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Institute of Education Sciences

EVALUATION BRIEF
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Do charter middle schools improve students' college outcomes?

The charter school sector plays an important role in efforts to reform the education system and better serve the nation's public school students. To help understand this role, more than a decade ago the National Evaluation of Charter Middle Schools examined how admission to about 30 charter middle schools affected students' achievement. On average, there were no significant effects. However, some charter middle schools in the study were successful in improving achievement, including those in urban areas and serving economically disadvantaged students – features of many charter schools today. This brief examines if the charter middle schools included in the National Evaluation affected students' college enrollment and completion and the relationship between each school's earlier achievement results and these important longer-term outcomes.

Key findings include:

- *Being admitted to a charter middle school in the study did not affect students' chances of enrolling in or completing college.*
- *Individual charter middle schools' success in improving students' middle school achievement was not related to their success in improving students' college enrollment and completion.*

Charter schools have played a key role in efforts to reform the public education system in the United States since the first ones opened in Minnesota in 1992. Charter schools are publicly financed, like traditional public schools, but are not governed by many of the same regulations such as those involving staffing, curriculum, and budget decisions. The charter school sector has grown substantially since 1992 and, as of the 2015–2016 school year, nearly 7,000 charter schools served about 2.8 million students across the United States (National Center for Education Statistics, 2018).[1]

Given the number of students served by public charter schools, it is important for policymakers and parents to understand whether they are a good alternative to traditional public schools. This includes knowing whether they improve students' outcomes in the short term (e.g., their effect on student achievement or academic learning). It also includes knowing whether they improve longer-term outcomes like college enrollment and completion, which are linked with students' later career and earnings success (Deming, Yuchtman, Abulafi, Goldin, & Katz, 2016; Jepsen, Troske, & Coomes, 2014; Zimmerman, 2014).

What is known about charter school effects on achievement and college outcomes?

Most research studies that examine groups of charter schools, including both urban and non-urban charter schools, suggest that, on average, students who attend charter schools perform academically about as well as, but no better than, students at nearby traditional public schools (for

example, Center for Research on Educational Outcomes, 2013; Furgeson et al, 2012; Gleason, Clark, Tuttle, & Dwoyer, 2010; Zimmer, Gill, Booker, Lavertu, & Witte, 2012).[2] However, these effects on academic achievement can vary widely, depending on the groups of students served, the educational approaches used by the charter schools, and the nearby traditional public schools the students would otherwise have attended. Specifically, the most successful charter schools are those located in urban areas and those that serve large numbers of disadvantaged students (see Angrist, Pathak, and Walters, 2013, and Gleason et al., 2010).

Less is known about how charter schools affect students in the long run, and the few studies that have been conducted tell a mixed story. Some studies suggest attending charter schools does not affect students' chances of enrolling in college (e.g., Angrist, Cohodes, Dynarski, Pathak, & Walters, 2016; Dobbie & Fryer, 2015), while others suggest attending charter schools does improve college outcomes (e.g., Sass, Zimmer, Gill, & Booker, 2016). Moreover, some evidence hints that the charter schools that improve students' achievement in the short term are not necessarily the same ones that improve students' educational attainment in the long term (see Dobbie and Fryer, 2015, and Sass et al., 2016).[3]

To provide additional evidence on how charter schools affect students' college enrollment and completion,[4] Mathematica Policy Research used data from its previous study of charter middle schools, conducted for the U.S. Department of Education's Institute of Education Sciences (IES), and collected new information on students' long-term outcomes.[5] This brief addresses two questions:

1. Does admission to a charter middle school affect students' college enrollment and completion?
2. Is charter middle schools' success in improving students' middle school achievement related to their success in improving students' college enrollment and completion?

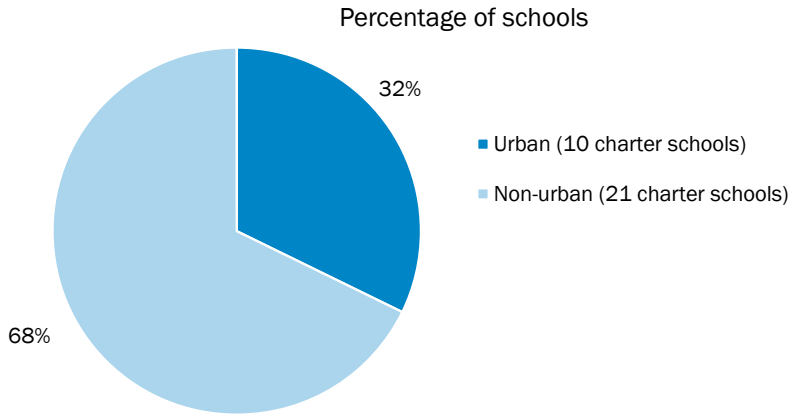
How was the study conducted?

The research team for the original IES study recruited 36 charter middle schools in 15 states that met the study requirements and agreed to participate.[6] For a charter school to participate in the study, it had to have more applicants than spots available and admit students by lottery, so that outcomes for lottery winners and losers could be compared. This limited the study sample to charter middle schools that were in relatively high demand (fewer than 18 percent of the 492 charter schools nationwide that were considered for this study) (Gleason et al., 2010, p. 6).

In other respects, the charter middle schools in the study were a diverse group. They were spread across every region of the United States (Gleason et al., 2010, p.7) and had the following characteristics:

- About one-third of participating schools (32 percent) were located in large urban areas, and the rest were in smaller cities, suburbs, or rural areas (Figure 1).
- The average study school had an enrollment of 387 students and had been operating for seven years (Gleason et al., 2010, pages 26-27).
- Most (55 percent) were low-poverty schools where less than one-quarter of students were eligible for free or reduced-price school meals. A minority (10 percent) had high poverty levels, with more than three-quarters of students eligible for free or reduced-price meals (Figure 2).
- About half of the schools (52 percent) had racially and ethnically diverse student populations. The other schools were less diverse, with mostly white (29 percent of schools) or mostly minority (19 percent of schools) student populations (Figure 2).

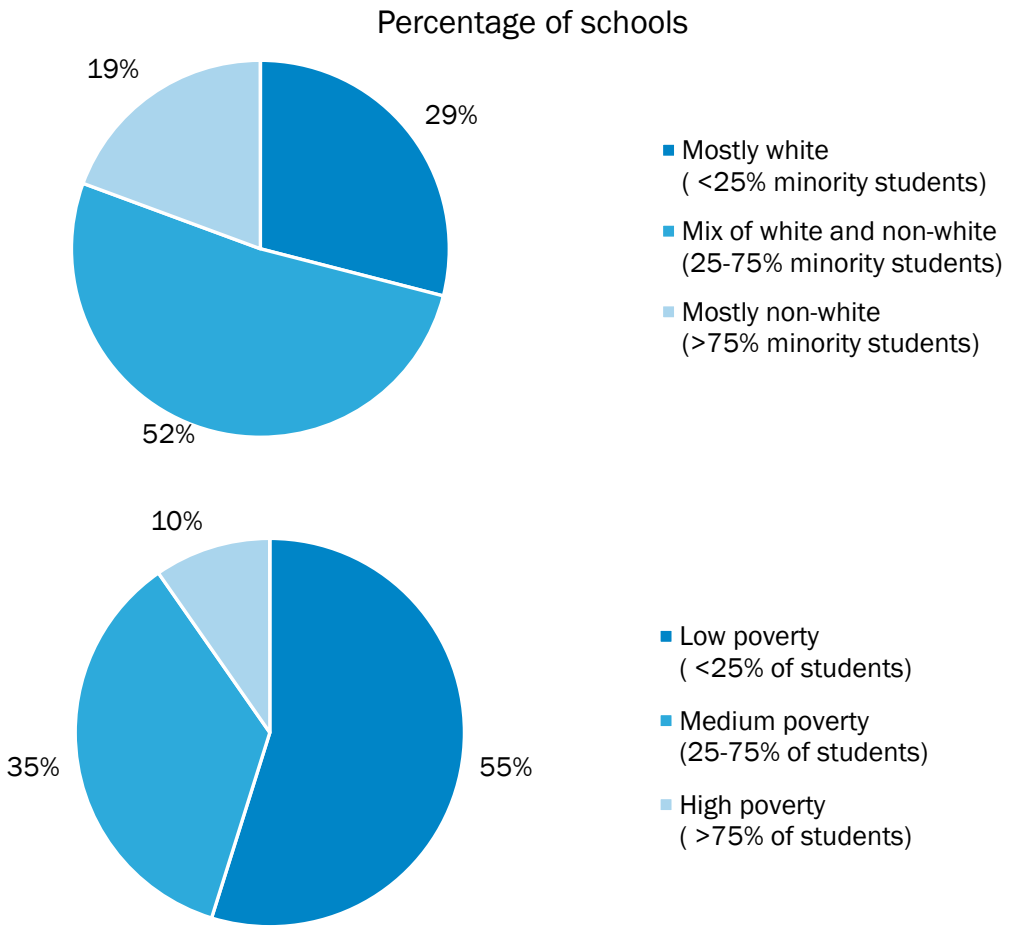
Figure 1. The study included a mix of urban and non-urban charter middle schools



Source: Common Core of Data.

Note: This figure represents the 31 charter middle school sites used in the main analysis. Most charter schools are their own site, but in five cases two charter schools were combined into a single charter school site (see Appendix A).

Figure 2. Study charter schools served diverse populations of students



Source: Data from principal surveys and administrative records, collected by Mathematica Policy Research.

Note: This figure represents the 31 charter middle school sites used in the main analysis.

A total of 2,904 students participated in the original study, including 1,744 lottery winners and 1,160 lottery losers. Of these, college data were obtained from the National Student Clearinghouse for 2,873 students (1,723 lottery winners and 1,150 lottery losers) who are used to examine the effect of admission[7] to charter middle schools in the study on college enrollment and completion.[8] The analysis comparing the impacts on college outcomes with the impacts on middle school achievement is limited to the smaller number of students who also had math and reading test scores available in the original study (1,295 lottery winners and 883 lottery losers) (See Appendix A, Figure A.1.). By December 2017, when college outcome data were obtained, most students in the original study (82 percent) would have had five or six academic years during which they could have enrolled in college, if they graduated from high school on a typical schedule (see Appendix A, Table A.3).[9] Data on student and school characteristics and student middle school math and reading test scores came from the original study (See Appendix A, Table A.5).

This update to the earlier study examined two primary college outcomes: (1) whether a student ever enrolled in any postsecondary institution, and (2) whether a student earned a degree (bachelor's, associate's, or certificate) or was still enrolled as of December 2017. To better understand the primary study results, this study also explored how admission to a charter middle school affected additional outcomes related to college enrollment and completion (see Table 1).

Table 1. Exploratory outcomes

Exploratory outcomes related to college enrollment	Exploratory outcomes related to college completion
Ever enrolled in postsecondary institution	**Graduated from postsecondary institution**
2-year college	Associate's degree (2-year college)
4-year college	Bachelor's degree (4-year college)
Type of institution where currently or most recently enrolled	Graduated with bachelor's degree within 4 years of projected high school graduation
Public	**Graduated or currently enrolled**
Private nonprofit	Graduated with associate's degree or currently enrolled in 2-year college
Private for-profit	Graduated with bachelor's degree or currently enrolled in 4-year college
Selectivity of postsecondary institution	**Number of years completed**
Highly selective (1–25% acceptance rate)	At 2-year college
Selective (26–50% acceptance rate)	At 4-year college
Somewhat selective (51–75% acceptance rate)	At any postsecondary institution
Less selective (76–100% acceptance rate)	
Dual enrollment participation	

Note: When comparisons between lottery winners and losers are made for a large number of outcomes, as proposed for the exploratory analysis, there is an increased likelihood of finding some effects – positive or negative – that are actually due to chance.

To measure the effects of admission to a charter middle school, the outcomes of lottery winners and losers were compared. Because lottery winners were selected at random, lottery winners and lottery losers were similar in all respects at the start of the study, on average, and any differences in their outcomes could be attributed to the effect of being admitted to a study charter school. If a larger percentage of lottery winners enrolled in college, for example, the results would indicate that admission to a charter middle school in the study increased students' college enrollment.[10] Because 22 percent of students who won the lottery opted not to attend the charter school that offered them admission, the study also estimated the effects of attending a charter middle school.[11]

Finding 1: Being admitted to a charter middle school did not affect students' college enrollment or completion

A key mission of most middle schools is to improve the educational success of students who enroll. If charter schools are better able than traditional public schools to meet this goal – through raising academic achievement or imparting other skills and behaviors that matter later – their students may enter high school better prepared to take higher-level classes, study hard, and have higher expectations for themselves. These students may, in turn, graduate high school better prepared for college. By shifting the educational trajectory of these students early on, charter middle schools could set them on a path to higher rates of college enrollment and completion, regardless of where they attended high school. The study investigated this hypothesis.

One indicator of a charter school's long-term success is whether its former students enroll in college. However, many students who enroll in college never complete the programs they enter. For instance, nationally, only 29 percent who entered two-year colleges in 2012 had graduated with an associate's degree within three years, and only 59 percent who enrolled in four-year colleges in 2009 had graduated with a bachelor's degree within six years (McFarland et al., 2017). Charter schools may be more (or less) likely to give students the kinds of skills that allow them to persist in and complete their college program. Therefore, the study also examined whether charter middle schools affected students' chances of earning a degree (bachelor's degree, associate's degree, or certificate).[12]

Being offered admission to or attending a charter middle school did not affect students' chances of enrolling in college. On average, 69 percent of both lottery winners and lottery losers enrolled in some type of college during the study period (Figure 3). This was the rate of college enrollment among 2015 high school graduates nationally (McFarland et al., 2017).[13] There was also no effect from attending a charter middle school (rather than just being offered admission) on college enrollment. (Detailed results can be found in Appendix B, Table B.1.)

These findings could mask other types of enrollment-related effects that could have consequences for students. For example, if charter schools create higher expectations for students than traditional public schools, students admitted to charter schools may be more likely to attend four-year rather than two-year colleges (Angrist et al., 2016, and Dobbie and Fryer, 2015), less likely to attend private for-profit institutions, and more likely to attend more selective colleges.

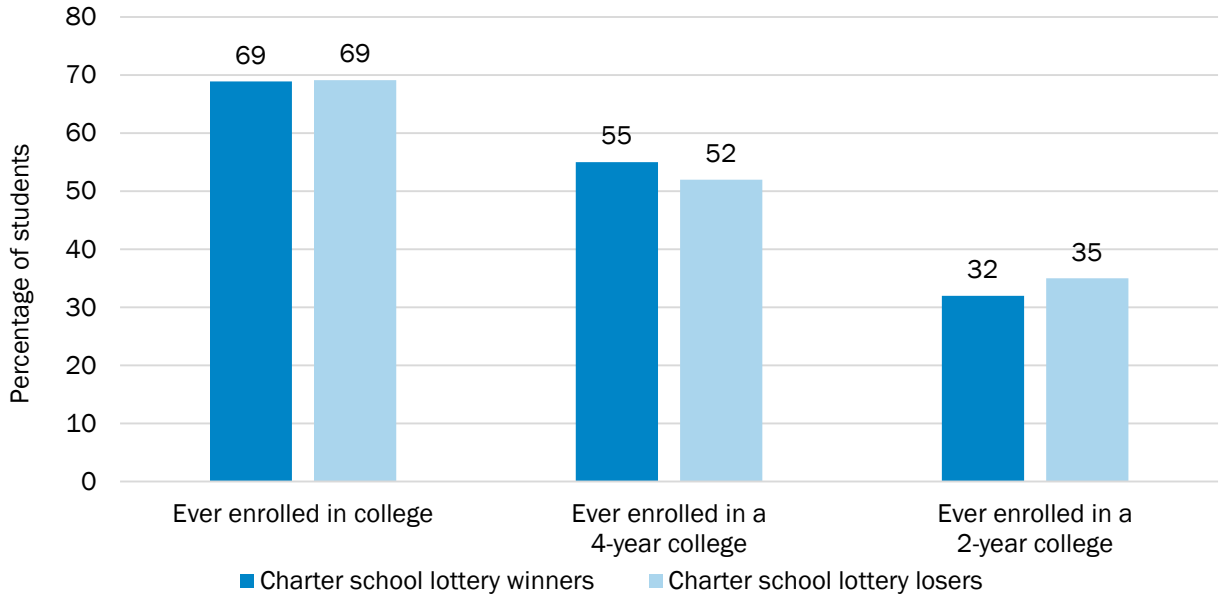
However, the study did not find evidence that being offered admission to or attending a charter middle school in the study affected the types of colleges students attended:

- Students offered admission to charter middle schools in the study were about as likely to attend four-year institutions and two-year institutions as those not offered admission (see Figure 3).[14] There were also no effects on the number of years that students attended college, either overall or in four-year versus two-year schools.
- There was no difference between lottery winners and losers in enrollment at public, private nonprofit, or private for-profit colleges. Among lottery winners, 55 percent enrolled in a public college, 13 percent in a private nonprofit college, and 1 percent in a private for-profit college. Lottery losers enrolled in these types of colleges at similar rates: 54 percent enrolled in a public college, 14 percent in a private nonprofit college, and 1 percent in a private for-profit college.
- Being offered admission to a charter middle school in the study did not affect the selectivity of colleges that students attended. For example, 16 percent of lottery winners and 15 percent

of lottery losers attended highly selective (1 to 25 percent acceptance rate) or selective (26 to 50 percent acceptance rate) colleges.[15]

- Students offered admission to a charter middle school were no more or less likely to earn college credit while in high school (commonly known as "dual enrollment"), which studies suggest may lead to higher rates of college enrollment (An, 2013; U.S. Department of Education, 2017b). About 9 percent of students offered admission earned college credits while in high school compared to 10 percent of those who were not offered admission.[16]

Figure 3. Admission to a study charter school did not affect students' college enrollment

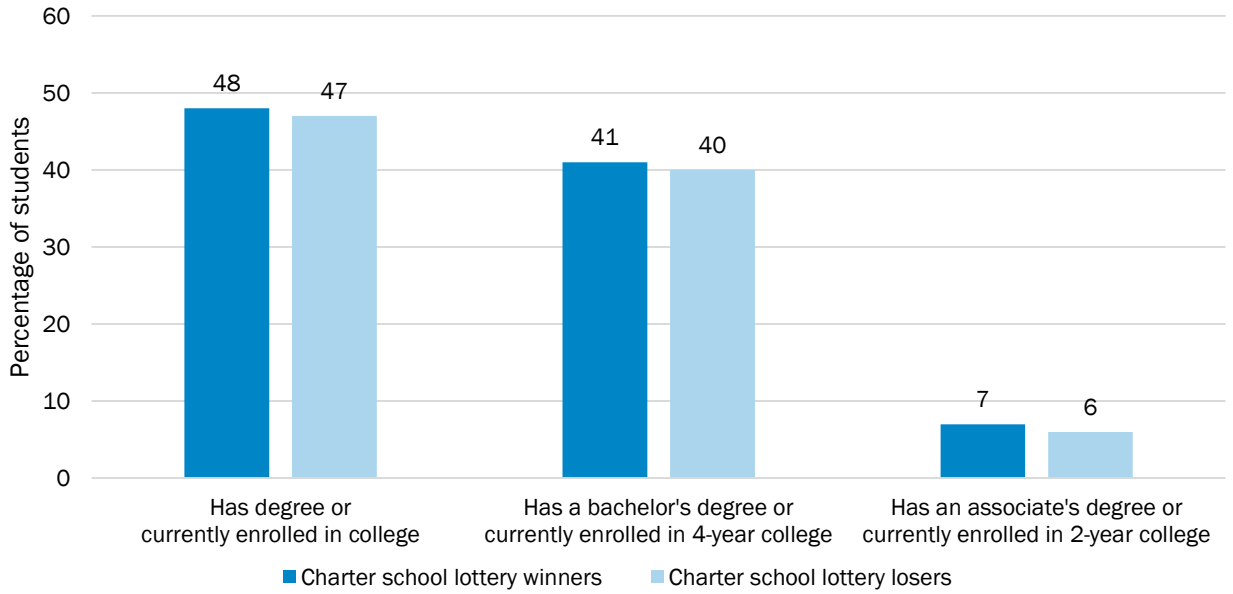


Note: The percentages reported include 2,873 students, 99 percent of the 2,904 students in the original study. In both the lottery winner and lottery loser groups, 3 percent of students who attended a postsecondary institution opted out of sharing their data. (The National Student Clearinghouse [NSC] reports a count of the number of students in each data request file who are found in NSC records but who opted out of sharing data.) The study team had no way to know whether individual students opted out of sharing data or were never enrolled in a postsecondary institution. Therefore, for both the lottery winners and lottery users, this figure underestimates overall enrollment by approximately 3 percentage points, but the estimated difference between the two groups was not affected. The percentages were generated from the study's regression model, as described in Appendix A. The percentages represent the average across all 31 charter school sites in the study. Each site estimate was based on a weighted analysis where the weight reflected each student's probability of assignment to the lottery winner or lottery loser group.

