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The Quality of Social Relationships in Schools and Adult Health: Differential Effects of Student–Student Versus Student–Teacher Relationships

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Students' sense of social relatedness at school predicts health and well-being throughout life. However, little is known about whether observed associations reflect unobserved family background factors and whether these associations differ between student–student and student–teacher relationships. Using data from the National Longitudinal Study of Adolescent to Adult Health, this study examined whether student–student and student–teacher relationships are differentially associated with adult health outcomes, measured by self-reported overall health, physical health, psychological health, and substance use. This study employed sibling fixed-effect models to take into account unobserved family background factors such as genetic endowments, family environment, as well as childhood social contexts (school and neighborhood effects). Naive ordinary least squares (OLS) models showed significant associations between relationships with other students and health outcomes in adulthood. However, the preferred sibling fixed-effect estimates revealed that family background characteristics confound these observed associations, with the exception of the depression outcome. Conversely, observed associations between adolescents' relationships with teachers and adult health were robust to controlling for unobserved family background characteristics shared between siblings. Taken together, improving the quality of social relationships in schools, especially student–teacher relationships, may improve adult health in the long run.

Impact and Implications
Results of the study suggest that the quality of student–teacher relationships has a more robust and consistent association with adult health compared with student–student relationships. One of the explanations for this surprising finding is that the associations between student–student relationships and adult health (with the notable exception of depression) are driven largely by unobserved family level factors that both determine the quality of student–student relationships and have an impact on students' health. Improving positive relationships in schools, especially with teachers, may have long-term implications for students' health.

Keywords: adolescence, school relationships, peers, teachers, health

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Social experiences, especially during formative developmental periods such as childhood and adolescence, are strongly linked to health outcomes in adulthood (Umberson, Crosnoe, & Reczek, 2010). Studies suggest that relationships with and attachment to parents during childhood are one of the most important determinants of adult health (Lucktong, Salisbury, & Chamratrithirong, 2018; Moretti & Peled, 2004; Wilkinson, 2004). A growing body of literature shows that unfavorable social circumstances in early life such as childhood maltreatment and parental divorce influence both physical and psychological health in adulthood (Danese,

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Pariante, Caspi, Taylor, & Poulton, 2007). As children grow into adolescence, however, relationships with individuals outside of their families become substantially influential to their cognitive, psychological, and social development (Giordano, 2003). School is one of the most important social milieus for developing social relationships because it is a context in which adolescents interact with various important social actors for long periods of time (Crosnoe, 2011).

Linking School-Based Social Relationships to Adult Health

School peers and teachers comprise the two major groups of social actors with whom students interact on a daily basis (Coleman, 1961). Despite potentially different domains and magnitudes of influence, it is well documented that other students and teachers have a profound impact on adolescents' lives (León & Liew, 2017; Moore et al., 2018; Wolters, Knoors, Cillessen, & Verhoeven, 2012). When students experience a sense of belonging to their school and have supportive relationships with other students and teachers, they are motivated to achieve academic success, and exhibit higher levels of social, emotional, and behavioral adjustment (Kiuru et al., 2015; McGrath & Van Bergen, 2015). In particular, school peers and teachers shape students' socialization and development processes in ways that affect individuals' long-term health and well-being (Umberson et al., 2010). Relationships among students and between students and teachers may shape adult health through multiple channels that are not necessarily mutually exclusive, and the pathways may be distinct for different health outcomes.

A students' relationships with other students and their teachers may shape physical health in adulthood through a physiological process. Recent studies in the social sciences have made important contributions to our understanding of how social processes trigger physiological processes that help to explain the link between social relationships and health (Umberson & Karas Montez, 2010). The stress response framework suggests that positive relationships with others in schools may promote healthy development of regulatory systems (such as enhancement of immune, cardiovascular, and endocrine functioning), whereas negative relationships may lead to physiological responses that place individuals at risk of poor health (such as inflammation burden, metabolic syndrome, and increased allostatic load; e.g., Uchino, Bowen, Kent de Grey, Mikel, & Fisher, 2018). Prolonged exposure to poor relationships with other students or teachers may cause chronic stress, which in turn evokes physiological stress responses (e.g., elevated serum leptin levels; Condon, 2018; Kohlboeck et al., 2014). The consequences of exposure to such stressors likely unfold over the entire life course, and thus adolescent social relationships may have long-term consequences for adult health. For example, physiological disturbances during adolescence likely contribute to the development of cardiovascular disease (CVD) risk through their adverse effects on nocturnal blood pressure recovery and elevated blood pressure (Steffen, McNeilly, Anderson, & Sherwood, 2003).

In addition to a direct, physiological pathway, the quality of social relationships in school may indirectly affect students' health in adulthood by shaping their engagement in health-related behaviors (Petrovic et al., 2018). For example, when students perceive a lack of social support from and social connection with other students and teachers, they are more likely to exhibit physical aggression, risky sexual behaviors, substance use, and poor diet (Holt-Lunstad, 2018). The long-term perspective offered by life course models suggests that health behaviors initiated in adolescence have cascading effects throughout life (Umberson et al., 2010). For example, adult smokers tend to begin smoking as teenagers, and smoking is a hard habit to break. Thus, adolescents' cigarette smoking in response to stress has implications for one's long-term health (Kristman-Valente, Brown, & Herrenkohl, 2013). In fact, a study has documented that peer support has protective effects on adolescents' healthy behaviors, the benefits of which persist through young adulthood (Frech, 2012).

