

# The Impact of Parental Education on Children's Cognitive Ability-An Empirical Study Based on the China Education Panel Survey

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**Abstract:** This study explores parental education's impact on children's cognitive ability and its mechanisms using 2014-2015 CEPS data and descriptive statistics/regression analysis. Results show that parental education has a significant positive impact on children's cognitive ability, with no significant differences between parents. Regarding heterogeneity, the positive effect is stronger for girls than for boys; the impact is most pronounced for children with average cognitive abilities, while the impact is weaker for those with lower or higher cognitive abilities. There are no significant differences in the impact between urban and rural areas. Mechanism analysis suggests that parental education influences children's cognitive ability through educational expectations (educational level requirements and children's own educational expectations) and educational investment (parent-child companionship), with the mediating effects of these three factors varying in proportion. academic performance requirements and parent-child activities do not have a significant mediating effect. Policies and parents can promote basic educational informatization, cognitive-level-based support, reasonable educational expectations and high-quality parent-child interaction.

**Keywords:** Parental Education; Cognitive Ability; Group Differences; Educational Expectations; Educational Investment

## 1. Introduction

Cognitive ability, as a core element of individual growth and development, not only directly determines academic performance-from the efficiency of mastering basic knowledge to the ability to analyze and solve complex problems, all are closely related to cognitive ability [1]; it also profoundly influences long-term career prospects, including the diversity of career

choices, the level of professional competitiveness, and even the ceiling of career achievement. It even significantly shapes an individual's social mobility trajectory and serves as a core indicator for measuring the quality of their human capital accumulation [2]. The family is the primary setting for the cultivation of children's cognitive abilities [3], and parents' educational attainment, as a concentrated reflection of family cultural capital and educational philosophy, is particularly crucial in the intergenerational influence on the formation of their children's cognitive abilities [4], permeating daily interactions, educational decision-making, and resource provision as a key source of individual differences in cognitive ability development. With the promulgation and implementation of the "Family Education Promotion Law of the People's Republic of China" clarifying families' primary responsibility in children's development, this study aims to explore how parental education influences children's cognitive abilities through the family context, which is crucial for addressing educational equity needs and improving national development quality.

## 2. Literature Review

Cognitive ability, as a core dimension of individual human capital accumulation, not only directly influences academic achievement and educational attainment but also plays a long-term role in determining occupational status, income growth, and even social mobility [5]. As the primary context for children's development, and as a core indicator of family socioeconomic status [6-7], the intergenerational impact of parental education on children's cognitive abilities has become a key research topic at the intersection of education, economics, and sociology. A review of existing literature shows that the academic community has produced rich research results on the "correlation between parents' education level and children's

cognitive ability", mainly focusing on dimensions such as impact effects, mechanisms of action, and heterogeneous characteristics.

From the perspective of impact, numerous empirical studies have confirmed a significant positive correlation between parental education and children's cognitive ability. From the perspective of intergenerational transmission, parental education has a systematic impact on children's cognitive development through the shaping of the family environment. Early research based on Western data found that for every additional year of parental education, children's cognitive test scores significantly improved [8]. This conclusion has also been confirmed in developing countries—data from the China Education Panel Studies (CEPS) show that for every additional year of parental maximum education, children's standardized cognitive ability scores increased by 0.019, and this effect remained robust after controlling for variables such as family income and school quality [9].

In terms of heterogeneity, this influence varies across three groups: First, urban-rural differences. The impact of parents' education on their children's cognitive abilities is significantly greater in urban areas than in rural areas. This is closely related to the concentrated educational resources and rich cultural capital of urban areas, making it easier for parents to translate their educational advantages into practical support for their children's cognitive development [10]. Furthermore, there are complex differences in urban and rural educational investment [11]. Second, gender differences. Parental education promotes girls' cognitive abilities more strongly than boys', which is related to the "mother-led childcare" family division of labor [12]. Mothers are more adept at enhancing girls' cognitive abilities through emotional interaction and learning support [13]. Furthermore, gender differences in educational attainment are more pronounced with lower family class status, while higher parental education can mitigate this bias. Third, differences in cognitive ability. Lower children's cognitive abilities are more significantly influenced by their parents' education, suggesting that children from disadvantaged families are more dependent on their parents' educational resources for cognitive development [9].

In terms of the mechanisms of action, academics have revealed the underlying pathways through

the theoretical frameworks of "resource conversion model" and "the theory of cultural capital reproduction." The resource conversion model emphasizes that parents transform their educational advantages into support for their children's cognitive development through material and time investments. On the one hand, highly educated parents are more likely to increase their material educational investments, such as purchasing books and providing extracurricular tutoring, creating a rich, cognitively stimulating environment for their children [15]. On the other hand, the quality of their time investment is even more crucial [16]. Parent-child companionship (such as shared reading and discussion) can directly promote the improvement of children's logical thinking and problem-solving abilities through language interaction and guided thinking [17]. However, empirical research shows that the mediating effect of parent-child companionship accounts for only 2.59% [9], indicating that its role is more complementary to other mechanisms.

In the theory of cultural capital reproduction, highly educated parents create a "implicit nurturing context" for cognitive development by fostering a family cultural atmosphere. The intergenerational transmission of educational expectations is a key mediator. Specifically, parents' expectations for their children's academic performance (e.g., "above average") and educational attainment (e.g., the expectation that their children will receive higher education) translate into self-motivation in their children, prompting them to invest more effort in improving their cognitive abilities [18]. Relevant data shows that for every 1-unit increase in parents' educational expectations, children's total study time increases by 0.7 hours and their educational investment increases by 149.73 yuan. This time and investment ultimately leads to a 0.23-unit improvement in cognitive ability per hour [19]. Further research confirms the centrality of this mechanism: the mediating effect of educational level requirements accounts for 44.52%, and the mediating effect of children's educational expectations, formed by their parents' expectations, accounts for 40.19% [9]. This suggests that, compared to material investment, the intergenerational transmission of educational expectations is a more central transmission pathway. Furthermore, parents' cultural habits also play a potential role. The reading and writing behaviors of highly educated

parents serve as models for their children to emulate, thus broadening their children's knowledge through "subtle" cultural immersion and indirectly improving their cognitive abilities [20].