The differences between lottery winners and lottery losers are not statistically significant at the .05 level, two-tailed test. The estimated shift from enrollment in two-year to enrollment in four-year colleges is not significantly different from zero at the .05 level, two-tailed test, but is significant at the 0.10 level ($p = 0.097$).

Being offered admission to a charter middle school did not affect students' chances of obtaining a degree or still being enrolled in college at the end of the study period. On average, 48 percent of lottery winners and 47 percent of lottery losers had a degree or were still enrolled as of December 2017 (Figure 4). *Attending* a charter middle school in the study also did not affect students' chances of obtaining a degree or continuing to be enrolled in college. Similar percentages of lottery winners and lottery losers had obtained two-year associate's degrees and four-year bachelor's degrees, or were still enrolled, by the end of the study period (see Figure 4). No differences were found for other exploratory outcomes related to college completion. Detailed results for college completion outcomes can be found in Appendix B, Table B.1.

Figure 4. Admission to a study charter school did not affect students' college completion



Note: This analysis includes 2,873 students, 99 percent of the 2,904 students in the original study. In both the lottery winner and lottery loser groups, 3 percent of students who attended a postsecondary institution opted out of sharing their data. (The National Student Clearinghouse [NSC] reports a count of the number of students in each data request file who are found in NSC records but who opted out of sharing data.) The study team had no way to know whether individual students opted out of sharing data or were never enrolled in a postsecondary institution. Therefore, for both the lottery winners and lottery users, this figure underestimates overall enrollment by approximately 3 percentage points, but the estimated difference between the two groups was not affected. The percentages were generated from the study's regression model, as described in Appendix A. The percentages represent the average across all 31 charter school sites in the study. Each site estimate was based on a weighted analysis, where the weight reflected each student's probability of assignment to the lottery winner or lottery loser group.

For the ever-enrolled outcomes, students may be represented in both categories (both four-year and two-year colleges) if they attended both a two-year and a four-year college at some point between 2009 and 2017. For the completion outcomes, students who had obtained an associate's degree were not included in the two-year outcome if they later obtained a bachelor's degree.

There was no evidence that being offered admission to a charter middle school in the study had different effects on college enrollment or completion for students with different characteristics, such as their economic backgrounds, race/ethnicities, or prior achievement levels. It is important to understand whether charter schools could help reduce differential rates of college enrollment and improve college outcomes for students who are from racial or ethnic subgroups, are from lower socioeconomic backgrounds, or have lower baseline (pre-lottery) achievement scores. For each of these groups of students, the pattern of findings was similar to the pattern of findings for all students in the study, as described above (see Appendix B, Tables B.2 and B.3).

Finding 2: Individual charter middle schools' effects on college enrollment and completion were not related to their effects on students' middle school achievement

Attending and completing college has long been considered a gateway to career advancement and higher earnings, with academic achievement in pre-college grades a stepping stone along this path (Card, 1999; Chetty, Friedman, Saez, Turner, & Yagan, 2017). If academic achievement in middle school is critical to students' long-term success, we might expect that the individual schools that were most successful in improving students' middle school test scores would also be most successful in improving their long-term outcomes. However, if other factors or areas of student development are most important, this may not be the case. For example, students' experiences in high school, regardless of their middle school achievement, may be most important in determining long-term outcomes.

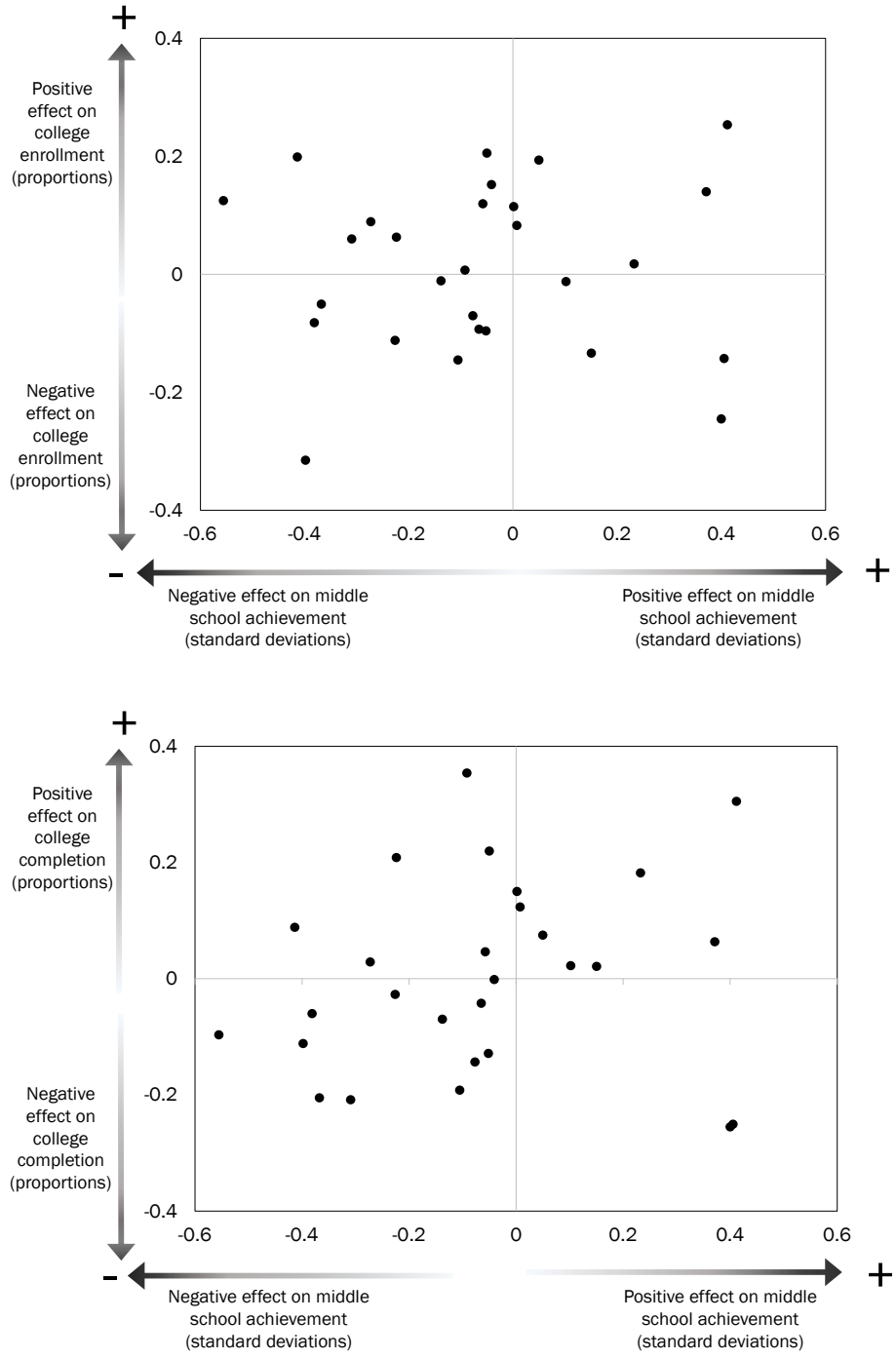
Federal and state policies promoting school improvement often presume a link between improving students' academic achievement and their later success in life, including in postsecondary education.[17] Yet several recent studies are beginning to question that assumption, as noted above. Therefore, this study explored the extent to which the short-term (achievement) and long-term (college) success of schools and students were related.

There was little evidence that a charter middle school's effects on middle school test scores were related to the school's effects on college enrollment and completion. Among charter schools in this study, for example, those in urban areas and those serving more disadvantaged students had more positive effects on students' middle school achievement (Gleason et al., 2010). However, these same subgroups of charter schools did not have more positive effects on students' long-term college outcomes (Appendix B, Table B.4 and Figures B.1 and B.2).

More generally, schools that were successful in improving middle school achievement were not consistently more successful than others in boosting students' college enrollment or completion (Figure 5). In the figure, each point represents one study charter school. This figure shows whether each study charter school had positive (or negative) effects on both middle school achievement and college enrollment (top graph) or completion (bottom graph), as well as how large or small those effects were. For example, a point in the top right quadrant represents a school where lottery winners had better outcomes than lottery losers on both middle school achievement and college enrollment (top) or college completion (bottom). In each case, the schools are scattered throughout the graph without any clear patterns, which indicates that there is not a consistent relationship between the effects that schools have on students' middle school achievement and college enrollment or between the effects on middle school achievement and college completion.

Looking across all charter middle schools in the study, there was no statistically significant relationship between how schools affected achievement and how they affected college outcomes (see Appendix B, Tables B.6 and B.8). For students in the study, middle school achievement was related to college outcomes, but the strength of that relationship was modest (see Appendix B, Tables B.5 and B.7). [18] These results suggest that factors other than middle school achievement may have been more influential in promoting college enrollment and completion among the students in this study. For example, students' motivation or persistence may have contributed to their success in college. Alternatively, the students' experiences in high school may have outweighed their middle school test scores in determining whether they entered and completed college.

Figure 5. Charter middle schools' effects on middle school test scores were not related to schools' effects on college enrollment and completion



Note: This figure shows whether each study school had positive (or negative) effects on middle school achievement and college enrollment/completion; that is, where lottery winners had better (or worse) outcomes than lottery losers. Each point represents one school. Students' middle school math and English language arts state test scores were standardized to allow for comparability across the 15 states represented in the study, and the middle school achievement effects are reported in standard deviations of student achievement. The college enrollment and completion effects are reported in proportions, which represents the fraction of the sample from each school who enrolled in college (top graph) and completed college (bottom graph). The sample includes the 1,919 students that had middle school test score data and postsecondary outcome data in 28 charter school sites.

Conclusion

There is little evidence that admission to the charter middle schools in this study affected students' college enrollment or completion, on average. This finding is similar to the earlier study of this same group of schools, which showed that they did not affect students' middle school achievement, on average (Gleason et al., 2010). However, although urban charters and those serving disadvantaged students positively affected their students' achievement in middle school, they were not equally successful in raising those students' enrollment in and completion of college. Nor did the negative impacts on middle school achievement found for non-urban charters and those serving more advantaged students lead to negative impacts on long-term college outcomes.

The study had a few important limitations. First, little is known about what happened to these students after middle school and before they had the chance to enter college, particularly whether students who attended the charter middle schools in the study also attended charter high schools. Because high schools may do more to directly prepare students for college than middle schools, students who attended both charter middle and charter high schools could have different college outcomes than students who returned to a traditional public school after middle school. A study on the long-term effects of charter high schools might show different results. Second, the study focused on charter middle schools that were operating in the 2005–2006 and 2006–2007 school years, and charter school practices that could influence students' long-term success might have changed since then. Finally, this study focused on a limited number of charter middle schools, and all of the schools in the study held admissions lotteries. The results might have been different if the study included a different or larger set of charter schools. This limitation is especially important in interpreting the findings related to groups of charter schools with similar characteristics (e.g., schools in urban areas).

The study's results point to the importance of learning more about how charter schools affect the long-term outcomes of their students. Increasingly, many policymakers and parents may care more about charter schools' effects on students' longer-term success in college and beyond than about interim indicators like test scores (U.S. Department of Education, 2017a).

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APPENDIX A: STUDY DESIGN AND ANALYTIC APPROACH

This appendix provides additional details on the study design and analytic approach used to estimate the effect of charter middle school admission on students' college enrollment and completion.[19]

Study design

The design for this study is based on the design of the original Institute of Education Sciences (IES) study of charter middle schools (Gleason et al., 2010), and much of the data analyzed in this study were collected as part of the original study. This section provides key information about the study design, including the schools and students in the study, the charter schools' admissions lotteries, data sources, analysis sample, and outcome measures. Additional details are provided in the original study report (Gleason et al., 2010).

Schools and students in the study

Characteristics of schools in the study. The team for the original IES study recruited charter middle schools from across the United States. A total of 36 charter middle schools in 15 states agreed to participate and met the following study requirements: (1) they had entry grades from grade 4 to grade 7, (2) they had been in operation for at least two years before the start of the study (allowing the study to focus on more established and stable schools), and (3) they had more students who applied for admission in the 2005–2006 and/or 2006–2007 school years than they could accommodate and used lotteries to randomly select students for admission.

Because of the participation requirements, charter middle schools in the study differed in some respects from the average charter middle school in operation in the United States at the time of the study. [20] On average, participating schools had been operating longer, and served higher socioeconomic status students, fewer minority students, and higher performing students than charters nationwide (Table A.1). However, the sample schools were similar to the average charter middle school in other ways, including enrollment and location. (See Gleason et al., 2010, pages 25–27, for additional details.)

Table A.1. Characteristics of study charter schools, compared to non-study charter schools

Outcome	(1) Study charter schools	(2) Other charter schools	(3) Difference
Years of operation (mean)	7.0	5.9	1.2*
Located in large urban area (percentage)	36	41	-4
Enrollment (mean)			
Total enrollment	387	298	90
Student-teacher ratio	14.6	16.7	-11
Student characteristics (percentage)			
Eligible for free or reduced-price meals	44	62	-18**
Scored proficient on state math assessment	66	51	15**
Belong to racial or ethnic minority	47	62	15*
Learning disability and/or IEP	12	12	0
Sample size—Characteristics based on principal survey or Common Core of Data	36	434	
Sample size—School test scores	36	380	

Source: Gleason et al. (2010), Table III.1, pages 26-27.

*Difference significantly different from zero at the .05 level, two-tailed test.

**Difference significantly different from zero at the .01 level, two-tailed test.

IEP = individualized education program.

Characteristics of students in the study. A total of 2,904 students applied for admission to one of the study charter middle schools, participated in the school's lottery, and provided parental consent to participate in the study. Students who were exempt from the lottery and automatically admitted to the school (including siblings of currently enrolled students and children of staff or board members) were not included in the study sample. (See Gleason et al., 2010, pages A-7 and A-8 for additional information.)

Most of the students who applied to the study charter middle schools met their state's proficiency standards for reading (71 percent) and math (66 percent) in the year that they participated in the lottery (Gleason et al., 2010). The student applicants were diverse: 53 percent were white, 13 percent were black, and 27 percent were Hispanic. In addition, one-third of the students qualified for free or reduced-price meals, 16 percent had an individualized education program (IEP), and 9 percent were English language learners or limited English proficient (Table A.2).

Charter school lotteries

The charter schools held their lotteries in the winter or spring before the 2005–2006 and 2006–2007 school years, and most lotteries were public events. After the lotteries were conducted and initial lottery winners were offered admission, study charter schools continued to admit applicants from a randomly ordered waiting list as space became available. Applicants who were offered admission to the school based on the initial lottery results or who were offered admission from the waiting list formed the "lottery winners" group. Those who participated in the lottery and were not offered admission immediately after the initial lottery or from the waiting list formed the "lottery losers" group.[21] Among the 2,904 students in the full sample, 1,744 were lottery winners and 1,160 were lottery losers.

To ensure that study schools conducted admissions lotteries and admitted students in ways consistent with the principles of random assignment, members of the original study team attended nearly all of these lotteries in person and monitored the wait lists (see Gleason et al., 2010, pages A-12 to A-15 for more detail about the lotteries). As expected with random assignment, the lottery winners and losers had similar characteristics at the time of the lotteries. Among the 50 characteristics examined, there were statistically significant differences between the two groups for only 5 of them. Only two of the significant differences were larger than 3 percentage points. For instance, lottery winners were less likely to have families who earned more than 300 percent of the poverty level and more likely to have attended public school at the time of the lottery than lottery losers (Table A.2).

The outcome of the lottery determined whether students in the study were offered admission to study charter schools, but did not guarantee that they would actually attend those schools. Conversely, some lottery losers might have ultimately attended study charter schools or some other charter schools. However, the majority of lottery winners attended charter schools, whereas most lottery losers attended traditional public schools. Of the lottery winners, 78 percent attended a study charter school. Of the lottery losers, 78 percent attended a traditional public school. Small proportions of students in each group attended non-study charter schools, private schools, or were home schooled (Gleason et al., 2010, page 20).

