

Effects of the school environment on early sexual risk behavior: a longitudinal analysis of students in English secondary schools

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Abstract

Introduction: The theory of human functioning and school organization proposes that schools promote health by strengthening students' educational engagement. Previous studies have relied on proxy measures of engagement and not examined sexual health. This paper addresses these gaps.

Methods: Longitudinal data came from the control arm of a randomized trial involving female and male students ages 12-14 in English secondary-schools (n=3337 students). Exposures measured at baseline included a proxy measure of school-level engagement (value-added education, VAE: the difference between observed absence and attainment rates and those predicted based on student characteristics) and direct measures of school- and student-level engagement (commitment, belonging, relationships and participation). Sexual behavior was measured at 24- and 36-months, including sexual debut and contraception use at first sex.

Results: Higher school-level VAE was associated with an increased risk of early sexual debut at 24-months. Students attending schools with higher overall levels of commitment and belonging were less likely to report sexual debut at 36 months. Students reporting stronger personal commitment to learning and teacher relationships at baseline were less likely to report sexual debut at both follow-up points. Associations involving participation and contraception use were largely nonsignificant.

Conclusions: Direct measures of the school environment are more strongly associated with reduced sexual risk behavior in early adolescence than the proxy measure, VAE. Results provide some support for the theory and suggest that personal disposition towards school as well as attending a school with high levels of student commitment and belonging are important for subsequent sexual decision making.

Keywords: school environment, sexual behaviour, adolescence, multilevel models

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Introduction¹

Increasingly, policy approaches (such as the Health Promoting School model and Whole School, Whole Community, Whole Child initiative) promote the school environment as a key factor for improving student health and well-being (Langford et al., 2014; Lewallen et al., 2015). While commonly used as settings for interventions to promote sexual health, observational studies indicate that the school environment is itself likely to be a social determinant of young people's sexual health (Patton et al., 2016). Students with stronger attachment (Greene et al., 2018; Oman et al., 2013; Paul et al., 2000; Rink et al., 2007; Steiner et al., 2014), involvement (Lauritsen, 1994), pro-school attitude (Bonell et al., 2005; Henderson et al., 2008), and relationships (McNeely & Falci, 2004) in school report reduced sexual risk behaviors and outcomes in terms of early sexual debut, failure to use contraception, pregnancy and STIs. Further, school-level studies suggest that students who attend schools with higher aggregate levels of positive attitude towards school (Kim, 2015), expectations of higher education (White & Warner, 2015) and attendance (Resnick et al., 1997) report delayed sexual debut. These patterns extend to other risk behaviors (Bonell et al., 2013), suggesting that modifying school environments might be an effective public health strategy (Aveyard et al., 2004; Markham et al., 2008, 2012; Tobler et al., 2011).

Studies of school health effects are commonly informed by the theory of human functioning and school organization developed by Markham and Aveyard (2003) which proposes that schools can promote student health by increasing students' commitment to learning and sense of belonging in school through a focus on students' needs and engagement and the development of their ability for practical

¹ Abbreviations: free school meals (FSM); income deprivation affecting index (IDACI); value-added education (VAE)

reasoning and affiliation. These capacities are considered crucial for developing the self-esteem, support systems and skills needed to make pro-active and adaptive decisions about health and well-being in adolescence and later in life. Markham and Aveyard propose that schools may improve these capacities by improving student relationships with teachers and other students, providing opportunities for engaging in social and academic activities, and aligning the values of schools with the surrounding community. These strategies are theorized to work most effectively for students with low socio-economic status for whom engagement with school, which predominantly represents the values and goals of middle socioeconomic classes (Bernstein, 1975), cannot be assumed to be the default.

Previous empirical studies have assessed this theory using ‘value-added education’ (VAE), a proxy measure of school-level aggregate student commitment and belonging (Aveyard et al., 2004). VAE measures the degree to which schools achieve higher student attainment in public examinations and attendance than would be expected based on the socio-demographic characteristics of their students. Several studies have examined the relationship of VAE with health outcomes including smoking, substance use, bullying and misbehavior (Aveyard et al., 2004; Bisset et al., 2007; Bonell et al., 2017, 2019; Markham et al., 2008, 2012; Tobler et al., 2011). Higher levels of VAE were associated with reduced smoking in three studies (Markham et al., 2008, 2012; Tobler et al., 2011) and with reduced alcohol and misbehavior in one study (Tobler et al., 2011). Associations of VAE with sexual behaviors have not been examined to date.

