



Research article

Can home labor education boost teenagers' academic performance? A Comparative analysis

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ABSTRACT

Labor education is an important part of the overall development of teenagers in terms of morality, intelligence, physical fitness and aesthetics. Family labor education should play a fundamental role in labor education. Previous empirical studies on the influence of family labor education on teenagers' academic performance are not comprehensive enough. In particular, there is still much room for improvement in terms of the authority of the data, the appropriateness of the methodology and the precision of the analyses.

This study analyzes the relationship between housework and teenagers' academic performance through the data of the China Education Panel Survey (CEPS), based on the theory of "Embodied Cognition", using OLS regression, propensity score matching (PSM), quantile regression and probit regression. The results show that housework is effective in improving teenagers' academic performance; participation in housework had the strongest impact on teenagers with middle and lower academic performance; however, the effect of housework on the academic performance of academic excellence students was not as strong; and addiction to online games was the main factor that prevented teenagers from participating in housework.

1. Introduction

Labor shapes the material and spiritual advancement of society. Labor is the source of human survival, social progress and continuity. Marx once said: "Any nation that ceases to work, not to mention a year, or even a few weeks, will perish." According to Marx, labor is the fundamental basis for the existence and development of human beings. Labor is the fundamental way in which one's creativity can be expressed and one's self-worth realized.

In March 2020, the State Council of China issued the Opinions on Comprehensively Strengthening Labour Education in Schools and Universities in the New Era, stating that "labor education is an important part of the socialist education system with Chinese characteristics, and it directly determines the labor values and labor skills of the nation's builders". Labor education enables teenagers to establish the correct attitude toward labor [1]. Labor education cultivates teenagers' love of labor and good labor habits [2].

In July 2020, the Guidelines for Labor Education in Universities, Middle Schools and Primary Schools issued by the Chinese Ministry of Education provided specific guidance on family labor education. In the new era, labor education is an important criterion for the cultivation of talent in universities, middle schools and primary schools. Labor education has been elevated to a national strategy and is an important part of achieving the overall development of students in terms of morality, intellect, physique, aesthetics

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and labor [3]. Labor is important to help students establish correct labor values and cultivate positive attitudes and noble virtues related to labor. Labor plays an important role in shaping good labor habits. Labor has the educational function of promoting the overall development of human beings [4].

Family labor education is an indispensable and important part of labor education. At present, most of the studies on the effects of domestic labor on teenagers' academic performance are theoretical and descriptive survey-type studies [5,6], with few empirical studies. Existing studies lack evidence of the correlation between housework and teenagers' academic performance.

Family education for teenagers is important. Therefore, in what way should parents promote home education? The purpose of this study is to examine whether participation in housework has an effect on teenagers' academic performance so that housework can be used as an important educational method in teenagers' family education. At the same time, parents and teenagers will be made aware of the importance of family labor education so that parents will be more willing to let their children participate in housework. Therefore, based on the data from the China Education Panel Survey (CEPS), this study adopts OLS regression, propensity score matching (PSM), quantile regression and probit regression to study the effects of participation in housework on teenagers' academic performance by applying the principle of "embodied cognition".

"Embodied cognition" refers to the fact that human beings rely not only on the intelligence of the brain but also on the movements and sensations of the body when performing cognitive activities [7]. In the process of "embodied cognition", the human brain acquires information by perceiving the movements and sensations of the body and then processes and analyses it. This cognitive approach not only embodies human intelligence but also combines the human body and intelligence, making human cognitive activities more flexible and efficient [8]. In this study, based on the principle of "embodied cognition", teenagers perform housework through body movements so that they can acquire information through body movements and sensations, thus combining body and intelligence, which affects teenagers' academic performance.

The research significance of this study is that it fills a gap in the literature by using large-scale sample survey data, data from a Chinese sample, and a heterogeneous feature analysis study. This study answers the following questions: first, does participation in housework affect teenagers' academic performance? Second, how does housework affect teenagers at different academic levels differently? Third, what are the factors that influence teenagers' participation in housework?

2. Literature review

For research on teenagers' participation in housework, some scholars have studied the impact of parents' child gender ideology on children's allocation of housework. Using survey data from Spanish teenagers aged 10–17 years from 2002 to 2003, some scholars found that parental attitudes toward their children's gender were positively associated with their children's housework, with an imbalance between boys and girls [9]. Using 24-h time diary data from South Indian teenagers, 554 girls and 577 boys were also surveyed to study how boys' and girls' participation in housework varied according to parents' gender ideology. The study found that girls with gender-equal parental treatment did far less housework than girls with gender-unequal parental treatment. In addition, boys did fewer chores regardless of their parents' attitudes toward their children's gender [10].

Some scholars have also studied the impact of parents' housework behavior on children's housework behavior; for example, using data from Germany and Spain, scholars have found a positive correlation between parents' and children's time spent on housework, suggesting that the more time parents devote to housework, the more time their children devote to housework [11]. A scholar investigated the involvement of 154 Korean fathers and their 5th and 6th grade primary school children in housework. The study found that fathers' involvement in housework significantly and positively influenced their children's involvement in housework [12].

Using data from a German study, an academic tracked the time use of boys and girls aged 12–17 years who did housework between 1991 and 2013. The study found that teenagers' overall participation in housework remained unchanged but that girls and boys spent fewer days on housework in 2012–2013 compared to 20 years earlier. The average amount of time teenagers spent on housework decreased over the observed timeframe, and children's time use was positively correlated with parental time use, especially in same-sex parent–child relationships [13].

