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ABSTRACT

Duke University's Talent Identification Program invites seventh graders who score in the top 3% on nationally normed, standardized tests to participate in the Talent Search. A small number of these students subsequently qualify, on the basis of relatively high ACT Assessment or SAT scores, for the Summer Residential Program (SRP), which provides intensive involvement in a particular academic subject. This study developed statistical evidence of how the SRP benefits students. The sample consisted of students who participated in the Talent Search between 1986 and 1992. The final file contained 35,317 records of Talent Search participants, 151 of whom were SRP participants. Results show that SRP participation is positively related to academically talented students' subsequent academic performance in high school, over and beyond their ACT scores as seventh graders. This information should be useful for encouraging academically talented students to participate in talent searches and intensive residential programs. Prospective students could be shown, for example, that SRP participants score about two scale score points higher on the ACT Mathematics test in high school, on average, than do Talent Search students who do not participate in the SRP. This finding is true regardless of the ACT Mathematics scores that Talent Search and SRP participants earn in seventh grade. Two appendixes contain charts of cumulative percentage distributions. (Contains 1 table, 4 references, and 24 figures.) (SLD)

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Abstract

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Academic Benefits in High School of an Intensive Summer Program for Academically Talented Seventh Graders

Duke University's Talent Identification Program (TIP) invites seventh graders who score in the top 3% on nationally normed, standardized tests to participate in the Talent Search. The purpose of the Talent Search is to identify and assist exceptionally able students whose academic needs are often not met in the traditional educational system. Students are provided various services through the Talent Search, including counseling and educational materials, recognition ceremonies, and a program that allows students to learn on their own.

Seventh graders who qualify for the Talent Search are invited to take either the ACT Assessment or the SAT, which are college admissions tests typically taken by high school juniors and seniors. This out-of-level testing experience offers an opportunity for Talent Search participants to demonstrate their academic skills and knowledge. In addition, the test scores are used to determine whether participants will qualify for recognition ceremonies and for the prestigious Summer Residential Program (SRP). A small percentage (about 6%) of Talent Search participants qualify, on the basis of relatively high ACT Assessment or SAT scores, for the SRP.

The hallmark of the SRP is intensive college-level instruction in a particular academic subject. Students choose several courses from an extensive list of offerings in history, language, mathematics, science, and social science, and TIP staff then assign students to courses on a first-come, first-served basis. Because SRP participants live and study for several weeks on the main campus of Duke University or on another associated campus, the SRP provides social interaction with similarly talented peers. SRP participants report experiencing both social and academic benefits as a result of

their involvement (Stocking, Cho, & Godfrey, 1996). Additional information about the Talent Search and the SRP may be found in Goldstein and Wagner (1993).

Given the intensive academic nature of the SRP, it seems plausible that participation in this program would be positively related to subsequent academic performance in high school. For example, SRP participants might be more likely to take advanced high school course work and to earn higher college admissions test scores, relative to Talent Search students who did not participate in the SRP. However, as Stocking et al. (1996) note, there has been little empirical research on the academic benefits of intensive summer programs for academically talented students. The purpose of this study, therefore, was to develop statistical evidence of how the SRP benefits Talent Search students. This was done by examining differences between SRP participants and nonparticipants in their subsequent academic performance in high school, as measured by ACT Assessment scores, high school grade averages, and advanced course work.

Data

The sample consisted of students who participated in TIP's Talent Search as 7th graders between 1986 and 1992. Each student record included 7th-grade ACT Assessment scores, corresponding 11th- or 12th-grade ACT Assessment scores, and information on 30 different high school courses, which students report when registering to take the ACT Assessment. Course information from the SRP was also available for students who participated in that program. The final file contained 35,317 records of Talent Search participants, 151 of which were from SRP participants.

It has been determined that ACT-tested students accurately report courses taken about 87% of the time, and that the rate of agreement between reported grades and those recorded on transcripts is about 71% (Sawyer, Laing, & Houston, 1988). These levels of accuracy, to the extent that they are generalizable to Talent Search participants, are likely sufficient for estimating group differences within the context of this study. It is conceivable, however, that Talent Search participants may differ from the overall population of ACT-tested high school students with respect to accuracy of course and grade reporting.

The SRP course information indicated that 40 students had taken a mathematics course of some type while participating in the SRP. This subgroup was considered sufficiently large that relationships between SRP mathematics course taking and other variables (e.g., high school ACT Mathematics score, high school mathematics grade average) could be analyzed. Too few students took SRP English, science, history, or social science courses for similar analyses to be performed for these courses.

Figure 1 illustrates the three samples investigated in this study. Note that students taking a mathematics course during the SRP (n=40) are a subset of the SRP participants (n=151), which are a subset of the Talent Search participants (n=35,317). The remainder of this section describes how these samples were obtained.

File Development

A file containing the names of SRP courses taken by 4,698 participants was matched with ACT's longitudinal Talent Search file, which has ACT Assessment scores and self-reported background information for 127,860 students who took the ACT

Assessment one or more times during the academic years 1986-87 through 1995-96 and sent their scores to TIP. This match yielded a total of 151 student records with 7th-grade ACT Assessment data, SRP course-taking information, and 11th- or 12th-grade ACT Assessment data. The majority of unmatched records belonged to Talent Search participants who elected to take the SAT, rather than the ACT Assessment. Note that the size of the longitudinal Talent Search file decreased considerably, to 35,317 records, because the records of all Talent Search students whose last ACT Assessment testing occurred prior to 11th-grade, or who had missing data for one or more of the variables examined, were excluded.

One potential limitation of this study is that no information was collected on any academic activities that might have occurred outside the SRP. For example, it is not known whether students engaged in reading and studying on their own, over and beyond their participation in the SRP. Such activities could, of course, be positively related to subsequent academic performance in high school.

Current and former ACT Assessment scores. In October 1989, a revised version of the ACT Assessment was introduced. The ACT Assessment is a curriculum-based test of educational development that is used for college admissions and placement. Scale scores on the ACT Assessment range from 1 to 36 for each of the four subject-area tests (English, Mathematics, Reading, and Science Reasoning) and for the Composite score, which is calculated by averaging the subject-area test scale scores.

The ACT English, Mathematics, and Composite scores of Talent Search students who took the pre-1989 version of the ACT Assessment were converted, using the

concordance tables for these tests (ACT, 1989), to estimated English, Mathematics, and Composite scores on the current (post-1989) ACT Assessment. Because the current Reading and Science Reasoning tests differ substantially in content from the former Social Studies Reading and Natural Sciences Reading tests, concordances between these tests were not developed. Including in the sample only those students who took the current ACT Assessment would have enabled some analyses to be performed on Reading and Science Reasoning scores, but would have resulted in a significant decrease in the number of SRP participants, which was already fairly small. This restriction was therefore not imposed in order to maximize the sample size. As a result, no analyses were performed on Reading and Science Reasoning scores.

SRP participation requirements. The minimum ACT Assessment and SAT scores required for participation in the SRP vary somewhat from year to year and, in addition, can differ depending on the difficulty of the particular course a student wishes to take. For example, the current ACT Assessment scores required for participation in relatively less difficult SRP courses are either a Mathematics score of 20 or higher, or an English score of 27 or higher. Alternatively, a student may participate if he or she has a Mathematics score of 19 or higher *and* an English score of 25 or higher. As a result of these requirements, it is possible for students with low scores on either the Mathematics or English test to participate in the SRP, provided that they earn the minimum score required on the other test.

Occasionally, students who are not participating in the Talent Search will apply directly to the SRP for admission. The educational experiences of these students likely

differ from those of students who participated in both the Talent Search and the SRP. The records of direct applicants (n=2) were therefore not included.

Method

Linear Modeling

One way to examine relationships between SRP participation and academic performance in high school is with linear modeling, in which seventh-grade academic skills and knowledge (as measured by ACT Assessment scores) are statistically controlled. Controlling for seventh-grade academic skills and knowledge is important; otherwise, it cannot be determined conclusively whether the relatively high academic performance of SRP participants in high school is related to attending the SRP, or whether it instead reflects participants' relatively high academic skills and knowledge prior to beginning this program.

Using linear modeling, comparisons were made between the academic performance of Talent Search students who participated in the SRP and that of Talent Search students who did not participate in this program. In addition, the performance of Talent Search students who took an SRP mathematics course, Talent Search students who took an SRP course other than mathematics, and Talent Search students who did not participate in the SRP was compared. Academic outcome variables included 11th- or 12th-grade ACT Assessment scores, high school grade average of 30 courses, subject-area grade averages, and number of high school courses taken in certain subject areas.

A linear model for comparing the high school ACT Assessment performance of SRP participants and nonparticipants, for example, may be expressed as

$$Y_{ij} = \mu + \tau_j + \gamma(X_{ij} - \bar{X}) + \varepsilon_{ij} ,$$

where Y_{ij} = high school ACT Assessment score of the *i*th student in treatment *j*,

μ = overall mean high school ACT score,

τ_j = treatment effect (participated in Talent Search and SRP; participated in Talent Search, but not SRP),

γ = regression effect of the covariate (seventh-grade ACT score), and

X_{ij} = seventh-grade ACT score of the *i*th student in treatment *j*.

This model yields estimated adjusted treatment means that reflect the effect of the covariate. Pairwise comparison tests were performed to determine whether differences between the adjusted treatment means were statistically significant. In addition, effect sizes were calculated to determine whether differences between these means were substantive; i.e., significant in a practical sense.

An important assumption in the linear model above is that the slopes of the two treatment regression lines are the same. If this assumption was not met, then the model was not used; separate within-treatment regression functions were compared instead.

Logistic Regression

Some of the academic outcome variables were dichotomous (e.g., whether or not a student took calculus in high school). One way to model such variables as a function of seventh-grade ACT Assessment score X is with a logistic regression function

$$\pi = (1 + e^{-\alpha-\beta x})^{-1} ,$$

where α and β are the parameters. If a dichotomous outcome variable is represented by a 0, 1 indicator variable, then the logistic regression function yields a probability. For example, if calculus course-taking (1 = took calculus, 0 = did not take) is modeled as a function of seventh-grade ACT Mathematics score, then $\hat{\pi}$ is the estimated conditional probability of taking calculus, given seventh-grade Mathematics score.

Separate (within-treatment) logistic regression models were developed and then compared for the two combinations of groups described previously: 1) SRP participants and nonparticipants, and 2) participants who took an SRP mathematics course, participants who took a course other than mathematics, and nonparticipants.

Results

When interpreting the results of this study, it is important to remember that students who did not participate in the SRP did participate in the Talent Search. These students, referred to as "nonparticipants," resemble SRP participants in that they are also very talented academically, relative to the general population of seventh-grade students. This is reflected in the high ACT Assessment scores and course grades earned by SRP participants and nonparticipants alike.

ACT Mathematics Scores

SRP participants vs. nonparticipants. Figure 2 shows (unadjusted) mean ACT Mathematics scores for SRP participants and nonparticipants. As expected, SRP participants had higher 7th-grade ACT Mathematics scores, on average, than did nonparticipants ($\bar{X}$=19.3 vs. 15.4, respectively). This was also true of ACT Mathematics

scores earned in grade 11 or 12 ($\bar{x}$=29.7 vs. 24.6, respectively). It is interesting to note, for comparative purposes, that the 1996 mean Mathematics score of ACT-tested high school students nationwide (20.2) was considerably lower than those of both SRP participants and nonparticipants when they were high school students.

In Figure 3, the regression of high school Mathematics score on 7th-grade Mathematics score is illustrated for SRP participants (represented by the solid line) and nonparticipants (represented by the dashed line). Each regression line has 95% confidence bands around it. Note that the plot points in this figure may represent more than one observation. For example, there were 72 nonparticipants who earned a 7th-grade ACT Mathematics score of 8 and a high school Mathematics score of 18.

The confidence bands around the regression lines in Figure 3 overlap for 7th-grade ACT Mathematics scores of about 25 or higher. The results shown in this figure indicate that SRP participants consistently outperformed nonparticipants on the ACT Mathematics test in high school, provided that students' 7th-grade Mathematics scores were lower than 25.

Nearly all Talent Search students in this study earned 7th-grade Mathematics scores lower than 25; the percentages of SRP participants and nonparticipants earning 7th-grade ACT Mathematics scores in this interval were 95% and nearly 100%, respectively. (See Appendix A, which contains distributions of 7th-grade ACT score cumulative percentages, rounded to the nearest integer, for SRP participants and nonparticipants.)

The regression lines in Figure 3 appear reasonably parallel, and a statistical test did not contradict this assumption. A linear model was therefore developed in which the treatment effect of SRP participation, adjusted for seventh-grade Mathematics score, was found to be statistically significant ($p<.0001$).

Estimated adjusted treatment means, with approximate 95% confidence limits, are shown in Figure 4. The dotted lines in this figure pass directly through the adjusted mean ACT Mathematics scores. Figure 4 illustrates that SRP participants earned higher ACT Mathematics scores in high school (adjusted mean = 26.4) than did nonparticipants (adjusted mean = 24.6) when 7th-grade ACT Mathematics performance was statistically controlled. There was a statistically significant ($p<.0001$) difference between the adjusted means for participants and nonparticipants. This is reflected in the non-overlapping confidence intervals for the two means. Note that the confidence interval around the mean for nonparticipants is relatively narrow; this is a result of the very large sample size for this group.

Although the difference between the two means in Figure 4 is statistically significant, it may not necessarily be substantive. One way to evaluate the substantiveness of differences between mean ACT Assessment scores is with effect sizes, which express the difference between means in terms of standard deviation units. An effect size for the difference between means for SRP participants and nonparticipants was calculated using the pooled ACT Mathematics standard deviation of the two groups as a denominator. The effect size for the difference between the mean high school ACT Mathematics scores for SRP participants and nonparticipants was .45. Representing a

difference between means of nearly one-half of an ACT standard deviation unit, the size of this effect is readily noticeable, and suggests that the average ACT Mathematics performance of SRP participants was meaningfully higher than that of nonparticipants.

SRP mathematics course takers vs. other groups. Figure 5 shows mean ACT Mathematics scores for SRP participants who took a mathematics course of any type (except for computer applications of mathematics) while attending the SRP. This figure also shows mean Mathematics scores of nonparticipants and mean Mathematics scores of SRP participants who took an SRP course other than mathematics. Talent Search students who took an SRP mathematics course had higher 7th-grade and high school mean ACT Mathematics scores (22.2 and 31.8, respectively) than did Talent Search students who took another type of SRP course (18.3 and 29.0) or who did not participate in the SRP (15.4 and 24.6).

