

Comprehensive sexuality education to reduce pregnancy and STIs in adolescents in the United States: A systematic review and meta-analysis

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Research article

Keywords: abstinence, adolescent, comprehensive sexuality education, pregnancy, sexually transmitted infections

Posted Date: September 21st, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-764336/v1>

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Abstract

Background.

The United States has a higher rate of teen pregnancy than any other developed country with 30% of American girls becoming pregnant before the age of 20. Laws regarding the inclusion and content of sexuality education vary across the country, which are associated with differences in pregnancy and sexually transmitted infection (STI) rates between states. This systematic review aims to determine whether comprehensive sexuality education (CSE) is more effective than abstinence-only or no sexuality education at reducing teenage pregnancy. Secondary objectives include analyzing the effect of CSE on STI incidence, sexual activity, safe-sex behaviors, and social discomfort.

Methods.

We searched MEDLINE (PubMed), EMBASE (Ovid), Cochrane Central Register of Controlled Trials, and Scopus for studies published from 1990–2021. Additionally, we searched ClinicalTrials.gov and Google Scholar and manually searched reference lists of included papers.

Results.

Twenty-nine studies met our inclusion criteria. Only seven included pregnancy as an outcome, with three fitting our meta-analysis criteria. There was a decrease in pregnancy rates for participants in the CSE intervention compared to the control ($n = 3$, risk ratio = 0.89, 95%CI 0.79– 1.00, $I^2 = 0\%$). Fifteen of 21 studies reporting safe-sex behaviors, 8 of 24 reporting sexual activity, and 0 of 3 reporting STI rates found statistically significant results favoring CSE. In the narrative synthesis, we found an increase in safe-sex behaviors, specifically condom use, in adolescents receiving CSE compared to no intervention.

Conclusions.

CSE is likely to reduce pregnancy rates; however, there was limited data available on this outcome. CSE increased safe-sex behaviors but did not have a notable impact on sexual activity or STIs. Future research should include the effects of CSE on social discomfort as well as more studies comparing CSE to abstinence-only education. This review can serve as evidence for the implementation of CSE in the US.

Background

Compared to other western developed countries, the United States (US) has a higher rate of teen pregnancy with persistent racial/ethnic, socioeconomic, and geographic disparities.[1, 2] The birth rate in 2014 for Hispanic and non-Hispanic Black females aged 15–19 was 39.8 and 37.0 per 1000, respectively, compared to 18.0 for White females.[3] Furthermore, low socioeconomic status is highly correlated with an increase in teenage pregnancies, with states clustered in the south and southwest regions with overall low socioeconomic status having higher rates.[2, 4] Seventy-five percent of these teenage pregnancies were unintended, and women who were non-Hispanic Black or whose income was below the poverty line were more likely to report an unintended pregnancy.[5] Teenage pregnancy is often associated with greater health risks, including eclampsia, postpartum endometritis, and systemic infections in the mother.[5] Teenage pregnancy can increase school dropout rates, limit future opportunities, and lead to rejection or violence from partners, guardians, or society.[4] Additionally, more than half of incident sexually transmitted infections (STIs) are diagnosed in individuals aged 15–24.[6] The disparities above shed light on the need for the US to provide successful interventions to reduce the rates of STIs and teenage pregnancy.

Adolescent sexuality education in the US varies by state, municipality, and school. Twenty-nine states mandate sexuality education in schools, 37 require sexuality education to cover abstinence, and 18 require information to be provided on birth control.[7] Only 15 states require the education to be medically accurate.[7] Comprehensive sexuality education (CSE) involves the physical and psychosocial sides of sexuality to promote healthy and safe sexual behaviors.[8] CSE can also include information on the benefits of abstinence. Abstinence-only education focuses only on waiting until marriage to have sex.[9] It has not been shown to reduce sexual behavior or unplanned pregnancy rates, and some studies have seen an increase in teenage pregnancy rates resulting from an abstinence-only education.[9, 10] A positive correlation was found between states with the highest-emphasis on abstinence-only education and teen pregnancy rate.[10] Arkansas, which has the highest rate of teen pregnancy at 30.4 per 1000, requires sexuality education to stress abstinence.[7] Conversely, Massachusetts, with the lowest rate at 7.2 per 1000, requires that sexuality education be culturally appropriate and unbiased, without a mandated stress on abstinence-only.[7] Alaska, with the highest rate of chlamydia, one of the most common STIs in the US, at 832.5 per 100,000, has no requirements for sexuality education.[11–13] West Virginia, with the lowest rate of chlamydia at 198.2 per 100,000, mandates that sexuality education covers contraception and condoms, in addition to abstinence.[7, 12] Prior research has focused primarily on school-based CSE interventions, but adolescents can learn in other settings, including at home or in the community. A systematic review on studies conducted in the US comparing CSE to abstinence-only or no sexuality education delivered in various settings has not been completed.

The objective of this review was to determine the extent to which CSE during adolescence (ages 10–18) in the US is beneficial in reducing teen pregnancy and STIs compared to abstinence-only or no sexuality education. As an intermediary measure of behaviors that reduce teen pregnancy and STIs, we also looked at how CSE programs impacted safe-sexual behaviors, such as condom use, and sexual activity levels.

Methods

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol.[14] The study was registered within the Open Science Framework (OSF) platform prospectively (OSF: osf.io/t6yku) on March 2, 2021. The original protocol is available upon request and a log of changes made after starting the formal review can be found in **Appendix 1**.

Study Eligibility

The inclusion criteria with justifications we used to determine study eligibility are in **Appendix 2**. We included randomized controlled trials (RCTs) that (1) included adolescents between 10 and 18 with at least 50% of participants under 24, (2) had a CSE intervention group, (3) had an abstinence-only or no intervention control group, and (4) reported on pregnancy (primary outcome), STIs, safe-sex behaviors, sexual activity, or social discomfort. Pregnancy included females reporting they were pregnant and/or males reporting they got someone pregnant.

Search Methods

Databases, Search Terms, and Limits

In collaboration with a research librarian we developed a comprehensive search strategy that was executed in MEDLINE (PubMed), EMBASE (Ovid), Cochrane Central Register of Controlled Trials, and Scopus from 1990 to January 28, 2021. See **Appendix 3** for full information on our search strategy. We limited our search to (1) studies in English due to resource-restrictions, and (2) studies published after 1990 because the publication of the SIECUS Guidelines for CSE for school-aged children and adolescents in 1991 marks a shift in the field of sexuality education.[8] This was the first national approach and framework indicating what should be covered in sexuality education at various ages. We therefore decided to focus our study on what has been deemed the “modern era” of sexuality education.[8]

Additional Search Methods

We also searched: (1) ClinicalTrials.gov from inception to January 21, 2021, (2) reference lists of included papers, and (3) the first 100 hits on Google Scholar from 1990–2021. The strategies and results for these additional search methods are outlined in **Appendix 3**.

Study Selection

We used EndNote (Clarivate Analytics) for deduplication then Rayyan for primary and secondary screening.[15] For the primary screen, two independent screeners per reference (AB, AC, or RN) scanned identified studies’ titles and abstracts for inclusion. The two screeners discussed identified disagreements and brought in a third screener (AB, AC, or RN) for resolution when needed. The same process was followed for full-text review including documenting reasons for study exclusion.

Data Extraction

Two blinded researchers per reference (AB, AC, or RN) independently extracted data for all included articles according to a predefined data collection form in Google Sheets. After extraction, a third author was used to discuss any discrepancies. After piloting the form using two included articles to ensure consistency amongst reviewers, we extracted specific data on study details, outcome data, and methodological quality. The full list of items extracted is in **Appendix 4**. For all endpoint data, we extracted outcomes at one-year of follow-up. If one-year data was not reported, we extracted the last follow-up time point result reported.

Quality Assessment

We used the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) approach to assess the quality and strength of evidence across all included studies.[16, 17] This tool rates the level of certainty for outcomes of included studies as high, moderate, low, or very low (H/M/L/VL) for the following domains: risk of bias, inconsistency of results, indirectness of evidence, imprecision, publication bias, large magnitude of effect, dose-response gradient, and residual confounding. We used GRADE for the primary outcome of each study.

Assessment of Bias

We reviewed the risk of bias of each study using Version 2 of the Cochrane risk-of-bias tool for randomized trials (RoB 2).[18] Two authors per reference (AC and RN) conducted the risk of bias assessment independently and discussed disagreements. We assessed the risk of bias for the primary outcome of each study.[19] If the primary outcome was not specified, we assessed bias using the outcome authors based their power analysis on or the first outcome reported in the results section.