Theories in social psychology identify psychosocial mechanisms that may explain how social relationships in schools influence mental health in adulthood. Relationships with students and teachers may influence one's mental health because these relationships shape individuals' feelings, perceptions, and behaviors (Bennett, Wolin, Robinson, Fowler, & Edwards, 2005; Inzlicht, McKay, & Aronson, 2006). Sustaining healthy relationships with other students and teachers brings about social support and fosters a sense of meaning and purpose in life, which may benefit students' mental health (Cohen, 2004). By contrast, negative relationships lower psychosocial resources such as a sense of mastery and control over one's life, self-esteem, perceptions of social support, and expectations about one's life chances, thereby leading to worse mental health in adulthood (Mays & Cochran, 2001). Relatedly, school-based social relationships may have indirect effects on mental health in the long run through the development of social and communication skills, an important determinant of health (Segrin, 2019). The lack of positive interpersonal relationships in schools is probably one of the biggest impediments to young people's development of social and communication skills (Neidell & Waldfogel, 2010). Thus, adolescents who struggle with relationships in school are more likely to develop fewer social resources (e.g., friendship, healthy marriage, etc.) that promote psychological health in the future (Thoits, 2011).

Limitations of the Existing Literature on Adolescents' Social Relationships and Health

Several studies show that social relationships with school actors are positively associated with health outcomes (Gustafsson, Janlert, Theorell, Westerlund, & Hammarström, 2012; Holt, Mattanah, & Long, 2018; Moore et al., 2018). However, these studies have three important limitations. First, while previous studies have focused heavily on peer relationships and their influence on health, student–teacher relationships have largely been ignored. Second, most previous studies have focused exclusively on psychological health during adolescence. To what extent these effects extend to physical and mental health as well as substance use over the life course is not established. Relatedly, previous studies rely primarily on cross-sectional research designs, possibly leading to bias due to reverse causality (de Matos, Barrett, Dadds, & Shortt, 2003; Long et al., 2020). Third, a key challenge in the extant literature is distinguishing between the impact of school-based social relationships on health (both in adolescence and adulthood) and confounding factors that simultaneously predict social relationships as well as health.

Family background is one of the most serious confounders to the social relationships–health link because students who struggle with peer and teacher relationships may be disproportionately from certain family backgrounds, which may predict an individual's health status as well. For example, early childhood socioeconomic disadvantage affects students' relationships in schools and elevates their risk of poor health in adulthood (Leventhal & Brooks-Gunn, 2000). A large body of evidence links parent–child relationships and adolescent social relationships outside of the family (Allen, Grande, Tan, & Loeb, 2018). This body of literature suggests that parenting styles and parental attachment hold implications for the development of a child's social relationships. It is worth noting, however, that unobserved family background is likely a more severe confounder for the relationship between peer relationships and adult health than for the relationship between teacher–student relationships and health. This is because students are more selective about students with whom they interact than teachers with whom they interact (Sacerdote, 2014).

If researchers do not account for underlying family level differences, observed differences in health outcomes across individuals with different levels of school-based relationships may be spurious due to observed and unobserved early life family factors. Sibling comparison models are a powerful means to address unobserved family background heterogeneity because siblings share a family environment and, on average, half their genotype. Yet, to the author's knowledge, no study has thoroughly investigated this possibility by taking into account unobserved confounders with sibling fixed-effects models.

Purpose of the Current Study

This study addresses the limitations of the existing literature described above in three major ways. First, using data from the National Longitudinal Study of Adolescent to Adult Health (Add Health), this study investigates the association between school-based relationships and health while distinguishing between adolescents' relationships with other students and teachers. Second, this study examines multiple health indicators in young adulthood, including self-reported overall health, physical and mental health, and substance use. Unlike previous studies, this study links social relationships during adolescence to adult health. In doing so, this study addresses the concern of reverse causation.

Third, to reduce potential bias from unobserved family characteristics, this study employs sibling fixed-effects models that control for shared factors at the family level. To address this possibility, previous studies have attempted to make statistical adjustments for family level confounding variables, such as family socioeconomic status and parental characteristics. However, these factors, although important, are only part of a broader set of family background characteristics. In fact, due to the nature of the diversity and complexity of family background and environmental characteristics, researchers are unable to fully account for them using conventional regression methods. Accounting for family level confounders is even more difficult and almost impossible when confounders are unobservable.