Based on the above literature, this study proposes the core hypothesis: parental education has a significant positive impact on children's cognitive abilities. Specifically, for every additional year of parents' highest level of education, children's cognitive abilities will improve significantly.

### 3. Data Sources and Descriptive Statistics

#### 3.1 Data Sources and Explanations

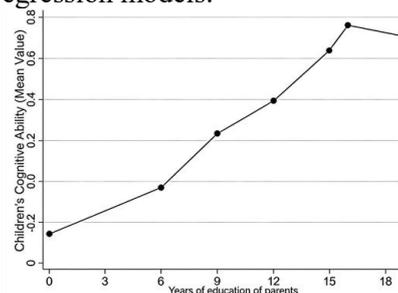
The data for this study are from the 2014-2015 academic year follow-up data from the China Education Panel Survey (CEPS). Designed and implemented by the China Survey and Data Center of Renmin University of China, this large-scale, nationally representative survey project. The CEPS uses the 2013-2014 academic year as its baseline, targeting first-year (7th grade) and third-year (9th grade) junior high school students. A multi-stage probability proportional to size (PPS) sampling is employed. The survey is school-based, ultimately encompassing all students in the sampled classes, parents, homeroom teachers, subject teachers (Chinese, mathematics, and English), and school leaders, forming a multi-source data. This study selected a valid sample size of 7,426 from this survey data, encompassing multiple data files, including student questionnaires and parent questionnaires. This data provides nationwide coverage, strong representativeness, and statistical power, providing a solid foundation for in-depth research on the relationship between parental education and children's cognitive abilities.

#### 3.2 Descriptive Statistical Analysis of the Relationship between Variables of the Relationship between Parents' Years of Education and Children's Cognitive Ability

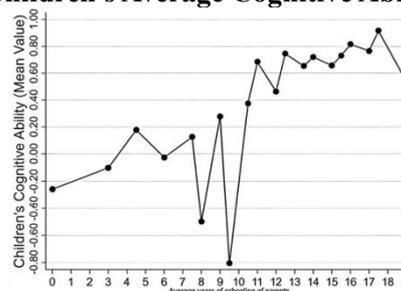
In order to further explore the possible intrinsic correlation between parents' education level and children's cognitive ability, this study systematically presents the correspondence between multi-dimensional parental education indicators and the mean value of children's cognitive ability through Figure 1, specifically covering four core dimensions: parents' highest

years of education, parents' average years of education, father's years of education, and mother's years of education. The trend in the figure shows that as parents' maximum years of education gradually increase from a lower level (e.g., no formal education or elementary school) to a higher level (e.g., high school, college, or above), their children's mean cognitive ability shows a steady upward trend. Similarly, in terms of average parental education, as the overall educational level of both parents increases, their children's mean cognitive ability also continues to rise. Examining the relationship between father's or mother's years of education and their children's cognitive ability separately also shows a consistent positive trend—that is, with each additional level of education, the average level of their children's cognitive ability improves to varying degrees.

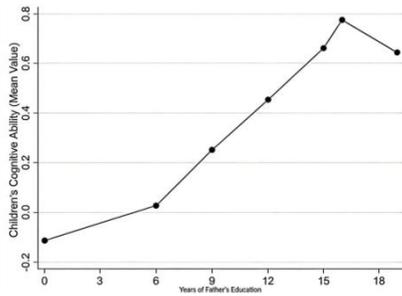
This consistent trend across multiple dimensions provides preliminary, intuitive evidence for a relationship between parental education and their children's cognitive ability. Based on the data characteristics, it can be inferred that the two may be positively correlated, meaning that higher parental education levels are associated with greater cognitive development in their children. This preliminary finding supports the core hypothesis of this study: "Parental education has a significant positive impact on children's cognitive ability," laying the foundation for more rigorous empirical testing using regression models.



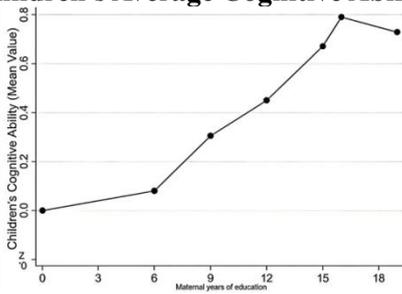
(a) Parents' Highest Years of Education and Children's Average Cognitive Ability



(b) Parents' Average Years of Education and Children's Average Cognitive Ability



(c) Father's Years of Education and Children's Average Cognitive Ability



(d) Mother's Years of Education and Children's Average Cognitive Ability

Figure 1. The Relationship between Parents' Years of Education and Children's Cognitive Ability

4. Model Establishment and Regression Analysis

4.1 Model Establishment and Variable Setting

Combining theoretical logic with existing research foundation, this paper sets the empirical model as follows

$$cogt_{ij} = \alpha + \beta_1 p_{educationij} + \theta Controls_{ij} + S_i + \epsilon_{ij} \quad (1)$$