Statistical Analysis

Measure of treatment effect:

We used RevMan 5.4 for statistical analyses.[20] For each included study reporting the primary outcome, pregnancy, we calculated the relative risk (RR) and 95% confidence interval (CI) and pooled the findings in a forest plot. We used a random effects model because the studies included were conducted by different researchers and used a variety of populations within the US.[21]

For all secondary outcomes, we qualitatively summarized the results. We completed a narrative summary on how different features of CSE interventions (CSE interventions that emphasized abstinence or were interactive) impacted the reported findings. We opted not to complete a meta-analysis for secondary outcomes because these outcomes included a variety of measures. For example, safe-sex behaviors included condom use, dental dam use, birth control use, and more.

Dealing with missing data:

We treated missing outcome data for our primary outcome as “not missing at random” because it may have been indicative of selective reporting bias and/or attrition bias.[22] We therefore opted to impute missing data with replacement values. These replacement values were either the last observation carried forward or a presumed value such as assuming that the intervention had no impact. As the meta-analysis was only planned for our primary outcome, we deemed it appropriate to treat missing data for our secondary outcomes as “missing at random” and analyzed only the available data.

Assessment of heterogeneity:

We calculated the Higgins I^2 statistic to assess heterogeneity in sample estimates for the pregnancy outcome.[23] Based on the Cochrane Handbook’s guidelines, we set our threshold of $I^2 = 50\%$ or higher as indicative of significant heterogeneity.[23]

To assess for heterogeneity in our qualitative analysis, we examined and compared the number of positive, negative, and null findings per outcome domain (sexual activity, safe-sex behaviors, STI prevalence, and social discomfort). We assumed heterogeneity if there was a spread between positive, negative, and null findings. In addition, we addressed potential heterogeneity in CSE interventions by creating subgroups of CSE interventions based on identified features.

Assessment of publication bias:

We created a funnel plot to assess publication bias for our meta-analysis. By plotting estimates from our study’s findings through the log odds ratio against sample size, we determined indirect evidence through the shape of the plot. We used the criteria in the GRADE handbook to assess publication bias for our qualitative analysis.[17]

Subgroup analysis:

We identified three variables *a priori* for our subgroup analysis to determine if certain groups yielded different results. These variables were sex (male and female), race/ethnicity (Black, Hispanic, Asian or Pacific Islander, White, and other), and method of CSE delivery (school-, community-, virtual-, and home-based). We also performed a subgroup analysis to provide data on the benefits of CSE over abstinence-only education or no intervention individually to see if the results differed by the type of control.

Sensitivity Analysis:

We performed a sensitivity analysis based on our methodological quality assessment by excluding studies with some concerns or high risk of bias. To assess the impact of our decision to treat missing data as “not missing at random,” we performed a sensitivity analysis excluding studies where we imputed missing data.

Results

Description of studies

Results of search

As outlined in **Figure 1**, we identified 2,015 unique citations after deduplication. After screening titles and abstracts, 162 citations warranted full-text review and 29 citations met our inclusion criteria and were included in our analysis.

Included studies

Table 1 presents the characteristics of the 29 included RCTs. All were published between 1992 and 2018 in peer-reviewed journals. A total of 23,915 participants were analyzed. There were two RCTs with no intervention as their control group and one RCT with both no intervention and abstinence-only education control groups. Outcomes varied by timeframe (e.g., past 3 weeks, 30 days, 6 months, ever) and metric (i.e., frequency of the event or percent reporting the event).

Included interventions

The CSE interventions analyzed were not homogenous in content or delivery style. Twelve CSE interventions were school-based, one was virtual, one was home-based, and the remaining 15 were delivered in various settings (see **Appendix 5** for additional information on the study authors’ definitions of CSE interventions). There were nine studies with CSE interventions emphasizing abstinence. Nine studies had interactive CSE interventions, for example, utilizing computer-based activities with virtual exercises.[24]

Risk of Bias and Methodological Quality of Included Studies

Supplemental Table 1 in **Appendix 6** presents our assessment of risk of bias. Studies with the outcomes of pregnancy, STI, safe sex behaviors, and sexual activity had a moderate level of risk of bias based on the domains of randomization process, deviations from intended interventions, missing outcomes, measurement of the outcome, and selection of reported results.

Similarly, some of these outcomes (safe-sex behaviors, pregnancy, and STI rates) had a moderate overall level of methodological quality based on the GRADE assessment and did not report a dose-gradient relationship. In contrast with the other outcomes, studies with the primary outcome of sexual activity had a high level of inconsistency due to a large amount of variation in point estimates and confidence intervals. Out of sixteen studies, only one showed evidence of a dose-gradient relationship[25] This outcome had an overall rating of low for the quality of studies. Further information about the methodological quality of included studies can be found in **Supplemental Table 2** in **Appendix 6**.

Primary Outcome - Pregnancy

Seven studies reported pregnancy as an outcome (**Table 2**), three could be included in our meta-analysis, with a total of 1424 subjects analyzed. Our analysis yielded a RR of 0.89 (95% CI: 0.79, 1.00) with a P-value of 0.05 and an I^2 of 0% (**Figure 2**). The results favor CSE but are not statistically significant. We determined that our results may be susceptible to publication bias due to the asymmetry of the funnel plot, which likely can be explained by the small number of studies (**Supplemental Figure 1** in **Appendix 7**). However, the three studies we included cover a wide range of sample sizes, which is beneficial for reducing the risk of publication bias.

The remaining four studies either did not provide enough information to calculate the RR or did not include a 12-month follow-up point. In each of these four studies, there was a consistent trend toward fewer pregnancies reported in the CSE intervention group. Two studies yielded statistically significant results. Across all seven studies reporting pregnancy, all favored CSE with four (57.1%) being statistically significant. Two did not provide enough data to determine significance.

CSE Delivery Method

We did not have enough studies reporting our primary outcome to perform the planned quantitative subgroup analyses, so we summarized these findings qualitatively. Of the seven studies that reported pregnancy as an outcome, three were school-based, two were home-based, and two were community-based. None of the interventions were conducted virtually. Two found significantly lower pregnancy rates in the school-based delivery subgroup, one found significantly lower pregnancy rates in the home-based delivery subgroup, and one found significantly lower pregnancy rates in the community-based CSE interventions. Based on this analysis, the three delivery methods seem to have similar effectiveness, but more studies are needed to make any final conclusions.

Race and Biological Sex

We defined the race and sex subgroups as studies with African-American only vs mixed race participants and female only vs mixed sex participants, respectively, since many studies did not report race- or sex-specific data. Only one study reporting on pregnancy had all African-American participants and the remaining six had mixed-race participants. The African-American-only study results were not statistically significant, but favored CSE, while three of the six mixed-race studies had statistically significant results, favoring CSE. The mixed-race studies did not stratify outcomes by race, making it difficult to analyze the impact of race any further. The two studies reporting pregnancy outcomes with female only participants favored the CSE intervention, but were not statistically significant, whereas three of the five mixed-sex studies were statistically significant in favor of CSE.

Intervention Type

There was one study that reported on pregnancy and had a CSE intervention that emphasized abstinence. This study did not find a statistically significant difference between the intervention and control groups. Of the six studies with a CSE intervention that did not emphasize abstinence and reported pregnancy outcomes three (50.0%) found a statistically significant difference in favor of the CSE intervention. Among studies with an interactive CSE intervention that reported on pregnancy (n=2), none found a statistically significant difference between the intervention and control groups. There were five studies without an interactive CSE intervention that reported on pregnancy. Three (60%) found a statistically significant difference in favor of the CSE intervention.

Sensitivity Analysis

We were unable to complete our planned sensitivity analyses due to having only three studies in our meta-analysis. We calculated missing data in one of the three studies, which had the largest number of participants, so removing this study likely would have an impact on the findings. Two of the three studies in our meta-analysis had some concerns for bias, and one had low concerns. None of these studies reported statistically significant results. They all favored CSE, but we could not determine whether or not the bias risk had an impact on the results due to the small number of studies.

Secondary Outcomes - STI rates, safe-sex behaviors, sexual activity, and social discomfort

Twenty-eight studies reported at least one of our secondary outcomes. Twenty-one reported safe-sex behavior outcomes, 24 reported sexual activity outcomes, and three reported STI outcomes. No studies reported outcomes on social discomfort.

STI Rates. None of the three studies reporting this outcome yielded statistically significant results, however, the results all favored CSE. None of the three studies reporting on STI rates had a CSE intervention that emphasized abstinence. Studies with and without an interactive component had results that favored CSE intervention. Many other studies specified objectives directly related to reduction in STIs, but they did not include any results on their prevalence post-intervention.

Safe-Sex Behaviors. Of the 21 studies reporting outcomes related to safe-sex behaviors, 12 (57.1%) reported at least one statistically significant result, favoring CSE (**Table 3**). The most commonly reported outcomes were related to condom use (15 out of 21 studies). Eight of these 15 studies reported results that were statistically significant in favor of CSE. Of these statistically significant results, the majority were related to consistency and frequency of condom use. Condom use was often the study's primary outcome. Nine studies reported outcomes related to unprotected sex, with four finding that unprotected sex was significantly lower for those who received CSE. Seven studies reported an outcome related to birth control use, and four of these studies found that birth control use was significantly higher in the CSE intervention group. We categorized frequency of STI testing as a safe-sex behavior. The study reporting this outcome did not yield significant results, although it did favor CSE.

