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RESEARCH ARTICLE

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Longitudinal associations between parent degree/occupation, parent support, and adolescent motivational beliefs in STEM

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Abstract

Introduction: The United States struggles with racial/ethnic disparities in STEM (science, technology, engineering, mathematics) degrees and occupations. According to situated expectancy-value theory, the experience and knowledge parents gain through STEM degrees and occupations shape the STEM support they provide and relatedly their adolescents' STEM motivational beliefs.

Methods: We analyzed data from the High School Longitudinal Study ($N = 14{,}000$; 50% female; $M_{age} = 14$ years old at 9th grade), which is a recent U.S. data set that surveyed a nationally representative sample of adolescents.

Results and Conclusions: Results showed that parent STEM support in 9th grade and adolescent STEM motivational beliefs in 11th grade were lower in families where parents did not have a STEM degree/occupation than in families where at least one parent had a STEM degree/occupation. Our within-group analyses suggested that parents' STEM support was generally positively related to adolescents' STEM motivational beliefs among families where parents did not have a STEM degree/occupation for all racial/ethnic groups except Black adolescents. However, these relations were not significant among adolescents who had a parent STEM degree/occupation. Furthermore, although Asian and White adolescents' parents were more likely to hold a STEM degree/occupation than Latina/o and Black adolescents' parents, the associations between parent STEM support and adolescents' STEM motivational beliefs emerged for Asian, Latina/o, and White adolescents.

KEYWORDS

motivational beliefs, parent support, race/ethnicity, STEM, STEM degree/occupation

1 | INTRODUCTION

STEM (science, technology, engineering, mathematics) is increasingly important for our daily lives and economic advances, but the United States continues to struggle with substantial racial/ethnic inequities in STEM degrees and occupations (Bøe et al., 2011; Feinstein, 2011; National Mathematics Advisory Panel, 2008; Xue & Larson, 2015). For example, less than 17% of all full-time STEM employees are Latina/o or Black, whereas White and Asian individuals comprise more than 80% (National Science Foundation, 2019). These current racial/ethnic disparities are, in part, the result of historically rooted structural inequities, which include uneven access to advanced STEM resources and opportunities, colorblind curricula that ignore race/ethnicity, as well as discrimination and implicit biases (Beasley & Fischer, 2012; Grossman & Porche, 2014; Museus & Liverman, 2010; Nasir & Vakil, 2017; Taningco et al., 2008).

These racial/ethnic disparities in STEM degrees and occupations not only have implications for adults in the current workforce (Jones, 2014; National Science Foundation, 2019), but they may also map onto disparities for the next generation. According to situated expectancy-value theory, parents' STEM education and occupations enrich the STEM support they provide their children, which has positive implications for their children's motivational beliefs (Eccles & Wigfield, 2020; Eccles, 2011). Nonetheless, prior studies also highlight the resilience of families traditionally marginalized in STEM where

parent STEM support still matters and helps promote adolescents' motivational beliefs (e.g., McGee & Spencer, 2015; Plunkett & Bámaca-Gómez, 2003; Soto-Lara & Simpkins, 2020). The current study explores this complexity by examining the differences between families with and without a parent STEM degree or occupation in terms of their parent STEM support, race/ethnicity, and adolescent STEM motivational beliefs. Additionally, we examined within-group variability by testing the extent to which parents' STEM support was associated with adolescents' STEM motivational beliefs *separately* among families where parents do and do not have a STEM degree/occupation for the four largest racial/ethnic groups in the United States. (i.e., Asian, Black, Latina/o, and White). These racial/ethnic within-group analyses provide complementary insight to the existing literature dominated by between-group differences and address if support may be helpful for each racial/ethnic group, including the extent to which parent support might promote resilience for adolescents whose parents are not situated within STEM.

1.2 | Parent STEM support and adolescents' motivational beliefs

A prominent theory to understand family influences and adolescents' STEM motivational beliefs is the situated expectancy-value theory (Eccles & Wigfield, 2020; Eccles, 2011; Jacobs & Simpkins, 2005; Watt, 2005; Wigfield & Eccles, 2000). According to situated expectancy-value theory, adolescents' motivational beliefs are shaped by contextual influences, with parents being one of the most important influencers (Wigfield et al., 2015). This theory argues that parents can support their children in STEM through a variety of strategies (e.g., helping with science projects, providing encouragement, and providing STEM-related resources and opportunities). And, although parents do not typically provide every single type of support, all of these supports theoretically promote their adolescents' STEM motivational beliefs (Bradley, 2004; Simpkins et al., 2015). We focus on four of the most immediate and central motivational beliefs in the situated expectancy-value theory. First, expectancy beliefs pertain to how good individuals think they will be in an area like STEM. Second, value beliefs include three positive constituents, namely, interest (i.e., how enjoyable individuals find STEM to be), utility value (i.e., how useful individuals find STEM to be), and attainment value (i.e., how central being a STEM person is to who the individual is). Because STEM motivational beliefs typically decline during adolescence, it is critical to examine factors that promote STEM motivational beliefs, such as parent STEM support, during this developmental period (Alfaro & Umaña-Taylor, 2015; Gottfried et al., 2007; Hsieh et al., 2019; Jacobs et al., 2002; Wang et al., 2017). More specifically, we examined parent STEM support at the beginning of high school (9th grade) as prior literature guided by the stage-environment fit theory suggests that adolescents' transition into high school is challenging for their motivational beliefs, making the support adolescents receive during this time consequential (Eccles & Roeser, 2009; National Research Council Institute of Medicine, 2004). We also examined adolescents' motivational beliefs 2 years later (11th grade), which corresponds to an important time when most adolescents are prompted to think concretely about their future educational and/or career plans (e.g., Barth & Masters, 2020).

Prior research supports the situated expectancy-value theory and shows that parents' supportive behaviors, such as encouragement, coactivity, and provision of materials, positively predict their adolescents' STEM expectancy belief, interest, utility value, and attainment value (Chakraverty et al., 2020; Gann & Carpenter, 2019; Kang et al., 2018; Simpkins et al., 2015). For example, the math and science encouragement that middle and high school adolescents report receiving from their parents is positively related to their math and science expectancy and value beliefs (Aschbacher et al., 2010; Gottfried et al., 2009; Stake, 2006; Turner et al., 2004). Similarly, parent co-participation in math and science activities (e.g., looking at science websites with their child) and providing access to math and science materials are positively associated with their children's and adolescents' math and science motivational beliefs (Jacobs & Bleeker, 2004; Mujtaba et al., 2018; Simpkins et al., 2006, 2015). Indices summarizing the number of unique strategies parents use to provide support in math and science also positively predict children's math and science motivational beliefs in elementary school and high school (Hsieh et al., 2019; Simpkins et al., 2015). This prior work, however, largely focuses on average associations. Though information on the average is helpful, there is also great variability around those averages; for example, parent support may predict adolescent motivational beliefs for most but not all families. Among which families might an index of parent support be a stronger predictor? We believe that parents' STEM degree/occupation may be a crucial factor.

1.3 | Parent STEM degrees and occupations

Situated expectancy-value theory argues that parents' educational degrees and occupations are two critical aspects of the cultural milieu that shapes family processes as well as adolescents' motivational beliefs, achievement, and choices (Eccles & Wigfield, 2020; Eccles, 2011). Aligned with this theory, evidence suggests that having a family member (e.g., parent) who has a science-related occupation positively predicts children's aspirations for a STEM career, even after controlling for children's STEM expectancy beliefs and participation in STEM activities (Bryant et al., 2006; Cheng et al., 2019; Gilmartin et al., 2006; Shapiro & Sax, 2011).

The parent socialization model of the situated expectancy-value theory further argues that parents' education and occupations shape their beliefs and behaviors, which then predict their children's STEM motivational beliefs (Davis-Kean, 2005; Eccles, 2005). Parents with STEM degrees or occupations are expected to provide more STEM support compared with those without STEM degrees and occupations because their STEM-related educational or occupational experiences might better prepare them to provide STEM support to their adolescents (DeWitt et al., 2016; Dika & Singh, 2002; Eccles, 2005). In a retrospective qualitative study, scientists attributed their burgeoning interest and subsequent enrollment in the STEM fields to their parents and other family members who possessed STEM "funds of knowledge" (Chakraverty et al., 2020). For example, parents with a STEM degree or occupation might engage in more conversations with their adolescents about STEM because more STEM-related instances at work prompted them to start those conversations (Chakraverty & Tai, 2013).