The dependent variable *cogt<sub>ij</sub>* represents the cognitive ability level of the *j*th student in the *i*-th school. To ensure scientific and comparable measurement, this variable is assessed using three core dimensions: language comprehension, encompassing vocabulary analysis, sentence logic, and text interpretation; graphic and spatial cognition, including pattern recognition, spatial imagination, and geometric relationship judgment; and computational and logical ability, involving mathematical operations, logical reasoning, and problem solving. The raw test

data were processed using the internationally accepted three-parameter IRT (Item Response Theory) model to produce a standardized total score. This processing effectively eliminates the unit and dimension effects caused by differences in test item difficulty, making the score comparable across groups and countries. Higher scores indicate stronger overall cognitive abilities. The core explanatory variable, *education<sub>ij</sub>*, focuses on parents' educational level, using "the highest number of years of education received by parents" as the core indicator (e.g., no education is counted as 0 years, elementary school as 6 years, junior high school as 9 years, high school as 12 years, junior college as 15 years, undergraduate as 16 years, and graduate school and above as 19 years). This indicator was chosen because the most educated parent in a family often plays a leading role in educational decision-making, resource provision, and cultural guidance, and thus better reflects the overall level of educational resources within the family. To eliminate the influence of other factors on cognitive ability, the model incorporates multiple control variables (*Controls<sub>ij</sub>*): at the individual level: gender (*gender*), age (*age*), ethnicity (*ethnicity*), academic performance (*grade*), and only child (*only*); these variables reflect fundamental differences in individual development; at the family level: household registration (*hukou*) (*hk*), number of books in the home (*Bbooks*), economic conditions (*ninc*), and extracurricular tutoring (*exedu*) to control for the influence of family economic and cultural background; at the school level: school quality (*shlrf*) and class quality (*classrf*) to reflect differences in the external educational environment. Furthermore, the model introduces a school dummy variable (*S<sub>i</sub>*) to control for unobservable differences in school conditions, teaching management, and other aspects, further improving estimation accuracy.  $\epsilon_{it}$  represents the residual term. Detailed statistical results for these variables are shown in Table 1.

Table 1. Variable Settings (N=7426)

Type	Variable	Definition	Mean	SD	Min	Max
Dependent variable	<i>cogt</i>	Cognitive ability	0.358	0.797	-3.137	2.063
Core explanatory variables	<i>maxedu</i>	Parents' highest years of education	11.006	3.185	0.000	19.00
	<i>ave edu</i>	Parents' average years of education	10.265	3.100	0.000	19.00
	<i>fedu</i>	Father's years of education	10.578	3.206	0.000	19.00
	<i>medu</i>	Mother's years of education	9.952	3.547	0.000	19.00
Control variables	<i>gender</i>	Gender	0.500	0.500	0.000	1.00

	age	Age	13.528	0.700	12.000	18.00
	ethnic	Ethnicity	0.912	0.283	0.000	1.00
	grade	Academic performance	81.852	21.256	9.667	213
	only	Only child	0.448	0.497	0.000	1.00
	hk	Hukou	0.260	0.439	0.000	1.00
	Bbook	Number of books	0.355	0.479	0.000	1.00
	ninc	Economic conditions	0.065	0.246	0.000	1.00
	exedu	Extracurricular tutoring	0.352	0.478	0.000	1.00
	shlrf	School quality	4.006	0.836	1.000	5.00
	classrf	Class quality	3.417	0.993	1.000	5.00
Mediating variables	acareq	Academic requirements	0.797	0.402	0.000	1.000
	edureqy	Educational expectations	16.756	2.959	6.000	22.00
	expedy	Personal educational expectations	16.314	3.039	6.000	22.00
	comp	Parent-child companionship	16.837	2.886	3.000	18.00
	act	Parent-child activities	6.212	3.131	3.000	18.00

#### 4.2 Regression Results Analysis

Because this study uses cross-sectional data for analysis, to ensure the validity and reliability of the model estimates, the model must be tested for multicollinearity and heteroskedasticity. The collinearity between the core explanatory variables (the principal component of parental education (PC\_educ)) and the control variables in the model was tested by variance inflation factor analysis. The results showed that the average VIF of the model was 1.21, and the VIF of each variable was much less than 10, indicating that the model did not have multicollinearity problems. The results of the Breusch-Pagan heteroscedastic test and White heteroscedastic test rejected the null hypothesis of "homoscedasticity of error terms", indicating that the model had heteroscedasticity. To overcome the impact of heteroscedasticity on the estimation results, the robust standard error (Huber-White) regression) was used to correct it to ensure the validity of statistical inference. The regression results are shown in Table 2. Model (1) is the baseline model with the maximum years of education of parents (maxedy) as the core explanatory variable; to enhance the robustness of the estimation, models (2)-(4) use the average years of education of parents (ave\_educ), the father's years of education (feduy), and the mother's years of education (meduy) as the core explanatory variables, respectively, as comparison models of the baseline model. Results of the analysis of models (1)-(4): The coefficients of the core explanatory variables are all positive and pass the 1% significance test, indicating that parents' education level has a significant positive effect on their children's

cognitive ability. That is, the longer the parents' years of education, the higher the children's cognitive ability. In the baseline model (1), for every additional year of parents' highest years of education, the children's cognitive ability increases by 0.017. Comparing models (3) and (4), the coefficient of "father's years of education" is higher. Analyzing model (5), we can see that when both parents' years of education are included, we manually test the difference in the impact of father's (feduy) and mother's (meduy) years of education on children's cognitive ability (cogt). The results show that the difference in coefficients between the two is 0.00415, and the corresponding significance test is 0.35. At the commonly used significance levels (such as 1%, 5%, and 10%), this indicates that the difference in coefficients between father's and mother's years of education on children's cognitive ability does not pass the significance test, that is, it cannot be strongly confirmed that the father's years of education have a significantly greater impact on children's cognitive ability than the mother's.

