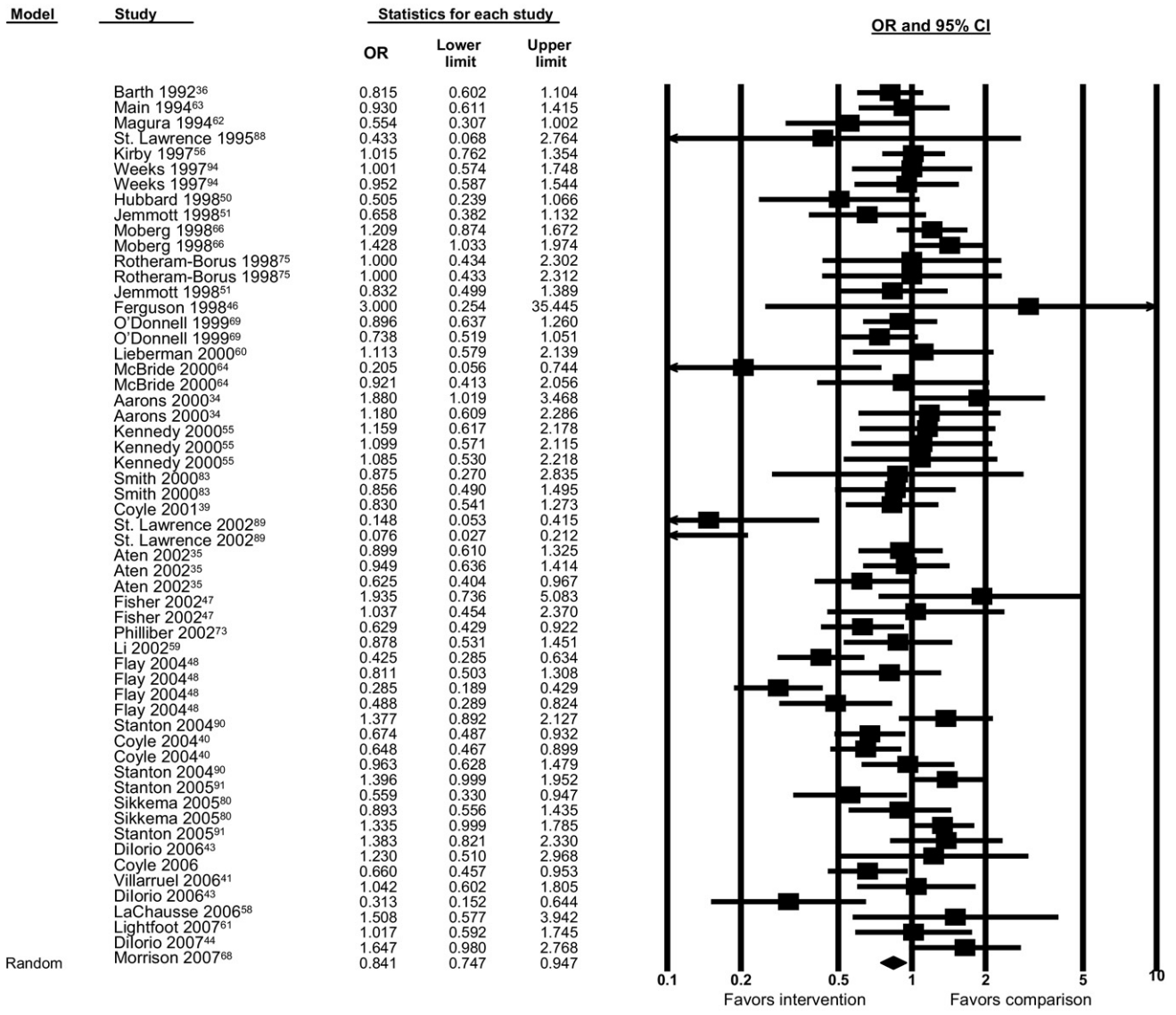

Figure 2. Forest plot of meta-analysis results for sexual activity outcome using random-effects model for comprehensive risk-reduction strategy

Sensitivity Testing

Publication bias. Results from Orwin's fail-safe N revealed that 45–213 studies demonstrating no effects would be needed to reduce the effects to trivial or nonsignificant for the significant primary comprehensive risk-reduction outcomes. No indication of publication bias was apparent, as the plots generally held to the inverse funnel shape.

One-study-removed analysis. Nearly all of the outcomes had a significant overall 95% CI and were not sensitive to the removal of any one study arm. The STI outcome was sensitive to the removal of either one of two study arms,[42,52] which resulted in the 95% CI becoming nonsignificant. When one study arm[64] was removed from the oral contraception outcome (subgroup of the overall protection outcome), the overall 95% CI changed from nonsignificant to significant. Dual use, another subgroup of the overall protection outcome, was also nonsignificant, but did not show this sensitivity to removal of a study arm.

Correlations with follow-up time. Follow-up time for each of the interventions varied. For the sexual activity outcome (the outcome with the most studies included), follow-up time varied from 5 to 208 weeks, with a median of 54 weeks. For all of the outcomes examined, no significant correlations between effectiveness and follow-up time were found (data not shown).

Applicability

The evidence from the comprehensive risk-reduction interventions included in this review is applicable across a

range of populations and settings. Studies included representation from a range of ages, racial/ethnic groups, and adolescents of differing baseline virginity status. The interventions reviewed were delivered to both single-gender and coed groups in both school and community settings. These interventions are also considered applicable when implemented in a variety of ways as the interventions reviewed varied by deliverer (peer or adult); tailoring to group characteristics; focus (HIV/STI, pregnancy, or both); and the inclusion of other interventions in addition to comprehensive risk reduction (e.g., condom distribution).

