



Differential Effects of Parents' Education on Adolescent Well-being Outcomes

Renuka Mahadevan¹ · Sha Fan²

Accepted: 28 August 2021 / Published online: 16 September 2021
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Abstract

This paper compares the causal effect of parents' education on three outcomes of their adolescent offspring aged 10–15 years in China. Empirical results from propensity score matching show that only mothers with a college degree have an effect on the emotional well-being of adolescents. Mothers' educational influence on health and emotional well-being of adolescents is also greater than fathers but in rural areas, only father's education has an impact on health and education of the adolescents. Sons however benefit more than daughters in the domains of health and educational well-being from parents' education. Evidence indicates that promoting women's education is a key urban policy although in rural areas, empowering women and providing an enabling environment through communities and schools is critical to improving various well-being outcomes of the next generation.

Keywords Parents' education · Adolescent well-being · Propensity score matching

1 Introduction

Ensuring healthy lives and promoting well-being at all ages is one of the 2030 UN Sustainable Development Goals. Of concern is the WHO (2017) report that 10–20% of the group of children and adolescents experience mental disorders particularly, those in low-and middle-income countries are at an elevated risk of poor development. Research into child development is crucial as childhood well-being sets the stage for an individual's transition into adulthood (Heckman, 2011).

✉ Renuka Mahadevan
r.mahadevan@uq.edu.au

Sha Fan
s.fan@bnu.edu.cn

¹ School of Economics, The University of Queensland, Brisbane, QLD 4072, Australia

² Center for Innovation and Development Studies, Institute of Advanced Studies in Humanities and Social Sciences, Beijing Normal University, Zhuhai Campus, Guangdong 519000, China

There is now wide consensus (Ben-Arieh et al., 2014; Elder et al., 2003; Rees & Bradshaw, 2018) that family background and childhood experiences exert significant long-term influence on later life outcomes of children such as educational attainment, occupational status, income, physical and mental health. A key element of family background in child development and well-being is parents' education (Davis-Kean, 2005; Schneider & Coleman, 2018). This is due to the resources that educated parents can provide for their children and education paves the way to increased access to information on where and how help can be obtained for the better development of their children.

Most studies however focus only on the effect of mother's education (Arroyo-Borrell et al., 2017; Carneiro et al., 2013; Cui et al., 2019) on child development. Of the studies comparing both parents' education effects, the vast majority of them are focused on schooling outcomes of children. This forms the large literature on the intergenerational transmission of human capital. The evidence on the influence of father's and mother's education on children's schooling in relation to number of years remains mixed.

For instance, findings from Amin et al. (2015) suggest that mothers' schooling matters more than fathers' schooling for daughter's schooling years in Sweden. Schneider and Coleman (2018) using data on the USA, and Black et al. (2005) using Norwegian data also find similar evidence while Behrman and Roszenweig (2002) find a negative (positive) effect of mother's (father's) schooling. Using data on urban China, Behrman et al. (2020) do not find any significant effect of either of the parents' schooling on children's schooling while Dong et al. (2019) find that both parents' schooling has significant effects on child schooling years in rural China.

By and large, these studies on children's schooling outcome used ordinary least squares (OLS) and fixed effects models to examine the issue. While there have been attempts in some of these studies to address endogeneity using instruments, finding strong instruments is not easy and not all aspects of endogeneity or confounding effects can be satisfactorily addressed by the instruments used. For instance, Aslam and Kingdon (2012) explain that parental schooling is endogenous if unobserved characteristics of the parents (such as tastes, values, and preferences) are correlated with both parental education and the child's health status. Another potential endogeneity is that parents and children are linked by similar genetics with regards to education (Dong et al., 2019). Le and Nguyen (2017) on the other hand raise the possibility of reverse causality from child development to parental mental health.

To date, most previous studies have examined associations rather than causal effects using regression analyses with a number of independent variables. Bai and Clark (2018) explain that to go beyond association as well as to overcome the endogeneity and confounding effects problems, the quasi-experimental propensity score matching (PSM) is an appropriate method. Studies such as Balbo and Arpino (2016) and Churchill et al. (2020) have also used PSM to examine causal effects. By adopting this approach in our paper, we make the first contribution to the literature, to control for a range of characteristics to compare the treated and untreated groups in order to isolate and examine the approximate

causal effect of father's and mother's education on children's educational outcomes. It must however be noted that the PSM is not a perfect identification strategy for making strong causal statements (Shafiq et al., 2019). Causality in this method relies on the conditional independence assumption that all factors relevant for selection in the treatment assignment are observed and taken into account in the formation of propensity scores. Nevertheless, we undertake the balancing score test (see Rosenbaum & Rubin, 1983) to ensure that the treated and control units are meaningful to compare and do a test on the common support or overlap condition to ensure that persons with the same characteristics have a positive probability of being both participants and non-participants (see Heckman et al., 1999).

The second contribution of this paper is that the analysis is extended to consider health and emotional well-being (WB) of children in addition to educational outcomes. Given that child well-being is a multifaceted concept (Ben-Arieh et al., 2014), considering three domains of child development provides depth and adds a holistic dimension to the analysis. To our knowledge, there are very limited number of studies comparing father and mother's educational impact on health (Aslam & Kingdon, 2012; Thomas, 1994), and subjective well-being (McMunn et al., 2001; Sonogo et al., 2013). Some studies (Rees & Bradshaw, 2018; Turunen et al., 2017) use parents' education as control variables since their focus was on different aspects of parental influence on child development.

