# Parental Migration and the Health and Nutritional Outcomes of Left-Behind Children in China

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# I. Introduction

China has experienced unparalleled economic growth and urbanization over the past four decades. Due to the enormous demand for labor in cities, rural to urban migration has increased substantially. The number of rural migrants was 286.5 million in 2017, comprising about 35 percent of China's total labor force (National Bureau of Statistics of China, 2017). In cities, however, rural migrant workers are disadvantaged: they are exposed to discrimination in workplaces and obstacles such as financial constraints. Moreover, China's household registration system (Hukou) prevents migrant parents from migrating with their children (Jordan, Ren, and Falkingham, 2014). The resulting issue of left-behind children has attracted people's attention in recent years. In rural China, there are about 61 million children left behind, which is 38 percent of rural children and 22 percent of the total children across the country (Hou, 2014).

The lack of parental care and support could generate a set of developmental challenges for left-behind children. Previous studies have mainly examined how parental migration affects the educational outcomes and time allocation patterns of left-behind children. This paper, however, focuses on examining the effects of fathers' migration on the physical health status of left-behind children in rural China.

According to the All-China Women's Federations Research Group (ACWF), left-behind children (LBC) refer to a group of disadvantaged rural children who grow up without one parent or both, because their parent(s) left them and migrated to other cities in search of better jobs and wages. As a consequence, these children are often cared for by relatives, mostly by grandparents with little or no education, by family friends or by themselves. In my paper, LBC are defined as rural children with both or one parent absent in the household, excluding those with divorced, widowed or separated parents. I examine how the migration status of the father affects LBC nutritional status due to limited cases of mother's migration and migration of both parents in my data. I identify fathers as migrant workers if they were not living in the household at the time of interview.

Regarding the child's nutritional status, there are many possible indicators such as anthropometric measurements (e.g., height and weight), low birth weight and vitamin and mineral deficiencies. I used anthropometric measures as the outcome variables in my study since Eveleth (1996) strongly recommends using anthropometric measurements to evaluate the health status of children and adolescents.

To study the relationship between fathers' migration and children's health status, I first perform a cross-sectional analysis using the 2011 wave of the China Health and Nutrition Survey (CHNS). I observe a significant and negative relationship between a father's migration and his children's health outcomes. Then, I carry out fixed effects regressions that account for time-invariant heterogeneity for each household. Results of the panel regressions contrast with those of the cross-sectional regressions: fathers' migration has a small but significantly positive impact on the height of left-behind children.

The remainder of the paper proceeds as follows. In the next section, I review some previous articles to better understand the potential relationship between parental migration and children's health outcomes, focusing on how family considerations affect individuals' migration decisions in part A and whether household income affects children's health status in part B. The third part of section II considers previous papers that have studied the relationship between parental migration and relevant child outcomes, including time allocation patterns, educational results, and health and nutrition outcomes. In part III, I describe the data and the summary statistics. In section IV, I set up the cross-sectional and panel econometric models, and I report the empirical results in part V. Finally, section VI provides conclusions and some policy implications of the observed findings.

## II. Literature Review

### A. How do family considerations affect individuals' migration decisions?

There are two main economic theories of migration: neoclassical migration theory and new economics of labor migration (NELM) theory. Neoclassical migration theory emphasizes the role of an individual in determining migration decisions while NELM theory focuses on the unity of a family. In the first part of my literature review, I will review three previous papers which focus on NELM theory since the migrant decisions of leaving children behind are typically made by families or households.

Mincer (1978) studied how family considerations (family ties) affected household migration decisions, which result in employment and income differences among family members. Mincer found that family ties increased the probability of family migration when women had lower earning status. However, family considerations had different impacts on jobs and income between male migrants and female migrants. In particular, family ties improved the employment and income of migrant husbands but lowered the labor market positions of their wives. He argued that family members tended to evaluate the net gain of the family, but not personal gain, when making family migration decisions. Borjas and Bronars (1991) examined the role of the family in affecting immigration decisions for US immigrants. They built a theoretical model assuming that families made migration decisions to maximize collective household income. Using the 1970 and 1980 Public Use Sample of the US census, Borjas and Bronars empirically found that immigrants were mostly negatively selected and married immigrants had higher skills and earnings relative to single immigrants.

The NELM theory also regards migration as a joint household decision to diversify risks through remittances. Groger and Zylberberg (2016) investigated the insurance role of internal labor migration based on a disastrous typhoon in Vietnam. They performed a difference-in-difference estimation using panel from data before and after the storm. Groger and Zylberberg observed a substantial decline in household income after this climate shock. However, established migrants from the affected households decided to send back more remittances, which helped to diversify the weather risk. The affected households with no migrant beforehand also agreed to send new migrants who returned the same amount of money as the established ones.

### B. Can household income affect child nutrition?

Income plays a significant role in health outcomes. The channel through which parental migration could positively affect a child's nutrition is by increasing household income (e.g., remittances). Dean Yang (2011) states that remittances aim to improve the consumption and investment of those remaining in migrant households. As a mechanism of insurance, remittances also insure weather risks and sustain the health and nutritional investments of rural recipient households in developing countries. Assuming healthy goods are normal goods, households could increase food consumption and purchase more healthy products when there is an increase in household income. Thus, will the family members back home change their consumption choices and eating habits when there is an increase in household income?

