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Dosage in Implementation of an Effective School-Based Health Program Impacts Youth Health Risk Behaviors and Experiences

Jingjing Li, Ph.D., M.D., M.P.H.[a,*], **Zach Timpe, Ph.D.**[b], **Nicolas A. Suarez, M.P.H.**[a], **Elyse Phillips, M.P.H.**[c], **Wojciech Kaczkowski, Ph.D.**[a], **Adina C. Cooper, Ph.D., M.Ed.**[a], **Patricia J. Dittus, Ph.D.**[a], **Leah Robin, Ph.D.**[a], **Lisa C. Barrios, Dr.P.H.**[a], **Kathleen A. Ethier, Ph.D.**[a]

[a]Division of Adolescent and School Health, Centers for Disease Control and Prevention, Atlanta, Georgia

[b]ICF, Atlanta, Georgia

[c]Metas Solutions LLC

Abstract

Purpose: This study is part of a larger evaluation of a multilevel, multistrategy federal program to reduce high school students' risk for HIV/sexually transmitted infection and unintended pregnancy. Local education agencies supported schools in implementing three strategies: delivering exemplary sexual health education, increasing student access to quality sexual health services, and enhancing safe and supportive school environments (SSE). We examined how levels of school implementation of these strategies moderated program effects on targeted student outcomes.

Methods: The Youth Risk Behavior Survey was implemented in participating local education agencies in 2015 and 2017 to assess student behaviors and experiences, whereas the School Health Profiles surveys assessed school policies and practices in 2014 and 2016. We used these surveys to measure student-level outcomes and school-level program delivery, respectively, which were analyzed using multilevel modeling in a difference-in-differences framework.

Results: Levels of SSE implementation significantly moderated program effects on multiple student outcomes, including ever having sex, having four or more lifetime sexual partners, being sexually active, using hormonal birth control, dual use of a condom and hormonal birth control, ever being forced to have sex, missing school because of safety concerns, and lifetime and current marijuana use. However, we found few moderating effects of exemplary sexual health education and sexual health services dosage.

Discussion: We found a significant relationship between incremental increases in implementation of activities to increase the safety and supportiveness of school environments and

[*]Address correspondence to: Jingjing Li, Ph.D., M.D., M.P.H., Division of Adolescent and School Health, Centers for Disease Control and Prevention, Atlanta, GA. ppy8@cdc.gov (J. Li).

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Supplementary Data

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enhanced program effects in improving multiple student health outcomes. These findings suggest that school implementation of SSE activities contributed to intended program effects.

Keywords

HIV; STIs; Adolescent health; Adolescent; Youth; School health; Sexual health services; Sexual health education; Implementation science

Multilevel interventions are more effective in achieving desired health outcomes than single-level interventions, with school environments being particularly suitable for multilevel intervention programs to address adolescent health [1–4]. Recent evidence shows that exposure to school-based multilevel interventions, comprising health education, environmental change, family and community outreach, and school policy change, is associated with decreased adolescent sexual risk behaviors [3–7]. Evaluating multilevel interventions is crucial to understanding how different aspects of program implementation may influence program outcomes. Still, evidence on this topic is lacking because such evaluation is often complex and time-consuming [8–10]. When evaluating complex intervention programs, it is therefore crucial to evaluate program implementation, particularly to gain an adequate interpretation of program effects [11]. Program implementation can impact how evidence-based programs achieve desired outcomes and suboptimal implementation often results in suboptimal program effects [12,13]. Among many important implementation features, dosage (i.e., the "amount" of an intervention program that participants were exposed to as measured by the number of program sessions, frequency, or other evidence-based practices [EBPs]) of implementation is particularly relevant to this study. Evidence suggests that varying program dosage was associated with differential program effects in school settings, with higher dosage often leading to better student outcomes [14–16]. In practice, however, students rarely receive the full dosage of a school-based intervention [12].

From 2013 to 2018, the Centers for Disease Control and Prevention's (CDC) Division of Adolescent and School Health (DASH) funded 17 large, mostly urban, school districts (local education agencies [LEAs]) to implement the *What Works in Schools* program [17], which was a multilevel, systemic health risk prevention program designed to change policies and practices in middle and high schools. The program consisted of three broad strategies: delivering exemplary sexual health education (ESHE), connecting students to quality sexual health services (SHS), and enhancing safe and supportive school environments (SSE) for all youth [18]. Specifically, ESHE included strengthening policies and educational practices to support effective health education. ESHE sought to enhance classroom delivery through tailored professional development, technical assistance, and follow-up support for teachers. SHS consisted of increasing student awareness of the need for, and availability of, SHS, and providing guidance and support to staff to identify student needs and refer students to appropriate services. Finally, SSE activities included promoting antibullying and sexual harassment policies and practices, increasing school connectedness, enhancing parental engagement, and fostering school environments to support programming for traditionally under-represented groups (Table A1).

Within each of above-mentioned strategies, LEAs were able to select a range of EBPs listed in the program guidance that were included based on meta-analyses, systematic reviews, and other empirical studies to tailor to the needs of their priority schools. LEA activities included establishing a support infrastructure for EBPs through districts, school health advisory councils, and district-level coordinators, assessing district policy and guidance, and providing professional development and materials supporting the implementation of all strategies.

Our recent evaluation of the effectiveness of the *What Works in Schools* program [3] found that exposure to the program is associated with significant decreases in ever having sex, having four or more lifetime sexual partners, being currently sexually active, not going to school because of safety concerns, having experienced forced sex, and lifetime and current marijuana use. The study also found that program exposure was associated with decreases in the use of effective hormonal birth control and with no significant changes in condom use, dual use of hormonal birth control and condoms, and HIV testing. Although the study supports the association between program exposure and improvements in certain student health outcomes, little is known about whether and to what extent the program implementation moderates the observed associations between program exposure and student outcomes.