VAE is a proxy measure for student engagement and relies on administrative data on attainment and attendance to assess belonging and commitment. It has been argued, however, that direct measures of school-level engagement with the school environment (i.e., aggregated student engagement) may more accurately reflect the extent to which schools are successfully engaging students as Markham and Aveyard suggest in their theory (Bonell et al., 2017, 2019). Using student reports, these studies have attempted to assess the theory with reliable direct measures of student engagement but have not examined sexual risk behavior. Previous school-level associations of school-related factors with sexual behavior

have been studied. However, these have primarily focused on the associations of school-level deprivation with sexual health (Henderson et al., 2008; Kim, 2015; Maticka-Tyndale & Tenkorang, 2010; Moore et al., 1998), rather than measures related to belonging in and commitment to school. An exception is a 1995 study from the western U.S. which found that school-level bonding – measured via aggregate self-reported belonging among 12th graders – was associated with lower rates of recent sexual activity among 9th grade boys (McBride et al., 1995). This study, however, did not account for known confounders of sexual behavior and could not establish temporality given its cross-sectional design. Further, previous school-level analyses used measures that were developed from available data rather than measures based on theory and established prior to data collection.

This paper aims, for the first time, to assess the theory of human functioning and school organization as it relates to sexual behavior in early adolescence, using VAE, as well as direct measures of student engagement with the school environment aligned with the theory. In addition to exploring direct measures of commitment to learning and sense of belonging, this analysis also examines two variables which Markham and Aveyard theorized as ways to improve student engagement in school: relationships with teachers and participation in school activities. Using longitudinal data from control schools in the INCLUSIVE trial (Bonell et al., 2014), we examine the effect of these school- and student-level factors, in addition to the VAE proxy measure, on sexual behavior. Our analysis addresses the following questions: 1) Is value-added education at baseline associated with student-level sexual behavior at follow-up? 2) Are direct school- and student-level measures of engagement with school environment (i.e., commitment, belonging, relationships and participation) at baseline associated with student-level sexual behavior at follow-up? 3) Do student-level measures of engagement with school environment mediate the relationship between VAE and sexual behavior? We hypothesize that VAE and direct measures of student- and school-level engagement with the school environment will be associated with reduced student sexual risk behavior. We also hypothesize that student-level measures of engagement with the school environment will mediate the relationship of VAE and student outcomes.

Methods

Design

The data for this paper come from English secondary schools enrolled in the control arm of the two-arm cluster randomized controlled trial (RCT) of a multi-component intervention to reduce bullying and aggression called INCLUSIVE. We limited our analysis to the 20 schools (3337 students at baseline) participating in the control arm of the RCT to avoid any confounding from intervention effects.

The INCLUSIVE trial was conducted from 2014 to 2017 by researchers from the London School of Hygiene and Tropical Medicine and the University College London (UCL) Institute of Child Health. State secondary schools were eligible to participate if they were within one-hour train ride from London and not evaluated as ‘inadequate’ by national school inspectors. There were no ineligibility criteria for students attending enrolled schools. Schools were allocated using computer-generated random numbers stratified by the following criteria: single- or mixed-sex enrollment; high or low rates of students receiving free school meals (FSM) (a proxy for government benefits entitlement); and school-level attainment in public examinations. Students provided written informed consent to participate in surveys with the option of parents withdrawing their children. Consenting students were surveyed prior to random allocation at baseline (age 11-12 years) and at 24-month and 36-month follow-up, when the students were aged 12-13 and 14-15, respectively. Trained field workers, blind to allocation, administered confidential, paper questionnaires to students in classrooms where teachers were present but unable to read student responses. Questionnaires were collected and entered by trained personnel into a password-protected system on a secure database. All student information was de-identified. The INCLUSIVE trial was approved by the UCL ethics committee (ref 5248/001). Full details of the trial are published elsewhere (Bonell et al., 2014, 2018).

Measures

To establish temporality, we examined exposure variables, including VAE and school-level and student-level commitment, belonging, relationships and participation, at baseline. Outcome variables, sexual debut and contraception use at first sex, were measured at 24- and 36-month follow-up. We also include student-level commitment, belonging, relationships and participation at 24-month follow-up to examine potential mediation between VAE and outcomes.

Value-added education: Exposure variable VAE was constructed as a continuous variable using administrative data as established in prior studies (Aveyard et al., 2004; Markham et al., 2008, 2012; Tobler et al., 2011). VAE is the difference between observed attainment and absence rates and those expected from a model based on the school's socio-demographic student profile. Attainment rates were five-year (2009-2013) averages of the proportion of students in year 11, passing at least five General Certificate of Secondary Education exams graded A*-C. Absence rates were five-year (2009-2013) averages of the proportion of half-days missed. Measures on ethnicity, sex, socio-economic status (area income deprivation, FSM eligibility and Family Affluence Scale), and English as an additional language were used to create a socio-demographic profile for each school. Ethnicity and Family Affluence Scale (Currie et al., 2008) data were derived from the study survey; all other socio-demographic data came from government websites. To calculate VAE, two logistic regression models using attainment and absence rates were created with the socio-demographic exposures. A single continuous variable was created using principal components analysis then standardized into a VAE score where +1 represented schools with performance one standard deviation above average and -1 indicated schools with one standard deviation below average.