The regression of high school ACT Mathematics score on 7th-grade ACT Mathematics score is shown for the three groups in Figure 6. The regression lines for SRP participants who took a mathematics course and those who took another type of course (represented by the solid line and heavy dashed line, respectively) illustrate that the high school ACT Mathematics performance of these two groups was higher than that of nonparticipants, given certain 7th-grade Mathematics scores. Participants who took a mathematics course and earned 7th-grade ACT Mathematics scores of about 20 or lower earned higher high school ACT Mathematics scores, on average, than did participants who took another type of course. A large percentage (80%) of SRP participants who took a course other than mathematics earned 7th-grade ACT

Mathematics scores of 20 or lower. In comparison, only 18% of SRP mathematics course takers earned 7th-grade Mathematics scores of 20 or lower. (These results are shown in Appendix B, which contains cumulative percentage distributions of 7th-grade ACT Mathematics score.)

Figure 6 also shows that SRP mathematics course takers earned higher high school Mathematics scores than did Talent Search students who did not participate in the SRP, given 7th-grade Mathematics scores of 26 or lower. Ninety-five percent of SRP mathematics course takers earned 7th-grade ACT Mathematics scores of 26 or lower; 100% of nonparticipants earned scores in this interval.

When confidence bands were placed around the regression lines in Figure 6, differentiation among them became difficult, and they are not illustrated here for this reason. Confidence bands (68%) did, however, show considerable overlap for the SRP mathematics course takers and SRP other course takers, suggesting caution when interpreting the performance differences illustrated in Figure 6 for these groups.

A statistical test of the slopes of the regression lines in Figure 6 indicated that they were not statistically significantly different from each other ($p=.30$). A subsequent linear model indicated a statistically significant ($p<.0001$) treatment effect, adjusted for 7th-grade ACT Mathematics score. Estimated adjusted treatment means, with approximate 95% simultaneous confidence limits, are plotted in Figure 7. The adjusted high school ACT Mathematics mean for students who took a mathematics course was slightly lower than that of students who took another type of course (26.0 vs. 26.5). These two means were not statistically significantly different from each other ($p\geq.05$). The adjusted high

school ACT Mathematics mean for nonparticipants (24.6) was statistically significantly lower ($p<.05$) than those of the other two groups.

Effect sizes for the differences between the adjusted means of SRP mathematics course takers, other course takers, and nonparticipants are shown in Table 1. The absolute value of the effect size for the difference between the mean ACT Mathematics score of SRP mathematics course takers and that of other course takers (.12) was fairly small, indicating that there was no substantive difference in the performance of these groups. Relatively large effect sizes were found for SRP mathematics course takers/nonparticipants (.37) and for SRP other course takers/nonparticipants (.49), suggesting that differences between the ACT Mathematics means of these groups were substantive.

Table 1

Effect Sizes for Pairs of Estimated Adjusted Mean High School ACT Mathematics Scores, by SRP Participation

	SRP participation	
SRP participation	Mathematics course	Other course
Other course	-.12	
None	.37	.49

ACT English Scores

Unadjusted mean ACT English scores for SRP participants and nonparticipants are illustrated in Figure 8. Not surprisingly, both the 7th-grade and high school ACT English score means of SRP participants (24.2 and 30.5, respectively) were higher than

those of nonparticipants (17.7 and 26.1, respectively). In comparison, the 1996 mean English score for ACT-tested high school students nationwide was 20.3.

The regression of high school ACT English score on 7th-grade ACT English score is plotted in Figure 9 for SRP participants and nonparticipants. This figure illustrates that SRP participants with 7th-grade ACT English scores of about 22 or lower earned higher English scores in high school, on average, than did nonparticipants with equivalent 7th-grade English scores.

A statistical test indicated that the slopes of the regression lines in Figure 9 differed significantly for SRP participants and nonparticipants. A linear model containing a term representing the effect of SRP participation was therefore not considered appropriate for analyzing these data.

It is possible that the relationship between 7th-grade ACT English score and 11th- or 12th-grade English score is nonlinear, and that if a polynomial regression model were fitted to these data, then somewhat different results might be found. Figure 10 illustrates the polynomial regression of high school ACT English score on 7th-grade English score. A second-order polynomial model was used

$$Y_i = \beta_0 + \beta_1 X_i + \beta_2 X_i^2 + \varepsilon_i ,$$

where Y_i and X_i are the high school and 7th-grade ACT English scores, respectively, of the ith student.

For SRP participants, the second-order polynomial model yielded a slightly larger R^2 than that of the linear model (.38 vs. .36). The increase in the proportion of variance

accounted for by the second-order polynomial model was statistically significant ($p<.05$). For nonparticipants, the second-order model similarly yielded a statistically significant ($p<.001$) increase in proportion of variance accounted for, although R^2 remained nearly identical to that of the linear model (.433 vs. .431).

Figure 10 shows that SRP participants outperformed nonparticipants on the ACT English test in high school, provided that students' 7th-grade English scores were between 12 and 24. Given that very few students earned 7th-grade English scores below 12, these results do not differ greatly from those of the linear models (Figure 9).

Third-order polynomial models were also developed for SRP participants and nonparticipants. However, for SRP participants, the regression coefficient corresponding to the cubic term in the model was not statistically significant ($p=.93$).

ACT Composite Scores

Figure 11 illustrates (unadjusted) mean ACT Composite scores for SRP participants and nonparticipants. It can be seen in this figure that the 7th-grade and high school Composite score means of SRP participants (22.2 and 30.6, respectively) were, as expected, higher than those of nonparticipants (17.1 and 25.9, respectively). The 1996 mean Composite score of ACT-tested high school students nationwide (20.9) was considerably lower than those of SRP participants and nonparticipants when they were high school students.

In Figure 12, the regression of high school Composite score on 7th-grade Composite score is illustrated for SRP participants and nonparticipants. This figure shows that SRP participants with 7th-grade Composite scores of 20 or lower earned, on

average, higher Composite scores in high school than did nonparticipants with equivalent 7th-grade Composite scores. Results of second-order polynomial models were similar to those of the linear models.

An ACT Composite score of 27 is a fairly high score; nationwide, only 10% of ACT-tested high school students earn Composite scores higher than this. Figure 13 illustrates estimated conditional probabilities of earning an ACT Composite score of 27 or higher in high school, given 7th-grade Composite score. The dotted lines at the ends of the logistic regression curves in this figure illustrate that the curves were extrapolated to 7th-grade ACT Composite scores beyond the range of observed scores by using the respective logistic regression functions. Sixty-eight percent confidence bands are shown around each logistic curve.

The logistic regression curves in Figure 13 illustrate that SRP participants had a greater estimated conditional probability of earning a Composite score of 27 or higher in high school than did nonparticipants, given a 7th-grade ACT Composite score between 16 and 21. For example, SRP participants who earned a Composite score of 18 in 7th grade had a 74% chance of earning a 27 or higher in high school. Nonparticipants, in comparison, had a 59% chance of earning this score, given the same 7th-grade Composite score.

Figure 14 shows estimated conditional probabilities of earning a high school ACT Composite score of 30 or higher, given 7th-grade ACT Composite score. These probabilities were higher for SRP participants than for nonparticipants, given a 7th-grade Composite score between 18 and 21. The probability of earning high school ACT

Composite scores of 31 or higher, 32 or higher, etc. could not be estimated effectively because too few nonparticipants had scores in these intervals.

High School Course Taking

SRP participants vs. nonparticipants--trigonometry. The percentage of SRP participants who reported taking trigonometry in high school (41%) was larger than that of nonparticipants (24%). The estimated conditional probability of taking trigonometry, given 7th-grade ACT Mathematics score, is plotted in Figure 15 for participants and nonparticipants. The results in this figure illustrate that SRP participants had a greater estimated conditional probability of taking trigonometry in high school than did nonparticipants, given 7th-grade ACT Mathematics scores between about 15 and 26. For example, at a 7th-grade Mathematics score of 22, the probability of an SRP participant taking trigonometry was about .49. In comparison, the probability of a nonparticipant with this same score taking trigonometry was about .38.

SRP mathematics course takers vs. other groups--trigonometry. A relatively high percentage (59%) of SRP participants who took a mathematics course while participating in the SRP reported taking trigonometry in high school. Fewer SRP participants who took another course in the SRP (35%) or who did not participate (24%) reported taking trigonometry in high school. Given 7th-grade ACT Mathematics scores of about 16 or higher, SRP mathematics course takers had a greater likelihood of taking trigonometry than did other course takers or nonparticipants (see Figure 16). Figure 16 also shows that for SRP participants who took other courses and earned Mathematics scores of

about 24 or higher, the probability of taking trigonometry was lower than that of nonparticipants.

SRP participants vs. nonparticipants--calculus. The percentage of SRP participants who reported taking calculus in high school (53%) was larger than that of nonparticipants (44%). Figure 17 illustrates that, given 7th-grade ACT Mathematics scores between about 19 and 23, SRP participants were more likely than nonparticipants to take calculus in high school.

SRP mathematics course takers vs. other groups--calculus. A relatively high percentage (60%) of SRP mathematics course takers reported taking calculus in high school. Relatively few SRP participants who took another SRP course (51%) or who did not participate (44%) reported taking calculus in high school.

Figure 18 shows probability curves associated with taking calculus in high school. The results shown in this figure suggest that SRP participants who earned 7th-grade ACT Mathematics scores of 19 or higher and took an SRP mathematics course had a higher estimated probability of taking calculus in high school than did other SRP participants and nonparticipants with equivalent 7th-grade Mathematics scores.

Other courses, such as chemistry and physics, were investigated as potential academic outcome variables. Problems were encountered in developing logistic regression models for these courses, however, due to small sample sizes. For example, a model that used Science Reasoning score as a predictor of science course taking could not be developed because some SRP participants took the former version of the ACT Assessment and therefore did not have Science Reasoning scores.

High School Grade Averages

Figures 19 and 20 show distributions of self-reported high school grade average and mathematics grade average, respectively, for SRP participants and nonparticipants. Most SRP participants (70%) had cumulative overall high school grade averages between 3.75 and 4.00. In comparison, most nonparticipants (59%) had grade averages between 3.50 and 4.00. The situation was similar for high school mathematics grade averages; most SRP participants (78%) had mathematics grade averages between 3.75 and 4.00, whereas most nonparticipants (62%) had mathematics grade averages between 3.50 and 4.00.

Too few SRP participants (n=4) had cumulative overall high school grade averages below B (3.00) to effectively estimate the probability of earning a grade average of B or higher, given seventh-grade ACT Assessment score. The probability of earning a cumulative overall grade average of A (4.00) similarly could not be estimated because relatively few students had this grade average.

The situation for mathematics grade average was somewhat different, however. The probability of earning a mathematics grade average of A (4.00), given 7th-grade ACT Mathematics score, could be estimated because a relatively large number of SRP participants (n=105) had a mathematics grade average of A. Figure 21 shows the resulting probability curves, with 68% confidence limits, for SRP participants and nonparticipants. This figure shows that given a 7th-grade ACT Mathematics score between approximately 14 and 31, SRP participants had a higher estimated probability than nonparticipants of earning a high school mathematics grade average of A.

College Credit

At the time of their high school ACT Assessment testing, 33% of SRP participants reported that they had previously earned college credit while in high school. In comparison, only about 16% of nonparticipants reported that they had previously earned college credit.

The estimated conditional probability of earning college credit while in high school, given 7th-grade ACT Composite score, is shown in Figure 22. This figure illustrates that SRP participants had a higher estimated probability than nonparticipants of earning college credit, given a 7th-grade Composite score between 14 and 28.

Awards for Scientific Work or Creative Writing

About 24% of SRP participants reported receiving an award for scientific work, and about 26% reported that they had published creative writing in a magazine or book. These percentages were higher than those for nonparticipants (9% and 15%, respectively).

Figure 23 displays estimated probabilities of receiving an award for scientific work, given 7th-grade ACT Composite score. The results indicate that SRP participants were more likely than nonparticipants to receive such an award, given a 7th-grade Composite score of 18 or higher.

Figure 24 illustrates estimated conditional probabilities of publishing creative writing. The overlapping confidence bands, across all 7th-grade ACT English scores, suggest that there was no appreciable difference between SRP participants and nonparticipants with respect to the likelihood of publishing creative writing.

Other Academic Outcome Variables

Other academic outcome variables were examined, including number of English and mathematics courses taken, and English grade averages. In all instances in which linear modeling could be used, treatment effects reflected by these variables were not statistically significant.

Discussion

The results of this study suggest that participation in the SRP is positively related to academically talented students' subsequent academic performance in high school, over and beyond their ACT Assessment scores as seventh graders. When seventh-grade ACT Assessment performance is statistically controlled, SRP participants have higher ACT Assessment scores in high school, on average, than do nonparticipants.

SRP participants have a higher probability than nonparticipants of taking trigonometry in high school, given 7th-grade ACT Mathematics score. In addition, participants are more likely than nonparticipants to earn high school mathematics grade averages of A, earn high school ACT Composite scores of 27 or higher, earn college credit while in high school, or receive some type of an award for scientific work.

Because the data in this study were observational, rather than experimental, a causal relationship between SRP participation and academic performance in high school cannot be firmly established. Nevertheless, the results should be useful for encouraging academically talented students to participate in talent searches and intensive residential programs. Prospective students could be shown, for example, that SRP participants score about two scale score points higher on the ACT Mathematics test in high school,

on average, than do Talent Search students who do not participate in the SRP. This finding is true regardless of the ACT Mathematics scores that Talent Search and SRP participants earn in seventh grade.

For talent search program participants who are considering postsecondary institutions with competitive admission requirements, the results of this study may be used to illustrate the estimated probability of earning a fairly high ACT Composite score (e.g., a score of 27 or higher) in high school, given 7th-grade Composite score. These students' interest in participating in an intensive residential program may increase when they discover that SRP participants' estimated probability of earning fairly high ACT Composite scores in high school is typically greater than that of nonparticipants.

The results of this study, because they are based on data from a single summer residential program, are generalizable to other talent search residential programs only to the extent that such programs are similar to TIP's SRP. In addition, it is conceivable that residential programs with criteria for participation that differ from those of the SRP (e.g., lower or higher cutoff scores) might demonstrate academic performance differences between program participants and nonparticipants that differ from those reported here.

Among the nonparticipants, there is a subgroup of students whose academic performance is of interest. This subgroup consists of qualifying nonparticipants, those Talent Search students who earned high ACT Assessment or SAT scores and qualified for, but chose not to attend, the SRP. It is possible that linear modeling of high school academic outcomes could yield different results for qualifying nonparticipants and SRP

participants. Unfortunately, there were too few qualifying nonparticipants for such modeling to be performed.

The sample sizes for SRP participants (n=151) and the subgroup of these students who took some type of mathematics course in the SRP (n=40) are not particularly large. Augmenting these data with data collected from both future SRP participants and qualifying nonparticipants might provide further insight into relationships between SRP participation and subsequent academic performance in high school.