The program allowed school districts of wide latitude in the activities they delivered within the three strategies. Although this flexibility offered districts the ability to tailor activities to schools' and students' needs, it necessitates an understanding of the dosage of different strategies and their relationship to student health outcomes. School teachers, staff, and other practitioners need to know how much and which type of activities they need to deliver to impact student health outcomes. District leadership and other policymakers may also need to decide how to scale up the program and whether it can achieve lasting population-level health benefits [19]. Therefore, studying the impact of implementation dosage on program effects fills important gaps, such as how programs produce intended effects and whether and how they should be scaled up [19].

The present study examines how implementation dosage, measured by the number of activities delivered at the school level, impacts the program's effect on intended student health outcomes. We hypothesize that for every strategy, implementation dosage moderates the association between program exposure and student outcomes. That is, an increased implementation dosage is associated with a greater program effect in improving student outcomes. Our assessment of dosage effects of a multilevel, multi-strategy federal program could aid program improvement and contribute to the knowledge base of implementation of science and to the enhancement of EBPs. This evaluation study focuses on high school students given the small number of middle schools that participated in the program and the lack of data among middle school students.

Methods

Study design

We conducted a secondary data analysis using multilevel modeling grounded in the difference-in-differences (DID) framework [20,21] to examine the interaction effects of implementation dosage on intended student-level outcomes of the CDC DASH program between exposed and unexposed schools. Exposed schools were a set of middle and high schools selected by each LEA, centering on those with higher rates of sexually transmitted infections (STIs), unintended pregnancies, and/or sexual risk behaviors. These schools implemented the full range of program activities with the support of the LEA. Unexposed schools were those in the same districts that were not the primary focus of programmatic efforts and, therefore, did not receive all program activities. Multilevel modeling was used to control for the clustering effects at the school and district levels. DID was applied because this study was quasi-experimental and thus lacked a random assignment to the exposed and unexposed schools, assuming exposed and unexposed school samples would meet the parallel trend assumption.

Data sources

Seventeen school districts participating in the program collected data in exposed schools and a set of unexposed schools to assess both program implementation and student health behaviors and experiences. School Health Profiles (Profiles) were implemented in 2014 and 2016 and included self-administered questionnaires completed by principals and leading health education teachers to monitor secondary school health policies and practices [22]. The Youth Risk Behavior Survey (YRBS) was administered to high school students in exposed schools and unexposed schools in 2015 and 2017. Additional information about participant recruitment, item selection, data collection, and response rates are available in the YRBS [23] and Profiles [22] overview and methods reports.

For this study, we merged the 2014 Profiles with the 2015 YRBS (serving as baseline data) and the 2016 Profiles with the 2017 YRBS at the student level (serving as follow-up data). The merged dataset is limited to schools that participated in both surveys, and thus results in a reduced student-level sample size were compared to the original YRBS samples (16.6% reduction of the original YRBS samples). The data used in this study were approved by CDC as research not involving identifiable human subjects because participants responded anonymously and an institution review board approval was not required.

Participants

The combined dataset of this study consisted of 84,852 students enrolled from both exposed and unexposed schools. Although most of the LEAs had YRBS response rates ranging from 60% to 90%, one LEA had a low YRBS response rate in 2015 among exposed schools (around 20%) and therefore was excluded from the analytic sample. Students who selected “ungraded” as their grade in school were also excluded, resulting in a final analytic sample of 82,461 students in 16 LEAs. Of those, 42,460 students were from 223 exposed schools and 40,001 students were from 268 unexposed schools.

Measures

Student health outcomes.—In total, 22 dichotomized items from the YRBS questionnaire were used to measure student health risk behaviors and experiences relevant to the DASH program (Table 1).

Exposed school attendance.—This variable was used to indicate whether a student attended an exposed school (dichotomized as 0, 1), with attending an unexposed school as the referent group and coded as 0.

Year.—A dichotomous measure indicated the school year in which the student completed the YRBS, with 0 indicating 2015 and 1 indicating 2017.

Implementation dosage (ESHE index, SHS index, and SSE index).—Dichotomized items from the Profiles questionnaire assessing the adoption of ESHE, SHS, and SSE strategies were summed into a total score (i.e., the index) for ESHE, SHS, and SSE, respectively. For each strategy, a higher dosage score indicates a greater level of program implementation (Table 2 for items and coding). There were 48 items related to ESHE, 30 related to SHS, and 30 related to SSE. We conducted a principal components analysis to reduce the number of ESHE items to be comparable with the SHS and SSE indices. This resulted in 36 items in the ESHE index (details provided in the footnote of Table 2).

Demographics.—Demographic variables including gender (male and female), grade (ninth, 10th, 11th, and 12th), and race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic/Latino, and other) were included in the analysis as covariates.

Analyses

Bivariate analyses were conducted using ANOVA and Chisquared tests across exposed and unexposed school status within years. We used list-wise deletion for missing observations for each variable. Exposed schools in general had more missingness compared to unexposed schools across years, with the exception of dual use of condoms and effective hormonal birth control, sexual dating violence, physical dating violence, forced sex, and ESHE and SHS dosage variables, which had less missingness in exposed schools across years (result not shown).

We previously [3] examined program's main effects using a multilevel DID framework. In that study, we used a statistically significant Exposure × Year interaction (i.e., the interaction term between exposed school attendance and year) to indicate program effectiveness. The current analysis expands our previous research by examining whether implementation dosage moderated the association between program exposure and student outcomes [24]. Thus, we included a three-way interaction of Implementation Dosage × Exposure × Year to test if varying levels of implementation dosage moderated the relationship between program exposure and student outcomes, controlling for individual-level covariates including gender, grade, and race/ethnicity.