One study used abstinence-only as a comparison group in addition to no intervention.[26] The outcome, “frequency of condom use,” was statistically significant when comparing CSE to no intervention, but not to the abstinence-only intervention. Among studies with CSE interventions that emphasized abstinence and reported safe-sex behaviors (n=6), five (83.3%) reported findings that were statistically significant and in favor of the CSE intervention. The remaining study reported condom use at last sex and did not find a statistically significant difference.[27] For studies of CSE interventions that did not emphasize abstinence (n=15), nine (60%) reported positive and statistically significant outcomes. For studies with an interactive CSE intervention and reporting safe-sex behaviors (n=7), six (85.7%) reported positive and statistically significant outcomes. Of the remaining studies without an interactive CSE intervention reporting on safe-sex behaviors (n=14), eight (57.1%) found a statistically significant difference in favor of the CSE intervention group.

Sexual Activity. Of the 24 studies reporting outcomes related to safe-sex behaviors, eight (33.3%) reported at least one statistically significant result, favoring CSE (Table 3). The most commonly reported outcomes were related to engaging in any type of sex or sexual behaviors (e.g., ever had sex, frequency of sexual activity, and number of sexual partners), with 17 out of 24 studies reporting outcomes in this category. Six of these 17 studies reported results that were statistically significant, favoring CSE. Of these statistically significant results, the majority were related to ever having sex or the number of sexual partners. These were common primary outcomes as well. Seven studies reported an outcome related specifically to engaging in vaginal sex, with two of these studies reporting statistically significant results in favor of CSE. There were four studies that reported outcomes related to engaging in anal or oral sex specifically, two found that these instances were significantly lower in the CSE intervention group. Four studies reported outcomes related to sexual initiation, three found that sexual initiation was significantly lower for those who received CSE. Finally, three studies reported outcomes related to abstaining from sex, e.g., chose not to have sex under pressure and virginity rates. Only one was statistically significant, favoring CSE, but this was only true for the females in the study. One study had consistently significant results, favoring CSE, for the males in the study but not for the females when looking at ever having sex and having sex in the past 12 months.[28] This was different from other studies that reported separate male and female results and did not see a drastic difference.

Among studies of CSE interventions that emphasized abstinence and reported on sexual activity (n=9), four (44.4%) studies reported outcomes that were statistically significant and in favor of the CSE intervention compared to control. There were 15 studies that had CSE interventions that did not emphasize abstinence and reported outcomes on sexual activity. Of these, six (40%) found a statistically significant difference in favor of the CSE intervention compared to control. Among studies with an interactive CSE that reported on sexual activity (n=7), 5 (71.4%) reported outcomes with a statistically significant difference in favor of the CSE intervention. There were 17 studies without interactive CSE interventions that reported on sexual activity. Five (29.4%) found a statistically significant difference in favor of the CSE intervention.

Discussion

Summary of main findings

There is sufficient evidence to address the objectives of this review. The data we gathered from RCTs show that adolescents who received CSE were less likely to experience pregnancy and more likely to practice safe-sex behaviors, particularly condom use. The data did not provide evidence for changes in sexual activity or STI incidence. Additionally, the lack of studies measuring pregnancy prevented us from making meaningful conclusions about various CSE delivery methods, race, and sex. Only one included study used abstinence-only education as the comparison condition. Therefore, our results suggest that CSE decreases pregnancy rates and increases condom use when compared to no intervention, as there is insufficient data to make any conclusions regarding CSE compared to an abstinence-only education.

There was heterogeneity in the secondary outcomes reported and CSE interventions across the studies. Additionally, the populations of the included studies were diverse, with respect to race, sex, and setting. Outcomes varied by timeframe and metric, however most were similar enough for us to determine which outcomes were most impacted by CSE. Studies with CSE interventions that emphasized abstinence or were interactive yielded more positive and statistically significant differences in safe-sex behaviors and sexual activity outcomes compared to CSE interventions that did not emphasize abstinence or were not interactive. Too few studies reported pregnancy and STI incidence outcomes to look at results by intervention design. However, the diversity in populations studied, timeframes, and metrics increased the generalizability of our findings.

We were surprised to see so few results on STI rates, as many of the interventions were tailored toward HIV/AIDS reduction or STI reduction in general. Testing for STIs before and after the intervention would be another helpful outcome to measure in the future. Despite no studies reporting outcomes related to social discomfort, many adolescents experience social discomfort when learning about or discussing sexual health topics, as this area is inherently uncomfortable; therefore, the degree of social discomfort that the participants felt could affect their ability to learn from the interventions and impact other outcomes.[29]

Quality of the evidence

Based on the GRADE assessment tool, the general methodological quality of the included studies is moderate. The methodological quality of included studies with pregnancy, safe-sex behaviors, and STI rates as the primary outcomes was moderate while that of studies with sexual activity as the primary outcome was low. These results did not have a high level of quality.

Both the safe-sex behavior and sexual activity outcomes were similar in certain domains of GRADE. Most studies in both outcomes had a high number of participants, so the publication bias risk was low for both groups. Also, the point estimates for these studies were small, so these studies did not have a large magnitude of effect and had inconsistent findings with differences in these point estimates and confidence intervals. Two studies in both groups addressed the potential effects of residual confounding. Both tools (Cochrane RoB and GRADE) did not assess the presence of detrimental confounding variables in studies, so the levels of methodological quality for each outcome could be lower than the reported levels from the GRADE assessment.

Strengths and limitations of this review

The prospective registration of our protocol and tracking of changes (**Appendix 1**) prevented the authors from imposing bias to the results reported. The changes made to the initial protocol did not alter our findings or the overall objective of this review. Our study employed a comprehensive search strategy to identify potentially eligible studies. Each step of our review was double blinded to ensure validity. We used standardized and empirically supported tools to assess risk of bias and methodological quality for each included study. Although our search strategy was comprehensive, we did not search some databases that might have been relevant but did not focus primarily on randomized trials (e.g., CINAHL). While we included referenced protocols and trial registrations, we did not request uncited protocols or missing data from authors. This could have led to undetected publication and reporting bias of included studies due to omitted information. Another potential limitation is that we did not conduct a subgroup analysis between studies that had control groups with an active intervention (e.g., healthy eating intervention) compared to no intervention. The latter studies may have suffered from confounding variables. While the overall results were robust, only three studies were included in our meta-analysis. Statistical significance may have been achieved in our primary outcome if more studies met our eligibility criteria for the meta-analysis.

Agreements and disagreements with other studies or reviews

A prior systematic review published in 2016 analyzed RCTs comparing CSE interventions to no intervention.^[30] This review only looked at school-based CSE and studies completed outside the US. In contrast to our review, they found no change in pregnancy or STI prevalence, except for one study that found a decrease in the prevalence of HSV. US-based studies may have different priorities than studies in other regions. We included more outcomes than the prior review, including safe-sex behaviors and sexual activity. These outcomes can be process measures for reducing STI incidence. We did find CSE to be advantageous at increasing safe-sex behaviors, which, although is not a definite conclusion, could be related to a decrease in STIs. Furthermore, state-level data indicates a relationship between CSE and STI rates with lower STI incidence in states where CSE is mandated.

Conclusions

Implications for practice

Data from this review can serve as evidence for implementing CSE into schools, homes, or community-based platforms. Future research should look at the impact that race has on the effectiveness of CSE interventions, as many studies that we included had African American-only participants. This group has been studied more often and has been said to be at a higher risk for unintended pregnancy and STIs, so determining whether CSE is more or less effective for this group would be notable.^[31]

Our results fit into the context of current practice by providing evidence and information about the benefits of CSE interventions, which can promote safe-sex behaviors like condom use. We identified that certain features, such as having an interactive intervention, may increase the efficacy of CSE interventions. Also, this review provides evidence for the benefits of teaching adolescents about the harms of unsafe sexual activity. US states without current sexuality education requirements should assess the evidence provided to note the benefits of a policy change regarding implementation of CSE. Additionally, there are potential cost-saving incentives for states mandating CSE based on the results showing improvements in teen pregnancy rates. Adolescent pregnancies cost the US at least \$9.1 billion annually.^[32] There are additional social costs too.^[32] Further studies comparing CSE to abstinence-only will be needed before determining whether or not states that require abstinence-only could benefit from a policy change to CSE.