Engagement with school environment scales: School environment exposure variables were collected from students at baseline using multi-item scales from the BeyondBlue School Climate Questionnaire (Sawyer et al., 2010). These continuous measures included a four-item commitment to learning sub-scale (Cronbach's $\alpha=0.82$), an eight-item sense of belonging sub-scale ($\alpha=0.85$), a nine-item relationships with

teachers sub-scale ($\alpha=0.89$) and a six-item participation in school sub-scale ($\alpha=0.81$) (Table 1). Students were asked to rate each item with one of four possible responses between 0 ('totally disagree') and 3 ('yes, totally agree'). School-level variables were calculated as aggregates of student-level scores.

Early sexual risk behavior: Questions used to assess sexual risk behaviors at 24- and 36-month follow-up were derived from previous surveys (Stephenson et al., 2004). A dichotomous outcome *sexual debut* (i.e., ever had sex with man/boy or woman/girl) was measured among all students and is inclusive of heterosexual and same-sex sexual behaviors. Among those who answered yes to sexual debut questions, students were asked if they used any methods of contraception the first time they had sex (e.g., condom, the pill, emergency contraception, other, not sure). A dichotomous variable of *did not use contraception at first sex* was derived from this question, with an answer of 'yes' indicating risk.

Covariates: The following covariates were used in the adjusted regression models described below, pre-hypothesized as potential confounders and effect modifiers. School size, school-level income deprivation affecting index (IDACI) and proportion of students eligible for FSM were derived from data on government websites. Student-level factors from the baseline student surveys included sex, ethnicity, family structure, levels of household employment and housing tenure.

Analysis

Analysis was conducted in several stages using Stata 15 (StataCorp, 2017). Descriptive analyses assessed the proportion and means of baseline exposures and covariates, including VAE, school environment measures and socio-demographic characteristics. Intraclass correlations, which assess how similar individuals within schools respond to a variable, were calculated for outcomes at each time point. Unadjusted longitudinal associations were then calculated between VAE, school- and student-level school environment measures at baseline and outcomes at 24- and 36-month follow-up using logistic mixed-regression models. We then assessed for interactions with the covariates prior to running adjusted analysis for each model. Where interactions were present ($p \leq 0.01$), we report adjusted analyses by strata. We used multiple imputation by chained equations to account for missing participant data in regression models.

Complete case analysis was used to inform model building, then data were imputed by accounting for variables in final models. All associations were adjusted for clustering at the school level.

To assess whether associations between VAE and sexual behavior outcomes were mediated by student-level reports of school engagement (i.e., belonging, commitment, relationships and participation), we first explored associations between: 1) VAE and student-level school environment measures at 24-month follow-up using linear mixed-regression; and 2) student-level school environment measures at 24-month follow-up and sexual behavior at 36-month follow-up using logistic mixed-regression. As no associations were found between VAE and 24-month school environment variables, no further mediation analysis was conducted.

Results

Across control schools, 3347 students completed surveys at baseline (92.7% of students eligible). Of these, 3195 (90.4% of eligible) and 3087 (85.0% of eligible) completed surveys at 24- and 36-months respectively (Table 2). At baseline, half of students were female. Almost 60% of students reported their ethnicity as other than White British. The majority of students reported living with two parents (79%) with at least one parent working (75%). Just under half (44%) of all students reported living in a home owned by their family.

At 24-month follow-up, 4.5% of students reported sexual debut. Female students were less likely than male students to report ever having had sex (Supplementary Table 1). Of all students reporting sexual debut at 24-months, 30.3% reported not using contraception at first sex. Outcomes at 24-months varied by school from 0-15.5% for sexual debut and 0-60% for no contraception at first sex. The intraclass correlations at 24 months were 0.11 for sexual debut and 0.51 for contraception use.

At 36-month follow-up, 10.4% of students overall reported sexual debut with female students being less likely to report sexual debut than male students (Supplementary Table 1). Of those reporting sexual debut at 36-months, 23.9% reported not using contraception at first sex. Outcomes at 36 months varied by

school from 2.9-17.1% for sexual debut and 0-42.2% for no contraception at first sex. Outcome intraclass correlations at 36 months were 0.14 for sexual debut and 0.55 for contraception use.

VAE and sexual behavior

In unadjusted (Table 3) and adjusted analyses (Table 4), students attending schools with higher levels of baseline VAE were more likely to report sexual debut at 24-month follow-up. Sexual debut at 36 months and contraception use at both time points was not associated with VAE in either unadjusted or adjusted analyses.

School-level school environment and sexual behavior

School-level associations indicate whether attending a school with higher levels of aggregate engagement with the school environment (i.e., commitment, belonging, relationships and participation) at baseline is associated with students' subsequent sexual behavior. In unadjusted analyses, direct school-level measures of the school environment at baseline did not appear to be associated with sexual behavior outcomes at 24 or 36 months. However, after identifying interactions and adjusting for school- and individual-level sociodemographic factors (Table 4), students who attended schools with low deprivation and higher levels of aggregate commitment to learning were less likely to report sexual debut at 24 months.