If adolescents in families where at least one parent has a STEM degree/occupation are exposed to more STEM-related experiences at home, they might report higher STEM motivational beliefs than those in families where parents do not have a STEM degree/occupation (Adamuti-Trache & Andres, 2008; Gilmartin et al., 2006; Leppel et al., 2001; Simpkins et al., 2006). However, more empirical evidence is needed to examine this proposition because there are mixed results. For example, Anaya et al. (2017) found that children of parents with science-related occupations had higher math performance but did not report higher math expectancy beliefs than children of parents with other occupations.

In addition to the mean-level differences across these two groups discussed above, the literature implies that the correlates of parent STEM support may vary. Parents' STEM degree/occupation might allow them to be more effective in discussing the values of STEM and the various options for STEM careers with their adolescents (Archer et al., 2013). For example, Hyde et al. (2006) showed that mothers with more math knowledge guided their children in solving mathematical problems more effectively compared to their peers. This effect may be more pronounced in high school as the increasing complexity of high school STEM courses might quickly surpass parents' comfort level (O'Sullivan et al., 2014). Though this expectation sounds intuitive and existing evidence supports it, that does not mean parent support does not matter for those who do not have STEM credentials or are otherwise marginalized in STEM (McGee & Spencer, 2015; Plunkett & Bámaca-Gómez, 2003; Soto-Lara & Simpkins, 2020). For example, Rozek et al. (2015) showed that an intervention promoting parents' STEM utility effectively enhanced adolescent boys' STEM course-taking for those who had low prior STEM performance but not for those with high prior STEM performance. Relatedly, Domina (2005) found that children from less-well-resourced families actually benefited more from parent educational support than their more-well-resourced peers. Taken together, some literature suggests parent STEM support should predict adolescent motivation for families with a parent STEM degree/occupation and for families without a parent STEM degree/occupation, though this has yet to be tested.

We argue it is important to examine both between-group and within-group variability. For example, testing mean-level differences between families with and without a parent STEM degree/occupation helps identify the magnitude of existing disparities between the two groups. However, to understand if interventions on parent support have the potential to promote resilience for adolescents within each group, researchers need to test these associations within each group. Thus, one of our goals was to examine the extent to which parent STEM support is associated with adolescent motivational beliefs within families with a parent STEM degree/occupation and, separately, within families without a parent STEM degree/occupation. Both pieces of information can help inform which interventions might be most beneficial for which adolescents and families.

1.3.1 | Racial/ethnic disparities in STEM

Historically rooted, structural inequities in the United States have produced substantial racial/ethnic disparities in STEM. In this study, we focus on the inequities in parents' STEM degrees/occupations because they are major markers or recognized qualifications for what are socially agreed-upon as prestigious and show profound racial/ethnic disparities (National Science Foundation, 2019). Acknowledging the existing racial/ethnic disparities in STEM, we first explicitly examined the differences in racial/ethnic representation between families with and without a parent STEM degree/occupation. We expected that White and Asian adolescents would be overrepresented in families with a parent STEM degree/occupation, whereas Black and Latina/o adolescents would be overrepresented in families without a parent STEM degree/occupation.

Although we hypothesized racial/ethnic differences in terms of representation, we take a family strength-based perspective and expect that parent STEM support would positively predict adolescents' STEM motivational beliefs for each racial/ethnic group. We intentionally conducted analyses within each of the four largest racial/ethnic groups in the United States (i.e., Asian, Black, Latina/o, and White) to understand how the associations between parent STEM support and adolescent STEM motivational beliefs manifest for families in each racial/ethnic group, acknowledging that in the United States, different racial/ethnic groups often have substantially different privileges and barriers that lead to unequal lived experiences with STEM to start with. That is, given the different social contexts that families of different racial/ethnic backgrounds are embedded in, we set out to examine if parent STEM support matters for each of the racial/ethnic groups, rather than pitting the groups against one another. Within-group analyses not only help counter the deficit narratives around Black and Latina/o youth in STEM that are based on group comparisons, within-group analyses are also the only type of

analysis that tests if parenting is beneficial to adolescents in each group. In a prior study, although Latina/o adolescents reported receiving less parent support and having lower science motivational beliefs than their White peers, the positive associations between parents' support and adolescents' science motivational beliefs emerged for each racial/ethnic group (Simpkins et al., 2015). Thus, we expect positive associations between parent STEM support and adolescent STEM motivational beliefs to emerge within each of the four racial/ethnic groups.

1.4 | Theoretically relevant factors to control

To examine parents' STEM support and adolescents' motivational beliefs, we accounted for several theoretically relevant parent and adolescent factors. To help isolate the effects of parent STEM support, we included two central indicators of parents' general educational support, namely their discussions about their adolescents' higher educational plans and their financial preparation for their adolescents' higher education (Eccles & Harold, 1996; Hill & Tyson, 2009; Wilder, 2014). Furthermore, an indicator of adolescents' ninth grade math achievement and a variable for whether adolescents' eighth grade math class was advanced were also included as covariates to account for the accumulation of earlier math/STEM-related parenting and developmental experiences. That is, we estimated the relations between parents' STEM support and adolescents' later STEM motivational beliefs for adolescents with similar math achievement levels to start with. Lastly, demographic factors (i.e., parent education level, adolescent gender, family income) and adolescents' school type were incorporated as covariates to account for some unobserved biases in the broader contexts that adolescents are embedded in (e.g., Jiang et al., 2020; Ketenci et al., 2020; Nasir & Vakil, 2017; Svoboda et al., 2016).

2 | THE CURRENT STUDY

The current study tested four hypotheses under two research aims.

Aim 1: Describe families with and without a parent STEM degree/occupation in terms of differences in adolescent racial/ethnic representation, parent STEM support, and adolescent STEM motivational beliefs.

Hypothesis 1.1. *White and Asian adolescents would be overrepresented, whereas Latina/o and Black adolescents would be underrepresented in families where parents had a STEM degree/occupation.*

Hypothesis 1.2. *Adolescents whose parents had a STEM degree/occupation would receive more parent STEM support in 9th grade and have higher STEM motivational beliefs in 11th grade compared with those whose parents did not have a STEM degree/occupation.*

Aim 2: Estimate the associations between parent STEM support and adolescents' STEM motivational beliefs separately for families with and without a parent STEM degree/occupation, and test if those relations emerge in each of the four racial/ethnic groups.

Hypothesis 2.1. *Parents with a STEM degree/occupation might have more relevant experience to draw upon to inform their STEM support, which is expected to positively predict adolescents' STEM motivational beliefs (e.g., Archer et al., 2013; Eccles, 2005). Nevertheless, STEM support from parents without a STEM degree/occupation might still matter in terms of promoting adolescents' STEM motivational beliefs (Rozek et al., 2015).*

Hypothesis 2.2. *The expected positive associations between parents' 9th grade STEM support and adolescents' 11th grade STEM motivational beliefs are expected to emerge within each of the four racial/ethnic groups.*

3 | METHOD

3.1 | Data set and participants

Participants for the current study were from the High School Longitudinal Study (HSLS) collected by the National Center for Educational Statistics (NCES; Ingels et al., 2011). HSLS is a fitting data set for the current study because it includes data reported by both adolescents and their parents. For every adolescent, one parent (71% were biological mothers, 21% were biological fathers) reported for themselves and (if applicable) on behalf of their spouse or partner living in the same household. We excluded participants who were selected for the study but did not participate in 9th

grade, which included 3760 adolescents and 5020 parents, and then participants who had missing data on parent STEM degree ($n = 820$). Lastly, we focused on participants whose race/ethnicity was White ($n = 8900$), Latina/o ($n = 2460$), Black ($n = 1470$), or Asian ($n = 1160$), namely, the four largest racial/ethnic groups in the United States, yielding a total analytical sample of 14,000 adolescents. Under this sampling frame, we excluded 1410 participants whose racial/ethnic group is too small (e.g., Native American) or heterogeneous (e.g., Multiracial) for our intended analyses. Sample sizes throughout this article are rounded to the nearest tens place in accordance with the NCES reporting requirements for restricted data sets. The demographics of the analytical sample (50% female; $M_{age} = 14$ years old at ninth grade) are shown in Table 1. As shown in Appendix A, the analytical sample reported statistically higher STEM motivational beliefs (with small effect sizes; $d = 0.05–0.14$) and a higher proportion of parents with a STEM degree/occupation (medium effect size; $d = 0.64$) than the excluded sample, but the two samples did not differ on the level of parent STEM support.