Bryan et al. (2014) studied how a random cash incentive affected households' migration behaviour and migrant families' consumption during famine season in Bangladesh. They randomly assigned an $8.50 cash incentive to some tenants conditional on their annual migration. Bryan et al. found that over 20 percent of treated households decided to send at least one migrant to the nearest urban area during the 2008 famine season. The treated families were also more likely to migrate in the subsequent famine season even after they removed the cash incentive. They argued that this induced seasonal migration significantly improved the well-being of the remaining household members by increasing their monthly consumption expenditures and daily calorie intake.

However, is there a positive relationship between household resources and children's health status even in the absence of migration?

Higher socioeconomic status (SES) in the US is associated with better health outcomes for children. Case et al. (2002) studied household income and children's health status in the US using four nationally representative datasets. Conducting several cross-sectional analyses, they observed a positive relationship between household long-run income and children's health status. This positive relationship became more noticeable as children grew older. Moreover, children living in low-income households tended to have worse health status in the presence of chronic diseases relative to affluent children. Currie and Stabile (2003) employed panel analysis and used data from the National Longitudinal Survey of Children and Youth (NLSCY) in Canada. They obtained similar results as Case et al. (2002) with evidence from Canada.

Transfers to the household such as pension programs could also help improve a child's health and nutrition status. Duflo (2000) investigated whether cash transfers affected child health and nutrition based on the expansion of the Old Age Pension Program in South Africa. Duflo used height-for-age Z score (HAZ) as a measure of children's health status. The results illustrated that a child's nutritional status improved when they lived with a female pension recipient. More specifically, cash transfers increased the HAZ score of girls born after January 1992 by 0.62 standard deviations; however, there was no significant height increase for boys. Also, Aizer et al. (2016) obtained similar results by studying the long-term effects of a US welfare program called Mothers' Pension Program. They matched their data with WWII enlistment and 1940 census records to investigate the long-run impacts of Mothers' Pension Program on child's health status. Using children with non-eligible mothers as the control group, Aizer and others found that children's longevity rose by approximately one year if they lived with eligible mothers. Furthermore, cash transfers decreased children's probability of being underweight in adulthood by fifty percent.

The expansion of other welfare programs is also correlated with better child health outcomes. Hoynes et al. (2015) studied the impacts of Earned Income Tax Credit on infant health in the US using US Vital Statistics Natality Data from 1983 to 1999. They found that cash transfers substantially increased the after-tax income of poor households. Employing a difference-in-difference strategy and fixed effects model, Hoynes and others concluded that cash transfers improved mean infant weight and decreased the low birth weight rate. In particular, the low birth weight rate declined by 2 to 3 percent for less educated mothers when there was a $1000 increase in their after-tax income. Milligan and Stabile (2011) examined the child benefit system and child health status in Canada. Their data came from the combination of the National Longitudinal Survey of Children and Youth (NLSCY) and Labor and Income Dynamics (SLID). Using simulated benefits as instrumental variables, they concluded that the proportion of boys from less educated families who had ever experienced hunger decreased after receiving child benefits. Also, there was an increase in height for boys from less educated households. They also provided evidence that child benefits improved the mental health status of girls.

### C. Does parental migration affect child outcomes?

There is a growing literature that examines how parental migration affects child outcomes, focusing mainly on the dimensions of gender discrimination, time allocation, educational attainment, and health and nutritional status.

Antman (2011a) studied whether fathers' international migration from Mexico to the US could affect gender discrimination among left-behind children. The study was based on the 2002 and 2005 waves of MXFLS, which was a nationally representative panel data set of Mexicans. The author found that mothers tended to increase clothing and educational expenditures for their daughters after spouses' migration and the fraction of household resources spent on boys declined.

There are also consistent findings on the impacts of parental migration on children's time allocation, showing that LBC tend to devote more time to work since they took on more financial responsibilities in the household. Antman (2011b) also studied how fathers' migration from Mexico to the US affected children's time allocation between study and work using an individual fixed effect model and IV strategy. Relevant US economic indicators were chosen to be instrumental variables for fathers' migration. She found that children spent 36 hours less per week on learning activities and spent 62 hours more per week on paid work when their father migrated to the US. Chang et al. (2011) examined parental migration and time allocation of LBC in rural China using data from the China Health and Nutrition Survey (CHNS). The authors used the number of relocating parents as a measure of parental migration and employed the share of migrating households in the village as instrumental variables. Chang and others suggested that a child was 2.1 percentage points more likely to participate in agricultural work if one of his parents migrated elsewhere. Moreover, the number of hours children spent per day on domestic chores increased 0.8 hours for girls and 0.2 hours for boys.