**Table 2. The Impact of Parental Education on Children's Cognitive Ability**

	(1)	(2)	(3)	(4)	(5)
maxedy	0.017***				
	(0.003)				
ave_educ		0.017***			
		(0.003)			
feduy			0.014***		0.011***
			(0.003)		(0.003)
meduy				0.012***	0.006**
				(0.003)	(0.003)
School dummy variable	Control	Control	Control	Control	Control
N	7426	7426	7426	7426	7426

adj. $R^2$	0.373	0.373	0.373	0.372	0.373
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Standard errors in parentheses

Note: Standard errors are robust standard errors, \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

### 4.3 Further Structural Analysis

#### 4.3.1 Analysis of urban-rural differences

Model (1) and model (2) in Table 3 analyze rural and urban samples respectively. The rural and urban samples are divided based on the father's household registration as the basis for distinction. This item is used to define the region type to which the sample belongs, and then the estimated results of the impact of parents' highest years of education on children's cognitive ability are reported. The reason for regional analysis is that there are significant differences between urban and rural areas in terms of educational resource allocation and family education models. This division can more accurately capture the regional heterogeneity of parents' education level in affecting children's cognitive ability, making the research conclusions more in line with the actual situation in different regions. In-depth analysis shows that in both rural and urban samples, the coefficient values of parents' highest years of education are positive and have successfully passed the 1% significance test. This clearly shows that there is a stable and significant positive correlation between parents' highest years of education and the improvement of children's cognitive ability. Specifically, for every one-year increase in rural parents' maximum years of education, their children's cognitive ability increased by 0.017; for urban parents, their cognitive ability increased by 0.021. To further explore the differences between urban and rural areas, we conducted a test for intergroup coefficient differences. The results showed that the difference between the two groups did not pass the 10% significance level test, indicating that the difference in the impact of urban and rural parents' maximum years of education on their children's cognitive ability was not statistically significant. This conclusion differs from the earlier study by Zheng Lei et al. (2019) [10], which found that urban parents' education level had a significantly greater impact than rural parents'. The reason for this change may be that, although in objective reality, there are inherent gaps in urban and rural educational resources, such as uneven distribution of high-quality teachers and gaps in hardware facilities, it is

worth noting that with the continuous advancement of basic educational informatization, a typical manifestation, such as the popularization of online courses, has built a new bridge for knowledge dissemination. Rural families can break through geographical restrictions and easily obtain rich and diverse cognitive development resources, from popular science lectures to subject tutoring courses, from quality development content to thinking training materials, gradually narrowing the difference in the impact of urban and rural parental education on their children's cognitive development, so that urban and rural children have more possibilities to stand on the same starting line on the road to cognitive ability development.

**Table 3. Urban-rural Differences in the Impact of Parents' Highest Education Level on their Children's Cognitive Ability**

Model	(1)	(2)
Region	Rural	Urban
maxeduy	0.017***	0.021***
	(0.004)	(0.006)
Constant term	4.493***	-0.190
	(0.285)	(0.431)
Student characteristics	Control	Control
Parent characteristics	Control	Control
School characteristics	Control	Control
School dummy variable	Control	Control
$N$	5495	1931
adj. $R^2$	0.391	0.273
Coefficient difference	-0.004***	

Standard errors in parentheses

Note: Standard errors are robust standard errors, \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

#### 4.3.2 Gender difference analysis

Table 4 By constructing a systematic regression analysis framework, we deeply explore the gender differences in the intergenerational transmission of parents' education level.

In Table 4, the female and male samples are divided according to the children's own gender attribute items, so as to analyze the impact of parents' education level on the cognitive ability of children of different genders. Gender-specific analysis is conducted because children of different genders may differ in family upbringing and social expectations. This facilitates precise exploration of gender heterogeneity in intergenerational transmission of education, enhancing the pertinence and persuasiveness of the conclusions. Focusing on children's cognitive ability as the core dependent

variable, the study distinguishes between female and male samples and includes three key explanatory variables: parents' maximum years of education (maxeduy), father's years of education (feduy), and mother's years of education (meduy). While strictly controlling for variables such as individual student and family characteristics, the study comprehensively analyzes the mechanisms of gender heterogeneity in intergenerational transmission of education. The core conclusion is that the positive impact of parents' years of education on children's cognitive ability passes the 1% significance test for both male and female samples. This result profoundly reveals that regardless of the child's gender, improved parental education can be a significant driver of their cognitive development. Family education, as a foundational context for cognitive development, has universal and critical value for children's growth. This result supports the conclusions of Liu et al. (2025) [9]. However, gender heterogeneity exhibits significant differences: For the dimensions of parents' maximum years of education (maxeduy), father's years of education (feduy), and mother's years of education (meduy), the coefficients for female samples (0.020\*\*\*, 0.017\*\*\*, and 0.014\*\*\*, respectively) are all higher than those for male samples (0.014\*\*\*, 0.012\*\*\*, and 0.009\*\*\*, respectively). This suggests that the same level of parental educational investment can yield higher "transformation efficiency" in the cognitive development of females, and that family educational resources exert a stronger influence on the growth of female offspring. This difference may stem from the potential influence of sociocultural expectations of different gender roles—for example, the implicit traditional precept that women "need to enhance their competitiveness through knowledge." It may also be related to factors such as girls' greater sensitivity to their family environment