3.2 | MEASURES

The primary indicators of this study were parents' STEM degree/occupation and parents' STEM support when their adolescents were in 9th grade, which were collected in year 2009, in addition to four distinct indicators of adolescents'

TABLE 1 Descriptive statistics for key variables, separately for parents with and without STEM (science, technology, engineering, mathematics) degree/occupation

	Parents who did not have a STEM degree/occupation ($n = 9,830$)		Parents who had a STEM degree/occupation ($n = 4,160$)				
	Mean	(SE)	Mean	(SE)	*t* statistic	χ^2	Cohen's *d* effect size
11th grade STEM motivational beliefs							
Expectancy belief	2.77	(0.01)	2.90	(0.01)	11.51***	-	0.21
Interest	2.74	(0.01)	2.82	(0.01)	7.43***	-	0.14
Utility value	3.15	(0.01)	3.24	(0.01)	9.55***	-	0.18
Attainment value	2.42	(0.01)	2.65	(0.01)	17.79***	-	0.33
9th grade parent STEM support	3.68	(0.02)	4.20	(0.02)	16.76***	-	0.31
Asian (8% of entire sample)	0.05	(0.00)	0.16	(0.01)	-	437.27***	0.39
Black (10% of entire sample)	0.12	(0.00)	0.08	(0.00)	-	36.07***	0.11
Latina/o (18% of entire sample)	0.21	(0.00)	0.10	(0.00)	-	270.97***	0.30
White (64% of entire sample)	0.62	(0.00)	0.67	(0.01)	-	23.38***	0.09
Covariates							
9th grade parent financial support for college	0.77	(0.00)	0.86	(0.01)	-	131.20***	0.21
9th grade parent communication with school about college	0.42	(0.01)	0.48	(0.01)	-	37.69***	0.11
Parent has a bachelor's degree	0.32	(0.00)	0.72	(0.01)	-	2216.65***	0.87
9th grade math achievement	50.65	(0.10)	55.94	(0.15)	29.89***	-	0.55
8th grade math class is advanced	0.36	(0.00)	0.54	(0.01)	-	392.59***	0.37
Female	0.50	(0.01)	0.49	(0.01)	-	0.80	0.02
Family income	4.05	(0.03)	6.18	(0.05)	40.05***	-	0.74
School type: private	0.18	(0.00)	0.27	(0.01)	-	161.92***	0.24

Note: Conventions for Cohen's *d*: 0.20—small, 0.50—medium, 0.80—large. *t* Statistics calculated for the continuous outcome, while χ^2s calculated for binary outcomes; - denotes not applicable. Missing data imputed with multiple imputation.

***$p < .001$.

Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09), Base Year and First Follow-Up.

11th grade STEM motivational beliefs (i.e., STEM expectancy belief, interest, utility value, and attainment value), and adolescents' race/ethnicity. The covariates included parents' general educational support, family income, parent education, as well as adolescents' ninth grade math achievement test score, eighth grade math course level, gender, and school type (public or private).

3.2.1 | Parent STEM degree/occupation

Parents reported their current/most recent occupation and the major of their highest degree at the time of data collection (i.e., when adolescents were in 9th grade) through open-ended questions. Their responses were coded by the HSLS team into STEM versus not based on Standard Occupational Classification and Classification of Instructional Programs codes, respectively (Bureau of Labor Statistics, 2012). Some major STEM categories included computer and information sciences, engineering, biomedical sciences, military technologies, and physical sciences. Parents' STEM degree/occupation was coded into a binary variable where 0 meant no parents had a STEM degree or occupation whereas 1 meant at least one parent had a STEM degree or occupation.

3.2.2 | Parent STEM support

Parents' STEM support was measured when their adolescents were in 9th grade and referred to whether (yes/no) parents provided support during the last year through seven dichotomous items: (1) helped child with school science fair, (2) went to science museum with child, (3) used computer with child, (4) helped child with science project, (5) discussed with child about STEM article or program, (6) talked to parent about science course selection in ninth grade, and (7) talked to parent about math course selection in ninth grade. The first five items were reported by the parents. The last two items were reported by adolescents. Prior studies have used similar items and showed that parents utilize a variety of math and science supportive behaviors, hence an index that cuts across the various dichotomous indicators instead of independent predictors perform better in predicting youth outcomes (Simpkins et al., 2006, 2015). Aligned with the scoring of other formative indices such as the H.O.M.E. index and risk indices (for a discussion of formative indices and the appropriate psychometric indicators, see Bradley, 2004), we summed the seven items to create an index of parent STEM support. Though some parents might provide all seven types of support, parents often vary in which support they provide. As formative indices, the STEM support items should not be assumed to exhibit strong inter-item association nor any particular dimensional structure (Bradley, 2004), though each type of support is theoretically expected to promote adolescents' motivational beliefs (Eccles, 2005; Simpkins et al., 2015). The parent STEM support index was positively and significantly correlated with family income and adolescents' math achievement (r's = .23 and .18, $p < .001$), suggesting convergent validity.

3.2.3 | Adolescent STEM motivational beliefs

The outcomes of this study were four STEM motivational beliefs that fit under the situated expectancy-value theory (Wigfield & Eccles, 2000), namely, (a) expectancy belief, (b) interest, (c) utility value, and (d) attainment value, measured in 11th grade. Original items were asked within math and separately within science, and then averaged into STEM for each of the four beliefs (Appendix B). STEM expectancy belief was a composite of eight items ($\alpha = .86$; e.g., "certain that you can master math skills"). STEM interest was a composite of six items ($\alpha = .75$; e.g., "enjoy math classes very much"), STEM utility value was also a composite of six items ($\alpha = .82$; e.g., "science is useful for a future career"), whereas STEM attainment value was a composite of four items ($\alpha = .74$; e.g., "you see yourself as a science person"). The four motivational beliefs are theoretically distinct (Eccles & Wigfield, 2020), and thus were analyzed as separate indicators. All four STEM motivational beliefs were measured using a 4-point Likert scale (1 = *strongly disagree*, 4 = *strongly agree*). These scales were developed for the HSLS study (Ingels et al., 2011), and similar scales have been used in prior studies to measure STEM motivational beliefs (e.g., Jacobs et al., 2005; Shanahan, 2009; Simpkins et al., 2015; Snodgrass Rangel et al., 2020). Confirmatory factor analysis including all four motivational beliefs and their respective items showed acceptable model fit in terms of RMSEA (0.07) and SRMR (0.04), and CFI (0.93). The four motivational beliefs were all positively and significantly correlated with adolescents' math achievement (r's = .17–.38, $p < .001$) and whether they took advanced math class (r's = .11–.26, $p < .001$), suggesting convergent validity.

3.2.4 | Adolescent race/ethnicity

Adolescents were asked in 9th grade to select all categories that described their racial background: White, Black, Asian, Native Hawaiian or other Pacific Islander, and American Indian or Alaska Native. We included adolescents who exclusively selected Asian, Black, and White in this study. Then, on top of that, adolescents were asked if they were of Hispanic or Latino/a origin. We included adolescents who responded yes, regardless of their reported racial background, as Latina/o for the current study. Our racial/ethnic categorization aligns with typical practices in this field of study (e.g., National Science Foundation, 2019).

3.2.5 | Covariates

Parent and family covariates included family income, parent education, and general educational support. Parent-reported family income (13 categories in $20,000 increments; ranged from less than 15,000 to more than 235,000) and a dichotomous indicator of whether at least one parent had a bachelor's degree (0 = *neither parent had a bachelor's degree*, 1 = *at least one parent had a bachelor's degree*) were included as covariates. Parents' general (i.e., non-STEM-specific) educational support was included to isolate the correlates of parents' STEM-specific support and measured with two dichotomous indicators when their adolescents were in ninth grade. Parents reported (a) whether they have talked to a school administrator about the adolescent's college-going plans and (b) whether they will provide financial support for the adolescent's higher education (0 = *no*, 1 = *yes*). These two indicators have been examined in prior literature as aspects of parents' educational support (Eccles & Harold, 1996; Fan & Chen, 2001; Jeynes, 2005).