There are mixed findings of the impacts of parental migration on child educational attainment. Antman (2012) examined how fathers' migration from Mexico to the US affected children's educational attainment in Mexico. Her data came from the Mexican Migration Project from 1987 to 2007. Antman employed a family fixed effect model and used elder children who had completed their education at the time of fathers' migration as a reference group. The results implied that young girls increased their years of schooling by 0.73 years if their fathers migrated to the US. Zhang et al. (2014) studied the effects of parental migration on test scores of LBC in rural China. They collected panel data from third to fifth graders in an impoverished county in Hunan province, where many LBC are concentrated. Employing difference-in-difference and GMM estimation, they found that children with both parents absent scored 5.4 percentage points lower in math exams and 5.1 percentage points lower in Chinese tests.

Mansuri (2006) investigated the relationship between parental temporary economic movement and child health in rural Pakistan using Pakistan Rural Household Survey (PRHS) between 2001 and 2002. She used height-for-age and weight-for-age Z-scores (HAZ and WAZ) as measures of a child's health status, and village migrant networks as an instrumental variable. She concluded that parental migration had significantly improved the HAZ and WAZ values of Pakistani children, especially for Pakistani girls.

Two Chinese studies, however, obtained the opposite results. Using pooled cross-sectional data from CHNS, Li et al. (2015) studied parental migration and the health of LBC in rural China. They divided LBC into three categories: children with father absent, children with mother absent and children with both parents absent. Employing peer migration rates as instrumental variables for parental migration, Li et al. concluded that the probability for LBC to become ill was 20 percent higher than those whose parents are present. Moreover, the effects of parental migration on children's health status are different by gender and age: girls and younger children are worse-off in the case of parental immigration. de Brauw and Mu (2011) investigated the relationship between parental migration and nutritional status of LBC. The authors used the Body Mass Index (BMI) to define underweight status and overweight status. They employed OLS estimation and fixed effects model based on CHNS. The authors found that the nutrition status of LBC aged between 2 to 7 was less likely to be affected by parental immigration status, while the probability of being underweight for older LBC aged between 7 to 12 was relatively high. Brauw and Mu explained this by providing evidence that migrant families invested less time in preparing food and older LBC had to allocate more time for household chores.

This paper contributes to the literature that examines the effects of parental migration on child's health and nutritional status in several ways. Previous studies have focused mainly on the use of HAZ and WAZ scores as measurements of a child's health outcomes. They concentrated on relatively younger children since the use of Z scores is not recommended for children over the age of 10 years (Lai et al. 1998). The probability of getting ill in the past few weeks is also another popular measure of a child's health status. However, it could reflect only short-term effects of nutritional shocks on children and may underestimate or overestimate the impacts of parental migration on child's health status. I use height and weight to measure the health status of LBC. Anthropometric measures enable me to study the health status of both younger LBC and older LBC. Moreover, these anthropometric measures could reveal the cumulative impacts of nutritional shocks on children.

The most recent data used in the previous studies of China were collected in 2009. In this paper, I use the 2011 wave of the China Health and Nutrition Survey (CHNS) and conduct a cross-sectional analysis. To date, the 2011 wave of CHNS is the largest and latest data set to present the health and nutritional status of children in China.

## III. Data and Summary Statistics

My data is from the China Health and Nutrition Survey (CHNS). CHNS is an ongoing international collaborative project between the Carolina Population Center at the University of North Carolina at Chapel Hill and the National Institute for Nutrition and Health at the Chinese Center for Disease Control and Prevention. Starting in 1989, CHNS has collected data from individuals, households, and communities to examine how economic development and social changes in China have affected the health and nutrition status of the Chinese population. Beginning with eight provinces, Liaoning, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi and Guizhou, in 1989, CHNS included Heilongjiang in 1997 and three autonomous cities, Beijing, Shanghai, and Chongqing, in 2011. These provinces and autonomous cities were selected since they provided significant geographical, health and economic variation. So far, there have been eight waves of panel surveys: 1989, 1991, 1997, 2000, 2004, 2006, 2009 and 2011.

CHNS consists of 48 different longitudinal master files, and a unique ID identifies each participant. My study is based on the roster file which contains variables such as date of birth, marital status, parental ID (if their parents were also participants), and geographical information for each observation in each survey year. Most importantly, questions such as "Does your father/mother live in the household?" were answered by participants, which were helpful for identifying the status of parental absence. I merged this roster file with another file called the birth master file and obtained information about the history of each surveyed child, such as gender and maternal ID. In this manner, I got a sample of children with data on ID, age, gender, parental migration status, and region.

In addition to household interviews and childbirth history, CHNS also conducted a series of physical examinations for all participants and recorded detailed data about their dietary intake, physical activity, blood pressure and anthropometric variables (e.g., height and weight) in the physical exam master file. I merged my data on children with the physical exam master file to obtain data on their height and weight. Finally, I combined this data with another file called the household income master file containing information on net annual household income (e.g., from business, wages, etc.) deflated to 2011 yuan.

I then imposed some restrictions on my sample. I restricted my sample only to children under the age of 18 since it initially included both children under the age of 18 and children over the age of 18. According to The United Nations Convention on the Right of the Child, a child refers to any person below the age of 18. Next, I limited my sample to rural children and deleted children from urban areas because the issue of LBC mostly occurs in rural China and I want to focus on the rural population. Finally, I excluded rural children whose parents were divorced, widowed or separated because their parents were also absent in the household in these cases, but I want to study only the impact of parental migration.

