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Not a family matter: The effects of religiosity on academic outcomes based on evidence from siblings

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ABSTRACT

Religiosity has been positively linked with multiple measures of academic success, but it is unclear whether the "effect" of religiosity on academic outcomes is causal or spurious. One source of heterogeneity that may contribute to a child's level of religiosity and his/her academic success is family background. This paper is the first to use sibling differences to estimate the associations between religiosity on short and long-term academic success. Our analysis yields two main results. First, more religious adolescents earned higher GPAs in high school, even after including family fixed effects. Second, because they earned higher GPAs in high school, more religious adolescents completed more years of education 14 years after their religiosity was measured. Our findings suggest that adolescents' religious commitments influence their schooling in both the short and long term and should be more actively included and theorized as important drivers of educational and economic stratification.

1. Introduction

Religion permeates every aspect of American society. Religious commitments shape where Americans live, how they vote, who their friends are, and even how happy they are. Religion is a particularly salient feature for millions of American teenagers: one in two see faith as central to their daily life, and one in three say they pray daily (Smith and Denton, 2005).[1] When it comes to academic performance, religiously engaged adolescents appear to have better academic outcomes than those who are not religiously active. They earn higher GPAs (Glanville et al., 2008; Good and Willoughby, 2011; McKune and Hoffmann, 2009; Milot and Ludden, 2009; Regnerus and Elder, 2003; Tirre, 2017; Toldson and Anderson, 2010), aspire to go farther in school[2] (Al-fadhli and Kersen, 2010; Muller and Ellison, 2001; Regnerus, 2000), and actually stay in school longer (Brown and Gary, 1991; Kim, 2015; Lee et al., 2007; Lee and Pearce, 2019; Lehrer, 2010, 2004; Loury, 2004; Mohanty, 2016). The theoretical reason for this positive association is that

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[1] In this paper, we are primarily referring to Christian forms of religious engagement. This is because surveys in the United States tend to phrase questions about religion in ways that reflect a Christian-centric view of religion (Hill and Hood, 1999). For example, the notion of "individual prayer" is more prevalent in Christianity than in non-Christian denominations. Thus, in nationally representative surveys (such as the one we will be using in this study), Christian respondents are more likely to appear as highly religious than non-Christian respondents.

[2] Some surveys ask students about aspirations (e.g., "how far would you like to go in school?"), and some ask about expectations (e.g., "how likely is it that you will graduate from college?"). We combine aspirations and expectations into one category.

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increased religiosity tends to deter young people from risky behaviors, promotes social capital and network closure, and motivates youth to act in ways that adhere to the moral grounding of their religious teachings (Smith, 2003).

While the evidence suggests that more religiously engaged students have better academic outcomes, questions remain as to how to interpret this evidence. The existing evidence has been derived from observational approaches that inherently limit the scope of inference; as a consequence, there is uncertainty about whether the "effect" of religiosity on academic outcomes is causal or spurious (Bagiella et al., 2005; Cochran et al., 1994; Freeman, 1986; Regnerus and Smith, 2005). We are particularly concerned about the role of family background—a key source of heterogeneity that influences children's level of religiosity as well as their academic success (Eirich, 2012; Ludwig and Mayer, 2006). While previous studies have attempted to eliminate family-level confounders by including a set of observed family-level controls (e.g., parental education, family income, and family structure), these controls do not effectively address family-level heterogeneity, especially when these factors are unobserved (Kim, 2018). Thus, previous studies may be overstating the actual effect of religiosity, which could be null or even negative. Approaches that allow for more stringent analyses of such observed associations are useful in such settings. Here, conduct within-family analysis by analyzing sibling pairs to better understand the association of religiosity, high school GPA, college aspirations, and educational attainment. Data on sibling pairs allow us to separate the contribution of religiosity from families by examining whether sibling differences in religiosity translate into sibling differences in academic achievement (since family differences are muted between siblings).

2. Background

2.1. Observational evidence linking religiosity and educational outcomes

Table 1 lists 18 studies that have relied on samples of U.S. students to examine the relationship between religiosity and the outcomes of interest in this study: grades, college aspirations/expectations, and educational attainment.[3] We identified these studies using a search in December 2019[4] and are listed in order of publication with the most recent studies listed first. As the table shows, almost all of the existing studies have examined the relationship between academic outcomes and religiosity using regression frameworks that verify the presence of a correlation between dependent and independent variables (Mohanty, 2016). We flag three deviations from this general trend. First, some recent studies have used propensity score matching in place of linear regression to explore whether religiosity has a causal effect on educational attainment (Kim, 2015; Mohanty, 2016). Using different data sources, both Kim (2015) and Mohanty (2016) find evidence that religious participation "causes" increased educational attainment. However, the matching algorithm employed in propensity score matching to adjust for selection into religiosity is based only on observed variables. Thus, even with propensity score matching, it is possible for unobserved factors to yield spurious results. Second, Loury (2004) attempted to account for unobserved factors shared by siblings by including the number of older siblings who attended college and the number of older siblings who were high school dropouts. According to Loury, these controls were good proxies for common family effects. She found that religious service attendance significantly predicted total years of schooling by adulthood. Third, Eirich (2012) examines whether there is an omitted variable linking parental religiosity and adolescent education by testing whether the errors of seemingly unrelated bivariate regressions are correlated. Although Loury's and Eirich's techniques alone do not warrant causal explanations, they do illustrate that there are ways to account for family level factors above and beyond the standard technique of controlling for socioeconomic variables. Aside from Loury's and Eirich's studies, little has been done to control for family level factors beyond common measures such as socioeconomic status and family structure. Admittedly, this is probably a reflection of data limitations because large national datasets generally do not include extensive questions about parenting styles and practices as well as other family level factors that might confound the relationship between religiosity and academic outcomes.

It is important to disentangle family background effects from the effects of religiosity on academic outcomes because families jointly predict their children's religiosity (Ellison and Xu, 2014; Smith et al., 2019) and their academic success (Henderson and Berla, 1994). For example, children who grow up in strict but warm households are likely to be more religious *and* might do better in school (Dornbusch et al., 1987; Steinberg et al., 1989). Alternatively, being raised in certain religious cultures, such as Conservative Protestantism, may lead to increased religiosity but lower educational aspirations and attainment (Darnell and Sherkat, 1997; Sherkat and Darnell, 1999). Neighborhood factors also influence both religiosity and academic outcomes. For example, living in a densely populated Jewish neighborhood may lead to increased Jewish involvement as well as higher levels of educational attainment (Burstein, 2007; Lehrer, 1999).

