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ARTICLE

Economic Evaluation of Safer Choices

A School-Based Human Immunodeficiency Virus, Other Sexually Transmitted Diseases, and Pregnancy Prevention Program

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Objective: To evaluate the cost-effectiveness and cost benefit of Safer Choices, a school-based human immunodeficiency virus, other sexually transmitted diseases, and unintended pregnancy prevention intervention for high school students.

Methods: The baseline cost-effectiveness and cost benefit were derived in 4 steps: (1) estimation of intervention costs; (2) adaptation of the Bernoulli model to translate increases in condom use into cases of human immunodeficiency virus and other sexually transmitted diseases averted, and development of a model to translate increases in contraceptive use into cases of pregnancy averted; (3) translation of cases averted into medical costs and social costs averted; and (4) calculation of the net benefit of the program. Multivariable sensitivity analysis was performed to determine the robustness of the base-case results.

Results: Under base-case assumptions, at an intervention cost of $105 243, Safer Choices achieved a 15% increase in condom use and an 11% increase in contraceptive use within 1 year among 345 sexually active students. An estimated 0.12 cases of human immunodeficiency virus, 24.37 cases of chlamydia, 2.77 cases of gonorrhea, 5.86 cases of pelvic inflammatory disease, and 18.5 pregnancies were prevented. For every dollar invested in the program, $2.65 in total medical and social costs were saved. Results of most of the scenarios remained cost saving under a wide range of model variable estimates.

Conclusions: The Safer Choices program is cost-effective and cost saving in most scenarios considered. School-based prevention programs of this type warrant careful consideration by policy makers and program planners. Program cost data should be routinely collected in evaluations of adolescent prevention programs.

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To REDUCE human immunodeficiency virus (HIV) infection, infection by other sexually transmitted diseases (STDs), and unintended pregnancy among US adolescents, school programs to reduce unprotected sexual intercourse have been implemented across the United States. Evaluations have shown that such programs indeed reduce unprotected sexual intercourse[1] and substantially increase condom use and other forms of contraceptive use among sexually active students.[2-6]

Because resources to fund school-based HIV, other STDs, and pregnancy prevention programs are limited, program efficacy alone is not sufficient to justify program implementation. Issues of practical concern to policy makers and program planners are cost (whether they can afford a particular prevention program), cost-effectiveness (whether the effects of a program justify the cost of its implementation), and cost benefit (whether the benefits of a program exceed its costs).

The effectiveness of selected school-based adolescent HIV, other STDs, and pregnancy prevention programs has been established; to our knowledge, however, no economic studies of those school programs have been conducted. From a broader perspective, cost-effectiveness and cost-benefit studies of behavioral interventions to reduce HIV and other STD infection and unintentional pregnancy among adults and adolescents are limited. Most of these studies have been of HIV risk reduction interventions that targeted intravenous drug users[7-10] (one of which includes youth in high-risk situations), adult urban women,[11] and adult or adolescent gay and bisexual men.[12,13] Few behavioral interventions have specifically addressed reduction of STDs other than HIV, and we found no published cost-effectiveness or cost-benefit analyses of such interventions or of interventions to

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MATERIALS AND METHODS

ANALYTICAL FRAMEWORK FOR ECONOMIC EVALUATION

Using a societal perspective, we considered the effects on the intervention students and their sexual partners in our models. We included program costs, the costs of condoms and oral contraceptives, and medical and social costs averted by prevention. All costs are in 1994 dollars to correspond with the timing of the intervention and data collection.

The base-case analysis was conducted in 4 steps. First, we estimated intervention costs. Second, we adapted the Bernoulli model[19] to translate increases in condom use into cases of HIV and other STDs averted, and we developed a pregnancy model to translate increases in contraceptive use into cases of pregnancy averted. Third, we translated cases of adverse health outcomes averted into medical and social costs averted. Fourth, we calculated the net benefit of the program. A multivariable sensitivity analysis was performed to determine the robustness of the base-case analysis.

INTERVENTION COSTS

Intervention costs consisted of program costs and the costs of condoms and oral contraceptives. To estimate the program costs, we conducted a retrospective cost analysis. We estimated the direct costs of program delivery (**Table 1**) incurred across the 5 major components of the Safer Choices program—school organization, curriculum and staff development, peer resources and school environment, parent education, and school-community linkages. We excluded the costs of developing the program and conducting the program evaluation.