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Appendix A. Cumulative Percentage Distributions of 7th-Grade ACT Assessment Score, by SRP Participation

	English		Mathematics		Composite	
ACT score	Participants	Nonparticipants	Participants	Nonparticipants	Participants	Nonparticipants
36	100	100	100	100	100	100
35	98	100	100	100	100	100
34	98	100	100	100	100	100
33	97	100	100	100	100	100
32	96	100	99	100	99	100
31	94	100	99	100	99	100
30	88	100	99	100	98	100
29	84	100	99	100	98	100
28	76	99	99	100	98	100
27	75	99	99	100	95	100
26	69	98	99	100	89	100
25	57	96	98	100	83	100
24	50	95	95	100	74	99
23	41	90	89	100	64	98
22	38	88	85	99	56	96
21	31	82	75	99	42	93
20	25	75	64	98	34	89
19	21	68	49	96	23	82
18	16	59	44	91	11	71
17	10	50	30	83	7	59
16	7	40	21	70	3	46
15	3	32	15	55	3	29
14	2	23	5	32	1	18
13	2	15	2	16	1	9
12	1	9	1	9	1	4
11	1	6	1	5	0	2
10	1	3	0	2	0	0
9	0	1	0	2	0	0
8	0	1	0	2	0	0
7	0	0	0	0	0	0
6	0	0	0	0	0	0
5	0	0	0	0	0	0
4	0	0	0	0	0	0
3	0	0	0	0	0	0
2	0	0	0	0	0	0
1	0	0	0	0	0	0

Appendix B. Cumulative Percentage Distributions of 7th-Grade ACT Mathematics Score for SRP Mathematics Course Takers, Other Course Takers, and Nonparticipants

	SRP		
ACT score	Mathematics	Other course	Nonparticipants
36	100	100	100
35	100	100	100
34	100	100	100
33	100	100	100
32	98	100	100
31	98	100	100
30	98	100	100
29	98	100	100
28	95	100	100
27	95	100	100
26	95	100	100
25	93	100	100
24	88	97	100
23	73	95	100
22	60	94	99
21	45	86	99
20	18	80	98
19	8	64	96
18	8	57	91
17	5	39	83
16	5	27	70
15	5	18	55
14	3	6	32
13	0	3	16
12	0	2	9
11	0	1	5
10	0	0	2
9	0	0	2
8	0	0	2
7	0	0	0
6	0	0	0
5	0	0	0
4	0	0	0
3	0	0	0
2	0	0	0
1	0	0	0

FIGURE 1. Samples

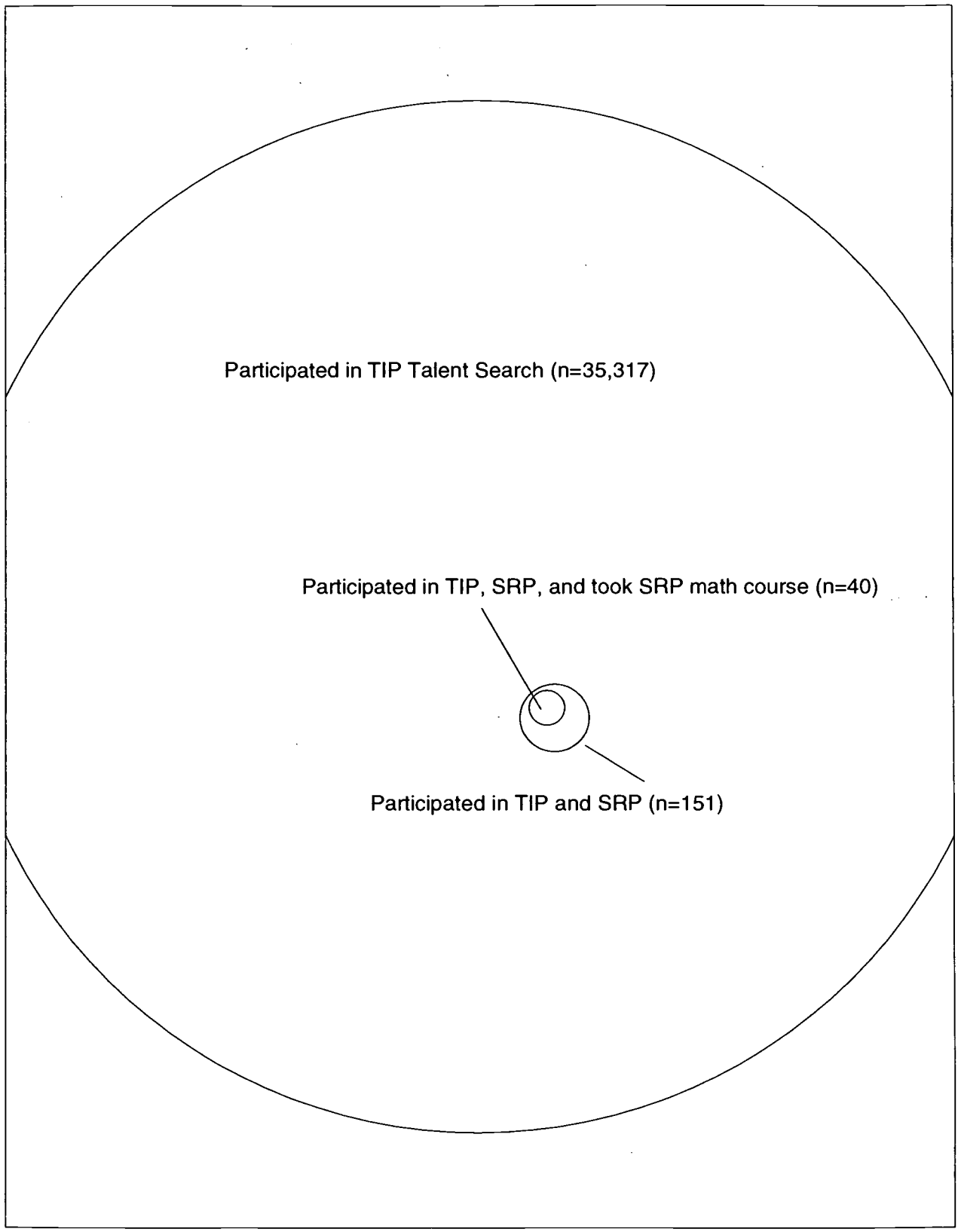


FIGURE 2. Mean ACT Mathematics Score, by Summer Residential Program Status

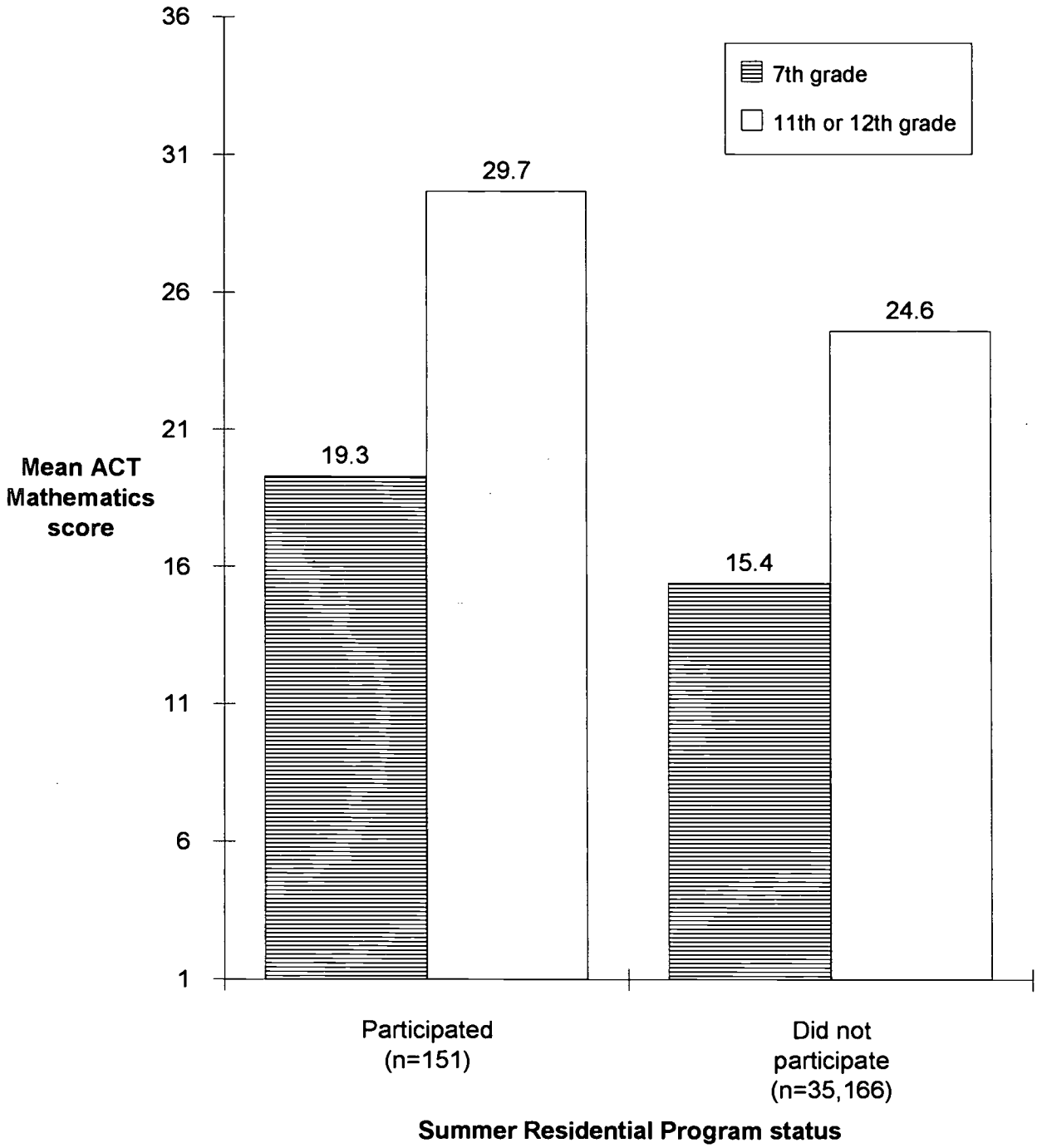


FIGURE 3. Regression of 11th- or 12th-Grade ACT Mathematics Score on 7th-Grade ACT Mathematics Score

(95% confidence limits)

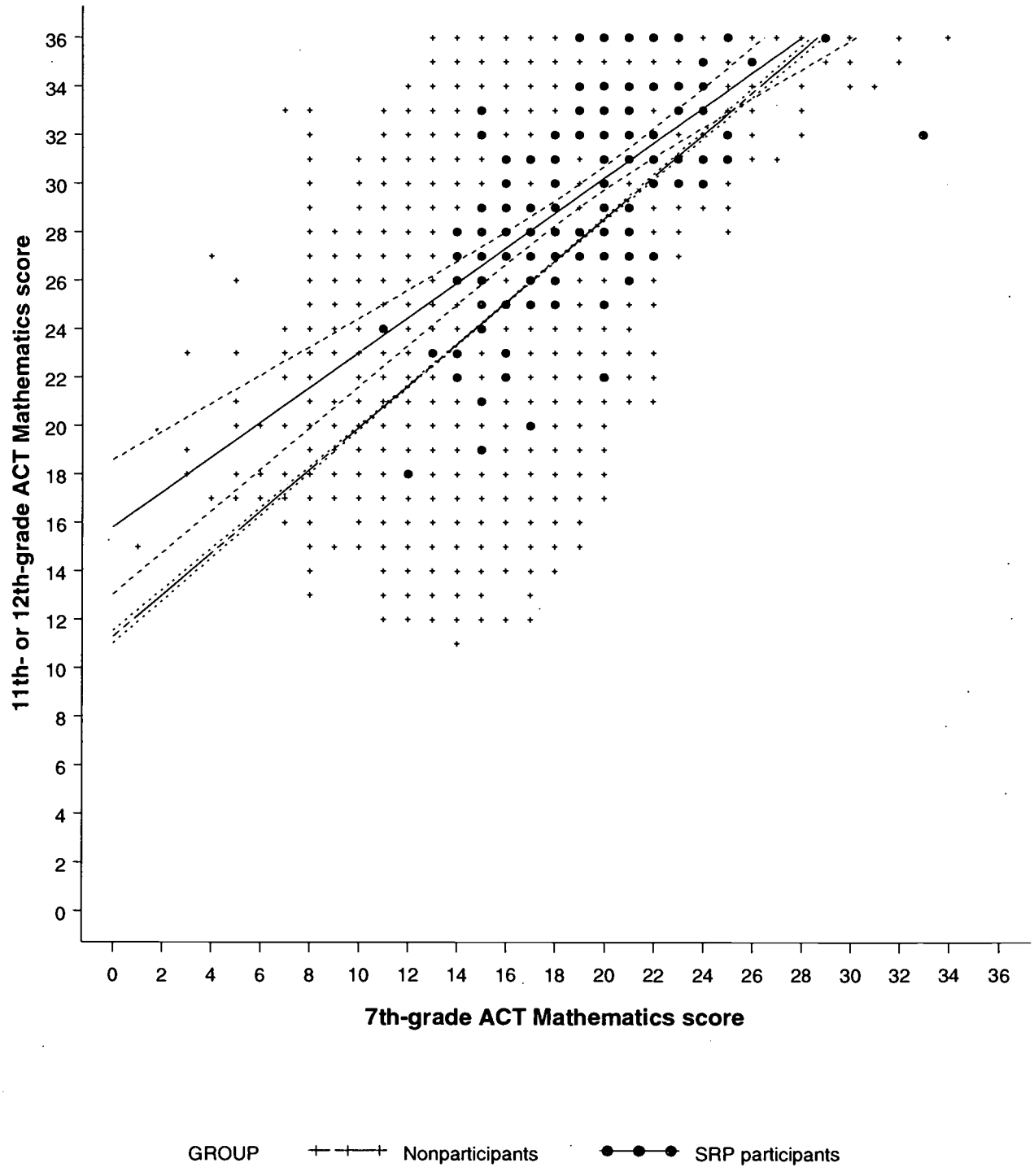


FIGURE 4. Estimated Adjusted Mean 11th- or 12th-Grade ACT Mathematics Score, by SRP Participation

(95% confidence limits)