Of the list of potential confounders (e.g., genetic endowments, parental involvement and attachment, parenting styles, schools, neighborhood, and so on), sibling fixed-effects models remove every part of each component shared by siblings. For example, siblings share approximately 50% of unique genetic variation, have similar cognitive and noncognitive abilities, have the same parents, interact with similar peers, often attend the same or similar schools, and live in the same neighborhood. Despite these apparent similarities between siblings, however, there are family level factors that they do not share. Only monozygotic twins are genetically identical. Half siblings share only one biological parent. Parents may treat siblings differently. Even in the school, they are in different grades and have similar but not identical teachers and friends. In this regard, although sibling fixed-effects models eliminate both measurable and unmeasurable family background characteristics shared by siblings, they are unable to account for child-specific confounding characteristics. Thus, this approach does not necessarily yield unbiased causal estimates unless observed child-specific control measures are specified so as to fully capture all confounding individual differences.

Method

Participants and Settings

Participants of the Add Health provided written informed consent for participation in all aspects of the Add Health in accordance with the University of North Carolina School of Public Health Institutional Review Board guidelines that are based on the Code of Federal Regulations on the Protection of Human Subjects 45CFR46: http://www.hhs.gov/ohrp/humansubjects/guidance/45cfr46.html. Written informed consent was given by participants (or next of kin/caregiver). Because this study was an analysis of secondary data with no identifying information, it was deemed exempt from Institutional Review Board approval.

The Add Health is a school-based, nationally representative, and longitudinal study of the health-related behaviors of adolescents and their outcomes in young adulthood. Beginning with an in-school questionnaire administered to a nationally representative sample of students in Grades 7 through 12 in 1994–1995 (Wave 1), the study follows up with respondents via a series of in-home interviews approximately 1 year (1996; Wave 2), 6 years (2001–2002; Wave 3), and 13 years later (2007–2008; Wave 4). This study uses data from Wave 1 to create key independent variable and data from Wave 4 to create outcome measures of interest.

An important benefit of the Add Health data is the availability of relatively large-scale sibling samples. It also contains a wide array of both subjective and objective health measures as well as rich information about individual- and family level characteristics. This study uses both the full and sibling samples. The Wave 1 in-home survey comprises 20,745 individuals, of which 15,701 were followed longitudinally to Wave 4. From this full sample, individuals with missing school identification numbers were dropped ($n = 276$). Additionally, approximately 400 respondents were dropped due to nonresponse on some of dependent and control variables (except family income and mother's education).

The sibling sample consists of 4,396 adolescents in Wave 1 (excluding unrelated siblings raised in the same household). Approximately 80% of them (3,666 students) were longitudinally followed along with their siblings into Wave 4. Individuals with missing information on school identification numbers ($n = 151$) and control variables ($n = 79$) were dropped from this analysis, resulting in a sample size of 3,436. The final sample sizes vary

slightly depending on the number of valid cases on the dependent variable. I show whether the final analytic sibling sample differs from the excluded sibling sample (Table A1 in online supplemental materials). Although women, Whites, and individuals with higher ability test scores (measured by the Peabody Picture Vocabulary Test) scores are more likely to be included in the analytic sample, I found no statistical evidence that key independent variables of the study are associated with the probability of being in the analytic sample.

This study uses multiple imputation to handle missing values in family income and mother's education measured at Wave 1 (about 20% missing data; Allison, 2002). Multiple imputation was implemented using the chain equations (ICE) procedure in STATA 16.0, and the estimates and standard errors reported in this study are combined estimates from the 10 multiple imputation data sets. However, it is important to note that the missing data on family level variables such as family income and maternal education do not affect the preferred specification of this study, that is, sibling fixed-effects model, because this sibling comparison model omits any characteristics shared by siblings.

Measures

Self-reported overall health. Self-reported overall health captures one's overall health status. Self-reported overall health is known to extend across multiple dimensions of health status including physical, psychological, and behavioral aspects (Ferraro & Farmer, 1999). The measure is based on respondents' report on the following question: "In general, how is your health?" Response options ranged from 1 (*poor*) to 5 (*excellent*), and the measure was treated as a continuous variable. Although this measure is based on a subjective rating of a single-item question, it is commonly used in health research because it is a statistically powerful predictor of mortality and morbidity in the general population, and it has good reliability and validity (Latham & Peek, 2013; Wu et al., 2013).

Physical health. For physical health outcomes, this study uses the following measures: (1) hard CVD risk and (2) full CVD risk. Both hard and full CVD risk measures are based on Framingham Risk Scores, using an algorithm whose inputs are sex, age in years, systolic blood pressure, use of antihypertensive treatment, current smoking status, diagnosis of diabetes, and body mass index (Pencina, D'Agostino, Larson, Massaro, & Vasan, 2009). These CVD risk measures can be interpreted as predicted probabilities of the development of a CVD event in the next 30 years. Other studies also estimate the 30-year risk for cardiovascular disease using the Add Health sample (Clark et al., 2014; Fletcher & McLaughlin, 2015).

Mental health. This study uses a depression scale and a clinical depression diagnosis to measure psychological health. The depression scale was measured by averaging responses (ranging from 0 to 3) from 9 items of Center for Epidemiological Studies Depression (CES-D) scale. The CES-D captures respondents' feelings, thoughts, and physical conditions during the past week. This study also uses self-reported clinical diagnosis of depression (yes or no).