The third contribution of this paper is the consideration of heterogenous effects based on child gender (boys and girls) and rural–urban residence of the family. The gender lens has been widely examined (but on different child outcomes to this study) as detailed in the literature review later. Geographical location/regional dimension of residence is however part of the environment in which children grow up and this has implications on facilities related to health and schooling available or the mindset of parents which may have an influence on child development (Hodes et al., 2018). While the urban–rural divide has been widely studied in other areas of research (Fan et al., 2021; Mahadevan & Suardi, 2014), it has not been examined for the three types of child outcomes considered here, other than on intergenerational mobility of educational attainment by Golley and Kong (2013). Some studies on child outcomes have focused on either rural (Dong et al., 2019) or urban areas (Behrman et al., 2020; Carlsson et al., 2014) but do not compare outcomes across rural and urban areas.

The analysis is undertaken using China as a case study and the reason for our choice is two-fold. First, China is a rapidly developing country which imposed a 9-year compulsory education policy in 1986. This led to an improvement in the educational attainment of women. Statistics from China's Ministry of Education shows that the proportion of women with tertiary education rose from 36.4% in 1996 to 48% in 2018. Hence it would be interesting to compare both parents' education impact. Second, is the happiness paradox in China where Chinese adults are not necessarily satisfied or happy with life despite their growing incomes (Cheng et al., 2018). This is a concern and it is timely to understand how China's next generation's development can be influenced to obtain more positive

outcomes for children, given the lasting effects of childhood on one's adulthood. This study draws on the most recently available data on adolescents from the 2016 China Family Panel Studies and we focus on those who are 10–15 years as only this age cohort was interviewed directly for their responses relevant for this paper.

The rest of the paper is organised as follows. The next section is a literature review on the measures of child development and the effect of parent's education on the three domains underlying child well-being. Section three sets out the PSM approach and the model to be used while section four describes the data and variables. Analysis of the empirical results are provided in section five while the last section concludes.

2 Literature Review

Here we review studies on the three domains of a child's development/well-being given by health (physical well-being), educational well-being (EdWB) and emotional well-being (EmWB).

a. Physical health domain

Physical health of children has been evaluated by several studies such as Dercon and Singh (2013), Welch et al. (2017) and Whetten et al. (2009) using nutrition indicators such as height-for-age, weight-for-age and body mass index (BMI)-for age scores. Based on the existing literature, our health measure comprises the z-scores of height-for-age (considered to be a long-run measure of nutritional status noted by Waterlow et al., 1977) and BMI-for-age by gender.

Aslam and Kingdon (2012) note that few studies have focused on the role of father's education in determining child health because fathers play a less obvious role in child care. This study on Pakistan finds that father's education is positively associated with the decision on child immunization while mother's education is critically associated with long-term health outcomes such as height-for-age. Using data on Brazil, Ghana and the US, Thomas (1994) found the effect of a mother's education to be larger on her daughter's height than her sons and that of father's education has a bigger impact on the height of his sons than his daughters.

b. Education domain

Educational well-being could be examined using subjective and objective indicators (Ben-Arieh et al., 2014) comprising cognitive and non-cognitive skills (Farkas, 2003). We consider math and memory test scores (these were the only two available from the dataset) for cognitive achievements/objective indicators and similar to Xu and Xie (2015), for non-cognitive skills/subjective indicators, we use interviewer's observation on the child's comprehension ability and general intelligence. Thus our EdWB measure considers four dimensions.

Most previous studies focused on schooling years of child as the educational outcome. Holmlund et al. (2011) using Swedish data found the effect of father's schooling on children's schooling to be positive while that of mother's schooling was close to zero. Golley and Kong (2013) found that girls' education in China is predominantly associated with that of father's education while mother's education has limited influence on sons. The authors also provide evidence of lower intergenerational correlation in rural compared to urban populations.

Agüero and Ramachandran (2020) find that in Zimbabwe, although mother's and father's education effect on daughter's years of schooling is slightly more than for sons, the difference is not statistically significant. This suggests that there are no systematic gender preferences in the schooling transmission. With regards to child's test scores, parents' education is said to have a strong relationship (Font & Potter, 2019; Fruehwirth & Gagete-Miranda, 2019; Reardon, 2011) but these studies do not differentiate between the gender of the children.

c. Emotional well-being domain

There is a vast and complex literature on the concept of children's EmWB and there is no definite rule for defining dimensions underlying EmWB (Bradshaw et al., 2013). Here, we adopt Diener's (2000) notion that EmWB is composed of affective and cognitive dimensions. The cognitive component refers to level of happiness (Rees & Bradshaw, 2018), life satisfaction or satisfaction on various aspects of life (Losada-Puente et al. 2019). The affective component concerns the experiences of positive and negative emotions. Positive affect (e.g., optimism about the future, excitement about something) and negative affect (e.g. feelings of alienation, depression) comprise the Affect Balance Scale (Bradburn, 1969; Li et al., 2019). In this study, we consider a combination of happiness level, evaluation of self-esteem (Baiocco et al., 2019) and depression proxied by the widely-used Centre for Epidemiological Studies Depression (CESD) scale.