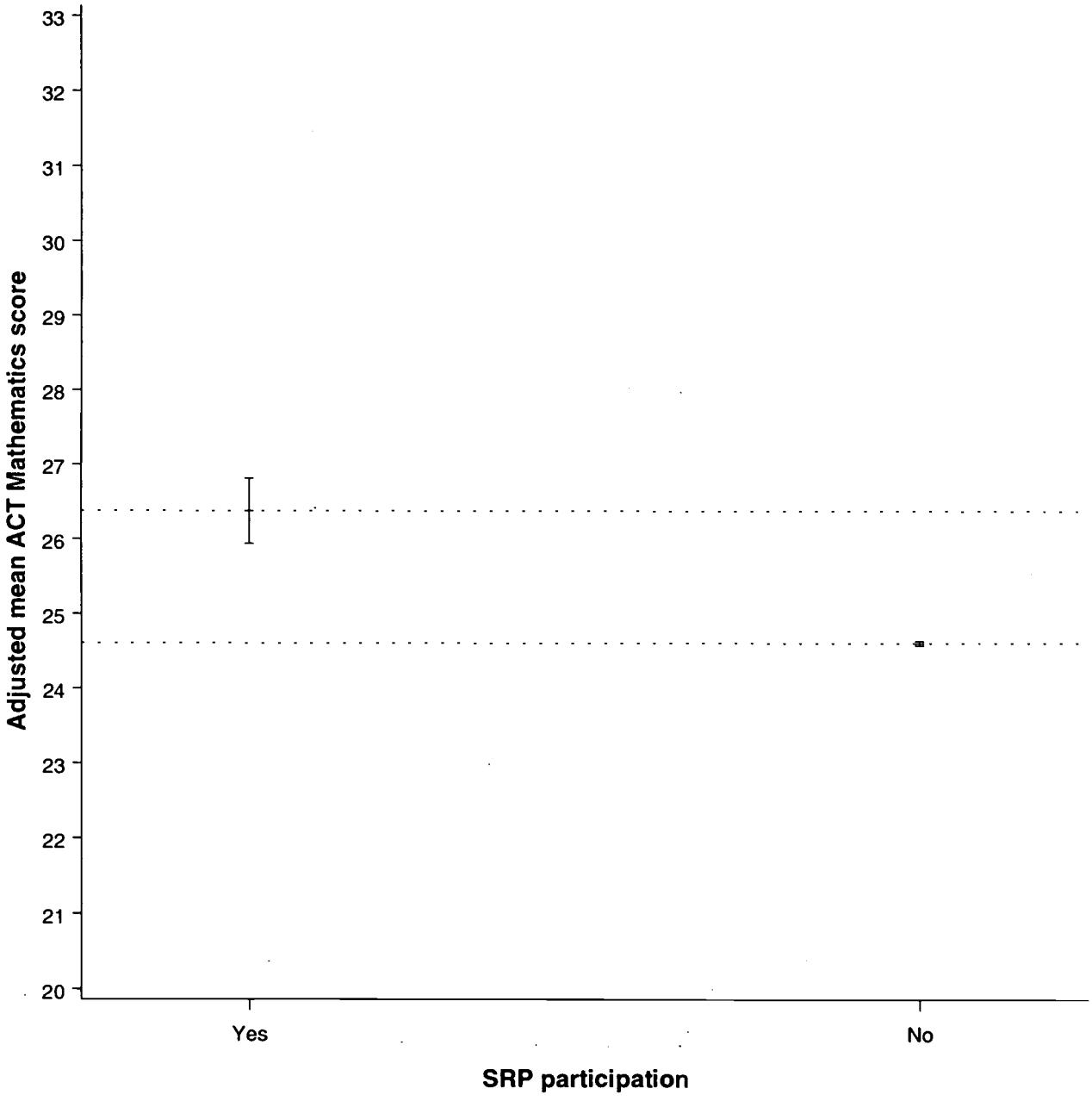


FIGURE 5. Mean ACT Mathematics Score, by Summer Residential Program Status

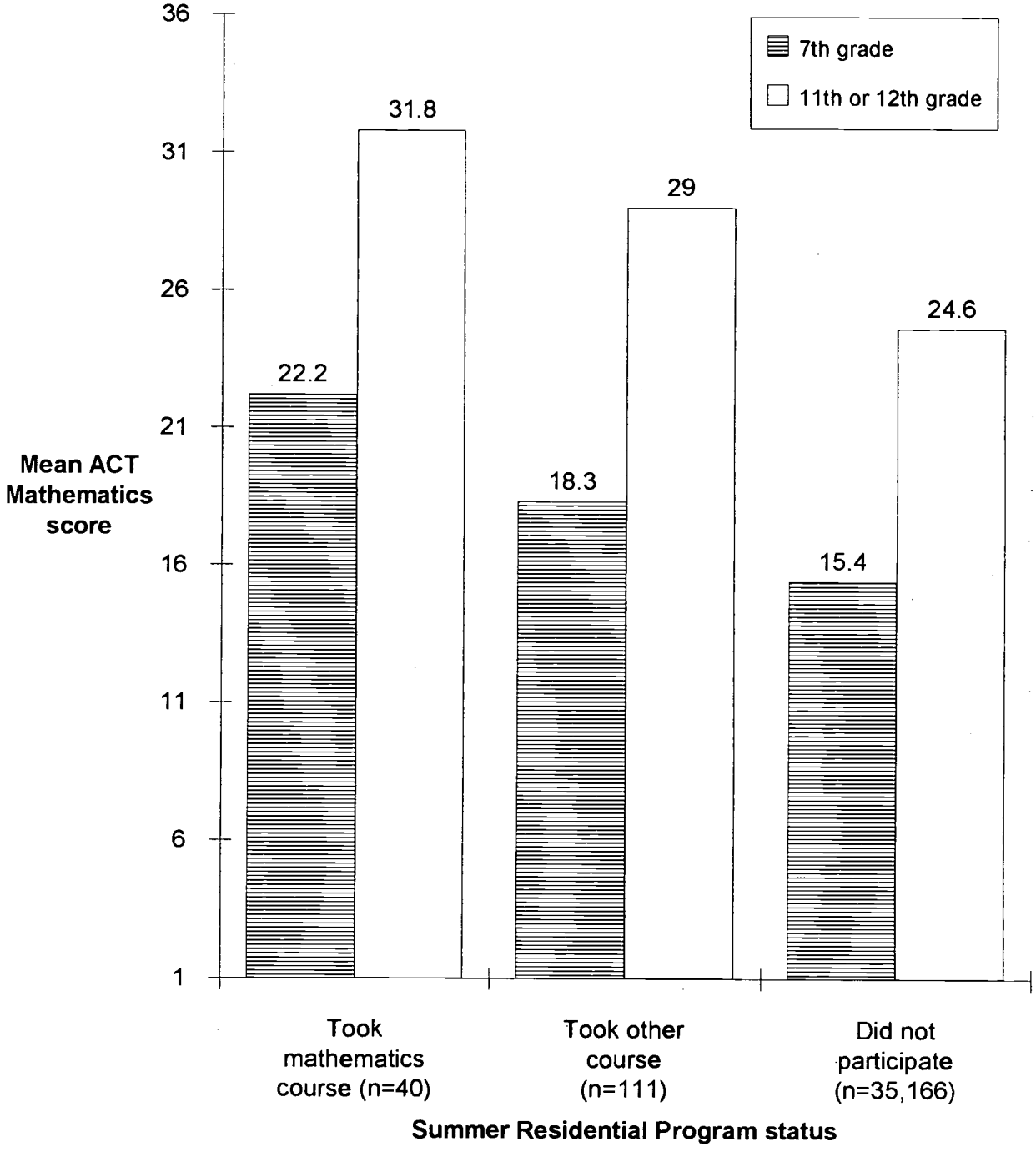


FIGURE 6. Regression of 11th- or 12th-Grade ACT Mathematics Score on 7th-Grade ACT Mathematics Score

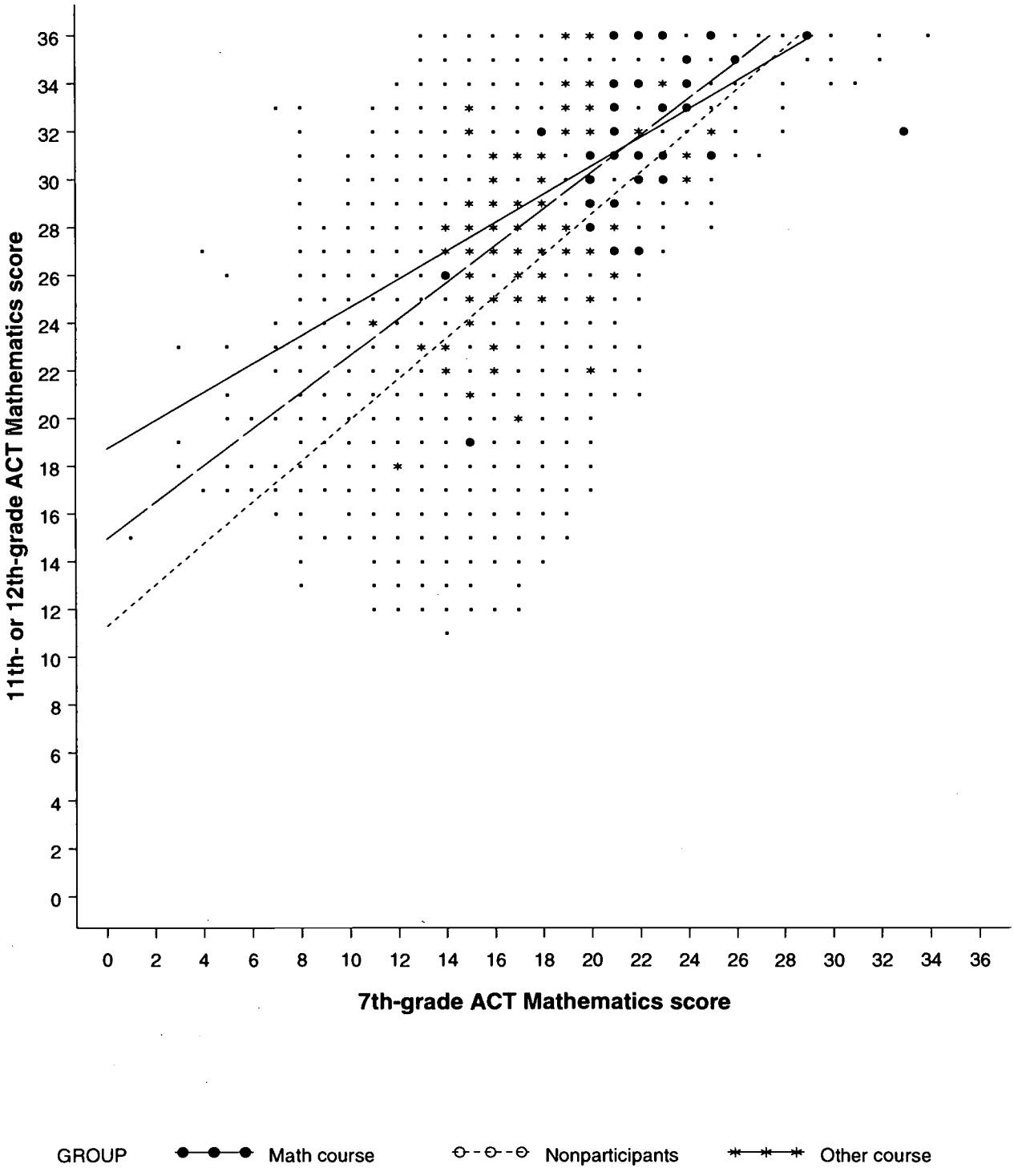


FIGURE 7. Estimated Adjusted Mean 11th- or 12th-Grade ACT Mathematics Score, by SRP Participation

(95% simultaneous confidence limits)