during their cognitive development and their learning styles being more adapted to family educational guidance models. This merits further exploration from multidisciplinary perspectives such as social psychology and educational sociology. In terms of model fit ( $R^2$ ), the  $R^2$  of the regression for boys' samples is generally higher than that for girls (for example, boys have a higher  $R^2$  in the maxeduy regression). This phenomenon directly reflects that control variables such as family and school have a stronger explanatory power for boys' cognitive ability differences, suggesting that there are fundamental differences in the mechanisms of education's influence from a gender perspective. Specifically, the development of boys' cognitive ability is more easily captured by variables in the existing model (such as parental education level, family economic conditions, and school resources), and the proportion of their cognitive differences that can be explained by quantifiable factors is higher. However, differences in girls' cognitive ability may be influenced by more unique factors not included in the model, such as gender-specific sociocultural pressures and the interaction between female-specific psychological traits and cognitive development. These factors are difficult to accurately measure using conventional control variables, resulting in a relatively limited explanatory power of the model for girls' cognitive differences. This opens up new avenues for future research to explore the hidden factors influencing women's cognitive development. In summary, the positive impact of parents' years of education on their children's cognitive ability shows significant gender heterogeneity: in terms of the strength of the variable's influence, the promoting effect is stronger for girls; however, in terms of the model's explanatory power, boys' cognitive differences are more easily explained by existing factors.

**Table 4. Gender Differences in the Effect of Parents' Highest Education Level on Children's Cognitive Ability**

	(1)	(2)	(3)	(4)	(5)	(6)
	Girls	Boys	Girls	Boys	Girls	Boys
maxeduy	0.020*** (0.004)	0.014*** (0.004)				
feduy			0.017*** (0.004)	0.012*** (0.004)		
meduy					0.014*** (0.004)	0.009** (0.004)

Constant term	-0.080 (0.265)	5.132*** (0.356)	-0.087 (0.266)	5.116*** (0.356)	0.088 (0.268)	5.059*** (0.358)
Student characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Parent characteristics	Yes	Yes	Yes	Yes	Yes	Yes
School characteristics	Yes	Yes	Yes	Yes	Yes	Yes
School dummy variable	Yes	Yes	Yes	Yes	Yes	Yes
N	3710	3716	3710	3716	3710	3716
adj. R <sup>2</sup>	0.372	0.374	0.371	0.373	0.370	0.373
Coefficient Difference	0.006		0.005		0.005	

Standard errors in parentheses

Note: Standard errors are robust standard errors, \* p<0.1, \*\* p<0.05, \*\*\* p<0.01

4.3.3 Quantile analysis

Table 5 reports the regression results of the impact of parents' maximum years of education on children's cognitive ability, estimated using quantile regression. The full quantile series (Figure 2) allows for further analysis. The data in Table 5 show that at the five quantiles (0.1, 0.25, 0.5, 0.75, and 0.9), the coefficients of the core explanatory variable, maxeduy (parents' maximum years of education), are all positive (0.016\*\*\*, 0.019\*\*\*, 0.019\*\*\*, 0.014\*\*\*, and 0.015\*\*\*, respectively), and all pass the 1% significance test. This indicates that regardless of the quantile level of children's cognitive ability, the positive impact of parents' maximum years of education on their cognitive ability remains significant, confirming the universal role of parental education level in children's cognitive development. Combining the full quantile series in Figure 2 with the coefficient trends in Table 5, we can see that the impact of parents' highest years of education is not static: at the low cognitive ability quantile (0.1 quantile), the coefficient is 0.016. As the quantile rises to the 0.25 and 0.5 quantiles (medium cognitive ability), the coefficient rises to 0.019, reaching its peak. As the quantile further increases to the 0.75 and 0.9 quantiles (high cognitive ability), the coefficients fall back to 0.014 and 0.015, showing an "increase followed by a decrease" pattern. This trend indicates that the impact of parents' highest years of education on their children's cognitive ability is most pronounced among those with medium cognitive ability, while the effect is relatively weaker among those with low or high cognitive ability. This result supports the conclusions of Liu et al. (2025) [9].

The practical significance of this result lies in: first, the positive effect of parental education level on children's cognitive ability is universal, with no "ineffective interval"; second, the

quantile differences in the strength of this effect suggest that for children with average cognitive ability, an increase in parental education level may have a more significant cognitive boost. For children with low or high cognitive abilities, in addition to parental education, more diverse interventions (such as targeted educational counseling and personalized development support) may be needed to optimize cognitive development. This provides empirical evidence from a quantile perspective for the precise formulation of family education support policies and the differentiated improvement of children's cognitive ability.

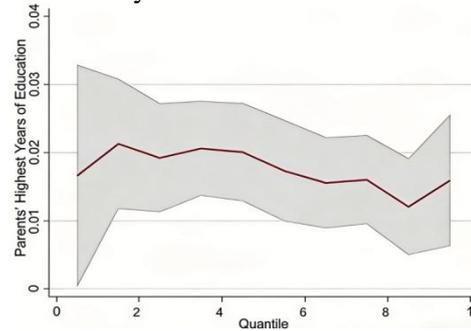


Figure 2. Full-Scale Series Chart

Table 5. Quantile Regression Results for the Effect of Parents' Highest Years of Education on Children's Cognitive Ability

	(1)	(2)	(3)	(4)	(5)
	0.1	0.25	0.5	0.75	0.9
maxeduy	0.016*** (0.006)	0.019*** (0.004)	0.019*** (0.004)	0.014*** (0.004)	0.015*** (0.004)
Student characteristics	Control	Control	Control	Control	Control
Parent characteristics	Control	Control	Control	Control	Control
School characteristics	Control	Control	Control	Control	Control
School Dummy Variable	Control	Control	Control	Control	Control
N	7426	7426	7426	7426	7426
r <sup>2</sup> p	0.264	0.269	0.214	0.174	0.162