Implications for research

The results and conclusions of this review may be different if additional research had been conducted. When we reviewed articles, we found that some studies did not explicitly explain the control condition and/or describe aspects of the standard sexuality education, so we excluded these. In the future, an RCT comparing CSE to abstinence-only education should be conducted. Most studies we included did not involve this comparison. Also, more studies should be conducted that analyze CSE interventions that are highly effective for at-risk groups (e.g., African American, Hispanic). Furthermore, studies including social discomfort as an outcome could assess to what degree social discomfort could potentially mediate the effectiveness of CSE.

List Of Abbreviations

Comprehensive Sexuality Education (CSE); Sexually transmitted infections (STI); United States (US); Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA); Open Science Framework (OSF); Randomized controlled trial (RCT); Grading of Recommendations, Assessment, Development and Evaluations (GRADE); Cochrane risk-of-bias (RoB); Relative risk (RR); Confidence interval (CI)

Declarations

Ethics approval and consent to participate

No ethical approval or participation consent was necessary for this report.

Consent for publication

Not applicable.

Availability of data and materials

Not applicable.

Competing interests

The authors declare no relevant conflicts of interest.

Funding

No funding was received to assist with this review.

Author Contributions

AB, AC, and AM conceptualized the idea for the study. Search methods and data extraction were performed by AB, AC, and RN. Data analysis was conducted by AB and Risk of Bias analysis was conducted by AC and RN. All authors contributed to the first draft of the manuscript and commented on subsequent manuscript versions. RY, the supervisor, critically revised the work, and all authors read and approved the final manuscript.

Acknowledgements

We thank Paige Scudder, Dr. Rebecca Emeny, and Dr. Rebecca Evans for their help with this review.

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Tables

Table 1. Characteristics of included studies

First author last name, year of publication	Study period	Age range	Race/ethnicity (%)	Gender (%)	Intervention delivery method	Comparator	Number enrolled	Number analyzed
DiClemente, 2004[33]	September 1995- August 2002	14-18	African American: 100%	Female: 100%	Other (specify)*	No intervention	1130	460
Barbee, 2016[34]	September 2011- March 2014	14-19	Non-Hispanic white: ~7% Non-Hispanic Black: ~88% Hispanic: ~3% Asian ~0.3%	Female: ~63%	Other (specify)*	No intervention	1448	1378
DiClemente, 2010[35]	April 1999- June 2000	14-20	African American: 100%	Female: 100%	Other (specify)*	No intervention	170	86
Jenner, 2016[36]	2012-2014	14-18	Intervention/Control: African American: 84.8%/82.66%	Intervention: Female: 52.63% Control: Female: 52.6%	Other (specify)*	No intervention	850	688
Jemmott, 1998[26]	NR	Mean: 11.8	African American: 100%	Female: 53%	School-based CSE	Abstinence only and No Intervention	NR	610
Koo, 2011[37]	2001-2003	Fifth-sixth grade	African American: 99%	Female: 54%	School-based CSE	No intervention	NR	928
Markham, 2012[24]	2006-2010	Mean (SD): 12.6 (0.76)	African American: 39.3% Hispanic: 48.4% Other 12.2%	Female: 59.8%	School-based CSE	No intervention	1742	794
Morrison-Beedy, 2013[38]	December 2004- August 2009	15-19	Black/African American: 69% White/Caucasian: 9% Mixed/multiracial: 11% Other: 11%	Girls: 100%	Other (specify)*	No intervention	738	484
O'Donnell, 2017[25]	2010-2014	Mean: 11.7	Latino: 100%	Female: 52.6%	Home-based CSE	No intervention	2621	3283
Kerr, 2009[39]	1997-2006	13-17	Caucasian: 74% African American: 2% Hispanic: 7% Native American: 4% Asian: 1% Mixed ethnic heritage: 13%	Female: 100%	Other (specify)*	No intervention	85	83
Peskin, 2015[40]	NR	Mean (SD): 14.32(0.59)	Hispanic: 74% African American: 17% Other: 9%	Female: 59%	Other (specify)*	No intervention	4718	1374
Oman, 2018[41]	2012-2014	13-18	Non-Hispanic White: 20.6% Hispanic: 36.8% Non-Hispanic Black: 20.0% Non-Hispanic Asian or Pacific Islander: 1.6% Non-Hispanic Native American/Alaska Native: 3.8% Non-Hispanic multiracial: 17.2%	Male: 79%	Other (specify)*	No intervention	1037	881
Sieving, 2011[42]	April 2007- October 2008	13-17	Intervention/Control: American Indian/Native American: 3%/2% Asian/Asian American/Pacific Islander: 10%/13%	Female: 100%	Other (specify)*	No intervention	253	239

			Black/African/African American: 45%/38% Hispanic /Latina: 17%/8% White/European American: 6%/16% Mixed/Multiple: 19%/23%					
Tortolero, 2010[43]	2004-2007	7th grade-9th grade. Mean: 13.0	African American: 42.3% Hispanic: 44% Other: 13.7%	Female: 59.1%	School-based CSE	No intervention	1445	907
LaChausse, 2016[44]	October 2013-May 2014	Mean (SD): Intervention: 14.63 (0.50) Control: 14.63 (0.48)	Intervention/Control: White: 0.34/0.38 Black: 0.18/0.18 Asian: 0.08/0.09	Intervention: Female: 0.52 Control: Female: 0.56	School-based CSE	No intervention	4267	3490
Kaufman, 2014[27]	2006-2007	10-12	American Indian and Alaska Native: 100%	Intervention: Female: 48.79% Control: Female: 45.17%	School-based CSE	No intervention	NR	635
Aarons, 2000[45]	February 1996-May 1997	7th-8th graders	Females/Males:: African American: 84.7%/82.3% Hispanic: 12.0%/14.1% Other: 1.8%/1.2%	Female: 274 (of 522)	School-based CSE	No intervention	582	422
Coyle, 2006[46]	2000-2001	NR	Intervention/Control: African American: 29.0%/25.8% Asian American: 16.9%/12.8% Hispanic/Latino: 27.6%/31.5% White: 12.2%/12.3% Other or multi-ethnic: 14.2%/17.6%	Intervention: Male: 61.2% Female: 38.8% Control: Male: 65.0% Female: 35.0%	School-based CSE	No intervention	988	308
Milhausen, 2008[47]	December 1996-April 1999	14-19	African American: 100%	Female: 100%	Other (specify)*	No intervention	522	460
Sherr, 2013[48]	NR	13-17	Intervention/Control: Black: 20.8%/26.8% Hispanic: 72.1%/68.4% White and other: 7.1%/7.8%	Intervention: Girl: 52.0% Boy: 48.0% Control: Girl: 59.1% Boy: 40.9%	School-based CSE	No intervention	973	966
Philliber, 2002[49]	NR	13-15	Intervention/Control: Black: 60%/52% Hispanic: 39%/45% Other: 1%/3%	Female: 55.4% Male: 44.6%	Other (specify)*	No intervention	600	484
Jemmott, 1992[50]	October 1988-January 1999	Mean: 14.64	Black: 100%	Male: 100%	Other (specify)*	No intervention	NR	157
Allen, 1997[51]	1995-1995	9-12th grade	Intervention/Control: Black: 67.7%/66.6% White: 17.0%/20.4% Hispanic: 12.9%/9.6% Other: 2.4%/3.4%	Intervention: Females: 86% Males: 14% Control: Females: 83.3% Males: 16.7%	School-based CSE	No intervention	NR	NR

Klein, 2011[52]	NR	14-18	African American: 100%	Female: 100%	Virtual CSE	No intervention	178	162
Walter, 1993[53]	1990-1991	12-20	Black: 36.7% Hispanic: 35.4% Other: 27.9%	Male: 41.5%	School-based CSE	No intervention	NR	1201
Scholes, 2003[54]	June 1999- April 2000	18-24	White: 69% Black: 19% Other: 12%	Female: 100%	Other (specify)*	No intervention	1210	1046
Coyle, 2004[28]	1997-1999	Mean: 11.5	African American: 5.2% Asian: 15.9% Latino: 59.3% White: 16.5% Other: 3.1%	Female: 50.1%	School-based CSE	No intervention	2829	NR
Jemmott, 2010[55]	February 1998- February 2002	13-18	Black or African American: 89.9%	Female: 56.2%	Other (specify)*	No intervention	3445	1707
Jemmott, 2005[56]	NR	12-19	African American: 463/682 Hispanic: 219/682	Female: 100%	Other (specify)*	No intervention	682	682

Abbreviations: NR (Not Reported); CSE (Comprehensive Sex Education); SD (Standard Deviation)
*See **Appendix 5** for additional information on intervention delivery method

Table 2. Summary of pregnancy outcome for adolescents provided with a comprehensive sexuality education versus an abstinence-only education or no sexuality education.