Economic Efficiency

The methods for this systematic economic review are described in the accompanying methods paper.[30] The initial search resulted in 8087 records of publications about comprehensive risk-reduction or abstinence education interventions. All monetary values presented here are in 2008 U.S. dollars. Ten comprehensive risk-reduction studies that included economic information were identified: eight economic evaluations[73,98–104] of individual programs; an evaluation[105] of multiple programs for the Washington state legislature; and a dissertation[106] that modeled economic outcomes based on combined results from six programs. All studies evaluating individual programs received at least a satisfactory score on the quality scoring criteria. A summary description of all included economic studies is provided in Table 4.

There was some overlap between the evidence considered in the economic and effectiveness reviews. Four[73,99,100,103] of eight economic evaluations of individual programs were also included in the effectiveness review. A 2004 evaluation[105] presented to the State of Washington legislature assessed various programs within the state with specific social and health objectives, one of which was a set of seven programs that included the objective of preventing teen pregnancies. To assess the effectiveness of this set of seven programs, that evaluation directly used four studies[39,50,73,107] also included in the current effectiveness review. Using 2000 U.S. Census data, the dissertation by Olaiya[106] modeled healthcare costs averted through prevention of pregnancies and STIs. Effect estimates were drawn from six school-based interventions, all of which incorporated comprehensive risk-reduction strategies and included small group discussions, role-playing, and experiential learning. Four[34,39,40,69] of those six interventions were also included in the current effectiveness review.

Various outcomes were estimated in the comprehensive risk-reduction studies: sexual activity,[73,100,102–104] condom use,[99,102,103,106] contraceptive use,[73,105] pregnancy,[73,98,101,103–106] STIs,[103,105,106] or HIV.[100,102,103] One evaluation study[98] also measured academic attainment. Where the intervention data provided only intermediate outcomes (e.g., increased condom use), three studies used additional modeling based on parameter values from the literature to estimate final outcomes such as averted HIV infections[102,103] and pregnancies.[103,106]

Program Costs

In six of eight studies[73,98,101–104] evaluating individual interventions, program costs ranged from $66[103] to $10,024[101] per person per year. Of the remaining two studies, one[99] reported an annual budget of $335,358 to cover staff salaries, operating expenses, materials, and purchased radio advertising time, and the other[100] reported a cost of $119 per participant for a 5-hour-long, 1-day HIV risk-reduction session for 85 male African-American adolescents that included food, transportation costs, and monetary incentives for participants. The evaluation of programs in Washington State[105] reported a range of program costs from $11 to $4486 per person per year that is narrower than the range of costs obtained in this review from individual interventions across different locations within the U.S.

The wide range in costs per participant per year for comprehensive risk-reduction programs can be attributed to variability in program content, number of participants, and program duration. The type of intervention setting is also important. Four studies[73,98,101,104] were multifaceted youth development interventions that extended over multiple years with intensive interactions between staff and participants, with three reporting program costs of $4192[98] to $10,024[101] per person per year.

The fourth[104] study reported a considerably lower per-person per-year cost of $173 because the fixed costs were spread over a large number of participants (1700, compared to the range of 50[101] to 242[73] participants in the other three studies), and because only 31% of the participants made extensive use of all services. Among the studies of individual programs, the lowest cost per person per year of $66 was found for a school-based program[103] that focused on curriculum-based education. The evaluation of multiple programs in Washington State reported the lowest cost per person per year of $11 for a program that also focused on school- and curriculum-based education.

Economic Summary Measure

An economic summary measure is composed of both intervention cost and intervention benefit. Averted healthcare and productivity costs constitute an important economic benefit from an intervention. Healthcare costs were estimated in six studies[98,100,102,103,105,106] and productivity costs in four studies.[98,102,103,105] Of six studies

that report an economic summary measure, two[100,102] provided cost effectiveness as cost per quality-adjusted life-year (QALY); two[98,103] provided benefit–cost ratios; one[101] provided net benefits; and one[105] provided both net benefits and a benefit–cost ratio.

Of two studies that evaluated HIV infections averted, one[100] estimated the cost per averted infection at $1.3 million. The cost–utility ratio from the two studies ranged from about $9000[102] to $76,000[100] per QALY. The benefits and costs of an intervention to affect incidence of HIV, gonorrhea, chlamydia, and pregnancies through increased condom use and reduced sexual activity were estimated to produce a benefit–cost ratio of 2.65.[103] In another cost–benefit study,[98] the intervention's impact on pregnancies and academic attainment is estimated to be a benefit–cost ratio of 3.68. On the other hand, one study[101] that also reported the highest program cost per person per year found that the benefits of pregnancy prevention were less than the cost of program, for an estimated net benefit of –$1708 per person per year.

The study on multiple programs in Washington State[105] did not find many of the pregnancy prevention programs to be cost-beneficial; only one of seven programs evaluated reported a benefit–cost ratio of 1.29 and a positive net benefit of $212 per participant; the other six reported net costs ranging from $15 to $10,640 per participant for intervention periods ranging from 1 to 4 years. The dissertation,[106] based on effect estimates from six interventions applied to the U.S. 2000 cohort, reported per-year per-person healthcare savings in averted STIs and pregnancies that ranged from $5.80 for people aged 13–14 years to $103 for those aged 15–17 years and $338 for ages 18–19 years. Averted pregnancies made up 80% of these savings for the youngest cohort and >95% for the oldest cohort.