However, the samples of children with absent mothers or both absent parents are limited. For example, between the year of 1989 and 2011, the number of children living in families with no father make up 3.9% of the total sample, compared to 0.096% and 0.022% of children living in families without a mother or both parents, respectively, after the children whose parents were divorced, widowed or separated was removed. Thus, the main focus of this paper is to examine how fathers' migration affects LBC's health and nutritional status.

My cross-sectional analysis uses the 2011 wave of CHNS since it used the most recent data and the sample size was relatively large. In 2011, CHNS included three additional autonomous cities which also have large rural areas under their jurisdiction. The survey used a multi-stage, random cluster process and selected 216 neighborhoods in 2011. There were 1,109 valid cases with 945 non-LBC and 164 father-absent children after imposing these restrictions in 2011.

I report the summary statistics for the 2011 sample of rural children in Table 1. I divided rural children into two groups: children with both parents living in the household (Non-LBC) and children whose fathers worked away from home (Father Absence). The height and weight for non-LBC were 126 centimeters and 31.1 kilograms which were higher compared to 115 centimeters and 25.6 kilograms for children with an absent father. However, children tended to be younger in the father absence group than in the non-LBC group. More specifically, approximately 41 percent of children were under the age of 6 in the father absence group, compared to 29 percent in the non-LBC group. There were also noticeable differences in the household income level between the non-LBC group and the father absence group. The total annual household income was an average of 52.612 thousand yuan for non-LBC households and 23.949 thousand yuan for father-absent homes. So on average, father-absent households' yearly income was half that of non-LBC families.

Lastly, there were some noteworthy regional characteristics of non-LBC households and father-absent households. Non-LBC families were relatively evenly distributed across the 12 provinces and autonomous cities in the sample. However, situations for father-absent homes were different: approximately one fourth and one fifth of the absent father's families lived in Henan and Guangxi provinces, respectively, in 2011. This is consistent with the anecdotal evidence about LBC in China because both Henan and Guangxi are famous labor-exporting provinces in China where people tend to migrate to other places to seek employment opportunities elsewhere.

## IV. Econometric Model and Specifications

There are many factors with the potential to bias the estimated effects of father's migration on children's height and weight. Children's height and weight vary across different gender and age groups. For example, girls and young children tend to have lower height and weight compared to boys and older children. Thus, child's gender and age will generate problems such as omitted variable bias if they are also correlated with father migration decisions. This is likely to occur as parents may have greater incentives to migrate and seek better jobs and wages when their children are young, and the pressure to make money may decrease as children grow older.

Household income could affect children's health status positively: children from affluent households are more likely to be in better health since their families could afford nutritional food. Moreover, the likelihood of high-income migrants is lower, as their migration opportunity costs are relatively higher. It can be argued that there is reverse causality between household income and health status, as poor health can have adverse impacts on household income by reducing an individual's work capacity (Fuchs, 1982; Marmot, 1999; Smith, 1999). However, the concern that household income is endogenous can be mitigated in this paper, since according to Case et al. (2002), there is no effect of children's health status on household income since most children do not contribute to family income.

Also, children's height and weight may differ across provinces in China. For example, Northern Chinese tend to be taller for biological and cultural reasons (Piazza, 1998). Moreover, coastal cities are generally prosperous due to China's 'Reform and Opening up Policy' in 1978. According to the 2011 China Statistical Yearbook, among my sample provinces, the annual per capita income for coastal regions such as Liaoning, Beijing, Shandong, Jiangsu, and Shanghai was above the average. However, the annual per capita income for areas in the interior such as Heilongjiang, Henan, Hubei, Guangxi, and Guizhou was below the mean. Moreover, people from low-income regions are more likely to migrate to high-income areas due to wage differentials (Bauer and Zimmermann, 1999; Massey et al. 1993; Borjas, 2008).

The cross-sectional econometric model therefore takes the following form:

$$Y_i=\beta_0+\beta_1 fatherabsence_i+\beta_2 female_i+\beta_3 age0\_6_i+\beta_4 age6\_12_i+\beta_5 householdincome_i+X'_i\beta_6+\varepsilon_i \qquad (1)$$

Where the dependent variable $Y_i$ could be $height_i$ and $weight_i$, which are the height and weight of rural child *i*. The variable $fatherabsence_i$ equals one if a child's father is not in the household and migrates elsewhere, and zero otherwise. The reference group is children with both parents present in the household since I have excluded households with absent mothers. I decided to divide children's age into three categories: children aged under 6 years old ($age0\_6_i$), children aged between 6 and 12 years old ($age6\_12_i$) and children aged between 12 and 18 years old ($age12\_18_i$). The reference group is children aged from 12 to 18 years old. The variable $householdincome_i$ is the net household income (deflated to 2011 yuan) of rural child *i*. The coefficients $\beta_1$, $\beta_2$, $\beta_3$, $\beta_4$, $\beta_5$ and $\beta_6$ measure how father's migration, child's gender, child's age, household income, and region affect the health and nutrition status of child *i*. For example, if $\beta_1$ is positive, it implies that a father's migration has a positive effect on the health and nutrition status of child *i*. *X* is a vector of region dummies to control for province fixed effects. I omit *beijing* from the regression and $\varepsilon_i$ is the error term. In some specifications, I interact $fatherabsence_i$ with the gender or age dummies to check for the presence of heterogeneous treatment effects.