2.2. Sibling comparisons as a tool to control for unobserved family factors

One way to account for unobserved family factors that jointly contribute to a child's level of religiosity and his/her academic success is to examine siblings using family fixed-effects models. As family level factors are netted out in the sibling models, the lack of

[3] Some studies have examined the relationship between religious denomination and educational outcomes (Beyerlein, 2004; Darnell and Sherkat, 1997; Lehrer, 1999), but we don't include them because religious denomination captures something different than religiosity.

[4] We located relevant studies using the terms "religiosity," "religion," "educational attainment," "school," "academic achievement," "grades," "GPA," and "college aspirations." This yielded 103 studies, published between 1971 and 2019. In this paper, we only include studies that met the following criteria: 1) the outcomes of interest include one of the outcomes we focus on in this paper: GPA/grades, college aspirations, and educational attainment, 2) the explanatory variable is religiosity during adolescence, and 3) the sample was U.S. students.

Table 1
Empirical Studies Conducted Between 1990 and 2019 Examining the Relationship between Religiosity and Academic Outcomes in US samples (N = 18).

Authors	Data Source/Data Collection Year[a] or Relevant Waves/ (Sample Size)	Relevant outcome(s) of interest	Analytic Method	Components of Religiosity	Attempts to control for family level factors	Relevant findings
Lee and Pearce (2019)	NSYR/W1, W2, W4/ (n = 119 interviews with 16–21 year olds & n = 2137 23–28 year olds)	Educational attainment	Multiple regression & interview analysis	Religious service attendance	Family SES	Religious involvement provides advantages to low-SES youth in terms of finishing high school and getting a 2-year degree, but not a 4-year degree. Religious involvement in adolescence also predicts earning a graduate degree. Transcendent and ideological resources are positively associated with educational outcomes, especially among disadvantaged youth, but social resources accessed through religious participation may not be valuable.
Tirre (2017)	Project Talent/1960 (n = approx. 80,000 12th graders)	Secondary school grades	Structural Equation Modeling	Parents' religious service attendance; number of religious books at home; Biblical literacy	None	First, parental religiosity and Bible literacy were positively related to conscientiousness, which related positively to academic achievement. Second, parental religiosity and Bible literacy were also directly related to academic achievement independently of general cognitive ability and conscientiousness.
Mohanty (2016)	NLSY/1979, 1982, 2000 (n = approx. 6000 14–21 year olds)	Educational attainment	Propensity Score Matching	Religious service attendance	Control for family structure, parents' income, and parents' education	Higher religious service attendance during youth is positively associated with increased educational attainment in adulthood. This is a causal relationship.
Kim (2015)	National Longitudinal Survey of Youth (NLSY)/ 2000 (n = 3461 15–17 year olds)	Educational attainment	Propensity Score Matching	Religious service attendance	Control for mother's education, region of residence, household size, and family income	Higher religious service attendance during youth is positively associated with increased educational attainment in adulthood. Returns to attendance are greater for low-income students. There are no differences by religious affiliation.
Eirich (2012)	National Longitudinal Survey of Youth (NLSY)/ 1997 (n = 2856 12–16 year olds)	Educational attainment	Various regression techniques	Parent's & child's religious service attendance; parent's frequency of prayer	Controls for parents' education, income, children living with both biological parents, # of siblings, parental school involvement, tidiness of the home, parental optimism &, parental cooperativeness; examines whether there is an omitted variable linking parental religiosity and	Parental religious service attendance is associated with children's educational attainment, and becomes more valuable as the educational transitions become less automatic, more difficult, and more expensive. Parental religiosity improves education because it cultivates religiosity in children, and because religious

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Table 1 (*continued*)

Authors	Data Source/Data Collection Year[a] or Relevant Waves/ (Sample Size)	Relevant outcome(s) of interest	Analytic Method	Components of Religiosity	Attempts to control for family level factors	Relevant findings
					adolescent education by testing whether errors of unrelated regressions are correlated	involvement enhances other parental resources conducive for education.
Al-fadhli & Kersen (2010)	Monitoring the Future (MTF)/2008 (n = 4273 African American 8th and 10th grade students)	College aspirations	Multiple regression	Religious service attendance and salience	Control for parental involvement (checking homework, talking with children about problems)	Religious involvement is associated with higher college aspirations. The relationship is mediated by religious social capital.
Lehrer (2010)	NSFG/1995 (n = 4181 white women)	Educational attainment	Multiple Regression	Religious service attendance	Control for family structure, # of siblings, and parents' education	Attending religious services more often in adolescence was associated with higher educational attainment downstream. The margin is substantial in the case of Catholics and conservative Protestants, and modest in the case of mainline Protestants.
Toldson and Anderson (2010)	MTF/2008 (n = 6795 8th and 10th grade students)	Secondary school grades	MANOVA	Religious service attendance & salience	None	Students who participated in more religious activities and who had stronger religious convictions were more likely to report higher grades. Among Black students, only religious participation (not religious salience) was associated with better grades.
McKune and Hoffmann (2009)	Add Health Wave 1 and 2 (n = 8051 7th-12th grade students)	Secondary school grades	Regression	Religious service attendance; frequency of prayer; religious salience; belief in biblical inerrancy; & beliefs about the Bible's origins	Control for family social capital (18 items about strength of relations between parents and children); community social capital (17 items about quality of adolescents' relationship in the community and adolescents' and parents' perception of the overall cohesiveness of the local community); parental education, family structure, family income	Increased religiosity predicts better grades, but the effect is attenuated when family and community social capital are accounted for.
Milot and Ludden (2009)	Original data collection/ year unknown/(n = 683 8th and 9th grade students from 13 schools in rural areas in the Midwest)	Secondary school grades; educational aspirations/ expectations	Multiple hierarchical regressions	Religious service attendance & salience	Control for parental support	Adolescents who reported that religion was important in their lives reported lower school misbehavior and higher motivation, although those with high religious attendance had higher grades. Interaction effects indicated that religious importance was particularly salient for males compared to females in

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Table 1 (*continued*)