Table A.2. Characteristics of lottery winners and losers in the analysis, at the time of the lottery (baseline characteristics)

Outcome	(1) Mean, lottery winners and losers	(2) Mean, lottery winners	(3) Mean, lottery losers	(4) Difference
Reading achievement				
Baseline reading score (*z*-score units)	0.40	0.39	0.41	-0.02
Baseline reading proficiency (proportions)				
Advanced	0.26	0.25	0.26	-0.01
Proficient or higher	0.70	0.70	0.71	-0.02
Partially proficient or higher	0.92	0.91	0.92	-0.02
Pre-baseline reading score (*z*-score units)	0.44	0.46	0.41	0.06
Pre-baseline reading proficiency (proportions)				
Advanced	0.28	0.27	0.28	-0.01
Proficient or higher	0.69	0.66	0.71	-0.04~
Partially proficient or higher	0.91	0.90	0.93	-0.02
Math achievement				
Baseline math score (*z*-score units)	0.41	0.41	0.41	0.00
Baseline math proficiency (proportions)				
Advanced	0.29	0.30	0.29	0.01
Proficient or higher	0.66	0.67	0.65	0.02
Partially proficient or higher	0.89	0.89	0.88	0.00
Pre-baseline math score (*z*-score units)	0.42	0.48	0.36	0.12~
Pre-baseline math proficiency (proportions)				
Advanced	0.27	0.25	0.27	-0.02
Proficient or higher	0.64	0.63	0.65	-0.02
Partially proficient or higher	0.88	0.89	0.87	0.02
Disciplinary measures				
Number of days absent in baseline school year	6.24	6.20	6.23	-0.03
Student suspended in baseline school year (proportion)	0.04	0.04	0.04	0.00
Demographic characteristics				
White, non-Hispanic (proportion)	0.53	0.54	0.52	0.03
Black, non-Hispanic (proportion)	0.13	0.13	0.13	-0.01
Other race, non-Hispanic (proportion)	0.07	0.06	0.08	-0.02~
Hispanic (proportion)	0.27	0.27	0.27	0.00
Male (proportion)	0.47	0.47	0.47	0.00
Age at start of school year	11.46	11.48	11.44	0.04 ~
Young for grade (proportion)	0.01	0.01	0.02	-0.01
Old for grade (proportion)	0.10	0.10	0.09	0.01
IEP status (proportion)	0.16	0.17	0.16	0.01
Limited English proficiency/ELL (proportion)	0.09	0.10	0.07	0.02*
Family characteristics (proportions)				
Income-to-poverty ratio				
0 to 100 percent	0.13	0.14	0.11	0.03~
100 to 200 percent	0.20	0.21	0.19	0.02
200 to 300 percent	0.17	0.17	0.17	0.00
Greater than 300 percent	0.50	0.47	0.53	-0.05*
Two-parent family	0.77	0.77	0.78	-0.01
Not two-parent family, but more than one adult	0.04	0.05	0.04	0.01
English main language spoken at home	0.90	0.89	0.91	-0.01

Outcome	(1) Mean, lottery winners and losers	(2) Mean, lottery winners	(3) Mean, lottery losers	(4) Difference
Mother's education				
High school or less	0.24	0.25	0.24	0.01
Some college	0.33	0.33	0.34	0.00
College degree or more	0.42	0.42	0.43	-0.01
Born in United States	0.93	0.93	0.93	0.00
Received TANF or food stamps in past year	0.06	0.08	0.05	0.02*
Free or reduced-price meal-eligible	0.35	0.35	0.34	0.01
Number of children in household				
One	0.23	0.23	0.23	0.00
Two	0.46	0.46	0.45	0.01
Three or more	0.32	0.31	0.32	-0.01
Baseline school enrollment (proportions)				
Enrolled in charter school	0.05	0.04	0.07	-0.03*
Enrolled in private school	0.10	0.08	0.11	-0.03~
Enrolled in public school	0.83	0.86	0.81	0.05*
Home-schooled	0.01	0.02	0.01	0.01
School type unknown	0.03	0.02	0.03	-0.01
Changed schools midyear	0.01	0.01	0.01	0.00
Number of students	2,873	1,723	1,150	
Number of sites	31			

Note: Sample includes students in the brief's impact analysis sample presented in Finding 1.

Means are calculated at the charter school site level and averaged across all 31 sites. Sample sizes vary by characteristic because some students have missing data for some characteristics. The reported sample size is the maximum number of students. This table presents only non-missing data (no imputed values are included).

*Difference significantly different from zero at the .05 level, two-tailed test.

**Difference significantly different from zero at the .01 level, two-tailed test.

~Difference significantly different from zero at the .10 level, two-tailed test.

ELL = English language learner; IEP = individualized education program; TANF = Temporary Assistance for Needy Families.

Data sources

To measure how the charter middle schools in the study affected students' college enrollment and completion, and to examine the relationship between these charter schools' impacts on students' middle school achievement and educational attainment, the study relied on five data sources: (1) National Student Clearinghouse (NSC) records on college enrollment and completion, (2) the Integrated Postsecondary Education Data System (IPEDS), (3) students' middle school math and reading test scores and other administrative data, (4) a parent survey, (5) and a principal survey. Data from the last three sources were collected by the original study team. The data sources are summarized in Table A.5.

NSC data. Data on college outcomes were obtained for students in the study sample from the NSC. The NSC is an organization that collects data on enrollment and completion from participating colleges across the United States, which must report the following information for each student: first name, last name, date of birth, enrollment status, dates of attendance, whether the student graduated, and the date of graduation. The NSC data cover 97 percent of students enrolled in degree-granting institutions who are eligible to accept federal student aid (Dundar & Shapiro, 2016). As of 2016, participation rates were higher for some types of colleges than others: 99 percent of public colleges,

96 of nonprofit private colleges, and 87 percent of for-profit private colleges provided data to the NSC.

Names and birth dates for students in the original study sample were used to request data on their college enrollment and completion from the NSC and to match the two data sources. The NSC data spanned August 2009 to December 2017, by which point students in the study sample would have been out of high school for three to seven years if they had graduated on a typical schedule (Table A.3).

Table A.3. Projected year of high school graduation and number of years of potential college enrollment

Projected year of high school graduation	Potential years of college enrollment	Number of students (Cohort 1)	Number of students (Cohort 2)	Total number of students	Percentage of sample
2011	7	156	--	156	5%
2012	6	839	237	1,076	37%
2013	5	354	947	1,301	45%
2014	4	0	342	342	12%
2015	3	--	20	20	1%

Source: Data from Gleason et al. (2010).

Note: At the time of data collection, the most recent available college graduation data were from spring and summer 2017. The most recent available enrollment information was from fall of the 2017–2018 school year.

Because of the nature of the NSC data, some missing observations are expected. In particular, the NSC provides data on college outcomes only for students enrolled in participating colleges, so students in the study sample who did not attend college were absent from the NSC data. However, we cannot assume that all students missing from the data set did not attend college. A student could be missing from the NSC data set for one of four reasons:

1. The student did not attend college.
2. The student's name was incorrect in the original data set (or in the NSC data) or had changed, and there was no match.
3. The student opted out of sharing his or her data under the Family Educational Rights and Privacy Act (FERPA). This law permits students to request that their educational data not be shared. The NSC reports the number of students in the returned data set who are missing because they opted out of sharing their records, but it does not identify these students.
4. The student attended a college that does not provide data to the NSC (see above).

It was not possible to determine with certainty whether students were missing from the NSC data because they did not attend college, which relates directly to the outcomes of interest, or for one of the other three reasons. Because the NSC data excluded some students who did in fact enroll in college (false negative matches), it is likely that the percentage of students who completed college was underestimated. It is also possible that a study student who did not attend college was incorrectly matched in the NSC data to a student with the same name and birth date (false positive matches), although Dynarski et al. (2015) indicate that in the NSC data, false negatives are much more common than false positives.

Even if the occurrence of false negatives in the NSC data led to an underestimation of educational attainment in the sample, it did not necessarily lead to bias in the estimates of how charter middle

schools affected college outcomes. The key issue is whether the rate of occurrence of false negatives or false positives differed among the students admitted to charter middle schools (the lottery winners) versus those not admitted (the lottery losers). If these rates were the same for the two groups, the estimates would likely be unbiased. Several analyses were conducted to assess the potential influence that false positive and false negative matches could have on the estimates.

First, the study examined whether there might be systematic differences in student names between lottery winners and losers that might lead those in one group to be more likely to fail to match. In cases where a student had two last names or a nickname in the original data file, NSC data were requested for the same student under multiple name variations. Although it is impossible to directly assess whether the lottery winners and losers had the same rate of name errors, it is possible to assess whether the rate of multiple name requests was the same. There was no statistically significant difference between the two groups (Table A.4). In addition, these data were collected primarily from parents before the lottery each year, and therefore any errors in this information should have been evenly distributed between the lottery winners and lottery losers.

Next, the study assessed whether the proportion of students who opted not to share their data under FERPA differed between lottery winners and losers. The NSC indicated how many total student records in each group were found in the NSC database (in other words, attended college), but were withheld due to students opting out on the basis of FERPA. Three percent of students in both the lottery winner and lottery loser group files withheld their data, suggesting this was not a source of bias (Table A.4).

Finally, among the students in the returned NSC data set, the study examined the distribution of types of colleges that students from both groups attended. If one group of students was more likely than the other to attend a college that does not report data to the NSC, the estimates could be biased. For example, if lottery losers were more likely to attend private for-profit colleges, the rate of college enrollment and completion among the lottery loser group might be underreported because private for-profit colleges are less likely to report data to the NSC than other institutions. However, the two groups attended public colleges (55 percent), private nonprofit colleges (13 percent), and private for-profit colleges (1 percent) at the same rates (Table A.4). Because for-profit colleges have a lower coverage rate (87 percent) than other types of colleges (96–99 percent) in the NSC data, there could be a larger difference between the lottery winners and lottery losers than the data suggest. However, given that only 1 percent of the lottery winners and losers in the NSC data attended for-profit colleges, it is highly unlikely that either lottery winners' or lottery losers' attendance at the 13 percent of for-profit colleges that are not included in the NSC would lead to any change in the study conclusions.

Based on these analyses, there are no reasons to believe that the rates of false positives or false negatives differed systematically between the two groups. Therefore, the study team proceeded with the analyses without any adjustments to the NSC data.

Table A.4. Summary of postsecondary data requested and returned, by treatment group

Outcome	(1) Mean, full sample	(2) Mean, lottery winners	(3) Mean, lottery losers	(4) Difference
Institution type where currently or most recently enrolled (full sample)				
Public	0.55	0.55	0.54	0.01
Private nonprofit	0.13	0.13	0.14	-0.01
Private for-profit	0.01	0.01	0.01	0.00
Opted out of sharing data with the NSC[a]	0.03	0.03	0.03	-0.01
Name variations				
Multiple names requested (full sample)	0.06	0.07	0.06	0.01
Single name requested (sample of students ever enrolled in postsecondary institution)	0.94	0.93	0.93	0.00
Multiple names requested for student ever enrolled in postsecondary institution	0.06	0.07	0.07	0.00
Number of students	2,873	1,723	1,150	

Note: Means are estimated at the site level and then averaged across all 31 sites in the study. The individual site-level estimates are weighted according to each student's probability of assignment to the lottery winner or lottery loser group.

The estimates are not statistically significant at the .05 level, two-tailed test.

[a]The National Student Clearinghouse (NSC) reports a count of the number of students in the data request file who were found in NSC records but had opted out of sharing their data. The means presented in this table represent the raw proportion of the lottery winner or lottery loser group students in the data request who opted out and are not adjusted for selection probability or site. Because the data requests included some of the same students multiple times with different name variations, the number of students in these calculations is 3,177 (1,908 in the lottery winner group and 1,269 in the lottery loser group). All other means in this table are weighted according to selection probability and include 2,873 students (full analytic sample) or 2,020 students (those who ever enrolled in any postsecondary institution).

IPEDS data. IPEDS, a data center within the U.S. Department of Education's National Center for Education Statistics, includes information on U.S. colleges, universities, and technical and vocational institutions. All postsecondary institutions that receive federal financial aid are required to complete the IPEDS survey. The IPEDS data were used for information on the types of institutions attended by students in the study sample (public, private nonprofit, private for-profit) and on the selectivity of institutions. In the few cases when the type of institution was unavailable in the IPEDS data, the study team manually looked up that information on the college websites and coded the variables.

Student administrative records. The original study team collected data on reading and math test scores, attendance, and disciplinary incidents. They collected these records for the baseline (pre-lottery) years when students applied for charter school admission (2004–2005 for the study's first cohort and 2005–2006 for the second cohort), as well as during the study's first and second follow-up years for each cohort. The models that estimate the impacts of charter middle school admission and attendance account for students' baseline (pre-lottery) test scores, attendance, and suspensions. Test score data from the second follow-up years were used to estimate the study charter schools' impacts on student achievement, as well as to examine the relationship between impacts on achievement and impacts on students' college enrollment and completion.

Parent survey. Parents completed a survey when they applied for their children's admission to a study charter school in spring 2005 or spring 2006. The study used data from these surveys to

account for family demographic and socioeconomic information of students in the models that compared the college enrollment and completion outcomes of lottery winners and lottery losers.

Table A.5. Study data sources, measures, and sample

Data source	Key measures	Number (percentage) with valid data	Number (percentage) of lottery winners with valid data	Number (percentage) of lottery losers with valid data	Notes
Student data					
National Student Clearinghouse (NSC)	Ever enrolled in any postsecondary institution	2,873 (99.7)	1,723 (99.8)	1,150 (99.4)	Sample for graduation with bachelor's degree outcomes was restricted to students who were projected to graduate from high school in 2013 or earlier (n = 2,511)
	Earned a degree (bachelor's, associate's, or certificate) or still enrolled as of December 2017				
	Ever enrolled in two-year college versus four-year college				
	Number of years attended college during study period				
	Graduated with associate's versus bachelor's degree				
	Enrolled in college classes while still enrolled in high school				
Integrated Postsecondary Education Data System (IPEDS)	Selectivity of college attended	2,857 (99.1)	1,712 (99.2)	1,145 (99.0)	
IPEDS and NSC	Whether they attended a public, private nonprofit, or private for-profit college	2,873 (99.7)	1,723 (99.8)	1,150 (99.4)	When data were missing, information from institution websites was used to determine institution type.
Student administrative records[a]	Student scores on state assessments in math and reading	1,926 (88.1)	1,174 (90.5)	752 (84.6)	
Parent baseline survey	Family economic and socioeconomic characteristics	2,699 (93.7)	1,632 (94.6)	1,067 (92.3)	
Number of students		2,882	1,726	1,156	
Charter school data					
Principal survey and publicly available data on school characteristics	Percentage of students eligible for free or reduced-price meals	31 (100)			
	Race/ethnicity of student population	31 (100)			
	Mean baseline achievement of students	30 (96.8)			
Common Core of Data	Urbanicity of charter school	31 (100)			
Number of charter school sites		31			

[a]The percentages of valid second-year follow-up test scores are calculated out of a total of 2,187 (1,298 lottery winners and 889 lottery losers), the number of students in the 28 sites included in the impact estimates that had valid baseline (pre-lottery schools). These estimates were used for the correlational analyses.

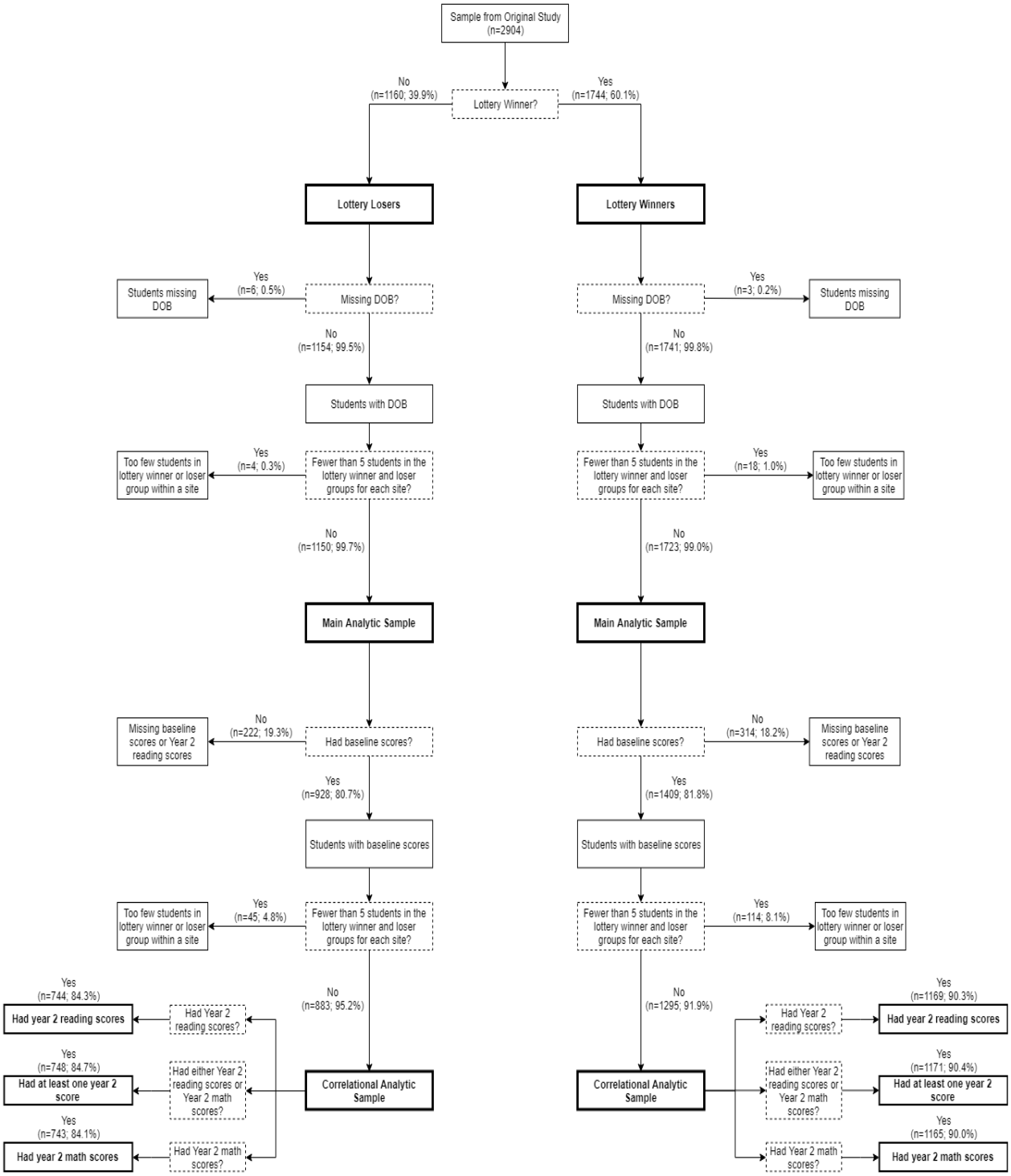
Data on middle school characteristics. The original study team administered surveys to principals of the schools attended by students in the study in fall 2006 and fall 2007. The team then supplemented the principal survey data with data from the National Center for Education Statistics' Common Core of Data and Private School Survey, the SchoolDataDirect website, and school-specific report cards from states' department of education websites. These data were used to define the characteristics of the different charter middle schools in the study and to examine whether charter schools with different characteristics (for example, schools that serve higher versus lower proportions of disadvantaged students) affected students' college enrollment and completion differently.