The coefficient of the three-way interaction, β_1, captured the moderating effect of implementation dosage. A negative coefficient for risk outcomes or positive for protective

outcomes indicates enhanced program effect. In addition, we estimated β_1 using three-level multilevel logistic models to account for students (level 1) nested in schools (level 2) within LEAs (level 3) for each student-level outcome. Analyses were conducted using SAS 9.4 (Cary, NC: SAS Institute Inc.). Statistical significance was set at $p < .05$.

Results

Students in exposed and unexposed schools varied significantly across demographic variables (Table 3). In 2015, there were significant differences in the distribution of ninth-grade and 10th-grade students between exposed and unexposed schools, with more ninth-grade students (28.1%) and 10th-grade students (26.4%) in exposed schools.

Bivariate analyses within years indicate that districts were successful in targeting program efforts toward the schools with students at a greater risk of HIV/STI and unintended pregnancy (Table 3). In 2015, exposed school students reported significantly higher proportions of ever having sex, four or more lifetime sexual partners, and currently sexually active compared to students in the unexposed schools. No significant differences were found between students in exposed and unexposed schools in using a condom during last sexual intercourse, using effective hormonal birth control, and using a condom and effective hormonal birth control. Students in exposed schools reported significantly higher proportions of risk across most outcomes related to violence victimization, suicide-related outcomes, current marijuana use, and injecting drug use (IDU) but not for sexual dating violence, being bullied at school, experiencing electronic bullying, and having persistent feelings of sadness or hopelessness, compared to their counterparts in unexposed schools.

The final modeling results are presented in Tables 4 and 5. These models were adjusted for demographic characteristics of gender, race/ethnicity, and grade. The interpretation of the coefficient of the three-way interaction β (Index × Exposure × Year) is that: a 1-unit change in the dosage is associated with a β-unit change in the association between the program exposure and the outcome or a β-unit change in program's effect size in influencing the outcome. As Tables 4 and 5 show, ESHE dosage did not show significant moderating effects. SHS dosage significantly moderated the program effect on current marijuana use (β = −0.017, SE = 0.006), meaning that a 1-unit increase in SHS dosage is associated with a 0.017-unit increase in the program's effect size in reducing current marijuana use.

We found multiple significant interactions between the SSE dosage, attending an exposed school, and year. SSE dosage significantly moderated the program effects on ever having sex (β = −0.027, SE = 0.007), having four or more lifetime sexual partners (β = −0.027, SE = 0.011), being currently sexually active (β = −0.018, SE = 0.008), use of effective hormonal birth control (β = −0.033, SE = 0.012), dual use of effective hormonal birth control and condoms (β = −0.048, SE = 0.021), did not go to school because of safety concerns (β = −0.025, SE = 0.010), forced sex (β = −0.024, SE = 0.010), ever marijuana use (β = −0.023, SE = 0.008), and current marijuana use (β = −0.016, SE = 0.007). These effects were all in the intended direction except for the use of effective hormonal birth control and the dual use of birth control and condoms.

Discussion

The present study found that SSE dosage, measured as the school-level implementation of SSE EBPs, moderates the program effects on multiple targeted student health outcomes. Specifically, an increased dosage of SSE activities was associated with strengthened program effects on sexual health (i.e., ever having sex, having four or more lifetime sexual partners, being currently sexually active), violence victimization (i.e., missing school because of safety concerns and ever being forced to have sex), and substance use out-comes (i.e., lifetime and current marijuana use). These results are parallel to our evaluation of the program's main effects [3], in which we found that the program exposure was associated with reduced student sexual risks, violence victimization, and substance use. Taken together, school implementation of activities to strengthen SSE, including antibullying activities [25,26] and efforts to increase school connectedness [6,27] and parent engagement [28,29], may contribute to decreases in health risk behaviors among high school students.

We also found significant moderating effects of SSE on the relationship between program exposure and the use of effective hormonal birth control and the dual use of a condom and effective hormonal birth control, in unintended directions. This finding is consistent with our previous evaluation of the program main effects [3], where we found a significant, negative association between program exposure and the use of effective hormonal birth control. It is possible that an increased SSE was associated with fewer students who were currently sexually active and thus students' perceived needs for hormonal birth pills might decrease. Future research is needed to examine whether decreased sexual activity relates to the decreased use of effective hormonal birth control. In addition, education agency policies vary with regard to providing students with access to hormonal birth control and might subsequently influence students' use of hormonal birth control. Further study is warranted to understand the multilevel drivers for the decreased use of hormonal birth control.

This study did not find any moderating effects of SSE activities on the relationship between program exposure and using a condom during the last sexual intercourse. Similarly, our previous study did not find a significant association between program exposure and the dual use of condoms and effective hormonal birth control. The YRBS national trend report (2009—2019) also shows little change in the dual use of a condom and effective hormonal birth control nationwide between 2015 and 2017 [30]. It is therefore likely that the significant moderating effect between SSE dosage and the dual use of a condom and effective hormonal birth control was mainly attributable to the significant association between SSE dosage and the use of effective hormonal birth control. Given that our bivariate results show considerable gender and race/ethnicity differences in the use of effective hormonal birth control and the dual use of a condom and effective hormonal birth control, our next step is to examine the effects of SSE by gender and race/ethnicity to further investigate the origin of the unintended effects of SSE on hormonal birth control—related outcomes.

ESHE and SHS dosage demonstrated few moderating effects on the relationship between program and student health outcomes. The only moderating effect found was SHS dosage activities on using marijuana in the past 30 days. The nonsignificant moderating effects of ESHE and SHS activities regarding sexual health behaviors were unexpected given their

specific tailoring to address sexual behaviors. One explanation may be that ESHE dosage was subject to a ceiling effect in the school-based delivery of ESHE given that the mean score of the ESHE dosage was high and that many schools routinely provide sexual health education. STI prevention and human sexuality topics are relatively common in large urban LEAs, with a median of 85.8% and 82.1% of secondary schools providing instruction on these topics, respectively [31]. Thus, the lack of a significant relationship between ESHE dosage and program effect on sexual risk behaviors may reflect a reduced variation in ESHE dosage scores. In addition, it is possible that our monotonic linear view of dosage did not represent educational intervention's theory of change and might not capture program effects that were nonlinear. Regarding the lack of relationships between SHS and program effects, school health services were provided by staff who may rotate among several schools within a district and whose activities (e.g., professional development) were likely at the district level or provided in the healthcare sector. Therefore, our measurement of SHS dosage (i.e., Profiles) might only capture a part of SHS activities occurring at school level and might miss the LEA-level activities.