Authors	Data Source/Data Collection Year[a] or Relevant Waves/ (Sample Size)	Relevant outcome(s) of interest	Analytic Method	Components of Religiosity	Attempts to control for family level factors	Relevant findings
						terms of enhanced school bonding and self-efficacy.
Glanville et al. (2008)	Add Health Wave 1 and 2 (n = 12,361 7th-12th grade students)	Secondary School Grades	Structural equation modeling	Religious service attendance	Control for family structure, family income and parents' education	Religious service attendance is positively associated with better grades. This relationship is partly mediated by higher intergenerational closure, friendship networks with higher educational resources and norms, and extracurricular participation.
Lee et al. (2007)	NELS/1988, 2000 (n = 11,551 10th graders)	Educational attainment	Multiple Regression	"To what extent are you a religious person?"	Control for parents' education, parents' income, parents' occupation, and parental involvement (six unspecified items)	Students' religiosity was significantly associated with bachelor's degree attainment for students regardless of gender or socioeconomic status (though only for some ethnic and religious groups).
Lehrer (2004)	National Survey of Family Growth (NSFG)/ 1995 (n = 974) conservative Protestant white women over age 27	Educational attainment	Multiple Regression	Religious service attendance	Parents' education, family structure and size, and mother's age at first birth	Being in the high religiosity category is associated with substantial increases in the probability of completing high school and of attending college. Women raised as conservative Protestants who attended religious services frequently during adolescence complete eight tenths of a year more schooling than their less observant counterparts.
Loury (2004)	NLSY 1979, 1993/(n = 2748 Christian white 14–17 years old)	Educational attainment	2SLS models	Religious service attendance	Control for the number of older siblings who attended college and who were high school dropouts	Higher religious service attendance during youth is positively associated with increased educational attainment in adulthood.
Regnerus and Elder (2003)	Add Health, W1 and W2 (n = approx. 9667 7th-12th graders)	Composite score: GPA, doing homework, getting along with peers, disciplinary action, & class attendance	Hierarchical linear modeling	Religious service attendance, religious salience	Control for family structure, family's financial status, parental education, and multiple neighborhood level variables such as proportion living in poverty	Church attendance among youth in high-risk neighborhoods contributed more to academic progress than it did among youth in higher-income neighborhoods.
Muller and Ellison (2001)	NELS/W2 & W3 (10th graders in public schools; no sample size specified)	Educational expectations	Multiple regression	Importance of religious activity, perceptions of religiousness, and	Control for family structure, SES, and neighborhood urbanicity	Religious involvement is positively associated with several key academic outcomes, including higher educational

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Table 1 (*continued*)

Authors	Data Source/Data Collection Year[a] or Relevant Waves/ (Sample Size)	Relevant outcome(s) of interest	Analytic Method	Components of Religiosity	Attempts to control for family level factors	Relevant findings
				religious service attendance		expectations (e.g., accumulation of advanced math credits, receipt of diploma). The effect of religion is largely mediated by family and community social capital.
Regnerus (2000)	High School Effectiveness Study linked with Common Core Data (n = 4434 10th grader public school students)	Educational expectations; Test-scores	Regression/ Hierarchical linear modeling	Participation in religious activities	Control for SES and neighborhood-level income	First, participation in church activities is related to heightened educational expectations and better scores on standardized math/reading tests. Second, the relationships don't vary across a neighborhood's poverty level.
Brown and Gary (1991)	Community sample of African Americans/ approx. 1988/(n = 532 adults)	Educational attainment	Multiple regression	Three items about religious socialization	Family structure, family closeness, neighborhood urbanicity	Religious socialization is positively associated with educational attainment.

[a] For studies using longitudinal data, I list the first wave of data collection analyzed because that is when respondents' religiosity is usually measured.

observed measures regarding the families of children becomes less salient. Thus, we ask whether associations between religiosity and academic success remain after accounting for unobserved family factors that may shape both religiosity and academic outcomes. We use data from the National Longitudinal Study of Adolescent to Adult Health (Add Health) (Harris et al., 2019), which has approximately 15,000[5] adolescents nested in schools, including sibling pairs (Harris et al., 2013). The main advantage of using sibling comparisons is to control for family background factors that are shared by brothers and/or sisters but generally unavailable in surveys (Fletcher, 2013). Data on sibling pairs allow us to separate the contribution of religiosity from families by examining whether sibling differences in religiosity translate into sibling differences in academic achievement (since family differences are muted between siblings). This approach allows us to eliminate not just confounders like family environment that do not vary between siblings, but also factors such as neighborhood characteristics. Our study follows the approach of several recent efforts to use sibling fixed-effects design to identify the effect of delinquency (Kim, 2018), attractiveness (Bauldry et al., 2016), personality traits (Fletcher, 2013), health conditions (Fletcher and Lehrer, 2011), life satisfaction (De Neve and Oswald, 2012), and genotypes (Rauscher, 2017) on downstream outcomes.

3. Data & methods

3.1. Add Health

This study utilizes data from the National Longitudinal Study of Adolescent to Adult Health (Add Health) (Harris et al., 2019). Add Health is a nationally representative cohort drawn from a probability sample of 80 U.S. high schools and 52 U.S. middle schools, representative of U.S. schools in 1994–1995 with respect to region, urban setting, school size, school type, and race or ethnic background (n = 20,745, ages 12–20 years at Wave 1 in 1994–1995). Beginning with an in-school questionnaire administered to a nationally representative sample of students in grades 7 through 12 in 1994–95, the study follows up with a series of in-home interviews of students approximately one year, six years, and thirteen years later.[6] Other sources of data include questionnaires for parents, siblings, fellow students, and school administrators.[7] Our population of interest is public and nonsectarian private school students. We exclude students who (in wave 1) attend private schools with a religious affiliation because academics at religious schools often looks different than in non-sectarian schools (e.g., students' GPAs might factor in courses such as Bible).

Of the 20,000+ students surveyed during Wave 1, more than 15,000 were followed longitudinally in the Wave 4 survey, when the respondents were in their late 20s. In addition to the "full sample" of nearly 15,000 individuals, the Add Health also contains a sibling subsample of individuals that we will use in this analysis to control for shared family environment that may be associated with religiosity and academic outcomes. The original Add Health design included oversamples of more than 3000 pairs of individuals with genetic resemblance, including twins, full/half siblings and unrelated siblings in the same household. In this paper, we only analyze the data on full siblings. Because these pairs were collected using all design features of Add Health, the subsample is also nationally representative (Fletcher, 2013; Harris et al., 2013).

In our primary analysis, we exclude approximately 12% of respondents who did not provide a religious denomination when asked "what is your religion?" (which yields an analytic sample of 12,052). Note that such respondents were not asked subsequent questions about their religious engagement (Cook et al., 2017; Pearce and Haynie, 2004). We exclude them altogether (rather than assigning them the lowest score on the religiosity scale) as we should not assume that respondents are completely religiously disengaged because they did not select a religious denomination. Indeed, it is quite plausible for someone to espouse religious beliefs and/or engage in religious behaviors without subscribing to a pre-defined religious denominations (Cotton et al., 2006).[8] However, we probe the sensitivity of our findings to the exclusion of these respondents (see Appendix A).

After eliminating observations for missing values for religiosity or academic outcomes (GPA, educational aspirations, and educational attainment), the main analytic sample is approximately 11,829 but varies slightly by outcome. The analytic sample contains 552 families with siblings (n = 1148) but also varies slightly by outcome. The mean birthyear for the full sample as well as the sibling sample, is 1979 (birthyear SD = 1.7). Descriptive statistics for the full and family samples are shown in Table 2.