Analysis sample

For the main analysis of impacts of the study's charter middle schools on college outcomes, the sample included 2,873 students in 31 sites (which together included 35 charter schools). A total of 2,904 students in 32 sites (36 charter schools) participated in the original study. Information necessary for matching to the NSC data (names and dates of birth) were missing for nine students, so these students were excluded from the NSC data request and the analyses. In addition, one charter school site (with 22 students) was also dropped because there were too few students in the lottery loser group for a reliable analysis. Of the 2,873 students included in the analysis, 1,723 were in the lottery winner group and 1,150 were in the lottery loser group (see Figure A.1).

For the correlational analysis that compared impacts on student achievement to impacts on college outcomes, the same analysis sample was used as in the original study, to the extent possible. The students without valid baseline (pre-lottery) test scores and without second-year follow-up test scores were omitted from the analysis. Four charter middle school sites were also dropped because there were fewer than five students in the lottery winner or lottery loser groups, which was consistent with the approach used in Gleason et al. (2010). The sample of students who had valid pre-lottery and second-year follow-up scores and met the other requirements included 1,913 for reading, 1,908 students for math, and 1,919 for either math or reading. For the main achievement measure, the study team averaged reading and math scores if a student had both, used the reading score alone if the student was missing the math score, and used the math score alone if the reading score was missing. Because more students had reading than math scores, the sample of 1,913 students was used to estimate the college impacts for the correlations. Of the 1,913 students included in this analysis, 1,169 were lottery winners and 744 were lottery losers (see Figure A.1).

Figure A.1. Description of analysis sample



Outcome measures

To learn about the effects of the study's charter middle schools on students' college enrollment and completion, the study examined impacts on two primary outcomes:

- **Ever enrolled in any college.** Student appeared in the NSC data set at any point in time between August 2009 and December 2017.
- **Obtained degree or currently enrolled.** Student completed college (earned a bachelor's degree, associate's degree, or certificate) or was enrolled as of December 2017. Any student who had dropped out of college was coded as not having obtained a degree or not currently enrolled.

An exploratory analysis was also conducted to help better understand the impacts of the two main outcomes.

The exploratory outcomes related to college enrollment include:

- **Ever enrolled in two-year college.** Student enrolled in a two-year college at any point in time between August 2009 and December 2017.
- **Ever enrolled in four-year college.** Student enrolled in a four-year college at any point in time between August 2009 and December 2017.
- **Selectivity of college.** Colleges were classified according to their reported acceptance rate in IPEDS: highly selective (1–25 percent acceptance rate), selective (26–50 percent acceptance rate), somewhat selective (51–75 percent acceptance rate), or less selective (76–100 percent acceptance rate). A student who enrolled in more than one college appears in only one category, reflecting the most selective college he or she attended.
- **Enrolled in college courses during high school.** Student enrolled part-time in college classes during the school year, within the two years prior to his or her projected high school graduation date.
- **College type where currently or most recently enrolled.** The NSC data classified colleges as public or private, and the IPEDS data provided information on whether the private colleges were nonprofit or for-profit. When the institution type was missing from the IPEDS data, the study team looked at the institution websites and manually coded these cases.

The exploratory outcomes related to college completion include:

- **Number of years completed in any college.** Number of academic years (or fraction thereof) that student completed at any college from August 2009 through December 2017. Following U.S. government guidelines, one full academic year was defined as 28 weeks of full-time enrollment, 56 weeks of half-time enrollment, or 112 weeks of enrollment less than half time (Dynarski, Hemelt, & Hyman, 2015). If a student was enrolled concurrently in more than one college, full-time enrollment was recorded, but not more. (In other words, enrollment was capped at 100 percent at any given time.) If a student withdrew from college during a semester, that enrollment period was not counted.
- **Number of years completed at two-year college.** Number of academic years (or fraction thereof) that student completed at a two-year college from August 2009 through December 2017.

- **Number of years completed at four-year college.** Number of academic years (or fraction thereof) that student completed at a four-year college from August 2009 through December 2017, prior to obtaining a bachelor's degree. (In other words, time spent working toward an advanced degree was not counted.)
- **Graduated with associate's degree (two-year college).** Student completed degree at a two-year college. If the student also completed a bachelor's degree, only the highest degree (bachelor's) was counted.
- **Graduated with bachelor's degree (four-year college).** Student completed degree at a four-year college. If the student also completed an associate's degree, only the highest degree (bachelor's) was counted.
- **Graduated with bachelor's degree within four years of projected high school graduation.** Student completed degree at a four-year college within four years. The sample for this variable is limited to the 87 percent of students who were projected to graduate from high school in 2013 or earlier.

Statistical power

To assess the statistical power of the design, we examined the ability of the analysis to detect impacts of admission to a study charter school on college enrollment and completion, the key outcomes of interest. To the extent possible, these calculations used the actual sample sizes and design parameters that were used in the original study, based on the objective of that study to provide estimates of the impact of charter middle school admission on student achievement (see Appendix D of Gleason et al., 2010). Because this study is a follow-up, the sample sizes could not be adjusted based on the power calculations. In calculating the minimum detectable effects, we used an 80 percent power level and a 5 percent level of statistical significance. This study has the power to detect moderate to large impacts of charter middle school admission on college enrollment and completion. The minimum detectable effect is 0.06 (or 6 percentage points) for impacts on college enrollment, which assumes a control group proportion of 0.69, the proportion of students who completed high school and immediately enrolled in college in 2015 (McFarland et al., 2018). For impacts on college completion, the minimum detectable effect is 0.07 (or 7 percentage points), which assumes a control group proportion of 0.46, the proportion of 25- to 29-year-olds with an associate's degree or higher in 2017 (McFarland et al., 2018). Thus, the study did not have the statistical power to reliably detect small impacts of being admitted to a charter middle school in the study on college enrollment or completion—impacts less than 6 percentage points for the former and 7 percentage points for the latter.

Analytic approach

This section describes the primary analyses that were conducted to answer the study research questions. These include the main impact and student subgroup analyses, the school subgroup analyses, and the correlational analyses. Many of these analyses used the same approach and models as the original IES study of charter middle schools (Gleason et al., 2010). This section provides the key information about the analytic approach, but additional details are provided in that report.

Estimating the impact of being admitted to a charter middle school (Finding 1)

The first step of the main impact analysis was to estimate the impact of the study's charter middle schools on students' college enrollment and completion for the full study sample. For consistency with the approach used in the original study (Gleason et al., 2010), a two-stage process was used to

estimate the average impact of the charter middle schools. The study team first estimated impacts in each of the 31 charter school sites included in the analysis and then calculated the average impact across these sites.

Estimating site-level impacts. To examine the effect of winning a charter school lottery, regardless of whether the student actually attended that school, the study used a regression model to compare the average (mean) outcome among lottery winners with the average (mean) outcome among lottery losers. The model adjusted for the characteristics of students at the time of the lottery.

The basic form of the model is

$$(1) \quad y_{ij} = \alpha_j + X_{ij}\beta + \delta_j T_{ij} + \varepsilon_{ij}$$

where y_{ij} is the outcome of interest for student *i* in charter school site *j*, α_j is a separate intercept term for each charter school site, X_{ij} includes a set of characteristics of student *i* in site *j*, T_{ij} represents the student's treatment status (lottery winner or lottery loser) and indicates whether or not student *i* was admitted to a charter school in site *j*, ε_{ij} is a random error term that reflects the influence of unobserved factors on the outcome, and β and δ_i are parameters or set of parameters to be estimated. The estimated coefficient $\hat{\delta}_j$ represents the impact of being admitted to a charter middle school in site *j*.

Sample weights, created by the original study team, were used in the impact estimation to account for a variety of factors that influenced the probability that a student would be admitted to a charter middle school. These factors include the number of open seats at the school, the number of students offered admission based on the initial lottery as well as from the waiting list after the lottery, whether parents gave consent for their children to participate in the study before the lottery, whether siblings applied together and each school's policy toward sibling acceptance, whether schools stratified their lotteries on the basis of predetermined student characteristics (that is, whether they conducted random assignment separately for different groups of students such as students from particular feeder schools), and whether students applied to more than one charter middle school in the study.

The impacts were estimated using linear regression models for both continuous and binary outcomes. Most of the postsecondary outcomes in this study are binary – that is, they have two possible values, such as whether or not a student attended a four-year college or obtained a bachelor's degree. In these models, the error variance is not constant, so robust standard errors were used to correct for heteroscedasticity. Several sensitivity tests were also conducted using different model specifications described in Appendix C.

The models controlled for student background characteristics and baseline (pre-lottery) test scores (Table A.2). This meant that variables for which there were statistically significant differences between lottery winners and lottery losers were controlled for, as suggested by guidance from the U.S. Department of Education's What Works Clearinghouse. Also, these are the same variables used in the original IES study, providing consistency across the two studies. The models in both studies also controlled for students' age at the start of school, whether students were young or old for their grade, and their cohort. These variables accounted for the number of years of possible college enrollment and for the fact that a student's college outcomes may have varied with the number of years that had passed since the student graduated from high school (Table A.3).

Accounting for missing data. Some baseline (pre-lottery) data were missing for some students in the sample. To account for missing baseline data, the sample median or mode was imputed for each baseline variable. In other words, the missing value was replaced with a valid value—the median or

mode value of that variable among all students in the analysis sample with valid data. In the impact models, the study team used the imputed baseline variables and included a missing dummy variable for each baseline variable with imputed values.

Averaging impacts across sites. After estimating the impact of each charter middle school, the impact estimates were averaged across sites to estimate the overall impact of the study's charter middle schools on each outcome. The average overall impact $\hat{\delta}$ was calculated as the sum of the impact of each site $\hat{\delta}_j$ divided by the number of sites J:

$$(2) \quad \hat{\delta} = \frac{1}{J}\sum_{j=1}^{J}\hat{\delta}_j$$

In this calculation, each site was given equal weight, so each charter school in the study contributed equally to the overall impact estimate. As a sensitivity test, the average was re-calculated, weighting each site according to the precision of its impact estimate. See Appendix C for a more detailed description.

Estimating the impact of attending a charter middle school. The impact of actually attending the charter middle schools in the study, rather than the impact of simply being offered admission, was also estimated. This is known as a treatment-on-the-treated estimate. To do this, the treatment status indicator—whether a student was a lottery winner or lottery loser—was used as an instrumental variable for charter middle school attendance.[22] As described in Gleason et al. (2010), using this instrumental variable can provide an unbiased estimate of the effect of attending a charter middle school when (1) winning the charter lottery is highly predictive of whether a student actually attends a charter school and (2) study charter schools were equally effective for lottery winners and lottery losers who attended them.

To obtain the treatment-on-the-treated estimate, we estimated a two-stage least squares model. First, a variable indicating whether each student attended a study charter middle school was regressed on the treatment status indicator and the other variables. From this regression model, each student's predicted charter school attendance was calculated. Second, the outcome variable was regressed on predicted charter school attendance and the other variables in the model. The coefficient on predicted charter school attendance in that model represents the impact of attending a study charter middle school.

Estimating the impact for subgroups of students. The study also examined whether the charter middle schools in the study had different effects on different types of students. The subgroup analyses focus on the same student subgroups as the original study to be able to determine (a) whether students who have traditionally experienced lower rates of college attendance and completion fare better if they are offered admission to charter schools than if they attend traditional public schools and (b) whether the subgroup findings for postsecondary outcomes were consistent with those that the original study found for student achievement.

Student groups were defined based on:

- Students' eligibility for free or reduced-price school meals
- Race/ethnicity
- Baseline (pre-lottery) math and reading achievement above or below the sample median.

To estimate the effects on student subgroups, the main regression model was used, with one variation:

$$(3) \quad yi_j = \alpha'_j + Xi_j\beta' + \delta'_j T_{ij} + \gamma'_j S + \zeta'_j Ti_j S + \varepsilon' i_j$$

where *S* is an indicator for whether the student is in the subgroup of interest, and the other variables are as defined as in Equation (1). The study team calculated the impacts for each subgroup separately and then tested the significance of the difference between the two groups.

Estimating the impact for groups of schools. The study also examined whether some types of charters were more effective than others. It is important for policymakers to understand the effectiveness of charter schools that serve different types of students and those in urban versus nonurban locations, given that research suggests the impacts on achievement can vary along with these characteristics. The models and approach for estimating the effects of different groups of charters were the same as the student subgroup model described above. Charter school subgroups were defined based on the following charter school characteristics:

- Proportion of students who were eligible for free or reduced-priced school meals (above or below the sample median)
- Proportion of students who were white or non-white (above or below the median)
- Urbanicity of the school (urban versus suburban or rural)
- Average baseline (pre-lottery) reading and math scores (above or below the median).

In addition to the possibility that the subgroups of charter middle schools defined by the above characteristics had different impacts on college outcomes than the average charter middle school in the study, there could be differences in charter schools' impacts based on other characteristics. To investigate the more general possibility that different charter schools have different impacts on college outcomes, the study estimated variation in impacts across the study schools. Specifically, the study tested whether impacts on each of the college outcomes were the same across all study charter schools, or whether different study charter schools had different impacts.

The estimates of the charter middle schools' impacts varied from -0.25 to 0.16 for college enrollment and -0.20 to 0.42 for completion, but one factor leading to this variation was sampling error. The impacts were based on the samples (number of students who went through lotteries) in each charter school site, and in some cases, the samples were small. As a result, some of the site-level estimates were not very precise and differences in the impacts of any two charter schools could have resulted from this sampling error. To determine whether there was a statistically significant difference in impact estimates across sites, a Q-test for homogeneity across all sites was conducted (Gleason et al., 2010). The study team was unable to reject the null hypothesis of no differences in impacts across schools at the 0.05 level for either the college enrollment impacts (p-value = 0.412) or the college completion impacts (p-value = 0.145). This means that there were not statistically significant differences in college impacts across the charter middle schools for either of the primary college outcomes. See Appendix C for details.

Estimating the relationship between impacts on student achievement and college enrollment and completion (Finding 2)

Finally, the study explored whether the charter middle schools that had positive impacts on students' academic achievement also had positive long-term impacts on students' college enrollment and completion, or whether short-term impacts on test scores were unrelated or negatively related to long-term impacts.

To examine the relationship between middle school achievement and college outcomes for individual students, the study estimated simple correlations between student middle school achievement and three postsecondary outcomes: (1) ever enrolled in college, (2) obtained a degree or currently enrolled, or (3) ever attended a four-year college. The correlations are presented in two ways. Middle school achievement was measured in three different ways—math scores, reading scores, and the average of math and reading scores, resulting in three separate analyses. Each postsecondary outcome was regressed on students' second-year follow-up (Year 2) math and/or reading test scores, using ordinary least squares and robust standard errors. As an alternative way of examining this relationship, simple Pearson correlation coefficients were estimated.

Next, the study estimated the correlations between the *impacts* of admission to study charter schools on students' math and reading achievement and the *impacts* of these schools on the college outcomes. The approach followed a similar correlational analysis presented in Angrist et al. (2016). It involved separately estimating impacts on six outcomes for students who applied to each charter middle school in the original study (Year 2 middle school math scores, Year 2 middle school reading scores, combined Year 2 math and reading scores, ever enrolled in college, obtained a degree or currently enrolled, and ever enrolled in four-year college).

Once impacts were estimated for each of the six outcome variables for each charter school lottery, the study team examined how impacts on students' math and reading achievement related to each postsecondary outcome. The estimated college enrollment impact was regressed on the estimated impacts on students' Year 2 math and reading test scores, using ordinary least squares. The estimated college completion impact was also regressed on these same achievement impact estimates. The study reports the coefficient estimates from this regression, which represent the predicted percentage point change in a college outcome, given a one-unit increase in achievement impacts.[23]

In addition, the Pearson correlation between the estimated impact on reading and math achievement and the impacts on each of the postsecondary outcomes were computed and reported. The correlation coefficient describes the strength of the relationship between test score impacts and college outcome impacts, accounting for the fact that more than one test score impact measure was included in the model. A correlation of 1 would indicate that impacts on middle school achievement perfectly predict impacts on college outcomes; a correlation of 0 would indicate that there is no relationship between the middle school impacts and college impacts.

APPENDIX B: SUPPORTING DETAIL FOR KEY FINDINGS

This appendix presents detailed results supporting the main findings described in the evaluation brief.

Supporting Detail for Overall Impacts on College Enrollment and Completion (Finding 1)

The first set of tables (Tables B.1 through B.3) show the full set of estimates of how admission to and enrollment in study charter middle schools affected college outcomes. Table B.1 presents evidence on how both being admitted to and attending a study charter school affected the main outcomes of college enrollment and completion as well as each of the exploratory college outcomes, among the sample of 2,873 students in 31 charter school sites. The exploratory outcomes provide additional information about the study's primary outcomes and allow us to better understand the charter middle schools' effects (or lack of effects) on the primary outcomes. For reference, the table also includes estimates of how study charter schools affected students' middle school achievement. The study also examined how admission to these study charter schools affected each of these outcomes for key subgroups of students, including students who had different background characteristics (Table B.2) and achievement levels prior to charter school admission (Table B.3).