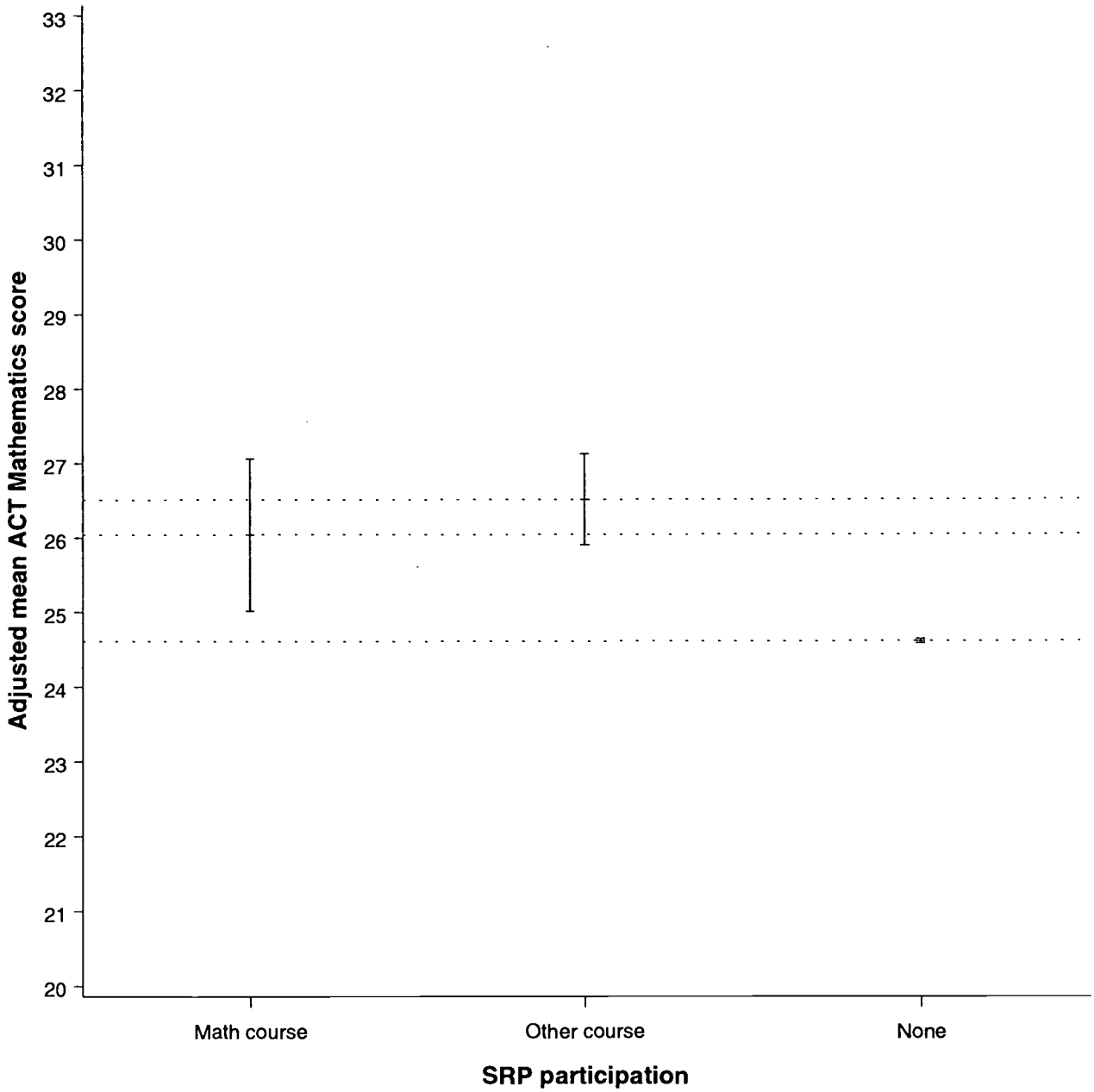


FIGURE 8. Mean ACT English Score, by Summer Residential Program Status

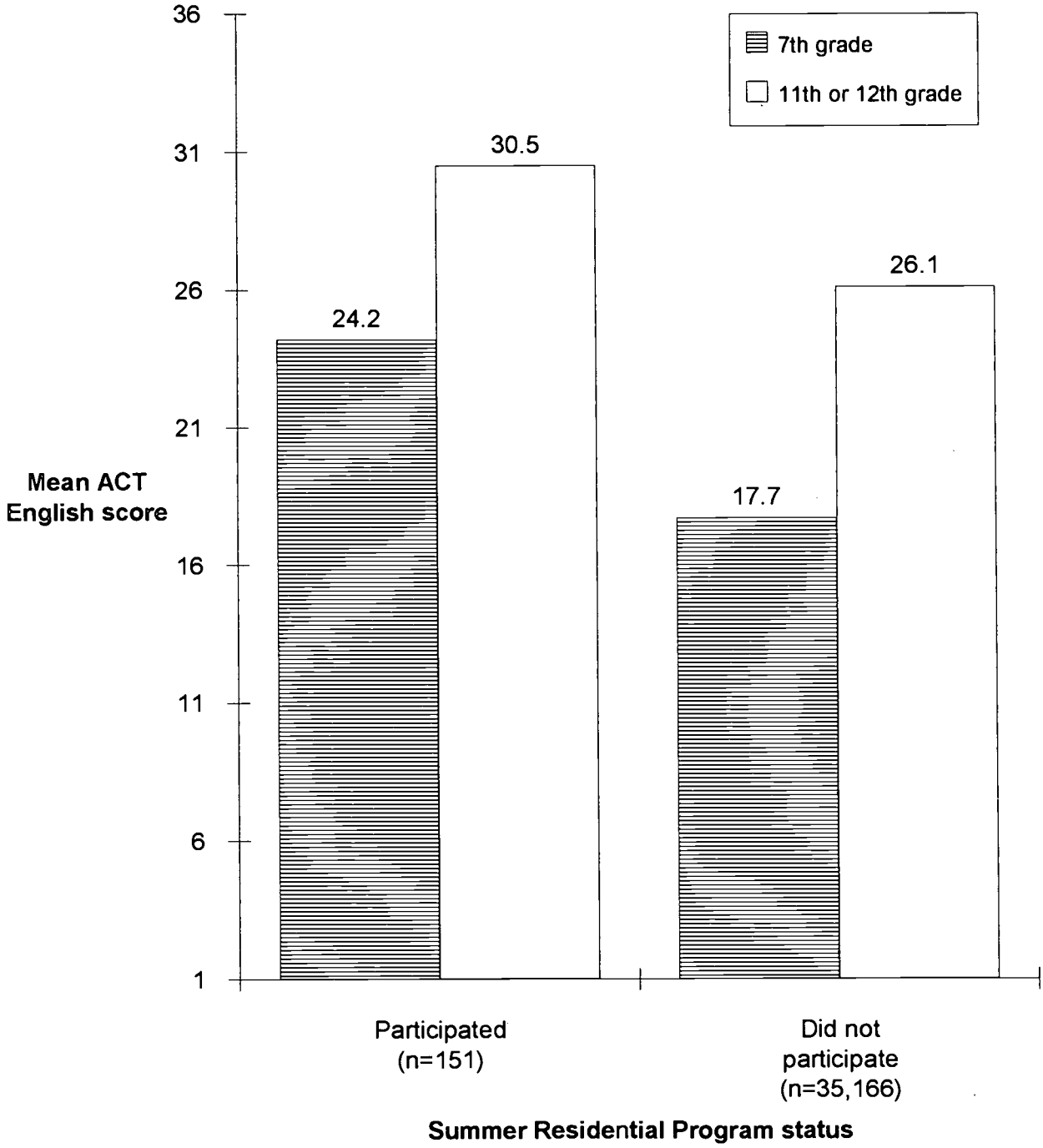


FIGURE 9. Regression of 11th- or 12th-Grade ACT English Score on 7th-Grade ACT English Score

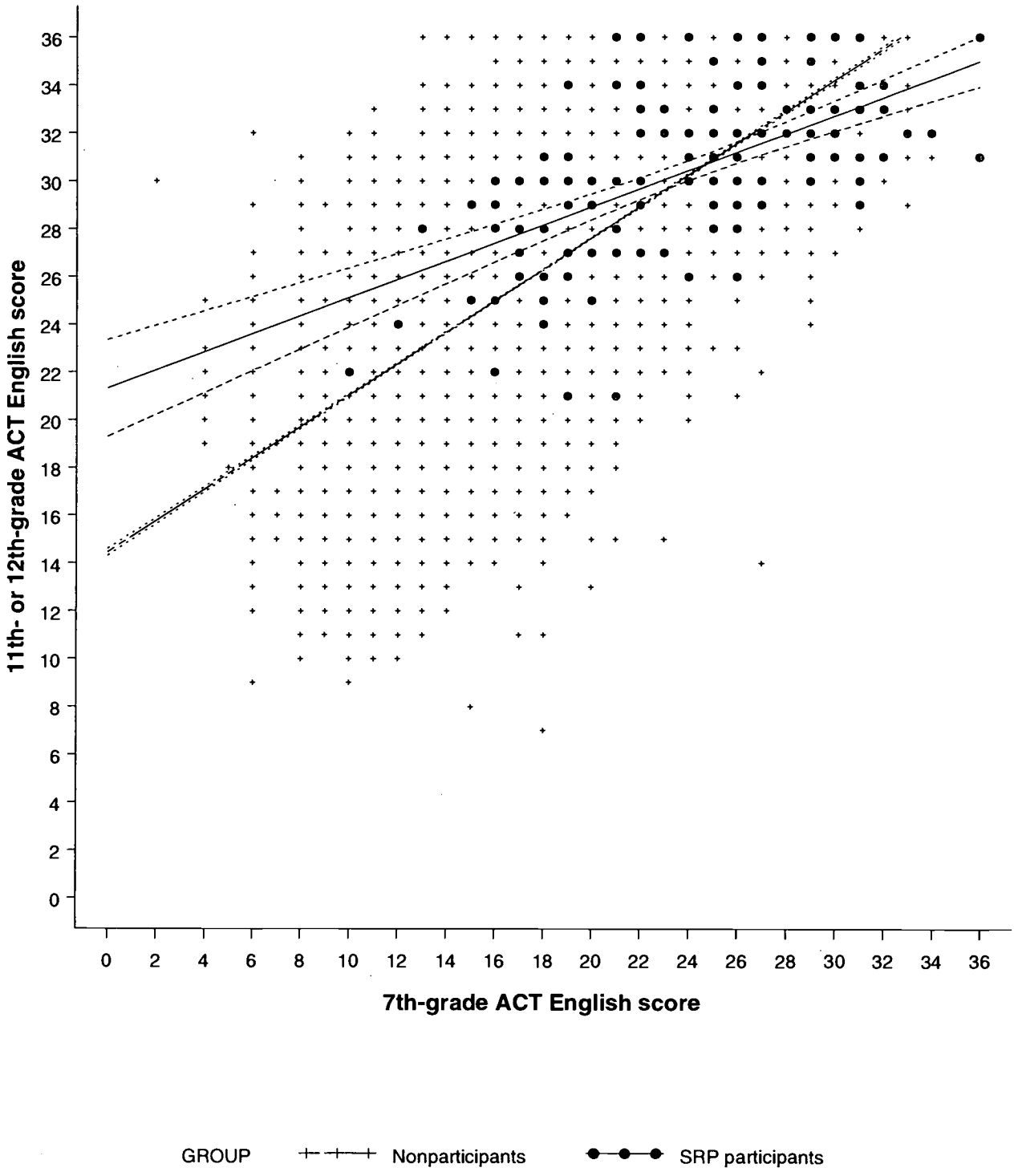


FIGURE 10. Regression of 11th- or 12th-Grade ACT English Score on 7th-Grade ACT English Score

Second-Order Polynomial Model

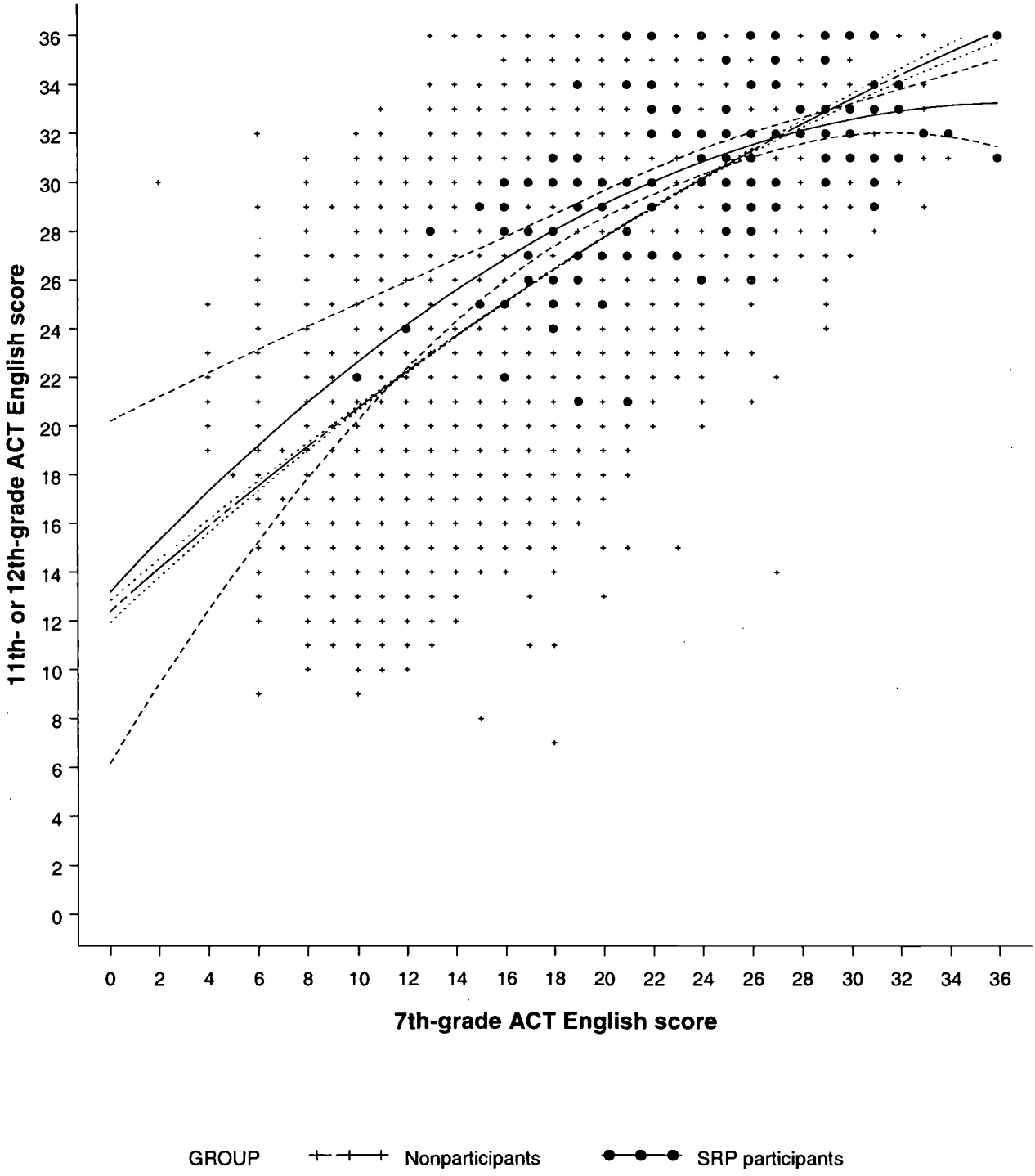


FIGURE 11. Mean ACT Composite Score, by Summer Residential Program Status

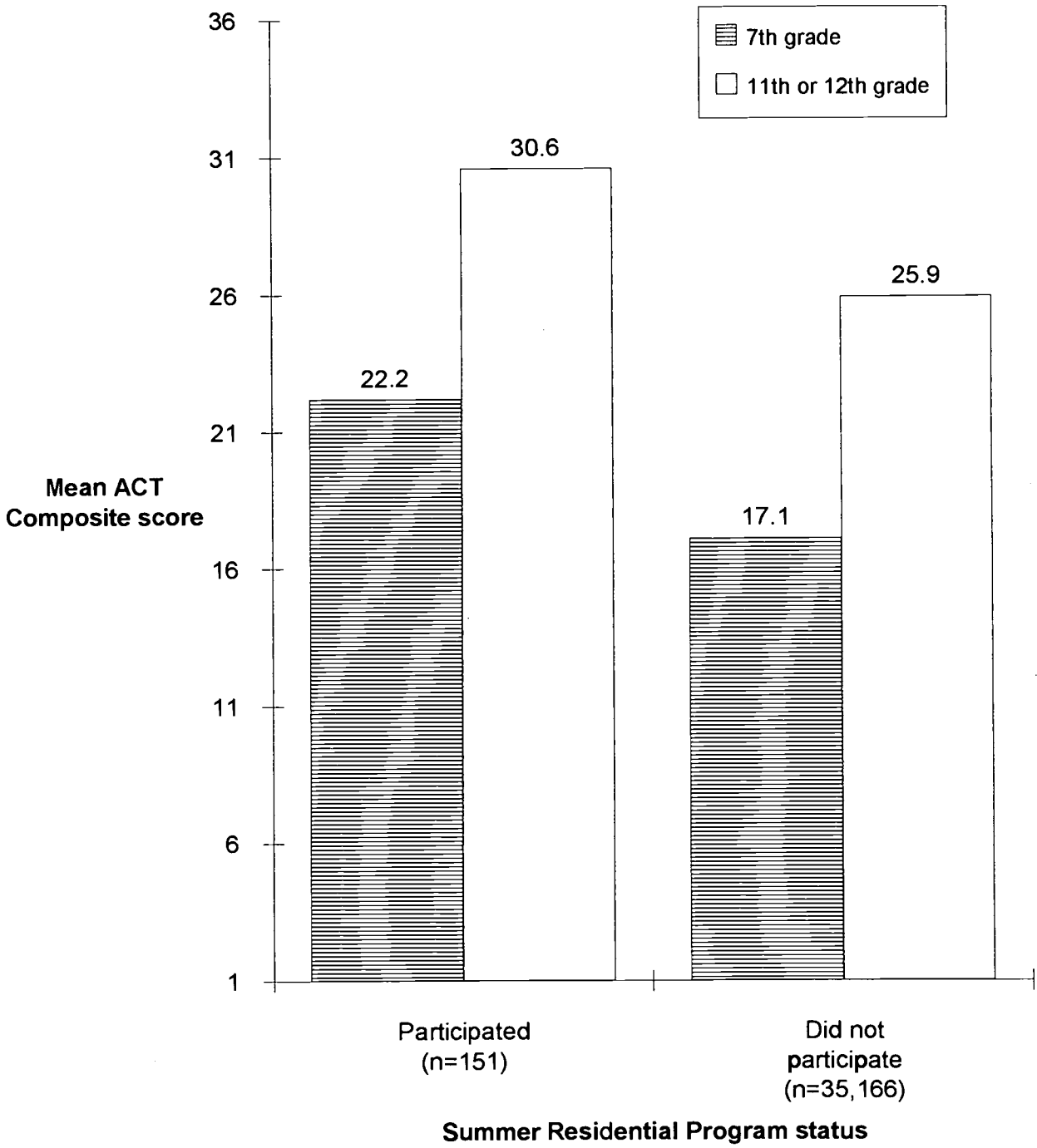


FIGURE 12. Regression of 11th- or 12th-Grade ACT Composite Score on 7th-Grade ACT Composite Score