Adolescent covariates included dichotomous indicators of adolescents' gender (0 = *male*, 1 = *female*), school type (0 = *public*, 1 = *private*), and 8th grade math course level (0 = *regular*, 1 = *advanced*), as well as a continuous indicator of adolescents' 9th grade math achievement. Adolescents' 9th grade math achievement was assessed with an item response theory measure using 40 questions that encompassed six algebraic content domains (e.g., proportional relationships and change) and four algebraic processes (e.g., solving algebraic problems). This math achievement measure was originally normed with a mean of 50 and standard deviation of 10; it was then standardized (to mean of 0 and standard deviation of 1) to ease interpretation.

3.3 | Missing data

All analyses were estimated on the analytic sample ($N = 14{,}000$) after multiple imputations (20 imputed data sets) for missing data on all variables (Enders, 2008). Auxiliary variables were included to strengthen the imputation process (i.e., variables that help with imputing missing data but are not used in the main analyses). They included the percent of students on free or reduced lunch in the adolescent's school, the percent of students who identify as White in the adolescent's school, the percent of students who repeated 9th grade in the adolescent's school, single-parent household, the number of children in the household, parents' help with adolescents' homework, adolescents' 9th grade GPA, and adolescents' 9th grade STEM motivational beliefs.

3.4 | Analysis plan

For Research Aim 1, we expected mean level differences between families with and without a parent STEM degree/occupation in terms of racial/ethnic representation, parents' STEM support, and adolescents' STEM motivational beliefs. *T* tests for continuous variables and χ^2 tests for categorical variables, in addition to their corresponding effect sizes, were calculated to statistically test the mean level differences. Descriptive statistics on all variables used in this study were presented separately for families whose parents had a STEM degree/occupation and those without a parent STEM degree/occupation.

Research Aim 2 examined the associations between parent STEM support and adolescent STEM motivational beliefs separately for families with and without a parent STEM degree/occupation. Each of the four STEM motivational beliefs (i.e., expectancy belief, interest, utility value, and attainment value as the outcome in separate models) were regressed on parents' STEM support and our list of covariates. The regressions were estimated separately for those in families where a parent has a STEM degree/occupation and in families where parents did not have a STEM degree/occupation. To understand if the association emerged within each racial/ethnic group in the current study, the above regressions were tested separately among Asian, Black, Latina/o, and White families. All the analyses were adjusted for the complex sampling design of HSLS (i.e., weights, primary sampling unit, strata, and clustered standard error) using Stata version 14 (StataCorp, 2015); see Appendix C for bivariate correlations of the main study variables.

4 | RESULTS

4.1 | Differences across families with versus without a parent STEM degree/occupation

As expected, adolescents whose parents had a STEM degree/occupation and adolescents whose parents did not have a STEM degree/occupation differed in terms of their race/ethnicity (Table 1). Overall, Asian adolescents, and White adolescents to a lesser extent, were overrepresented in families with parent STEM degree/occupation. On the contrary, Latina/o adolescents, and Black adolescents to a lesser extent, were overrepresented in families without a parent STEM degree/occupation. Specifically, Asian adolescents comprised 16% of adolescents whose parents had a STEM degree/occupation, they accounted for only 5% of adolescents whose parents did not have a STEM degree/occupation; this difference was statistically significant ($\chi^2 = 437.27$, $p < .001$) and had a small effect size ($d = .39$). Also, White adolescents made up 67% of adolescents whose parents had a STEM degree/occupation and 62% of those without a STEM degree/occupation ($\chi^2 = 23.38$, $p < .001$, $d = 0.09$). In contrast, Latina/o adolescents only accounted for 10% of adolescents whose parents had a STEM degree/occupation, but 21% of those without a parent STEM degree/occupation ($\chi^2 = 270.97$, $p < .001$, $d = 0.30$). Black adolescents comprised 8% and 12% of those with and without a parent STEM degree/occupation, respectively ($\chi^2 = 36.07$, $p < .001$, $d = 0.11$).

In addition to differences in racial/ethnic representation, families with and without a parent STEM degree/occupation also differed on the STEM indicators of interest in the current study. As expected, parents who had a STEM degree/occupation provided more types of STEM support than parents without a STEM degree/occupation ($t = 16.76$, $p < .001$, $d = 0.31$). Specifically, parents with a STEM degree/occupation on average provided 4.20 types of STEM support, which was about 0.5 higher compared with parents without a STEM degree/occupation who provided 3.68 types of STEM support (out of seven possible types of support). Also as expected, adolescents whose parent had a STEM degree/occupation reported higher STEM motivational beliefs compared to adolescents whose parents did not have a STEM degree/occupation ($t = 0.43$–17.79, $p < .001$, $d = 0.14$–0.33). Specifically, adolescents whose parents had a STEM degree/occupation had STEM motivational beliefs that ranged from 2.65 to 3.24 (on a 1–4 scale), which was about 0.2 units higher compared with adolescents whose parents did not have a STEM degree/occupation and had STEM motivational beliefs that ranged from 2.42 to 3.15.

Lastly, we tested the differences on all covariates and demographic indicators across families with and without a parent STEM degree/occupation. Parents who had a STEM degree/occupation were much more likely to have a Bachelor's degree ($\chi^2 = 2216.65$, $p < .001$, $d = 0.76$; 72% compared to 32% for parents with and without a STEM degree/occupation, respectively) and report higher family incomes ($t = 40.05$, $p < .001$, $d = 0.74$) than parents without a STEM degree/occupation. Relatedly, parents who had a STEM degree/occupation on average were more likely to provide general educational (i.e., non-STEM-specific) support than parents without STEM degree/occupation ($\chi^2 = 131.20$, 37.69, $p < .001$, $d = 0.21$, 0.11, respectively, for providing financial support for college and communication with school about adolescents' college plan). Adolescents whose parents had a STEM degree/occupation on average had higher math achievement in ninth grade ($t = 29.89$, $p < .001$, $d = 0.55$), were more likely to take an advanced math class in eighth grade ($\chi^2 = 378.05$, $p < .001$, $d = 0.33$), and were more likely to attend a private school ($\chi^2 = 154.27$, $p < .001$, $d = 0.87$) compared with adolescents whose parents did not have a STEM degree/occupation. Adolescents whose parents had a STEM degree/occupation did not differ on gender from those whose parents did not have a STEM degree/occupation ($\chi^2 = 0.80$, ns, $d = 0.02$).

These results demonstrate the numerous differences between families with and without a parent STEM degree/occupation (see Table 1 for the means and standard errors breakdown by the two groups), which supported our reasoning to examine these family environments separately instead of in the same model. In the next section, we summarize our findings concerning the associations between parent STEM support and adolescent STEM motivational beliefs separately for those two groups.

4.2 | Associations between parent STEM support and adolescent STEM motivational beliefs

The within-group analyses suggested that parent STEM support typically positively predicted adolescents' STEM motivational beliefs for Asian, Latina/o, and White adolescents whose parents did *not* have a STEM degree/occupation, but not among adolescents whose parents had a STEM degree/occupation. As shown in Table 2 (also Figure 1), parent support predicted adolescents' STEM expectancy beliefs for Asian, Latina/o, and White adolescents whose parents did not have STEM degree/occupation, even after controlling for parents' general educational support, adolescent's prior math achievement, and other demographic indicators. Specifically, one additional parent STEM support type corresponded to 0.07, 0.05, and 0.03 (on a 4-point scale) greater STEM expectancy beliefs for Asian, Latina/o, and White adolescents, respectively. This association was not significant for Black adolescents whose parents did not have a STEM degree/occupation ($B = 0.01$, ns). Additionally, for families with parents STEM degree/occupation, parent support was not significantly associated with adolescents' expectancy-value beliefs for any racial/ethnic group ($B = -0.07$ to .07, ns).