The five studies that reported benefit–cost or cost-effectiveness ratios modeled averted healthcare and productivity losses from reduced cases of HIV and STI infections and reduced pregnancy rates, and on various underlying assumptions. One of these studies[98] also considered education benefits and the resultant increase in income from the particular intervention in its estimation of the benefit–cost ratio. Two studies[98,103] showed favorable benefit–cost ratios and two studies[100,102] reported cost-effectiveness ratios either much lower than or close to the conventional benchmark of cost effectiveness of $50,000 per QALY. One study[101] with high cost per participant per year and negative net benefits mentioned that a break-even point could be achieved if the program could include more participants or was extended to include participants aged between 20 and 21 years, because the older cohort is more active sexually.

Finally, other dimensions of positive behaviors are affected by such interventions (especially youth development), and are hard to quantify and monetize (e.g., reduced crime, improved academic attainment, and better parenting skills). Overall, most comprehensive risk-reduction studies that take into account a comprehensive assessment of the benefits of preventing pregnancy, STI, and HIV, and secondary benefits (e.g., education attainment) demonstrate a positive economic value from investments in such interventions.

Abstinence Education

Effectiveness. This review identified 23 studies[107–124] (27 study arms) that used an abstinence education intervention approach, including one paper[107] that provided information on three studies and another paper[118] that provided information on four studies. Of these, two studies[114,115] (four study arms) had limited quality of execution and were removed from further analysis. The remaining 21 studies[107–113,116–124] (23 study arms) were of greatest study design suitability. Two studies[118,120] (two study arms) had good quality of execution and 19 studies[107–113,116–119,121–124] (21 study arms) had fair quality of execution.[30] Most of the outcome measures were self-report, with the STI outcome sometimes confirmed with laboratory testing. Summary evidence tables that provide further information on the details of each study are available at www.thecommunityguide.org/hiv/supportingmaterials/SETAbstinence.pdf.

Characteristics of the interventions, sample demographics, and study design. The characteristics of the evidence base for abstinence education by number of study arms are presented in Table 5. Most of the intervention arms used a single component intervention (i.e., involved group-based education only that was usually curriculum-based); were focused on HIV/STI and pregnancy; took place in the school setting; and were delivered by a trained adult. Most interventions did not use a targeted approach.[97] Intervention dosage (number of hours of contact with the deliverer of the intervention) varied. Almost all participants were aged 10–14 years, with representation across gender and race/ethnicity. The majority of participants were virgins at baseline. Most comparison groups were untreated or minimally treated and less than half of the studies were RCTs.

Primary outcomes. The meta-analytic results demonstrate effect estimates in the favorable direction for both of the primary behavioral outcomes for abstinence education (sexual activity OR=0.81 and frequency of sexual activity OR=0.77; Table 6). These results indicate reductions in sexual activity and frequency of sexual activity with significant reduction for sexual activity only. How-

Table 4. Description of economics studies included in the systematic review

Study	Program costs ($)	Type of intervention Setting	Description of intervention Length of intervention Number of intervention participants	Breakdown of program cost	Considered healthcare costs averted? Considered productivity losses averted?	Health outcome(s) monetized or included in economic summary Summary economic measure
Hahn (1994)[98]	4192 per participant per year	Type—YD Some school-based	Description—Intervention consists of education/academic tutoring; community service; developmental help in sex, drugs, family planning Length—4-year program with about 750 hours' exposure each year Participants—25 each in four intervention and one control sites	About 46% for program and staff; remaining for college fund, stipends, and completion incentives	Health—assumed first-year cost of childbirth in Medicaid family=$15,808 Productivity—considered income increments from completion of high school, 2-year college, 4-year university	Effects considered for a cohort of 100, with 14 averted childbirths included in summary 4-year program cost=$1,676,847 and 4-year benefits=$6,170,895, composed of $5,949,588 for education benefits and $221,307 for averted childbirth costs; benefit–cost ratio=3.68
Kennedy (2000)[99]	335,358 annual budget	Type—social marketing Community setting	Description—safe sex and condom use by radio advertisement; posters and small media; skills workshop; peer outreach; telephone information line Length—1 year Participants—extent of mass media coverage unclear	Staff salaries, operating expenses, creative materials development contracts, and purchased advertising time; details not provided.	None	No economic summary measure reported
Philliber (2002)[73]	5169 per participant per year	Type—YD Community setting	Description—family life, sex, health education; career support; academic support; artistic expression; recreation; physical and mental health services. Modeled after Children's Aid Society's Carrera Program Length—3 years Participants—242	Staff salaries, medical and dental services; stipends for "Job Club"; wages for work on entrepreneurial, community service, internship jobs; details not provided.	None	No summary economic measures reported although cost per day is reported to be less than cost of afterschool child care
Pinkerton (2000)[100]	119 per participant for a 5-hour-long 1-day session	Type—CB Setting not clear	Description—1-day HIV education and condom use; dispel misconceptions about HIV through video; games; exercises; role-play in sexual negotiations Length—1 day (5 hours) Participants—85 African-American male adolescents	22% personnel salaries; 29% incentives; 13% facilities; 23% training facilitators	Health—lifetime averted healthcare costs per HIV infection—$261,832 Productivity—not considered directly but may be captured in QALY	Cost per infection averted—$1,337,000 ICER reported to be $76K/QALY HIV infections averted modeled on reduction in risky sex acts