Table B.1. Being admitted to or attending a study charter school did not affect students' college outcomes

Outcome	Impact of being admitted to and attending a study charter middle school on college enrollment and completion outcomes					
	Impact of admission offer				Impact of attendance	
	(1) Mean, lottery winners	(2) Mean, lottery losers	(3) Difference (impact estimate)	(4) *p*-value	(5) Adjusted impact estimate	(6) *p*-value
Primary outcomes						
Ever enrolled in any postsecondary institution	0.69	0.69	0.00	0.923	-0.03	0.733
Obtained a certificate, associate's degree, or bachelor's degree or currently enrolled	0.48	0.47	0.01	0.634	0.02	0.696
Exploratory outcomes related to college enrollment						
Ever enrolled in postsecondary institution						
2-year college	0.32	0.35	-0.03	0.188	-0.03	0.649
4-year college	0.55	0.52	0.02	0.296	0.04	0.409
Type of institution where currently or most recently enrolled						
Public	0.55	0.54	0.00	0.918	-0.01	0.885
Private nonprofit	0.13	0.14	-0.01	0.729	-0.03	0.637
Private for-profit	0.01	0.01	0.00	0.945	0.01	0.485
Selectivity of postsecondary institution						
Highly selective (1–25% acceptance rate)	0.03	0.02	0.01	0.130	0.03	0.151
Selective (26–50% acceptance rate)	0.13	0.13	0.00	0.995	0.01	0.768
Somewhat selective (51–75% acceptance rate)	0.25	0.23	0.02	0.330	0.01	0.845
Less selective (76–100% acceptance rate)	0.27	0.30	-0.03	0.133	-0.08	0.320
Dual enrollment participation	0.09	0.10	-0.01	0.543	-0.05	0.635
Exploratory outcomes related to college completion						
Graduated from postsecondary institution[a]						
Associate's degree (2-year college)	0.03	0.05	-0.01	0.209	-0.05	0.575
Bachelor's degree (4-year college)	0.27	0.29	-0.02	0.361	-0.04	0.288
Graduated with bachelor's degree within 4 years of projected high school graduation	0.24	0.25	-0.01	0.731	-0.02	0.596

Outcome	Impact of being admitted to and attending a study charter middle school on college enrollment and completion outcomes					
	Impact of admission offer				Impact of attendance	
	(1) Mean, lottery winners	(2) Mean, lottery losers	(3) Difference (impact estimate)	(4) *p*-value	(5) Adjusted impact estimate	(6) *p*-value
Graduated or currently enrolled						
Graduated with associate's degree or currently enrolled in 2-year college	0.07	0.06	0.01	0.204	0.06	0.411
Graduated with bachelor's degree or currently enrolled in 4-year college	0.41	0.40	0.01	0.805	-0.02	0.815
Number of years completed						
At 2-year college	0.34	0.38	-0.04	0.423	-0.02	0.837
At 4-year college	1.89	1.81	0.08	0.412	0.06	0.715
At any postsecondary institution	2.36	2.34	0.02	0.847	0.02	0.938
Middle school Year 2 achievement[b]						
Reading	0.31	0.38	-0.07	0.032+	-0.08	0.117
Math	0.32	0.38	-0.06	0.136	-0.08	0.202
Number of students	1,723	1,150	2,873		2,822	
Number of sites			31		31	

Note: In both the lottery winner and lottery loser groups, 3 percent of students who attended a postsecondary institution opted out of sharing their data. In the student-level postsecondary data file, these students are indistinguishable from the students who never enrolled in a postsecondary institution, and are counted as if they never enrolled. Therefore, estimates presented in this table underestimate overall enrollment by approximately 3 percentage points.

We estimated means at the site level and then averaged across all 31 sites in the study, with the averages weighted according to each student's probability of assignment to the lottery winner or lottery loser group.

The *p*-value represents the probability of getting the estimated difference or impact if, in fact, the true difference or impact was equal to 0.

The results are presented in proportions, with the exception of the number of years completed outcomes, which are presented in years, and middle school Year 2 achievement outcomes, which are presented in standard deviations.

[a]The sample for the graduation outcomes is limited to students who are projected to have completed college if they enrolled immediately after high school and for whom we have at least four years of additional data to measure college completion (n = 2,511 for the impact of admission offer estimates and n = 2,466 for the impact of attendance estimates).

[b]The achievement impact estimates are from Table IV.1 of Gleason et al. (2010). The middle school Year 2 achievement sample is 1,920 students.

*Significantly different from zero at the .05 level, two-tailed test.

**Significantly different from zero at the .01 level, two-tailed test.

+Difference significantly different from zero at the .05 level, two-tailed test.

++Difference significantly different from zero at the .01 level, two-tailed test.

Table B.2. Being admitted to a study charter school did not affect students' college outcomes differently for students with different characteristics

Outcome	Impact of being admitted to a study charter middle school on college enrollment and completion outcomes, by student background characteristic					
	Certification for free or reduced-price meals			Race		
	(1) Not certified	(2) Certified	(3) Difference	(4) White, non-Hispanic	(5) Nonwhite and/or Hispanic	(6) Difference
Primary outcomes						
Ever enrolled in any postsecondary institution	-0.02	0.01	0.03	-0.02	0.01	0.03
Obtained a certificate, associate's degree, or bachelor's degree or currently enrolled	-0.01	-0.01	0.00	-0.04	0.00	0.04
Exploratory outcomes related to college enrollment						
Ever enrolled in postsecondary institution						
2-year college	-0.02	-0.03	-0.01	-0.04	0.01	0.05
4-year college	0.00	0.02	0.02	0.01	0.00	-0.01
Type of institution where currently or most recently enrolled						
Public	0.00	0.02	0.02	0.03	0.01	-0.02
Private nonprofit	-0.02	-0.01	0.01	-0.04~	-0.01	0.04
Private for-profit	0.00	0.00	0.00	0.00	0.00	0.00
Selectivity of postsecondary institution						
Highly selective (1-25% acceptance rate)	0.02~	0.00	-0.02	0.00	0.03	0.03
Selective (26-50% acceptance rate)	-0.01	0.01	0.01	0.02	0.00	-0.02
Somewhat selective (51-75% acceptance rate)	0.01	0.06~	0.05	0.01	0.01	0.00
Less selective (76-100% acceptance rate)	-0.04	-0.05	-0.01	-0.05~	-0.03	0.02
Dual enrollment participation	-0.02	0.03	0.05	0.00	0.00	0.00
Exploratory outcomes related to college completion						
Graduated from postsecondary institution[a]						
Associate's degree (2-year college)	-0.01	-0.03	-0.02	-0.02	0.00	0.02
Bachelor's degree (4-year college)	-0.04	0.00	0.05	-0.02	-0.06~	-0.04
Graduated with bachelor's degree within 4 years of projected high school graduation	-0.02	-0.01	0.01	0.00	-0.04	-0.04
Graduated or currently enrolled						
Graduated with associate's degree or currently enrolled in 2-year college	0.03~	-0.01	-0.04~	-0.01	0.04~	0.05+
Graduated with bachelor's degree or currently enrolled in 4-year college	-0.03	0.02	0.06	-0.03	-0.02	0.01

Outcome	Impact of being admitted to a study charter middle school on college enrollment and completion outcomes, by student background characteristic					
	Certification for free or reduced-price meals			Race		
	(1) Not certified	(2) Certified	(3) Difference	(4) White, non-Hispanic	(5) Nonwhite and/or Hispanic	(6) Difference
Number of years completed						
At 2-year college	0.01	-0.07	-0.08	-0.06	0.03	0.09
At 4-year college	-0.06	0.11	0.17	0.02	-0.13	-0.15
At any postsecondary institution	-0.07	0.06	0.13	-0.08	-0.11	-0.03
Middle school Year 2 achievement						
Reading	-0.12**	0.05	0.17+	-0.07	-0.08	-0.02
Math	-0.14*	0.17*	0.31++	-0.09	-0.03	0.05
Number of students	2,005	819	2,824	1,587	1,218	2,805
Number of sites	31	19		25	25	

Note: The results are presented in proportions, with the exception of the number of years completed outcomes, which are presented in years, and middle school Year 2 achievement outcomes, which are presented in standard deviations.

[a]The sample for the graduation outcomes is limited to students who are projected to have completed college if they enrolled immediately after high school and for whom we have at least four years of additional data to measure college completion (n = 2,511 for the impact of admission offer estimates and n = 2,466 for the impact of attendance estimates).

*Significantly different from zero at the .05 level, two-tailed test.

**Significantly different from zero at the .01 level, two-tailed test.

+Difference significantly different from zero at the .05 level, two-tailed test.

++Difference significantly different from zero at the .01 level, two-tailed test.

~Estimate or difference significantly different from zero at the .10 level, two-tailed test.

Table B.3. Being admitted to a study charter school did not affect students' college outcomes differently for students with different pre-charter school achievement levels

Outcome	Impact of being admitted to a study charter middle school on college enrollment and completion outcomes, by student baseline achievement					
	Reading achievement			Math achievement		
	(1) Below median	(2) Above median	(3) Difference	(4) Below median	(5) Above median	(6) Difference
Primary outcomes						
Ever enrolled in any postsecondary institution	-0.04	0.04	0.07~	-0.01	0.04	0.05
Obtained a certificate, associate's degree, or bachelor's degree or currently enrolled	-0.01	0.03	0.04	0.01	0.00	-0.01
Exploratory outcomes related to college enrollment						
Ever enrolled in postsecondary institution						
2-year college	-0.04	-0.04	0.00	-0.05~	-0.01	0.04
4-year college	-0.02	0.08*	0.11+	0.01	0.06~	0.05
Type of institution where currently or most recently enrolled						
Public	-0.03	0.04	0.07	-0.02	0.05	0.07
Private nonprofit	-0.01	0.01	0.01	-0.01	0.00	0.01
Private for-profit	0.00	-0.01	-0.01	0.01	-0.01	-0.02~
Selectivity of postsecondary institution						
Highly selective (1-25% acceptance rate)	0.00	0.01	0.01	0.01	0.01	0.00
Selective (26-50% acceptance rate)	-0.01	0.02	0.03	0.00	0.03	0.02
Somewhat selective (51-75% acceptance rate)	-0.01	0.04	0.05	0.00	0.03	0.03
Less selective (76-100% acceptance rate)	-0.02	-0.04	-0.02	-0.02	-0.03	0.00
Dual enrollment participation	0.01	-0.01	-0.03	0.00	0.00	0.00
Exploratory outcomes related to college enrollment						
Graduated from postsecondary institution[a]						
Associate's degree (2-year college)	-0.02	0.01	0.03	-0.02~	0.01	0.03~
Bachelor's degree (4-year college)	-0.04	-0.03	0.01	-0.03	-0.01	0.02
Graduated with bachelor's degree within 4 years of projected high school graduation	-0.02	-0.02	0.00	-0.01	-0.01	-0.01

Outcome	Impact of being admitted to a study charter middle school on college enrollment and completion outcomes, by student baseline achievement					
	Reading achievement			Math achievement		
	(1) Below median	(2) Above median	(3) Difference	(4) Below median	(5) Above median	(6) Difference
Graduated or currently enrolled						
Graduated with associate's degree or currently enrolled in 2-year college	0.02	0.01	-0.01	0.02	0.00	-0.03
Graduated with bachelor's degree or currently enrolled in 4-year college	-0.02	0.03	0.05	0.00	0.01	0.01
Number of years completed						
At 2-year college	-0.02	-0.07	-0.05	-0.08	0.00	0.08
At 4-year college	-0.13	0.21	0.34~	0.07	0.09	0.01
At any postsecondary institution	-0.19	0.15	0.34	-0.05	0.06	0.11
Middle school Year 2 achievement						
Reading	-0.02	-0.13*	-0.11	0.01	-0.10	-0.12
Math	0.05	-0.11	-0.16	0.08	-0.10	-0.18
Number of students	1,714	1,143	2,857	1,706	1,148	2,854
Number of sites	31	27		31	27	

Note: The results are presented in proportions, with the exception of the number of years completed outcomes, which are presented in years, and middle school Year 2 achievement outcomes, which are presented in standard deviations.

[a]The sample for the graduation outcomes is limited to students who are projected to have completed college if they enrolled immediately after high school and for whom we have at least four years of additional data to measure college completion (n = 2,511 for the impact of admission offer estimates and n = 2,466 for the impact of attendance estimates).

*Significantly different from zero at the .05 level, two-tailed test.

**Significantly different from zero at the .01 level, two-tailed test.

+Difference is significantly different from zero at the .05 level, two-tailed test.

++Difference is significantly different from zero at the .01 level, two-tailed test.

~Estimate or difference is significantly different from zero at the .10 level, two-tailed test.

Table B.4 shows the impact of being admitted to charter schools with different characteristics on students' college outcomes. In particular, the table shows the full set of results for charter sites serving more versus fewer economically advantaged students, more non-white versus more white students, and low-achieving versus high-achieving students, as well as sites within large urban areas versus outside of large urban areas. Figures B.1 and B.2 show these results graphically.

Table B.4. Subgroups of charter middle schools with different characteristics had similar effects on college outcomes

Outcome	Impact of being admitted to a study charter middle school on college enrollment and completion outcomes, by charter school characteristic											
	Percentage eligible for free or reduced-price meals			Percentage of white students			Mean pre-lottery achievement			Urbanicity		
	(1) Sites serving more economically advantaged students	(2) Sites serving fewer economically advantaged students	(3) Difference	(4) Sites serving more non-white students	(5) Sites serving more white students	(6) Difference	(7) Sites serving low-achieving students	(8) Sites serving high-achieving students	(9) Difference	(10) Sites outside of large urban areas	(11) Sites in large urban areas	(12) Difference
Primary outcomes												
Ever enrolled in any postsecondary institution	-0.01	0.01	0.02	0.02	-0.03	-0.05	0.00	-0.01	0.00	0.00	-0.01	-0.01
Obtained a certificate, associate's degree, or bachelor's degree or currently enrolled	0.00	0.03	0.03	0.05	-0.04	-0.09+	0.03	-0.02	-0.05	0.00	0.02	0.02
Exploratory outcomes related to college enrollment												
Ever enrolled in postsecondary institution												
2-year college	-0.06~	0.00	0.06	0.01	-0.07*	-0.08~	-0.02	-0.05~	-0.03	-0.05~	0.01	0.06
4-year college	0.00	0.05	0.05	0.06~	-0.02	-0.07	0.03	0.01	-0.02	0.02	0.04	0.02
Type of institution where currently or most recently enrolled												
Public	0.02	-0.02	-0.05	-0.01	0.01	0.02	-0.02	0.02	0.03	0.01	0.00	-0.01
Private nonprofit	-0.03	0.02	0.04	0.02	-0.04	-0.06~	0.01	-0.02	-0.03	0.00	-0.01	-0.01
Private for-profit	-0.01	0.01	0.02+	0.01	-0.01	-0.02	0.00	0.00	0.00	0.00	0.01	0.01
Selectivity of postsecondary institution												
Highly selective (1-25% acceptance rate)	0.00	0.02**	0.01	0.02**	0.00	-0.03~	0.01	0.01	0.00	0.01	0.02~	0.01
Selective (26-50% acceptance rate)	0.00	0.00	-0.01	0.02	-0.02	-0.04	0.00	0.00	0.00	-0.01	0.03	0.04
Somewhat selective (51-75% acceptance rate)	0.01	0.03	0.02	0.01	0.03	0.01	0.04~	0.00	-0.05	0.02	0.03	0.01
Less selective (76-100% acceptance rate)	-0.03	-0.03	0.00	-0.04	-0.03	0.00	-0.05	-0.01	0.04	-0.01	-0.08*	-0.07
Dual enrollment participation	-0.03~	0.02	0.05~	0.00	-0.03	-0.03	0.00	-0.01	-0.01	0.00	-0.03	-0.03

Outcome	Impact of being admitted to a study charter middle school on college enrollment and completion outcomes, by charter school characteristic											
	Percentage eligible for free or reduced-price meals			Percentage of white students			Mean pre-lottery achievement			Urbanicity		
	(1) Sites serving more economically advantaged students	(2) Sites serving fewer economically advantaged students	(3) Difference	(4) Sites serving more non-white students	(5) Sites serving more white students	(6) Difference	(7) Sites serving low-achieving students	(8) Sites serving high-achieving students	(9) Difference	(10) Sites outside of large urban areas	(11) Sites in large urban areas	(12) Difference
Exploratory outcomes related to college completion												
Graduated from postsecondary institution[a]												
Associate's degree (2-year college)	-0.02~	-0.01	0.01	0.00	-0.03~	-0.03	0.00	-0.01	-0.01	-0.01	-0.01	0.00
Bachelor's degree (4-year college)	-0.01	-0.03	-0.01	-0.01	-0.03	-0.02	-0.03	-0.01	0.02	-0.01	-0.03	-0.02
Graduated with bachelor's degree within 4 years of projected high school graduation	0.01	-0.03	-0.04	-0.01	-0.01	0.00	-0.03	0.02	0.05	0.00	-0.02	-0.02
Graduated or currently enrolled												
Graduated with associate's degree or currently enrolled in 2-year college	0.00	0.04~	0.04~	0.04*	-0.01	-0.05+	0.02	0.00	-0.02	0.01	0.02	0.01
Graduated with bachelor's degree or currently enrolled in 4-year college	0.01	0.00	-0.01	0.03	-0.03	-0.06	0.02	-0.01	-0.03	0.00	0.01	0.01
Number of years completed												
At 2-year college	-0.02	-0.06	-0.04	-0.02	-0.06	-0.04	0.00	-0.08	-0.08	-0.03	-0.04	-0.01
At 4-year college	0.09	0.07	-0.02	0.14	0.00	-0.14	0.10	0.03	-0.06	0.10	0.04	-0.06
At any postsecondary institution	0.04	0.00	-0.04	0.15	-0.14	-0.28	0.12	-0.12	-0.23	0.03	0.00	-0.02
Middle school Year 2 achievement[b]												
Reading	-0.11	0	0.11	-0.08*	-0.03	0.05	0.03	-0.15**	-0.17++	-0.08*	-0.02	0.06
Math	-0.24**	0.18**	0.41++	0.01	-0.11	-0.12	0.12*	-0.21**	-0.33++	-0.14**	0.16*	0.30++
Number of students	1,366	1,507	2,873	1,676	1,197	2,873	1,448	1,405	2,853	1,903	970	2,873
Number of sites	16	15	31	17	14	31	15	15	30	21	10	31

Note: The results are presented in proportions, with the exception of the number of years completed outcomes, which are presented in years, and middle school Year 2 achievement outcomes, which are presented in standard deviations.

[a]The sample for the graduation outcomes was limited to students projected to have completed college if they enrolled immediately after high school (n = 2,511).

[b]The achievement impact estimates are from Tables G.11, G.14, G.15, and G.16 of Gleason et al. (2010). The reported sample sizes vary depending on the charter school characteristic.

*Significantly different from zero at the .05 level, two-tailed test.