McMunn et al. (2001) used data on England and found that a more educated mother has a positive effect on children's well-being while father's education has no significant effect. Sonego et al. (2013) on the other hand found that for Spanish children aged 4 to 11 years, the effect of mother's education is larger than the father's on child's mental health. For those between 12–15 years, there does not appear to be any significant effect of either of their parent's education level. Others who focussed only on maternal education (Carneiro et al., 2013; Harding, 2015) found a positive significant effect on children's behavioural outcomes which may be related to children's EmWB.

While parents' education may not have a direct effect on EmWB, it has been argued that parent's education affects their involvement in exposing their children to stimulating activities and materials such as reading books and visiting cultural institutions (Schneider & Coleman, 2018). There is also an indirect effect through higher income earned by parents in better paying job opportunities due to their education. Studies such as Clark et al. (2019) and Bornstein et al. (2003) suggest positive associations between socio-economic status of parents and child well-

being. By controlling for family income in the PSM approach, we are able to examine if any direct effect from parents' education to child well-being exists.

3 Model Specification

To investigate the effect of parents' education on adolescent well-being, we use PSM to estimate the average treatment effects for the treated (ATT). That is, the average education effect of parents having a college degree or not. Y_i^T is the outcome for adolescent i if he/she is treated (has parent with a college degree or above). Y_i^C is the outcome for the same adolescent if he/she is untreated (has parent with no college degree). The ATT could be computed as:

$$ATT = E(Y_i^T - Y_i^C | D_i = 1) = E(Y_i^T | D_i = 1) - E(Y_i^C | D_i = 1) \quad (1)$$

where $D_i = 1$ if being treated and $D_i = 0$ otherwise. However, it is impossible to observe Y_i^C for the same adolescent who is treated. The underlying causal question here is: what adolescent i 's well-being would be if he/she were to receive the treatment (i.e., have a parent with a college degree or above) compared with not receiving the treatment (i.e., have a parent without a college degree). As only one of the two outcome values, Y_i^T or Y_i^C , is actually observed, we can infer the treatment effect at the group rather than individual level (Holland, 1986).

To infer ATT, we make use of the following assumption—that the treated and untreated adolescents are not systematically different in unobserved characteristics if they are matched on observable characteristics that affect treatment (Rosenbaum & Rubin, 1983). In other words, if we assume that conditional on a set of observed characteristics, X , there exists a matched analogue in the control group for each treated adolescent, then the following conditional independence is satisfied:

$$E(Y_i^C | X, D_i = 1) = E(Y_i^C | X, D_i = 0) = E(Y_i^C | X) \quad (2)$$

We then estimate ATT as:

$$ATT = E[Y^T | D = 1, \Pr(D = 1 | X)] - E[Y^C | D = 0, \Pr(D = 1 | X)] \quad (3)$$

where $\Pr(D = 1 | X)$ is the probability of being treated conditional on the covariates X . To estimate the effects of parents' education on adolescent well-being, we match the two groups of adolescents by the propensity score of their parent's education using the following variables: family income, size of family, number of children, father's and mothers' work satisfaction and their CESD score as well as the cognitive abilities of father and mother using their mathematics and memory tests.

The choice of these variables for matching are drawn from the literature. Pooled family income has been used by studies such as Sacerdote (2007) and Prakash and Smyth (2019) as often parents use their joint financial resources

to spend on the family. Size of family and number of children are negatively correlated with child outcomes as these factors affect parent's attention available per child (Åslund & Grönqvist, 2010; Sacerdote, 2007). Job satisfaction is said to affect an individual's well-being (Prakash & Smyth, 2019; Unanue et al., 2017,) and parents' mental health affects child development (Rees & Bradshaw, 2018; Schepman et al., 2011). To control for genetic educational transmission, scores of mathematics and memory tests of parents are included. The choice of the matching variables is also to control for confounding effects. For instance, higher education is one of the factors resulting in greater well-being among the parents (Carlsson et al., 2014).

The above-mentioned factors are first estimated with the parent's educational achievement (having or not having a college degree) being the independent variable. We use the probit model for this estimation. Based on this estimation, a probability of each adolescent having a college educated father or mother will be obtained, which is the match score for each adolescent. This score will be used to match all observations in the sample. The matched treated, and untreated observation will then be used in further estimation.

The probability function for each adolescent of having college-educated parents, incorporating the variables discussed for matching that may be related to parent's education is given by:

$$\log\left(\frac{p_i}{1-p_i}\right) = b_0 + b_1X + \varepsilon_i \quad (4)$$

where $p_i = P(D_i = 1|X)$ represents the probability of adolescent i for having college educated parents; X represents variables that affect parent's education; and ε_i is the error term.

4 Data and Variables

The data from the 2016 China Family Panel Studies (CFPS) provides information on the economic and non-economic well-being of the Chinese population, with a wealth of information covering topics such as economic activities, education outcomes, family dynamics and relationships, migration and health. The survey is conducted by the Institute of Social Science in China's Peking University.

The baseline survey in 2010 has 14 960 household responses from 635 communities, including 33 600 adults and 8 990 children from 25 designated provinces. It has an approximate response rate of 81% with the majority of non-responses due to non-contact. The stratified multistage sampling strategy used ensures that the sample represents 95% of the total population in China (Xie & Hu, 2014).