The costs of condoms and oral contraceptives were estimated as the product of the number of condoms or oral contraceptives used within 1 year among intervention students and their sexual partners and the wholesale price of condoms or oral contraceptives. Because many teenagers obtain free condoms and subsidized oral contraceptives, the wholesale price is a more appropriate reflection of societal costs than the retail price. In our study, we used a wholesale price of $0.08 per condom, calculated by Tao and Remafedi.[15] In the Safer Choices evaluation,[18] 67% of 345 intervention students reported using condoms, and the average number of sexual contacts within 3 months was 6.65. Therefore, the estimated number of condoms used by intervention students and their partners within 1 year is 6148 (345 × 67% × 6.65 × 4). Because no published data are available for the wholesale price of oral contraceptives, we used a price of $0.95 per pack based on the purchase price at the Michigan State Health Department. Of 345 intervention students, 68% reported using contraceptives (oral contraceptives alone, condoms alone, or oral contraceptives and condoms), and the average number of sexual partners was 1.83 among these students.[18] Among the 345 intervention students, 50.7% were males and 49.3% were females, so the total number of female students and female partners was 490 [(345 × 50.7% × 1.83) + (345 × 49.3%)]. We assumed that half of the students who reported using any contraceptive used oral contraceptives and estimated number of oral contraceptive packs used within 1 year to be 1999 (490 × 68% × 0.5 × 12).

CASES OF HIV AND OTHER STDS AVERTED

We translated the increase in condom use into cases of HIV and other STDs averted. In our study, the category "other STDs" consists of chlamydia and gonorrhea infections and pelvic inflammatory disease (PID), a major medical consequence of these infections. We did not include human papilloma virus infection, the most prevalent STD in the United States,[20] because the effectiveness of condom use to prevent human papilloma virus infection is not clear. We also translated the increase in contraceptive use into cases of pregnancy and pregnancy outcomes averted. In our study, pregnancy outcomes include abortion, miscarriage, and live birth.

For our economic analysis, we made several assumptions in translating the increase in condom use into cases of HIV and other STDs averted. (1) All sexual partners were of the opposite sex. The effectiveness study of Safer Choices asked about sexual intercourse without specifically inquiring about same-sex behavior. (2) The sexual partners of intervention students were from a pool outside the intervention group with no overlap among sexual partners. Because only about 35 students were sexually active in each intervention school, the chance that their sexual partners were in the same group is small. (3) The intervention prevented disease transmission from infected sexual partners to uninfected intervention students (primary transmission), and it prevented transmission from infected intervention students to uninfected sexual partners (secondary transmission). (4) The HIV prevalence rates and STD incidence rates among sexual partners of intervention students were the average rates of 2 age groups, those aged 15 to 19 years and those aged 10 to 44 years, because we did not know the age distribution of the students' partners. (Other STDs are all bacterial infections or, in the case of PID, caused by bacterial infection. Because the time between transmission and treatment is much shorter than that of viral STDs, such as HIV, we used the prevalence rate for HIV and the incidence rate for other STDs.) (5) Condom use per act was equal to the percentage of students using condoms at last intercourse. (6) The intervention effects lasted for 1 year.

We adapted the Bernoulli model of HIV transmission[19] to translate the increase in condom use into cases of HIV and other STDs averted. The Bernoulli model is a cumulative probability equation that estimates the probability of HIV infection based on 4 variables—number of sexual partners, number of sexual contacts with each partner, HIV prevalence, and probability of transmission. According to the model, the probability, P, of becoming infected as the result of engaging in a total of n sexual acts with a single partner is as follows:

$$P = 1 - [(1 - \pi) + \pi(1 - \alpha)^n],$$

where π is the prevalence of HIV infection in the population and α is the transmission probability of HIV. For primary transmission, we first calculated the probability of a sexually active student becoming infected in each study condition within 3 months as the result of engaging in an average of n sexual acts with each of the m partners (P_c or P_i), where i indicates the intervention condition and c indicates the control condition; then we converted the 3-month probability into a 1-year probability:

$$[1 - (1 - P_i)^4] \text{ or } [1 - (1 - P_c)^4].$$

For secondary transmission, we first calculated the probability of an uninfected sexual partner becoming infected in each condition within 3 months as the result of engaging in a total of n sexual acts with one infected student (P_c' or P_i'); then we converted the 3-month probability into a 1-year probability:

$$[1-(1-P_i')^4] \text{ or } [1-(1-P_c')^4].$$

Using the following equations, we calculated the total number of cases averted as X_p+X_s.