First author last name, year	Authors' description of outcome	Length of follow-up	CSE			Abstinence-only or no intervention			Difference between groups
			Baseline n(%) or mean (SD)	Endpoint n(%) or mean (SD)	Change	Baseline n(%) or mean (SD)	Endpoint n(%) or mean (SD)	Change	
Kerr, 2009	Pregnancy since baseline.	12 months	0	9.1% (of 44)	N/A	0	17.9% (of 39)	N/A	NR
Oman, 2018	Ever been or gotten someone pregnant	12 months	177 (34.6%)	220 (50.5%)	NR	185 (36.4%)	250 (56.2%)	NR	AOR: 0.67 (95%CI 0.46-0.99)
DiClemente, 2010	Self-reported pregnancy	12 months	NR	6.00%	NR	NR	8.50%	NR	AOR: 0.74 (P=0.52, 95%CI 0.30-1.82)
LaChausse, 2016	Ever been pregnant or gotten someone pregnant	6 months	0.60%	0.02 (0.12)	NR	0.60%	0.03 (0.16)	NR	Mean difference: -0.01 (P=0.07)
Coyle, 2006	Pregnancy since baseline (among sub-sample reporting sexual activity previous 3 months)	12 months	NR	NR	NR	NR	NR	NR	OR: 1.15 (P=0.66)
Philliber, 2002	Became pregnant or caused pregnancy	3 years	NR	10	NR	NR	17	NR	P<0.05
Allen, 1997	Pregnancy (ever)	9 months	6.10%	4.20%	NR	10%	9.8%	NR	P<0.05

Abbreviations: CSE (Comprehensive Sexuality Education); N (Number); SD (Standard Deviation); CI (Confidence Interval); N/A (Not Applicable); NR (Not Reported); AOR (Adjusted Odds Ratio); OR (Odds Ratio)

Table 3. Summary of secondary outcomes for adolescents provided with a comprehensive sexuality education versus an abstinence-only education or no sexuality education.

			CSE			Abstinence-only or no intervention			Difference between groups
First author last name, year	Authors' description of outcome	Length of follow-up	Baseline n(%) or mean (SD)	Endpoint n(%) or mean (SD)	Change	Baseline n(%) or mean (SD)	Endpoint n(%) or mean (SD)	Change	
Safe-sex behaviors									
DiClemente, 2004	Consistent condom use in last 30 days	12 months	60 (40.3)	73.30%	NR	75 (43.4)	56.50%	NR	AOR: 2.23 (P=0.02, 95%CI 1.17-4.27)
	Consistent condom use in last 6 months	12 months	101 (43.5)	58.10%	NR	119 (48.6)	45.30%	NR	AOR: 2.14 (P=0.01, 95%CI 1.20-3.84)
	Condom use during last sex	12 months	74 (31.9)	72.30%	NR	79 (32.1)	53.90%	NR	AOR: 3.32 (P<0.001, 95%CI 1.86-5.92)
	Percent that used condom in past 30 days	12 months	79.23 (38)	79.97 (36.64)	NR	77.47(38)	62.82 (45.28)	NR	Mean difference: 21.09 (P<0.001, 95%CI 10.73-32.20)
	Percent that used condom in past 6 months	12 months	72.44 (37)	73.49 (37.86)	NR	70.38(38)	57.58 (43.21)	NR	Mean difference: 18.33 (P=0.001, 95%CI 9.46-29.86)
	Episodes of unprotected vaginal sex in last 30 days	12 months	1.12 (2.84)	1.15 (3.03)	NR	0.84 (2.01)	2.04 (4.47)	NR	Mean difference: -1.06 (P=0.002, 95%CI -1.86--0.44)
	Episodes of unprotected vaginal sex in last 6 months	12 months	4.81 (16.01)	5.77 (16.41)	NR	4.23 (10.25)	10.25 (24.66)	NR	Mean difference: -5.51 (P=0.02, 95%CI -11.18--0.34)
	Frequency of applying condoms on sex partner	12 months	NR	1.97 (1.28)	NR	NR	1.59 (1.09)	NR	Mean difference: 0.44 (P=0.003, 95%CI 0.19-0.77)
Barbee, 2016	Sex without condom in past 3 months	6 months	RTR: 317 (13.56%) LN: 320 (12.81%)	RTR: 317 (12.30%) LN: 320 (9.70%)	NR	13.79% of 290	16.6% of 290	NR	RTR: P=0.08 LN: P=0.007
	Sex without birth control	6 months	RTR: 317 (11.04%) LN: 313 (11.18%)	RTR: 317 (9.10%) LN: 313 (8.30%)	NR	12.24% (of 286)	17.5% (of 286)	NR	RTR: P=0.005 LN: P=0.001
DiClemente, 2010	Condom use at last intercourse	6-9 months	28.40%	NR	NR	28.20%	NR	NR	AOR: 3.9 (P=0.05, 95%CI 1.00-15.71)
	Consistent condom use over the past 30 days	6-9 months	NR	NR	NR	NR	NR	NR	AOR: 7.9 (P=0.05, 95%CI 1.00-56.7)
Jenner,	Inconsistency of	6	10.40%	Mean: 9.05	NR	12.79%	Mean:	NR	Mean

2016	condom use	months	(SD: 25.57)			(SD: 27.14)	6.74		difference (SD): 2.31 (1.80, P=0.2)
Jemmott, 1998	Reporting consistent condom use	12 months	NR	20 (62.5%)	NR	NR	AO: 14 (41.2%) NI: 21 (51.2%)	NR	AO: P=0.09 NO: P=0.35
	Frequency of condom use	12 months	NR	4.15 (1.21)	NR	NR	AO: 3.94 (1.28) NO: 3.16 (1.69)	NR	AO: P=0.55 NO: P=0.004
	Frequency of unprotected sexual intercourse	12 months	NR	0.17 (2.26)	NR	NR	AO: 0.29 (2.25) NO: 0.51 (2.26)	NR	AO: P=0.17 NI: P=0.13
	Percent reporting unprotected sexual intercourse	12 months	NR	9(5.4%)	NR	NR	AO: 16(9.8%) NO: 18 (10.8%)	NR	AO: P=0.13 NI: P=0.16
Markham, 2012	Unprotected sex at last vaginal intercourse	26 months	NR	NR	NR	NR	NR	NR	AOR: 0.67 (P<0.05, 95%CI 0.47-0.96)
	Number of times having vaginal sex in the last 3 months without a condom: one or more vs. zero	26 months	NR	NR	NR	NR	NR	NR	AOR: 0.59 (P<0.05, 95%CI 0.36-0.95)
	Number of times having anal sex in the last 3 months without a condom: one or more vs. zero	26 months	NR	NR	NR	NR	NR	NR	AOR: 0.96 (P<0.05, 95%CI 0.45-2.06)
Morrison-Beedy, 2014	Any episodes of unprotected vaginal sex	12 months	216 (66.7%)	170 (68.3%)	NR	211 (68.3%)	171 (72.8%)	NR	P>0.10
	Any episodes of unprotected vaginal sex with steady partner	12 months	206 (63.6%)	154 (63.4%)	NR	190 (61.5%)	160 (69.3%)	NR	P>0.10
	Any episodes of unprotected vaginal sex with non-steady partner(s)	12 months	41 (12.8%)	29 (11.9%)	NR	47 (15.3%)	36 (15.3%)	NR	P>0.10
Oman, 2018	Had sex without using birth control in past 3 months	12 months	131 (27.2%)	158 (37.9%)	NR	133 (26.8%)	165 (38.0%)	NR	AOR: 0.92 (95%CI 0.67-1.25)
Sieving, 2011	Condom use consistency	12 months	Never: 14% ≤ 1 time: 32% > 1 time: 23% Every time: 31%	Mean score: 0.96	NR	Never :9% ≤ 1 time: 33% > 1 time: 26% Every time: 32%	Mean score: 0.66	NR	AOR: 1.45 (P=0, 95%CI 1.26-1.67)
	Hormonal use consistency	12 months	No use: 36% 1 month: 21%	Mean score: 4.27	NR	No use: 45%	Mean score: 2.91	NR	AOR: 1.46 (P=0, 95%CI 1.13-1.89)