[5] This is the number of participants in Wave 4, which is approximately 75% of the original Wave 1 sample.

[6] Approximately 80% of the original sample was resurveyed at Wave 4; attrition between waves suggests little bias (Brownstein et al., 2010).

[7] Details on the Add Health study can be found in Harris et al., (2019).

[8] We recognize that assuming respondents who select "no religious denomination" on their survey are not religiously engaged is potentially misleading. Indeed, it is quite plausible for someone to espouse religious beliefs and/or engage in religious behaviors without subscribing to one of the pre-defined religious denominations. Analyses from the National Study of Youth and Religion, a study of similar aged adolescents, show that about 20% of adolescents who say they have no religious denomination actually engage in some form of religious practices or espouse some religious beliefs (Pearce and Denton, 2011).

Table 2
Key descriptive statistics.

	Individual Sample (n = 11,829)			Family Sample (n = 1148; 552 families)		
	N (full sample)	Mean	SD	N (full sample)	Mean	SD
Outcome Variables						
GPA	8062	2.61	0.82	850	2.68	0.83
College aspirations/expectations	11,819	4.49	0.98	1147	4.44	1.04
Educational Attainment	11,829	14.29	2.17	1148	14.35	2.15
Explanatory Variables						
Religiosity Index	11,827	−0.01	1.00	1147	0.07	0.98
Private religiosity (Prayer & Salience)	11,827	0.00	0.99	1147	0.14	0.97
Public religiosity (Service Attendance)	11,827	−0.01	1.00	1147	0.02	0.99
Verbal Ability (Peabody Picture Vocab Test)	11,278	100.80	14.15	1110	100.76	13.64
Socioeconomic Status	11,829	0.04	1.32	1148	0.10	1.27

Note: We report the actual values for the academic outcomes and the PVT, although in the analysis, we use standardized variables. The religiosity and socioeconomic status variables are composite scores and are already standardized.

3.2. Measures

3.2.1. Explanatory variables

Religiosity: We use three variables from wave 1 (h1re3, h1re4, h1re6)[9] to create three measures of religiosity. We construct a measure of the private dimension of religiosity using the first two items which focus on (1) self-reported importance of religion and (2) frequency of individual prayer. We use the third item, which measures the frequency of religious service attendance over the prior 12 months, to captures the public dimension of religiosity. In addition to the private and public measure of religiosity, we also create a composite score of religiosity (i.e., religiosity index) (alpha = 0.71) (Martinez, 2017)[10]. The religiosity index is our main explanatory variable, although we also report results from the private and public dimensions of religion. The religiosity index is standardized with a mean of 0 and a standard deviation of 1. Our approach of creating a composite score of religiosity is similar to other studies that have used Add Health data (Barrett et al., 2007; Conover-Williams and Chang, 2016; Martinez, 2017), as well as to studies of religiosity that rely on other data sources (Lim and Putnam, 2010).[11]

Verbal ability: Verbal ability (i.e., receptive vocabulary) is measured based on a modified version of the Peabody Picture Vocabulary Test (PVT), a measure of receptive vocabulary wherein a respondent is asked to identify which picture corresponds to a word delivered by the interviewer. (Dunn and Dunn, 1981). The PVT was administered during the in-home interview in Wave 1 (when respondents were 12–20 years old. We use the raw score and standardize it for ease of interpretability. The mean raw PVT score is 100.80 (SD = 14.15) for the full sample and 100.76 (SD = 13.64) for the family sample. We are interested in people's verbal ability for two reasons. First, a person's vocabulary affects what (s)he can do with a language, and how well (s)he can do it (Nation and Anthony, 2016). The PVT is correlated with general academic success as well as intelligence tests (Rowe et al., 1999; Udry et al., 2003). But intelligence is also negatively associated with religiosity (Zuckerman et al., 2013), thus it represents an important control. Second, parents may treat their children differently based on their perceptions of the child's academic potential. For example, parents may promote or push a child who has a higher PVT score into intellectual pursuits, enroll their child into more academic after-school activities during elementary school, or talk more about the importance of college. As the child with a high PVT score gets older, parents might be more likely to take them on college tours, invest in additional resources and SAT preparation courses, or hire a college counselor. All of these actions would bias the underlying quasi-experiment assumption of family fixed effects that family influence is shared equally among siblings. By accounting for the PVT score in our models, we control for the fact that parents may treat children differently according to their PVT score.

Socioeconomic Status: We measured the family-level socioeconomic status (SES) of Add Health participants from information about their families collected at the Wave I interview. We include this SES measure in our baseline OLS models, which we will compare

[9] Respondents were also asked whether they agreed that the "sacred scripture of their religion was the word of God and completely without mistakes" (64% agreed). We don't include this item in because it reflects a belief about biblical inerrancy that is not prevalent outside of fundamentalist Christianity. Believing in biblical inerrancy is more of a style of being religious rather than a measure of how religiously engaged one is. For example, one could be a very religiously engaged Catholic but not agree with the notion of biblical inerrancy because this belief doesn't align with how Catholics view the bible.

[10] We recognize that measuring religiosity on an assumed low-to-high continuum does not necessarily reflect the ways individuals uniquely combine varying types and levels of religious practices and beliefs in their daily lives (Storm, 2009). Pearce and Denton (2011) have attempted to improve upon this approach by using latent class analysis with the National Study of Youth and Religion. However, the Add Health doesn't allow for this type of more sophisticated analysis because the religiosity questions are limited and not asked of everyone.

[11] The conceptualization of religiosity in Add Health reflects a Christian religious bias (Hill and Hood, 1999), even though the survey was intended to capture a broad range of religious engagement. However, we choose to include all respondents in our analytic sample (regardless of their religious denominations) because that is what has been done in earlier studies. We want to keep our analytic sample comparable to previous studies to see if the controls for family factors change prior results; if we change the nature of the analytic sample, it won't be as clear whether potential changes in the results are due to the use of our sibling method or due to the use of a different analytic sample.

the family fixed effects models. Comparing these models allows us to assess whether the baseline models are spuriously driven by omitted variable bias at the family and neighborhood levels. The SES measure is based on four variables: parental education, parental occupation, household income, and household receipt of public assistance. These four measures were correlated ($r > 0.19$). We conducted principal components analysis of the measures to produce a factor score. The first principal component explained 53% of the variance. We used loadings on this component to compute SES,[12] which is a continuous measure with a mean of 0.04 (SD = 1.32) for the full sample, and 0.10 (SD = 1.27) for the sibling sample.