(1) Primary Transmission

$$P_c=1-\{[1-\pi]+\pi[1-\alpha(1-ef_c)]^n\}^m$$
$$P_i=1-\{[1-\pi]+\pi[1-\alpha(1-ef_i)]^n\}^m$$
$$X_p=N_p[(1-P_i)^4-(1-P_c)^4]$$

(2) Secondary Transmission

$$P_c'=1-[1-\alpha(1-ef_c)]^n$$
$$P_i'=1-[1-\alpha(1-ef_i)]^n$$
$$X_s=N_s[(1-P_i')^4-(1-P_c')^4],$$

where X_p is the number of cases averted by preventing primary transmission within 1 year and X_s is the number of cases averted by preventing secondary transmission within 1 year. The remaining model variables are listed in **Table 2** with their definitions, base-case values, the range of values used for sensitivity analyses, and sources.

For the HIV prevalence rate, we used 50% of the estimated prevalence of the Job Corps population in California and Texas (0.0019) for the 15- to 19-year-old age group because the Job Corps population is a group with a higher prevalence of HIV infection than the general adolescent population. For the 10- to 44-year-old age group, we used data from the *Guide to Clinical Preventive Services*[21] to determine the HIV prevalence rate. We estimated STD incidence rates using surveillance data from the Centers for Disease Control and Prevention, Atlanta, Ga,[24,25] and case report data from California and Texas.

We considered the number of PID cases averted as a result of preventing chlamydia and gonorrhea infections. Chlamydia infections affect 4 million persons each year and cause 25% to 50% (average, 37.5%) of the 2.5 million cases of PID reported each year in the United States.[21] Between 10% and 20% (average, 15%) of untreated gonorrhea infections lead to PID, and up to 80% of women infected with gonorrhea are asymptomatic.[21] Using the 1994 STD incidence rates from California and Texas, we estimated the proportion of gonorrhea infections by sex (men, 54%; and women, 46%). Then, we concluded that for each case of chlamydia prevented, 0.234 (37.5% × 2.5 ÷ 4) cases of PID would be averted, and that for each case of gonorrhea prevented, 0.055 (15% × 80% × 46%) cases of PID would be averted.

PREGNANCY CASES AVERTED

We developed a pregnancy model to translate contraceptive use into cases of pregnancy averted:

$$Y=N_f\{[g_cK+(1-g_c)L]-[g_iK+(1-g_i)L]\}$$
$$L=1-(1-Q)^{12}$$
$$Q=q_1\times q_2\times q_3\times q_4,$$

where Y is the total number of pregnancies averted. The remaining model variables are listed in **Table 3** with their definitions, base-case values, the range of values used for sensitivity analyses, and sources.

Because there were no directly measured data for the probability of becoming pregnant within 1 year without contraceptive use (L), we first calculated the 1-month probability (Q) as $q_1 \times q_2 \times q_3 \times q_4$, and converted this 1-month probability into a 1-year probability as $1-(1-Q)$.[12] *Contraceptive failure rates* are defined as the percentage of women aged 15 to 19 years who experience an unintended pregnancy within the first year of use[14]: 16.6% for condoms, 5.9% for oral contraceptives, and 1.0% for both condoms and oral contraceptives. We estimated the overall contraceptive failure (K) as the weighted average failure rate of the 3 contraceptive methods (condoms, 16.6% × 49.25%; oral contraceptives, 5.9% × 1.5%; and both, 1.0% × 49.25%).

COSTS AVERTED

We considered medical and social costs averted by the Safer Choices program.

Medical costs averted by preventing HIV, other STDs, and pregnancies were calculated as the number of cases averted multiplied by the medical cost per case. For medical cost per case, we considered 2 payer perspectives—private sector and public sector (**Table 4**). Because studies on public sector costs are limited, we were restricted to using private sector cost data for the base-case analysis. We used private sector and public sector costs for the sensitivity analysis.