Scholars have also examined the extent of gender typing in teenagers' housework and how parents directly and indirectly influence their children's division of housework [14]. Using data from the German Socio-Economic Panel, which analyzed a sample of 2293 data, it was found that parental division of housework for 8- to 11-year-olds directly affects the likelihood of sons' (as well as daughters') participation in housework [15].

A sample of 1263 German four-person households, including aggregated data from 1991 to 1992, 2001–2002, and 2012–2013, using linear regression research showed that mothers and daughters spent more time doing housework than fathers and sons and that the lowest total time spent on housework was in households with two sons, while households with two daughters had the highest total time spent on housework [16].

Some scholars have studied the issue of students' time allocation; for example, scholars used data from the US ATUS (2003–2007) to investigate the allocation of students' time to homework, chores, sleep, internet access, and work and found that an increase in paid work reduces the amount of time students spend on homework, chores, sleep, and internet access by 84 percent [17].

Generally, the academic community has not yet developed a great deal of research experience around the relationship between housework and the development of academic performance, and there is still room for expansion of related research. First, in terms of research data, few studies have analyzed the relationship between participation in housework and teenagers' academic performance using large-scale sample survey data. Second, in terms of research methodology, previous studies have seldom chosen the research method of heterogeneous analysis of characteristics, which is not conducive to the academic community to clarify the positive or negative impact of housework on the academic performance of different types of teenagers and thus cannot provide the basis and

information support for schools and families to encourage different types of teenagers to participate in housework.

3. Research design

3.1. Research data

The data for the study are derived from the China Education Panel Survey (CEPS) survey data at the junior secondary level. These survey data were organized and implemented by the China Survey and Data Centre of Renmin University of China. The CEPS survey data is national, so the findings of this study can be extrapolated at the national level of research. The total number of junior high school students in the baseline survey of the CEPS was approximately 20,000 [18]. In this study, first-grade middle school students were selected as the research subjects, and after excluding some abnormal data samples, 6394 valid analysis samples were obtained, including 5734 samples in the treatment group and 660 samples in the control group.

3.2. Variable design

3.2.1. Dependent and independent variables

The dependent variable in this study was the academic performance of the teenagers. Academic performance is the average of standardized scores in mathematics, Chinese and English. The independent variable of this study was whether teenagers participate in housework. In Table 1, we find that the mean value of academic performance for participation in housework is 71.142, which is higher than the mean value of academic performance for nonparticipation in housework (mean = 68.773).

3.2.2. Control variables

In terms of teenagers' participation in housework and related factors affecting academic performance, five aspects were selected: time spent completing homework, time spent reading extracurricular books, time spent playing sports, time spent watching TV, and time spent playing online games on an average day from Monday to Sunday. Statistical descriptions showed that teenagers in the treatment group spent relatively more time completing homework, reading extracurricular books, playing sports and watching TV than those in the control group.

Family characteristics in this study were controlled for three dimensions: family economic conditions, parents' education, and parents' occupation [19]. Family economic conditions are expressed in terms of teenagers' self-assessed economic conditions (very difficult = 1; relatively difficult = 2; moderate = 3; relatively wealthy = 4; very wealthy = 5).

For parental education (no education = 1; primary school = 2; junior high school = 3; secondary/technical school = 4; vocational high school = 5; senior high school = 6; university college = 7; undergraduate degree = 8; postgraduate and doctoral degree = 9), information on the parent with the higher level of education was used. For parental occupation (other = 1; unemployed = 2; farmers = 3; self-employed = 4; general employees in business and services = 5; general employees in production and manufacturing = 6; skilled laborers, drivers = 7; teachers, engineers, doctors, lawyers = 8; middle and senior managers in companies = 9; leaders and staff of state institutions = 10), information on the parent with the higher level of occupation was used.

In this study, factor scores for parental occupation, economics, and education were fitted to the SES variable, representing students' family background, using practices commonly used in large-scale databases for family background [20]. Since parental educational expectations significantly affect children's academic performance [21], parental educational expectations were introduced (indifferent = 1; don't study now = 2; junior high school graduation = 3; junior high school/technical school = 4; vocational high school = 5; regular high school = 6; college = 7; undergraduate college = 8; graduate school = 9; Ph.D. = 10), and the family educational expectations reflect the importance that parents place on their children's degree of academic performance [22].

Individual characteristics of teenagers in this study were controlled for five dimensions: gender, age, ethnicity, household

Table 1
Variable meaning and statistical description.

Variable name	Treatment group (N = 5734)		Control group (N = 660)	
	Mean	SD	Mean	SD
Academic performance	71.142	7.967	68.773	8.903
Homework time	2.472	1.638	2.270	1.776
Time to read extracurricular books	1.257	1.085	0.835	1.212
Sports time	0.966	1.079	0.559	0.975
TV time	1.355	1.378	1.163	1.595
Online game time	0.924	1.306	1.284	2.089
SES	0.327	0.096	0.328	0.097
Parental education expectations	6.930	1.629	6.806	1.971
Gender	0.503	0.500	0.606	0.489
Age	13.518	0.695	13.683	0.805
Ethnic group	0.925	0.263	0.877	0.328
Household registration	0.471	0.499	0.512	0.500
Only child	0.437	0.496	0.459	0.499
Health condition	4.140	0.877	3.977	0.977

registration, and health status [23]. The specific variables were set as follows: gender (male = 1; female = 0), age (actual age), ethnicity (Han ethnic group = 1; minority ethnic group = 0), household registration (nonagricultural household registration = 1; agricultural household registration = 0), only child status (only child = 1; families with more than one child = 0), and health (very bad = 1; not very good = 2; fair = 3; good = 4; very good = 5).