Religious Affiliation: Religious affiliation comes from respondents' response to the following question from wave 1: "What is your religion?" We control for religious affiliation because religious affiliation influences both religiosity and academic outcomes (Beyerlein, 2004; Darnell and Sherkat, 1997; Keysar and Kosmin, 1995; Lehrer, 1999). We follow the ARDA Religious Classification Guide (ARDA, n.d.) to reclassify the Add Health response variables into the following categories: 1) Evangelical Protestant, 2) Mainline Protestant, 3) Black Protestant, 4) Catholic, 5) LDS, 6) Jewish, and 7) Other.

Other Controls: We also include individual controls for sex, birthyear and race.

3.2.2. Academic outcome variables

GPA: GPA is based on high school transcript data collected at Wave III once all adolescents had finished high school.[13] GPA is the average of the respondent's grades in mathematics, English, history or social studies, and science (on a 4-point scale). The mean GPA was 2.61 (SD = 0.82) for the full sample, and 2.68 (SD = 0.83) for the family sample, both of which equate to just below a B-. The GPA variable is standardized in the models for ease of interpretability.

College aspirations/expectations: This measure is based on the following question from wave 1: "On a scale of 1–5, where 1 is low and 5 is high, how much do you want to go to college?" The college aspirations/expectations variable is standardized. The average response was 4.49 (SD = 0.98) for the full sample and 4.44 (SD = 1.04) for the family sample, suggesting that most respondents wanted to attend college.

Educational Attainment: This is a measure of the highest degree completed by the time of interview at Wave 4 when respondents were asked, "What is the highest level of education that you have achieved to date?" Response options and their numeric values (in parentheses) were eighth grade or less (8), some high school (10), high school graduate (12), some vocational/technical training (13), completed vocational/technical training (14), some college (14), completed college (16), some graduate school (17), completed a master's degree (18), some graduate train-ing beyond a master's degree (19), completed a doctoral degree (20), some post-baccalaureate professional education (18), and completed post-baccalaureate professional education (19) (Domingue et al., 2015). Respondents in the full sample completed 14.29 (SD = 2.17) years of schooling on average by wave 4. Respondents in the family sample completed 14.35 years of schooling on average (SD = 2.15). Of the sibling pairs, 64% varied in their educational attainment (mean difference = 1.6 years). The educational attainment variable is standardized in the models for ease of interpretability. The fact that siblings within the same families have different rates of educational attainment is notable. In studies that examine differences in educational attainment between individuals, the variance in educational attainments is mostly accounted for by structural features of the social environments in which children grow up, such as their parents' education levels, the types of neighborhoods in which they live, and the schools they attend (Domingue et al., 2015).

4. Analytic strategy

The key interest of this analysis is to examine whether (and to what extent) observed associations between educational achievements and religiosity are due to (potentially unmeasured) features of the family. Relying on fixed effects estimates, the present study also examines whether the inclusion of potential mechanism variables explains the observed effects of religiosity. One issue with sibling models is the often high concordance of the variables of interest between siblings (e.g. religiosity) so that the sample that identifies the effect of interest (i.e. using discordant siblings) may be small and not representative (Fletcher, 2013). The intra-class correlation (ICC) for religiosity was 0.50, which means there is substantial variation between siblings in their religiosity. The ICC for GPA was 0.53, and the ICC for siblings' educational attainment was 0.46.

We begin with ordinary least squares (OLS) regression using the individual sample, followed by the family sample. In the individual sample, robust standard errors are clustered at the school level. Specifically, we examine

$$Outcome_{ij} = \beta_0 + \beta_1 Scale + X'\beta + \varepsilon \quad (1)$$

β_1 gives the association between the religiosity index and the outcome. Controls (X) include sex, birthyear, race, religious denomination, parental socioeconomic status, and verbal ability.

Equation (1) cannot account for unobserved factors that might simultaneously affect religiosity and academic outcomes. To address the potential biases that may stem from unobserved heterogeneity at the family level, we extend Eqn (1) to include a family-level fixed effect. We compare the coefficients of religiosity estimated by OLS and family fixed effects models to assess whether the baseline models are spuriously driven by omitted variable bias at the family and neighborhood levels. In family fixed effects models, robust

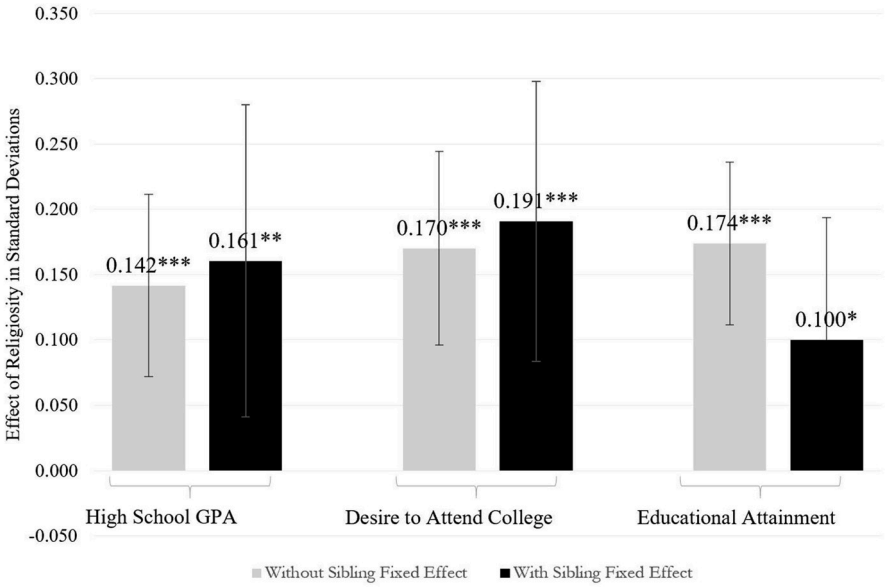
[12] More information can be found in section 1.2 in the Supplemental Material to Genetic Analysis of Social Mobility (Belsky et al., 2018): https://www.pnas.org/content/pnas/suppl/2018/07/04/1801238115.DCSupplemental/pnas.1801238115.sapp.pdf.

[13] More information about the AHAA can be found at http://www.prc.utexas.edu/ahaa/.

Table 3
Full sample results.