For the cost of HIV treatment, we used the medical cost of intermediate level of care, discounted at 5% and adjusted to 1994 dollars, from a study by Holtgrave and Pinkerton.[15] The cost data for chlamydia and gonorrhea treatments are from a study by Trussell et al,[14] also adjusted to 1994 dollars. Trussell and colleagues drew costs for the private sector analysis from Medstat's 1993 MarketScan database, which contains payment information from large employer programs, and drew costs for the public sector analysis from the California Medicaid program. For the medical cost per case of PID in the private sector setting, we used the weighted cost estimated by Howell et al.[27] Howell and colleagues calculated the weighted cost of PID by combining the probability of sequelae (hospitalization for PID, chronic pelvic pain, ectopic pregnancy, or infertility) and the associated costs as estimated by Washington and Katz,[28] who had reviewed discharge data from California acute care hospitals and cost data from San Francisco, Calif, practices and the American Medical Association. No cost data per case of PID are available for the public sector, so we assumed the cost to be 50% of the private sector cost.

The medical cost per live birth was estimated by the Division of Reproductive Health, Centers for Disease Control and Prevention, using 9 months of Medstat Data from 1995 (**Table 5**). Diagnosis-related group codes were used to categorize maternal and birth status. The cost per live birth includes the costs of maternal and newborn care and was estimated as a weighted average cost by combining the probability of various birth outcomes (normal full-term infants, preterm infants, and infants with problems). We calculated the abortion rate by using the birth rate and abortion ratio reported by Koonin and colleagues.[30] We calculated the miscarriage rate by subtracting the abortion rate and birth rate from the pregnancy rate. No data were available on medical costs of miscarriage; we

Continued on next page

assumed them to be the same as those for abortion. For the occurrence of prenatal care, we used data from the study of Ventura et al,[31] in which 92.7% of mothers had live births and used prenatal care. The medical cost per pregnancy was calculated as the weighted average of costs for abortion, miscarriage, live birth, and prenatal care.

For the social cost of HIV infection, we used the approximation of $430 000 per patient (in 1990 dollars) in lost productivity (foregone wages) determined by Holtgrave et al[33] which was based on earlier calculations by McKay and Phillips.[34] The estimate was based on a 6% discount rate and the assumption that the average patient with acquired immunodeficiency syndrome is 37 years old at the time of diagnosis. For the social cost of pregnancy, we used the average cost of $8606 per case of childbearing (in 1996 dollars) by Maynard,[16] which estimated the average cost saving during a 13-year period following childbirth among women who gave birth at the age of 20 to 21 years compared with women who gave birth at younger than 18 years. The estimate was based on a 5% discount rate, and included the costs of earnings-related outcomes, public assistance, and other consequences. We calculated the social costs averted by preventing HIV and pregnancy as the number of cases averted multiplied by the estimated social cost per case.

SENSITIVITY ANALYSIS

To test the robustness of the base-case results, we conducted a multivariable sensitivity analysis over a reasonable range of 6 variable estimates: probability of HIV and other STD transmission, HIV prevalence rate, STD incidence rates, condom use per act, contraceptive failure rate, percentage of students using contraceptives, and medical cost per case. The data sources for all variables are the same as those used in the base-case analysis. For condom use per act and percentage of students using contraceptives, we used a 50% SE and the base-case value to calculate the upper- and lower-bound estimates.