In this study, 51.38 percent of the respondents were male and 48.62 percent were female; 47.5 percent were from nonagricultural households and 52.5 percent were from agricultural households; and 43.92 percent were only children and 56.82 percent were nononly children.

3.3. Measurement models and research methods

3.3.1. OLS regression model

Regression analysis is the use of statistical principles of data to explore the pattern of change of the dependent variable when the independent variable information is certain [24]. In this study, OLS regression was first used to estimate the effect of participation in housework on academic performance. In this study, participation in housework is used as the independent variable, and teenagers' academic performance is used as the dependent variable. Referring to the existing literature [25], the OLS regression model is constructed, and the regression equation is as follows:

$$\text{Achievement}_{ij} = \beta_0 + \beta_1 \text{Labour}_{ij} + \beta_2 \text{Control}_{ij} + \varepsilon_i \tag{1}$$

Among them, Achievement_{ij} is the dependent variable, representing i family j teenagers' academic performance; Labour_{ij} is an independent variable, representing whether teenagers participate in housework; and β_1 is a parameter estimate. Control_{ij} is the control variable for this study, which is composed of family background, parents' educational expectations, individual characteristics of teenagers, etc. ε_i represents the random error term of the regression equation.

3.3.2. Propensity score matching

Assuming that teenagers' participation in housework is randomly assigned, it is possible to accurately estimate the net effect of participation in housework using least squares regression. However, teenagers' participation in housework is not random but is influenced by many factors, such as family background and individual characteristics. At the same time, the least squares regression model may have some omitted variables, which can lead to biased estimation of the effect of participation in housework on teenagers' academic performance. Therefore, in this study, the propensity score matching model was used to adjust the selectivity bias of the sample [26] so that the real effect of participation in housework on teenagers' academic performance could be estimated.

The net effect of teenagers' participation in housework on academic performance, which is recorded as the average treatment effect (ATT) for the treatment group in the propensity score matching model, is modeled as in Equation (2):

$$\text{ATT} = E\{E[\text{Achievement}_{i1}|D_i = 1, P(X)] - E[\text{Achievement}_{i0}|D_i = 0, P(X)]\} \tag{2}$$

where Achievement_{i1} represents the academic performance of individual teenagers i involved in housework and Achievement_{i0} represents the academic performance of teenagers not involved in housework. D_i represents the treatment variable, i.e., a dummy variable for participation or nonparticipation in housework. $D_i = 1$ represents participation in housework, and $D_i = 0$ represents nonparticipation in housework. $P(X)$ stands for the propensity score value and represents the conditional probability of teenagers' participation in housework, controlling for the covariate X . In terms of matching strategy, this study used K nearest neighbor matching.

3.3.3. Quantile regression model

Since the OLS regression model described above is essentially a regression to the mean, it needs to be assumed a priori that there is consistency in the marginal effects of housework on teenagers with different academic performances. In fact, there may be some variation in the impact of housework on academic performance as academic performance tertiles rise. Therefore, the quantile regression method proposed by Bassett and Koenker was chosen for this study [27].

To study the heterogeneous effects of participation in housework on teenagers' academic performance: Suppose $\text{Achievement}_q(x)$ is a linear function of x , as follows:

$$\text{Achievement}_q(x_i) = x'_i \beta_q \tag{3}$$

where β_q is called the "q quantile regression coefficient", and its estimator $\hat{\beta}_q$ can be defined by the following minimization problem:

$$\min_{\beta_q} \sum_{i: \text{Achievement} \geq x'_i \beta_q} q |y_i - x'_i \beta_q| + \min_{\beta_q} \sum_{i: \text{Achievement} < x'_i \beta_q} (1 - q) |y_i - x'_i \beta_q| \tag{4}$$

The estimator of $\hat{\beta}_q$ is obtained by the least weighted absolute deviation of Formula (4), the result is brought into Formula (1), and quantile regression can be used to capture the heterogeneous effect of participating in housework on the academic performance of teenagers.

3.3.4. Probit regression model

Since we want to sort out the influencing factors of teenagers' participation in housework, a probit regression model is constructed. The probit model is called the "discrete choice model" or "qualitative response model". This work adopts binary probit regression, and the model is as follows:

$$Y_i = \beta_0 + \beta X + \varepsilon \tag{5}$$

In the above formula, Y_i represents teenagers' participation in housework, and X represents the influencing factors of participation in housework.

3.4. Theoretical framework

Previous studies have found that the way teenagers allocate their time affects academic performance [28–30]. Family background also affects teenagers' academic performance [31]. Teenagers' personal characteristics also affect academic performance [32,33].

The theoretical framework of this study is shown in Fig. 1. We argue that teenagers' time allocation, family background, and personal characteristics affect their level of participation in housework [34,35]. As an embodied cognitive activity, participation in housework has an impact on teenagers' academic performance, and this impact varies across student groups at different academic levels. Specifically, we hypothesized the following.