			2 months: 12% 3 months: 5% 4 months: 9% 5 months: 1% 6 months: 6% 7 months: 10%			1 month: 7% 2 months: 14% 3 months: 8% 4 months: 3% 5 months: 6% 6 months: 9% 7 months: 8%			
	Dual method use consistency	12 months	NR	Mean score: 0.83	NR	NR	Mean score: 0.53	NR	AOR: 1.58 (P=0.01, 95%CI 1.03-2.42)
Tortolero, 2014	Condom at last sex (for vaginal sex only)	Ninth grade follow-up	26(7.4%)	NR	NR	32(5.7)	NR	NR	ARR: 1.04 (95%CI 0.87-1.25)
	Number of times having vaginal sex in the last 3 months without a condom: 1 or more versus 0	Ninth grade follow-up	NR	NR	NR	NR	NR	NR	ARR: 0.92 (95%CI 0.71-1.19)
	Number of times having anal sex in the last 3 months without a condom: 1 or more versus 0	Ninth grade follow-up	NR	NR	NR	NR	NR	NR	ARR: 1.12 (95%CI 0.38-3.35)
	Number of vaginal sex partners in the last 3 months without a condom: 1 or more versus 0	Ninth grade follow-up	NR	NR	NR	NR	NR	NR	ARR: 0.86 (95%CI 0.63-1.18)
	Number of times having sex in the last 3 months without effective pregnancy prevention	Ninth grade follow-up	NR	NR	NR	NR	NR	NR	ARR: 0.59 (95%CI 0.51-1.35)
LaChausse, 2016	Ever had sexual intercourse without using birth control in the past 3 months	6 months	2%	0.04 (0.18)	NR	3%	0.06 (0.23)	NR	Mean difference: -0.02 (P=0.01)
Kaufman, 2014	Condom use at last sex	12 months	80.65%	NR	NR	76.19%	NR	NR	Girls: B: -0.498 (P=0.736, 95%CI -3.391-2.394) Boys: B: -0.704 (P=0.464, 95%CI -2.589-1.181)
Aarons, 2000	Used birth control/condoms	12 months	Females: 39.1% (of 139)	NR	NR	Females: 27.3% (of	NR	NR	Females: AOR: 3.39 (P<0.05,

	last time had sex		Males: 79.7% (of 123)			135) Males: 71.2% (of 125)			95%CI 1.16-9.95) Males: AOR: 1.54 (95%CI 0.55-4.26)
Coyle, 2006	Frequency of intercourse without a condom in previous 3 months	12 months	NR	NR	NR	NR	NR	NR	Ratio of adjusted means: 1.2 (P=0.6)
	Use of condom at last intercourse	12 months	NR	NR	NR	NR	NR	NR	OR: 0.88 (P=0.66, 95%CI 1.24-3.56)
	Number of partners without a condom previous 3 months	12 months	NR	NR	NR	NR	NR	NR	Ratio of adjusted means: 0.79 (P=0.27)
	Use of effective pregnancy prevention method at last intercourse	12 months	NR	NR	NR	NR	NR	NR	OR: 1.12 (P=0.6, 95%CI 0.74-1.66)
	Frequency of intercourse without a condom in previous 3 months with steady partners	12 months	NR	NR	NR	NR	NR	NR	Ratio of adjusted means: 0.09 (P=0.51)
	Frequency of intercourse without a condom in previous 3 months with non-steady partners	12 months	NR	NR	NR	NR	NR	NR	Ratio of adjusted means: 0.1 (P=0.65)
	Number of partners without a condom past 3 months	12 months	NR	NR	NR	NR	NR	NR	Ratio of adjusted means: 0.07 (P=0.74)
	Number of non-steady partners without a condom previous 3 months	12 months	NR	NR	NR	NR	NR	NR	Ratio of adjusted means: 0.03 (P=0.99)
	Number of times tested for HIV	12 months	NR	NR	NR	NR	NR	NR	Ratio of adjusted means: 0 (P=0.99)
	Number of times tested for other STD	12 months	NR	NR	NR	NR	NR	NR	Ratio of adjusted means: 0.06 (P=0.5)
Philliber, 2002	Used condom and hormonal method at last sex	3 years	NR	21%	NR	NR	20	NR	NS
	Used condom at last sex	3 years	NR	86%	NR	NR	83	NR	NS
Jemmott,	Rated frequency	3	NR	Mean	NR	NR	Mean	NR	Mean

1992	of condom use	months		(SD): 4.25(22)			(SD): 3.50(21)		difference: 0.85 (95%CI 0.14-1.56)
	Number of days the respondent did not use a condom during coitus	3 months	NR	Mean (SD): 0.64(58)	NR	NR	Mean (SD): 2.38(48)	NR	Mean difference: -1.73 (95%CI -2.86--0.60)
Klein, 2011	Number of vaginal sex acts with condom last 90 days	3 months	2.67	5.53	2.86 (P=0.05, 95%CI 0.02-5.71)	4.79	4.67	-0.13 (P=0.95, 95%CI -4.02-3.76)	NR
	Proportion of vaginal sex acts with condoms last 90 days (sexually initiated who have had vaginal sex in the last 90 days only)	3 months	0.51	0.71	0.2 (P=0.05, 95%CI 0.00-0.40)	0.72	0.57	-0.16 (P=0.12, 95%CI -0.36-0.05)	NR
Walter, 1993	Percentage of students who changed for high-risk partners	3 months	NR	NR	NR	NR	NR	NR	P<0.05
	Percentage of students who changed for monogamy	3 months	NR	NR	NR	NR	NR	NR	P<0.05
	Percentage change of students with consistent condom use	3 months	NR	NR	NR	NR	NR	NR	P<0.05
Scholes, 2003	Any use of condoms in prior 3 months with: any partner	6 months	71%	72.8%	NR	73%	63.00%	NR	OR: 1.86 (P=0.0005, 95%CI 1.32-2.65)
	Any use of condoms in prior 3 months with: a primary partner	6 months	67%	69.10%	NR	68%	57.90%	NR	OR: 1.97 (P=0.003, 95%CI 1.37-2.86)
	Any use of condoms in prior 3 months with: a non-primary partner	6 months	79%	87.50%	NR	73%	76.90%	NR	OR: 2.25 (P=0.09, 95%CI 0.91-6.07)
	Average percentage of time condoms used with any partner	6 months	NR	52.70%	NR	NR	47.90%	NR	OR: 5.2 (P=0.05, 95%CI 0.4-10.4)
	Consistent use of condoms in prior 3 months with all partners	6 months	NR	36.80%	NR	NR	33.50%	NR	OR: 1.24 (P=0.21, 95%CI 0.89-1.73)
Jemmott, 2010	Consistently use condoms in prior 90 days	12 months	210 (56.9%)	156 (56.1%)	NR	205 (60.3%)	126 (50.0%)	NR	OR: 1.39 (P=0.02, 95%CI 1.06-1.84)
	Proportion of condom-protected sexual intercourse in prior 90 days	12 months	Mean (SE): 0.72 (0.02)	Mean (SE): 0.72 (0.02)	NR	Mean (SE): 0.76 (0.02)	Mean (SE): 0.69 (0.03)	NR	Beta: 0.06 (P=0.04, 0.00-0.12)

	Frequency of condom use in prior 90 days	12 months	Mean (SE): 3.81 (0.08)	Mean (SE): 3.60 (0.08)	NR	Mean (SE): 3.92 (0.08)	Mean (SE): 3.57 (0.10)	NR	Mean difference: 0.2 (P=0.03, 95%CI 0.02-0.39)
	Used condom at last sexual intercourse	12 months	340 (70.2%)	250 (71%)	NR	330 (74.0%)	224 (70.9%)	NR	OR: 1.29 (P=0.05, 95%CI 1.00-1.67)
Jemmott, 2005	Number of days of sex without condom use in the past 3 months	12 months	Mean (SE): Information: 3.45 (0.55) Skills: 2.23(0.40)	Mean (SE): Information: 5.04 (0.81) Skills: 2.90 (0.44)	NR	Mean (SE): 2.82 (0.44)	Mean (SE): 5.73 (0.99)	NR	Information: P=0.32 Skills: P=0.002
Sexual activity									
DiClemente, 2004	New vaginal sex partner in last 30 days	12 months	11 (4.4%)	3.60%	NR	20(7.4%)	5.60%	NR	AOR: 0.59 (P=0.36; 95%CI 0.19-1.84)
Barbee, 2016	Number of partners	6 months	RTR: 0.82 LN: 0.71	RTR: 0.41 LN: 0.32	NR	0.59%	0.71%	NR	RTR: P=0.05 LN: P=0.01
	Ever had sex	6 months	RTR: 317 (40.38%) LN: 319 (36.99%)	RTR: 317 (36.78%) LN: 319 (34.00%)	NR	38.49%	40.6%	NR	RTR: P=0.05 LN: P=0.02
Jenner, 2016	Frequency of sexual activity	6 months	0.98 (2.77)	Mean: 1.40	NR	1.17 (3.42)	Mean: 1.73	NR	Mean difference(SE): -0.17(0.37, P=0.65)
Jemmott, 1998	Percent who had sexual intercourse	12 months	NR	27(16.5%)	NR	NR	AO: 35(20%) NO: 40 (23.1%)	NR	AO: P=0.91 NO: P=0.37
	Frequency of intercourse	12 months	NR	0.58 (2.97)*	NR	NR	AO: 0.82 (2.97)* NO: 1.15 (2.97)	NR	AO: P=0.54 NI: P=0.36
Koo, 2011	Ever had sex	End of school year	Males: 25(18%) Females: 6(4.2%)	Males: 54(47%) Females: 23 (14.7%)	NR	Males: 20 (17.2%) Females: 8(5.4%)	Males: 66 (51.2%) Females: 12(8.5%)	NR	Males: P=0.912 Females: P=0.112
Markham, 2012	Any sexual initiation	26 months	NR	NR	NR	NR	NR	NR	AOR: 0.65 (P<0.01, 95%CI 0.54-0.77)
	Oral sex initiation	26 months	NR	NR	NR	NR	NR	NR	AOR: 0.69 (P>0.05, 95%CI 0.44-1.06)
	Vaginal sex initiation	26 months	NR	NR	NR	NR	NR	NR	AOR: 0.64 (P<0.05, 95%CI 0.45-0.93)
	Anal sex initiation	26 months	NR	NR	NR	NR	NR	NR	AOR: 0.83 (P>0.05, 95%CI 0.26-2.62)
	Number of times having oral sex in the past 3 months:	26 months	NR	NR	NR	NR	NR	NR	AOR: 0.66 (P>0.05, 95%CI 0.34-1.28)