Table 1. Safer Choices Program Costs*

Component	Variable	California	Texas	Total Cost, $
Teacher training	No. of teachers	26.00	35.00	...
	Hourly pay, $	19.47	13.33	...
	No. of hours	30.00	30.00	...
	Subtotal, $	15 186.60	13 996.50	**29 183.10**
Teaching	No. of schools	5.00	5.00	...
	No. of classes per school	10.00	10.00	...
	No. of lessons	10.00	10.00	...
	Hourly pay, $	19.47	13.33	...
	Subtotal, $	9735.00	6665.00	**16 400.00**
Peer facilitators	No. of peer facilitators	5.00	5.00	...
	Stipend per person, $	2000.00	3087.36	...
	Subtotal, $	10 000.00	15 436.80	**25 436.80**
Site coordinator training	No. of site coordinators	5.00	5.00	...
	No. of hours	10.00	10.00	...
	Hourly pay, $	19.47	13.33	...
	Subtotal, $	973.50	666.50	**1640.00**
Site coordination	No. of site coordinators	5.00	5.00	...
	No. of hours	144.00	144.00	...
	Hourly pay, $	19.47	13.33	...
	Subtotal, $	14 018.40	9597.60	**23 616.00**
Curriculum packages	No. of curriculum packages	26.00	35.00	...
	Price for one curriculum, $	64.00	64.00	...
	Subtotal, $	1664.00	2240.00	**3904.00**
Implementation manuals	No. of implementation manuals	5.00	5.00	...
	Price for one implementation manual, $	49.00	49.00	...
	Subtotal, $	245.00	245.00	**490.00**
Activity kits	No. of activity kits	5.00	5.00	...
	Price for one activity kit, $	59.00	59.00	...
	Subtotal, $	295.00	295.00	**590.00**
Photocopies for students	No. of handouts	19.00	19.00	...
	No. of students in the intervention group	1255.00	1010.00	...
	Price of photocopy per page, $	0.01	0.01	...
	Subtotal, $	238.45	191.90	**430.35**
Photocopies for teachers	No. of handouts	19.00	19.00	...
	No. of teachers	26.00	35.00	...
	Price of photocopy per page, $	0.01	0.01	...
	Subtotal, $	4.94	6.65	**11.59**
Videos	No. of videos	5.00	5.00	...
	Cost of video, $	115.00	115.00	...
	Subtotal, $	575.00	575.00	**1150.00**

Values were provided by ETR Associates, Scotts Valley, Calif. The total program cost was $102 851.84. Ellipses indicate data not applicable.

Table 2. Data Used to Calculate HIV and Other STD Cases Averted*

Data Used (Variable)	Reference	Value† HIV	Value† Chlamydia	Value† Gonorrhea
HIV prevalence rate or STD incidence rate of sexual partners				
Partners aged 15-19 y	‡ and §	0.001	0.117	0.009
Partners aged 10-44 y	US Preventive Services Task Force[21] and §	0.004	0.038	0.004
Average (π)	‖	0.002 (0.001-0.004)	0.078 (0.038-0.117)	0.006 (0.004-0.009)
Single sex act transmission probability (α)	Jones and Wasserheit[20] and Brockmeyer and Gail[22]	0.016 (0.001-0.030)	0.450 (0.350-0.550)	0.530 (0.350-0.700)
Condom effectiveness in preventing HIV and other STDs (e)	Centers for Disease Control and Prevention[23]	0.95	0.95	0.95
Condom use per act				
Control condition (f_c)	Coyle et al[18]	0.52	0.52	0.52
Intervention condition (f_i)	Coyle et al[18]	0.67 (0.64-0.70)	0.67 (0.64-0.70)	0.67 (0.64-0.70)
No. of contacts with one partner within the last 3 mo, intervention condition (n)	Coyle et al[18]	3.63	3.63	3.63
No. of partners per student within the last 3 mo, intervention condition (m)	Coyle et al[18]	1.83	1.83	1.83
No. of uninfected students, intervention condition (N_s)	‖	343.70	185.17	332.96
No. of uninfected sexual partners of infected students, intervention condition (N_r)	‖	2.37	269.80	21.90

*Cases of pelvic inflammatory disease averted were not calculated using these variables. See "Cases of HIV and Other STDs Averted" subsection in the "Materials and Methods" section for description. HIV indicates human immunodeficiency virus; STD, sexually transmitted disease.
†Values in parenthesis were used for sensitivity analyses.
‡Fifty percent of the estimated HIV prevalence (0.0019) among Job Corps participants in California and Texas.
§Derived from state STD and population data of California and Texas.
‖Authors' calculations.

prevent teenaged pregnancy. A few studies[14-17] have examined the costs associated with HIV and other STD treatment and the costs of teenage pregnancy and parenthood.