H1. There is a positive correlation between participation in housework and teenagers' academic performance;

H2. There is a difference in the impact of housework on students of different academic levels.

In the statistical model, we used housework as the independent variable and academic performance as the dependent variable, controlling for moderating variables such as teenagers' time allocation, family background and personal characteristics. We verified the above hypotheses through regression analyses.

4. Results

4.1. OLS regression results

This work first uses OLS regression to estimate the mean effect of participation in housework on teenagers' academic performance and uses the estimated results of OLS regression as a benchmark for heterogeneity analysis. Table 2 shows the results of the OLS regression. The dependent variable is the academic performance of teenagers. The independent variable is whether they participate in housework.

In Table 2, the parameter estimate of β_1 for participation in housework is 1.661 and is significant at the 0.01 level. This indicates that controlling for other control variables, the standardized score of academic performance of teenagers involved in housework is 1.661 standard scores higher than that of teenagers not involved in housework. This indicates that participation in housework has a positive correlation with teenagers' academic performance, i.e., participation in housework helps to improve teenagers' academic performance. Parenting expectations positively promote teenagers' academic performance. The less time teenagers take to complete their homework, the better their academic performance. However, indulgence in online games is negatively associated with teenagers' academic performance, which is supported by the results of this study, as we explain below.

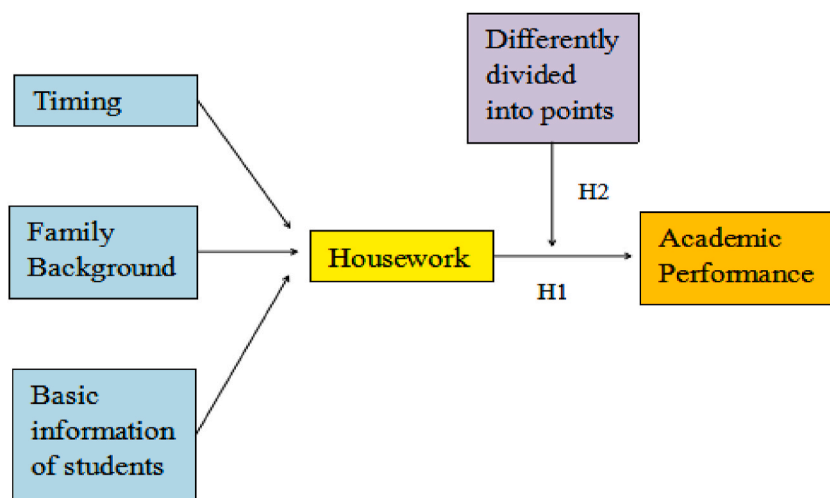


Fig. 1. Theoretical framework of the impact of participation in housework on teenagers' academic performance.

Table 2
OLS regression results.

Variable	Coefficient	Std. err.	t	sig
Housework	1.661	0.312	5.320	<.01***
Homework time	-0.106	0.058	-1.850	<.1*
Time to read extracurricular books	0.108	0.090	1.200	-
Sports time	-0.290	0.092	-3.150	<.01***
TV time	-0.063	0.071	-0.890	-
Online game time	-0.557	0.070	-7.980	<.01***
SES	0.861	1.099	0.780	-
Parental education expectations	1.251	0.058	21.660	<.01***
Basic information of students	YES			
Constant	75.990	2.183	34.820	<.01***
Adj R ²	0.161			
F	88.63			
N	6394			

Note: Significance level: ***p < 0.01, **p < 0.05, *p < 0.1.

4.2. Propensity score matching results

4.2.1. Common support domain test

This subsection uses the nearest neighbor matching method for the analysis. Table 3 shows the results of the hypothetical test of the common support domain for nearest neighbor matching. The number of observables is 6394, and the total number of observations in the common support domain is 6394. Fig. 2 tests the common range of values for the propensity score that satisfy the common support domain hypothesis.

4.2.2. Balance test for matching

This subsection examines the balance of covariates using the nearest neighbor matching method. As shown in Table 4, Columns 3 and 4 report the sample means of the treatment group (involved in housework) and the control group (not involved in housework) before and after matching. Column 5 reports the standard deviation of the sample before and after matching. Column 6 is the absolute value of the percentage cut in bias, and Column 7 reports the t value. In Table 4, subject age has the largest cut in bias, with a 98.9 % reduction. In contrast, family background SES has the smallest cut in bias, with a 26.9 % reduction. As shown in Fig. 3, a more favorable match was obtained, and therefore, the balance hypothesis was tested.

4.2.3. Average treatment effect estimates

Based on the common support domain test and the balance test of covariates, we used the nearest neighbor matching method to estimate the net effect of participation in housework affecting teenagers' academic performance, i.e., the average treatment effect (ATT). In this study, we adopt the matching strategy of K nearest neighbor matching. In Table 5, the ATT of participation in housework is 1.702 (p < 0.01), indicating that teenagers who participate in housework can improve their academic performance by 1.702 standard scores relative to those who do not participate in housework. The OLS regression method and the PSM method both showed that participation in housework can effectively improve teenagers' academic performance.