Substance use. This study uses two measures of substance use: (1) current smoking status and (2) binge drinking. Respondents who reported smoking at least a day in the past 30 days were defined as a current smoker. The measure of binge drinking was created based on the following question: "Over the past 12 months, on how many days did you drink 5 or more drinks in a row?" Possible responses ranged from 0 (*never*) to 6 (*every day or almost every day*). Detailed descriptions about all health measures used in this study are available in Table A2 in the online supplemental materials.

School-based social relationships. The composite independent variables were constructed through extracting the first principal component of survey variables from the Wave I in-home survey grouped as follows: (1) *Student–student relationships*: How often have you had trouble getting along with other students?; How much do you agree that friends care about you?; How much do you agree that students at school are prejudiced?; and (2) *Student–teacher relationships*: How often have you had trouble getting along with your teachers?; How much do you agree that teachers care about you?; How much do you feel that teachers at school treat students fairly? Possible responses were "strongly agree," "agree," "neither agree nor disagree," "disagree," and "strongly disagree." These items were commonly and widely adopted in previous studies that used the Add Health (e.g., Bifulco, Fletcher, & Ross, 2011; Hannon, DeFina, & Bruch, 2013; Kim, 2020; Sutton, Langenkamp, Muller, & Schiller, 2018).

The scales of independent variables were constructed by principal component analysis (PCA), the most widely used form of factoring, in order to establish single factor solutions for different input data. For each domain of school-based social relationships, I conducted PCA on the contributing survey measures and extracted the first component, which was used as the outcome measure. Table A3 in supplementary materials presents factor loadings for each of the three items included in the PCA. Then, I used predicted individual scores from the PCA as the indicators of independent variables. I found that the results of this study are robust across different data reduction techniques (Table A4 in online supplemental materials).

Control variables. The empirical models control for individual-level variables such as gender, age, race/ethnicity, firstborn child status, and cognitive ability (standardized Peabody Picture Vocabulary Test score). In naive OLS models, the following set of family level control variables is included: mother's education, family income, and rural status. In sibling fixed-effects models, any individual- and family-level characteristics shared by siblings (such as race/ethnicity, mother's education, family income, and rural status) are dropped.

Analytic Strategy

The present study begins with naive OLS regression models and then adds sibling fixed effects. As a baseline empirical specification, this study estimates variations of the following OLS regression model:

$$Y_i = \alpha \cdot SR_i + \boldsymbol{X}_i\gamma + \varepsilon_i, \quad (1)$$

where Y_i is the outcome of interest, a variety of health measures, and SR_i is the key independent variable, social relationships (SR) in schools. The model includes covariates in order to reduce potential bias from the correlation between the error term and social relationships. The vector $\boldsymbol{X}$ represents a vector of sociodemographic characteristics, and individual- as well as family-level controls. In naive OLS models, to gauge the extent of reduced

external validity arising from the study's reliance on sibling sample, I compare the estimates of the associations from models using the sibling and full samples.

In order to examine potential biases from unobserved heterogeneity at the family level, Eq. (1) is expanded to allow for sibling fixed effects. Sibling fixed-effects models are specified as follows:

$$Y_{if} = \beta \cdot SR_{if} + \boldsymbol{Z}_{if}\delta + \tau_f + \varepsilon_{if}, \quad (2)$$

where τ_f is a set of family dummies. The vector $\boldsymbol{Z}$ represents individual-level variables that vary between siblings (e.g., gender, age, birth order, cognitive ability, etc.). A major part of the analysis is the comparison of the coefficients of school-based relationships estimated by OLS and sibling fixed-effects models. These estimates will be used to assess whether baseline models are spuriously driven by omitted variable bias at the family level. Robust standard errors are allowed to be clustered at the school and family levels in Eq. (1) and Eq. (2), respectively.

Results

Descriptive Statistics

Summary statistics for the sibling and full samples are presented in Table 1. Consistent with prior studies using sibling data in the Add Health (e.g., Kim, 2016), I found no discernable differences in observed characteristics for the sibling and full samples. The mean age of the participants in both samples at Wave 4 was approximately 28 years old, and the gender composition was relatively balanced in both samples. Approximately 57% of the respondents in the sibling sample were White. Furthermore, nearly 28% of the adolescents reported living in rural areas.

Table 2 presents the extent of discordance in key measures between siblings. Column 1 shows that varying proportions of siblings (23%–100%) are discordant in health outcome measures. In particular, as shown in Column 2, 15%–22% of the siblings are substantially discordant in terms of continuous health measures (i.e., greater than one standard deviation). For independent variables, Column 2 demonstrates that about 24% and 21% of the siblings in the sample have substantial discordance in student–student and student–teacher relationships, respectively. This suggests that there is sufficient within-family variation in key variables.

School-Based Social Relationships and Adult Health

Table 3 presents results on the associations between student–student relationships and adult health. OLS results from the models using the full sample (Model 1) and the sibling sample (Model 2) yield statistically significant associations of student–student relationships with health outcomes in adulthood. These results are consistent with previous studies. Importantly, despite slight differences in the magnitude, results for the full and sibling samples are qualitatively similar. This suggests that potential differences in sample characteristics between the Add Health full and sibling samples do not lead to dramatic differences in estimated associations between student–student relationships and adult health.