(95% confidence limits)

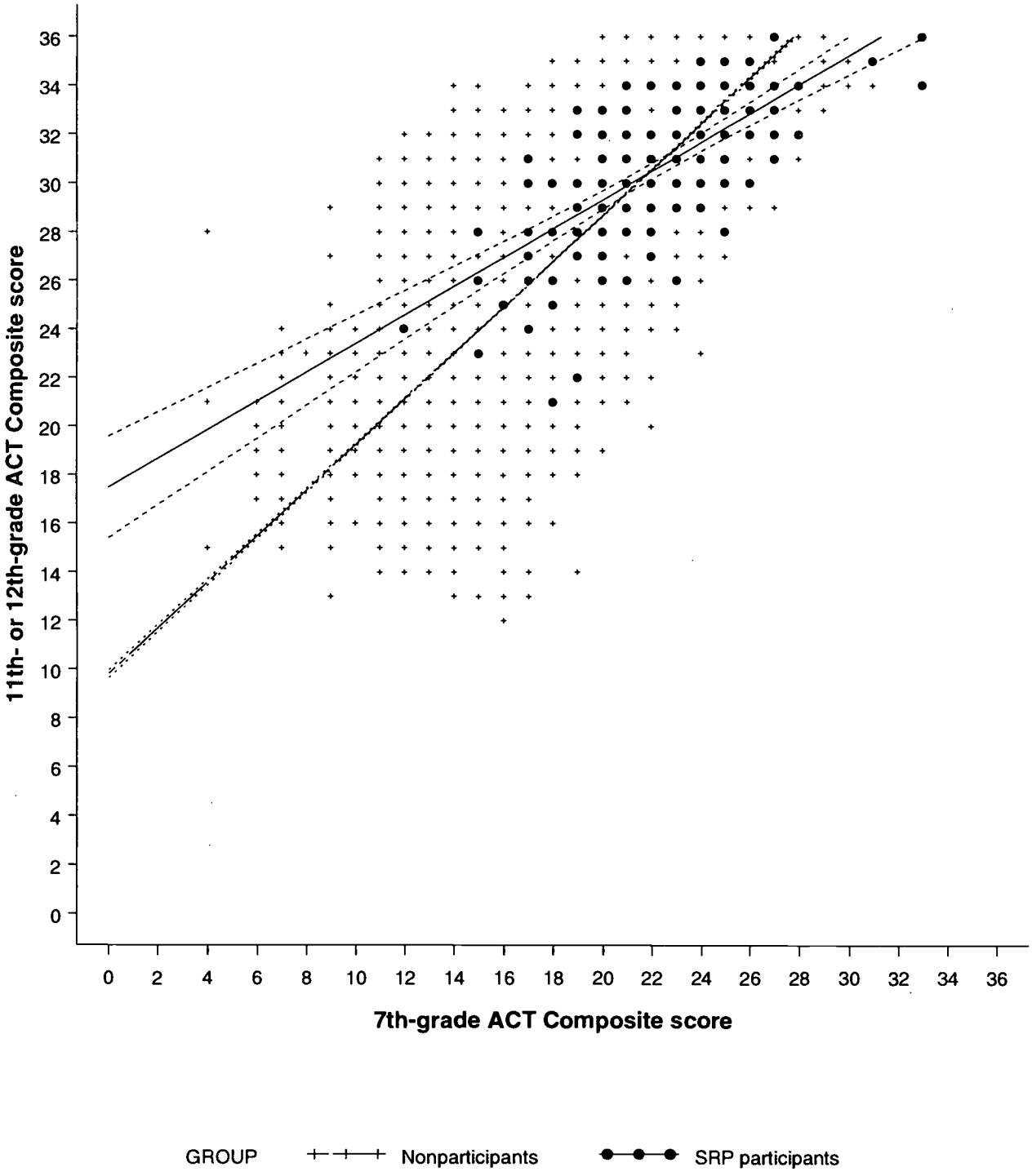


FIGURE 13. Estimated Conditional Probability of Earning an ACT Composite Score of 27 or Higher, Given 7th-Grade ACT Composite Score

(68% confidence limits)

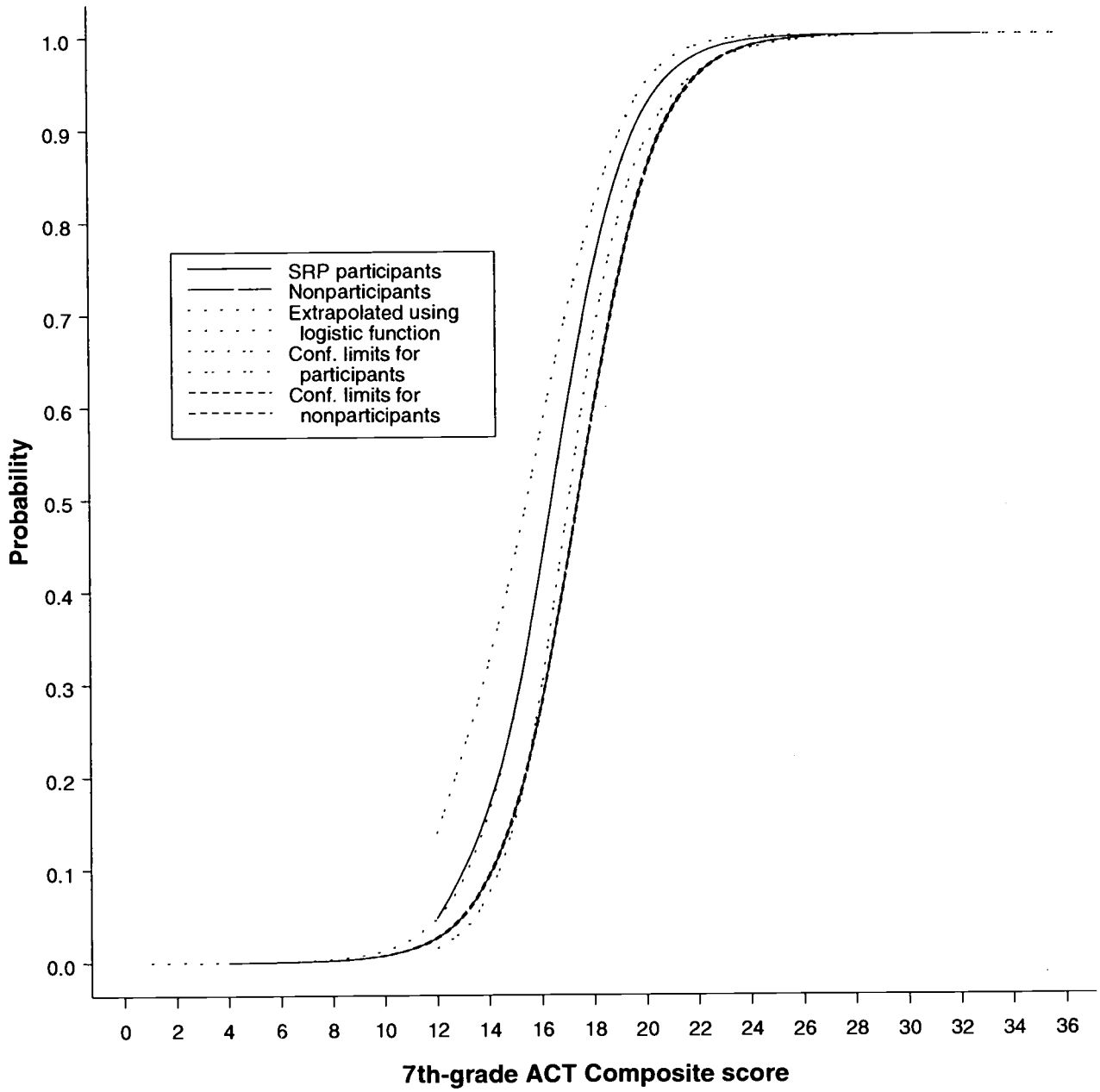


FIGURE 14. Estimated Conditional Probability of Earning an ACT Composite Score of 30 or Higher, Given 7th-Grade ACT Composite Score

(68% confidence limits)

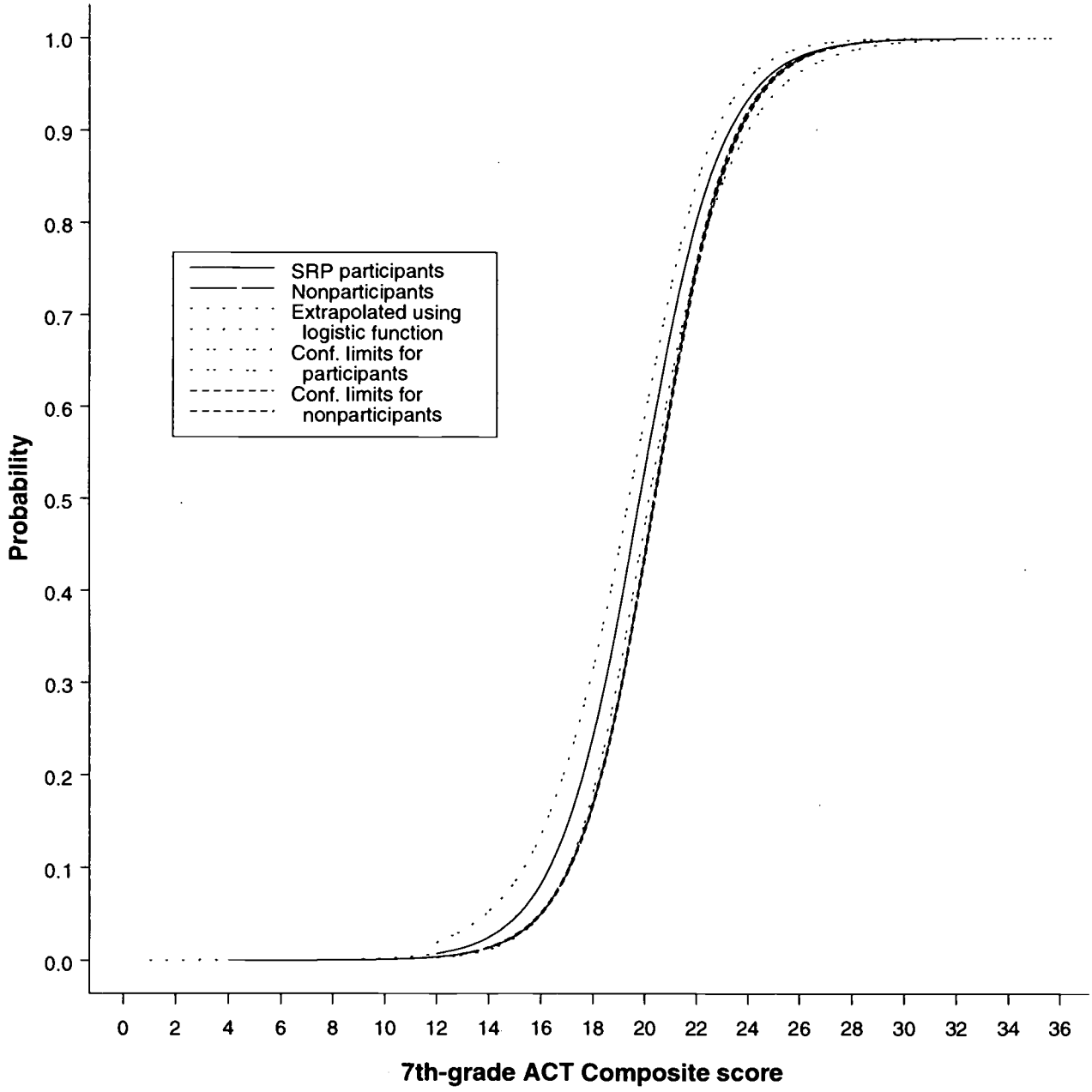


FIGURE 15. Estimated Conditional Probability of Taking Trigonometry, Given 7th-Grade ACT Mathematics Score

(68% confidence limits)