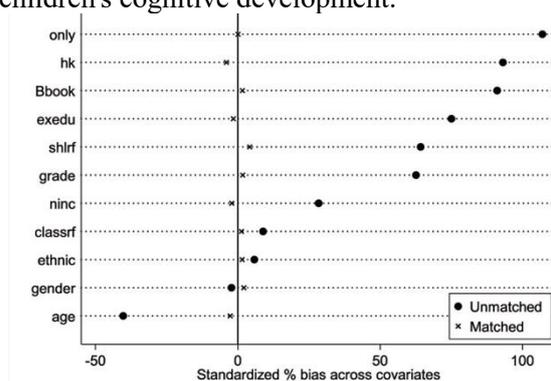
Standard errors in parentheses

Note: Standard errors are robust standard errors, \* p<0.1, \*\* p<0.05, \*\*\* p<0.01

**5. Robustness Test**

Using the classic propensity score matching (PSM) under the counterfactual framework, we can further remove the interference of confounding factors and accurately identify the net effect of parents' education level on children's cognitive ability. In terms of matching quality, the balance test results in Figure 3 intuitively demonstrate that before matching (Unmatched), the standardized biases (Standardized % bias) of various covariates (such as student age (age), gender (gender), ethnicity (ethnicity), class quality (classrf), economic conditions (ninc), student average grade (grade), school quality (shlrf), extracurricular tutoring (exedu), number of books (Bbook), household registration (hk), and whether or not the child was only a child) showed significant differences. The absolute value of the bias for some variables exceeded 50%, suggesting that there were systematic differences in the underlying characteristics between the treatment group (parents with a college degree or higher) and the control group (parents with a college degree or lower). After matching (Matched), the standardized biases of all covariates were significantly reduced to near zero, and no variable had an absolute bias exceeding 10%. This indicates that the nearest neighbor matching ( $k = 4$ ) method successfully balanced the underlying characteristics of the two groups, satisfying the "conditional independence assumption" and providing a reliable premise for subsequent causal inference. To enhance the robustness of the estimation results, Table 7 further reports the PSM analysis results for four matching methods: nearest neighbor matching, radius matching, kernel matching, and local linear regression matching. All four models control for student characteristics (such as age and gender), parent characteristics (such as family income and educational values), and school characteristics (such as school ranking and faculty quality). The

sample size for the treatment group (parents with a college degree or higher) was 1,775, and the sample size for the control group (parents with less than a college degree) was 5,651. The results show that the average treatment effect (ATT) under the four matching methods is 0.147\*\*\*, 0.146\*\*\*, 0.144\*\*\*, and 0.145\*\*\*, respectively, with standard deviations of 0.031, 0.030, 0.030, and 0.035, respectively. All models pass the 1% significance test (\*\*\*) indicates  $p < 0.01$ ), which is far lower than the 5% significance level in the original statement, indicating that the results are statistically robust. These results clearly demonstrate that, regardless of the matching method used, having a parental education level of college or higher has a significant net positive effect on children's cognitive ability. Specifically, compared with children from families where parents have less than a college education, children with parents who have a college education or higher have an average cognitive improvement of 0.144-0.147 units. This finding not only confirms a causal relationship between parental education level and children's cognitive ability, but also, through rigorous balance tests (Figure 3) and multi-method robustness validation (Table 7), eliminates spurious associations due to differences in family background, student foundation, and other factors, providing more rigorous empirical support for the positive effect of increasing parental education level on children's cognitive development.



**Figure 3. Balance Test Diagram**

**Table 6. PSM Analysis Results of the Impact of Parental Education Level on Children's Cognitive Ability**

Model	Dependent Variable: cogt			
	(1)	(2)	(3)	(4)
Matching Method	Nearest Neighbor Matching	Radius Matching	Kernel Matching	Local Linear Regression
ATT	0.147***	0.146***	0.144***	0.145***
	(0.031)	(0.030)	(0.030)	(0.035)
Student characteristics	Control	Control	Control	Control

Parent characteristics	Control	Control	Control	Control
School characteristics	Control	Control	Control	Control
Control Group	5651	5651	5651	5651
Treatment Group	1775	1775	1775	1775

Standard errors in parentheses

Note: Standard errors are robust standard errors, \* p<0.1, \*\* p<0.05, \*\*\* p<0.01

$$Mi = \beta_0 + a \times \text{maxeduyi} + \lambda \times CVi + \epsilon_i \quad (3)$$

This model examines the impact of parents' maximum years of education on various mediating variables (M), specifically how parents' education level influences mediating variables such as academic achievement requirements and academic level requirements. Path C model is:

$$Cogti = \gamma_0 + c' \times \text{maxeduyi} + bMi + \mu \times CVi + \epsilon_i \quad (4)$$

This method examines the combined effects of parents' maximum years of education and mediating variables on children's cognitive ability after the introduction of mediating variables, thereby determining whether the mediating variables play a role.

Where M is the mediating variable, specifically including academic performance requirements, educational level requirements, children's own educational expectations, parent-child companionship, and parent-child activities. The following explanation is based on academic performance requirements. First, using Path A in formula (2), a regression analysis is conducted to explore the effect of parents' highest years of education on children's cognitive ability when no mediating variable is introduced. If the coefficient c is significant, it indicates that parents' highest years of education have an overall effect on children's cognitive ability, and subsequent analysis can be continued; otherwise, the analysis is stopped. Secondly, Path B is used to analyze the impact of parents' highest years of education on academic performance requirements. Then, Path C is used to study the impact of parents' highest years of education and academic performance requirements on children's cognitive ability. Path C adds a mediating variable to Path A. If both the coefficient a of Path B and the coefficient b of Path C are significant, it indicates that a mediation effect exists. Now, observe the significance of c'. If c' is insignificant, it means that academic performance requirements play a full mediating role; if c' is significant, it indicates that academic performance requirements play a partial mediating role. Finally, if at least one of the coefficients a of Path B and b of Path C is insignificant, use the Sobel-Goodman test to determine whether the mediating effect is significant.