TABLE 2 Parents' STEM (science, technology, engineering, mathematics) support predicting Asian, Black, Latina/o, and White adolescent's STEM expectancy beliefs, separately for parents without and with STEM degrees/occupations

	11th grade STEM outcome: STEM expectancy beliefs							
	Parents who did not have a STEM degree/occupation				Parents who had a STEM degree/occupation			
Predictors	Asian *B* (SE)	Black *B* (SE)	Latina/o *B* (SE)	White *B* (SE)	Asian *B* (SE)	Black *B* (SE)	Latina/o *B* (SE)	White *B* (SE)
Constant	2.68***	2.99***	2.69***	2.75***	3.06***	2.78***	3.03***	3.06***
	(0.15)	(0.10)	(0.08)	(0.05)	(0.25)	(0.32)	(0.26)	(0.10)
Main predictors								
Grade-9 parent STEM support	0.07*	0.01	0.05**	0.03**	0.07	0.01	−0.07	0.01
	(0.03)	(0.02)	(0.02)	(0.01)	(0.05)	(0.05)	(0.05)	(0.01)
Covariates								
9th grade parent financial support for college	−0.21	−0.03	−0.04	−0.07	−0.29	0.08	−0.15	−0.12**
	(0.12)	(0.12)	(0.07)	(0.04)	(0.13)	(0.17)	(0.16)	(0.07)
9th grade parent communication with school about college	0.01	−0.00	0.09	0.01	0.11	−0.07	0.11	−0.00
	(0.14)	(0.08)	(0.05)	(0.03)	(0.12)	(0.12)	(0.13)	(0.04)
Parent has a Bachelor's degree	0.01	−0.02	−0.20*	−0.07*	0.07	0.16	0.10	−0.06
	(0.11)	(0.09)	(0.09)	(0.04)	(0.18)	(0.14)	(0.16)	(0.05)
9th grade math achievement	0.02***	0.01	0.01**	0.02***	0.01	−0.00	0.02**	0.02***
	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)
8th grade math class is advanced	0.09	0.10	0.05	0.06	−0.25	0.03	0.05	0.10*
	(0.12)	(0.08)	(0.07)	(0.03)	(0.16)	(0.15)	(0.12)	(0.05)
Female	−0.32**	−0.18**	−0.19**	−0.15***	−0.20	−0.39**	0.17	−0.22***
	(0.10)	(0.06)	(0.06)	(0.03)	(0.11)	(0.12)	(0.12)	(0.04)
Family income	−0.05**	−0.05	0.01	0.01*	−0.00	−0.03	0.01	0.02*
	(0.02)	(0.03)	(0.02)	(0.01)	(0.02)	(0.03)	(0.02)	(0.01)
School type: private	0.25	0.16	0.09	0.06	−0.11	0.21	−0.44	0.04
	(0.16)	(0.11)	(0.10)	(0.04)	(0.20)	(0.13)	(0.26)	(0.05)

Note: Outcome was adolescents' STEM expectancy belief. Race/ethnicity-specific models were estimated for adolescents with and without parent STEM degree/occupation separately. Coefficients were unstandardized; cluster-adjusted standard error in parenthesis. Weight, primary sampling unit, and strata incorporated. Continuous covariates (ninth grade math achievement and family income) were lefted.

*$p < .05$; **$p < .01$; ***$p < .001$.

Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09), Base Year and First Follow-Up.

The associations concerning adolescents' STEM interest (Table 3) were similar in that parent STEM support was positively and significantly associated with STEM interest for Asian, Latina/o, and White adolescents whose parents did not have a STEM degree/occupation ($B = 0.05$–0.08, $p < .05$), but were not significantly related for Black adolescents whose parents did not have a STEM degree/occupation ($B = 0.01$, ns). Parent STEM support was also not significantly associated with adolescents' STEM interest for adolescents from any racial/ethnic group if their parents had a STEM degree/occupation ($B = -0.06$ to 0.05, ns).

The same pattern held for the associations between parent STEM support and adolescents' STEM utility value (Table 4). Specifically, one additional parent STEM support type corresponded to 0.08, 0.06, and 0.03 (on a 4-point scale) greater STEM utility value for Asian, Latina/o, and White adolescents (respectively) if their parent did not have a STEM degree/occupation. Parallel to the prior outcomes, parent support was not significantly associated with adolescents' STEM utility value for adolescents whose parents had STEM degree/occupation ($B = -0.00$ to 0.05, ns), nor was the association significant for Black adolescents whose parents did not have a STEM degree/occupation ($B = 0.02$, ns).

Lastly, parent STEM support predicted Latina/o and White adolescents' STEM attainment value for those whose parents did not have a STEM degree/occupation ($B = 0.06$, 0.03, $p < .01$; Table 5). Parent support, however, was not significantly

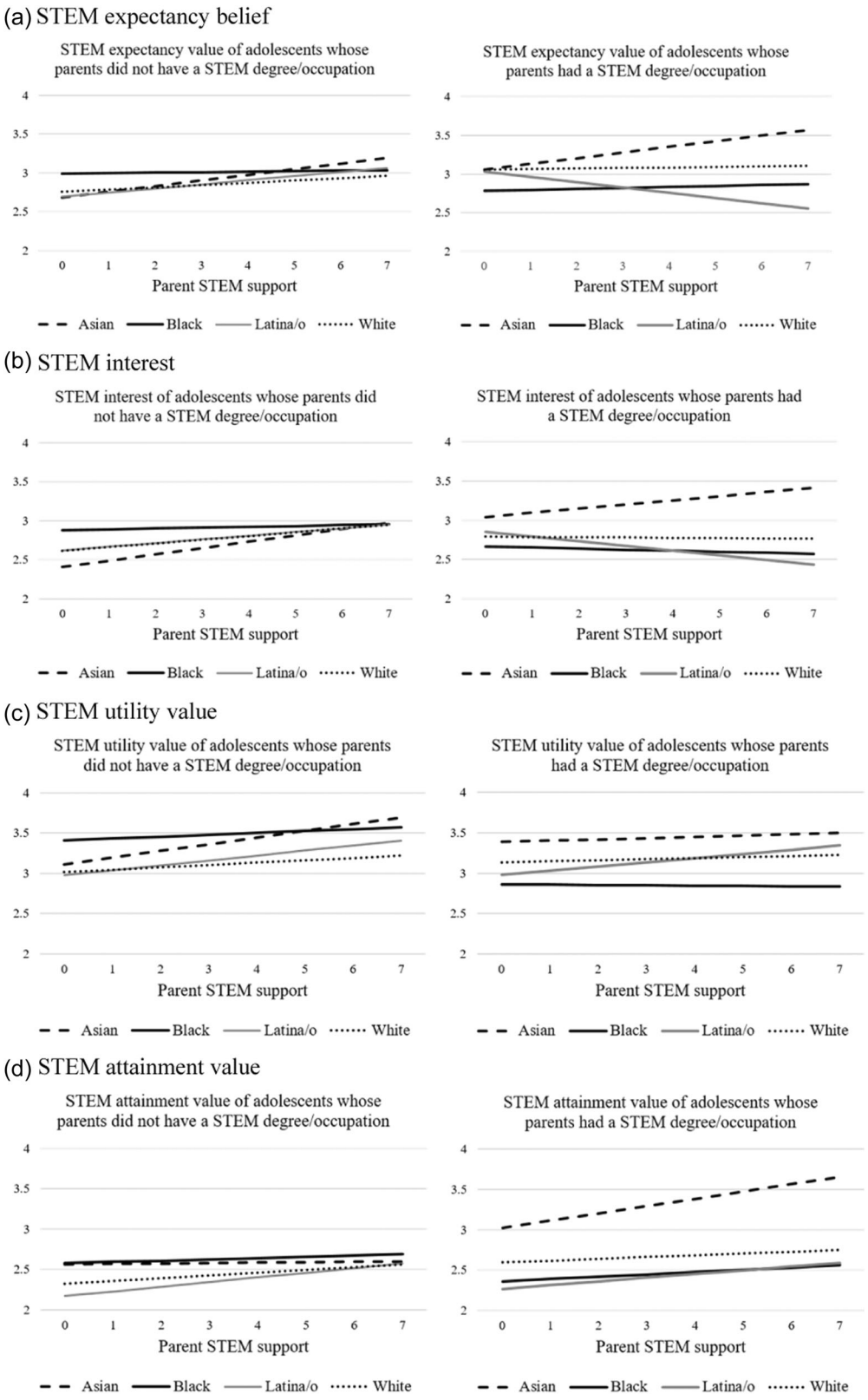

FIGURE 1 Separately for parents with and without STEM (science, technology, engineering, mathematics) degrees/occupations, parents' STEM support predicting Asian, Black, Latina/o, and White adolescent's STEM (a) expectancy belief, (b) interest, (c) utility value, and (d) attainment value.