This study evaluates the cost-effectiveness and cost benefit of Safer Choices, a school-based education program designed to prevent HIV, other STDs, and pregnancy among high school students. Safer Choices is a 2-year, theory-based, multicomponent intervention, an evaluation of which was implemented during the 1993-1994 and 1994-1995 school years. The primary aim of Safer Choices is to reduce the number of students engaging in unprotected sexual intercourse by reducing the number of sexually active high school students and by increasing condom and contraceptive use among those students who have sex. The program focuses on schoolwide change to influence student behavior.

The effectiveness evaluation of Safer Choices was a randomized trial involving 10 schools in northern California and 10 schools in southeast Texas. Five of the schools in each state were randomly assigned to the intervention; the remaining schools were assigned to a comparison program consisting of a standard, information-based, HIV prevention curriculum. Data from baseline and 3 follow-ups at 7, 19, and 31 months were collected for the effectiveness evaluation, but our study is based on only the 7-month results because the results for the subsequent follow-ups are still unpublished. The cohort for the effectiveness evaluation of the first 7 months of Safer Choices consisted of 3677 ninth-grade students who completed the baseline and first follow-up surveys.[18] Of these students, 47.5% were male and 52.5% were female. The ethnic and racial representation was mixed: 31% white, 27% Hispanic, 18% Asian or Pacific Islander, 17% African American, and less than 1% American Indian or Alaska Native; 7% of the students indicated they were of another race or ethnicity. Multilevel statistical analyses were used to adjust for baseline variation and the clustering effects within schools. These analyses found a significant increase in condom ($P=.02$) and contraceptive ($P=.03$) use at last intercourse among the 345 students who reported having sex in the previous 3 months. At first follow-up, 52% of students in the control group and 67% of students in the intervention group reported using condoms at last intercourse, and 57% of students in the control group and 68% of students in the intervention group reported using contraception at last intercourse.

RESULTS

The **Figure** displays the results of base-case analysis. The results of the sensitivity analysis (**Table 6** and **Table 7**) demonstrate that changes in major model variables influenced health and economic benefits. Although the results of most scenarios remained cost saving, there are 2 scenarios in which the results are not cost saving. The first occurs when the following variable estimates are used:

low probability of HIV or STD transmission, low percentage of students using contraceptives, high contraceptive failure rate, low medical costs, and low prevalence or incidence rate. The second scenario is identical to the first scenario, except that low condom use per act is used instead of low prevalence or incidence rate. The probability of either scenario occurring is low. Although not cost saving, the 2 scenarios may well be cost-effective, because the total costs averted in the scenarios are close to the intervention cost.

COMMENT

The models developed in our study allowed us to test the cost-effectiveness and cost benefit of a sexual risk reduction intervention to determine whether the intervention can be justified from an economic perspective. The methods and data used are conservative, and the findings are generally robust. The results of our study suggest that the Safer Choices program can be delivered at a reasonable cost and that it is cost-effective and cost saving in most scenarios considered. The cost-effectiveness of the program may vary by geographic region and depends largely on 4 factors: HIV prevalence and STD incidence rates; program costs; medical care costs for HIV and other STDs treatment; and medical care costs of pregnancy outcomes, especially live birth. The Safer Choices program will generally be more cost-effective, with higher prevalence and incidence rates, higher health care costs, and lower program costs.

The results of our study are generally consistent with those of other economic analyses showing modest behavioral effects to be cost-effective. For example, one study[7] found that prevention could be cost-effective even if as few as 1 in 260 drug users changed his or her behavior to prevent a new HIV infection. Other economic analyses[11-13] have also found that behavioral interventions may be cost-effective in reducing HIV infection. Our study expands the existing literature by providing a realistic economic assessment of the effect of an intervention on several adverse outcomes related to risky sexual behavior in a general population.