4.3. Heterogeneity analysis results

OLS regression can only provide the mean effect of participation in housework affecting teenagers' academic performance but cannot determine whether teenagers' participation in housework is characterized by heterogeneity. Compared with OLS regression, quantile regression is more robust and can analyze the change in the dependent variable at different points. Therefore, this subsection uses quantile regression to investigate the heterogeneous characteristics of participation in housework. Based on the research design section's formula (3), Table 6 shows the heterogeneity results of the quantile regression analysis, where 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, and 0.9 were selected as the academic performance quantile points, which denote the teenagers' level of academic performance from the lowest to the highest level of academic performance.

In Table 6, the parameter estimates of β_1 at the 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, and 0.9 quantiles were found to be 2.785, 3.496, 2.203, 1.680, 1.279, 0.735, 0.777, 0.840, and 1.002, respectively, and were found to be statistically significant (q = 0.6 is not

Table 3
Hypothesis test of common support domain.

	Common support	Total
	On support	
Control group	660	660
Treatment group	5734	5734
Total	6394	6394

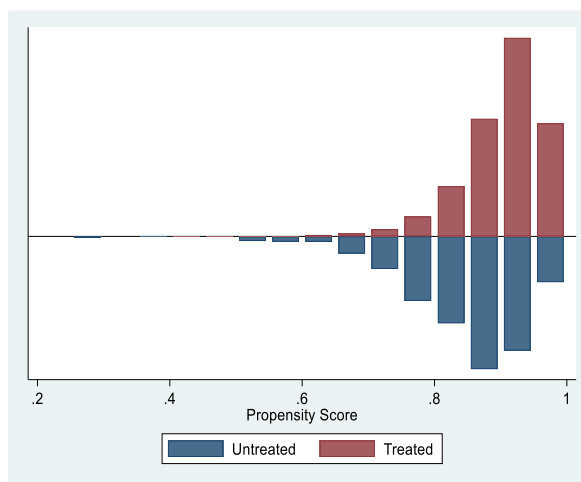


Fig. 2. Common value range of propensity scores.

Table 4
Balance test results of covariates.

Variable	Match status	Treatment group	Control group	%bias	%reduct bias	t
Homework time	Unmatched	2.472	2.270	11.800		2.970
	Matched	2.472	2.492	-1.200	90.100	-0.620
Time to read extracurricular books	Unmatched	1.257	0.835	36.600		9.330
	Matched	1.257	1.331	-6.500	82.300	-2.950
Sports time	Unmatched	0.966	0.559	39.600		9.270
	Matched	0.966	0.931	3.400	91.400	1.600
TV time	Unmatched	1.355	1.163	12.800		3.320
	Matched	1.355	1.396	-2.700	78.600	-1.400
Online game time	Unmatched	0.924	1.284	-20.700		-6.240
	Matched	0.924	0.985	-3.500	83.100	-2.310
SES	Unmatched	0.327	0.328	-1.900		-0.470
	Matched	0.327	0.328	-1.400	26.900	-0.760
Parental education expectations	Unmatched	6.930	6.806	6.800		1.800
	Matched	6.930	6.881	2.700	60.700	1.500
Gender	Unmatched	0.503	0.606	-20.800		-5.020
	Matched	0.503	0.527	-4.800	76.700	-2.570
age	Unmatched	13.518	13.683	-22.000		-5.700
	Matched	13.518	13.520	-0.200	98.900	-0.130
Ethnic group	Unmatched	0.925	0.877	16.000		4.290
	Matched	0.925	0.917	2.800	82.400	1.670
Household registration	Unmatched	0.471	0.512	-8.300		-2.020
	Matched	0.471	0.468	0.500	94.200	0.260
Only child	Unmatched	0.437	0.459	-4.500		-1.090
	Matched	0.437	0.440	-0.700	85.300	-0.350
Health condition	Unmatched	4.140	3.977	17.600		4.460
	Matched	4.140	4.132	0.900	94.700	0.530

Note: Significance level: ***p < 0.01 , **p < 0.05 , *p < 0.1.

significant, but the effect is positive). This means that for every unit of increase in teenagers' participation in housework, academic performance at the 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, and 0.9 quartiles increases by 2.785, 3.496, 2.203, 1.680, 1.279, 0.735, 0.777, 0.840, and 1.002 standard scores, respectively. This shows that participation in housework had the strongest impact on teenagers with middle and lower academic performance; however, the effect of housework on the academic performance of the academic excellence students was not as strong (as shown in the second panel of Fig. 4).

The heterogeneity of participation in housework can be attributed to an approximate "inverted V" curve. As shown in the second panel of Fig. 4, the effect of participation in housework among teenagers shows a tendency to increase and then decrease as the academic performance quartile rises. The extreme point occurs at the 0.2 quantile, and its parameter estimate is 3.496.

4.4. Analysis of influencing factors of participation in housework

Since we want to sort out the factors influencing teenagers' participation in housework, this subsection uses a probit binary model

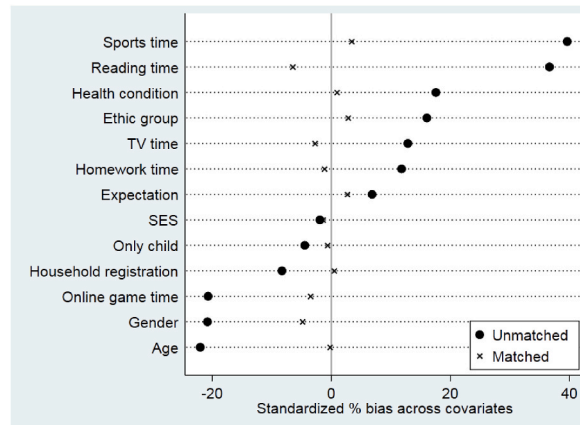


Fig. 3. Standardized % bias across covariates.