TABLE 3 Parents' STEM (science, technology, engineering, mathematics) support predicting Asian, Black, Latina/o, and White adolescent's STEM interest, separately for parents without and with STEM degrees/occupations

	11th grade STEM outcome: STEM interest							
	Parents who did not have a STEM degree/occupation				Parents who had a STEM degree/occupation			
Predictors	**Asian** ***B*** **(SE)**	**Black** ***B*** **(SE)**	**Latina/o** ***B*** **(SE)**	**White** ***B*** **(SE)**	**Asian** ***B*** **(SE)**	**Black** ***B*** **(SE)**	**Latina/o** ***B*** **(SE)**	**White** ***B*** **(SE)**
Constant	2.40***	2.88***	2.62***	2.61***	3.04***	2.67***	2.85***	2.79***
	(0.22)	(0.17)	(0.11)	(0.05)	(0.17)	(0.25)	(0.18)	(0.09)
Main predictors								
9th grade parent	0.08*	0.01	0.05**	0.05***	0.05	−0.01	−0.06	−0.00
STEM support	(0.03)	(0.03)	(0.02)	(0.01)	(0.04)	(0.03)	(0.03)	(0.02)
Covariates								
9th grade parent financial support for college	−0.06	−0.03	−0.02	−0.04	−0.12	0.01	0.15	−0.02
	(0.17)	(0.16)	(0.09)	(0.05)	(0.13)	(0.18)	(0.12)	(0.09)
9th grade parent communication with school about college	0.16	0.02	0.00	−0.04	0.09	0.08	0.16	−0.00
	(0.17)	(0.09)	(0.07)	(0.03)	(0.14)	(0.12)	(0.12)	(0.05)
Parent has a Bachelor's degree	0.04	0.04	−0.18	−0.10**	−0.07	−0.03	−0.05	−0.11
	(0.16)	(0.13)	(0.13)	(0.04)	(0.12)	(0.12)	(0.11)	(0.06)
9th grade math achievement	0.03**	0.01	0.01	0.01***	0.01	0.00	0.01**	0.01***
	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)
8th grade math class is advanced	0.07	−0.07	0.10	0.01	−0.41*	−0.15	−0.09	0.17**
	(0.14)	(0.11)	(0.08)	(0.04)	(0.15)	(0.12)	(0.10)	(0.05)
Female	−0.26*	−0.05	−0.05**	0.01	−0.02	0.15	−0.02	0.05
	(0.12)	(0.09)	(0.07)	(0.03)	(0.13)	(0.10)	(0.11)	(0.05)
Family income	−0.06*	−0.04	−0.03	0.00	−0.01	−0.02	−0.03	0.02*
	(0.02)	(0.03)	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)
School type: private	0.22	0.10	0.16	0.03	−0.02	0.27*	−0.09	−0.03
	(0.17)	(0.11)	(0.10)	(0.05)	(0.19)	(0.12)	(0.19)	(0.05)

Note: Outcome was adolescents' STEM interest. Race/ethnicity-specific models were estimated for adolescents with and without parent STEM degree/occupation separately. Coefficients were unstandardized; cluster-adjusted standard error in parenthesis. Weight, primary sampling unit, and strata incorporated. Continuous covariates (ninth grade math achievement and family income) were lefted.

*$p < .05$; **$p < .01$; ***$p < .001$.

Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09), Base Year and First Follow-Up.

associated with adolescents' STEM attainment value for Asian and Black adolescents whose parents did not have a STEM degree/occupation ($B = 0.00$, 0.02, ns) nor for those whose parents had a STEM degree/occupation ($B = 0.02$–0.09, ns). In sum, parent STEM support was positively associated with adolescents' STEM motivational beliefs among Latina/o, Asian, and White families where parents did not have a STEM degree or occupation. These relations were not statistically significant among Black families or families of any race/ethnicity where at least one parent had a STEM degree or occupation.

5 | DISCUSSION

The United States struggles with unequal racial/ethnic representation in STEM, which is even more worrisome as STEM becomes increasingly central to our daily lives and advancements in the economy (Feinstein, 2011; National Science Foundation, 2019; Xue & Larson, 2015). For our first research goal, we examined how families with and without a parent

TABLE 4 Parents' STEM (science, technology, engineering, mathematics) support predicting Asian, Black, Latina/o, and White adolescent's STEM utility value, separately for parents without and with STEM degrees/occupations

	11th grade STEM outcome: STEM utility value							
	Parents who did not have a STEM degree/occupation				Parents who had a STEM degree/occupation			
Predictors	**Asian** ***B*** **(SE)**	**Black** ***B*** **(SE)**	**Latina/o** ***B*** **(SE)**	**White** ***B*** **(SE)**	**Asian** ***B*** **(SE)**	**Black** ***B*** **(SE)**	**Latina/o** ***B*** **(SE)**	**White** ***B*** **(SE)**
Constant	3.11***	3.41***	2.98***	3.01***	3.39***	2.86***	2.98***	3.13***
	(0.18)	(0.15)	(0.08)	(0.05)	(0.14)	(0.30)	(0.26)	(0.12)
Main predictors								
9th grade parent	0.08*	0.02	0.06**	0.03**	0.02	−0.00	0.05	0.01
STEM support	(0.03)	(0.02)	(0.02)	(0.01)	(0.03)	(0.04)	(0.04)	(0.01)
Covariates								
9th grade parent financial support for college	−0.08	−0.13	0.04	−0.05	−0.15*	0.14	0.04	0.06
	(0.17)	(0.10)	(0.06)	(0.04)	(0.08)	(0.22)	(0.17)	(0.07)
9th grade parent communication with school about college	−0.08	−0.03	−0.05	0.01	−0.02	0.00	0.22*	0.02
	(0.11)	(0.08)	(0.06)	(0.03)	(0.10)	(0.12)	(0.09)	(0.04)
Parent has a Bachelor's degree	−0.25*	−0.04	−0.09	−0.03	0.11	0.29	−0.20	−0.06
	(0.11)	(0.10)	(0.10)	(0.03)	(0.09)	(0.16)	(0.12)	(0.05)
9th grade math achievement	0.00	0.01*	0.01	0.01***	0.01	0.00	0.01*	0.01***
	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)
8th grade math class is advanced	−0.03	−0.06	−0.07	0.04	−0.11*	0.04	−0.01	0.06
	(0.12)	(0.08)	(0.06)	(0.03)	(0.12)	(0.13)	(0.12)	(0.04)
Female	−0.02*	−0.06	−0.03	0.00	0.08	0.08	0.02	−0.04
	(0.11)	(0.08)	(0.05)	(0.03)	(0.09)	(0.12)	(0.12)	(0.04)
Family income	−0.08***	−0.03	−0.02	−0.01	−0.02	−0.04	0.00	−0.00
	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)
School type: private	0.24	0.00	0.01	0.02	−0.22	0.13	−0.20	0.00
	(0.13)	(0.10)	(0.08)	(0.04)	(0.17)	(0.11)	(0.14)	(0.04)

Note: Outcome was adolescents' STEM utility value. Race/ethnicity-specific models were estimated for adolescents with and without parent STEM degree/occupation separately. Coefficients were unstandardized; cluster-adjusted standard error in parenthesis. Weight, primary sampling unit, and strata incorporated. Continuous covariates (ninth grade math achievement and family income) were lefted.

*$p < .05$; **$p < .01$; ***$p < .001$.

Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09), Base Year and First Follow-Up.