At the outset, only adolescents whose (natural) parents are still married are considered in this study. This is because studies such as McLanahan and Sandefur (1994) and Waldfogel et al. (2010) concur that family relationships affected by divorce matter for children's outcomes and the focus is to remove the effect of fragility of family

Table 1 Descriptive statistics on adolescents

| Variables | Definition | Mean | Std. Dev | Min | Max |
|----------------|---|--------|----------|-------|------|
| Height-for-age | Adolescent height adjusted for age given by z score | -0.21 | 1.44 | -4.99 | 4.30 |
| BMI-for-age | Adolescent BMI adjusted for gender given by z score | 0.29 | 1.89 | -4.98 | 4.99 |
| ChildMem | Adolescent memory test score | 6.14 | 1.63 | 0 | 10 |
| ChildMath | Adolescent math test score | 524.64 | 29.63 | 409 | 584 |
| Compreh_Interv | Adolescent comprehensive ability, through observation | 5.85 | 1.07 | 1 | 7 |
| Intel_Interv | Adolescent general intelligence, through observation | 5.81 | 1.07 | 1 | 7 |
| ChildHappy | Evaluation of happiness | 8.37 | 2.04 | 0 | 10 |
| ChildCESD | CESD Score summed over 20 items | 30.06 | 5.86 | 20 | 58 |
| SelfesLow | Evaluation of low self-esteem | 2.06 | 0.50 | 1 | 5 |
| Child Age | Adolescent age | 12.40 | 1.68 | 10 | 15 |
| Boy | Gender defined as 1 | 0.55 | 0.50 | 0 | 1 |
| Urban | Residency defined as 1 | 0.42 | 0.39 | 0 | 1 |

structure on the parental influence on their children. In addition, migrant parents from rural to urban areas and their left-behind kids are also excluded from the sample to keep it clean from these influences.

The sample size of our study comprises 1937 households and 2221 adolescent with around 42% of the adolescents living in urban areas as is shown in Table 1. About 55% of the sample are boys and the mean age of the adolescents is about 12 years. The adolescent's height is age standardized and BMI is age and gender standardized through z scores of anthropometric measures according to WHO growth charts (WHO, 2007). Various scores such as CESD and self-esteem are averaged over the underlying items.¹

The CESD is a 4-point Likert scale with answers varying from 'rarely or none of the time' for 0–1 days to 'most or all of the time' for 5–7 days to assess depressive symptoms experienced in the previous week. The sum of all 20 items is the value for CESD, with the higher score representing the worse mental health status. The results of the CESD score of the parents did not change when factor analysis was used. The mathematical and memory scores for the adolescents and parents are from paper tests administered during the interview and survey. Details on the test questions are given in Xie et al. (2017). With self-esteem, the following questions were asked: "All in all, I am inclined to feel that I am a failure; I feel I do not have much to be proud of; I certainly feel useless at times; I often think I am good for nothing". Answers range from 1 for 'strongly disagree' to 5 for 'strongly agree'. The mean of the answers for these four questions were used as the score for self-esteem. The question on happiness is, 'Overall, are you happy with your life?' Answers are 0 for lowest score and 10 or highest score.

¹ We also used factor analysis of the items for these scores and results were found to be qualitatively similar.

Table 2 Descriptive statistics on parents

| Variable | Definition | Mean | Std. Dev | Min | Max |
|--------------|---|--------|----------|------|-------|
| fage | Father's age | 41.63 | 5.31 | 29 | 76 |
| mage | Mother's age | 39.74 | 5.12 | 27 | 62 |
| fedu_year | Father's years of schooling | 8.27 | 3.73 | 0 | 19 |
| medu_year | Mother's years of schooling | 6.99 | 4.25 | 0 | 19 |
| fcollege | 1 if father has a college degree, 0 otherwise | 0.09 | 0.29 | 0 | 1 |
| mcollege | 1 if mother has a college degree, 0 otherwise | 0.07 | 0.25 | 0 | 1 |
| fmincome | log of family annual income in yuan | 10.33 | 0.98 | 4.25 | 14 |
| familynumber | Number of family members | 5.17 | 2.25 | 1 | 19 |
| childnumber | Number of children | 1.74 | 0.98 | 0 | 7 |
| fwork | Father's work satisfaction | 6.21 | 5.41 | 1 | 17.33 |
| mwork | Mother's work satisfaction | 5.75 | 5.08 | 1 | 17.33 |
| fcesd | Father's CESD score summed over 20 items | 31.38 | 6.98 | 20 | 72 |
| mcesd | Mother's CESD score summed over 20 items | 32.92 | 7.24 | 20 | 72 |
| fmath | Father's math test score | 513.05 | 39.51 | 409 | 584 |
| mmath | Mother's math test score | 506.16 | 43.42 | 409 | 584 |
| fmem | Father's memory test score | 5.36 | 1.60 | 0 | 10 |
| mmem | Mother's memory test score | 5.53 | 1.71 | 0 | 10 |