	2 or more vs. 1 or none								
	Number of times having vaginal sex in the past 3 months: 2 or more vs. 1 or none	26 months	NR	NR	NR	NR	NR	NR	AOR: 0.73 (P<0.05, 95%CI 0.53-1.00)
	Number of times having anal sex in the past 3 months: 2 or more vs. 1 or none	26 months	NR	NR	NR	NR	NR	NR	AOR: 0.53 (P<0.01, 95%CI 0.33-0.84)
	# of vaginal sex partners in past 3 months (2+ vs one or none)	26 months	NR	NR	NR	NR	NR	NR	1.15 (P>0.05, 95%CI 0.60-2.22)
	# of anal sex partners in past 3 months (2+ vs one or none)	26 months	NR	NR	NR	NR	NR	NR	NR** (Sample size too small)
Morrison-Beedy, 2013	Any episodes of vaginal sex	12 months	292 (90.1%)	206 (82.7%)	NR	283 (91.6%)	198 (84.3%)	NR	P>0.10
	Number of girls with 0 sexual partners	12 months	25 (7.7%)	31 (12.4%)	NR	14 (4.5%)	23 (9.7%)	NR	NR
	Number of girls with 1 sexual partner	12 months	207 (63.7%)	173 (69.5%)	NR	197 (63.8%)	164 (69.5%)	NR	OR: 0.785 (P>0.05, 95%CI 0.434-1.421)
	Number of girls with 2 or more sexual partners	12 months	93 (28.6%)	45 (18.1%)	NR	98 (31.7%)	49 (20.8%)	NR	OR: 0.715 (P>0.06, 95%CI 0.359-1.424)
O'Donnell, 2017	Touched/been touched	12 months	NR	NR	NR	NR	NR	NR	AOR: 0.69 (P<0.001, 95%CI 0.56-0.84)
	Sex initiation	12 months	NR	NR	NR	NR	NR	NR	AOR: 0.74 (P<0.01, 95%CI 0.61-0.90)
Peskin, 2015	Ever had sex (any)	12 months	153 (19.9%)	NR	NR	114 (18.8%)	NR	NR	AOR: 1 (95%CI 0.70-1.41)
	Oral sex	12 months	102 (13.3%)	NR	NR	61 (10.1%)	NR	NR	AOR: 1.09 (95%CI 0.67-1.76)
	Vaginal sex	12 months	117 (15.2%)	NR	NR	85 (14%)	NR	NR	AOR: 1.01 (95%CI 0.69-1.48)
	Anal sex	12 months	48 (6.3%)	NR	NR	29 (4.8%)	NR	NR	AOR: 1.05 (95%CI 0.47-2.35)
Sieving, 2011	Number of male sex partners, past 6 months	12 months	1.54 (0.21)	Mean score: 1.55	NR	1.76 (0.07)	Mean score: 1.44	NR	AOR: 1.08 (P=0.44, 95%CI 0.89-1.31)
Tortolero, 2010	Initiated sex (among those who reported no experience at seventh-grade baseline but reporting having initiated)	Ninth grade follow-up	0	308 (23.4%)	NR	0	509 (29.9%)	NR	ARR: 1.29 (P≤0.05, 95%CI 1.02-1.64)

at ninth-grade follow-up)								
Initiated oral sex (among those who reported no experience at seventh-grade baseline but reporting having initiated at ninth-grade follow-up)	Ninth grade follow-up	0	319 (10.0%)	NR	0	512 (17.6%)	NR	ARR: 1.76 (P≤0.01, 95%CI 1.21-2.56)
Initiated vaginal sex (among those who reported no experience at seventh-grade baseline but reporting having initiated at ninth-grade follow-up)	Ninth grade follow-up	0	305 (22.3%)	NR	0	499 (26.9%)	NR	ARR: 1.26 (95%CI 0.98-1.61)
Initiated anal sex (among those who reported no experience at seventh-grade baseline but reporting having initiated at ninth-grade follow-up)	Ninth grade follow-up	0	321 (3.7%)	NR	0	514 (9.9%)	NR	ARR: 2.67 (P≤0.01, 95%CI 1.45-4.94)
Number of times having oral sex in the last 3 months: 2 or more versus 1	Ninth grade follow-up	NR	NR	NR	NR	NR	NR	ARR: 0.93 (95%CI 0.69-1.28)
Number of times having vaginal sex in the last 3 months: 2 or more versus 1	Ninth grade follow-up	NR	NR	NR	NR	NR	NR	ARR: 1.3 (P<0.05, 95%CI 1.02-1.66)
Number of times having anal sex in the last 3 months: 2 or more versus 1	Ninth grade follow-up	NR	NR	NR	NR	NR	NR	ARR: 27.14 (95%CI 0.10-7693)
Number of lifetime oral sex partners (2 or more versus 1)	Ninth grade follow-up	NR	NR	NR	NR	NR	NR	ARR: 1.17 (95%CI 0.82-1.68)
Number of lifetime vaginal sex partners (2 or more versus 1)	Ninth grade follow-up	NR	NR	NR	NR	NR	NR	ARR: 1.05 (95%CI 0.89-1.24)
Number of lifetime anal sex partners (2 or more versus 1)	Ninth grade follow-up	NR	NR	NR	NR	NR	NR	ARR: 0.89 (95%CI 0.15-4.81)
Number of vaginal sex partners in the last 3 months: 2 or more versus 1	Ninth grade follow-up	NR	NR	NR	NR	NR	NR	ARR: 1.31 (95%CI 0.83-2.07)

	Number of anal sex partners in the last 3 months: 2 or more versus 1	Ninth grade follow-up	NR	NR	NR	NR	NR	NR	NR	Unable to estimate
LaChausse, 2016	Ever had sexual intercourse	6 months	12%	0.14 (0.34)	NR	12%	0.18 (0.38)	NR	NR	Mean difference: -0.04 (P=0.01)
Kaufman, 2014	Ever had sex	12 months	12.80%	NR	NR	17.67%	NR	NR	NR	Girls: B: -0.516 (P=0.367, 95%CI -1.638-0.606) Boys: B: 0.413 (P=0.321, 95%CI -0.402-1.229)
	Had sex in last 12 months	12 months	7.72%	NR	NR	10.29%	NR	NR	NR	B: Girls: B: 0.135 (P=0.864, 95%CI -1.409-1.679) Boys: B: 0.664 (P=0.223, 95%CI -0.405-1.733)
Aarons, 2000	Virginity rates	12 months	Females: 83.7% (of 139) Males: 44.9% (of 123)	NR	NR	Females: 78.0% (of 135) Males: 43.1% (of 125)	NR	NR	NR	Females: AOR: 1.88 (95%CI 1.02-3.47) Males: AOR: 1.18 (95%CI 0.61-2.29)
Coyle, 2006	Frequency of sexual intercourse previous 3 months	12 months	NR	NR	NR	NR	NR	NR	NR	Ratio of adjusted means: 0.12 (P=0.24)
	Number of sexual partners previous	12 months	NR	NR	NR	NR	NR	NR	NR	Ratio of adjusted means: 0 (P=0.57)
	Sexual initiation (among sexually inexperienced at baseline)	12 months	NR	NR	NR	NR	NR	NR	NR	N/A
Milhausen, 2008	Frequencies (number of events in previous six months) of Vaginal Sex	12 months	NR	16.67*	NR	NR	17.94*	NR	NR	Relative change: -7.07% (P=0.65, 95%CI -35.09-49.29)
Sherr, 2013	Sexual intercourse within the last three weeks	6 months	NR	NR	NR	NR	NR	NR	NR	B: -0.15 (P≥0.05, 95%CI -0.331-0.032)
Philliber, 2002	Chose not to have sex under pressure	3 years	NR	NR	NR	NR	NR	NR	NR	NR
	Ever had sex	3 years	26%	63	NR	25%	72	NR	NR	P<0.05
Jemmott, 1992	Coitus in the last 3 months	3 months	NR	Mean (SD): 0.48(62)	NR	NR	Mean (SD): 0.60(53)	NR	NR	Mean difference: -0.12 (95%CI -0.27-0.3)
	Number of days	3	NR	Mean	NR	NR	Mean	NR	NR	Mean