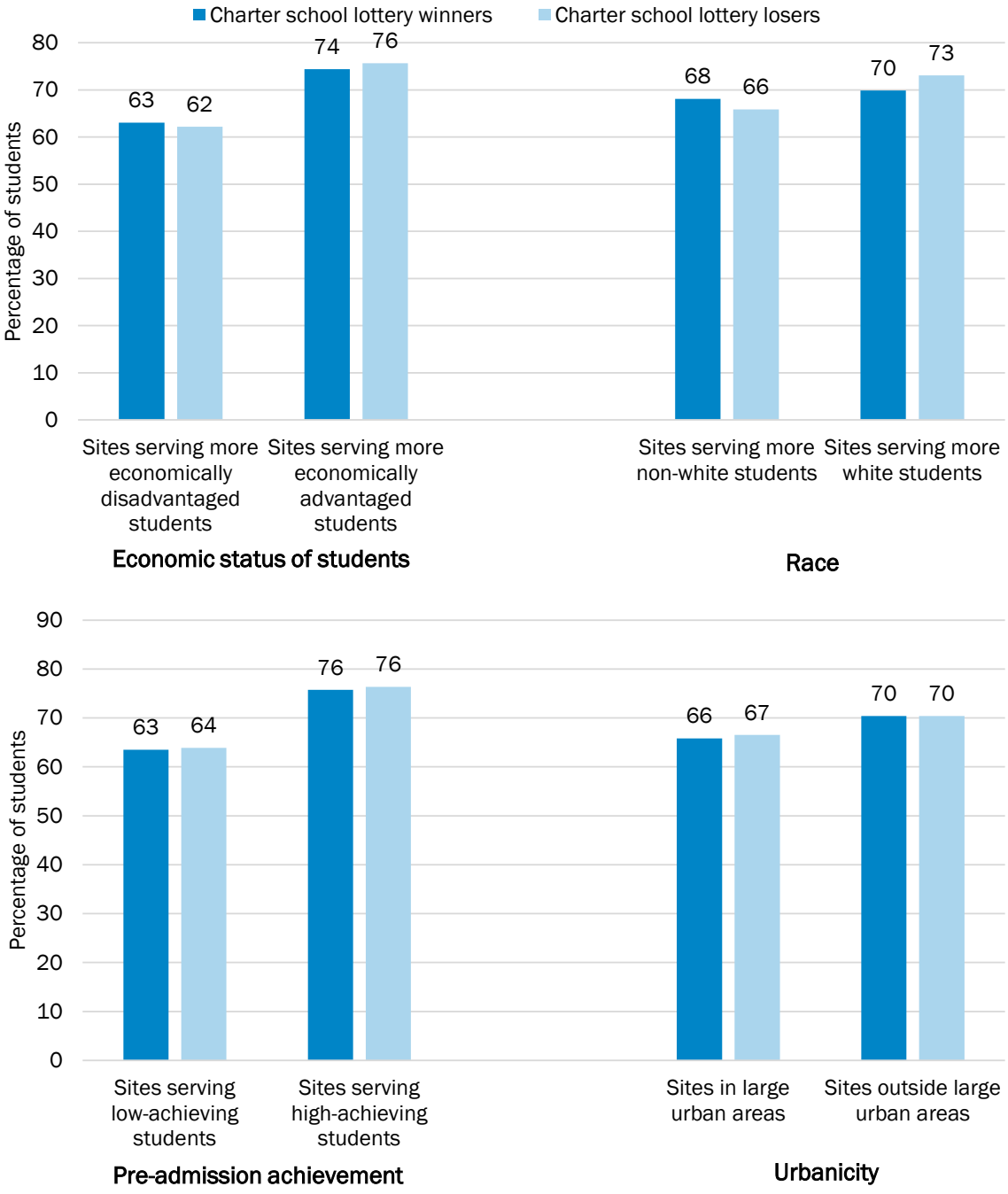
**Significantly different from zero at the .01 level, two-tailed test.

+Difference is significantly different from zero at the .05 level, two-tailed test.

++Difference is significantly different from zero at the .01 level, two-tailed test.

~Estimate or difference is significantly different from zero at the .10 level, two-tailed test.

Figure B.1. Subgroups of charter schools with different characteristics had similar effects on college enrollment: Percentage of lottery winners and losers who enrolled in college, by charter school characteristic

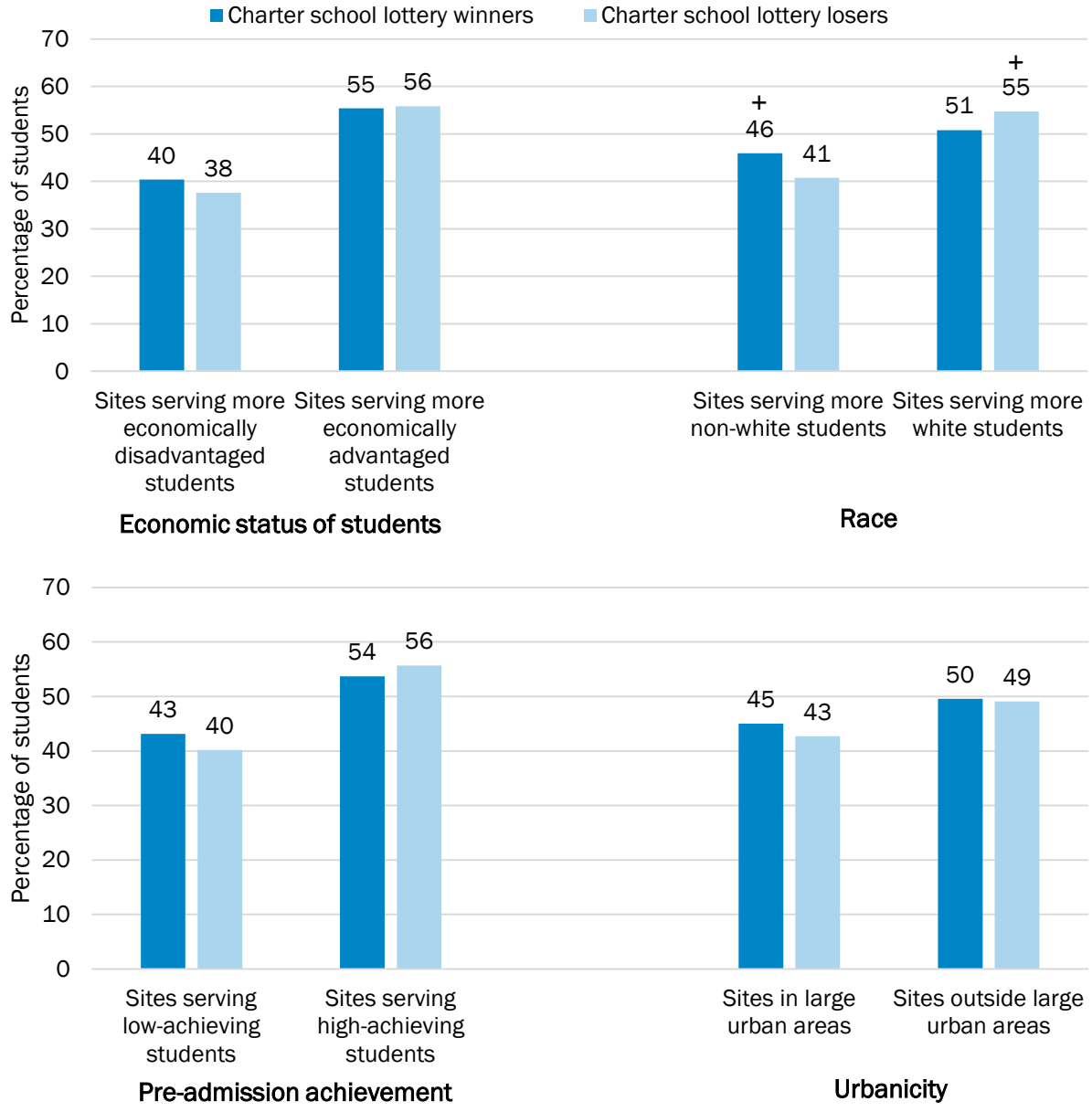


Note: Subgroups of charter schools by race, economic status, and pre-admission achievement were based on whether the charter schools' students were above or below the median value of that characteristic across all charter school sites in the study. Thus, there were approximately equal numbers of charter schools in each of these subgroups. The number of students and sites varied by characteristic because of missing data: 2,873 students and 31 sites for economic status; 2,857 students and 31 sites for race; and 2,853 students and 30 sites for pre-admission achievement.

There were 21 non-urban and 10 urban charter schools. The sample for the urbanicity estimates included 2,873 students.

Within each subgroup, the differences between lottery winners and lottery losers are not statistically significant at the .05 level, two-tailed test.

Figure B.2. Subgroups of charter schools with different characteristics were similar in how they affected college degree completion or continued enrollment: Percentage of lottery winners and losers who completed college, by charter school characteristic



Note: Subgroups of charter schools by race, economic status, and pre-admission achievement were based on whether the charter schools' students were above or below the median value of that characteristic across all charter schools in the study. Thus, there were approximately equal numbers of charter schools in each of these subgroups. The number of students and schools varied by characteristic: 2,873 students and 31 charter school sites for economic status; 2,857 students and 31 charter school sites for race; and 2,853 students and 30 charter school sites for pre-admission achievement.

There were 21 non-urban and 10 urban charter school sites. 2,873 students were included in the sample for the urbanicity estimates.

Within each subgroup, the differences between lottery winners and lottery losers are not statistically significant at the .05 level, two-tailed test.

+The difference in impacts between charter schools serving more white students and charter schools serving more non-white students (9 percentage points) is significantly different from zero at the .05 level, two-tailed test.

Supporting Detail for the Relationship between Impacts on College Enrollment and Completion and Impacts on Student Achievement (Finding 2)

The final set of tables and figures show the results of the analysis of whether charter schools' impacts on middle school achievement were related to their impacts on college outcomes. The relationships between middle school achievement and college outcomes at the student level are presented in Table B.5, based on a regression analysis, and Table B.7, based on a calculation of simple correlation coefficients. The relationships between the success of charter middle schools in the study in improving middle school academic achievement and their success in improving college enrollment and completion are presented in Tables B.6 and B.8 and Figures B.3 and B.4. Although most estimates of charter schools' impacts on middle school achievement were positively related to impacts on college outcomes, none of these regression coefficients (Table B.6) or correlation coefficients (Table B.8) were statistically significant. The lack of a strong relationship can be seen in the scatter plots shown in Figures B.3 and B.4. In each scatter plot, each data point represents a single charter school site in the study. The site's position on the x-axis of the graph represents its estimated impact on students' middle school achievement while its position on the y-axis represents its estimated impact on students' college enrollment (Figure B.3) or completion (Figure B.4). Larger circles represent more precise estimates of a charter school site's impact on students' middle school achievement, and smaller circles represent less precise estimates.

Table B.5. Students with higher middle school academic achievement were predicted to have higher rates of college enrollment and completion

Postsecondary outcomes	Estimated difference in college enrollment and completion (proportion of students), given a one standard deviation increase in middle school achievement					
	One standard deviation increase in Year 2 reading scores		One standard deviation increase in Year 2 math scores		One standard deviation increase in average Year 2 math and reading scores	
	(1) Predicted change in postsecondary outcomes	(2) *p*-value	(3) Predicted change in postsecondary outcomes	(4) *p*-value	(5) Predicted change in postsecondary outcomes	(6) *p*-value
Ever enrolled in any postsecondary institution	0.08**	0.000	0.07**	0.000	0.09**	0.000
Obtained a certificate, associate's degree, or bachelor's degree, or currently enrolled	0.14**	0.000	0.11**	0.000	0.15**	0.000
Ever enrolled in a four-year college	0.16**	0.000	0.13**	0.000	0.17**	0.000
Number of students	1,913	1,913	1,908	1,908	1,919	1,919

Note: These estimates were calculated by regressing each postsecondary outcome on each middle school achievement outcome, using linear probability models with robust standard errors and weights to account for different selection probability of each student. The reported estimates are a student's predicted change in postsecondary outcome (as a proportion), given a one standard deviation increase in student middle school achievement.

The *p*-value represents the probability of finding the estimated difference or impact if, in fact, the true difference or impact was equal to 0.

*Significantly different from zero at the .05 level, two-tailed test.

**Significantly different from zero at the .01 level, two-tailed test.

Table B.6. Estimated impacts of charter schools on middle school achievement did not significantly predict estimated impacts on college enrollment and completion

Postsecondary impacts	Estimated difference in college enrollment and completion impacts (proportion of students), given a one standard deviation increase in impacts on middle school achievement					
	One standard deviation increase in Year 2 reading score impacts		One standard deviation increase in Year 2 math score impacts		One standard deviation increase in average Year 2 math and reading score impacts	
	(1) Predicted change in postsecondary impacts	(2) *p*-value	(3) Predicted change in postsecondary impacts	(4) *p*-value	(5) Predicted change in postsecondary impacts	(6) *p*-value
Ever enrolled in any postsecondary institution	0.04	0.777	0.00	0.988	0.01	0.957
Obtained a certificate, associate's degree or bachelor's degree, or currently enrolled	0.10	0.533	0.07	0.531	0.10	0.495
Ever enrolled in a four-year college	-0.05	0.741	0.00	0.974	-0.02	0.894
Number of students	1,913	1,913	1,913	1,913	1,913	1,913
Number of sites	28	28	28	28	28	28

Note: These estimates were calculated by regressing the site-level postsecondary impact estimates on each site-level middle school achievement impact, using linear probability models with robust standard errors. The reported estimates are the predicted difference in postsecondary impacts (as a proportion), given a one standard deviation increase in student middle school achievement impacts.

The *p*-value represents the probability of finding the estimated difference or impact if, in fact, the true difference or impact was equal to 0.

The estimates are not statistically significant at the .05 level, two-tailed test.

Table B.7. Students' middle school academic achievement was positively correlated with college enrollment and completion

Postsecondary outcomes	Correlation between students' middle school achievement and their college enrollment and completion		
	(1) Year 2 reading scores	(2) Year 2 math scores	(3) Year 2 math and reading scores
Ever enrolled in any postsecondary institution	0.17**	0.16**	0.18**
Obtained a certificate, associate's degree or bachelor's degree, or currently enrolled	0.26**	0.24**	0.27**
Ever enrolled in a four-year college	0.29**	0.29**	0.32**
Number of students	1,913	1,908	1,919

Note: These estimates are the Pearson correlations of the student-level postsecondary outcomes and the student-level middle school achievement outcomes.

*Significantly different from zero at the .05 level, two-tailed test.

**Significantly different from zero at the .01 level, two-tailed test.

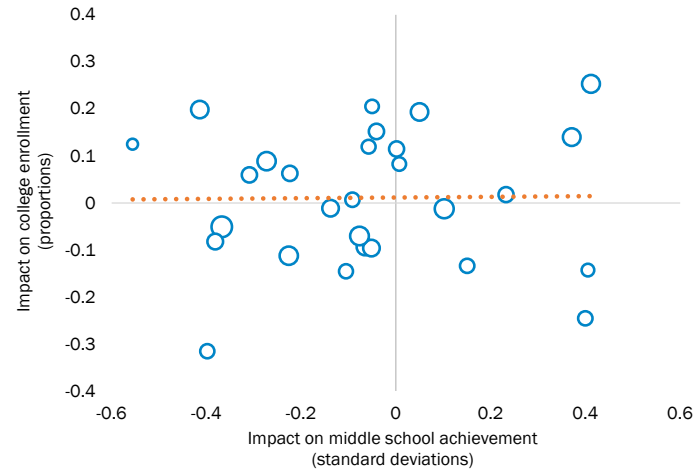
Table B.8. Charter school impacts on middle school academic achievement were not significantly correlated with impacts on college enrollment and completion

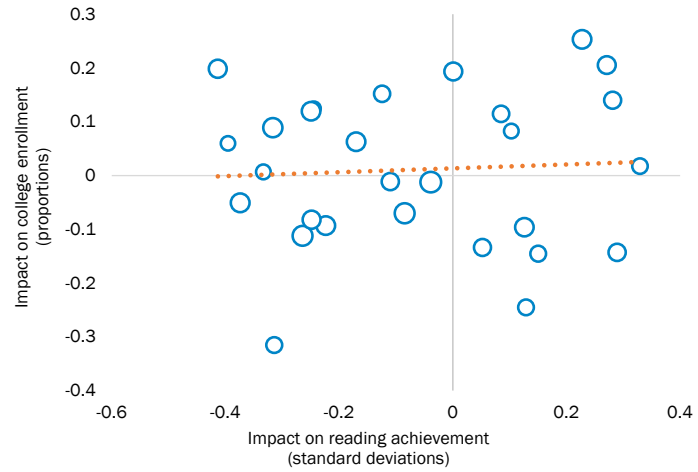
Postsecondary impacts	Correlation between impacts on middle school achievement and impacts on college enrollment and completion		
	(1) Year 2 reading score impacts	(2) Year 2 math score impacts	(3) Year 2 math and reading score impacts
Ever enrolled in any postsecondary institution	0.06	0.00	0.01
Obtained a certificate, associate's degree or bachelor's degree, or currently enrolled	0.14	0.15	0.16
Ever enrolled in a four-year college	-0.08	0.01	-0.04
Number of sites	28	28	28

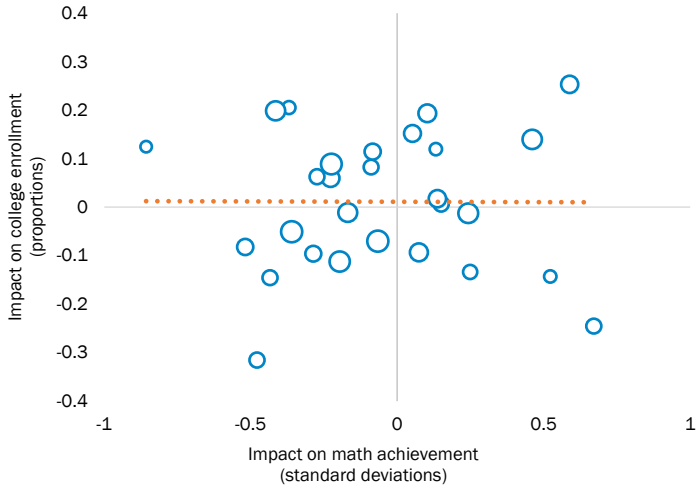
Note: These estimates are the Pearson correlations of the site-level postsecondary impact estimates and the site-level middle school achievement impacts.

The correlations are not statistically significant at the .05 level, two-tailed test.