(continued on next page)

Table 4. *(continued)*

Study	Program costs ($)	Type of intervention Setting	Description of intervention Length of intervention Number of intervention participants	Breakdown of program cost	Considered healthcare costs averted? Considered productivity losses averted?	Health outcome(s) monetized or included in economic summary Summary economic measure
Rosenthal (2009)[101]	10,024 per participant per year	Type—YD Community setting	Description—family life, sex, health education; career support; academic support; artistic expression; recreation; physical and mental health referral Modeled after Children's Aid Society's Carrera program; comprehensive risk reduction plus parallel family program implying 24/7 contact with staff Length—7 years Participants—50 annually	Compensation for staff, rent/utilities/ maintenance, food, fundraising, establish and maintain work experience, and training program; details not provided.	Health—direct health costs of childbearing and pregnancies drawn from 1997 Urban Institute study, *Kids Having Kids*; reports $8741 to $17,064 per pregnancy Productivity—productivity costs of teen pregnancy drawn from 1997 Urban Institute study; also includes "other benefits" of averted pregnancies; details not provided but reports $8323 per participating child	Even with "other benefits," the program is not cost-saving, with net benefit at –$1708 per student per year. Break-even occurs when horizon is extended to age 20–21 years or number of participants is increased to >60.
Tao (1998)[102]	3219 per participant per year	Type—assessment and counseling Community setting	Description—HIV risk assessment, peer counseling and education, and referrals Length—1 year (modeled over 10 years) Participants—501 gay and bisexual male adolescents	Assess and counsel—21%; Administration—32%; Support staff—18%; Rental—6%; Outreach—7%	Health—averted healthcare costs based on HIV modeling over 10 years—$141,467 Productivity—human capital gains reported to be $1,616,153 over 10 years, based on HIV modeling	ICER reported to be $8978/ QALY Efficacy used in calculations is 60% lower probability of having unprotected anal sex with recent partner
Wang (2000)[103]	66 per participant per year	Type—CB Setting—SB	Description—didactic education, peer facilitation, and videos to reduce sex risk Length—2 years Participants—2265	Teacher training—28%; Teaching—16%; Peer facilitators—25%; Coordination—23%; Curriculum packages—4%	Health—lifetime averted healthcare costs based on modeling of HIV, pelvic inflammatory disease, gonorrhea, chlamydia, and pregnancy—$252,190 Productivity—averted income loss due to HIV and pregnancy at age 18 years rather than 21 years modeled over lifetime—$202,970	Pregnancy, STIs, and HIV modeled on self-reported condom and contraceptive use Net benefit=$253,182 Benefit–cost ratio=2.65
Zabin (1988)[104]	173 per participant per year	Type—YD Setting—SB plus off-site clinic	Description—sex education, counseling, discussions. Classroom presentations; small group discussions; individual counseling at school Group education; individual counseling; dental and medical services in clinic Length—3 years Participants—1700	Personnel—75%–88%; Supplies—5%–11% Medical services made up 52% of costs in clinics.	None	No summary measure reported

(continued on next page)

Table 4. Description of economics studies included in the systematic review *(continued)*

Study	Program costs ($)	Type of study	Description of evaluation method Length of intervention	Health outcomes considered	Program costs Considered healthcare costs averted? Considered productivity losses averted?	Health outcome(s) monetized or included in economic summary Summary economic measure
Dissertation and review of programs						
Aos (2004)[105]	—	Evaluation for State of Washington legislature	The charge to Aos et al. from the legislature was to evaluate state programs targeting youth with social or health objectives. The current review focuses on seven programs that include the objective of pregnancy prevention. The effectiveness parameter values are drawn from 12 intervention evaluation studies associated with the seven programs. Intervention length for included studies—five were 1-year programs, and one each were 3 and 4 years.	Pregnancies	Costs per person, which is inclusive of program costs, ranged from minimum of $11 to a maximum of $13457, with median $725 The authors performed a comprehensive economic estimation of healthcare, productivity, and public welfare impacts.	Favorable net societal benefit is reported for one program of the seven evaluated, at $212 per person. The other six programs result in greater societal cost than benefit, ranging from –$15 to –$10,640 with a median of –$518.
Olaiya (2006)[106]	—	PhD dissertation evaluating the effect of comprehensive sex education programs	Parameter values for effect size drawn from six school-based intervention evaluation studies and applied to Census 2000 population Intervention description of included studies—all six studies were school-based behavioral interventions that included small group discussions, experiential learning, and role-playing. Two interventions included peer facilitators as staff in addition to adult professionals. All studies involved contraception education and communication skills, two involved the community, and one involved parents. Intervention length of included studies—duration ranged from 2–3 weeks to over 3 years.	Considered effect of programs on pregnancies and STIs	Program costs included interventions, ranged from $67.50 to $805 per person Evaluated healthcare costs averted for three age groups for pregnancies and STIs	Per-person 1-year averted healthcare costs for pregnancies and STIs: Aged 13–14 years—$7.25 Aged 15–17 years—$143.55 Aged 18–19 years—$406

CB, curriculum-based; ICER, incremental cost-effectiveness ratio; QALY, quality-adjusted life-year; SB, school-based; STI, sexually transmitted infection; YD, youth development