Table 3. Data Used to Calculate Pregnancies Averted

Data Used (Variable)	Reference	Value*
Probability that ovulation in a given month can support a pregnancy (q_1)	Becker[25]	0.45
Probability of coitus in the fertile period $q_2 = 1 - [1 - (2/28)]^s$	Becker[26]	0.18
Probability of fertilization given coitus in the fertile period (q_3)	Becker[26]	0.95
Probability that a conception is recognized, given fertilization occurs (q_4)	Becker[26]	0.61
Probability of becoming pregnant within 1 mo without contraceptive use ($Q = q_1 q_2 q_3 q_4$)	†	0.05
Probability of becoming pregnant within 1 y without contraceptive use [$L = 1 - (1 - Q)^{12}$]	†	0.43
Women who experience a contraceptive failure within 1 y of initiating contraception (K), %	†	9 (5-13)
Frequency of student sexual contacts within 1 mo, intervention condition (s)	Coyle et al[18]	2.22
Students using contraception, %		
Control condition (g_c)	Coyle et al[18]	57
Intervention condition (g_i)	Coyle et al[18]	68 (65-71)
No. of female students plus No. of female sexual partners of male intervention students (N)	†	488.18

*Values in parenthesis were used for sensitivity analyses.
†Authors' calculations.

Table 4. Cost of Medical Treatment per Case of HIV and Other STDs*

		Cost, $	
Disease	Reference	Private Sector (Base-Case Analysis)	Public Sector (Sensitivity Analysis)
HIV	Holtgrave and Pinkerton[15]	148 518.26	148 518.26
Chlamydia	Trussell et al[14]	107.80	100.60
Gonorrhea	Trussell et al[14]	107.80	62.60
PID	Howell et al[27] (private sector and public sector†)	4891.00	2445.50

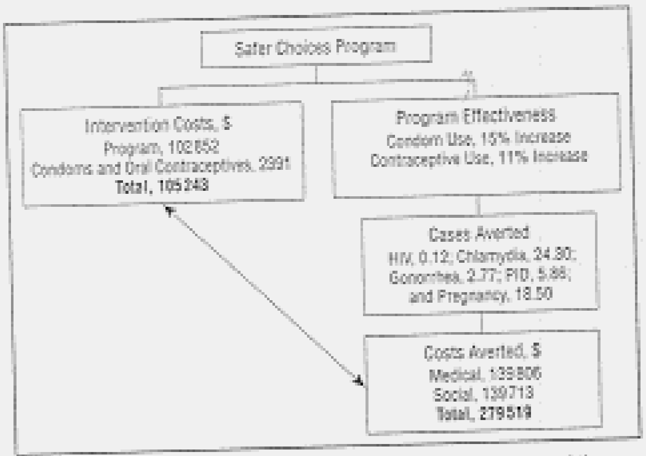
*Costs were adjusted to 1994 dollars. HIV indicates human immunodeficiency virus; STD, sexually transmitted disease; and PID, pelvic inflammatory disease.
†Authors assumed public sector cost was 50% of private sector cost.

Table 5. Pregnancy Consequences and Medical Cost per Case*

	Occurrence			Medical Cost			
	Per 1000 Women		All Pregnancies %	Private Sector (Base-Case Analysis)		Public Sector (Sensitivity Analysis)	
Variable	No.	Reference		$	Reference	$	Reference
Pregnancy	108.0	Ventura et al[29]	100.00	4885.10	†	2239.50	†
Abortion	24.4	Koonin et al[30]	22.63	314.00	‡	147.20	‡
Miscarriage	24.7	. . .	22.83	314.00	. . .	147.20	. . .
Live birth	58.9	Ventura et al[29]	54.54	8169.10	§	3719.90	Holtgrave and Pinkerton[15]
Prenatal care	54.6	Ventura et al[31]	50.56	568.70	Institute of Medicine[32]	284.30	‖

*Costs were adjusted to 1994 dollars. Ellipses indicate data not available.
†Weighted average medical costs for abortion, miscarriage, live birth, and prenatal care.
‡Planned Parenthood of Georgia, Atlanta, 1998.
§Division of Reproductive Health, Centers for Disease Control and Prevention, Atlanta, Ga, 1999.
‖Authors assumed public sector cost was 50% of private sector cost.

To our knowledge, our study is the first to assess the cost-effectiveness of a school-based sexual risk reduction intervention. The study findings have implications for resource allocation and curriculum decisions made by school health administrators in state and local education agencies and in individual schools. First, a school-based sexual risk intervention can be cost-effective; thus, school-based prevention programs of this type warrant careful consideration by policy makers and school administrators. Second, local factors such as program costs, prevalence rates, incidence rates, and medical costs should be taken into account in making decisions about whether an intervention will be cost-effective. Third, more economic analyses of school programs must be performed to enable policy makers and school administrators to look beyond simple effectiveness in making decisions about which curricula to implement in classrooms. Researchers should routinely include cost data and other variables likely to influence cost-effectiveness in their program evaluations.