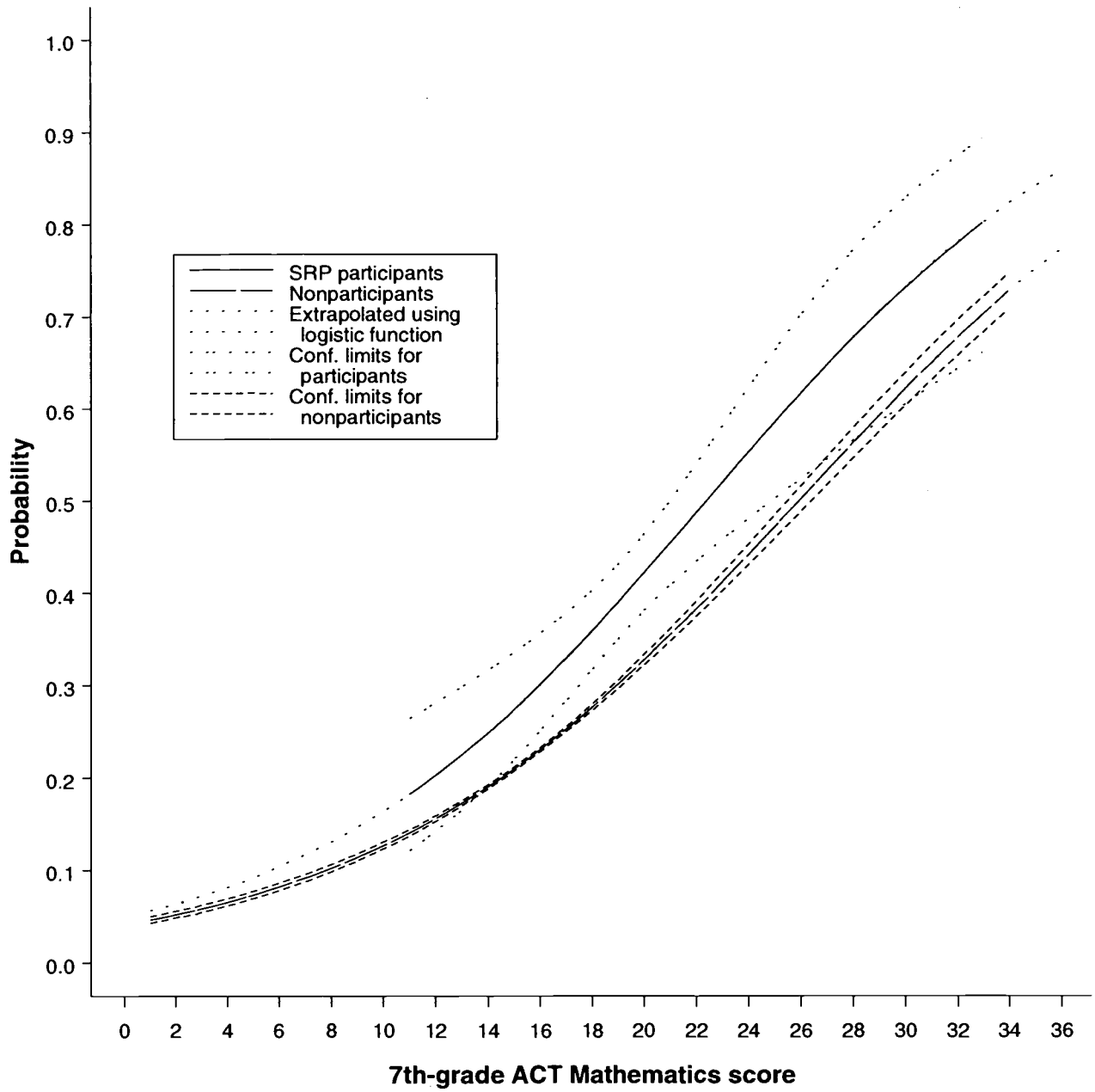


FIGURE 16. Estimated Conditional Probability of Taking Trigonometry, Given 7th-Grade ACT Mathematics Score

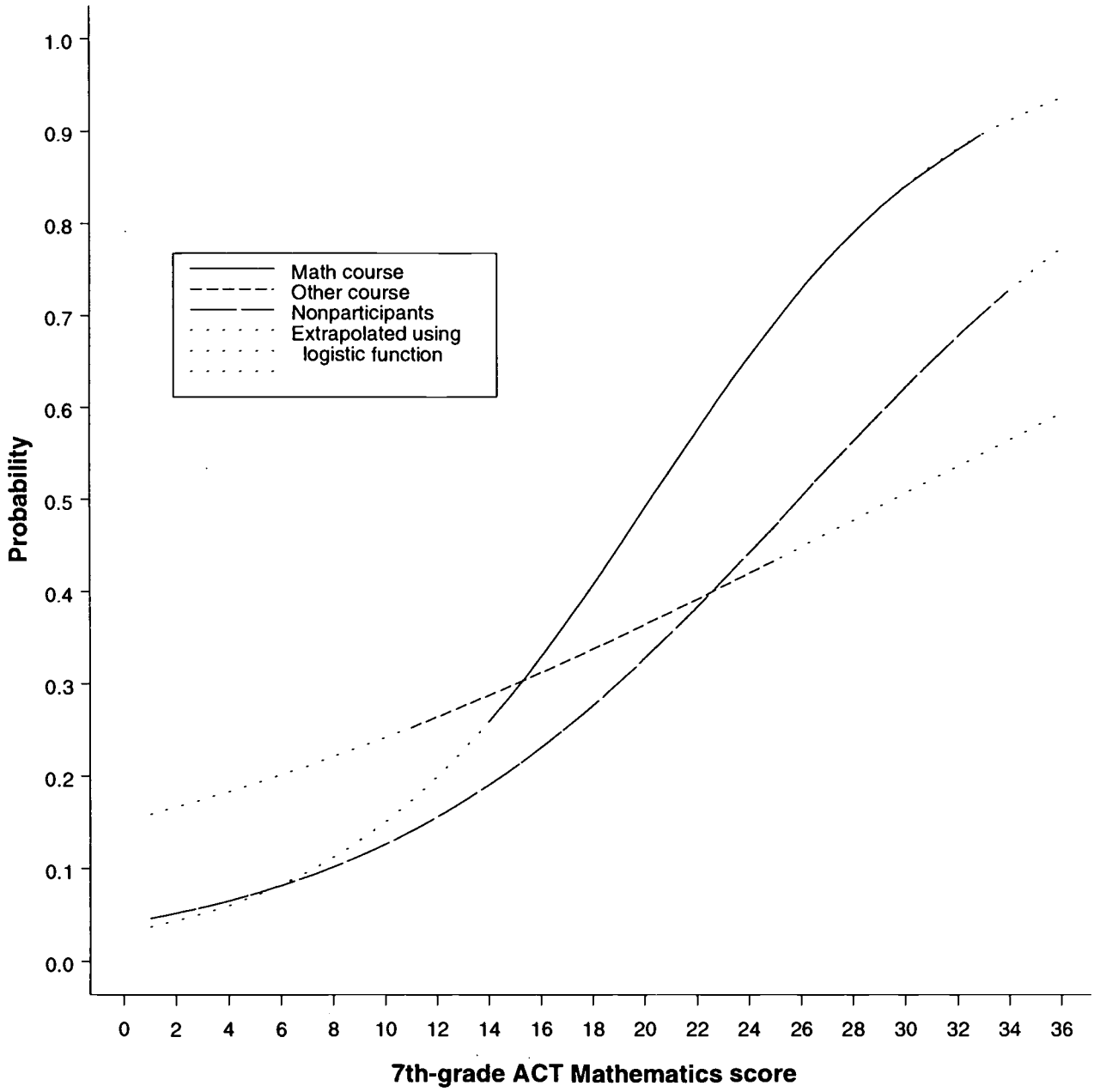


FIGURE 17. Estimated Conditional Probability of Taking Calculus, Given 7th-Grade ACT Mathematics Score

(68% confidence limits)

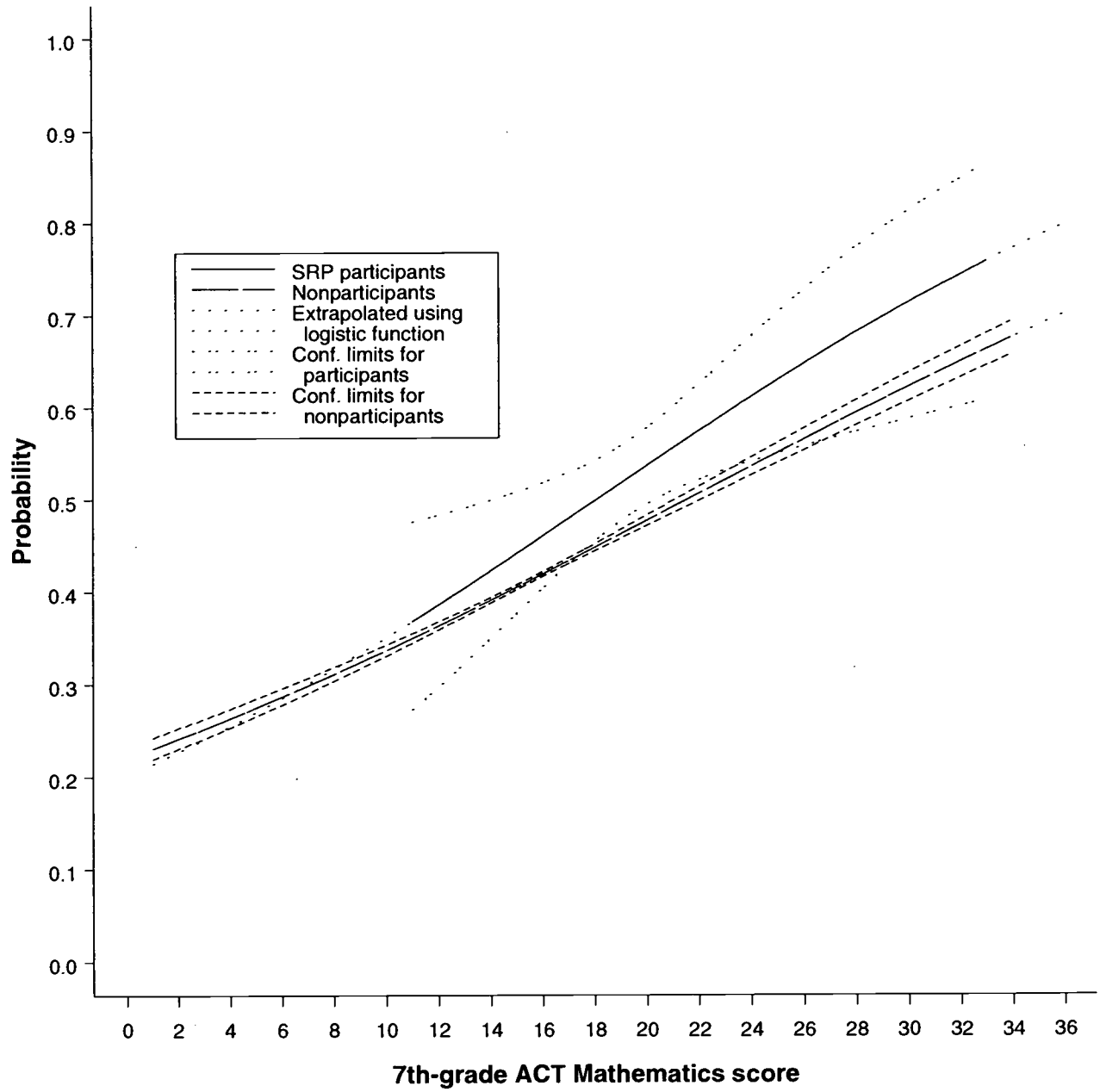


FIGURE 18. Estimated Conditional Probability of Taking Calculus, Given 7th-Grade ACT Mathematics Score

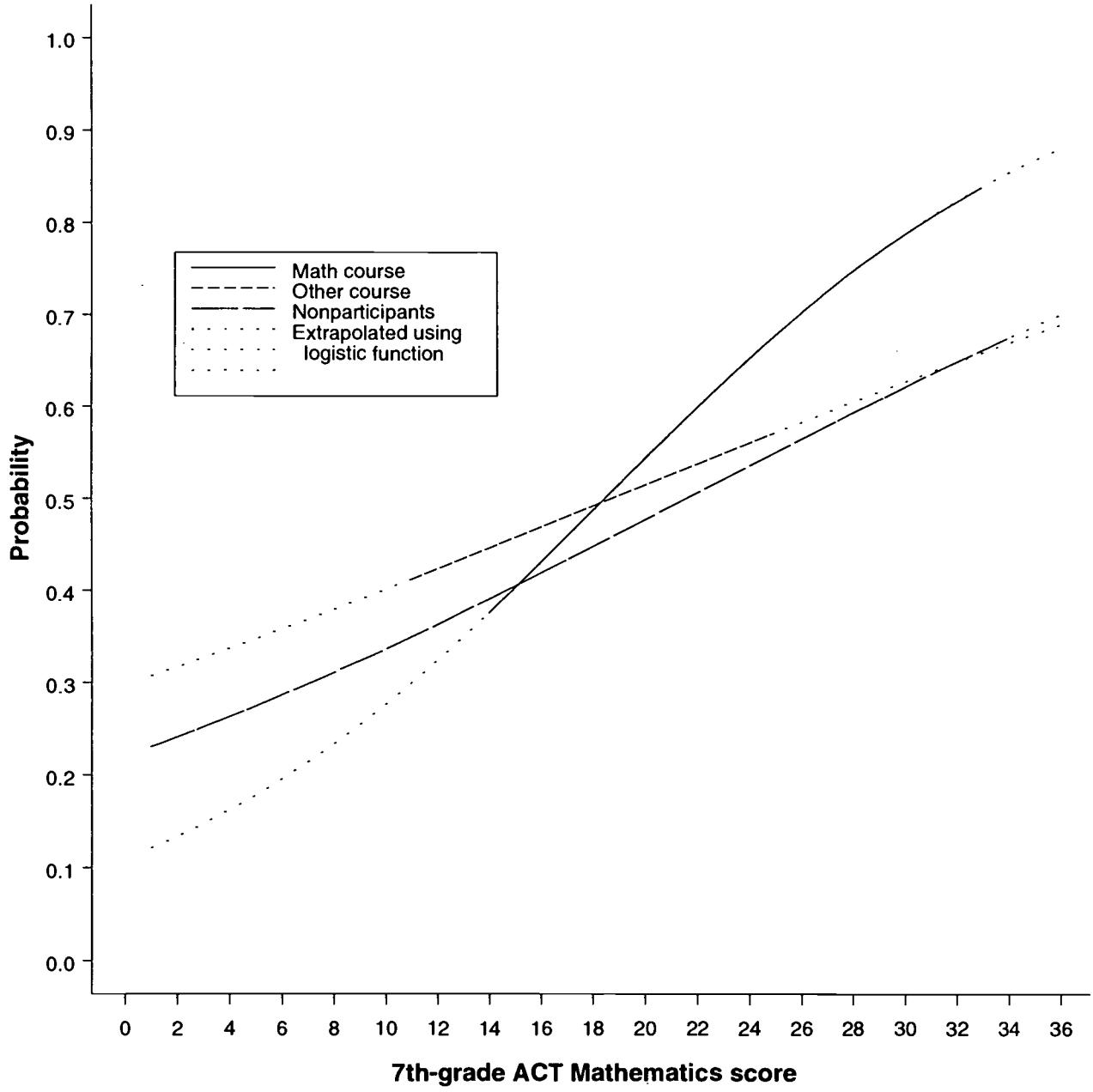


FIGURE 19. Self-Reported High School Grade Average of Summer Residential Program Participants