Table 3 Factor loadings and reliability measures for adolescent well-being

| Factors | Loadings | Communality# | Eigen Value | % of Variance Explained | Kaiser–Meyer–Olkin Test * |
|------------------------|----------|--------------|-------------|-------------------------|---------------------------|
| Health | | | 2.01 | 65.58 | 0.59 |
| Height-for-age | 0.226 | 0.509 | | | |
| BMI-for-age | 0.038 | 0.650 | | | |
| Educational Well-being | | | 3.85 | 79.78 | 0.66 |
| ChildMem | 0.262 | 0.524 | | | |
| ChildMath | 0.288 | 0.643 | | | |
| Compreh_Interv | 0.829 | 0.696 | | | |
| Intel_Interv | 0.828 | 0.694 | | | |
| Emotional Well-Being | | | 2.31 | 97.72 | 0.85 |
| ChildHappy | 0.440 | 0.693 | | | |
| ChildCESD | -0.480 | 0.731 | | | |
| SelfesLow | -0.295 | 0.867 | | | |

Communality refers to the degree to which original information contained in each variable can be extracted by the common factor. The rule of thumb on communality is that a value larger than 0.4 indicates that this variable contains sufficient information for index construction

* High values of KMO test (greater than 0.5) indicates that the data used is suitable for the concept being identified

Table 4 Correlation coefficient of adolescent well-being indices

| | Health | EdWB | EmWB |
|--------|--------|-------|------|
| Health | 1 | | |
| EdWB | 0.192 | 1 | |
| EmWB | 0.104 | 0.177 | 1 |

Table 2 shows the descriptive statistics of the parents. On average, fathers have schooled for about 8 years which is a year more than the mothers. About 9% of the fathers and 6.8% of the mothers have a college degree.

5 Results

5.1 Adolescent Well-Being Domains

An exploratory and confirmatory factor analysis of the dimensions listed in Table 1 is carried out. Using Principal Axis Factoring with direct oblimin rotation and greater than one Eigen values), factors underlying the three well-being indicators related to health, EdWB and EmWB were extracted as seen in Table 3. The validity of the well-being indicators is given by the Kaiser–Meyer–Olkin test on sample adequacy, the proportion of the variance explained, and the communality test. The low correlation between the three types of well-being shown in Table 4 supports examining adolescent development from difference perspectives. Using the factor loadings in Table 3, three well-being indices are computed for analysis.

It can be seen from Table 5 that there are some gender and rural/urban differences in the well-being indices. The two-sample *t*-test shows that the null hypothesis of equal mean is rejected at the 1% level of significance for all the well-being domains except for EmWB between boys and girls. While not fully comparable (as our EmWB index is constructed differently) with Migliorini et al. (2019) and Savahl et al. (2015), they too do not find significant differences in the EmWB between girls and boys. On average, our results show that boys' EdWB is higher than that of girls' and boys are also in better health. Adolescents in rural areas

Table 5 Adolescent well-being by gender and rural/urban area

| | Girls | Boys | p-value | Rural | Urban | p-value |
|--------|---------------|---------------|---------|---------------|---------------|---------|
| Health | 0.52 (0.74) | 0.69 (0.79) | 0.00 | 0.54 (0.76) | 0.96 (0.75) | 0.00 |
| EdWB | 149.42 (8.72) | 151.01 (8.07) | 0.00 | 149.63 (8.24) | 153.10 (8.58) | 0.00 |
| EmWB | -11.11 (3.14) | -11.31 (3.16) | 0.83 | -11.37 (3.14) | -10.56 (3.11) | 0.00 |