Table 5. Characteristics of the included studies for abstinence education

Characteristics	No. of study arms	% of total or M (min, max)
Components		
Single	18	78.3
Multiple	5	21.7
Focus		
HIV/STI only or multi (HIV/STI and pregnancy)	17	73.9
Pregnancy only	6	26.1
Setting		
School	18	78.3
Community	5	21.7
Deliverer		
Adult only (no peer)	21	91.3
Adult plus peer	2	8.7
Targeting		
No	16	69.6
Yes	7	30.4
Dosage		
Mean hours of contact with deliverer	16	15.8 (5, 52)
School level and age of recipients		
Middle (10–14 years)	22	95.7
High (15–19 years)	1	4.3
Gender		
Female only	1	4.3
Male only	0	0.0
Co-ed	20	91.3
Not reported	2	8.7
Majority race		
African-American	7	30.4
White	8	34.8
Hispanic	4	17.4
Asian	1	4.3
Mixed samples	1	4.3
Not reported	2	8.7
Virginity status		
Mean baseline percentage	16	80.0 (43,100)
Comparison group		
Untreated and minimal treatment	20	87
Treated	3	13
Study design		
RCT	10	43.5
Non-RCT	13	56.5

STI, sexually transmitted infection

ever, the results for sexual activity were significantly different when stratified by study design (see Subgroup Analyses section). Effect estimates for pregnancy and STI were in the unfavorable direction and significant for pregnancy. However, the pregnancy effect estimate was sensitive to the removal of any one of ten study arms (see One-Study-Removed section).

Secondary outcomes. The ORs for the secondary abstinence education outcomes number of sex partners, unprotected sexual activity, and use of protection during sexual activity were close to unity and not significant (Table 6).

Subgroup analyses. The same between- and within-study analyses were performed for the abstinence education review as for the comprehensive risk-reduction review. Meta-analysis revealed no consistent patterns across any of the moderator variables examined in these analyses except for study design. Between-study analyses revealed larger effect estimates for non-RCTs[110,111,117,119–124] and smaller effect estimates for RCTs.[107–109,112,113,116,118] For the sexual activity outcome—the only outcome with a substantial number of data points from both types of studies—the difference in effect estimates was significant (for RCTs, OR=0.94, 95% CI=0.81, 1.10; for non-RCTs, OR=0.66, 95% CI=0.54, 0.81; p=0.007; see Figure 3).

There also were differences in follow-up times for the two categories of study design. Longer follow-up times were reported in the RCTs—up to 6.5 years (M=3.2 years) whereas the maximum follow-up time for non-RCTs was 1 year (M=0.6 years).

Sensitivity Testing

Publication bias. Orwin's fail-safe N analysis indicated that 31 studies demonstrating no effect would be necessary to produce nonsignificant results for the sexual activity outcome. For all other outcomes, the results were

Table 6. Meta-analysis results and estimated RRs for primary and secondary review outcomes for abstinence education interventions

Outcomes[a]	*k*	*n* (studies)	*n* (study arms)	OR (95% CI)	Q statistic *p*-value	I^2	Estimated RR
Sexual activity[b]	23	19	21	0.81 (0.70, 0.94)	0.00	57.33	0.84
Frequency of sexual activity[b]	5	4	5	0.77 (0.57, 1.04)	0.03	62.73	—[c]
Number of sex partners	10	9	10	0.96 (0.83, 1.11)	0.32	13.35	0.96
Unprotected sexual activity	5	5	5	1.07 (0.86, 1.33)	0.96	0.00	1.06
Protection[d]	19	9	10	1.06 (0.96, 1.17)	0.68	0.00	1.06
Condoms[d]	10	9	10	1.04 (0.91, 1.19)	0.63	0.00	1.03
Oral contraceptives[d]	9	8	9	1.08 (0.94, 1.24)	0.49	0.00	1.05
Pregnancy[b]	10	9	10	1.15 (1.00, 1.32)[e]	0.43	1.02	1.08
STI[b]	9	8	9	1.08 (0.90, 1.29)	0.25	21.82	1.15
HIV[b]	0	0	0	—	—	—	—

[a]All of these outcomes were self-reported, with the exception of STIs, which were either self-reported or clinically documented.
[b]These outcomes reflect primary intended outcomes.
[c]Unable to calculate
[d]ORs >1.0 indicate beneficial effects.
[e]Secondary analyses suggest that this is an unreliable effect estimate.
RR, risk ratio; STI, sexually transmitted infection

not significant, and this analysis did not apply. Visual inspection of the funnel plot suggested the possible presence of publication bias, as studies with small sample sizes, which are subject to more chance variation, showed a pattern of greater intervention effects than larger studies.

One-study-removed analysis. Two of the seven outcomes were sensitive to the results of single studies. Removing one study arm[107] from frequency of sexual activity changed the overall nonsignificant effect size to significant. For pregnancy, removal of any one of the ten study arms[107,108,112,118] resulted in the overall effect becoming nonsignificant.

Economic Efficiency

Economic information about abstinence education interventions is limited. Federal and state matching funding for such programs since Fiscal Year 1998 was estimated at around $115.5 million annually.[118] One expert stated that more than $1.5 billion had been spent to date in 2005.[125] The only available estimate for cost of individual programs[126] is reported as cost of curricula, which ranged from $31 to $646 with an average cost of $220 for 21 curricula. The lower end of the cost is reported to include instructor guidelines, whereas the more expensive curricula included specialized training for the instructors. Published information about abstinence education programs is insufficient to estimate the economic benefit or cost effectiveness of these programs.