Further, in adjusted analyses, students who attended schools with higher levels of baseline school-level commitment to learning and belonging were less likely to report sexual debut at 36 months. Additionally, male students who attended schools with higher aggregate levels of relationships with teachers were less likely to report sexual debut at 36 months. School-level baseline variables were not associated with contraception use at 24 or 36 months, even after adjusting for sociodemographic factors.

Student-level school environment and sexual behavior

Student-level associations indicate whether a student's own engagement with school (i.e., commitment, sense of belonging, etc.) at baseline is associated with their subsequent sexual behavior. Several student-

level associations were identified at 24 and 36 months. Unadjusted and adjusted analyses showed that increased student-level commitment and good relationships with teachers were significantly associated with decreased odds of sexual debut at 24-months. After testing for interactions and adjusting for school- and individual-level sociodemographic factors, analyses suggested that, among students who attended schools with low deprivation, those who reported greater participation in school appeared less likely to report sexual debut at 24 months. None of the student-level measures of school engagement were associated with contraception use at 24 months.

At 36-month follow-up, baseline students who reported higher commitment to learning, in both unadjusted and adjusted analyses, were less likely to report sexual debut. After adjusting for sociodemographic factors, students with stronger relationships with teachers were less likely to report sexual debut at 36 months, as well as less likely to report a failure to use contraception if they were sexually active. Additionally, among students who attended small schools, students with higher levels of belonging appeared less likely to report sexual debut at 36 months.

Mediation of VAE and sexual behavior by student-level engagement with school environment

We found that VAE was not associated with any of the student-level measures of engagement with the school environment at 24-months (Supplementary Table 2) or sexual behavior outcomes at 36-months in unadjusted or adjusted analyses, and thus mediation analysis was not possible. We did find that student-level measures of increased commitment and relationships at 24 months were significantly associated with reduced odds of sexual debut at 36 months adjusting for previous sexual behavior (Supplementary Table 3). Additionally, students with stronger relationships with teachers were less likely to report not using contraception at first sex at 36 months. These relationships were maintained after adjusting for school- and individual-level sociodemographic variables.

Discussion

We found no evidence that attending schools with higher levels of VAE was associated with reduced sexual risk behavior among early adolescents. In fact, findings appear to show that increased VAE was associated with greater sexual risk at 24 months. However, based on direct measures of engaging school environments, we found some evidence that school-level commitment and belonging may reduce the likelihood of early sexual debut. Other school-level associations appear to be isolated to particular subgroups, such as male students and schools with low deprivation, and should be interpreted with caution given the large number of significance tests conducted and that interaction tests were underpowered. Student-level measures of engagement with the school environment were more strongly associated with reduced risk of sexual behavior. In particular, relationships with teachers appeared to be most consistently associated with reduced sexual risk behavior, across school- and student-levels, timepoints and outcomes.

This study is the first to assess the theory of human functioning and school organization (Markham & Aveyard, 2003) for sexual behaviors, contributing to the overall assessment of the theory on student health outcomes. Our findings indicate that having higher levels of personal engagement with the school environment, as well as attending schools with higher aggregate levels of commitment and belonging, are important for subsequent sexual decision-making in early adolescence. These findings add to the body of research on the school effects on sexual behavior by using a longitudinal design and theoretically-aligned variables of commitment, belonging, relationships and participation in school.

In contrast to our hypothesis and previous studies that reported positive or null associations between VAE and risk behaviors (Aveyard et al., 2004; Bisset et al., 2007; Bonell et al., 2017, 2019; Markham et al., 2008; Tobler et al., 2011), our findings suggest a possible harmful effect of VAE on sexual risk behavior at 24-month follow-up. This is consistent with a single, previous study from Scotland that reported an association between higher VAE and increased substance use behavior (Markham et al., 2012). VAE is based on the assumption that achieving higher academic attainment and attendance rates

than would be expected from the school's demographic profile represents a school's broader ability to support its students' social development and, thus, influence their behavior. It has been argued, however, that recent changes to U.K. education policy focus too narrowly on achieving traditional academic success, and thus, academic metrics have become less associated with a school's ability to engage and support students' broader development (Bonell et al., 2017). Our analysis appears to support this line of thinking as VAE was not associated with any of our direct measures of students' engagement with the school environment at 24 months. It is possible that a school with higher VAE may be effective at improving academic outcomes but not effective at supporting its students' development in ways that would lead to lower risk behavior.

Our findings that school-level commitment, belonging and relationships were associated with reduced sexual risk behavior suggests that school environment factors are important for student health above and beyond personal disposition towards school. Further, while it is possible that factors such as commitment and belonging may be proxy measures of more general prosocial behavior, our school-level findings indicate that these variables measure something about the school climate above any individual-level mechanism. This is consistent with previous reports of direct school-level measures of the school environment on other risk behaviors (Bonell et al., 2017, 2019) and provides support for the theory of human functioning and school organization, in that attending schools with other students who have positive associations with school, may delay sexual debut in early adolescence. More associations were present at 36-month follow-up than at 24-months, indicating early school environment experiences are important for shaping behavior over time.