Table 5
Mean treatment effect estimates for participation in housework affecting academic performance.

Match status	Treatment group	Control group	Difference	S.E.	T-stat
Unmatched	71.142	68.773	2.369	0.332	7.140***
Matched	ATT 71.142	69.440	1.702	0.449	3.790***

Note: Significance level: ***p < 0.01, **p < 0.05, *p < 0.1.

Table 6
Results of heterogeneity analysis (Quantile regression).

Variable	q = 0.1	q = 0.2	q = 0.3	q = 0.4	q = 0.5	q = 0.6	q = 0.7	q = 0.8	q = 0.9
Housework	2.785***	3.496***	2.203***	1.680***	1.279***	0.735	0.777***	0.840**	1.002***
Homework time	-0.285**	-0.116	-0.088	-0.11	-0.099	-0.132*	-0.104	-0.115*	-0.041
Time to read extracurricular books	0.089	0.157	0.061	0.164	0.151	0.094	0.132	0.068	0.04
Sports time	-0.172	-0.251	-0.438***	-0.291	-0.226**	-0.225*	-0.197*	-0.086	0
TV time	-0.091	-0.328**	-0.108	-0.005	-0.006	-0.078	-0.052	0.001	-0.011
Online game time	-0.904***	-0.676***	-0.682***	-0.597***	-0.556***	-0.554***	-0.457***	-0.408***	-0.352***
SES	2.185	3.048	3.247**	2.464	1.236	0.547	0.12	0.136	-2.412*
Parental education expectations	1.338***	1.451***	1.484***	1.399***	1.406***	1.315***	1.193***	1.057***	0.920***
Basic information of students	YES	YES	YES	YES	YES	YES	YES	YES	YES
Constant	73.702***	71.248***	73.369***	75.349***	76.642***	80.749***	79.356***	79.083***	79.570***

Note: Significance level: ***p < 0.01, **p < 0.05, *p < 0.1.

to estimate the effect of each factor on teenagers' participation in housework. Based on the research design section's formula (5), Table 7 presents the estimation results. Because the dependent variable of the probit model is a binary variable, i.e., whether or not to participate in housework, the estimation results of the probit model can only indicate the direction of the influence of each factor on whether or not the teenagers participate in housework, and it does not yield probabilistic information. Therefore, to obtain the probability values of each influencing factor, this subsection also calculates the average marginal effect (dy/dx) of each variable, as shown in Column 6 of Table 7.

Table 7 shows that the estimated coefficients and average marginal effects of the probit dichotomous choice model are generally consistent in the direction of the parameters and at the significance level, suggesting that the variables involved in the equation provide relatively robust explanations of whether teenagers are involved in housework. In terms of individual characteristics in Table 7, females have a 3.2 percentage point higher rate of participation in housework than males. The Han ethnic group has a 4.2 percentage point higher rate of participation in housework than ethnic minority teenagers. The participation rate in housework is 1.8 percentage points higher for teenagers with rural household registration than for those with urban household registration. The participation rate in housework of nononly children (families with more than one child) is 1.4 percentage points higher than that of only children. Family characteristics are not significant, as shown in Table 7. Online gaming is negatively associated with participation in housework.

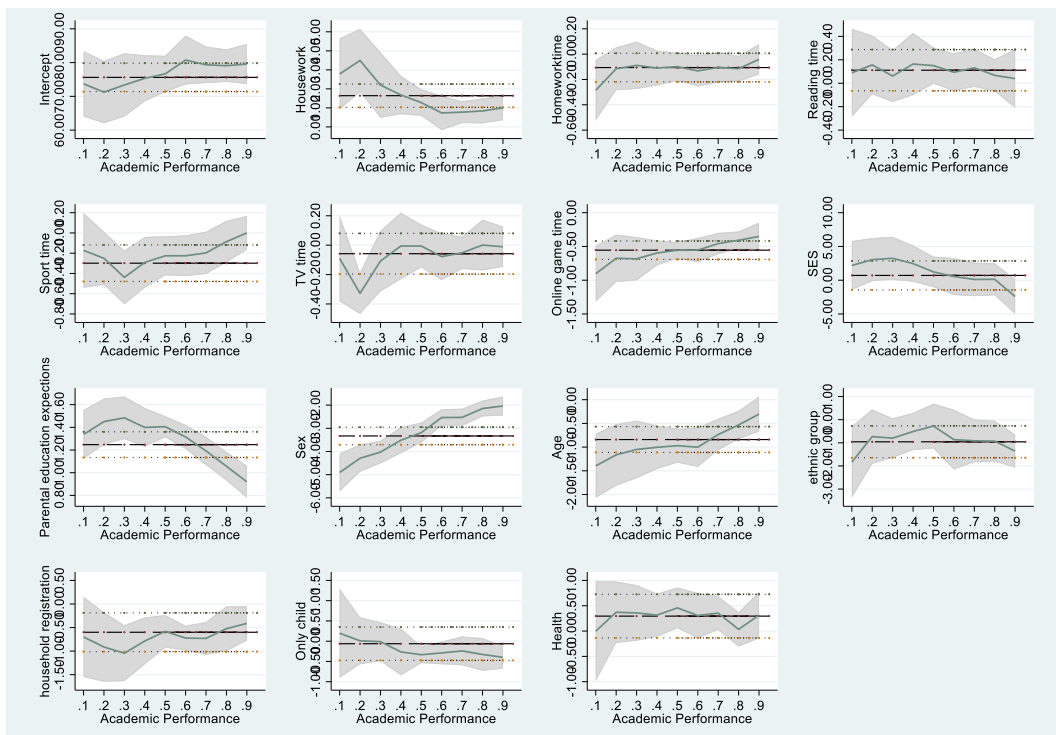


Fig. 4. Change trends of each variable on each quantile of academic performance.