Although program effects on students' health outcomes seem to be enhanced primarily by SSE activities, LEAs were required to implement activities related to all three strategies and the three strategies could have had synergistic effects. In other words, the study evaluated the effects of SSE strategies when implemented in conjunction with ESHE and SHS strategies. Thus, we cannot decisively determine whether the observed effects can be attributed independently to SSE activities or whether the context of the other two sets of strategies potentially contributes to these observed significant relationships. We could only hypothesize the nature of those synergistic effects, but it is possible that SSE activities allowed the ESHE and SHS activities to be more effective. For example, better classroom management may contribute to a better learning environment for ESHE and increased connectedness to school and school staff may enhance students' ability to receive or willingness to act on referrals to health services.[32–34] Future research could examine the extent to which the strategies operate as independent moderators on health risk behaviors and experiences and whether they are synergistic.

In addition, some of the LEAs may have participated in other programs with comparable objectives, such as the Teen Pregnancy Prevention Program which was conducted simultaneously and also focused on the implementation of similar strategies in schools with students at a higher risk for adverse sexual health behaviors [35]. Some of the higher dosage observed in these LEAs could be attributed to the additional resources and efforts provided by such programs. Therefore, further study is needed to better examine the independent contribution of the program on student health outcomes.

Limitations

Our analysis is subject to some limitations. Bivariate analyses indicated that exposed and unexposed schools were nonequivalent groups. However, we controlled for clustering effects at the district and school level and for covariates at the individual level to control for such nonequivalence. Furthermore, this study may be subject to selection bias for a number of reasons. These include retaining only schools that administered both Profiles

and YRBS when merging the data. We also retained all students in the ninth through 12th grades from the 2015 and 2017 YRBS administrations which might have resulted in the inclusion of students who were not exposed to the program (i.e., uneven exposure) and a loss to follow-up of who would have had experienced the programming but had graduated before the 2017 YRBS. However, our bivariate results show that unexposed students rarely exhibit improved health outcomes; thus, we believe the uneven exposure and loss to follow-up likely attenuates the effect sizes of program on the outcomes, leading to an underestimation of our results. Finally, selection bias might also occur as a result of list-wise deletion of missingness. Exposed schools had more missingness, which may lead to an underestimation of our results. For three recoded variables, dual use of condoms and effective hormonal birth control, sexual dating violence, and physical dating violence, as their missingness contains both exclusions and actual missingness, were unable to determine the degree or the direction of how these outcomes were influenced. For forced sex, we cannot rule out the possibility that the finding on forced sex was attributable to the greater missingness in the unexposed schools rather than to the intervention dosage. Moreover, ESHE and SHS dosage variables had more missingness in unexposed schools. This may reduce our analytical power and explain the null findings for ESHE and SHS models. It is worth noting, however, that our findings are robust as they largely parallel our main effect analysis [3] which used different analytical samples with different missingness patterns. Another limitation is that Profiles and YRBS data were both self-reported and subject to response bias. YRBS does not define sexual intercourse or differentiate among different kinds of sexual activity and this may also result in response bias. Another limitation is that we adopt a traditional monotonic linear view of dose response between implementation and program effect, which may not fully represent the intervention's theory of behavior change. In addition, we measured implementation using dosage defined as the number of activities implemented or delivered but were unable to assess other aspects of program implementation (e.g., implementation quality, dose received, duration) due to data availability. More comprehensive implementation measurement is needed to better examine the association between implementation and program effects. Finally, our findings cannot be generalized further than the analytical sample included in this study.

Conclusion

This study found that an increased dosage of SSE activities was significantly associated with enhanced program effects on improving certain student health outcomes. Although the program was designed to focus on sexual health, the literature on school connectedness and parent engagement, which were protective factors targeted by the SSE activities, shows these constructs have long been found to have an impact on a broader set of outcomes [36]. It is in line with this literature then, that increased school-level implementation of these strategies, was associated with a wide variety of reductions in health risk behaviors and experiences. Findings in this study, together with the evidence in our prior assessment of the main effect of the program, jointly support the conclusion that program activities contributed to reductions in student health risk behaviors and experiences. LEAs may wish to consider similar multicomponent, multilevel system approaches to increase school implementation of EBPs. Because multiple risk behaviors among adolescents have common antecedents, such programs may help reduce interrelated risk behaviors and experiences among students.

Finally, LEAs that benefited from the program may need to plan carefully about how to sustain the program effects, such as allocating additional efforts and funding to maintain and strengthen infrastructure established, to best leverage the program activities.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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IMPLICATIONS AND CONTRIBUTION

Study explored how levels of program implementation impacted the program's effect on targeted student health outcomes. An increased implementation of activities to make school environments safer and more supportive was associated with strengthened program effects for multiple student outcomes. Education agencies should emphasize improving school environments in multilevel, systemic health programs.