Besides gender, age, total household income, and region, there is still much unobserved time-invariant heterogeneity across families that may bias the estimated effects of father's migration on children's height and weight. The unobserved time-invariant heterogeneity in variables such as family wealth and parental educational attainment could affect a child's health status and are correlated with a father's migration decisions. For example, children from low-income households may still have good health status if their families have high values of assets. Moreover, the likelihood of low-income individuals choosing to be migrants still could be relatively low when their families are rich.

The panel econometric model therefore takes the following form:

$$Y_{it}=\alpha_0+\alpha_1 fatherabsence_{it}+\alpha_2 age0\_6_{it}+\alpha_3 age6\_12_{it}+\alpha_4 householdincome_{it}+\mu_i+\lambda_t+\varepsilon_{it} \quad (2)$$

Where $Y_{it}$ is a child's nutritional status measured by the height and weight of rural child *i* in year *t*. The variable $fatherabsence_{it}$ takes on a value of one if a child's father is absent elsewhere in year t, and zero otherwise. The variables $age0\_6_{it}$ and $age6\_12_{it}$ are equal to one if a child is under 6 years old or between 6 and 12 years old in year t, respectively, and zero if if the child is between 12 and 18 years old in year t. The variable $householdincome_{it}$ is the total annual household income for rural child *i* in year *t* (deflated to 2011 yuan). The individual fixed effect $\mu_i$ controls for all time-invariant heterogeneity of household *i*, such as family wealth, that could affect both a child's health status and his father's migration decisions. The time fixed effect $\lambda_t$ is a series of year dummies that capture all time-varying heterogeneity across the whole sample, such as economic growth. $\varepsilon_{it}$ is the error term.

## V. Empirical Results

I first carried out OLS regressions analyzing the effects of father's migration on LBC's height in 2011. Table 2 presents the regression results in three steps. In column (1), I only controlled for child's gender and age. Then, I included eleven region dummies to control for region fixed effects in column (2) and I added the total yearly household income (deflated to 2011 yuan) in column (3).

As shown in column (1), the absence of a father had significant effects on the health status of his child. Children's heights were on average 5.26 centimeters shorter if they had absent fathers, controlling for gender and age. The coefficient of father's migration was economically important and statistically significant at the 5% level. Other coefficient carried the expected signs. There were no significant height differences between boys and girls. However, the height of a child is strongly correlated with his age. Children below 6 and children aged between 6 and 12 were on average 48.18 and 9.38 centimeters shorter compared to children aged between 12 and 18, all else being equal. As shown in columns (2) and (3), all these coefficients were not sensitive to the region and total household income. Children from Beijing (a city in northeast China) were taller than those from several other provinces, keeping all else constant. In particular, the heights of children from Beijing were significantly higher than children from Henan, Hubei, Hunan, Guangxi, Guizhou, and Chongqing. In column (3), children were 0.0011 centimeters shorter when their household income increased by 1,000 yuan, but the results were not statistically significant.

However, the effects of father absence on the height of LBC may differ according to children's gender and age groups. Thus, I interacted fathers' absence status with LBC's gender and age groups to study their interaction effects on the height of LBC. In column (1) of Table 3, the negative effects of father absence varied by LBC's gender and were smaller for girls, but the difference was not statistically significant at the 10% level. As shown in column (3), the effects of father migration differed across LBC's age groups. In particular, fathers' migration had smaller effects for LBC aged below 6 and LBC aged between 6 and 12 than for LBC aged above 12, and the differences were statistically significant at the 5% level and 10% level, respectively.

I obtained similar results for the effects of father's migration on the LBC's weight in 2011. Table 4 presents the regression results for the child's weight using the same three specifications. Children's weights were 2.5 kilograms lower on average if their fathers were absent, controlling for their sex and age. The coefficient was statistically significant at 5% level. Gender had a statistically significant effect on a child's weight, and girls' weights were 1.64 kilograms lower than those of boys, keeping all else constant. There was also a positive relationship between a child's age and his weight. Children below 6 and children aged between 6 and 12 were on average 25.7 and 11.28 kilograms lighter compared to children aged between 12 and 18, all else being equal. None of these coefficients was sensitive to the region and total household income. Children from Beijing weighed significantly more than children from Henan, Hubei, Hunan, Guangxi, Guizhou, and Chongqing. Moreover, increasing total household income did not significantly affect children's weight.

Similarly, the effects of fathers' migration on LBC's weight may also depend on LBC's gender and age groups. As shown in column (1) of Table 5, the negative effects of father absence on LBC's weight were smaller for girls, and the difference was statistically significant at the 5% level. Moreover, the effects of father absence on LBC's weight also varied across LBC's age groups. Fathers' migration had smaller effects for LBC aged below 6 and LBC aged between 6 and 12 than for LBC aged above 12, and the differences were statistically significant at the 10% level.