This research confirms that, at the individual level, students who engage with school are less likely to report early sexual behaviors. These findings align with the theory of human functioning and school organization in that students who are unable to meet the academic demands or feel alienated from the school community are more likely to engage in risk behaviors. Higher levels of student-level belonging and participation were associated with delayed sexual debut at 24-months only among students attending

schools with low deprivation, perhaps aligning with Markham and Aveyard's assumption that students with higher socioeconomic backgrounds are more likely to be aligned with school values. Having stronger relationships with teachers, however, was associated with sexual debut at 24-months for students who attended schools with either low or high deprivation, suggesting teacher relationships potentially mitigate the effects of socioeconomic status on early initiation of sex.

Indeed, across school-level and student-level exposures, relationships appeared to be an important determinant of sexual behavior, which the theory of human functioning and school organization theorizes are critical for improving student commitment to school. Attending a school with higher levels of good teacher-student relationships appeared to be associated with lower risk of early sexual debut among male students. Further, personally having good relationships with teachers appears to reduce the risk of early sexual debut and failure to use contraception when initiating sex. Qualitative research supports this finding in that adolescent mothers reported negative experiences with teachers and school staff, resulting in a disconnection from school prior to pregnancy (Peterson & Bonell, 2018). At the school-level, students may be responding to how teachers connect with others in the classroom. The finding that school-level relationships may be associated with sexual debut only for boys might result from the higher proportion of boys having sex. However, it may also reflect gendered experiences in school; for example, students may bond with teachers differently based on teachers' characteristics or observations of how teachers interact with other students, depending on their gender.

Our findings are subject to several limitations. While the analysis used a longitudinal design with a relatively large sample, some analyses were underpowered, such as interaction tests. Further, the sample for contraception use was very small due to the low prevalence of students reporting sexual debut, likely making associations difficult to detect. Additionally, we could not assess differences by subgroups related to heterosexual or same-sex behaviors, nor could we assess behaviors of students who identified as having a nonbinary gender. It is also possible that we did not account for all school- or individual-level confounders; however, the inclusion of our covariates was based on known influences on sexual behavior.

We did not adjust for age but students were enrolled in the same year at school and were primarily within the same age range (e.g., 11-12 years at baseline). Despite adequate retention, multiple imputation was used to account for missing outcome data. We did not adjust for multiple testing but instead were cautious in our interpretation of significance tests. Given the UK setting, our findings may not be generalizable to other settings. For example, calculation of VAE may be based on other measures of attainment and attendance in other country settings (Markham et al., 2012), potentially producing a different relationship between VAE and risk behaviors.

Despite these limitations, our research indicates that engagement with the school environment is an important social determinant of sexual health in early adolescence. New research is needed on interventions that address the school environment, such as those following Health Promoting School and Whole School, Whole Community, Whole Child frameworks. Results from a recent meta-analysis indicate that programs addressing the school environment can be effective at promoting young people's sexual health (Peterson et al., 2019). Given the findings on VAE in this study and others, interventions should be careful in solely focusing on academic attainment and attendance as indicators of commitment and belonging. More research is also needed on the mechanisms by which the school environment influences sexual behaviors. These mechanisms may differ from other risk behaviors, as engagement in sexual behavior becomes more biologically and developmentally appropriate with age. As this study examined data from schools representative of southeast England, replication of this analysis in other settings would be useful for understanding the extent to which school-related factors influence sexual health, especially in low- or middle-income country settings and in schools with higher levels of deprivation in high-income countries. These studies may also include, in addition to aggregated student data, observations by researchers of the physical and social environment or self-reported data from other members of the student community, including teachers and staff, on the ability of schools to engage students effectively.

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Table 1*Subscale items of student-reported school environment measures^a*

Subscale	Subscale Item
Commitment to learning	<p>I try hard in school</p> <p>Doing well in school is important to me</p> <p>Continuing or completing my education is important to me</p> <p>I feel like I am successful in this school</p>
Sense of belonging	<p>I feel very different from most other students here</p> <p>I can really be myself at this school</p> <p>Other students in this school take my opinions seriously</p> <p>I am encouraged to express my own views in my class(es)</p> <p>Most of the students in my class(es) enjoy being together</p> <p>Most of the students in my class(es) are kind and helpful</p> <p>Most other students accept me as I am</p> <p>I feel I belong at this school</p>
Relationships with teachers	<p>My teachers are fair in dealing with students</p> <p>There's at least one teacher or other adult in this school I can talk to if I have a problem</p> <p>I feel I can go to my teacher with the things that are on my mind</p> <p>In this school, teachers believe all students can learn</p> <p>In this school, students' ideas are listened to and valued</p> <p>In this school, teachers and students really trust one another</p> <p>In this school, teachers treat students with respect</p> <p>This school really cares about students as individuals</p> <p>Most of my teachers really listen to what I have to say</p>
Participation in school	<p>There are lots of chances for students at my school to get involved in sports, clubs and other activities outside class</p> <p>Teachers notice when students are doing a good job and let them know about it</p> <p>At my school, students have a lot of chances to help decide and plan things like school activities, events and policies</p> <p>Student activities at this school offer something for everyone</p> <p>Students have a say in decisions affecting them at this school</p> <p>Students at this school are encouraged to take part in activities, programs and special events</p> <p>There are lots of chances for students at my school to get involved in sports, clubs and other activities outside class</p>