Table 1

Youth Risk Behavior Survey items and analytic coding for primary and secondary study outcomes—2015, 2017 Youth Risk Behavior Survey

Variable	YRBS items	Analytic coding
Primary Outcomes		
Ever had sex	Have you ever had sexual intercourse?	0 = No; 1 = Yes
Had ≥4 lifetime sexual partners	During your life, with how many people have you had sexual intercourse?	0 ≤ 3 people 1 ≥ 4 people
Currently sexually active	During the past 3 months, with how many people did you have sexual intercourse?	0 = None 1 ≥ 1 people
Effective hormonal birth control use[a]	The last time you had sexual intercourse, what one method did you or your partner use to prevent pregnancy? (Select only one response.) (Responses include birth control pills; an IUD; implant; shot; patch; or birth control ring)	0 = None of those responses 1 = One of those responses
Used a condom during last sexual intercourse[a]	The last time you had sexual intercourse did you or your partner use a condom?	0 = No; 1 = Yes
Condom and effective hormonal birth control use[a]	"Yes" responses to one or more "used effective hormonal birth control" responses and "used a condom during last sex"	0 = Yes to one or none 1 = Yes to both
Ever tested for HIV	Have you ever been tested for HIV, the virus that causes AIDS? (Do not count tests done if you donated blood)	0 = No; 1 = Yes
Secondary Outcomes		
Did not go to school because of safety concerns	During the past 30 days, on how many days did you not go to school because you felt you would be unsafe at school or on your way to or from school?	0 = 0 days 1 ≥ 1 day
Threatened or injured with a weapon at school	During the past 12 months, how many times has someone threatened or injured you with a weapon such as a gun, knife, or club on school property?	0 = 0 times 1 ≥ 1 time
Forced sex	Have you ever been physically forced to have sexual intercourse when you did not want to?	0 = No; 1 = Yes
Sexual dating violence (DV)[b]	During the past 12 months, how many times did someone you were dating or going out with force you to do sexual things that you did not want to do? (Count such things as kissing, touching, or being physically forced to have sexual intercourse)	0 = 0 times 1 ≥ 1 time
Physical dating violence (DV)[b]	During the past 12 months, how many times did someone you were dating or going out with physically hurt you on purpose? (Count such things as being hit, slammed into something, or injured with an object or weapon)	0 = 0 times 1 ≥ 1 time
Bullied at school	During the past 12 months, have you ever been bullied on school property?	0 = No; 1 = Yes
Electronically bullied	During the past 12 months, have you ever been electronically bullied? (Count being bullied through texting, Instagram, Facebook, or other social media)	0 = No; 1 = Yes
Persistent feelings of sadness or hopelessness	During the past 12 months, did you ever feel so sad or hopeless almost every day for 2 weeks or more in a row that you stopped doing some usual activities?	0 = No; 1 = Yes
Seriously considered attempting suicide	During the past 12 months, did you ever seriously consider attempting suicide?	0 = No; 1 = Yes
Made a suicide plan	During the past 12 months, did you make a plan about how you would attempt suicide?	0 = No; 1 = Yes
Attempted suicide	During the past 12 months, how many times did you actually attempt suicide?	0 = 0 times 1 ≥ 1 time

Variable	YRBS items	Analytic coding
Injured in a suicide attempt	If you attempted suicide during the past 12 months, did any attempt result in an injury, poisoning, or overdose that had to be treated by a doctor or nurse?	0 = No; 1 = Yes
Injection drug use	During your life, how many times have you used a needle to inject any illegal drug into your body?	0 = 0 times 1 ≥ 1 time
Ever use marijuana	During your life, how many times have you used marijuana?	0 = 0 times 1 ≥ 1 time
Currently use marijuana	During the past 30 days, how many times did you use marijuana?	0 = 0 times 1 ≥ 1 time

[a] This question was only asked if the participants self-reported being sexually active.

[b] The denominator of this variable is students who ever dated or went out with someone during the 12 months before the survey.

Table 2

Dose index variables and coding—2014, 2016 School Health Profiles

Constructs	Profile question	Questionnaire recipient	Analytic coding
Exemplary sexual health education (ESHE) index (n = 36)			
Teaching	High school (HS) taught how HIV and other STDs are transmitted	Lead health educator	0 = No; 1 = Yes
	HS taught health consequences of HIV, other STDs, and pregnancy	Lead health educator	0 = No; 1 = Yes
	HS taught how to access valid and reliable health information, products, and services related to HIV, other STDs, and pregnancy	Lead health educator	0 = No; 1 = Yes
	HS taught influences of family, peers, media, technology, and other factors on sexual risk behaviors	Lead health educator	0 = No; 1 = Yes
	HS taught communication and negotiation skills related to eliminating or reducing risk for HIV, other STDs, and pregnancy	Lead health educator	0 = No; 1 = Yes
	HS taught goal-setting and decision-making skills related to eliminating or reducing risk for HIV, other STDs, and pregnancy	Lead health educator	0 = No; 1 = Yes
	HS taught influencing and supporting others to avoid or reduce sexual risk behaviors	Lead health educator	0 = No; 1 = Yes
	HS taught efficacy of condoms	Lead health educator	0 = No; 1 = Yes
	HS taught importance of using condoms consistently and correctly	Lead health educator	0 = No; 1 = Yes
	HS taught how to obtain condoms	Lead health educator	0 = No; 1 = Yes
	HS taught how to correctly use a condom	Lead health educator	0 = No; 1 = Yes
	HS taught methods of contraception other than condoms	Lead health educator	0 = No; 1 = Yes
	HS taught importance of using a condom at the same time as another form of contraception to prevent both STDs and pregnancy	Lead health educator	0 = No; 1 = Yes
Assessment	HS assessed comprehension of concepts important to prevent HIV, other STDs, and pregnancy	Lead health educator	0 = No; 1 = Yes
	HS assessed analysis of influence of family, peers, culture, media, technology, and other factors on sexual risk behaviors	Lead health educator	0 = No; 1 = Yes
	HS assessed access of valid information, products, and services to prevent HIV, other STDs, and pregnancy	Lead health educator	0 = No; 1 = Yes
	HS assessed use of interpersonal communication skills to avoid or reduce sexual risk behaviors	Lead health educator	0 = No; 1 = Yes
	HS assessed use of decision-making skills to prevent HIV, other STDs, and pregnancy	Lead health educator	0 = No; 1 = Yes
	HS assessed influence and support of others to avoid or reduce sexual risk behaviors	Lead health educator	0 = No; 1 = Yes
Sex Education materials	District provided sex education materials on goals, objectives, and expected outcomes for sexual health education	Lead health educator	0 = No; 1 = Yes
	District provided sex education materials on a written health education curriculum that includes objectives and content addressing sexual health education	Lead health educator	0 = No; 1 = Yes
	District provided sex education materials on a chart describing the annual scope and sequence of instruction for sexual health education	Lead health educator	0 = No; 1 = Yes
	District provided sex education materials on strategies that are age-appropriate, relevant, and actively engage students in learning	Lead health educator	0 = No; 1 = Yes
	District provided sex education materials on methods to assess student knowledge and skills related to sexual health education	Lead health educator	0 = No; 1 = Yes
Professional development	Provided professional development (PD) on HIV prevention	Lead health educator	0 = No; 1 = Yes