Standard deviation is parentheses

With EmWB, the lower negative value denotes higher EmWB

p-value is for the two-sampled *t*-test on the difference of the means

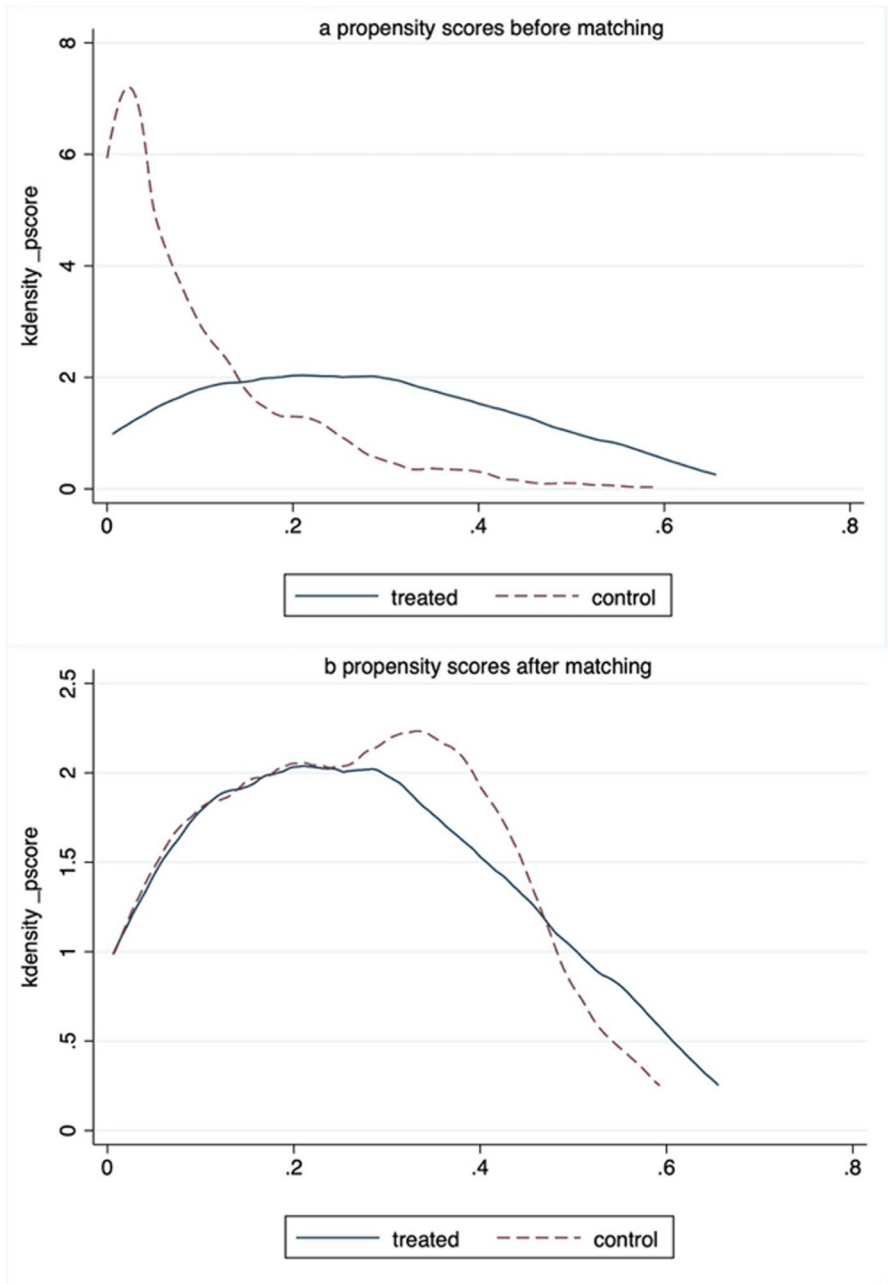


Fig. 1 Kernel density distributions of the propensity scores for the groups. **a** propensity scores before matching. **b** propensity scores after matching

Table 6 Average treatment effects

| | Parents with college degree | Parents without college degree | ATT (Std. Err.) | |
|----------------------------|-----------------------------|--------------------------------|-----------------|-----------------|
| | Mean of Adolescent Index | Mean of Adolescent Index | | |
| Mother with college degree | Health | 1.145 | 0.587 | 0.648***(0.102) |
| | EdWB | 154.450 | 150.136 | 4.774***(1.188) |
| | EmWB | -10.112 | -11.244 | 1.228**(0.521) |
| Father with college degree | Health | 1.025 | 0.586 | 0.423***(0.087) |
| | EdWB | 154.078 | 150.125 | 3.708***(0.995) |
| | EmWB | -10.459 | -11.298 | 0.535 (0.488) |

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

are however found to lag behind their urban counterparts in all three domains of well-being.

5.2 Propensity Score Matching Analysis

First, the parent's education function is estimated using a probit model. Results provided in Appendix 1 Table 8 show that eight of the 11 variables are significant. Next, we undertake the balance test on the chosen covariates for the PSM. Results in Appendix 2 Table 9 show that the t -test on the difference between all the treated and untreated groups after matching is not statistically significant. This means that the treated and untreated groups are sufficiently balanced to conduct the analysis.

Figure 1 shows the kernel density functions of the propensity values before and after the samples of the treated and control groups are matched. It is necessary to test if the matching common support condition is met to ensure that there is sufficient sample matching between the treated and control group. The interval between the overlaps of treated and control groups is supposed to be wide to avoid the invalidation of tendency score matching (Caliendo & Kopeinig, 2008). Figure 1a shows that the supporting domains of the treated and control groups samples have large differences before matching. After matching, Fig. 1b shows that the propensity score ranges of the two groups have a considerable overlap. Thus the common support condition is met and the matching process is validated.

In this study, we opted for kernel-based matching instead of other methods such as nearest neighbor matching and radius matching. So we conduct the Rosenbaum bounds sensitivity analysis for the estimation of ATT (see DiPrete & Gangl, 2004) to support our chosen method. This involves a Wilcoxon signed rank test

Table 7 Influence of parent's education on boys/girls and in rural/urban areas

| | | Girls ATT (Std. Err.) | Boys ATT (Std. Err.) | Urban ATT (Std. Err.) | Rural [#] ATT (Std. Err.) |
|------------------------------|--------|--------------------------|-------------------------|--------------------------|---------------------------------------|
| Mother with a college degree | Health | 0.345*(0.185) | 0.715***(0.123) | 0.360***(0.129) | 0.112(0.104) |
| | EdWB | 2.693**(1.081) | 5.168***(1.313) | 3.296**(1.451) | 1.287(1.218) |
| | EmWB | 0.727**(0.339) | 1.413**(0.624) | 1.177**(0.585) | 1.043(0.662) |
| Father with a college degree | Health | 0.188(0.141) | 0.519***(0.111) | 0.257**(0.124) | 0.137*(0.0802) |
| | EdWB | 3.046*(1.799) | 3.750***(1.148) | 3.786***(1.354) | 2.821***(0.921) |
| | EmWB | 0.734(0.811) | 0.377(0.612) | 0.295(0.597) | -0.293(0.508) |

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In rural areas, the treatment is parents with a high school education or not. This is due to the fact that on average, education in rural areas was much lower than in urban areas

to evaluate how robust the estimated ATT is against the so-called hidden bias—a potential unobserved confounding variable that affects selection into the treatment group. The strength of the unobserved confounder is varied in terms of the odds ratio of the differential treatment assignment owing to this omitted variable and denoted by Gamma to discern the extent to which the estimated ATT is biased (ibid). Results in Appendix 3 Table 10 show that the results are robust for the three well-being indices as their Gamma range is acceptable in relation to the marginal significance given in the second column (details of procedure in DiPrete & Gangl, 2004).