In cross-sectional studies, I could not control for time-invariant heterogeneity of each household. Therefore, I conducted a fixed effects model that tracked the same LBC across years and accounted for this unobserved heterogeneity as well as time-varying heterogeneity across the whole sample. Table 6 and Table 7 present the results for this fixed effects regression. Time-invariant explanatory variables such as gender and province were omitted from the regression.

Column (1) of Table 6 reports the effects of father's migration on child's height for the fixed effects regression. The estimated effect of father absence on the child's height changed to 0.99, which was positive and statistically significant at the 5% level. Thus, father's migration improved the height of his child by approximately 1 centimeter, keeping all else constant. It could be that the coefficient of father absence on the child's height had a downward bias in the cross-sectional analysis. In the cross-sectional model, I did not control for time-invariant heterogeneity of each household such as family wealth, which could lead to potential omitted variable bias in the cross-sectional regression. As we discussed previously, family wealth may improve children's health outcomes and decrease the possibility of father's migration. Thus, omitting household wealth could bias the coefficient of father absence downward in the cross-sectional model. So the positive sign of the coefficient on father absence in the panel regression may suggest that LBC indeed gained more height due to the migration activities of their fathers. However, the results remained similar when I controlled for household income in column (2).

Column (1) of Table 7 presented the effects of father's migration on child's weight for the fixed effects regression. The coefficient on father absence was negative but not statistically significant even at a 10% level, which implied that a father's migration had no discernible effect on the weight of his child. Moreover, the results were unchanged after I controlled for household income in column (2).

## VI. Conclusions and Discussions

Using a panel dataset, I have examined the relationship between fathers' migration and the health and nutritional status of left-behind children in rural China. I first conducted a cross-sectional analysis based on the 2011 wave of the China Health and Nutrition Survey, and found that fathers' migration had adverse impacts on the health outcomes of left-behind children. I found that children on average are 5.15 centimeters shorter and 2.62 kilograms lighter when they had a migrant father in the household. The results of a panel regression, however, contrasted with those of the cross-sectional analysis. Children were approximately 1 centimeter taller if their fathers migrated and worked elsewhere. Also, fathers' migration did not have noticeable effects on the weight of left-behind children. I attributed the downward bias of father's migration on child's height to the omitted variable bias from variables such as family wealth in the cross-sectional regression.

However, there are some limitations to my study. First of all, I could not account for time-variant factors of each household by using panel analysis. Time-variant household heterogeneity such as a temporary income shock is correlated with father's migration decisions and could affect child's health outcomes. Second, there could be reverse causality between father's migration and a child's health outcomes. For example, parents tend to stay at home and take care of their children when children are in poor health, which indicates that child's health status may affect father's migration decisions in the other direction. However, I could not find an appropriate instrumental variable for father's migration status since CHNS is not originally designed to study migration behaviours.

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Table 1. Summary Statistics: Means and Standard Deviations

| Variables | Non LBC | Father Absence |
|---|---|---|
| A. Demographics | | |
| Height | 126.006 (30.780) | 114.825 (31.205) |
| Weight | 31.119 (17.450) | 25. 673 (16.745) |
| Girls | 0.448 (0.498) | 0.433 (0.497) |
| Age 0_6 | 0.291 (0.454) | 0.412 (0.495) |
| Age 6_12 | 0.307 (0.461) | 0.274 (0.448) |
| Age 12_18 | 0.217 (0.412) | 0.128 (0.335) |
| Household Income | 52.61203 (50.12854) | 23.94909 (67.20683) |
| B. Region | | |
| Heilongjiang | 0.074 (0.262) | 0.030 (0.172) |
| Liaoning | 0.049 (0.215) | 0.098 (0.298) |
| Beijing | 0.074 (0.262) | 0.055 (0.228) |
| Shanghai | 0.078 (0.269) | 0.006 (0.078) |
| Jiangsu | 0.074 (0.262) | 0.067 (0.251) |
| Shandong | 0.071 (0.257) | 0. 061 (0.240) |
| Henan | 0.086 (0.280) | 0.250 (0.434) |
| Hubei | 0.049 (0.215) | 0.037 (0.188) |
| Hunan | 0.085 (0.279) | 0.067 (0.251) |
| Guangxi | 0.169 (0.375) | 0.195 (0.398) |
| Guizhou | 0.095 (0.294) | 0.055 (0.228) |
| Chongqing | 0.096 (0.295) | 0.080 (0.271) |
| Observations | 945 | 164 |

*Notes:* Standard deviations are in brackets. Non LBC is the abbreviation for non left-behind child. Height is measured in centimetres and weight is measured in kilograms. Child's age is divided into 3 age groups: age 0 to 6, age 6 to 12 and age 12 to 18. Household income is the total household income inflated to 2011 currency and is measured in thousands of yuan. Data source: China Health and Nutrition Survey (CHNS) Wave 2011.