^aAll items come from the Beyondblue Questionnaire (Sawyer et al., 2010)

Table 2*Baseline descriptive statistics*

Exposure Variables and Covariates	Prevalence/mean	SD	Range (Min-Max)
School-level			
VAE	0.03	1.02	-3.30-1.79
Belonging	2.97	0.10	2.80-3.13
Commitment	3.62	0.05	3.54-3.72
Relationships	3.08	0.13	2.72-3.30
Participation	3.29	0.11	2.97-3.44
School size	11.76	3.25	7.68-18.41
Free School Meals	0.35	0.18	0.08-0.79
IDACI Score	0.26	0.20	0-0.70
Student-level			
Belonging	2.97	0.57	1.00-4.00
Commitment	3.62	0.43	1.00-4.00
Relationships	3.08	0.57	1.00-4.00
Participation	3.29	0.54	1.00-4.00
Sex			
Male	50%		
Female	50%		
Ethnicity			
White British	42%		
White Other	9%		
Asian/Asian British	26%		
Black/Black British	12%		
Mixed ethnicity	7%		
Other	4%		
Family affluence			
Low	4%		
Medium	33%		
High	63%		
Household composition			
Two-parent	79%		
Single-parent	19%		
Other	1%		
Parental employment			
In work	74%		
Not in work	9%		
Do not know	17%		
Housing tenure			
Rented from council/ housing association	14%		
Rented from landlord	12%		
Owned by family	44%		
Other	2%		

Do not know/not sure

28%

Table 3*Unadjusted associations of baseline exposures with outcomes at follow-ups*

Exposure variable	24-month follow-up		36-month follow-up	
	Unadjusted OR (CI) ^a	P value	Unadjusted OR (CI) ^a	P value
Ever had sex ^b				
School-level				
VAE	1.42 (1.07, 1.88)	0.01	0.94 (0.77, 1.15)	0.54
Commitment	1.35 (0.72, 2.54)	0.35	0.65 (0.41, 1.02)	0.06
Belonging	1.12 (0.82, 1.53)	0.46	0.84 (0.67, 1.05)	0.13
Relationships	0.99 (0.79, 1.26)	0.98	0.92 (0.78, 1.08)	0.31
Participation	1.08 (0.82, 1.44)	0.58	0.94 (0.76, 1.15)	0.53
Student-level				
Commitment	0.42 (0.29, 0.61)	0.00	0.40 (0.29, 0.55)	0.00
Belonging	0.90 (0.66, 1.24)	0.53	0.78 (0.61, 1.00)	0.05
Relationships	0.46 (0.34, 0.62)	0.00	0.60 (0.48, 0.76)	0.00
Participation	0.73 (0.51, 1.04)	0.08	0.85 (0.67, 1.09)	0.20
Did not use contraception at first sex ^c				
School-level				
VAE	1.45 (0.77, 2.77)	0.25	0.85 (0.64, 1.13)	0.26
Commitment	1.54 (0.50, 4.74)	0.45	0.73 (0.34, 1.53)	0.40
Belonging	1.44 (0.83, 2.48)	0.20	0.77 (0.55, 1.07)	0.12
Relationships	1.08 (0.68, 1.72)	0.77	0.83 (0.67, 1.03)	0.10
Participation	1.24 (0.74, 2.09)	0.41	0.83 (0.63, 1.10)	0.19
Student-level				
Commitment	0.89 (0.31, 2.53)	0.83	1.01 (0.47, 2.18)	0.98
Belonging	0.71 (0.32, 1.54)	0.38	0.78 (0.45, 1.33)	0.35
Relationships	0.86 (0.41, 1.79)	0.72	0.48 (0.26, 0.90)	0.02
Participation	0.64 (0.28, 1.42)	0.29	0.63 (0.36, 1.13)	0.12

^a Adjusted for clustering^b n=3337^c n=111 at 24-month follow-up; n=237 at 36-month follow-up

Table 4*Adjusted relationships between VAE and school environment at baseline and sexual behavior outcomes at 24- and 36-months*