	GPA	GPA	GPA	College aspiration	College aspiration	College aspiration	Educ Attain.	Educ Attain	Educ Attain	Educ Attain*
	(M1)	(M2)	(M3)	(M4)	(M5)	(M6)	(M7)	(M8)	(M9)	(M10)
Religiosity index	0.105***	0.142***	0.161**	0.116***	0.170***	0.191***	0.114***	0.174***	0.100*	0.020
Private religiosity	0.086***	0.107***	0.109*	0.125***	0.191***	0.179***	0.100***	0.166***	0.101*	0.034
Public religiosity	0.101***	0.145***	0.146*	0.057***	0.061	0.068	0.100***	0.120***	0.017	−0.039
Sample	Full	Family	Family	Full	Family	Family	Full	Family	Family	Family
N (students)	7690	828	828	11,267	1120	1120	11,276	1121	1121	828
N (family clusters)			489			555			556	489
Individual level controls (race, sex, birthyear, religious affiliation, PVT scores)	X	X		X	X		X	X		
Family level SES control	X	X		X	X		X	X		
Family fixed effect			X			X			X	X
Robust standard error	School	Family	Family	School	Family	Family	School	Family	Family	Family

All Outcomes Reported in Standard Deviations; *p < .05. **p < .01. ***p < .001.
*control for high school GPA.



Note: Error bars represent the 95% confidence interval. All outcomes are reported in standard deviations; *p < .05. **p < .01. ***p < .001.

Fig. 1. Visual display of results for the family sample for all academic outcomes using the religiosity index, with and without sibling fixed effects (visual depiction of M2 vs M3; M5 vs M6; and M8 vs M9).

standard errors are clustered at the family level.

Table 3 shows three models for each of our three outcomes: high school GPA, college aspirations/expectations, and educational attainment. For each outcome, we begin with a baseline model that presents OLS estimates of the association of religiosity (as measured by an index) with each outcome, including individual and family level controls for SES. The second model for each outcome re-estimates the association of religiosity and education using the family sample. In the third set of models, we utilize the family structure of the data to generate a sibling fixed-effect estimate that fully controls for shared family background factors and any characteristics that may vary across families. Because the estimate is based on comparing siblings, any parental, neighborhood, or school factors that are shared by siblings in a family are controlled by the design of the model.[14] Across all the models, we control for verbal ability (as measured by PVT scores) to make sure that any potential relationship between religiosity and GPA is not driven by

[14] Across all the models, all coefficients for control variables are omitted, but are available in supplementary files.

higher verbal ability. Controlling for verbal ability also helps us account for the fact that parents may treat children differently based on how intelligent they perceive them to be. Fig. 1 visually depicts the results for the family samples (with and without the sibling fixed-effect) where religiosity is measured as an index. In our final model for educational attainment (M10), we include a control for high school GPA so that we can try to explain the observed effects of religiosity.

Since measuring religiosity using an index might obscure which aspect of religiosity matters, we also run separate models to distinguish between the private and public forms of religion. This means that we have a set of models in which the independent variable is the private dimension of religion (as measured by personal prayer and religious salience), and another set of models in which the independent variable is the private dimension of religion (as measured by religious service attendance).

5. Results

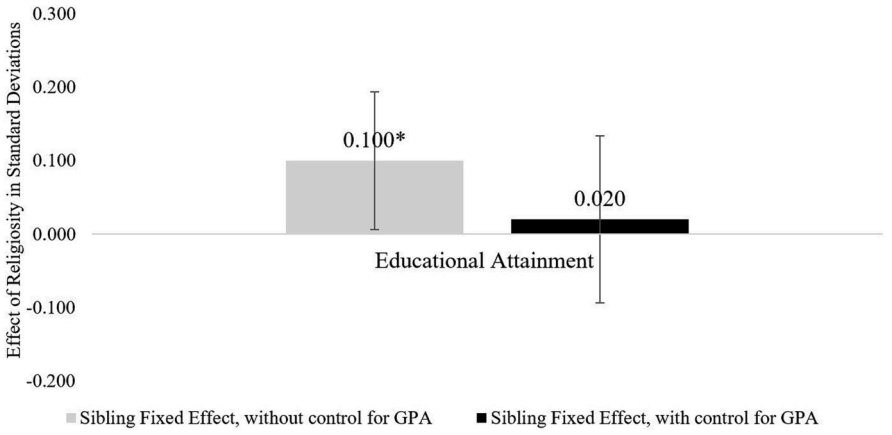
5.1. More religious adolescents earn higher GPAs

First, we examine the association between religiosity and GPA (M1-M3). Based on the family sample with family-level SES controls and PVT scores, we see that religiosity predicts GPA, regardless of which of the three religiosity measurements we use (index, private, or public). For example, the effect of religiosity is 0.142 ($p < .05$) when measured by a religiosity index, 0.107 ($p < .05$) when measured as private religiosity, and 0.145 ($p < .05$) when measured as public religiosity.

These estimates are not surprising given that other studies using Add Health have found similar associations (Regnerus and Elder, 2003). What is noteworthy is that the effect of religiosity remains even after we include family-level effects. After controlling for family fixed effects and PVT scores, a one-unit increase in the religiosity index is associated with a 0.161 standard deviation increase in GPA ($p < .05$). Since the effect remains statistically significant even after we add family fixed effects, we can infer that the relationship between religiosity and GPA is not spurious, and that the effect of religiosity is not only a function of family factors but may represent causal influence. We also note the magnitude of the within-family association. Given that families play a crucial role in their children's academic outcomes, we expected the effect of religiosity to become attenuated after we added the sibling fixed effects. But the effect is similar in both the family-level model with full SES controls and the sibling fixed effects model. Thus, a sibling who is more religious earns better grades than their less religious sibling. In Appendix A, we show that our estimates are similar, regardless of whether we include or exclude the 12% of the sample who were skipped out of the religiosity questions because they did not indicate a religious denomination.

5.2. More religious adolescents are more interested in going to college

Next, we examine the association between adolescents' religiosity (as measured by an index) and their interest in attending college. The pattern is similar to that of GPA: adding the sibling fixed effect does not attenuate the effect of religiosity. M4-M6 show that even after controlling for PVT scores and sibling fixed effects, a one-unit increase in religiosity is associated with a 0.191 standard deviation increase in college aspirations ($p < .05$). Again, these between-family estimates are to be expected given that other studies have found similar associations between religiosity and college aspirations/expectations (Al-fadhli; Kersen, 2010; Muller and Ellison, 2001; Regnerus, 2000). What is surprising is that the effect of religiosity remains even after we include sibling fixed effects. Since the effect increased and remains statistically significant after we add family fixed-effects, we can conclude that the relationship between religiosity and college aspirations/expectations is not spuriously driven by family-level factors (and these factors actually suppress the



Note: Error bars represent the 95% confidence interval. All outcomes are reported in standard deviations; *p < .05. **p < .01. ***p < .001.

Fig. 2. The role of GPA in explaining the relationship between religiosity index and educational attainment (visual depiction of M9 vs M10).

positive relationship some).

It is also surprising that, unlike with GPA, religiosity only predicts college aspirations when we use the religiosity index or private religiosity. The effect size for public religiosity (0.068) in the fixed effects models is less than half the effect for private religiosity (0.179). In addition, the effect for public religiosity is not significant in the models with the fixed effects.