Potential Benefits and Harms, Barriers to Implementation, and Research Gaps for Comprehensive Risk-Reduction and Abstinence Education Interventions

Other positive or negative effects. The team sought to identify other positive or negative effects across both reviews. The additional benefits from both comprehensive risk-reduction and abstinence education interventions were identified in the review of the literature on sex education for adolescents as well as from evidence in each review. Potential harms noted in these reviews came only from evidence in studies in each review.

Potential benefits. One potential benefit is the positive effects on parent–child communication about sexual activity and other sensitive issues when these interventions involve parents.[108] However, parental involvement was uncommon in the studies in this review.

Potential harms. There are potential harms in the literature[127–129] regarding comprehensive risk-reduction and abstinence education interventions. The potential harms presented here focus only on those that could be addressed with the results from each review. A common concern about comprehensive risk-reduction interventions delivered to adolescents involves the potential for the intervention to lead to earlier initiation and greater frequency of sexual activity.[130] The results from the current systematic review of comprehensive risk-reduction interventions, however, indicate reductions in both sex-

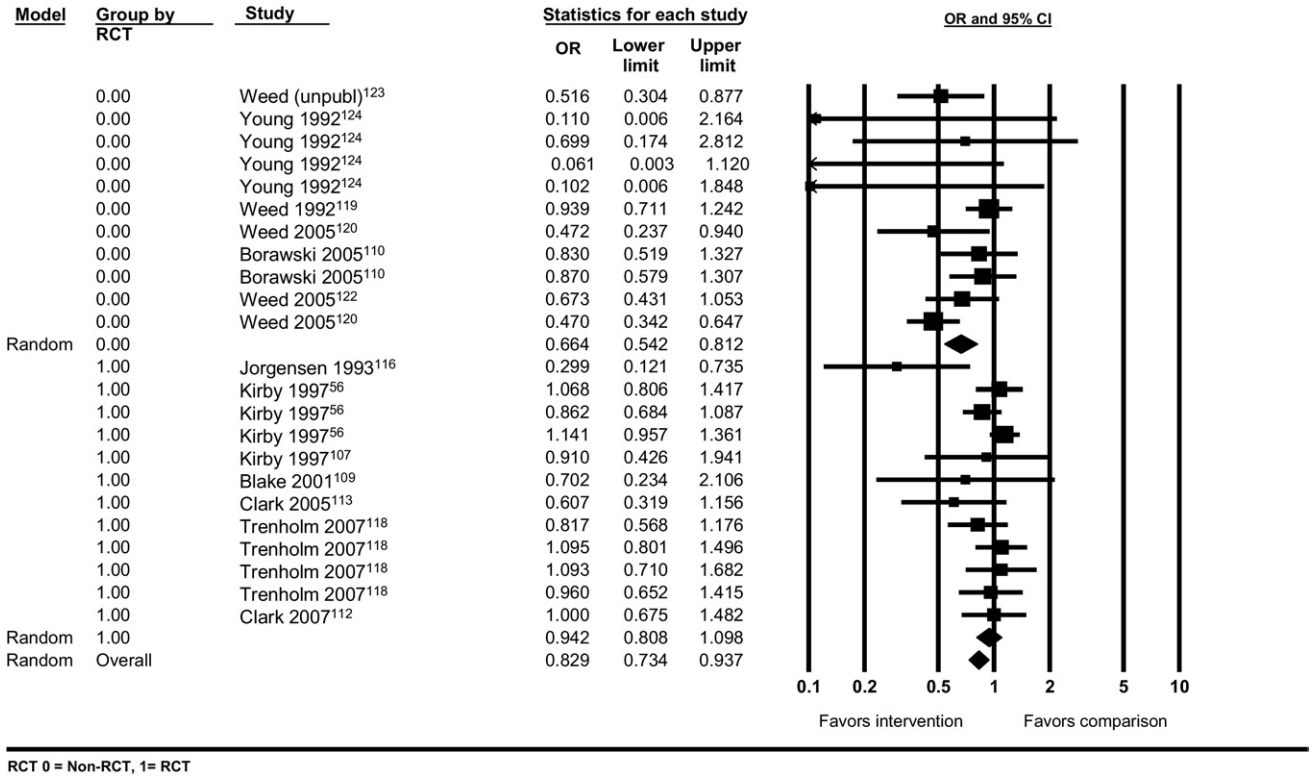

Figure 3. Forest plot of meta-analysis results for sexual activity outcome using random-effects model for abstinence education strategy

Note: Results are stratified by type of study design.

ual activity and frequency of sexual activity among adolescents compared to adolescents not receiving the intervention. Another common criticism of comprehensive risk-reduction interventions is that condoms do not provide complete protection from pregnancy and STIs, particularly because adolescents do not use them consistently,[130] but in this review the effects were similar for consistent condom use (in the few studies that reported it) compared to the broader condom use outcome.

A similar concern about abstinence education interventions is that they could potentially lead to a reduction in use of protection during sexual activity. However, the majority of the abstinence education studies measured this outcome and the results did not show any difference in use of protection between the treatment and comparison groups as a result of the intervention. Therefore, the results did not support the hypothesized outcome. Consistent condom use could not be evaluated because it was not reported among the abstinence education studies.