Exposure variable	24-month follow-up			36-month follow-up		
	Variables with moderations ^a	Overall or stratified OR (CI) ^b	P value	Variables with moderations ^a	Overall or stratified OR (CI) ^b	P value
Ever had sex ^c						
School-level VAE		1.45 (1.14, 1.86)	0.00		0.96 (0.81, 1.14)	0.64
Commitment	Low deprivation	0.31 (0.10, 0.97)	0.05		0.61 (0.36, 1.00)	0.05
	High deprivation	2.4 (0.93, 6.19)	0.07			
Belonging		1.20 (0.89, 1.61)	0.22		0.80 (0.65, 0.97)	0.02
Relationships		0.99 (0.78, 1.26)	0.96	Female	0.95 (0.80, 1.13)	0.56
				Male	0.76 (0.62, 0.93)	0.01
Participation		1.03 (0.78, 1.36)	0.85		0.86 (0.72, 1.03)	0.10
Student-level Commitment		0.47 (0.32, 0.69)	0.00	Two parents	0.34 (0.24, 0.50)	0.00
Belonging	Low deprivation	0.60 (0.37, 1.00)	0.05	One parents	0.56 (0.34, 0.92)	0.02
	High deprivation	1.24 (0.81, 1.91)	0.33	Small School	0.66 (0.46, 0.94)	0.02
				Large School	0.91 (0.63, 1.30)	0.59
Relationships	Low deprivation	0.34 (0.21, 0.55)	0.00		0.62 (0.48, 0.79)	0.00
	High deprivation	0.64 (0.43, 0.96)	0.03			
Participation	Low deprivation	0.55 (0.30, 0.98)	0.04		0.83 (0.65, 1.08)	0.17
	High deprivation	0.96 (0.61, 1.50)	0.85			
Did not use contraception ^d						
School-level VAE		1.16 (0.52, 2.60)	0.71		0.74 (0.51, 1.07)	0.11
Commitment		1.41 (0.10, 20.51)	0.80	Female	3.54 (0.64, 19.50)	0.15
				Male	0.58 (0.13, 2.57)	0.47
Belonging		0.86 (0.36, 2.04)	0.73		0.69 (0.42, 1.13)	0.14

Relationships		0.86 (0.48, 1.56)	0.62	0.75 (0.53, 1.05)	0.09
Participation		1.08 (0.56, 2.08)	0.82	0.90 (0.62, 1.29)	0.56
Student-level					
Commitment		0.35 (0.05, 2.42)	0.29	1.02 (0.41, 2.51)	0.98
Belonging		0.60 (0.17, 2.11)	0.43	0.76 (0.39, 1.49)	0.42
Relationships	Family owns home	0.40 (0.09, 1.85)	0.24	0.35 (0.16, 0.78)	0.01
	Family rents home	9.31 (0.88, 98.55)	0.06		
Participation		0.66 (0.20, 2.14)	0.49	0.60 (0.28, 1.31)	0.20

^a Reported by stratification at $p < 0.01$.

^b Adjusted for clustering, school size, school-level deprivation and proportion of students eligible for FSM, and student-level sex, ethnicity, family structure, levels of household employment and housing tenure.

^c $n=3337$

^d $n=111$ at 24-month follow-up; $n=237$ at 36-month follow-up

Supplementary Material

Supplemental Table 1

Unadjusted associations of baseline covariates with outcomes

Covariate	24-month follow-up		36-month follow-up	
	Unadjusted OR (CI)	P value	Unadjusted OR (CI)	P value
Ever had sex ^a				
School-level				
School size				
Small	Reference		Reference	
Large	0.81 (0.44, 1.49)	0.50	1.33 (0.86, 2.04)	0.20
Free School Meals				
Low score	Reference		Reference	
High score	1.34 (0.73, 2.45)	0.34	0.63 (0.43, 0.94)	0.02
IDACI Score				
Low score	Reference		Reference	
High score	1.42 (0.78, 2.58)	0.25	0.80 (0.52, 1.24)	0.32
Student-level				
Sex				
Male	Reference		Reference	
Female	0.56 (0.34, 0.87)	0.01	0.66 (0.50, 0.87)	0.00
Ethnicity				
White British	Reference		Reference	
White Other	1.61 (0.77, 3.34)		0.99 (0.60, 1.64)	
Asian/Asian British	1.56 (0.84, 2.89)		0.55 (0.35, 0.84)	
Black/Black British	1.97 (0.95, 4.11)		0.91 (0.56, 1.46)	
Mixed ethnicity	2.68 (1.28, 5.61)		1.32 (0.78, 2.23)	
Other	2.07 (0.85, 5.04)	0.11	1.09 (0.57, 2.09)	0.05
Family affluence				
High	Reference		Reference	
Medium	0.84 (0.41, 2.47)		0.75 (0.56, 1.01)	
Low	1.00 (0.41, 2.47)	0.69	0.77 (0.34, 1.73)	0.17
Household composition				
Two-parent	Reference		Reference	
Single-parent	1.66 (1.08, 2.55)		1.49 (1.08, 2.05)	
Other	1.88 (0.49, 7.24)	0.06	1.55 (0.55, 4.39)	0.04
Parental employment				
At least one parent in work	Reference		Reference	
Neither parent in work	0.99 (0.51, 1.91)		0.44 (0.20, 0.97)	
Do not know	0.90 (0.56, 1.44)	0.91	0.91 (0.61, 2.35)	0.10
Housing tenure				
Privately owned	Reference		Reference	
Rented from council	1.34 (0.75, 2.40)		1.12 (0.74, 1.70)	