Figure B.3. Scatter plots of charter school impacts on college enrollment versus impacts on middle school achievement

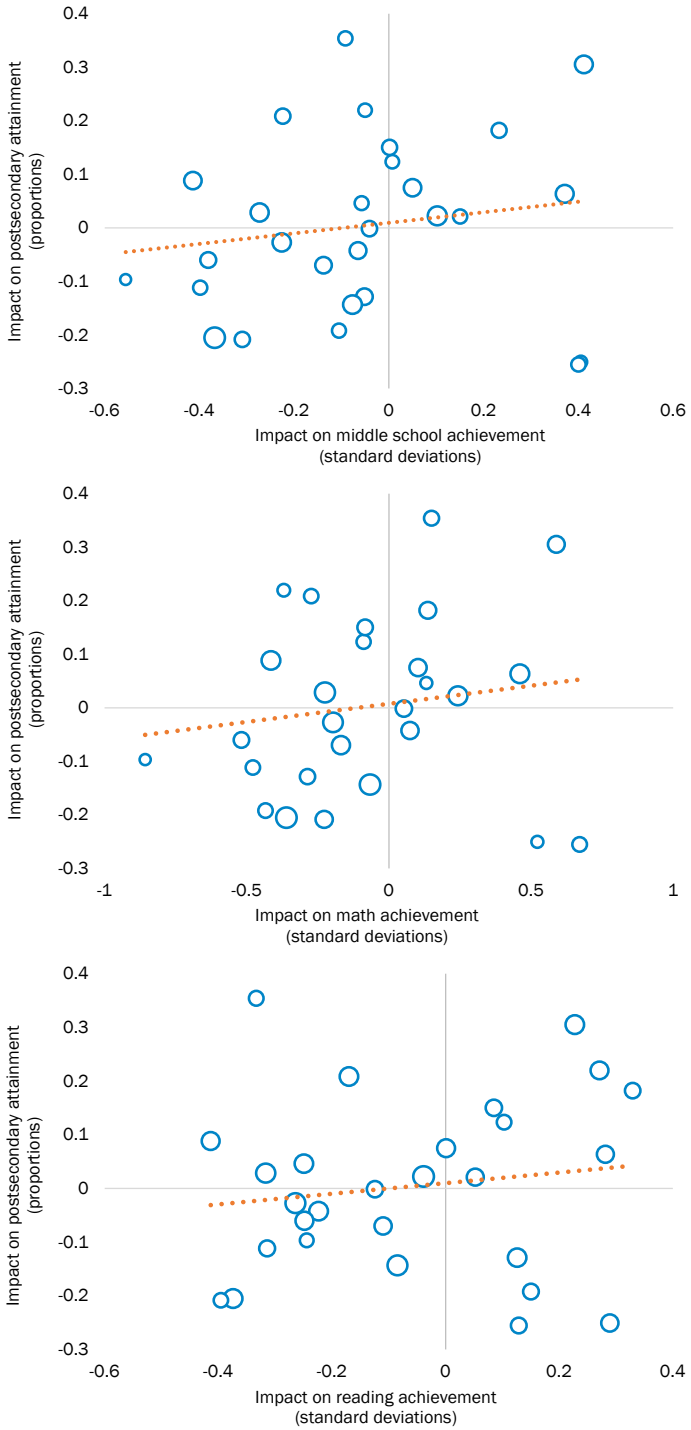






Note: Each circle in a graph represents the estimated impact of a single charter school site on students' middle school achievement (x-axis) and college enrollment (y-axis). Each dotted line represents the correlation between the impacts on achievement and the impacts on college outcomes, estimated with a linear regression model. Larger circles represent more precise estimates of a charter school site's impact on students' middle school achievement, and smaller circles represent less precise estimates. (The area of each circle is proportional to the inverse of the standard error of that school's estimated impact on middle school achievement.)

Figure B.4. Scatter plots of charter school impacts on college completion versus impacts on middle school achievement



Note: Each circle in a graph represents the estimated impact of a single charter school site on students' middle school achievement (x-axis) and college completion (y-axis). Each dotted line represents the correlation between the impacts on achievement and the impacts on college outcomes, estimated with a linear regression model. Larger circles represent more precise estimates of a charter school site's impact on students' middle school achievement, and smaller circles represent less precise estimates. (The area of each circle is proportional to the inverse of the standard error of that school's estimated impact on middle school achievement.)

APPENDIX C: SENSITIVITY ANALYSES

This appendix describes the analyses that were conducted to test whether the main findings were sensitive to the method or approach that was used to produce the findings. In other words, these sensitivity analyses examined whether the results of the study would change if a different method was used. The study team conducted four types of sensitivity analyses: (1) changing the sample of students used to calculate the impacts on college outcomes, (2) changing how the impacts for individual charter middle schools in the study were combined to calculate the overall impact of the charter middle schools, (3) using different methods for estimating the impacts of charter schools, and (4) improving the precision of the correlational estimates. The results of the sensitivity analyses were consistent with the main findings, meaning that the findings were similar, regardless of the approach used.

Estimating impacts on college outcomes with the smaller sample of students used to estimate impacts on student achievement in the original study

This analysis was conducted to ensure that any differences in the estimates of charter schools' long-term effects on college outcomes (Findings 1 and 2) and their short-term effects on achievement (Gleason et al., 2010) were not caused by the use of different student samples to calculate each set of impacts. The impacts on college outcomes described under Findings 1 and 2 were based on almost all students for whom college information was available[24] – a sample of 2,873 students or 99 percent of all 2,904 students who went through lotteries at the study charter middle schools. This sample was substantially larger than the sample used to estimate the impacts of charter schools on students' middle school achievement in the original study (Gleason et al., 2010). To determine the sensitivity of Findings 1 and 2 to the students included in the analysis, the study team estimated charter schools' impacts on college enrollment and completion again but using the same group of students included in the original study sample—those with valid achievement test scores.[25] Like the main results, none of the main impact estimates (Table C.1) or the differences across subgroups (Table C.2) were statistically significant.

Estimating impacts with all students pooled together rather than estimating them separately by school and then combining

The average impact of admission to a charter middle school could vary depending on how it is calculated. The impacts on college outcomes presented under Finding 1 and Finding 2 were estimated separately by charter school site, and then combined by taking a simple average (mean value) of these site-specific impact estimates (with each site weighted equally in the calculation). To assess the sensitivity of the results, an alternative approach was used that first combined ("pooled") students from all sites and then calculated a single overall pooled impact estimate, rather than separate estimates for each charter school site. The pooled models included the same covariates as the main models that produced the estimates described in Findings 1 and 2. In practical terms, this pooled approach gives greater weight in the calculation of overall charter school impacts to those sites with more students in the analysis. The alternative results (columns 1 and 2 of Table C.3) were consistent with the main results: none of these impact estimates were statistically significant.

Estimating impacts on binary outcomes using logit and probit models

Most of the outcomes examined in this brief are "binary" in that they have two possible values – such as ever enrolled in college or not – and impacts for binary outcomes can be estimated in different ways that could conceivably produce different results. In the main analyses, ordinary least squares

(OLS) regression models (referred to as linear probability models when estimated with binary outcome variables) were used to estimate impacts because the results from linear probability models are easier to interpret than results based on other approaches. To ensure the study findings can be used with confidence, two different alternative approaches were used to reestimate the impacts of charter schools on the binary outcome variables (called logit and probit models) (columns 3–6 of Table C.3). The small number of students in each charter school site made it impossible to use the logit and probit models when calculating impacts separately by charter school site and averaging those site estimates together (the study's main approach). Instead the logit and probit models build on the pooled sample of students approach discussed above. Each of the logit and probit models also include the same covariates as the original models. As reported above, the pooled approach with OLS for the binary outcomes produced results similar to the main findings. Similarly, the logit and probit models with the pooled sample approach also produced results similar to the main findings: none of these alternate estimates of the impacts of charter schools on key outcomes were statistically significant. For comparability across the OLS and probit and logit models, all of the findings in Table C.3 are presented as marginal impacts.

Estimating correlations between charter schools' impacts on student achievement and college outcomes using weighted least squares models and larger sample to improve precision

It is possible that the study found no correlation between charter schools' impacts on middle school achievement and impacts and college outcomes because the estimates of impacts of individual charter schools were imprecise. In other words, the student samples may have been too small to allow us to estimate the impacts of each school with much certainty. The study conducted two sensitivity tests to improve precision in the correlational analysis: (1) giving more weight in the calculation of the correlation to the more precisely estimated charter school impacts than to the less precisely estimated impacts, and (2) increasing the sample size.

First, the correlations between middle school achievement impacts and college impacts were reestimated using a weighted least squares method, with the weights based on the precision of the school's estimated achievement impacts. This approach potentially provides more precise estimates of the correlations between a school's impacts on achievement and impacts on college outcomes. And because it gives different weight to different charter schools in the analysis, this estimated correlation itself could be different. Although the weighted least squares estimates do provide a more precise estimate of the correlation between impacts on achievement and impacts on college outcomes, none of the estimates were statistically significant (Table C.5), as in the main analysis.

Second, to maximize the sample size used to conduct the correlational analysis between charter schools' impacts on middle school achievement and college outcomes, impacts were estimated separately for each lottery in each school. Each of these estimated impacts was included as a separate observation in the analysis of correlations between impacts on achievement and attainment. For example, if a charter school conducted a lottery in 2005 for the 2005–2006 school year and in 2006 for the 2006–2007 school year, the school contributed two separate impact estimates as observations to the analysis. The same sample of students (2,356) and charter sites was used to separately estimate middle school achievement and college enrollment and completion impacts. Then, the correlations between the impacts were estimated again. Like the main analyses, none of the correlations were statistically significant.

Table C.1. Charter school impacts on college enrollment and completion, using smaller sample of students used to estimate achievement impacts in original study

Outcome	Impact of admission offer				Impact of attendance	
	(1) Mean, lottery winners	(2) Mean, lottery losers	(3) Difference (impact estimate)	(4) *p*-value	(5) Adjusted impact estimate	(6) *p*-value
Primary outcomes						
Ever enrolled in any postsecondary institution	0.72	0.71	0.01	0.662	0.00	0.941
Obtained a certificate, associate's degree, or bachelor's degree, or currently enrolled	0.48	0.48	0.00	0.898	-0.01	0.834
Exploratory outcomes related to college enrollment						
Ever enrolled in postsecondary institution						
2-year college	0.36	0.36	0.00	0.936	-0.01	0.869
4-year college	0.56	0.54	0.02	0.393	0.02	0.694
Type of institution where currently or most recently enrolled						
Public	0.59	0.58	0.01	0.778	0.00	0.951
Private nonprofit	0.12	0.12	0.00	0.912	0.00	0.909
Private for-profit	0.01	0.01	0.00	0.870	0.00	0.919
Selectivity of postsecondary institution						
Highly selective (1–25% acceptance rate)	0.03	0.02	0.01	0.273	0.01	0.222
Selective (26–50% acceptance rate)	0.15	0.14	0.00	0.826	-0.01	0.814
Somewhat selective (51–75% acceptance rate)	0.25	0.21	0.04	0.098	0.04	0.245
Less selective (76–100% acceptance rate)	0.30	0.33	-0.04	0.155	-0.06	0.225
Dual enrollment participation	0.10	0.10	0.01	0.750	0.01	0.702
Exploratory outcomes related to college completion						
Graduated from postsecondary institution[a]						
Associate's degree (2-year college)	0.03	0.04	-0.01	0.456	-0.01	0.585
Bachelor's degree (4-year college)	0.28	0.30	-0.02	0.527	-0.03	0.429
Graduated with bachelor's degree within 4 years of projected high school graduation	0.25	0.26	-0.01	0.673	-0.02	0.574
Graduated or currently enrolled						
Graduated with associate's degree or currently enrolled in 2-year college	0.06	0.05	0.01	0.438	0.02	0.374
Graduated with bachelor's degree or currently enrolled in 4-year college	0.41	0.41	0.00	0.887	-0.01	0.801
Number of years completed						
At 2-year college	0.41	0.40	0.01	0.819	0.00	0.986
At 4-year college	1.95	1.93	0.02	0.832	-0.04	0.844
At any postsecondary institution	2.51	2.48	0.02	0.840	-0.05	0.803
Middle school Year 2 achievement[b]						
Reading	0.31	0.38	-0.07	0.032+	-0.08	0.117
Math	0.32	0.38	-0.06	0.136	-0.08	0.202
Number of students	1,169	744	1,913		1,905	
Number of sites			28		28	

Note: The estimates presented in this table use nearly the same sample as the original study estimates. The original study sample included 1,920 students in the Year 2 estimates, including 1,172 in the lottery winners group and 748 in the

lottery losers group. The estimates shown here have seven fewer students because these students did not have dates of birth and therefore were omitted from the NSC data request and the analysis.

In both the lottery winners and lottery losers groups, 3 percent of students who attended a postsecondary institution opted out of sharing their data. In the student-level postsecondary data file, these students are indistinguishable from the students who never enrolled in a postsecondary institution, and are counted as if they never enrolled. Therefore, estimates presented in this table underestimate overall enrollment.

Means are estimated at the site level and then averaged across all 29 sites in the study. The estimates are weighted according to each student's probability of assignment to the lottery winner or lottery loser group.

The *p*-value represents the probability of finding the estimated difference or impact if, in fact, the true difference or impact was equal to 0.

[a] The sample for the graduation outcomes is limited to students who are projected to have completed college if they enrolled immediately after high school and for whom we have at least four years of additional data to measure college completion (n = 1,818 for the impact of admission offer estimates and n = 1,810 for the impact of attendance estimates).

[b] The achievement impact estimates are from Table IV.1 of Gleason et al. (2010).

*Significantly different from zero at the .05 level, two-tailed test.

**Significantly different from zero at the .01 level, two-tailed test.

+Difference significantly different from zero at the .05 level, two-tailed test.

++Difference significantly different from zero at the .01 level, two-tailed test.

Table C.2. Impacts on postsecondary enrollment and completion, by charter school characteristics, using smaller sample of students used to estimate achievement impacts in original study

Outcome	Percentage eligible for free or reduced-price meals			Percentage of white students			Mean pre-lottery achievement			Urbanicity		
	(1) Sites serving more economically advantaged students	(2) Sites serving fewer economically advantaged students	(3) Difference	(4) Sites serving more non-white students	(5) Sites serving more white students	(6) Difference	(7) Sites serving low-achieving students	(8) Sites serving high-achieving students	(9) Difference	(10) Sites outside of large urban areas	(11) Sites in large urban areas	(12) Difference
Primary outcomes												
Ever enrolled in any postsecondary institution	-0.01	0.03	0.04	0.04	-0.03	-0.08	0.01	0.00	-0.01	0.01	0.00	-0.02
Obtained a certificate, associate's degree, or bachelor's degree, or currently enrolled	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.01	0.02
Exploratory outcomes related to college enrollment												
Ever enrolled in postsecondary institution												
2-year college	-0.04	0.03	0.07	0.04	-0.06	-0.10~	0.02	-0.03	-0.05	-0.02	0.02	0.05
4-year college	0.01	0.02	0.01	0.04	0.00	-0.04	0.00	0.04	0.04	0.02	0.01	-0.01
Type of institution where currently or most recently enrolled												
Public	0.01	0.01	0.00	0.02	0.00	-0.02	0.02	0.00	-0.02	0.01	0.00	-0.01
Private nonprofit	-0.02	0.01	0.03	0.02	-0.03	-0.06	-0.01	0.00	0.01	0.00	-0.01	-0.01
Private for-profit	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Selectivity of postsecondary institution												
Highly selective (1–25% acceptance rate)	0.00	0.02*	0.02	0.01*	0.00	-0.02	0.00	0.01	0.01	0.00	0.01	0.01
Selective (26–50% acceptance rate)	0.01	0.00	0.00	0.02	-0.02	-0.04	0.00	0.01	0.00	0.00	0.01	0.01
Somewhat selective (51–75% acceptance rate)	0.02	0.05~	0.03	0.03	0.04	0.01	0.06*	0.01	-0.04	0.03	0.04	0.01
Less selective (76–100% acceptance rate)	-0.04	-0.04	0.00	-0.03	-0.05	-0.03	-0.05	-0.03	0.02	-0.02	-0.07	-0.05
Dual enrollment participation	-0.01	0.03	0.05	0.01	0.00	-0.01	0.01	0.00	-0.01	0.02	-0.01	-0.03
Exploratory outcomes related to college completion												
Graduated from postsecondary institution[a]												
Associate's degree (2-year college)	-0.01	0.00	0.01	0.00	-0.02	-0.02	0.00	-0.01	0.00	-0.01	0.00	0.02

Outcome	Percentage eligible for free or reduced-price meals			Percentage of white students			Mean pre-lottery achievement			Urbanicity		
	(1) Sites serving more economically advantaged students	(2) Sites serving fewer economically advantaged students	(3) Difference	(4) Sites serving more non-white students	(5) Sites serving more white students	(6) Difference	(7) Sites serving low-achieving students	(8) Sites serving high-achieving students	(9) Difference	(10) Sites outside of large urban areas	(11) Sites in large urban areas	(12) Difference
Bachelor's degree (4-year college)	0.00	-0.05	-0.05	-0.03	-0.02	0.01	-0.06~	0.01	0.07	-0.01	-0.06	-0.05
Graduated with bachelor's degree within 4 years of projected high school graduation	0.01	-0.05~	-0.07	-0.02	-0.01	0.01	-0.06*	0.03	0.09~	0.00	-0.04	-0.04
Graduated or currently enrolled												
Graduated with associate's degree or currently enrolled in 2-year college	-0.01	0.03~	0.04~	0.03*	-0.02	-0.05~	0.02	-0.01	-0.03	0.00	0.03	0.03
Graduated with bachelor's degree or currently enrolled in 4-year college	0.03	-0.03	-0.06	-0.01	0.01	0.02	-0.02	0.02	0.04	0.00	-0.01	-0.01
Number of years completed												
At 2-year college	0.03	-0.02	-0.05	0.04	-0.04	-0.08	0.06	-0.06	-0.12	0.00	0.01	0.01
At 4-year college	0.08	-0.06	-0.14	-0.02	0.06	0.08	-0.04	0.07	0.11	0.09	-0.16	-0.25
At any postsecondary institution	0.07	-0.09	-0.16	0.05	-0.06	-0.11	0.03	-0.04	-0.07	0.07	-0.15	-0.21
Middle school Year 2 achievement[b]												
Reading	-0.11	0	0.11	-0.08*	-0.03	0.05	0.03	-0.15**	-0.17++	-0.08*	-0.02	0.06
Math	-0.24**	0.18**	0.41++	0.01	-0.11	-0.12	0.12*	-0.21**	-0.33++	-0.14**	0.16*	0.30++
Number of students	817	1,096	1,913	1,235	678	1,913	1,025	888	1,913	1,275	638	1,913
Number of sites	15	13	28	15	13	28	14	14	28	19	9	28

Note: The estimates presented in this table use nearly the same sample as the original study estimates. The original study sample included 1,920 students. The estimates shown here have seven fewer students because these students did not have dates of birth and therefore were omitted from the NSC data request and the analysis.