However, the sibling fixed-effects model casts doubt on these naive OLS regression estimates of the associations for student–

Table 1
Summary Statistics With Between-Sibling Variation in Independent and Dependent Variables, Family and Full Samples (N = 3409)

Variables	Sibling sample		Full sample			
	M	*SD*	*M*	*SD*	Min	Max
Dependent variables						
Self-reported overall health	3.65	0.92	3.66	0.92	1.00	5.00
Hard CVD risk	6.70	5.93	6.70	5.92	0.61	64.75
Full CVD risk	12.56	9.05	12.57	8.98	1.64	79.79
Depression scale	0.60	0.48	0.58	0.46	0.00	3.00
Diagnosis of depression	0.15	0.36	0.15	0.36	0.00	1.00
Current smoker	0.37	0.48	0.35	0.48	0.00	1.00
Binge drinking	1.11	1.52	1.13	1.52	0.00	6.00
Key independent variable						
Student–student relationships	−0.01	0.39	−0.00	0.38	−1.84	0.67
Student–teacher relationships	−0.01	0.73	0.00	0.71	−2.54	1.21
Control variables						
Age	28.42	1.75	28.47	1.77	24.00	34.00
Female	0.52	0.50	0.53	0.50	0.00	1.00
White	0.57	0.49	0.55	0.50	0.00	1.00
Black	0.23	0.42	0.23	0.42	0.00	1.00
Hispanic	0.13	0.34	0.15	0.36	0.00	1.00
Other race/ethnicity	0.07	0.25	0.07	0.25	0.00	1.00
Standardized PVT score	−0.00	0.93	0.08	0.95	−5.71	3.06
First-born child status	0.34	0.47	0.37	0.48	0.00	1.00
Mother's education	13.09	2.36	13.23	2.37	0.00	17.00
Family income	0.44	0.49	0.47	0.51	0.00	9.99
Rural status	0.28	0.45	0.26	0.44	0.00	1.00

Note. CVD = cardiovascular disease; PVT = Picture Vocabulary Test. Summary statistics are calculated for the largest sibling sample (Column 1 of Table 5). Summary statistics do not include imputed values.

Table 2
Description of Between-Sibling Variation in Measures

Variables	Proportion of discordant siblings	Proportion of discordant siblings ($SD > 1$)
Dependent variables		
Self-reported overall health	0.686	0.203
Hard CVD risk	1.000	0.153
Full CVD risk	1.000	0.173
Depression scale	0.918	0.212
Diagnosis of depression	0.229	N/A
Current smoker	0.376	N/A
Binge drinking	0.594	0.223
Key independent variable		
Student–student relationships	0.954	0.243
Student–teacher relationships	0.955	0.207

Note. CVD = cardiovascular disease. The proportion of discordant siblings is derived by calculating the number of siblings who differ in terms of each measure. For continuous measures, the proportion of discordant siblings is computed based on the number of siblings with greater than one standard deviation of the measure.

student relationships. Once the model accounts for family-specific heterogeneity (Model 3), point estimates of student–student relationships with all adult health outcomes, with the notable exception of depression, are substantially reduced (49% [(0.194–0.098)/0.194] for self-reported overall health, 73% [(0.886–0.240)/0.886] for hard CVD risk, 69% [(1.360–0.416)/1.360] for full CVD risk, and 78% [(0.125–0.027)/0.125] for smoking status) and lose their statistical significance. These findings suggest that the statistically significant estimated associations between student–student relationships and adult health outcomes presented in Model 2 are likely spurious due to unobserved family background characteristics. Interestingly, the association between social relationships and depression remain robust even after controlling for sibling fixed effects.

Table 4 presents results for the association between student–teacher relationships and adult health. Similar to findings in Table 3, naive OLS results for the full and sibling samples demonstrate that student–teacher relationships are associated with adult health at a statistically significant level. There are no discernable differences between the full and sibling samples (Models 1 and 2). However, distinct from the results for student–student relationships, associations between student–teacher relationships and health outcomes are robust to controls for sibling fixed effects, although the estimated associations attenuate by 10%–56% (Model 3). These results suggest that associations of the influence of student–teacher relationships on adult health are not confounded by unobserved family-level characteristics.

Table 5 presents results from preferred final models, wherein the effects of student–student and student–teacher relationships are estimated simultaneously. Consistent with Tables 3 and 4, sibling fixed-effects estimates reveal that estimated associations of student–teacher relationships are stable and statistically significant, whereas student–student relationships are only associated with depression. To interpret, a one-standard-deviation increase in student–teacher relationships is associated with 0.07 standard deviation increase in self-reported overall health ($0.091 \times 0.73/0.92$; Model 1) and 0.07 standard deviation decrease in hard ($-0.572 \times 0.73/5.93$) and full CVD risk ($-0.884 \times 0.73/9.05$; Models 2 and 3). In terms of psychological health, a one-standard-deviation increase in student–student relationships is associated with a 0.12 standard deviation decrease in the depression scale ($-0.153 \times 0.39/0.48$), which is almost twice as large as the coefficient for student–teacher relationships (0.06 [$-0.041 \times 0.73/0.48$] standard deviation decrease). The same amount of an increase in student–teacher relationships also decreases the chance of smoking and binge drinking by a 0.06 standard deviation ($-0.04 \times 0.73/0.48$ and $-0.124 \times 0.73/1.52$, respectively; Models 6 and 7).