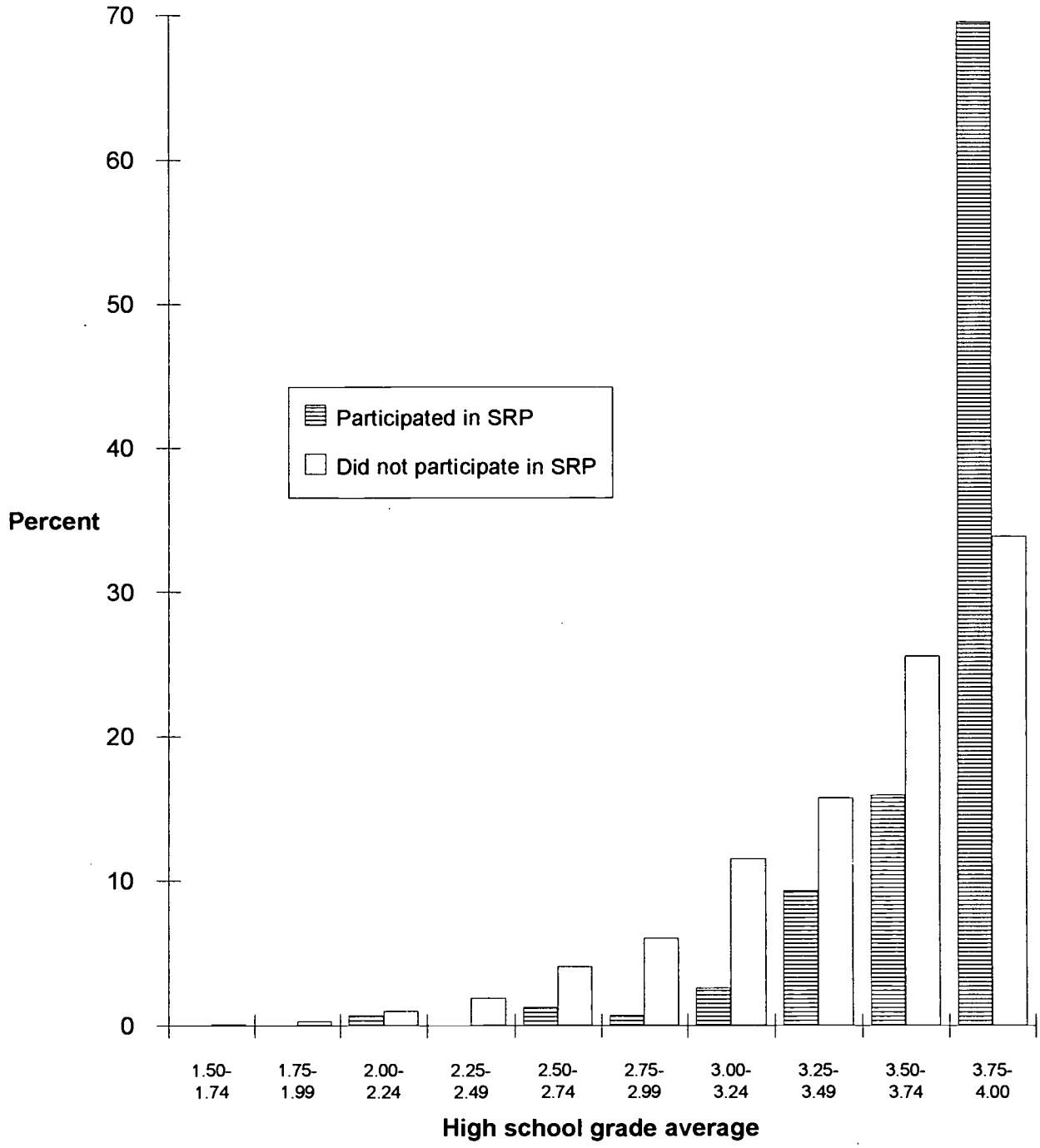


FIGURE 20. Self-Reported Mathematics Grade Average of Summer Residential Program Participants

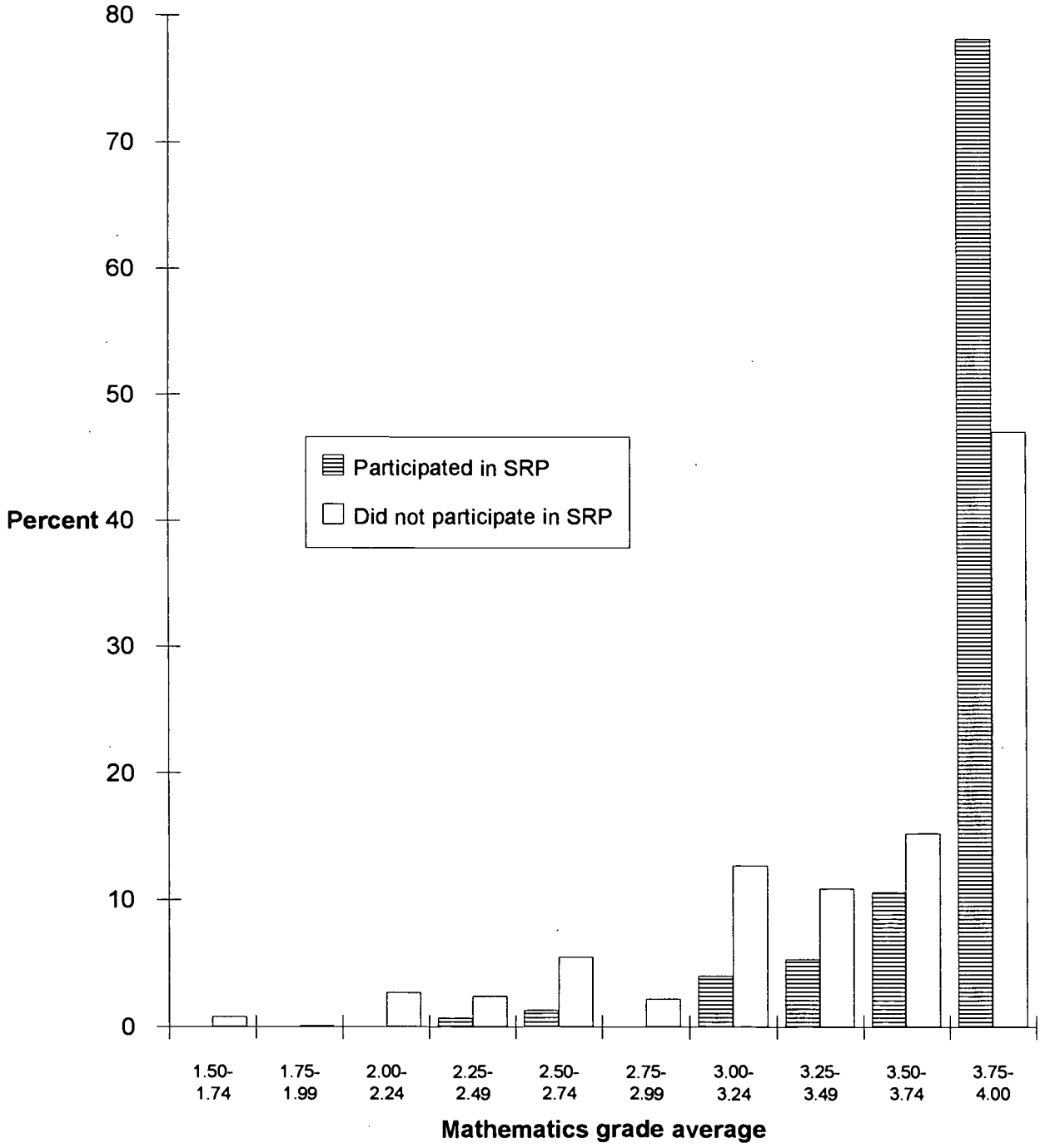


FIGURE 21. Estimated Conditional Probability of Earning a High School Mathematics Grade Average of A, Given 7th-Grade ACT Mathematics Score

(68% confidence limits)

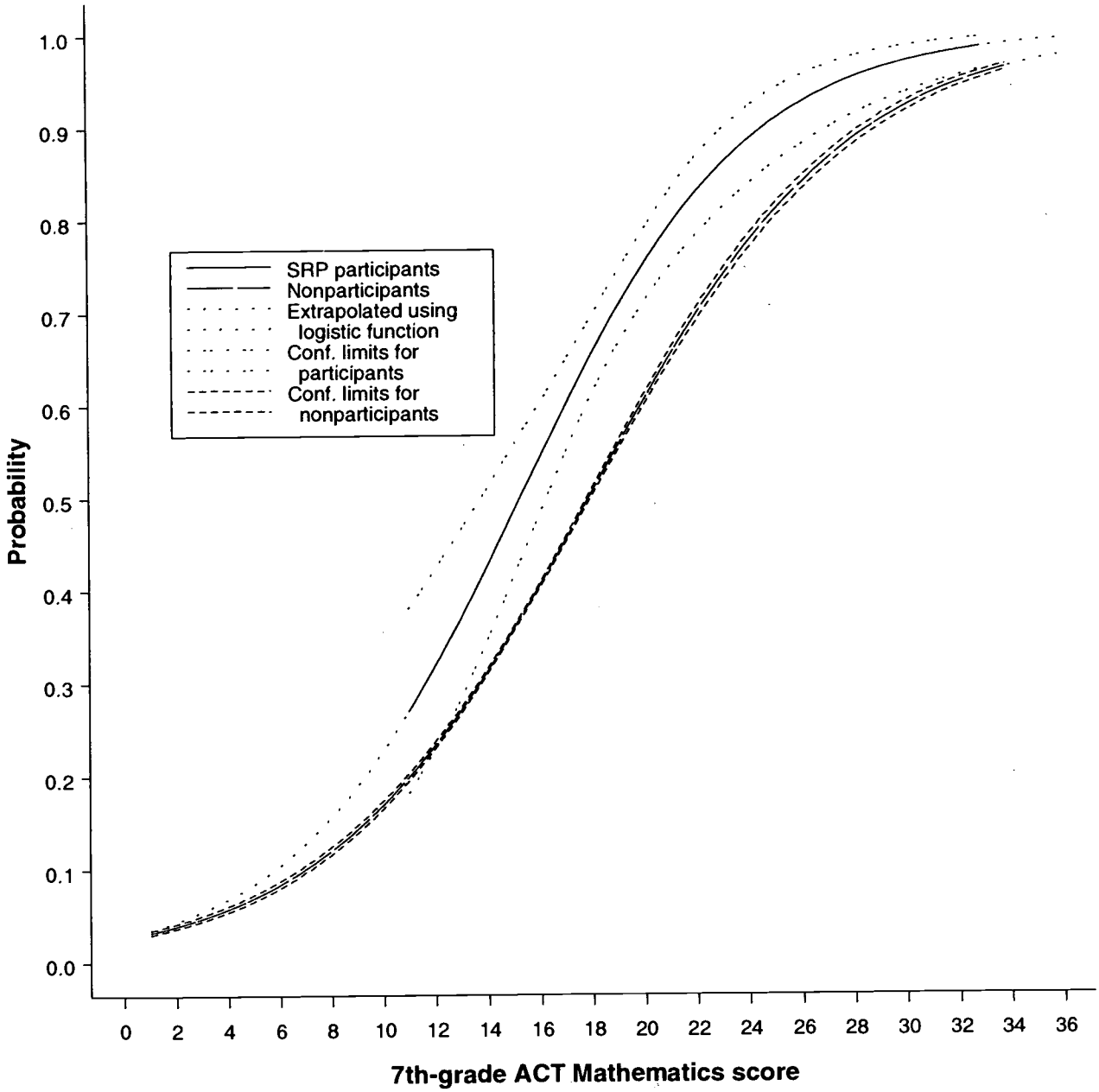
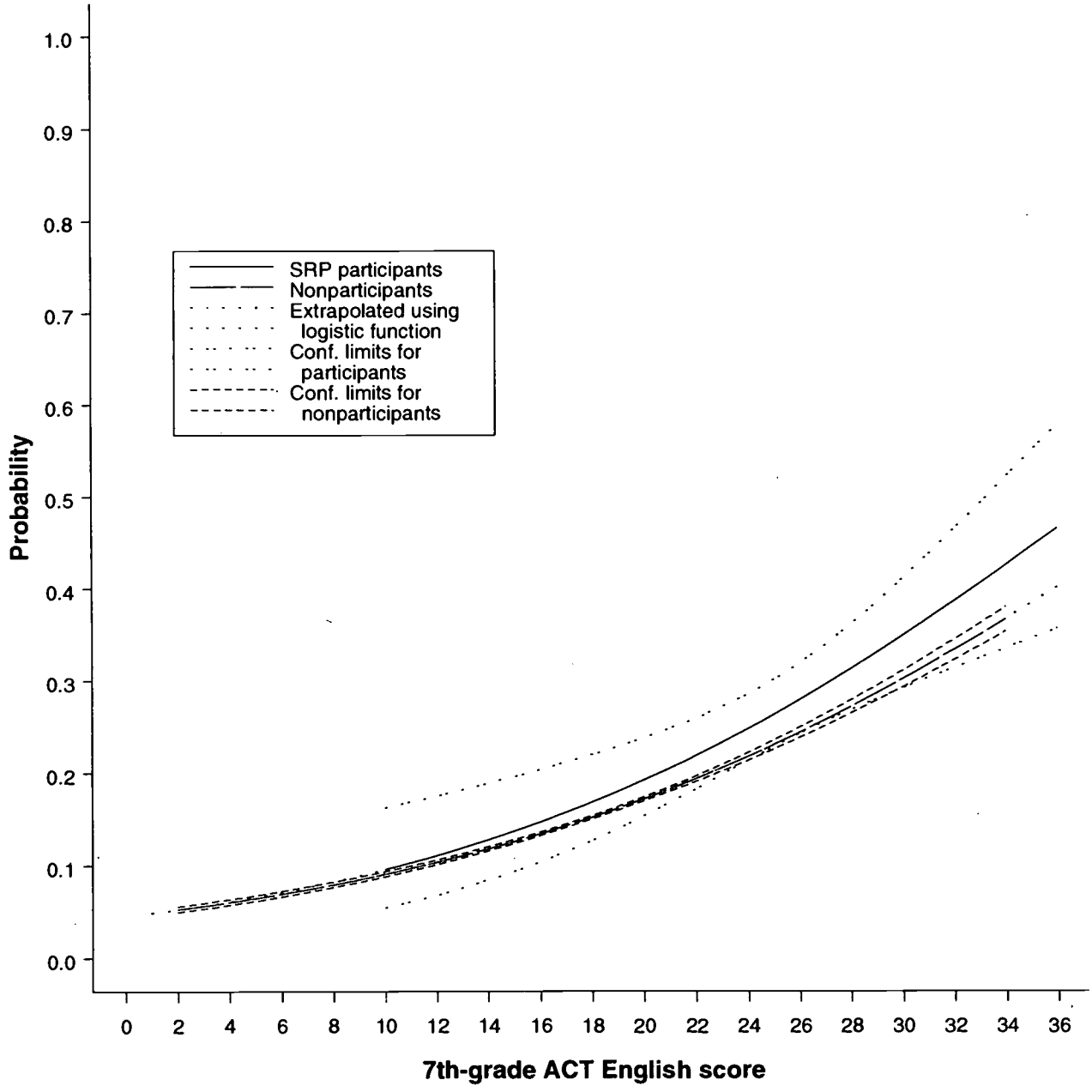


FIGURE 24. Estimated Conditional Probability of Publishing Creative Writing, Given 7th-Grade ACT English Score

(68% confidence limits)



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