In both the lottery winners and lottery losers groups, 3 percent of students who attended a postsecondary institution opted out of sharing their data. In the student-level postsecondary data file, these students are indistinguishable from the students who never enrolled in a postsecondary institution, and are counted as if they never enrolled. Therefore, estimates presented in this table underestimate overall enrollment.

[a] The sample for the graduation outcomes is limited to students who are projected to have completed college if they enrolled immediately after high school and for whom we have at least four years of additional data to measure college completion (n = 1,818).

[b] The achievement impact estimates are from Tables G.11, G.14, G.15, and G.16 of Gleason et al. (2010). The reported sample sizes vary depending on the charter school characteristic.

*Significantly different from zero at the .05 level, two-tailed test.

**Significantly different from zero at the .01 level, two-tailed test.

+Difference is significantly different from zero at the .05 level, two-tailed test.

++Difference is significantly different from zero at the .01 level, two-tailed test.

~Estimate or difference is significantly different from zero at the .10 level, two-tailed test.

Table C.3. Impact estimates using ordinary least squares (OLS), logit, and probit models for pooled sample of all students

Postsecondary impacts	(1) OLS impact estimate	(2) *p*-value	(3) Logit impact estimate	(4) *p*-value	(5) Probit impact estimate	(6) *p*-value
Primary outcomes						
Ever enrolled in any postsecondary institution	0.01	0.655	0.01	0.675	0.01	0.590
Obtained a certificate, associate's degree, or bachelor's degree, or currently enrolled	0.01	0.799	0.00	0.836	0.00	0.816
Exploratory outcomes related to college enrollment						
Ever enrolled in postsecondary institution						
2-year college	-0.01	0.637	-0.01	0.648	-0.01	0.606
4-year college	0.03	0.171	0.03	0.186	0.03	0.170
Type of institution where currently or most recently enrolled						
Public	0.01	0.557	0.01	0.525	0.01	0.529
Private nonprofit	-0.01	0.590	0.00	0.739	-0.01	0.680
Private for-profit[c]	0.00	0.511		0.914		0.767
Selectivity of postsecondary institution						
Highly selective (1–25% acceptance rate)	0.01	0.112	0.01	0.219	0.01	0.324
Selective (26–50% acceptance rate)	0.01	0.316	0.02	0.220	0.02	0.219
Somewhat selective (51–75% acceptance rate)	0.03	0.107	0.03	0.071	0.03	0.091
Less selective (76–100% acceptance rate)	-0.04*	0.024	-0.04*	0.039	-0.04*	0.034
Dual enrollment participation	-0.01	0.593	-0.01	0.489	-0.01	0.408
Exploratory outcomes related to college completion						
Graduated from postsecondary institution[a]						
Associate's degree (2-year college)	-0.01	0.541	0.00	0.689	-0.01	0.443
Bachelor's degree (4-year college)	-0.01	0.721	0.00	0.800	-0.01	0.764
Graduated with bachelor's degree within 4 years of projected high school graduation	0.00	0.819	0.00	0.967	0.00	0.930

Postsecondary impacts	(1) OLS impact estimate	(2) *p*-value	(3) Logit impact estimate	(4) *p*-value	(5) Probit impact estimate	(6) *p*-value
Graduated or currently enrolled						
Graduated with associate's degree or currently enrolled in 2-year college	0.01	0.622	0.01	0.563	0.01	0.577
Graduated with bachelor's degree or currently enrolled in 4-year college	0.01	0.525	0.01	0.531	0.01	0.547
Number of years completed[b]						
At 2-year college	-0.04	0.393	-	-	-	-
At 4-year college	0.08	0.375	-	-	-	-
At any postsecondary institution	0.03	0.754	-	-	-	-
Number of students	2,895		2,895		2,895	

Note: The impact estimates are the marginal effects. Therefore, the logit and probit estimates are directly comparable to the impact estimates from the OLS models.

In both the lottery winners and lottery losers groups, 3 percent of students who attended a postsecondary institution opted out of sharing their data. In the student-level postsecondary data file, these students are indistinguishable from the students who never enrolled in a postsecondary institution, and are counted as if they never enrolled. Therefore, estimates presented in this table underestimate overall enrollment by approximately 3 percentage points.

The estimates are weighted according to each student's probability of winning the charter school lottery.

The *p*-value represents the probability of finding the estimated difference or impact if, in fact, the true difference or impact was equal to 0.

[a]The sample for the graduation outcomes is limited to students who are projected to have completed college if they enrolled immediately after high school and for whom we have at least four years of additional data to measure college completion (n = 2,511 for the impact of admission offer estimates and n = 2,466 for the impact of attendance estimates).

[b]Because number of years completed is a continuous variable, we do not report results from the logit and probit models.

[c]The logit and probit models for attendance at private for-profit colleges did not converge because only about 1 percent of students attended these types of colleges.

*Significantly different from zero at the .05 level, two-tailed test.

**Significantly different from zero at the .01 level, two-tailed test.

Table C.4. Predicted difference in postsecondary impacts, given a one standard deviation increase in impacts on middle school academic achievement, using weighted least squares method

Postsecondary impacts	One standard deviation increase in Year 2 reading score impacts		One standard deviation increase in Year 2 math score impacts		One standard deviation increase in average Year 2 math and reading score impacts	
	(1) Predicted change in postsecondary impacts	(2) *p*-value	(3) Predicted change in postsecondary impacts	(4) *p*-value	(5) Predicted change in postsecondary impacts	(6) *p*-value
Ever enrolled in any postsecondary institution	0.16	0.140	0.04	0.537	0.10	0.291
Obtained a certificate, associate's degree, or bachelor's degree, or currently enrolled	0.14	0.259	0.06	0.500	0.11	0.356
Ever enrolled in a four-year college	0.14	0.313	0.12	0.186	0.16	0.195
Number of students	2,356	2,356	2,356	2,356	2,365	2,365
Number of sites	33	33	33	33	33	33

Note: We calculated these estimates by using weighted least squares regressions, with analytic weights based on the precision of a school's estimated achievement impacts. We report the predicted difference in postsecondary impacts (as a proportion), given a one standard deviation increase in student middle school achievement impacts.

The *p*-value represents the probability of finding the estimated difference or impact if, in fact, the true difference or impact was equal to 0.

To maximize sample size, we treated sites that conducted more than one lottery as two separate sites. This increased the sample size from the main impact estimates by two sites.

Table C.5. Students with higher middle school academic achievement were predicted to have higher rates of college enrollment and completion

Postsecondary outcomes	One standard deviation increase in Year 2 reading scores		One standard deviation increase in Year 2 math scores		One standard deviation increase in average Year 2 math and reading scores	
	(1) Predicted change in postsecondary outcomes	(2) *p*-value	(3) Predicted change in postsecondary outcomes	(4) *p*-value	(5) Predicted change in postsecondary outcomes	(6) *p*-value
Ever enrolled in any postsecondary institution	0.08**	0.000	0.06**	0.000	0.08**	0.000
Obtained a certificate, associate's degree, or bachelor's degree, or currently enrolled	0.13**	0.000	0.10**	0.000	0.14**	0.000
Ever enrolled in a four-year college	0.15**	0.000	0.12**	0.000	0.16**	0.000
Number of students	2,356	2,356	2,346	2,346	2,365	2,365

Note: These estimates were calculated by regressing each postsecondary outcome on each middle school achievement outcome, using linear probability models with robust standard errors and weights to account for different selection probability of each student. The reported estimates are a student's predicted change in postsecondary outcome (as a proportion), given a one standard deviation increase in student middle school achievement.

The *p*-value represents the probability of finding the estimated difference or impact if, in fact, the true difference or impact was equal to 0.

*Significantly different from zero at the .05 level, two-tailed test.

**Significantly different from zero at the .01 level, two-tailed test.

Table C.6. Estimated impacts of charter schools on middle school achievement did not significantly predict estimated impacts on college enrollment and completion

Postsecondary impacts	One standard deviation increase in Year 2 reading score impacts		One standard deviation increase in Year 2 math score impacts		One standard deviation increase in average Year 2 math and reading score impacts	
	(1) Predicted change in postsecondary impacts	(2) *p*-value	(3) Predicted change in postsecondary impacts	(4) *p*-value	(5) Predicted change in postsecondary impacts	(6) *p*-value
Ever enrolled in any postsecondary institution	0.05	0.634	-0.01	0.862	0.01	0.962
Obtained a certificate, associate's degree or bachelor's degree, or currently enrolled	0.11	0.429	0.06	0.532	0.10	0.466
Ever enrolled in a four-year college	0.04	0.807	0.04	0.723	0.05	0.769
Number of students	2,356	2,356	2,356	2,356	2,365	2,365
Number of sites	33	33	33	33	33	33

Note: These estimates were calculated by regressing the site-level postsecondary impact estimates on each site-level middle school achievement impact, using linear probability models with robust standard errors. The reported estimates are the predicted difference in postsecondary impacts (as a proportion), given a one standard deviation increase in student middle school achievement impacts.

The *p*-value represents the probability of getting the estimated difference or impact if, in fact, the true difference or impact was equal to 0.

To maximize sample size, we treated sites that conducted more than one lottery as two separate sites. This increased the sample size from the main impact estimates by two sites.

The estimates are not statistically significant at the .05 level, two-tailed test.

Table C.7. Students' middle school academic achievement was positively correlated with college enrollment and completion

Postsecondary outcomes	(1) Year 2 reading scores	(2) Year 2 math scores	(3) Year 2 math and reading scores
Ever enrolled in any postsecondary institution	0.16**	0.15**	0.17**
Obtained a certificate, associate's degree or bachelor's degree, or currently enrolled	0.26**	0.24**	0.27**
Ever enrolled in a four-year college	0.29**	0.29**	0.32**
Number of students	2,356	2,346	2,365

Note: These estimates are the Pearson correlations of the student-level postsecondary outcomes and the student-level middle school achievement outcomes.

To maximize sample size, the sites that conducted more than one lottery were treated as two separate sites. This increased the sample size from the main impact estimates by two sites.

*Significantly different from zero at the .05 level, two-tailed test.

**Significantly different from zero at the .01 level, two-tailed test.

Table C.8. Charter school impacts on middle school academic achievement were not significantly correlated with impacts on college enrollment and completion

Postsecondary impacts	(1) Year 2 reading score impacts	(2) Year 2 math score impacts	(3) Year 2 math and reading score impacts
Ever enrolled in any postsecondary institution	0.08	-0.03	0.01
Obtained a certificate, associate's degree or bachelor's degree, or currently enrolled	0.15	0.11	0.14
Ever enrolled in a four-year college	0.05	0.08	0.07
Number of sites	33	33	33

Note: These estimates are the Pearson correlations of the site-level postsecondary impact estimates and the site-level middle school achievement impacts.

To maximize sample size, the sites that conducted more than one lottery were treated as two separate sites. This increased the sample size from the main impact estimates by two sites.

The correlations are not statistically significant at the .05 level, two-tailed test.

ENDNOTES

[1] Although growth has slowed recently, new charter schools continue to open each year. More than 300 new charter schools opened in fall 2017, and after accounting for schools that closed, there was a still nationwide increase of about 70 charters (David & Hesla, 2018).

[2] More recently, a Center for Research on Education Outcomes study (CREDO, 2017) focused mainly on the impacts of charter management organizations but also examined independent charter schools. That study found small but positive impacts of charter management organizations, on average, and impacts of independent charter schools that were close to zero.

[3] In addition to the research described here, a recent meta-analysis (Hitt, McShane, & Wolf, 2018) argued that in the area of school choice research more generally (including research on school voucher programs), "achievement impact estimates appear to be almost entirely uncorrelated with attainment impacts."

[4] Throughout this evaluation brief, *college enrollment* refers to students' enrollment in any postsecondary institution, including four-year colleges and universities, two-year colleges, and other postsecondary programs such as technical institutes. Similarly, the completion of a program of study at these institutions through receipt of a certificate, degree, or other credential is referred to as *college completion* or receipt of a *college degree*.

[5] See: Gleason, P., Clark, M., Tuttle, C. C., & Dwoyer, E. (2010). *The evaluation of charter school impacts: Final report* (NCEE 2010-4029). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education.

[6] Although 36 charter schools participated in the study, the analyses include only 31 charter school sites. Most charter schools are their own site, but in five cases two charter schools were combined into a single charter school site because these pairs of charter schools in the study shared some common applicants—students who applied to both schools in the pair. When this happened, the study team treated each pair as a single site and considered a student to be a lottery winner if he or she was offered admission to either of the schools in the pair.

[7] Although admissions offers did not guarantee that students would decide to attend the charter schools in this study, most lottery winners (78 percent) attended charter schools and most lottery losers (78 percent) attended traditional public schools.

[8] Nine students (three lottery winners and six lottery losers) were missing dates of birth, which are required for the National Student Clearinghouse data request. In addition, charter school sites with fewer than five lottery losers were excluded to ensure impact estimates were reliable. This led to an additional 22 students being excluded.

[9] Students in the study applied to charter schools for either the 2005–2006 or 2006–2007 school years and participated in school lotteries to enter into 4th, 5th, 6th, or 7th grade. Therefore, students would be expected to graduate from high school as early as 2011 and as late as 2015, with a majority of students (82 percent) expected to graduate in 2012 or 2013.

[10] The study used a statistical approach called linear regression analysis to account for any possible small differences in the two groups' characteristics just prior to the lottery. This analysis used sample weights to account for the fact that different students had different probabilities of being offered admission to the charter school, as described in Appendix A.

[11] To estimate the effect of attending a charter school, the study team used the standard approach for estimating the impact of the treatment on the treated (TOT) developed by Angrist et al. (1996). This approach also accounts for the fact that a small proportion of lottery losers attended a charter school. The estimated effect of attending a charter school is based on adjusting the study's estimate of the effect of being offered admission to a charter school using information on the proportion of lottery winners and lottery losers who attend a charter school.

[12] Because students were followed for a limited time after their expected high school graduation (three to seven academic years), some students may have still been on track to earn a degree or certificate when the data collection period ended. Therefore, the study measured whether a student had earned a degree or was still enrolled at the end of the data collection period in December 2017.

[13] The college enrollment rates of both lottery winners and losers could be as high as 72 percent. The National Student Clearinghouse (NSC) reports a count of the number of students in the data request file who were found in their records

but opted out of allowing the NSC to share their data. Three percent of students in each group enrolled in a postsecondary institution but opted not to share their data.

[14] A larger percentage of lottery winners than lottery losers enrolled in four-year schools (55 versus 52 percent), whereas the reverse was true of two-year school enrollment (32 percent among lottery winners and 35 percent among lottery losers). The difference between lottery winners and losers was not statistically significant for either outcome individually. However, another way of thinking about these results is that charter schools caused about 3 percent of students who would have enrolled in a two-year school to enroll in a four-year school instead; that is, they caused a shift in enrollment from two-year to four-year schools. This shift was marginally significant ($p = 0.097$). This effect is noted in the report's text because other studies, including Angrist et al. (2016), did not find effects of charter schools on college enrollment overall but did find a shift in enrollment from two-year to four-year colleges.

[15] The selectivity of each college was based on the reported percentage of students accepted for admission at each institution in IES's Integrated Postsecondary Education Data System.

[16] While the study was not able to document the high school that students attended, the NSC provides data on the dates and institutions of all colleges students attended, so it was possible to estimate which students took college courses while still in high school.

[17] The Every Student Succeeds Act (ESSA) requires states to develop accountability systems that report on student growth and English language and mathematics proficiency among other indicators. Title I, Part A provides funding for states to develop new college and career readiness assessments. Taken together, there is a clear assumption that achievement, as measured by academic assessments, should link to college readiness and therefore college outcomes.

[18] On average, lottery winners and losers with high middle school test scores were more likely to enroll in college and obtain a degree than those with lower scores. Middle school achievement was a stronger predictor of a student's college completion (correlation of 0.27) than whether the student enrolled in college at all (correlation of 0.18) (see Appendix B, Tables B.5 and B.7 for more detail). (A correlation of 0 would have indicated no relationship at all between students' middle school test scores and their college outcomes, while a correlation of 1 would have indicated that middle school test scores were a perfect predictor of students' long-term college enrollment and completion.) These correlations, which are substantially less than the maximum correlation of 1.0, suggest that other factors also contributed to these long-term outcomes. As a point of reference, the College Board (which administers the SAT) reported a correlation of 0.30 between SAT math scores and first-year college grade-point average (Shaw et al., 2016).

[19] Throughout this appendix, *college enrollment* refers to students' enrollment in any postsecondary institution, including four-year colleges and universities, two-year colleges, and other postsecondary programs such as technical institutes. Similarly, the completion of a program of study at these institutions through receipt of a certificate, degree, or other credential is referred to as *college completion* or receipt of a *college degree*.

[20] The original study team collected data on participating charter middle schools in fall 2006 and fall 2007. The team collected data on other charter middle schools in operation at the time of the study in fall 2007.

[21] A few students who were initially on the waiting list but were later offered admission to a study charter school after the first few months of the school year were also included in the lottery losers group.

[22] This study used the same models as Gleason et al. (2010), which followed the approach described by Angrist et al. (1996).

[23] The achievement impacts are reported in student standard deviation units. For example, an impact of one unit would indicate that admission to a charter school led to an increase in student achievement of one standard deviation in the student test score distribution. Most charter schools in the study had estimated impacts on student achievement in math and reading that were much less than 1, typically between -0.40 and +0.40.

[24] Twenty-two students from one charter site had college outcome data but were dropped from the analysis because the lottery loser group had fewer than five students. Because each charter site contributes equally to the results, Gleason et al. (2010) determined that sites with fewer than five students cannot be estimated with precision and therefore should be excluded from the analysis. To be consistent with that study, this analysis also adopted that approach.

[25] This sensitivity analysis included seven fewer students than the analyses from the original study because these students were lacking birth dates in the data. College outcome data were not available for these students, because birth dates are required for the NSC data request.

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