5.3. *More religious adolescents get more years of education because they earn high GPAs in high school*

Finally, we turn to the association between adolescent religiosity and downstream educational attainment (M7-M9). The pattern continues to be similar to the previous models of GPA and college aspirations/expectations. Even in the models with sibling fixed effects, religiosity (as measured by an index) during adolescence predicts more years of higher education ($B = 0.100$, $p < .05$). This suggests that the relationship between religiosity and educational attainment is not spurious, and that effect of religiosity is not only a function of family factors but rather has some causal influence. It is notable that educational attainment is the only outcome for which the effect size decreased after we included sibling fixed effects (from 0.174 to 0.100). This may reflect that the amount of education one gets is more impacted by unobserved family level factors, such as parental emphasis on higher education or parental knowledge of the college application process. That is, siblings might have different GPAs and college aspirations because these outcomes are more within their control, whereas educational attainment reflects one's effort in school as well as parental influence.

It is also noteworthy that, as with college aspirations, religiosity only predicts educational attainment when we use the religiosity index or private religiosity. The effect size for public religiosity (0.017) in the fixed effects models is very small compared to the effect for private religiosity (0.101). In addition, the effect for public religiosity is not significant in the models with family fixed effects.

Finally, we examine whether adolescents who were more religious in wave 1 have higher educational attainment in wave 4 because they had higher GPAs in high school. That is, do more religious students get more years of education because they are better able to get into college in the first place? Model 10 tests this potential mediating relationship by controlling for high school GPA (see Fig. 2). We find that the effect size of religiosity (as measured by an index) reduces from 0.100 ($p < .05$) to 0.020 and loses its significance. This pattern is consistent even when we use measures of private and public religiosity. This finding would suggest that high school GPA mediates the entire relationship between religiosity and educational attainment. We then ran a mediation test (Tingley et al., 2014) on the individual sample to formally investigate the role of high school GPA as a causal mechanism mediating the relationship between religiosity and educational attainment. Results indicate that high school GPA mediates 68% of the relationship between religiosity and educational attainment (Mediated Effect = 0.12; Direct Effect = 0.05; Total Effect = 0.17; Proportion Mediated = 0.68). Thus, students who were more religious during adolescence have higher rates of educational attainment largely because they have better GPAs in high school. This finding aligns with previous studies showing that high school GPA is a strong predicter of academic success in college, including college completion (Geiser and Santelices, 2007; Zwick and Sklar, 2005).

6. Discussion & conclusion

Using sibling comparison to control for measured and unmeasured family background characteristics, our analyses yield two key findings. First, the effect of religiosity on high school GPA, college aspirations/expectations, and educational attainment is not driven purely by shared family characteristics. The effect of religiosity persists even after controlling for individuals' verbal ability. Second, one of the key reasons why highly religious individuals have higher rates of educational attainment is because they have better high school GPAs. The key takeaway of this study is as follows: highly religious adolescents earned higher GPAs in high school and were generally more academically prepared for college. Thus, more religious adolescents had higher educational attainment 14 years after their original religiosity was measured.

Our paper makes both a substantive and methodological contribution. By holding the family environment and a large portion of genetic variation constant, we accounted for a significant amount of omitted variable bias that has not been possible in prior research. By comparing siblings who are discordant on religiosity but are partly or fully matched on genetic makeup and rearing environment, we get as close as possible to an idealized counterfactual design. If we had failed to observe an association within discordant sibling pairs, we could assume that the relationship between religiosity and academic outcomes identified in earlier studies was merely a reflection of shared family factors. But this is not what we found. Not only do we find that religiosity during adolescence improves one's high school GPA and college aspirations, but our mediation analysis identified these very mechanisms as playing a strong role in explaining why adolescent religiosity predicts higher educational attainment 14 years later. The fact that more religious adolescents earn higher GPAs fully explains why they ultimately get more years of education. Including PVT scores in this longitudinal study allows us to better control for the possibility that parents use different childrearing strategies with their children. Compared with prior studies, our findings provide stronger evidence about the causal influence of adolescent religiosity in the short and long term. Furthermore, this study provides clearer evidence that the relationship between religiosity and academic outcomes is not simply due to family level differences.

However, while the discordant sibling fixed-effects design is an innovative approach to account for early environment confounding, it is not without limitations (Madsen and Osler, 2009). First, although this study rules out important family background and childhood experiences shared by siblings, it is unable to account for confounding characteristics that are idiosyncratic to each sibling. Even if siblings share many things, there are family-level factors that they do not share. For example, parents may treat siblings differently based on their individual characteristics, some of which we can control for and some for which we cannot. For example, religious cultures tend to differ in their teachings about gender roles, and there are specific tenets within the doctrines that focus on women's and men's relative responsibilities for activities like child-rearing (Whitehead, 2012). It is likely that parents with more conservative

religious beliefs invest less in their daughters' education. To account for parents' differential treatment of sons and daughters, we control for gender. Parents may also treat their children differently based on their perceptions of each child's academic potential. If parents perceive one child to be more intelligent or academically inclined than their other children, they might direct more resources to that child. We account for this possibility by controlling for individuals' PVT scores, but future research should consider how else they might account for the possibility that parents treat children differently in ways that might influence their long-term education. In addition, siblings have different genetic makeups and different experiences outside the home. In school, they are in different grades and have similar but not identical teachers and friends. It is also quite possible that children who are significantly less religious than their parents, are seen as deviant and treated differently by their families. Horwitz (Unpublished results) found that adolescents who believe that God exists but are otherwise religiously disengaged (both privately and publicly), are less likely to demonstrate signs of positive youth development. These adolescents appear to reject school, religion, and other social institutions. In this study, we are unable to control for these types of differences because we lack appropriate personality measures. Therefore, estimates derived from family fixed effects models can still be biased due to individual heterogeneity, which would be a useful direction for future research (Daw et al., 2015; Kim, 2018).

A second potential issue with sibling models is the reduction in both endogenous and exogenous determinants of the outcome of interest. Indeed, if endogenous variation is a large portion of the remaining variation (after removing fixed effects), then the estimates could become more biased than the baseline model (Bound and Solon, 1999). We note the general consistency between our between- and within-family results; such consistency argues against the introduction of additional sources of bias in our sibling models. Third, statistical power in the fixed-effects models is limited leading to relatively imprecise estimates (Madsen and Osler, 2009). However, given our interest in ruling out family background as the determinative factor in observed associations between religiosity and educational outcomes, we are less concerned about the reduced precision in our estimates (i.e., we are mainly concerned with distinguishing them from zero).