Table 2. Father Absence and Child's Height

| Explanatory Variables | (1) | (2) | (3) |
|---|---|---|---|
| Father Absence | -5.263** | -4.850** | -5.152** |
| | (2.063) | (2.132) | (2.160) |
| Female | -1.820 | -1.344 | -1.390 |
| | (1.361) | (1.354) | (1.353) |
| Age 0_6 | -48.177*** | -48.337*** | -48.211*** |
| | (1.786) | (1.813) | (1.821) |
| Age 6_12 | -9.380*** | -8.977*** | -8.990*** |
| | (1.702) | (1.702) | (1.702) |
| Household Income | | | -0.012 |
| | | | (0.0131) |
| Heilongjiang | | 0.864 | 0.716 |
| | | (3.008) | (3.020) |
| Liaoning | | -0.272 | -0.042 |
| | | (3.210) | (3.205) |
| Shanghai | | -3.100 | -2.768 |
| | | (3.812) | (3.858) |
| Jiangsu | | 2.040 | 2.282 |
| | | (3.415) | (3.407) |
| Shandong | | -4.148 | -4.162 |
| | | (3.623) | (3.628) |
| Henan | | -7.057** | -7.385** |
| | | (3.282) | (3.304) |
| Hubei | | -8.096** | -8.224** |
| | | (4.018) | (4.029) |
| Hunan | | -12.545*** | -12.508*** |
| | | (3.323) | (3.329) |
| Guangxi | | -7.591*** | -7.669*** |
| | | (2.703) | (2.710) |
| Guizhou | | -7.342** | -7.369** |
| | | (3.179) | (3.183) |
| Chongqing | | -9.930*** | -10.076*** |
| | | (3.364) | (3.373) |
| R-squared | 0.4589 | 0.4781 | 0.4785 |
| Observations | 1,109 | 1,109 | 1,109 |

*Notes:* Standard deviations are in brackets, calculated using robust standard errors. Height is measured in centimetres. Children aged from 12 to 18 and Beijing are omitted from the regression. Household income is the total household income inflated to 2011 currency and is measured in thousands of yuan. Data source: China Health and Nutrition Survey (CHNS) Wave 2011.

*Significant at 10%.

** Significant at 5%.

*** Significant at 1%.

Table 3. Father Absence and Child's Height: Effects by Gender and Age Groups

| Explanatory Variables | (1) | (2) |
|---|---|---|
| Father Absence | -7.963*** | -12.796** |
| | (3.001) | (5.621) |
| Female | -4.277 | -3.823 |
| | (3.086) | (3.089) |
| Age 0_6 | -48.475*** | -50.065*** |
| | (2.447) | (2.469) |
| Age 6_12 | -11.457*** | -13.178*** |
| | (2.382) | (2.411) |
| Father Absence×Female | 6.228 | |
| | (4.006) | |
| Age 0_6×Female | 0.531 | |
| | (3.550) | |
| Age 6_12×Female | 4.524 | |
| | (3.377) | |
| Father Absence×Age 0_6 | | 9.905* |
| | | (5.984) |
| Female×Age 0_6 | | 1.286 |
| | | (3.509) |
| Father Absence×Age 6_12 | | 12.657** |
| | | (5.908) |
| Female×Age 6_12 | | 4.959 |
| | | (3.363) |
| R-squared | 0.4611 | 0.4635 |
| Observations | 1,109 | 1,109 |

*Notes:* Standard deviations are in brackets, calculated using robust standard errors. Height is measured in centimetres. Data source: China Health and Nutrition Survey (CHNS) Wave 2011.

*Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

Table 4. Father Absence and Child's Weight

| Explanatory Variables | (1) | (2) | (3) |
|---|---|---|---|
| Father Absence | -2.503** | -2.225* | -2.619** |
| | (1.126) | (1.225) | (1.211) |
| Female | -1.639** | -1.403* | -1.462* |
| | (0.807) | (0.789) | (0.789) |
| Age 0_6 | -25.699*** | -26.227*** | -26.063*** |
| | (1.006) | (1.018) | (1.017) |
| Age 6_12 | -11.275*** | -11.272*** | -11.285*** |
| | (1.073) | (1.047) | (1.046) |
| Household Income | | | -0.0157* |
| | | | (0.00832) |
| Heilongjiang | | -1.619 | -1.812 |
| | | (2.307) | (2.308) |
| Liaoning | | -0.346 | -0.046 |
| | | (2.419) | (2.407) |
| Shanghai | | -2.540 | -2.107 |
| | | (2.366) | (2.384) |
| Jiangsu | | -1.590 | -1.273 |
| | | (2.345) | (2.335) |
| Shandong | | -2.224 | -2.242 |
| | | (2.432) | (2.425) |
| Henan | | -5.908*** | -6.335*** |
| | | (2.195) | (2.189) |
| Hubei | | -8.093*** | -8.260*** |
| | | (2.416) | (2.424) |
| Hunan | | -8.014*** | -7.966*** |
| | | (2.176) | (2.176) |
| Guangxi | | -9.401*** | -9.502*** |
| | | (1.897) | (1.891) |
| Guizhou | | -8.778*** | -8.814*** |
| | | (2.107) | (2.098) |
| Chongqing | | -8.460*** | -8.651*** |
| | | (2.101) | (2.101) |
| R-squared | 0.3860 | 0.4265 | 0.4285 |
| Observations | 1,109 | 1,109 | 1,109 |

*Notes:* Standard deviations are in brackets, calculated using robust standard errors. Weight is measured in kilograms. Children aged from 12 to 18 and Beijing are omitted from the regression. Household income is the total household income inflated to 2011currency and is measured in thousands of yuan. Data source: China Health and Nutrition Survey (CHNS) Wave 2011.