Constructs	Profile question	Questionnaire recipient	Analytic coding
	Provided PD on human sexuality	Lead health educator	0 = No; 1 = Yes
	Provided PD on pregnancy prevention	Lead health educator	0 = No; 1 = Yes
	Provided PD on STD prevention	Lead health educator	0 = No; 1 = Yes
	Provided PD on aligning lessons and materials with district scope and sequence for sexual health education	Lead health educator	0 = No; 1 = Yes
	Provided PD on creating a comfortable and safe learning environment for students receiving sexual health education	Lead health educator	0 = No; 1 = Yes
	Provided PD on using a variety of effective instructional strategies to deliver sexual health education	Lead health educator	0 = No; 1 = Yes
	Provided PD on building student skills in HIV, other STD, and pregnancy prevention	Lead health educator	0 = No; 1 = Yes
	Provided PD on assessing student knowledge and skills in sexual health education	Lead health educator	0 = No; 1 = Yes
	Provided PD on understanding current district or school board policies or curriculum guidance regarding sexual health education	Lead health educator	0 = No; 1 = Yes
Other	HS included LGB specific education curricula	Lead health educator	0 = No; 1 = Yes
	HS education required (grades 6—12, any)	Lead health educator	0 = No; 1 = Yes
Sexual health services (SHS) Index (n = 30)			
SHS	Had any on-site HIV-related SHS services/referrals	Principal	0 = No; 1 = Yes
	Provided HIV testing	Principal	0 = No; 1 = Yes
	Provided HIV treatment	Principal	0 = No; 1 = Yes
	Provided STD testing	Principal	0 = No; 1 = Yes
	Provided STD treatment	Principal	0 = No; 1 = Yes
	Provided pregnancy testing	Principal	0 = No; 1 = Yes
	Provided condoms	Principal	0 = No; 1 = Yes
	Provided condom-compatible lubricants	Principal	0 = No; 1 = Yes
	Provided contraceptives other than condoms	Principal	0 = No; 1 = Yes
	Provided prenatal care	Principal	0 = No; 1 = Yes
	Provided Human papillomavirus (HPV) vaccine administration	Principal	0 = No; 1 = Yes
	Referral for HIV testing	Principal	0 = No; 1 = Yes
	Referral for HIV treatment	Principal	0 = No; 1 = Yes
	Referral for nPEP	Principal	0 = No; 1 = Yes
	Referral for STD testing	Principal	0 = No; 1 = Yes
	Referral for STD treatment	Principal	0 = No; 1 = Yes
	Referral for pregnancy testing	Principal	0 = No; 1 = Yes
	Referral for provision of condoms	Principal	0 = No; 1 = Yes
	Referral for provision of condom-compatible lubricants	Principal	0 = No; 1 = Yes

Constructs	Profile question	Questionnaire recipient	Analytic coding
	Referral for provision of contraceptives other than condoms	Principal	0 = No; 1 = Yes
	Referral for prenatal care	Principal	0 = No; 1 = Yes
	Referral for human papillomavirus (HPV) vaccine administration	Principal	0 = No; 1 = Yes
Other	Staff worked with health services staff	Lead health educator	0 = No; 1 = Yes
	School Improvement Plan (SIP) included health services	Principal	0 = No; 1 = Yes
	Full-time nurse at school	Principal	0 = No; 1 = Yes
	Part-time nurse at school	Principal	0 = No; 1 = Yes
	School-based health center	Principal	0 = No; 1 = Yes
	Protocol for insurance programs	Principal	0 = No; 1 = Yes
	School practice when sexual health services provided	Principal	0 = No; 1 = Yes
SSE Index (n = 30)	School practice when sexual health services referred	Principal	0 = No; 1 = Yes
Antiharassment	Provided PD on bullying/harassment	Principal	0 = No; 1 = Yes
	Had confidential report on bullying/harassment	Principal	0 = No; 1 = Yes
	Publicized bullying/harassment rules	Principal	0 = No; 1 = Yes
School connectedness	Had programs to mentor students	Principal	0 = No; 1 = Yes
	Provided service-learning opportunities	Principal	0 = No; 1 = Yes
	Provided peer tutoring	Principal	0 = No; 1 = Yes
	Provided PD on encouraging family or community involvement	Teacher	0 = No; 1 = Yes
	Had clubs to learn about people different	Principal	0 = No; 1 = Yes
	School offered lessons in class on people different	Principal	0 = No; 1 = Yes
	School offered special events sponsored by school/community organizations on people different	Principal	0 = No; 1 = Yes
	Had gay/straight alliance	Principal	0 = No; 1 = Yes
Parent engagement	Provided parents and families with information about how to communicate with their child about sex	Principal	0 = No; 1 = Yes
	Provided parents with information about how to monitor their child	Principal	0 = No; 1 = Yes
	Involved parents as school volunteers in delivery of health education activities and services	Principal	0 = No; 1 = Yes
	Linked parents and families to health services and programs in community	Principal	0 = No; 1 = Yes
	Did homework with parents	Principal	0 = No; 1 = Yes
	Informed parents about health services	Principal	0 = No; 1 = Yes
	Families helped develop school health policies	Principal	0 = No; 1 = Yes
LGBTQ support	School identified ‘safe spaces’ where LGBTQ youth can receive support from administrators, teachers, or other school staff	Principal	0 = No; 1 = Yes
	School prohibited harassment based on a student’s perceived or actual sexual orientation or gender identity	Principal	0 = No; 1 = Yes