### 6. Mechanism Analysis

Based on theoretical analysis, parental education influences children's cognitive ability by influencing educational expectations and educational investment. Therefore, variables in these two dimensions were selected as mediating variables to explore the specific mechanisms. Among them, the educational expectation dimension includes academic performance requirements (acareq), educational level requirements (edureq) and children's own educational expectations (expedy). Academic performance requirements are measured by whether parents' expectations for their children's academic performance are above the average level. Educational level requirements and children's own educational expectations are converted into years of education based on educational level. The educational investment dimension covers parent-child companionship (comp) and parent-child activities (act). Parent-child companionship is obtained by summing up the frequency of daily activities such as parents having dinner with their children. Parent-child activities are obtained by summing up the frequency of activities such as parents accompanying their children to visit museums, zoos, science and technology museums, etc., in order to measure the frequency of parents' interaction with their children inside and outside the family [21].

Referring to the mediation effect test method, three models were set up to test the mediation effect. Path A model is:

$$Cogti = \alpha_0 + c \times \text{maxeduyi} + \eta \times CVi + \epsilon_i \quad (2)$$

This model examines the total effect of parents' maximum years of education (maxeduy) on children's cognitive ability (Cogti), specifically the direct impact of parents' maximum years of education on their children's cognitive ability. The coefficient c in this model has been verified to be significant, indicating that parents' maximum years of education have a significant impact on their children's cognitive ability, which forms the basis for subsequent analysis. Path B model is:

During the regression analysis, since Path A has been confirmed, we focus on the estimated results of Paths B and C (as shown in Table 7). In Path B, the effects of parents' maximum years of education (maxedy) on some mediating variables differ: the regression coefficients for educational level requirements (edureq), children's educational expectations (expedy), parent-child companionship (comp), and parent-child activities (act) are all significant, indicating that higher levels of parental education are associated with higher educational requirements and expectations for their children's own education, and with greater investment in parent-child companionship and activities. However, the effect on academic performance requirements (acareq, coefficient -0.002) is not significant, indicating that there is no correlation between parental education and expectations for children's academic performance. In Path C, educational level requirements (edureq), children's educational expectations (expedy), and parent-child companionship (comp) all meet the characteristics of a partial mediation effect: after introduction, the effect of parents' maximum years of education on children's cognitive ability (cogt) remains significantly positive, with coefficients decreasing compared to Path A. Furthermore, in Path B, parental education has a significant impact on these three variables. Although parental education still had a significant effect on cognitive ability after the introduction of academic achievement requirements (acareq) (0.017\*\*\*), it did not constitute a mediating effect because parental education had a nonsignificant effect in Path B. Parental education also had a significant effect on cognitive ability after the introduction of parent-child activities (act), but its own effect on cognitive ability was nonsignificant (-0.001). Combining Path B with the Sobel-Goodman test, this did not constitute a mediating effect. The significance of the mediation effect was determined by calculating the proportion of the mediating effect to the total effect and conducting a Sobel-Goodman test. From the Sobel-Goodman test results and the proportion of mediating effects in Table 7, we can see that the mediating effect of academic achievement requirements (acareq) accounts for 2.453% of the total effect, but its Sobel-Goodman test stat (-1.263) does not pass the significance test; the mediating effect of educational level

requirements (edureq) accounts for 12.934%, and the Sobel-Goodman test stat (5.562\*\*\*) passes the significance test; the mediating effect of children's own educational expectations (expedy) accounts for 13.567%, and the Sobel-Goodman test stat (5.705\*\*\*) passes the significance test; the mediating effect of parent-child companionship (comp) accounts for 4.771%, and the Sobel-Goodman test stat (3.386\*\*\*) passes the significance test; the mediating effect of parent-child activities (act) accounts for 0.921%, and its Sobel-Goodman test stat (-0.428) does not pass the significance test.

In summary, parents' maximum years of education influence children's cognitive ability through the three mediating variables of educational expectations (educational level requirements and children's own educational expectations) and educational investment (parent-child companionship), and all three variables play a partial mediating role. The mediating effect of educational expectations is significant, while the mediating effect of parent-child companionship in the educational investment dimension is relatively small. academic performance requirements and parent-child activities do not exhibit significant mediating effects. These results profoundly reveal the underlying logic behind how parental education influences children's cognitive abilities: Parents' educational expectations are clearly intergenerational. Highly educated parents' stringent expectations for their children's educational attainment, coupled with their children's inherent high educational aspirations, translate into internal motivation for their children to improve their cognitive abilities, forming a virtuous cycle of "expectation-motivation-improvement." Furthermore, by increasing parent-child time together (e.g., daily interactions like eating and reading together), parents can create a richer cognitive stimulation environment for their children, fostering the development of cognitive abilities such as language expression and logical thinking through frequent parent-child communication. This provides multi-dimensional insights for relevant educational policymaking and family education practices. At the policy level, efforts can be made to strengthen the positive impact of parental educational expectations and the quality of parent-child companionship through programs

guiding parental educational expectations and establishing support platforms for parent-child companionship (e.g., community parent-child activity centers). At the family education level, parents should prioritize cultivating reasonable educational expectations for their children, avoiding a singular focus on short-term academic achievement. Furthermore, they should increase high-quality parent-child

interaction time, ensuring that companionship truly serves as a catalyst for their children's cognitive development. Overall, this research result highlights the core value of parental educational expectations and effective parent-child companionship in children's cognitive development, providing empirical evidence for solving the puzzle of how parental education influences children's development.