Barriers to Implementation

Barriers to intervention implementation identified in one or more of the included studies and the broader literature can be organized into three categories: restrictions on intervention activities, funding requirements, and participation challenges. One example of a restriction on intervention activities is community demands about intervention content.[131] Barriers related to funding requirements were numerous, but of particular note are those related to federal funding. During most of the time period covered in these reviews, to receive federal funding, sex education programs were required to teach abstinence and most needed to meet the eight federal abstinence education guidelines (Table 1).[20] There was no direct funding for comprehensive sex education, so these programs needed to seek other opportunities outside of federal funding. Currently, under the Patient Protection and Affordable Care Act of 2010, in addition to the Title V abstinence funding,[21,22] there is also funding available for evidence-based pregnancy prevention programs.[22,23] These programs can be either abstinence education or comprehensive risk reduction and do not need to specifically address HIV and other STIs.

Lastly, participation is also a challenge in these types of interventions. Low parental participation is common and may pose a challenge in studies where this is a component of the intervention.[132] There are also participation challenges for adolescents, especially in voluntary programs,

which can have difficulty recruiting participants and maintaining participation.[133]

Research Gaps

Across both reviews, there was no consistent evidence of differential effects on outcomes for any of the 12 critical moderator variables (gender, virginity status, age, race/ethnicity, setting, dosage, focus, deliverer, multicomponent, targeting, study design, and comparison group type). Also, the majority of the studies examined interventions delivered to coed groups and results were not reported by gender. This limits the ability to determine differential effectiveness by gender for comprehensive risk-reduction and abstinence education interventions. This limitation extends to the evaluation of the effectiveness of parental participation as well, since it was an uncommon component in these reviews and often had low participation rates.

More consistent reporting of moderator variables by study authors is needed to clarify which of these (or other characteristics) may maximize the effectiveness of adolescent sexual behavior interventions. In addition, common measures of sexual behavior and standard intervals for follow-up assessments of these outcomes would allow for more comparability across studies and lead to a better determination of the overall public health impact of these interventions.

In terms of economic efficiency, future research is needed to examine how cost–benefit or cost-effectiveness estimates vary depending on age, gender, and risk status of participants. For programs with objectives beyond pregnancy and STI prevention, future research needs to evaluate the full impact of such programs from a societal perspective, including nonhealth outcomes such as improved employment potential, and higher future earnings of program participants. Finally, for school-based programs, additional research needs to address the impact on school resources where the facilities, staff, or time from the school systems may be used for these programs.

Discussion

These two reviews summarize the evidence for Task Force conclusions on comprehensive risk-reduction and abstinence education interventions delivered to adolescents to prevent or reduce the risk of pregnancy, HIV, and other STIs.

Comprehensive Risk-Reduction Interventions

The overall effects for each outcome examined by the comprehensive risk-reduction interventions reviewed are considered meaningful when applied at the population level for both middle and high school students and across all of the protective and risk-reducing behaviors evaluated. Moreover, the magnitude of effect was sufficient to result in meaningful health improvements for all behavioral outcomes that comprehensive risk reduction was expected to influence (see analytic framework, Figure 1). Results from meta-analyses show that effects were favorable and significant for most primary outcomes, with approximate decreases of 12% in sexual activity (risk ratio [RR]=0.88); 14% in number of sex partners (RR=0.86); 25% in unprotected sexual activity (RR=0.75); 31% in prevalence of STIs (RR=0.69); and an approximate increase of 13% in use of protection (RR=1.13). The approximately 11% decrease in pregnancy (RR=0.89) was not significant. There were not enough data to estimate an RR for frequency of sexual activity, although the OR indicates a reduction (OR=0.81).

The results for all outcomes were favorable; however, there was a substantial amount of heterogeneity in the effects across studies. One explanation for the heterogeneity may be due to the diversity of interventions in the comprehensive risk-reduction review in terms of focus, length, and intensity of activities. Further, individual interventions demonstrated a wide range in magnitude of effect. The analysis of moderator variables did not find any specific variable that reduced heterogeneity, resulting in concern about a substantial amount of unexplained variability. Both heterogeneity and diversity among interventions tempered the findings of the review. Similarly, authors of a previous review[134] also noted that they were unable to determine key characteristics of effective interventions, possibly because of the varied content and methods of implementation of these interventions.

No one moderator variable was consistently associated with greater or lesser effectiveness of comprehensive risk-reduction interventions. For example, delivery of the intervention in a school setting was more effective for some outcomes, whereas for other outcomes, delivery in a community setting was associated with greater effectiveness. Although no explanation for this difference was found in the analyses conducted in this review, authors from a previous review[135] found that one of the characteristics of effective short programs (duration of 1–5 hours) was implementation in community settings, whereas one of the characteristics of programs with long-term effects (at follow-up >2 years) was implementation in school settings.

Differences in gender were seen for sexual activity and protection outcomes, with interventions having a greater effect on boys compared to girls. The team felt that this result may be because boys are more sexually active com-

pared to girls and boys have more control of decisions regarding condom use. Differential results among boys and girls have also been found when studying other risk behaviors such as substance abuse and violence.[136,137]

Abstinence Education Interventions

The analyses of abstinence education interventions demonstrated a potentially meaningful and significant effect on sexual activity, but demonstrated large differences in effect estimates when stratified by type of study design: the team found a nonsignificant effect of a similar magnitude on frequency of sexual activity and had difficulty drawing clear conclusions about effects on pregnancy and STIs. As expected, abstinence education interventions do not have an impact on secondary outcomes associated with reducing the risk of sexual activity. These results are consistent with a previous review of abstinence education.[17,118]

Although evidence on the effects of abstinence education suggests reductions in sexual activity of a similar magnitude to those found for comprehensive risk reduction, and no meaningful effects on any of the sexual risk-reduction behaviors, these results should be interpreted cautiously. As discussed previously,[17] it has been difficult to assess the effectiveness of abstinence education because of too few studies, weak designs, and the heterogeneity of program curricula and their implementation. This review identified a relatively small number of studies, with inconsistent findings across studies that vary by study design and follow-up time, leading to considerable uncertainty around the effect estimates for abstinence education. Closer investigation of the studies also revealed that the investigators conducting the studies also varied by study design.