Constructs	Profile question	Questionnaire recipient	Analytic coding
	School encouraged staff to attend professional development on safe and supportive school environments for all students	Principal	0 = No; 1 = Yes
	School facilitated access to providers not on school property who have an experience in providing health services, including HIV/STD testing and counseling to LGBTQ youth	Principal	0 = No; 1 = Yes
	School facilitated access to providers not on school property who have experience in providing social and psychological services to LGBTQ youth	Principal	0 = No; 1 = Yes
Other	Provided parents with info on HIV, other STD, or pregnancy prevention	Lead health educator	0 = No; 1 = Yes
	Staff worked with health services staff	Lead health educator	0 = No; 1 = Yes
	Staff worked with mental health or social services staff	Lead health educator	0 = No; 1 = Yes
	Provided parents with information on preventing student bullying and sexual harassment	Lead health educator	0 = No; 1 = Yes
	Schools provided curricula or supplementary materials that include HIV, STD, or pregnancy prevention information that is relevant to lesbian, gay, bisexual, transgender, and questioning youth	Lead health educator	0 = No; 1 = Yes
	Received PD on classroom management techniques	Lead health educator	0 = No; 1 = Yes
	Have SIP that included health education	Principal	0 = No; 1 = Yes

The ESHE/SHS/SSE index variables are composite variables that each set of ESHE/SHS/SSE items were assigned 1 = yes and 0 = no and then summed.

Originally, there were 48 items in the Profiles data that were related to ESHE, nearly doubling the number of SHS items. We applied principal component analysis (PCA) to Profiles data to refine the ESHE index. PCA is a multivariate statistical tool to reduce the number of items in a dataset into a smaller dataset by removing uncorrelated items, so the remaining items can address the largest possible proportion of deviance in the original data. We applied Landgraf and Lee's logistic PCA method and used the Logistic PCA R package for our analysis. Specifically, we excluded 12 items from ESHE that had scores of less than 0.20 for each obtained principal component, resulting in the final ESHE index with 36 items and 84.93% of deviance explained. These refined items form an index for each strategy. Furthermore, each item was coded (0 = *no* and 1 = *yes*). Then, all items in each strategy were summed. For each strategy, a higher score indicates a higher overall adoption of the intervention (i.e., implementation dosage).

HS = high school; PD = professional development; SIP = school improvement plan; STD = sexually transmitted disease.

Table 3

Characteristics of demographic and outcomes variables, overall and by baseline and follow-up

Variables	Overall (column yes% or M [SD])	Baseline			Follow-up		
		Exposed schools	Unexposed schools	*p* value	Exposed schools	Unexposed schools	*p* value
		Column yes% or M (SD)			Column yes% or M (SD)		
Covariates							
Grade (N = 81,370)				**<.001**			**<.001**
Ninth grade	26.8	28.1	26.0		25.2	27.6	
10th grade	26.6	26.4	25.6		26.0	28.3	
11th grade	23.8	22.8	24.7		25.1	22.9	
12th grade	22.8	22.6	23.7		23.7	21.2	
Sex (N = 81,553)				**<.001**			**<.001**
Male	49.3	50.3	48.7		50.4	47.8	
Female	50.7	49.7	51.3		49.6	52.2	
Race/Ethnicity (N = 79,448)				**<.001**			**<.001**
non-Hispanic White	13.9	11.4	16.7		10.8	16.8	
non-Hispanic Black	31.6	36.4	29.3		34.5	26.3	
Hispanic/Latino	38.9	36.5	39.5		37.9	41.5	
Other	15.6	15.6	14.5		16.8	15.4	
Profiles Dosage[c]							
ESHE Index (N = 77,371)	23.75 (7.18)	23.87 (6.43)	22.61 (7.79)	**<.001**	25.90 (5.51)	22.53 (8.24)	**<.001**
SHS Index (N = 81,808)	13.29 (8.72)	11.32 (6.78)	11.20 (6.75)	.062	16.82 (9.76)	13.88 (9.84)	**<.001**
SSE Index (N = 81,910)	22.90 (6.64)	22.33 (6.68)	22.86 (7.15)	**<.001**	23.80 (5.50)	22.63 (7.01)	**<.001**
Primary Outcomes							
Ever had sex (N = 64,855)	36.7	40.2	35.1	**<.001**	39.6	32.6	**<.001**
Had ≥4 lifetime sexual partners (N = 60,400)	10.4	13.3	9.3	**<.001**	11.9	7.8	**<.001**
Currently sexually active (N = 62,825)	25.4	27.9	24.4	**<.001**	27.2	22.5	**<.001**
Effective hormonal birth control use[a] (N = 16,390)	18.8	19.5	19.1	.157	18.8	18.1	.401
Used a condom during last sexual intercourse[a] (N = 15,070)	58.2	59.0	60.6	.700	56.0	56.7	.514
Condom and effective hormonal birth control use[a] (N = 14,222)	6.9	6.5	6.5	.934	7.0	7.5	.489