Rented from landlord	0.98 (0.50, 1.90)		1.09 (0.72, 1.67)	
Other	0.77 (0.12, 4.89)		1.37 (0.58, 3.21)	
Don't Know	1.11 (0.68, 1.83)	0.87	0.84 (0.58, 1.21)	0.60
Did not use contraception at first sex ^b				
School-level				
School size				
Small	Reference		Reference	
Large	1.16 (0.37, 3.63)	0.80	0.83 (0.43, 1.60)	0.58
Free School Meals				
Low score	Reference		Reference	
High score	0.79 (0.26, 2.46)	0.69	0.76 (0.39, 1.47)	
IDACI Score				
Low score	Reference		Reference	
High score	0.87 (0.28, 2.71)	0.81	0.72 (0.38, 1.36)	0.30
Student-level				
Sex				
Male	Reference		Reference	
Female	1.33 (0.47, 3.74)	0.59	1.01 (0.53, 1.92)	0.98
Ethnicity				
White British	Reference		Reference	
White Other	1.33 (0.16, 11.26)		0.68 (0.22, 2.14)	
Asian/Asian British	1.71 (0.44, 6.68)		0.57 (0.21, 1.53)	
Black/Black British	1.41 (0.26, 7.57)		1.76 (0.62, 5.00)	
Mixed ethnicity	1.87 (0.34, 10.32)		0.84 (0.25, 2.86)	
Other	1.72 (0.22, 13.49)	0.98	0.64 (0.13, 3.15)	0.61
Family affluence				
High	Reference		Reference	
Medium	2.25 (0.80, 6.35)		0.67 (0.30, 1.52)	
Low	7.00 (0.84, 58.23)	0.10	1.52 (0.27, 8.61)	0.54
Household composition				
Two-parent	Reference		Reference	
Single-parent	2.52 (0.83, 7.70)		1.16 (0.56, 2.42)	
Other	-	0.24	2.77 (0.17, 45.54)	0.71
Parental employment				
At least one parent in work	Reference		Reference	
Neither parent in work	3.44 (0.70, 16.97)		0.52 (0.06, 4.43)	
Do not know	1.17 (0.34, 4.03)	0.31	0.66 (0.22, 1.98)	0.64
Housing tenure				
Privately owned	Reference		Reference	
Rented from council	0.93 (0.22, 3.96)		0.60 (0.21, 1.72)	
Rented from landlord	2.39 (0.51, 11.31)		0.83 (0.28, 2.51)	
Other	-		-	
Don't Know	2.95 (0.88, 0.84)	0.30	0.98 (0.44, 2.19)	0.92

^a n=3337. ^b n=111 at 24-month follow-up; n=237 at 36-month follow-up.

Supplemental Table 2

Unadjusted and adjusted associations between value-added education and student-level variables at 24 months

	Unadjusted		Adjusted ^a	
	Coefficient	P value	Coefficient	P value
Value-Added Education ^b				
Student-Level				
Commitment	0.01 (-0.01, 0.03)	0.23	0.01 (-0.01, 0.03)	0.53
Belonging	0.02 (-0.01, 0.05)	0.16	0.01 (-0.02, 0.04)	0.45
Relationships	0.00 (-0.05, 0.05)	0.78	0.01 (-0.04, 0.05)	0.77
Participation	0.01 (-0.03, 0.05)	0.61	0.01 (-0.03, 0.05)	0.52

^aAdjusted for clustering, school size, school-level deprivation and proportion of students eligible

for FSM, and student-level sex, ethnicity, family structure, levels of household employment and

housing tenure. ^b n=3337.

Supplemental Table 3

Unadjusted and adjusted associations between student-level variables at 24 months and sexual behavior outcomes at 36 months

Exposures	Unadjusted		Adjusted ^a	
	OR (CI)	P value	OR (CI)	P value
Ever had sex ^b				
Commitment	0.55 (0.40, 0.77)	0.00	0.59 (0.42, 0.82)	0.00
Belonging	0.82 (0.62, 1.07)	0.14	0.81 (0.61, 1.07)	0.13
Relationships	0.57 (0.42, 0.77)	0.00	0.57 (0.43, 0.77)	0.00
Participation	0.81 (0.62, 1.05)	0.11	0.81 (0.61, 2.07)	0.13
Did not use contraception at first sex ^c				
Commitment	0.88 (0.45, 1.72)	0.70	0.69 (0.27, 1.77)	0.44
Belonging	0.76 (0.44, 1.33)	0.34	0.65 (0.29, 1.49)	0.23
Relationships	0.56 (0.31, 1.03)	0.06	0.40 (0.18, 0.89)	0.03
Participation	0.68 (0.37, 1.22)	0.19	0.53 (0.4, 1.17)	0.12

^aAdjusted for clustering, previous sexual behavior, school size, school-level deprivation and

proportion of students eligible for FSM, and student-level sex, ethnicity, family structure, levels

of household employment and housing tenure. ^b n=3337. ^c n=237.