Table 6 presents the estimates of the ATT of parents' education on adolescent well-being after matching. There are significant differences in the well-being indices of the adolescents depending on whether their parents have a college degree or not. The positive maternal effect is greater than the paternal effect for health and EdWB. Statistically, the difference between the maternal and paternal effect on adolescent health is significant based on the t -test of the two coefficients. However, the difference on the effect on EdWB from mother's and father's education is not statistically significant. With EmWB, unlike fathers, mothers' education causes a significant improvement for their adolescents. Mirowsky and Ross (2003) explain that education represents skills for gathering information and applying this information to deal with difficult situations, thereby leading to less stress and better well-being. It is thus possible that there is transmission of education to better EmWB outcomes for adolescents.

Some studies such as Bornstein et al. (2013) and Schneider and Coleman (2018) explain that there may be a high correlation in the education level of spouses as a highly educated man or woman is likely to seek a match in someone equally educated. In our dataset, that correlation was 0.65 and so we tested the robustness of the ATT results of Table 6 by examining the treatment effect from father's education controlling for mother's education and vice versa. Results (not shown here but available upon request) show that

the similar qualitative results to Table 6 were obtained, thereby providing a robust check.

When gender of the adolescent is considered (see Table 7), first, the effects of parental (be it father's or mother's) education are always bigger for boys than for girls and this is statistically significant for education and health but not emotional well-being. In fact, the mother-son effect is twice that of the effect of mother-daughter transmission in health and educational well-being. One reason for our result could be the phenomenon of son preference in China, also seen in other developing countries (Chen et al., 2013; Zimmerman, 2018). A son is preferred over a daughter because in the Chinese society, it is the son who will carry forth the lineage of the family. There are also expectations that sons would be successful and there is every effort to make that happen (Chen et al., 2013). Jayachandran (2015) further explains that social cultures such as fatherhood, paternalism, and the custom of preparing dowries for daughters reinforce the value of male offspring and hence more traditional gender role attitudes. Also, in Asian cultures, sons (more than daughters) are expected to look after their parents in their old age. From an economic point of view, it is possible that returns to investment in sons is perceived to be higher than in daughters.

Second, mother's education effect is higher than father's in all three domains of well-being for both sons and daughters, but the effect of the difference is only significant on the daughters. This could be due to mothers still commonly being the primary caregivers which makes their role especially important (Harding, 2015). Moreover, father's education does not affect daughter's health and only has a weak (statistically significant at 10% level) effect on her EdWB.

Table 7 also shows that in rural areas, mother's education (even when only high school is considered) does not affect any domain of adolescent well-being. Fathers in the rural areas however have a significant effect on the adolescents' EdWB but only a weak (statistically significant at 10% level) effect on adolescent health. The coefficients on the ATT for father's education in the rural areas are lower than the urban areas, indicating a lower level of intergenerational transmission of education quite similar to Golley and Kong (2013) and Dong et al. (2019) for China.

Our results on mother's education in rural China is however in stark contrast to the above-mentioned studies. Nevertheless, we draw from the literature to support our finding—education is said to be a proxy for women's bargaining power and the lack of education more so in rural areas translates to low decision making power for the females which can affect investments in the health and education of children (Doss, 2013). The low status of women in rural China is said to affect their relationship with their children as noted by Song (2017).

6 Conclusion

This study highlights the importance of maternal education (having a college degree for urban residents and high school education for rural residents) for the domains of health, education and emotional WB of adolescents. Using propensity score matching to control for several confounding factors, results show a causal effect from maternal education to adolescent development that is larger in its impacts than that of fathers. Also, sons were found to benefit more than daughters from both parents' education.

The finding that only father's education in rural areas matter for adolescents' EdWB and that of mothers have no impact means that there is room for those outside the family such as schools, communities and society at large to make an impact on adolescent development. Thus attention should be given to create an enabling environment for adolescents to grow up in, such as their social network, the school program and school environment. Perhaps mothers in rural areas could be empowered by associations for women or non-government organisations to help them understand their potential to nurture adolescents in terms of better interaction and building an effective relationship with their kids to help them develop better outcomes.

There are however several limitations of this study which can be improved for future research.

First, since matching based on unobservable factors (such as parents unobserved endowments) is by definition not possible and therefore cannot be controlled for, our estimates may still be affected by omitted variable bias. Second, there may be a sample selection problem in our results as migrant parents from rural to urban areas and their left-behind kids were deliberately excluded as they are not comparable to non-migrant parents. While it is beyond the scope of this study to examine this group, future research on this would be useful.

Third, the age cohort examined was 10–15 years and these results cannot be generalised to those below 10 years or above 15 years. Fourth, adolescents from China come from a country where traditional norms and gender inequalities (and son preference) still persist, so the results may not be applicable to less sexist cultural contexts. The one-child policy is a distinct feature in China and this may have effects on parents' mindset and parenting behaviour which may not be similar in other countries.