To help benchmark the magnitude of these effects, these positive effects are equivalent to health gains due to the following additional years of completed schooling (author's calculation; see

Table 3
Regression of Adult Health Outcomes on Student–Student Relationships in Adolescence

Dependent variables	M1	M2	M3	*n* (full sample)	*n* (sibling sample)
Panel A. Overall health					
Self-reported overall health	0.213^{***} (0.023)	0.194^{***} (0.046)	0.098 (0.063)	15027	3422
Panel B. Physical health					
Hard CVD risk	-0.520^{***} (0.112)	-0.886^{***} (0.219)	−0.240 (0.292)	14273	3265
Full CVD risk	-0.917^{***} (0.169)	-1.360^{***} (0.345)	−0.416 (0.470)	14273	3265
Panel C. Mental health					
Depression scale	-0.169^{***} (0.010)	-0.171^{***} (0.020)	-0.181^{***} (0.034)	15027	3422
Diagnosis of depression	-0.086^{***} (0.010)	-0.067^{***} (0.019)	$-0.046^{\dagger}$ (0.024)	15024	3421
Panel D. Substance use					
Current smoker	-0.097^{***} (0.011)	-0.125^{***} (0.024)	−0.027 (0.032)	14903	3393
Binge drinking	-0.092^{*} (0.039)	$-0.135^{\dagger}$ (0.071)	−0.163 (0.108)	14969	3406
Sample	Full	Sibling	Sibling		
Fixed-effects	No	No	Sibling		
Individual-level controls[a]	Yes	Yes	Yes		
Family-level controls	Yes	Yes	No		
Robust *SE*	School	School	Family		

Note. CVD = cardiovascular disease; PVT = Picture Vocabulary Test.
[a] Race/ethnicity is dropped in sibling fixed-effects models because siblings have the same race/ethnicity. Individual-level control variables include gender, age, race/ethnicity, first-born child status, and standardized PVT score. Family-level control variables include mother's education, family income, and rural status.
$^{\dagger} p < .1$. $^{*} p < .05$. $^{**} p < .01$. $^{***} p < .001$.

Table 4
Regression of Adult Health Outcomes on Student–Teacher Relationships in Adolescence

Dependent variables	M1	M2	M3	*n* (full sample)	*n* (sibling sample)
Panel A. Overall health					
Self-reported overall health	0.134*** (0.011)	0.146*** (0.019)	0.110*** (0.032)	15035	3420
Panel B. Physical health					
Hard CVD risk	−0.535*** (0.080)	−0.763*** (0.129)	−0.560** (0.175)	14274	3262
Full CVD risk	−0.878*** (0.125)	−1.222*** (0.186)	−0.881** (0.274)	14274	3262
Panel C. Mental health					
Depression scale	−0.083*** (0.005)	−0.078*** (0.012)	−0.070*** (0.018)	15034	3420
Diagnosis of depression	−0.044*** (0.004)	−0.047*** (0.009)	−0.033** (0.012)	15032	3419
Panel D. Substance use					
Current smoker	−0.099*** (0.007)	−0.103*** (0.013)	−0.045** (0.017)	14909	3391
Binge drinking	−0.159*** (0.018)	−0.159*** (0.038)	−0.139* (0.057)	14977	3404
Sample	Full	Sibling	Sibling		
Fixed-effects	No	No	Sibling		
Individual-level controls[a]	Yes	Yes	Yes		
Family-level controls	Yes	Yes	No		
Robust *SE*	School	School	Family		

Note. CVD = cardiovascular disease; PVT = Picture Vocabulary Test.
[a] Race/ethnicity is dropped in sibling fixed-effects models because siblings have the same race/ethnicity. Individual-level control variables include gender, age, race/ethnicity, first-born child status, and standardized PVT score. Family-level control variables include mother's education, family income, and rural status.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Table A5 in online supplemental materials): 1.2 years (self-reported overall health), 2.3 years (hard CVD risk), 2.0 years (full CVD risk), 0.8 years (depression scale), 1.9 years (depression diagnosis), 0.6 years (smoking), and 3.1 years (binge drinking). Given that educational attainment is one of the strongest and most persistent predictors of health, the association between school-based social relationships and adult health is notable.

In supplementary analyses, I examined whether individual items of student–student and student–teacher relationships separately predict adult health outcomes (Table A6 in the online supplemental materials). Results show that associations for some individual items of student–teacher relationships are more pronounced and that these patterns differ by outcome measures. For example, while having trouble getting along with teachers is associated with worse psychological health and greater substance use, perceived emotional support from teachers is associated with better physical health. These results suggest the possibility that complex underlying mechanisms drive the effect of student–teacher relationships on adult health.