*Significant at 10%.

** Significant at 5%.

*** Significant at 1%.

Table 5. Father Absence and Child's Weight: Effects by Gender and Age Groups

| Explanatory Variables | (1) | (2) |
|---|---|---|
| Father Absence | -4.563*** | -6.842** |
| | (1.724) | (3.206) |
| Female | -3.509* | -3.126* |
| | (1.836) | (1.835) |
| Age 0_6 | -26.590*** | -27.644*** |
| | (1.415) | (1.457) |
| Age 6_12 | -12.160*** | -13.026*** |
| | (1.564) | (1.604) |
| Father Absence×Female | 4.674** | |
| | (2.375) | |
| Age 0_6×Female | 1.896 | |
| | (1.980) | |
| Age 6_12×Female | 1.953 | |
| | (2.111) | |
| Father Absence×Age 0_6 | | 6.275* |
| | | (3.374) |
| Female×Age 0_6 | | 2.415 |
| | | (1.970) |
| Father Absence×Age 6_12 | | 6.359* |
| | | (3.615) |
| Female×Age 6_12 | | 2.215 |
| | | (2.110) |
| R-squared | 0.3891 | 0.3905 |
| Observations | 1,109 | 1,109 |

*Notes:* Standard deviations are in brackets, calculated using robust standard errors. Height is measured in centimetres. Data source: China Health and Nutrition Survey (CHNS) Wave 2011.

*Significant at 10%.

** Significant at 5%.

*** Significant at 1%.

Table 6. Fixed Effects Regression Results: Child's Height

| Explanatory Variables | (1) | (2) |
|---|---|---|
| Father absence | 0.991** | 0.980** |
| | (0.434) | (0.437) |
| Age 0_6 | -1.156*** | -1.157*** |
| | (0.367) | (0.194) |
| Age 6_12 | 1.747*** | 1.745*** |
| | (0.194) | (0.004) |
| Household Income | | -0.001 |
| | | (0.004) |
| Wave | | |
| 1993 | 11.117*** | 11.118*** |
| | (0.140) | (0.141) |
| 1997 | 32.888*** | 32.894*** |
| | (0.265) | (0.266) |
| 2000 | 49.855*** | 49.864*** |
| | (0.341) | (0.344) |
| 2004 | 71.755*** | 71.769*** |
| | (0.502) | (0.504) |
| 2006 | 82.707*** | 82.726*** |
| | (0.587) | (0.592) |
| 2009 | 101.010*** | 101.046*** |
| | (0.723) | (0.731) |
| 2011 | 113.113*** | 113.158*** |
| | (0.846) | (0.864) |
| R-squared | 0.9402 | 0.9402 |
| Observations | 13,440 | 13,440 |

*Notes:* Standard deviations are in brackets, calculated using standard errors clustered by household. Gender and region are omitted from the regression. Wave 1989 is the reference year. Data source: China Health and Nutrition Survey (CHNS).

*Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

Table 7. Fixed Effects Regression Results: Child's Weight

| Explanatory Variables | (1) | (2) |
|---|---|---|
| Father absence | -0.332 | -0.367 |
| | (0.371) | (0.366) |
| Age 0_6 | 1.498*** | 1.494*** |
| | (0.179) | (0.179) |
| Age 6_12 | -3.177*** | -3.18*** |
| | (0.118) | (0.118) |
| Household Income | | -0.004 |
| | | (0.004) |
| Wave | | |
| 1993 | 6.102*** | 6.105*** |
| | (0.094) | (0.094) |
| 1997 | 17.942*** | 17.960*** |
| | (0.170) | (0.171) |
| 2000 | 26.930*** | 26.960*** |
| | (0.220) | (0.223) |
| 2004 | 39.584*** | 39.630*** |
| | (0.310) | (0.315) |
| 2006 | 45.440*** | 45.500*** |
| | (0.361) | (0.369) |
| 2009 | 54.707*** | 54.820*** |
| | (0.436) | (0.460) |
| 2011 | 62.049*** | 62.190*** |
| | (0.535) | (0.578) |
| R-squared | 0.8877 | 0.8878 |
| Observations | 13,440 | 13,440 |

*Notes:* Standard deviations are in brackets, calculated using standard errors clustered by household. Gender and region are omitted from the regression. Wave 1989 is the reference year. Data source: China Health and Nutrition Survey (CHNS).

*Significant at 10%.

** Significant at 5%.

*** Significant at 1%.