Parents' education may also differ for different levels (high and low) in the well-being domains of the children. A quantile regression analysis may shed light on this but for methodological reasons underlying the use of propensity score matching, this was not possible to test. Future research could use longitudinal data to trace changes in child well-being domains and different age groups over time for more robust and conclusive analysis. Lastly, if data were available on time and money spent by each parent and the activities they undertook with their children, this can be useful to examine the mechanisms underlying parental education effect on adolescents' well-being.

Appendix 1

Table 8 Probit estimation results in PSM for mother's education

| | Coefficient (Std. Err.) |
|-----------------------|-------------------------|
| fmincome | 0.579***(0.186) |
| familynumber | -0.053***(0.017) |
| childnumber | -0.574***(0.047) |
| fwork | 0.01(0.008) |
| mwork | -0.026***(0.009) |
| fcesd | -0.004 (0.005) |
| mcesd | -0.003 (0.005) |
| fmath | 0.006***(0.001) |
| mmath | 0.005***(0.001) |
| fmem | 0.093***(0.022) |
| mmem | 0.116***(0.021) |
| constant | -6.807***(0.702) |
| Observations | 3221 |
| Log Likelihood | -1051.36 |
| Likelihood-Ratio test | 574.34 |
| Pseudo R ² | 0.25 |

Similar results (available upon request) were obtained for father's education

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix 2

Table 9 Covariate balance in the average treatment effect for mother's education

| Variable | Sample | Mean of Treated Group | Mean of Control Group | p-value [#] |
|--------------|-----------|-----------------------|-----------------------|----------------------|
| fmincome | Unmatched | 11.39 | 10.74 | 0.05** |
| | Matched | 11.39 | 11.84 | 0.33 |
| familynumber | Unmatched | 4.51 | 5.10 | 0.00*** |
| | Matched | 4.51 | 4.60 | 0.51 |
| childnumber | Unmatched | 1.34 | 2.05 | 0.00*** |
| | Matched | 1.34 | 1.36 | 0.77 |
| fwork | Unmatched | 5.30 | 6.27 | 0.00*** |
| | Matched | 5.30 | 4.74 | 0.11 |
| mwork | Unmatched | 3.93 | 4.60 | 0.05** |
| | Matched | 3.93 | 4.58 | 0.12 |
| fcesd | Unmatched | 30.29 | 31.54 | 0.00*** |
| | Matched | 30.29 | 30.51 | 0.64 |
| mcesd | Unmatched | 31.65 | 33.04 | 0.00*** |
| | Matched | 31.65 | 31.32 | 0.49 |
| fmath | Unmatched | 396.19 | 382.47 | 0.27 |
| | Matched | 396.19 | 377.08 | 0.26 |
| mmath | Unmatched | 411.73 | 415.27 | 0.74 |
| | Matched | 411.73 | 391.40 | 0.20 |
| fmem | Unmatched | 2.57 | 1.93 | 0.05** |
| | Matched | 2.57 | 1.95 | 0.17 |
| mmem | Unmatched | 3.31 | 3.019 | 0.32 |
| | Matched | 3.31 | 2.68 | 0.15 |

Similar results (available upon request) were obtained for father's education

p-value for the two-sampled *t*-test on the difference of the means

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix 3

Table 10 Rosenbuam bounds sensitivity analysis of treatment effects

| Health | Gamma | sig + | t-hat + |
|--------|-------|-------|---------|
| | 1 | 0.020 | 0.232 |
| | 1.05 | 0.034 | 0.204 |
| | 1.1 | 0.053 | 0.181 |
| | 1.15 | 0.079 | 0.162 |
| | 1.2 | 0.111 | 0.139 |
| | 1.25 | 0.150 | 0.117 |
| | 1.3 | 0.194 | 0.097 |
| EdWB | Gamma | sig + | t-hat + |
| | 1 | 0.074 | 1.703 |
| | 1.05 | 0.109 | 1.432 |
| | 1.1 | 0.152 | 1.215 |
| | 1.15 | 0.202 | 0.964 |
| | 1.2 | 0.258 | 0.761 |
| | 1.25 | 0.318 | 0.522 |
| | 1.3 | 0.381 | 0.335 |
| EmWB | Gamma | sig + | t-hat + |
| | 1 | 0.005 | 0.675 |
| | 1.05 | 0.056 | 0.605 |
| | 1.1 | 0.060 | 0.583 |
| | 1.15 | 0.065 | 0.522 |
| | 1.2 | 0.069 | 0.573 |
| | 1.25 | 0.072 | 0.165 |
| | 1.3 | 0.081 | 0.174 |
| | 2.5 | 0.131 | 0.117 |

Author Contributions Authors contributed equally to this paper.

Data Availability The data used in this article are available online. Institute of Social Science Survey, Peking University, 2015, "China Family Panel Studies (CFPS)". <https://doi.org/10.18170/DVN/45LCSO>

Code Availability Stata 15 is used for the estimation in this paper. Code is available upon request.

Declarations

Conflicts of Interest/Competing Interests No conflicts of interest.

Ethics Approval Not applicable.

Consent to participate Not applicable.

Consent for Publication Not applicable.

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