Discussion

This study examines the associations between school-based social relationships in adolescence and adult health outcomes while differentiating adolescents' relationships with other students and teachers. First, consistent with previous studies, naive OLS results showed that both student–student relationships and student–teacher relationships are associated with health status and substance use in young adulthood. However, when accounting for unobserved family characteristics, this study found a striking pattern. This study showed that controlling for sibling fixed effects substantially attenuates and renders statistically insignificant the coefficient that reflects the effect of student–student relationships on health outcomes. Depressive symptoms are the exception to this pattern. These results indicate that student–student relationships are correlated with unobserved factors at the family level, and that these unobserved factors also influence individual health. By contrast, associations between student–teacher relationships and adult health are robust to controlling for sibling fixed effects. This suggests that time-invariant family characteristics shared between siblings do not confound these associations.

Contributions of the Study

This study contributes to the existing literature in several important ways. First, findings of this study add depth and nuance to research on the health consequence of adolescent social relationships (Gustafsson et al., 2012; Oldfield, Humphrey, & Hebron, 2016; Wilkinson, 2004). Despite substantial evidence showing that school contextual factors shape cognitive functioning through late life (Moorman, Greenfield, & Garcia, 2019; Walsemann & Ailshire, 2020), little effort has been made to understand the long-term impact of school-based social relationships on health. Building on the life course perspective, this study offers new empirical evidence about the enduring impacts of social relationships in adolescence on health outcomes in young adulthood. This study's finding about the influence of social relationships in schools on health across the life course contributes to our theoretical and empirical understanding of the effect of social embeddedness on cumulative health processes (Umberson et al., 2010).

Second, this study extends previous studies by simultaneously estimating the impact of the relationships with students and teachers. Results of this study are novel because the role of student–teacher relationships as a determinant of health (especially in adulthood) has been largely ignored in psychology and health research alike. While previous studies showed that peers are the single biggest social factor in predicting adolescent health and health behaviors, this study revealed a somewhat different picture. This study found that student–student relationships do not have statistically significant associations with self-reported overall

Table 5
Regression of Adult Health Outcomes on Student–Student and Student–Teacher Relationships in Adolescence

Variables	Self-reported overall health	Hard CVD risk	Full CVD risk	Depression scale	Diagnosis of depression	Current smoker	Binge drinking
Student–student relationships	0.070 (0.063)	0.043 (0.312)	−0.002 (0.495)	−0.153*** (0.032)	−0.021 (0.024)	−0.025 (0.031)	−0.110 (0.106)
Student–teacher relationships	0.091** (0.035)	−0.572** (0.197)	−0.884** (0.306)	−0.041* (0.019)	−0.029* (0.013)	−0.040* (0.018)	−0.124* (0.061)
n (sibling sample)	3409	3252	3252	3409	3408	3380	3393
Sample	Sibling	Sibling	Sibling	Sibling	Sibling	Sibling	Sibling
Fixed-effects	Sibling	Sibling	Sibling	Sibling	Sibling	Sibling	Sibling
Individual-level controls[a]	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Family-level controls	No	No	No	No	No	No	No
Robust *SE*	Family	Family	Family	Family	Family	Family	Family

Note. CVD = cardiovascular disease; PVT = Picture Vocabulary Test.
[a] Race/ethnicity is dropped in sibling fixed-effects models because siblings have the same race/ethnicity. Individual-level control variables include gender, age, race/ethnicity, first-born child status, and standardized PVT score. Family-level control variables include mother's education, family income, and rural status.
* $p < .05$. ** $p < .01$. *** $p < .001$.

health, physical health, and substance use in adulthood, although they remain a crucial determinant of psychological health (Almquist, 2011; Modin, Östberg, & Almquist, 2011; Wilkinson, 2004). By contrast, this study demonstrated that associations between student–teacher relationships and adult health are robust and consistent across multiple health outcomes.

There can be several explanations for the contrasting findings between student–student and student–teacher relationships. One potential explanation is that student–student relationships reflect unobserved family level heterogeneity to a larger extent than student–teacher relationships. There may be stronger self-selection into a peer group than teachers, which is unobserved to the researchers. Therefore, when controlling for sibling fixed effects, part of unmeasured peer selection effects (captured by naive OLS models) may have been accounted for because siblings tend to have similar friends. The positive selection in which people associate with similar others could thus lead to upward bias in the estimated magnitude of peer influences in naive OLS models (Sacerdote, 2011). In this regard, researchers should be cautious when examining the effect of peer relationships on health, and should ideally use a statistical model that explicitly accounts for unobserved family factors that may bias parameter estimates.

In addition, the nature of student–student relationships may be different from that of student–teacher relationships. For example, positive relationships with peers do not necessarily have a positive effect on health, especially in the domain of health behaviors. A large literature shows that interpersonal closeness of peers and relationship quality amplify the association between peer behavior and adolescent substance use initiation and continuity (Liu, Zhao, Chen, Falk, & Albarracín, 2017). Thus, simultaneously studying relationships with other students and teachers allows for a better understanding of the differential effects of school-based social relationships on health.

Third, this study makes a unique methodological contribution. Using a nationally representative study with large-scale sibling data, this study takes into account unobserved family background effects. To the author's knowledge, this is the first study to employ sibling fixed-effects models to test the possibility that unobserved family background spuriously confounds the link between students' social relationships and their future health. This study also presents a comprehensive account of the consequences of school-based social relationships on multiple health measures that cover a wide range of objective, clinically relevant markers of physical disease, as well as subjective physical health, mental health, and substance use.