STEM degree/occupation differed in their racial/ethnic representation, level of parent STEM support, and adolescents' STEM motivational beliefs. Our results align with the persistent, unequal racial/ethnic representation among those who obtain STEM degrees and are employed in STEM fields (National Science Foundation, 2019), with disproportionally more Asian and White adolescents but disproportionally fewer Latina/o and Black adolescents having a parent who held a STEM degree/occupation. The gaps were largest for Asian and Latina/o adolescents. Next, we showed that parents who had a STEM degree/occupation provided more STEM support compared to parents without a STEM degree/occupation, which aligns not only with the parent socialization model (Eccles, 2005) but also with the literature on STEM capital (DeWitt et al., 2016). STEM capital (labeled "science capital" in the authors' original wording) pertains to individuals' knowledge, attitudes, experiences, and social connections to access assets that facilitate their advancement in STEM (DeWitt et al., 2016; Saw, 2020). Although parent STEM degree and occupation only represent two potential constituents of STEM capital, our findings support the notion that parents with more STEM capital provide more STEM support (DeWitt et al., 2016; Plasman et al., 2020). Lastly, our results further suggest that families with and without parent STEM degree/occupation differed on their next generation's

TABLE 5 Parents' STEM (science, technology, engineering, mathematics) support predicting Asian, Black, Latina/o, and White adolescent's STEM attainment value, separately for parents without and with STEM degrees/occupations

	11th grade STEM outcome: STEM attainment value							
	Parents who did not have a STEM degree/occupation				Parents who had a STEM degree/occupation			
Predictors	Asian *B* (SE)	Black *B* (SE)	Latina/o *B* (SE)	White *B* (SE)	Asian *B* (SE)	Black *B* (SE)	Latina/o *B* (SE)	White *B* (SE)
Constant	2.56***	2.58***	2.17***	2.32***	3.02***	2.36***	2.27***	2.59***
	(0.17)	(0.11)	(0.10)	(0.06)	(0.20)	(0.25)	(0.26)	(0.11)
Main predictors								
9th grade parent	0.00	0.02	0.06**	0.03**	0.09	0.03	0.05	0.02
STEM support	(0.04)	(0.02)	(0.02)	(0.01)	(0.05)	(0.05)	(0.04)	(0.02)
Covariates								
9th grade parent financial support for college	−0.22	0.01	0.04	−0.03	−0.44**	−0.23	−0.18	−0.13
	(0.15)	(0.13)	(0.06)	(0.05)	(0.13)	(0.21)	(0.21)	(0.08)
9th grade parent communication with school about college	0.14	0.04	0.10	0.03	0.06	0.00	0.03	0.05
	(0.16)	(0.09)	(0.05)	(0.03)	(0.17)	(0.15)	(0.17)	(0.05)
Parent has a Bachelor's degree	−0.11	−0.09	−0.02	−0.09*	0.13	0.15	0.13	0.02
	(0.15)	(0.09)	(0.10)	(0.04)	(0.16)	(0.23)	(0.15)	(0.06)
9th grade math achievement	0.04***	0.02***	0.02***	0.03***	0.01	0.00	0.03***	0.03***
	(0.01)	(0.00)	(0.05)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)
8th grade math class is advanced	0.03	0.28**	0.17**	0.13**	−0.32	−0.06	0.22	0.18***
	(0.17)	(0.08)	(0.06)	(0.04)	(0.19)	(0.19)	(0.14)	(0.05)
Female	−0.12	−0.35***	−0.19**	−0.12***	−0.27	0.09	0.10	−0.14**
	(0.11)	(0.08)	(0.06)	(0.03)	(0.15)	(0.17)	(0.16)	(0.04)
Family income	−0.07**	−0.04	−0.02	−0.00	0.00	−0.00	0.01	0.02*
	(0.02)	(0.03)	(0.02)	(0.01)	(0.02)	(0.03)	(0.02)	(0.01)
School type: private	0.19	0.21	−0.07	−0.03	−0.07	0.24	−0.36	−0.44
	(0.16)	(0.13)	(0.09)	(0.06)	(0.22)	(0.14)	(0.22)	(0.06)

Note: Outcome was adolescents' STEM attainment value. Race/ethnicity-specific models were estimated for adolescents with and without parent STEM degree/occupation separately. Coefficients were unstandardized; cluster-adjusted standard error in parenthesis. Weight, primary sampling unit, and strata incorporated. Continuous covariates (ninth grade math achievement and family income) were lefted.

*$p < .05$; **$p < .01$; ***$p < .001$.

Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09), Base Year and First Follow-Up.

STEM indicators, including their adolescents' 11th grade STEM motivational beliefs. Parent STEM degree/occupation also mapped onto differences among adolescents even earlier, including their math performance at the end of middle school and at beginning of high school. These intergenerational links align with situated expectancy-value theory (Eccles, 2011) and supports that some variation in adolescents' STEM motivational beliefs could be accounted for by their parents' STEM educational and occupational experiences.

Our second research goal was to examine the associations between parent STEM support and adolescents' STEM motivational beliefs among families with and without a parent STEM degree/occupation and, to test if those relations emerged for Asian, Black, Latina/o, and White adolescents. Prior literature on parent support has often controlled for parent education or occupation but not considered if parent support predicts adolescents' motivational beliefs in families with and without a parent STEM degree/occupation. We found that although the association between parent STEM support and adolescent STEM motivational beliefs was not significant for those whose parents had a STEM degree/occupation, parent STEM support positively predicted Asian, Latina/o, and White adolescents' STEM motivational beliefs for those whose parents did *not* have a STEM degree/occupation, even after including covariates such as adolescents' prior math achievement.

This is an encouraging takeaway that aligns with studies showing that parent support matters among families marginalized in STEM (McGee & Spencer, 2015; Plunkett & Bámaca-Gómez, 2003; Rozek et al., 2015; Soto-Lara & Simpkins, 2020). Thus, interventions promoting parent STEM support for traditionally marginalized groups (i.e., families without parent STEM degree/occupation) might help level the playing field for the next generation. This implication aligns with Harachiewicz and colleague's (2016) experimental study where an intervention that promoted college students' STEM value beliefs was most effective among those who were underrepresented in the fields. Our findings support the parent socialization model suggesting that parent/family characteristics map onto differences in socialization processes and youth outcomes, including their motivational beliefs (Eccles & Wigfield, 2020; Eccles, 2005). Further, these results also suggest that parent STEM support may be a tangible leverage point to help level playing field and counter barriers that marginalize some groups in STEM (namely, families without a parent STEM degree/occupation).

That said, these positive relations between parent STEM support and adolescents' STEM motivational beliefs did not emerge for Black adolescents regardless of parents' STEM degree/occupation. A possible explanation for these nonsignificant findings might be that Black adolescents face such profound structural barriers, stereotypes, and other microaggressions that overwhelmingly influence their STEM motivational beliefs above and beyond the influence of their parents' STEM support. This is not to say that parent STEM support is ineffective for Black adolescents—on the contrary, parents are often one of the biggest sources of support for Black students' STEM learning (e.g., McGee & Spencer, 2015). Rather, our finding should be interpreted to prompt attention to the structural factors that may render the association between parent STEM support and Black adolescents' STEM motivational beliefs nonsignificant. That is, future studies need to examine what structural barriers are in place to suppress the association between parent STEM support and adolescent STEM motivational beliefs that are otherwise significant for Asian, Latina/o, and White adolescents whose parents did not have a STEM degree/occupation.

Regarding the finding that parent STEM support did not significantly associate with adolescents' STEM motivational beliefs among families with a parent STEM degree/occupation, a possible explanation might be that the influence of parent STEM degree/occupation outweighed that of parent STEM support. Situated expectancy-value theory argues that parents' degrees and occupations are part of the cultural milieu that shapes the family environment and, in turn, adolescents' STEM motivational beliefs (Eccles, 2005; Eccles & Wigfield, 2020). It is possible that parents' degrees and occupations have a stronger influence on adolescents' STEM motivational beliefs than parents' support because parent degrees and occupations shape numerous developmental processes from parent–child interactions, parents' educational expectations, the home environment, out-of-school environments, and school selection (Davis-Kean, 2005; Eccles, 2005). In the current results, families where a parent had a STEM degree/occupation reported significantly higher incomes, parent education levels, and the likelihood of their adolescents attending private schools than families without parent STEM degree/occupation, all of which suggest parent STEM degree/occupation is a critical marker for differences in familial and school environments that have implications for adolescents' STEM motivational beliefs (e.g., Archer et al., 2013). To this end, a future direction is to better understand what contributes to the null associations between parent STEM support and adolescents' STEM motivational beliefs among those with parent STEM degree/occupation.

5.1 | Limitations and future directions

This study contributes to the body of literature on the importance of parents in shaping their adolescents' STEM motivational beliefs (e.g., Crowley et al., 2001; Harachiewicz et al., 2012; Simpkins et al., 2015). We focused on the affordances provided by parents, but other social agents such as teachers, mentors, and peers also provide STEM support to adolescents (Simpkins et al., 2019; Stanton-Salazar, 2011). For example, parents who had a STEM degree/occupation might hold STEM capital that allows easier and greater access to other STEM-enriching environments such as enrolling their children into classes with more experienced STEM teachers (Eccles, 2005). On the contrary, different socializers might provide STEM support that compensates each other. To disentangle this complexity and examine adolescents' exposure to STEM more holistically, future studies could examine how support from non-parent social agents is associated with adolescents' STEM motivational beliefs among families with and without a parent STEM degree/occupation.