Table 7
Probit estimates of housework participation rates.

Housework	B	RSE	z	sig	dy/dx	RSE	z	sig
Homework time	0.008	0.029	0.270	–	0.001	0.003	0.270	–
Time to read extracurricular books	0.333	0.087	3.830	<.01***	0.029	0.008	3.850	<.01***
Sports time	0.492	0.088	5.590	<.01***	0.043	0.008	5.620	<.01***
TV time	0.119	0.044	2.720	<.01***	0.010	0.004	2.730	<.01***
Online game time	–0.153	0.028	–5.510	<.01***	–0.013	0.002	–5.510	<.01***
SES	–0.687	0.496	–1.380	–	–0.060	0.044	–1.380	–
Parental education expectations	–0.002	0.028	–0.060	–	0.000	0.002	–0.060	–
Gender	–0.362	0.089	–4.070	<.01***	–0.032	0.008	–4.050	<.01***
Age	–0.255	0.061	–4.190	<.01***	–0.022	0.005	–4.190	<.01***
Ethnic group	0.475	0.133	3.560	<.01***	0.042	0.012	3.540	<.01***
Household registration	–0.203	0.095	–2.140	<.05**	–0.018	0.008	–2.140	<.05**
Only child	–0.163	0.094	–1.730	<.1*	–0.014	0.008	–1.730	<.1*
Health condition	0.251	0.096	2.620	<.01***	0.022	0.008	2.610	<.01***
Constant	4.920	0.924	5.330	<.01***	–	–	–	–
Log likelihood	–1973.054	–	–	–	–	–	–	–
Pseudo R2	0.071	–	–	–	–	–	–	–

Note: Significance level: ***p < 0.01 , **p < 0.05 , *p < 0.1.

5. Discussion

5.1. Housework is effective in improving the academic performance of teenagers

In this study, by using both the OLS regression method and PSM method, it was found that participation in housework is effective in improving the academic performance of teenagers. The results of this study are consistent with previous studies [5,6].

Participation in housework helps to improve teenagers' academic performance, which may be due to the following reasons: first, housework helps to improve teenagers' intelligence. According to the theory of "embodied cognition" [36,37], teenagers rely on the movements and sensations of the body in the process of housework, which promotes the generation of rich neural connections in the brain, activates the brain's level of activity and capacity, and makes the person more flexible and efficient in performing cognitive activities [38,39]. This affects the academic performance of teenagers. Moreover, housework is mainly a physical activity. Children can

also improve respiration and blood circulation during labor, promote physiological metabolic processes and regulate brain fatigue, thus contributing to the development of the brain.

Second, housework can help cultivate the strong will of teenagers [40]. As some experts have pointed out, letting children do some housework when they are young can cultivate them to endure hardship and cherish the fruits of their labor [41]. Teenagers will encounter some difficulties and setbacks in the process of participating in housework. In the process of facing setbacks and solving difficulties, teenagers' strong will will be trained so that they will not be afraid of boredom and difficulties in the process of ordinary learning.

Once again, housework can help develop teenagers' logical thinking ability [42]. Faced with hard and complicated housework, teenagers have to use their brains to determine how to complete housework quickly and well. This process exercises teenagers' logical thinking ability so that they can take advantage of logical thinking in their studies.

5.2. Participation in housework had the strongest impact on teenagers with middle and lower academic performance; however, the effect of housework on the academic performance of academic excellence students was not as strong.

Using quantile regression, it was found that participation in housework had the strongest impact on teenagers in the middle and lower academic performance quartiles. The heterogeneity of participation in housework can be attributed to an approximately inverted V-shaped curve. As the academic performance quartile rises, the effect of teenagers' participation in housework tends to increase and then decrease. The extreme point occurs at the 0.2 quantile, with a parameter estimate of 3.496. As a result, participation in housework had the strongest impact on teenagers with middle and lower academic performance; however, the effect of housework on the academic performance of academic excellence students was not as strong (as shown in the second panel of Fig. 4).

The reason for this phenomenon may be that participating in housework can enhance the intelligence of teenagers. At the same time, housework can help develop teenagers' strong will and logical thinking ability. However, to become academic excellence students, they must put their studies first and value their time. The vast majority of academic excellence students have to be highly concentrated and highly devoted to their studies [43].

In the minds of excellence students, learning should come before recreation [44]. They are persistent and dedicated. They make good use of fractions of time to memorize words, recite formulas, solve difficult problems and regulate their emotions [45]. They are diligent in thinking and good at analyzing the intrinsic connection between knowledge points. This study found that participating in housework has a positive effect on improving the academic performance of academic excellence students, but the effect is not as strong as that on the academic performance of students with middle and lower academic performance.