The results of base-case analysis. The net benefit was $174 276, and the benefit-cost ratio was 2.65. HIV indicates human immunodeficiency syndrome; PID, pelvic inflammatory disease.

Our study has several limitations. First, we used a simple, 1-year cumulative probability to estimate the number of HIV and other STD infections averted. Such an approach does not take into account long-term and dynamic infections averted; a more complicated model is needed to simulate the epidemic of HIV and other STDs transmission more precisely. However, the simple model yields conservative estimates of infections averted. Second, data on model variables are limited. There are no empirical data directly available for some of the model variables, such as HIV prevalence rate and other STD incidence rates of sexual partners of intervention students, the probability of becoming pregnant without contraceptive use, medical care costs of adolescent pregnancy, and other variables. In these cases, the best estimates for the base-case analysis were not precise. Third, we assumed that all sexual relations were heterosexual because there are no data available for the percentage of adolescents who engage in same-sex sexual acts nor the differential effectiveness of the intervention for these youth. Fourth, in the absence of information about partner choices, we assumed that sexual partners of inter-

Table 6. Sensitivity Analysis Part 1: HIV and Other STD Cases and Costs Averted*

Variable	Probability of Transmission (Value)	No. of Cases Averted				Medical Costs Averted, $		Social Costs Averted, $	Total Costs Averted, $	
		HIV	Chlamydia	Gonorrhea	PID	Private Setting	Public Setting		Private Setting	Public Setting
Prevalence or incidence rate (value)										
Lower bound	Lower bound	0.006	26.95	2.76	6.46	35 524	19 413	2887	38 411	22 299†
Upper bound	Lower bound	0.010	34.72	4.20	8.36	46 287	25 415	4811	51 098	30 226
Lower bound	Upper bound	0.159	14.41	1.47	3.45	38 071	29 458	76 495	114 566	105 952
Upper bound	Upper bound	0.274	21.85	3.15	5.29	62 105	48 878	131 821	193 926	180 699
Condom use per act (value)										
Lower bound	Lower bound	0.006	23.46	2.65	5.64	31 112	17 043	2887	33 999	19 929†
Upper bound	Lower bound	0.010	40.30	4.41	9.67	53 354	29 211	4811	58 165	34 022
Lower bound	Upper bound	0.173	13.81	1.75	3.33	39 140	30 824	83 230	122 370	114 054
Upper bound	Upper bound	0.261	24.94	2.97	6.00	64 315	49 330	125 567	189 881	174 897

*HIV indicates human immunodeficiency virus; STD, sexually transmitted disease; and PID, pelvic inflammatory disease.
†Not cost saving.

Table 7. Sensitivity Analysis Part 2: Pregnancy Cases and Costs Averted

Contraceptive Use Per Act (Value)	Contraceptive Failure Rate (Value)	No. of Cases Averted		Medical Costs Averted, $		Social Costs Averted, $	Total Costs Averted, $	
		Pregnancy	Live Birth	Private Setting	Public Setting		Private Setting	Public Setting
Lower bound	Lower bound	15.0	8.18	73 277	33 593	66 406	139 683	99 999
Upper bound	Lower bound	26.3	14.33	128 478	58 899	116 431	244 909	175 330
Lower bound	Upper bound	11.9	6.49	58 133	26 650	52 682	110 815	79 332*
Upper bound	Upper bound	20.8	11.34	101 610	46 582	92 082	193 692	138 664

*Not cost saving.

vention students were from a pool outside of the intervention group based on the few intervention students in each school. Fifth, cost studies on adolescent pregnancy and pregnancy outcomes are limited; more up-to-date cost analyses are needed.

This study has demonstrated how economic analysis can be applied to a primary prevention intervention targeting adolescents. As more behavioral studies of school- and community-based interventions demonstrate effectiveness in reducing adolescent risk behaviors, it will be increasingly important to study their cost-effectiveness. Economic evaluation should become a routine part of adolescent health research to better enable policy makers and program planners to determine which intervention programs will most efficiently decrease adolescent risk behaviors and at what cost.

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