Study Limitations

Findings of this study should be considered alongside its limitations. First, although a sibling fixed-effects design is a rigorous quasi-experimental analytical approach, this research design contains limitations. A potentially important cost of this approach is that it limits generalizability of within-family estimates to a specific subpopulation, in this case families with multiple children. Nevertheless, I showed that OLS estimates of the associations between school-based social relationships and adult health are similar between the full and sibling samples. This suggests that potential sample differences between the full and sibling samples are not a major concern in this study. Moreover, sibling fixed-

effects models do not account for time-varying family characteristics and confounding characteristics idiosyncratic to each sibling. If a student who gets along well with her peers and teachers is systematically different from her sibling who does not, observed differences in health between siblings may not be attributable to school-based social relationships. Potential sources of child-specific individual-level heterogeneity include psychosocial resources and constraints, personality traits, and so on.

Second, this study was not able to directly test potential mechanisms that link school-based social relationships to adult health, although the findings on substance use provide indirect support for behavioral pathways. Future research may consider uncovering the complex physiological pathways through which social relationships in schools "get under the skin" (Goldman, Stamler, Kleinman, Kerner, & Lewis, 2016). Third, this study did not consider other health-related behaviors in adulthood. The proposed behavioral pathways suggest that health behaviors such as diet, physical activity, and having a sedentary lifestyle may mediate the relationship between social relationships and health. Fourth, despite the fact that examining multiple domains of health simultaneously is a strength of this study, it is limited by its reliance on retrospective self-reports of health conditions (with the exception of CVD risk). For example, although a CES-D depression scale and self-reported diagnosis of depression are the two most commonly used indicators for measuring depressive symptoms in research on mental health (Perreira, Deeb-Sossa, Harris, & Bollen, 2005), they do not cover multiple dimensions of psychological health, including but not limited to anxiety disorders, schizophrenia, eating disorders, and addictive behaviors.

Implications

This study can inform policy. Findings of this study suggest that in order to understand how school-based social relationships shape adolescents' future health, researchers and policymakers must consider different bonds that adolescents establish in school contexts, namely student relationships to their teachers and other students. Considering that having negative relationships with teachers is associated with a greater risk for physical health problems, psychological illnesses, and engagement in health-harming behaviors in adulthood, beyond academic success, improving students' relationships with teachers would have important, positive, and long-lasting implications for students' health in the long run (Thapa, Cohen, Guffey, & Higgins-D'Alessandro, 2013). Moreover, student–teacher relationships are policy-relevant since there are more intervention tools to target improving teacher relationships than peer relationships. Relatedly, student–teacher relationships are practical for direct policy interventions because they are more durable than peer relationships. For example, only about 65% of friendships among adolescents survive across a school year (Poulin & Chan, 2010).

At the school level, it might be prudent to monitor not only student academic achievement, but also student–teacher relationships. This may require regular assessment of the quality of students' interpersonal relationships with teachers. This information may be useful for teachers and schools to target interventions that promote positive student–teacher relationships. Schools' efforts to enhance positive student–teacher relationships may be more effective when targeting students in middle or high schools than elementary schools, since student engagement with teachers tends to decline as students progress through school (Mahatmya, Lohman, Matjasko, & Farb, 2012). That said, it is also important for teachers to pay special attention to children at risk for behavioral issues and build positive relationships with them at an early age, because persistent student–teacher conflict throughout the elementary years increases the likelihood that children will exhibit negative externalizing behaviors in the future (O'Connor, Collins, & Supplee, 2012).

Teachers receive very little to no training in how to build supportive and warm interpersonal relationships with students. Teacher professional development may be one important medium to help teachers build and maintain positive relationships with students. It may not be enough to provide strategies for teachers to improve the management of the classroom as a whole. Instead, teacher training in social–emotional development and interpersonal skills could help teachers assess and adjust beliefs as well as practices, which may in turn lead to improvements in the quality of the student–teacher relationships (Malm, 2009; Shagrir, 2010). A neglected yet useful strategy to improve student–teacher relationships might be to exploit spillover effects by establishing high quality bonds and strong channels of communication between teachers and students' families (Scarlett, 2014). For teachers, it may be worth investing in this endeavor because enhancing student–teacher relationships is beneficial for the psychological well-being of teachers as well as students (Grayson & Alvarez, 2008; Spilt, Koomen, & Thijs, 2011).

Conclusion

The present study extends existing research by simultaneously exploring the role of students' relationships with other students and teachers on health status in young adulthood. Results showed that when students had positive relationships with teachers, they tended to have better physical and mental health as well as lower levels of substance use. By contrast, student–student relationships showed a robust association with a depression scale and not with other health outcomes. Findings confirm that schools can contribute to students' future health. This study holds implications for research, theory, and practice aimed at improving students' relationships with other students and teachers. Future research should explore school-based interventions that can promote students' relationships with social actors in school, which consequently influences students' future health and well-being.

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