Variables	Overall (column yes% or M [SD])	Baseline			Follow-up		
		Exposed schools	Unexposed schools	*p* value	Exposed schools	Unexposed schools	*p* value
		Column yes% or M (SD)			Column yes% or M (SD)		
Ever tested for HIV (N = 70,891)	20.7	23.0	20.5	**<.001**	21.6	17.7	**<.001**
Secondary Outcomes							
Did not go to school because of safety concerns (N = 74,489)	9.1	10.1	6.9	**<.001**	11.7	8.2	**<.001**
Threatened or injured with a weapon at school (N = 77,799)	7.2	7.9	6.2	**<.001**	8.4	6.3	**<.001**
Forced sex (N = 69,124)	9.0	9.7	7.7	**<.001**	9.9	8.6	**<.001**
Sexual dating violence (DV)[b] (N = 43,478)	9.0	9.9	9.7	.561	8.0	8.1	.867
Physical dating violence (DV)[b] (N = 47,290)	9.8	10.6	9.3	**<.001**	11.0	8.3	**<.001**
Bullied at school (N = 78,191)	14.1	14.5	13.9	.069	14.1	13.9	.546
Electronically bullied (N = 78,435)	11.4	11.0	11.2	.550	11.3	11.9	.100
Persistent feelings of sadness or hopelessness (N = 77,644)	30.3	29.8	29.1	.186	31.6	31.0	.197
Seriously considered attempting suicide (N = 77,920)	15.2	15.4	14.2	**<.001**	15.7	15.6	.993
Made a suicide plan (N = 62,601)	13.8	14.7	13.2	**<.001**	14.1	13.1	**.006**
Attempted suicide (N = 67,067)	11.5	13.6	9.3	**<.001**	13.7	9.5	**<.001**
Injured in a suicide attempt (N = 56,240)	3.7	4.2	3.1	**<.001**	4.3	3.2	**<.001**
Injection drug use (N = 45,696)	3.0	3.5	2.6	**<.001**	3.8	2.5	**<.001**
Ever use marijuana (N = 46,899)	37.4	39.2	38.2	.128	37.6	34.9	**<.001**
Currently use marijuana (N = 75,524)	21.9	23.0	20.5	**<.001**	23.4	20.7	**<.001**

Bolded numbers indicates $p < .05$

[a] This question was only asked if the participants self-reported being sexually active.

[b] The denominator of this variable is students who ever dated or went out with someone during the 12 months before the survey.

[c] Dosage index variables were measured in 2014 and 2016. Results show that ESHE index value ranged between 0 and 29, SHS index ranged between 0 and 34, and SSE index ranged 0 and 33.

Table 4

The moderating effects of exemplary sexual health education, sexual health services, and safe and supportive environments program implementation dosage on program effects, primary outcomes

	Ever had sex	Had > 4 lifetime sexual partners	Were currently sexually active	Used hormonal birth control	Used a condom during last sex	Used a condom & hormonal birth control	Ever tested for HIV
	Coefficient (Std. Error)[a]						
ESHE Index × Exposure × Year[b]	0.004 (0.008)	0.004 (0.010)	0.008 (0.008)	−0.007 (0.012)	0.016 (0.011)	0.005 (0.022)	−0.002 (0.008)
SHS Index × Exposure × Year[b]	−0.012 (0.006)	0.001 (0.009)	−0.007 (0.006)	−0.004 (0.011)	−0.004 (0.009)	−0.023 (0.018)	−0.002 (0.007)
SSE Index × Exposure × Year[b]	**−0.027 (0.007)**	**−0.027 (0.011)**	**−0.018 (0.008)**	**−0.033 (0.012)**	0.002 (0.011)	**−0.048 (0.021)**	−0.006 (0.008)

[a] Bolded numbers indicated $p < .05$.

[b] Models had controlled for individual-level covariates: gender, grade, and race/ethnicity.

Table 5

The moderating effects of exemplary sexual health education, sexual health services, and safe and supportive environments dosage on program effects, secondary outcomes

	Unsafe at school	Threatened at school	Forced sex	Sexual dating violence	Physical dating violence	Bullied at school	Electronic bullying
	Coefficient (Std. Error)[a]						
ESHE Index × Exposure × Year[b]	−0.004 (0.010)	−0.001 (0.011)	−0.002 (0.010)	−0.000 (0.012)	−0.000 (0.011)	−0.002 (0.007)	−0.005 (0.008)
SHS Index × Exposure × Year[b]	−0.003 (0.009)	0.008 (0.009)	0.007 (0.008)	−0.002 (0.011)	−0.005 (0.009)	0.003 (0.006)	−0.001 (0.007)
SSE Index × Exposure × Year[b]	**−0.025 (0.010)**	−0.016 (0.011)	**−0.024 (0.010)**	0.005 (0.008)	−0.018 (0.011)	−0.004 (0.007)	−0.013 (0.008)

	Persist sadness	Consider suicide	Suicide plan	Attempt suicide	Injurious suicide attempt	Injection drug use	Ever use marijuana	Currently use marijuana
	Coefficient (Std. Error)[a]							
ESHE Index × Exposure × Year	−0.010 (0.006)	−0.009 (0.007)	−0.009 (0.008)	−0.006 (0.009)	−0.014 (0.015)	0.012 (0.017)	0.012 (0.006)	0.009 (0.006)
SHS Index × Exposure × Year	−0.001 (0.005)	−0.006 (0.006)	−0.005 (0.007)	−0.002 (0.008)	−0.003 (0.014)	0.007 (0.019)	−0.010 (0.008)	**−0.017 (0.006)**
SSE Index × Exposure × Year	−0.000 (0.006)	−0.004 (0.007)	−0.008 (0.008)	−0.004 (0.009)	−0.004 (0.017)	−0.030 (0.021)	**−0.023 (0.008)**	**−0.016 (0.007)**

[a] Bolded numbers indicated $p < .05$.

[b] Models had controlled for individual-level covariates: gender, grade, and race/ethnicity.