5.2. Indulgence in online games is the main factor that prevents teenagers from participating in housework

The probit model was used to find that teenagers' online gaming time was negatively correlated with their participation in housework. It shows that teenagers' online game time constitutes a crowding out relationship to their participation in housework. At present, with the advent of the network era, due to the problem of institutional constraints, the regulation of the network is not standardized, resulting in teenagers with little self-control becoming the biggest victims of online gaming [46]. China's number of teenage internet users is very large. Between 2007 and 2015, the number of China's teenage internet users grew from 107 million to 287 million.

When teenagers spend much time on online games, the time left for real life is naturally very little [47]; therefore, addiction to online games inevitably prevents teenagers from participating in housework. Some scholars also point out that teenagers' addiction to online games can lead to truancy, running away from home, theft, robbery, and even suicide [48]. Therefore, educators and the community should pay great attention to the problem of teenagers' addiction to online games.

In addition, other factors influence teenagers' participation in housework. Rural household registration is positively associated with teenagers' participation in housework. This finding has been mentioned in previous studies [49]. In addition, being a nononly child (families with more than one child) was positively associated with participation in housework. The reason for this may be the more pampered parenting of only children [50], where parents cannot afford to have their children do anything as long as they study well. However, nononly child families have two or more children. Children in nononly child (families with more than one child) families are not very spoiled and have some housework assigned to them. In addition, there is a positive correlation between female students and the rate of participating in housework, and the results of this study are consistent with previous studies [10].

6. Recommendations

6.1. It is important to raise awareness of the benefits of teenage participation in housework

Children's overall development is first impacted by family education. Family education is an important field for the formation of outlooks on life and values [51]. Labor education is an essential and important part of family education. Appropriate housework can not only help teenagers develop the abilities of self-care and self-service in daily life but also has a positive effect on the formation of excellent qualities such as independence and diligence. These qualities will have an impact on teenagers' growth process and future development. Therefore, education authorities and schools should increase awareness of family labor education. The importance of family labor education should be made clear and promoted in a variety of ways. It is necessary to vigorously advocate for the concept of labor in the new era, lead teenagers to establish labor as the most noble concept, and enhance teenagers' awareness of family labor [52].

6.2. *Appropriate family labor education should be developed according to the individual differences of teenagers*

Teenagers have a rich extracurricular life every day. In this study, it is found that teenagers' time spent online gaming minimizes the time for participation in housework. Therefore, it is necessary to choose suitable labor projects according to the psychological and physiological characteristics of teenagers of different ages. At the same time, the labor time should be controlled. For teenagers with different personality traits, household labor should be distributed in appropriate amounts. Family labor education should vary from person to person and should be carried out in an appropriate and timely manner [53].

6.3. *Establishing the role of parents as exemplary role models of family labor*

Parents are the most direct influencers of their children. Parents should establish a good family model of loving labor [54]. Parents themselves should play a leading role as labor models in daily life. Parents should lead their children to participate in housework together. In a natural and relaxed family environment, teenagers can master the necessary life and labor skills. Thus, parents can influence their children's labor behavior. Teenagers' labor habits should be cultivated through a good family labor atmosphere [55].

6.4. *Building a multifaceted and synergistic labor education system*

The educational mechanism of cooperation among family, school and society should be established [56]. First, the family should play a fundamental role in labor education. Labor education for teenagers should be an important part of family life. Parents assume the main role in family labor education. Second, school is an important field for teenage labor education. Experiential and interesting labor education courses should be set up [57]. Finally, society should also play a role in labor education. Society should provide more social practice bases and actively develop a platform for labor education activities to cooperate with schools and families to carry out labor education effectively.

7. Conclusions

Based on the data from the China Education Panel Survey and the theory of "embodied cognition", this study analyzed the effects of participation in housework on teenagers' academic performance using OLS regression, PSM, quantile regression and probit regression analysis. The study found that housework can effectively improve teenagers' academic performance. The results of this study are consistent with previous studies [5,6]. At the same time, participation in housework had the strongest impact on teenagers with middle and lower academic performance; however, the effect of housework on the academic performance of academic excellence students was not as strong. In addition, being addicted to online games was the main factor that prevented teenagers from participating in housework.

Research Limitations and Prospects

This study also has some shortcomings. The research data in this work come from the survey data of CEPS junior high school students. The data samples do not include elementary school students, high school students or college students. Therefore, whether the conclusions of this study reflect teenagers of each age group needs further verification. In future research, attention should be given to the introduction of tracking data at different stages for data analysis.

This study found that housework education can effectively improve the academic performance of teenagers. If parents realize the importance of housework, they will be more willing to let their children participate in housework. As far as existing research is concerned, there is no empirical study that analyzes the impact of participating in housework on teenagers' personality, mental health and values. This should be achieved in follow-up studies.

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Ethics statement

Review and/or approval by an ethics committee was not needed for this study because CEPS data is publicly available online. The data are available online at <http://ceps.ruc.edu.cn>. Informed consent was not required for this study because CEPS data is publicly available online.

Data availability statement

The data that support the findings of this study are available in Chinese Education Panel Survey Data. Archive at <http://www.cnsda.org/index.php?r=projects/view&id=72810330>. The data are also available from the corresponding author (zhangzheyx@

126.com).

CRedit authorship contribution statement

Zhe Zhang: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Bangyin Ye:** Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2024.e25770>.

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