Unlike the comprehensive risk-reduction review, study design had a consistent pattern of different effect estimates across all outcomes examined, with larger effects for nonrandomized studies compared to randomized studies. However, there are concerns about factors in both types of study designs. For example, follow-up times among study designs could not be compared because much longer follow-up times were reported in RCTs compared to non-RCTs. Moreover, although some authors had more than one study included in the review, all authors conducted studies with the same design (RCTs vs CBAs) and therefore no author had studies in both categories of the analysis when the studies were stratified by study design.

Since the completion of the abstinence education review, only one additional paper reporting positive results for an abstinence education intervention that would have met the inclusion criteria for this review was found.[138] The authors rigorously evaluated a school-based abstinence education intervention for 6th- and 7th-grade students (mean age 12 years) using an RCT design. The study reported reductions in sexual activity and frequency of sexual activity and would have contributed positive effects to the abstinence education analyses. However, the addition of this study in the meta-analysis resulted in a smaller overall effect estimate for sexual activity that is now nonsignificant (OR=0.90, 95% CI=0.81, 1.01) and it did not affect the problem of differential effects when stratified by study design (OR=0.97, 95% CI=0.86, 1.10 for RCTs with new study added and OR=0.65, 95% CI=0.50, 0.83 for non-RCTs). Additional studies of similar rigor are needed to add to the abstinence evidence base.

Limitations of Reviewed Studies

Studies included in both the comprehensive risk-reduction and abstinence education reviews had several limitations. First, all measures of behavioral outcomes were based on self-report, resulting in questions about validity. Review of the literature, however, suggests that group-level self-reported sexual behavior among adolescents is valid when such data are collected under appropriate conditions.[139] Description of the conditions under which data were collected in the studies in these reviews was often inadequate to determine if conditions were appropriate. Second, the description of intervention content was often thin, with no citations provided for more-detailed information. Team members who are experts in the field assisted with accurately categorizing the interventions examined. Finally, fidelity of implementation was not reported or adequately assessed in many studies.

Limitations were also identified during the analysis stage of the comprehensive risk-reduction review. As previously discussed, a large amount of heterogeneity was found across the studies (reflected by $I^2 > 50\%$ in most of the meta-analyses). Although the average effect is positive for all outcomes examined, several programs included in the analysis of these outcomes did not have positive effects.

In the abstinence education review, only one study evaluated the intervention in the older age group of adolescents (aged 15–19 years), which prevented any interpretation of the effect of this type of intervention when delivered to older adolescents. In the comprehensive risk-reduction review, most of the evidence for the STI outcome came from interventions conducted in the community setting. This distribution of studies by setting is important to note, because most of the evidence for the STI outcome comes from samples of adolescents at high risk for STIs who were recruited in clinical settings and the results may not be generalizable to the

school setting. No studies in either review reported HIV outcomes specifically or provided HIV screening to participants. However, the team hypothesized that the effect on HIV reduction would be similar to that of STI reduction in general, an outcome that was analyzed in these reviews.

Another limitation is that the search period for these reviews ended at the end of August 2007. For the comprehensive risk-reduction review, additional studies reporting results since 2007 probably would not change the overall conclusion that comprehensive risk reduction is effective, because, at minimum, 45 studies reporting null results would be needed to overturn the findings of a single outcome. For the abstinence education review, the team found only one additional paper that reports positive results for a theory-based abstinence education intervention.[138] As described earlier, the addition of data from this one paper does not change the conclusion from the abstinence education review as the issue of differential effects by type of study design remains.

Public Health Impact

In assessing the overall public health impact of abstinence education and comprehensive risk reduction, the ways in which each intervention is intended or expected to influence the ultimate health outcomes of interest—HIV, other STIs, and pregnancy—were identified. Comprehensive risk-reduction interventions are expected to both (1) reduce sexual activity and (2) increase behaviors that reduce the risks of sexual activity, whereas abstinence education would be expected to reduce only the public health outcomes of interest by reducing sexual activity. Because comprehensive risk reduction offers benefits both to adolescents who abstain from sex and to those who are sexually active, the overall public health impact for comprehensive risk reduction is expected to be greater than that for abstinence education when the intervention effects on sexual activity are similar. In addition, there was evidence of effectiveness for comprehensive risk-reduction interventions for both younger (aged 10–14 years) and older (aged 15–19 years) adolescents, whereas the evidence for abstinence education was almost solely based on adolescents in the younger (10–14 years) age group. Comprehensive risk reduction's broader distribution of benefits across the population of age groups and sexually active and sexually inactive adolescents is also desirable from a health equity perspective.

Conclusion

The value of these reviews is that they looked systematically and thoroughly across the entire identified body of evidence for trends, and the conclusions reached considered both the overall effects in the two reviews and extensive secondary analyses. They also serve as the foundation for the recommendations made by the Task Force on comprehensive risk-reduction and abstinence education interventions delivered to adolescents.[1] Findings from the comprehensive risk-reduction review showed these interventions to be effective in reducing sexual activity and increasing protective sexual behaviors in adolescents, whereas the findings from the review of abstinence education interventions were inconclusive because of inconsistencies in their effects on the outcomes examined.

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