This paper also contributes to the ongoing debate about which form of religiosity matter for academic success. Some studies suggest that religious participation drives positive educational outcomes (Glanville et al., 2008; Lee and Pearce, 2019; Regnerus, 2000; Regnerus and Elder, 2003), while others argue that a combination of religious participation and salience is what matters (Al-fadhli and Kersen, 2010; Jeynes, 2010; Muller and Ellison, 2001; Toldson and Anderson, 2010). Overall, we found that the religiosity index was a more robust predictor across all three academic outcomes. We also found that the results for GPA were similar regardless of which of the three religiosity measurements we used. However, for college aspirations and educational attainment, private religiosity appeared to matter more than public religiosity. This suggests that belonging without believing benefits one's grades, but not one's college aspirations or downstream educational outcomes.

We also recognize that using religious service attendance, personal prayer and religious salience as proxies of religiosity may not accurately reflect the ways individuals uniquely combine varying types and levels of religious practices and beliefs (Storm, 2009). To address the shortcomings of previous conceptions and measures of religiosity, Pearce and Denton (2011) and Pearce et al. (2013) proposed an alternative to the variable-based, low-to-high continuum approach by conducting a latent class analysis using survey data from the National Study of Youth and Religion (NSYR). Future studies could use these LCA categories to see if the relationship between religion and academic outcomes looks different when one moves away from the more common composite measure, or individual measures of salience/participation.

We also want to acknowledge four additional limitations. First, our data are right censored. Some Add Health participants may not have completed their educational careers by the time of the most recent Wave 4 interview. Continued follow-up of the cohort is needed. Second, our data are left censored. Add Health began when some participants were well along their adolescent educational careers (the cohort included adolescents in 7–12th grade). We were therefore unable to observe preschooling characteristics but also unable to observe all possible educational transitions (e.g., we have left and right censoring). Add Health does follow all those adolescents who dropped out of school (even at Wave 1) and are included in the Wave 4 educational attainment outcome. Third, cognitive assessment in Add Health at baseline was limited to the modified Peabody Picture Vocabulary Test. It is possible that other assessment of cognitive ability might have yielded different results. Fourth, the data preclude us from distinguishing between two distinct types of religiously disengaged adolescents: (1) atheists and (2) those who believe in God but don't engage in religious practices. Based on rates of atheism in wave 1 of National Study of Youth and Religion (2002), which is a study of similar aged adolescents, we estimate that the percentage of atheists in the Add Health sample is about 3%. Examining heterogeneity in the academic outcomes of different types of non-religious adolescents is important for future research because atheists seem to perform just as well as the most religious adolescents (Horwitz, Unpublished results). If this is the case, atheists in the Add Health may be raising the average performance of religiously disengaged adolescents.

Based on this paper's findings, the next obvious step is to continue examining the mechanisms by which religiosity effects academic outcomes. Although scholars have offered several explanations—increased religiosity tends to deter young people from risky behaviors, promotes social capital and network closure, and motivates youth to act in ways that adhere to the moral grounding of their religious teachings— few studies have empirically tested these mechanisms to see how well they explain the effect of religiosity on academic exception. This is an important next step for further research.

In summary, this article extends prior literature by showing that the effect of religiosity on academic outcomes may be causal. As we show, more religious adolescents earned higher GPAs in high school and were more interested in going to college. Because of their higher GPAs, more religious adolescents were better positioned to get into college and had completed more years of education 14 years after their religiosity was measured. Thus, we suggest that scholars take more seriously the idea that adolescents' religious commitments influence schooling experiences. Future research needs to examine the mechanisms underlying this relationship, ideally using qualitative data or mixed methods (Lee and Pearce, 2019). Identifying how religion impacts people's behaviors in, and attitudes

towards, school is crucial given the highly religious character of American society.

Declaration of competing interest

None.

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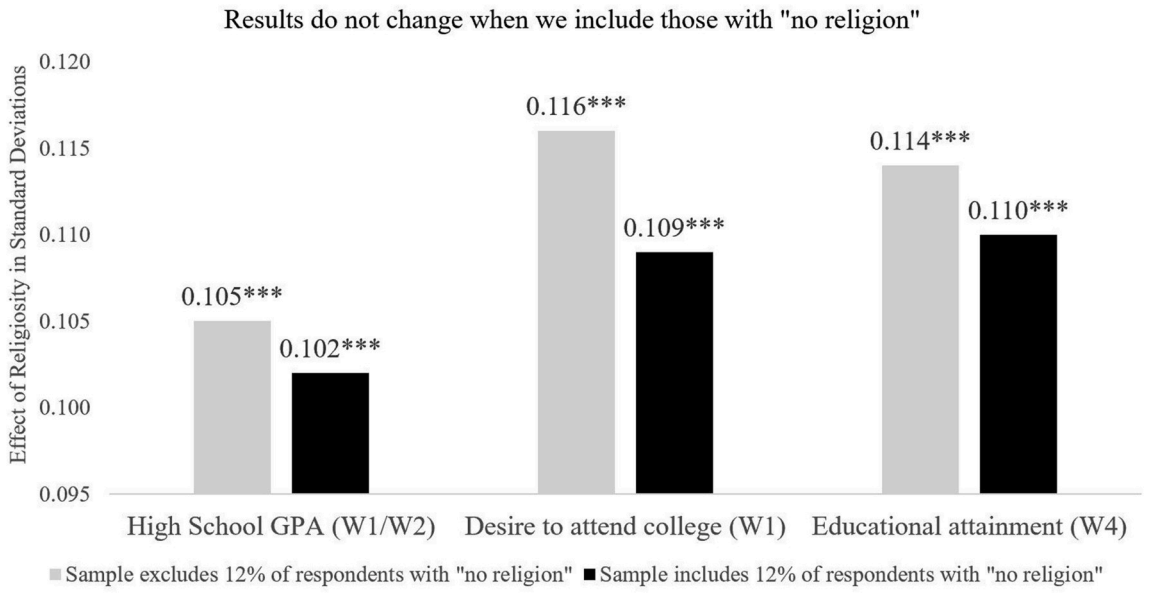
Appendix A

We reran our analyses on the "individual" sample to include the 12% of respondents who were not asked the religiosity questions (because they didn't indicate a religion) and were excluded from our primary analysis. In these analyses, we mark these respondents as their own denominational category and assign them a religiosity scale of 0. In the figure below, we compare the effect size of religiosity on our three academic outcomes (high school GPA, educational aspirations, educational attainment) using our restricted sample (which excludes those with "no religion") to the sample that includes the "no religion" respondents. To be clear, the effect sizes in gray (the restricted sample) are the same as the estimates we provided in Table 3 for the "individual sample". The effect sizes in black are based on the broader sample that includes respondents with "no religion." What we see is that the effect of religiosity remains very similar, regardless of whether we include or exclude the respondents who were not asked the religiosity questions.



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