	respondent had coitus	months		(SD): 2.15(53)			(SD): 5.48(47)		difference: -3.32 (95%CI -5.78--0.89)
	Number of coital partners	3 months	NR	Mean (SD): 0.85(63)	NR	NR	Mean (SD): 1.79(52)	NR	Mean difference: -0.93 (95%CI -1.53--0.33)
	Number of coital partners involved with other men	3 months	NR	Mean (SD): 0.19(60)	NR	NR	Mean (SD): 1.75(48)	NR	Mean difference: -1.55 (95%CI -2.67--0.43)
	Heterosexual anal sex	3 months	NR	Mean (SD): 0.07(68)	NR	NR	Mean (SD): 0.27(49)	NR	Mean difference: -0.19 (95%CI -0.32--0.06)
	Number of days respondent had heterosexual anal sex	3 months	NR	Mean (SD): 0.36(64)	NR	NR	Mean (SD): 0.92(46)	NR	Mean difference: -0.55 (95%CI -1.17-0.7)
	Number of female sex partners	3 months	NR	Mean (SD): 0.13(65)	NR	NR	Mean (SD): 0.61(49)	NR	Mean difference: -0.47 (-0.86-0.08)
Klein, 2011	Number of vaginal sex acts in last 90 days	3 months	Mean: 7.33	Mean: 8.51	1.18 (P=0.43, 95%CI -1.78-4.12)	Mean: 7.9	Mean: 7.67	-0.23 (P=0.91, 95%CI 4.11-3.65)	NR
Walter, 1993	Percentage change of students with abstinence	3 months	NR	NR	NR	NR	NR	NR	P<0.60
Coyle, 2004	Ever had sex	36 months	Boys: 4.7% Girls: 2.7%	Boys: 19.3% Girls: 20.3%	NR	Boys: 3.6% Girls: 2.2%	Boys: 27.2% Girls: 22.1%	NR	Boys: P=0.02 Girls: P=0.53
	Had sex in the past 12 months	36 months	Boys: 2.8% Girls: 1.5%	Boys: 17.3% Girls: 18.2%	NR	Boys: 2.9% Girls: 1.1%	Boys: 24.5% Girls: 19.9%	NR	Boys:P= 0.03 Girls: P=0.52
	Ever had sex	36 months	Boys: 4.7% Girls: 2.7%	Boys: 19.3% Girls: 20.3%	NR	Boys: 3.6% Girls: 2.2%	Boys: 27.2% Girls: 22.1%	NR	Boys: P=0.02 Girls: P=0.53
	Had sex in the past 12 months	36 months	Boys: 2.8% Girls: 1.5%	Boys: 17.3% Girls: 18.2%	NR	Boys: 2.9% Girls: 1.1%	Boys: 24.5% Girls: 19.9%	NR	Boys: P=0.03 Girls: P=0.52
Jemmott, 2010	Frequency of sexual intercourse in prior 90 days	12 months	Mean (SE): 2.78 (0.26)	Mean (SE): 3.68 (0.34)	NR	Mean (SE): 3.15 (0.34)	Mean (SE): 4.25 (0.41)	NR	Event rate ratio: 1.06 (P=0.56, 95%CI 0.88-1.28)
Jemmott, 2005	Number of partners in past 3 months	12 months	Mean (SE): Information: 1.06 (0.05) Skills: 1.04(0.05)	Mean (SE): Information: 1.02 (0.05) Skills: 0.93 (0.04)	NR	Mean (SE): 1.10 (0.05)	Mean (SE): 1.06 (0.06)	NR	Information: P=0.51 Skills: P=0.04
	Percentage reporting multiple partners in the past 3 months	12 months	Mean (SE): Information: 15.1 (2.6) Skills: 12.4 (2.3)	Mean (SE): Information: 11.4 (2.3) Skills: 7.4 (1.8)	NR	Mean (SE): 15.3 (2.6)	Mean (SE): 15.3 (2.6)	NR	Information: P=0.09 Skills: P=0.002

Sexually Transmitted Infections

Walter, 1993	Percentage change of students with STI incidence	3 months	NR	NR	NR	NR	NR	NR	P<0.10
Scholes, 2003	STD diagnosis in prior 3 months	6 months	NR	3.50%	NR	NR	3.60%	NR	OR: 0.97 (P=0.93, 95%CI 0.49-1.96)
Jemmott, 2005	Percentage testing positive for an STD	12 months	Mean (SE): Information: 24.7 (3.5) Skills: 23.6 (3.5)	Mean (SE): Information: 16.0 (3.0) Skills: 10.8 (2.6)	NR	Mean (SE): 14.3 (2.8)	Mean (SE): 17.4 (3.0)	NR	Information: P=0.44 Skills: P=0.05

Abbreviations: CSE (Comprehensive Sexuality Education); N (Number); SD (Standard Deviation); CI (Confidence Interval); NR (Not Reported); AOR (Adjusted Odds Ratio); RTR (Reduce the Risk); LN (Love Notes); PTC (Power Through Choice); IRR (Incidence Rate Ratio); ARR (Adjusted Risk Ratio); B (Linear Estimate); AO (Abstinence-Only); NI (No Intervention)

Figures

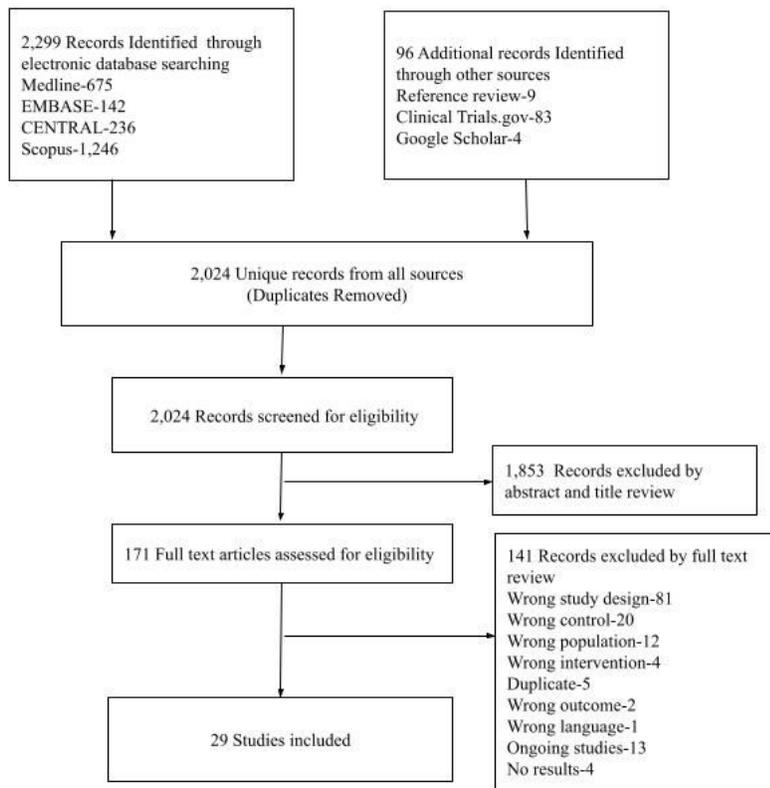


Figure 1

Study Selection Flow Diagram The flow diagram shows the number of studies included after each additional search method and subsequent screening processes, resulting in 29 studies total.

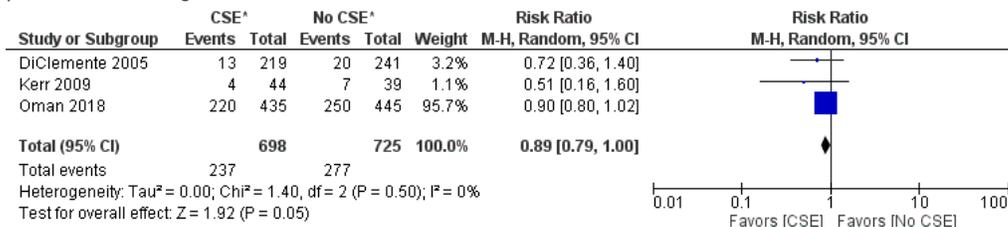


Figure 2

Forest Plot of Meta-Analysis Results for Pregnancy Outcome Risk Ratio This forest plot shows the results of the analysis using the pooled RRs and 95% CI for studies included in the meta-analysis reporting on pregnancy.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Appendix.docx](#)