The current study focuses on adolescence, which is a critical time for parent STEM support because adolescents' STEM motivational beliefs typically decline during this development stage (e.g., Alfaro & Umaña-Taylor, 2015; Jacobs et al., 2002), but parental influences on STEM are also evident earlier in development (e.g., Crowley et al., 2001; Simpkins et al., 2015). Even in the current findings, students' math performance at the end of middle school demonstrated differences among families with and without a parent STEM degree/occupation. Hence, an important future direction is to examine the relations between parent STEM support and children's STEM motivational beliefs among families with and without a parent STEM degree/occupation at earlier development stages. For example, parents' STEM support from those with a STEM degree/occupation might positively predict their children's STEM motivational beliefs earlier in development (e.g., Hyde et al., 2006).

Lastly, regarding our finding that parent STEM support generally predicted adolescents' STEM motivational beliefs among families without a parent STEM degree/occupation, but not among families with a parent STEM degree/occupation, a future direction is to understand with greater depth why that is the case. A more holistic operationalization of parent STEM support beyond our 7-item measure would be insightful, especially considering that our observed associations between parent STEM support and adolescent STEM motivational beliefs were small in size. For example, including adolescents' perception of parents' general STEM support might be valuable to complement the specific behavioral items. Relatedly, as we focused on differences in the quantity of the same types of parent STEM support in this study, a follow-up could be to examine how parents with and without STEM degree/occupations engage in qualitatively different types of STEM support. For example, how might parents rely on different practices or to what extent does their STEM degree/occupation, or lack of, shape the quality of their STEM support? We found that there were disproportionally more Black and Latina/o parents without a STEM degree/occupation, and prior studies (e.g., McGee & Spencer, 2015; Soto-Lara & Simpkins, 2020) further showed that Black and Latina/o parents support their children in math and science beyond traditional ways to overcome barriers and educational inequities. As such, one reason that we did not find relations between parent STEM support and adolescent motivational beliefs for Black families could be that the current parent support measures failed to capture the types of STEM support that matter most for Black adolescents. So, how do qualitatively different parent STEM support practices evolve for each racial/ethnic group, and to what extent are those related to parent STEM degrees/occupations? Qualitatively understanding how the very makeup of parent STEM support varies by parent STEM degree/occupation might help us understand why we found a significant association between parent STEM support and adolescents' STEM motivational beliefs for families without, but not with, parent STEM degrees/occupations.

6 | CONCLUSION

Our study addressed the associations between parents' STEM degrees/occupations and STEM support, and the potential intergenerational continuity of STEM racial/ethnic disparities. The findings showed that Black and Latina/o adolescents were overrepresented, whereas Asian and White adolescents were underrepresented among those whose parents did not have a STEM degree/occupation. This group on average reported lower parent STEM support and adolescent motivational beliefs than those whose parents had a STEM degree/occupation. Nonetheless, parent STEM support positively predicted Asian, Latina/o, and White adolescents' STEM motivational beliefs among the those without a parent STEM degree/occupation, but not among those with a parent STEM degree/occupation.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from National Center for Education Statistics (NCES). Restrictions apply to the availability of these data, which were used under license for this study. Data are available from https://nces.ed.gov/surveys/hsls09/hsls09_data.asp with the permission of the National Center for Education Statistics (NCES).

ETHICS APPROVAL STATEMENT

The use of data for the current study was approved by the Institutional Review Board at the University of California, Irvine (IRB protocol number: HS#:2018-4349).

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APPENDIX A

Table A1.

TABLE A1 Analysis versus excluded sample

	Analysis sample (n = 14,200)		Excluded sample (n = 11,010)				
	Mean	SD	Mean	SD	t Statistics	χ^2	Cohen's d effect size
11th grade STEM motivational beliefs							
Expectancy belief	2.81	0.58	2.76	0.59	6.08***	-	0.09
Interest	2.76	0.59	2.72	0.59	4.81***	-	0.07
Utility value	3.18	0.52	3.15	0.53	3.49***	-	0.05
Attainment value	2.49	0.70	2.40	0.68	9.38***	-	0.14
9th grade parent STEM support	3.85	1.63	3.78	1.63	1.67	-	0.04
Parent STEM degree/occupation	0.31	0.46	0.06	0.23	-	2538.52***	0.64
Asian	0.08	0.28	0.08	0.28		0.11	0.00
Black	0.11	0.31	0.10	0.31		0.00	0.00
Latina/o	0.17	0.38	0.14	0.35		59.52***	0.10
White	0.64	0.48	0.29	0.45	-	3339.55***	0.73
Covariates							
9th grade parent financial support for college	0.81	0.39	0.78	0.41	-	7.69**	0.04
9th grade parent communication with school about college	0.44	0.50	0.43	0.49	-	1.48	0.02
Parent has a bachelor's degree	0.44	0.50	0.10	0.29	-	4048.92***	0.81
9th grade math achievement	52.28	10.02	48.82	9.80	24.08***	-	0.35
8th grade math class is advanced	0.42	0.49	0.32	0.46	-	212.63***	0.19
Female	0.50	0.50	0.47	0.50	-	13.52***	0.05
Family income	4.71	3.09	4.22	2.80	7.69***	-	0.16
School type: private	0.20	0.40	0.15	0.36	-	117.89***	0.14

Note: Conventions for Cohen's d 0.20 small, 0.50 medium, 0.80 large. t Statistics calculated for continuous outcome while χ^2 calculated for binary outcomes; - denotes not applicable.

**$p < .01$; ***$p < .001$.

Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09), Base Year and First Follow-Up.

APPENDIX B

Items for 11th grade STEM motivational beliefs (all on a 4-point Likert scale: 1 = *strongly disagree*, 4 = *strongly agree*)

STEM expectancy belief

- You are confident that you can do an excellent job on math tests.
- You are confident that you can do an excellent job on science tests.
- You are certain that you can master math skills.
- You are certain that you can master science skills.
- You are confident that you can do an excellent job on math assignments.
- You are confident that you can do an excellent job on science assignments.
- You are certain that you can understand the most difficult material presented in math textbooks.

- You are certain that you can understand the most difficult material presented in science textbooks.

STEM interest

- You enjoy math classes very much.
- You enjoy science classes very much.
- You think math classes are a waste of your time.
- You think science classes are a waste of your time.
- You think math classes are boring.
- You think science classes are boring.

STEM utility value

- Math is useful for everyday life.
- Science is useful for everyday life.
- Math is useful for college.
- Science is useful for college.
- Math is useful for a future career.
- Science is useful for a future career.

STEM attainment value

- You see yourself as a math person.
- You see yourself as a science person.
- Others see you as a math person.
- Others see you as a science person.

APPENDIX C

Table C1.

TABLE C1 Bivariate correlations of main variables among families with parent STEM degree/occupation (above the diagonal) and among families without parent STEM degree/occupation (below the diagonal)

		1	2	3	4	5	6	7	8	9
1.	11th grade STEM expectancy belief	1	.55***	.44***	.59***	.10***	.08***	−.06***	.00	−.03
2.	11th grade STEM interest	.55***	1	.48***	.51***	.12***	.09***	−.00	−.03	−.05**
3.	11th grade STEM utility value	.43***	.48***	1	.55***	.09***	.12***	−.02	−.01	−.08***
4.	11th grade STEM attainment value	.57***	.50***	.50***	1	.15***	.16***	−.07***	−.07***	−.04*
5.	9th grade parent STEM support	.11***	.10***	.11***	.13***	1	−.00	−.02	.01	.01
6.	Asian	.04***	.06***	.08***	.08***	−.04***	1	−.14***	−.12***	−.62***
7.	Latina/o	−.02*	.04***	.00	−.04***	−.07***	−.11***	1	−.09***	−.46***
8.	Black	.05***	.04***	.07***	-.01	−.01	−.08***	−.16***	1	−.41***
9.	White	−.03**	−.08***	−.09	.00	.07***	−.32***	−.68***	−.46***	1

Note: Families with parent STEM degree/occupation ($n = 4160$) are above the diagonal, families without parent STEM degree/occupation ($n = 9830$) are below the diagonal. Missing data imputed with multiple imputations.

*$p < .05$; **$p < .01$; ***$p < .001$.

Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09), Base Year and First Follow-Up.