**Table 7. Estimated Results of Mechanism Analysis of the Impact of Parents' Maximum Years of Education on Children's Cognitive Ability**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	acareq	cogt	edureqycogt	expeduy	cogt	comp	cogt	act	cogt	
maxeduy	-0.002 (0.002)	0.017*** (0.003)	0.117*** (0.013)	0.015*** (0.003)	0.089*** (0.013)	0.015*** (0.003)	0.054*** (0.013)	0.016*** (0.003)	0.143*** (0.013)	0.017*** (0.003)
acareq		0.186*** (0.019)								
edureqycogt				0.019*** (0.003)						
expeduy						0.026*** (0.003)				
comp								0.015*** (0.003)		
act										-0.001 (0.003)
Student characteristics	Control	Control	Control	Control	Control	Control	Control	Control	Control	Control
Parent characteristics	Control	Control	Control	Control	Control	Control	Control	Control	Control	Control
School characteristics	Control	Control	Control	Control	Control	Control	Control	Control	Control	Control
School Dummy Variable	Control	Control	Control	Control	Control	Control	Control	Control	Control	Control
N	7426	7426	7426	7426	7426	7426	7426	7426	7426	7426
adj. R <sup>2</sup>	0.104	0.381	0.163	0.377	0.208	0.381	0.091	0.376	0.154	0.373
F	8.261	39.103	13.166	38.488	17.406	39.086	7.252	38.269	12.341	37.844
Sobel-Goodman	-1.263		5.562***		5.705***		3.386***		-0.428	
Mediation Effect	2.453%		12.934%		13.567%		4.771%		0.921%	

Standard errors in parentheses

Note: Standard errors are robust standard errors, \* p<0.1, \*\* p<0.05, \*\*\* p<0.01

**7. Conclusions and Recommendations**

Through in-depth research on the relationship between parents' education level and their children's cognitive abilities, we can draw a series of clear conclusions, and based on this, we can put forward targeted policy and practice recommendations. First, from the perspective of overall impact, the positive impact of parents' education level on their children's cognitive abilities presents a significant and stable characteristic. Specifically, for every year of parents' education, their children's cognitive

abilities will increase by 0.017. This data clearly quantifies the positive role of parents' educational background in their children's cognitive process. It is worth noting that in this influence process, the difference in the effects of the father's and mother's years of education is not significant. In other words, whether it is the father or the mother, the length of their education has roughly the same effect on improving their children's cognitive abilities. This breaks the possible concept that "the role of the father or the mother in the education of their children is not significant."

The cognition of "more prominent" highlights the importance of the common educational background of both parents on their children's

cognition. At the same time, this influence also has obvious heterogeneous characteristics. From the perspective of gender, the effect of parents' education level on girls' cognitive ability is significantly stronger than that of boys, which means that under the same family education background, girls may benefit more from improving their cognitive ability; from the perspective of children's own cognitive level, the influence of parents' education level is most prominent among children with medium cognitive level, while in groups with low or high cognitive level, this influence is relatively weak, which shows that parents' educational background has a more critical driving role for children in the intermediate cognitive stage; from the perspective of urban and rural differences Despite certain disparities between urban and rural areas in educational resources, the difference in the impact of parents' years of education on their children's cognitive abilities between urban and rural areas does not reach a significant level, indicating that the impact of parental education does not differ fundamentally depending on the region. Furthermore, the mechanism by which parental education influences children's cognitive abilities is also quite clear. The study found that parental education primarily exerts its influence through two channels: educational expectations and educational investment. Educational expectations include both parents' expectations of their children's educational attainment and the children's own expectations of their educational attainment, while educational investment primarily reflects parental companionship. The mediating effects of these three factors accounted for 12.934%, 13.567%, and 4.771% of the total effect, respectively. Academic performance requirements and parent-child activities did not show significant mediating effects in this mechanism. This provides a clear path for understanding how parents' educational background specifically influences their children's cognitive abilities. Based on the above conclusions, recommendations can be made at both the policy and practical levels. Promote the development of basic educational informatization: Leverage modern educational methods such as online courses to overcome geographical constraints, enable rural families to easily access high-quality cognitive development resources, and narrow the gap in educational resources between urban and rural areas to lay a

more equitable foundation for the balanced development of children's cognitive abilities. Provide cognitive-level-based differentiated educational support: Develop targeted educational strategies for children with different cognitive levels, strengthen educational guidance for children with medium cognitive abilities, and offer diversified intervention measures (e.g., targeted tutoring, personalized developmental support) for those with low or high cognitive abilities to meet their developmental needs.

The full text has certain shortcomings. In terms of the sample, the sample limitations are mainly reflected in the following aspects: the data only covers junior high school students, and does not include primary school or high school groups. It may not reflect the life cycle differences in the impact of parents' education level on their children's cognitive ability, which may limit the representativeness and persuasiveness of the research conclusions to a certain extent, and it is difficult to fully and accurately reflect the actual situation of different groups. In addition, in the exploration of the mechanism of action, other forms of education investment other than parent-child companionship, such as education funding and learning materials purchase, have not been deeply analyzed, which makes the grasp of the impact path not comprehensive; in the heterogeneity analysis, there is also a lack of more detailed exploration of the internal reasons why the urban-rural differences have not reached a significant level. These need to be further improved in subsequent research.

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