Parental Migration and Children's Dietary Diversity: Evidence from Rural China

by Yanying Yu, Kevin Chen, Chengfang Liu, and Shaoping Li

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Abstract: There is a growing literature documenting the link between parental migration and children's health. However, few studies have explain the underlying mechanism of this observed relationship. This paper examines the effect of parental migration on children's health through dietary diversity, using survey data collected in a poor region of rural China in 2018. To account for the potential endogeneity issue, we instrument parental migration with the proportion of households with migrated labor force at the township level, and find that parental migration increases children's dietary diversity. In particular, our results show that parental migration increases the likelihood of children consuming vitamin A-rich fruits and vegetables, eggs, milk products, legumes, nuts and seeds. These findings lend further support to the previous findings that parental migration has a positive effect on children's health through better nutrition.

Keywords: Parental migration; Left-behind children; Dietary diversity; Rural China

JEL codes: J12; J13; O15

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1. Introduction

A parallel phenomenon of rapid economic growth in China is the growing number of children who were left in rural villages. Since the reform and opening-up in 1978, China has witnessed a large-scale rural-urban labor migration flow. By 2019, the number of rural migrant workers has reached about 291 million and is still expected to grow in the future years (National Bureau of Statistics, 2020). However, due to the household registration system (hukou) in China, rural migrants have limited access to public services including children's education and other social security programs (Song, 2014). Rural parents often choose to leave their children in their source villages when they move to cities for jobs. As a result, nearly 61 million rural children are left behind with only one parent or a non-parent caregiver (grandparents most of the time) around (All-China Women's Federation, 2013).

Although a large and growing body of literature has examined the effects of parental migration on children's health, the results are mixed. Some authors argued that parental migration hurt children's health because of parental absenteeism (Gao et al, 2010; de Brauw and Mu, 2011; Lei et al., 2017; Meng and Yamauchi, 2017). Meanwhile, due to the remittance from migrated parents, other studies find parental migration played a positive role in children's physical fitness (Azzarri and Zezza, 2011; Carletto et al., 2011; de Brauw, 2011; Mu and de Brauw, 2015). Moreover, there is also a strand of the literature finding no or little effect of parental migration on children's health outcomes (Xu and Xie, 2015; Zhou et al., 2015; Guo et al., 2017).

A natural question arises as to why the effect is mixed. There might be many explanations (Chang et al., 2019). One possible explanation is that the existing studies lack investigation of the underlying mechanisms behind parental migration and children's health outcomes, which is the key to a better understanding about the nature of these linkages (Antman, 2011). As some scholars have noted, dietary diversity is one of these underlying mechanisms open for debate, given that positive associations of dietary diversity and children's health status are well documented (Arimond and Ruel, 2004).

However, to date little has been known about what the impact of parental migration on the dietary diversity of left-behind children, if any. Although some studies have examined the effects of migration on the dietary diversity of left-behind family members on a whole (eg. Nguyen and Winters, 2011; Min et al., 2019), they were not able to provide any evidence on the impact of migration on individual family members due to lack of individual diet records,

not to mention left-behind children. As far as we know, fewer studies have shed light on the dietary diversity of left-behind children (eg. Gibson et al., 2010; Nguyen, 2016; Zhang et al., 2016). Moreover, most existing studies mainly focus on a country as a whole or the urban or township areas only, little attention has been paid to any remote and poor rural areas with a high concentration of ethnic minorities. Another limitation of these studies is the lack of investigation on the effects of parental migration on early childhood development, which is a critical period of children's life course (Zhang et al., 2015).

To better understand the effects of parental migration on children's dietary diversity, we conduct a field survey covering 1,334 preschoolers in the south-central part of China to get first-hand information on parental migration and individual children's diets. To address the concern of endogeneity due to the fact that unobserved factors can simultaneously influence parents' out-migration decisions and children's dietary diversity and thus produce biased estimates, we instrument parental migration with the proportion of households with migrated labor force at the township level. We find that parental migration has a significantly positive effect on children's dietary diversity. Furthermore, parental migration is found to increase the likelihood of children consuming vitamin A-rich fruits and vegetables, eggs, milk products, legumes, nuts and seeds. These findings lend further support to the previous findings that parental migration has a positive effect on left-behind children's health.

The contribution of this paper to the literature is fourfold. Firstly, the paper provides direct evidence about the effects of parental migration on the dietary diversity of left-behind children by using a firsthand survey on children's diet records. It addresses a typical shortcoming of the earlier studies that did not have information on food consumption by each family member and therefore unable to examine children's dietary diversity. Secondly, the paper focuses on left-behind children's dietary diversity in remote, poor and ethnic rural areas, where limited empirical studies were conducted. The previous studies typically focus on children's food consumption and nutrient intake in a whole country or the urban or township regions. Thirdly, the paper examines the effects of parental migration on preschoolers' dietary diversity. Preschool years are a critical period of human capital accumulation but little consideration is given to the effects of parental migration happening during that time. Finally, the paper adds further evidence to the previous inconclusive literature that studies the relationship between parental migration and children's health outcomes. It provides insights into how parental migration changes children's dietary diversity, which is an important underlying channel behind parental migration and children's

health outcomes and bears important policy implications (Min et al., 2019).

The remainder of the paper is structured as follows. Section 2 reviews relevant literature and develops a conceptual framework to examine the impact channels of parental migration on children's dietary diversity. Section 3 describes the sampling framework and the data. Section 4 specifies the empirical model and discusses the identification strategy. Section 5 displays empirical results. We conclude in Section 6.

2. Conceptual framework: parental migration and children's dietary diversity

Parental migration and the family separation it leads to are considered as necessary sacrifices for improving the next generation's growth in the developing countries (Antman, 2011). The consequence of parental migration on children's dietary diversity and therefore health is hard to predict due to the multiple yet conflicting effects of migration. The literature has proposed four possible channels on how parental migration could affect children's dietary diversity.

To begin with, income effects from parental migration can positively change children's dietary diversity. Labor migration creates income growth linkages (Taylor, 1999). Remittance of these increasing earnings may ease the family's budget constraint (Yang, 2011; Zhang et al., 2014) and increase food expenditures (Yu et al., 2018). In addition, a better condition of assets accumulated through migration links to diversified meals. For example, owning a refrigerator or vehicle was found positively related to the dietary diversity of the family members (Liu et al., 2014).

Parental migration can also play a positive role in children's dietary diversity beyond solely income effects. Parents who migrate to cities are more likely to expose to multiple information and practices, resulting in the change of their parenting practices. For example, they may know more tips about how to promote children's nutrition and put them into action (Lee & Park, 2010). And these migrated parents probably also impart nutrition knowledge to other family members including the surrogate primary caregiver, which would contribute to better diets for children (Karamba et al., 2011).

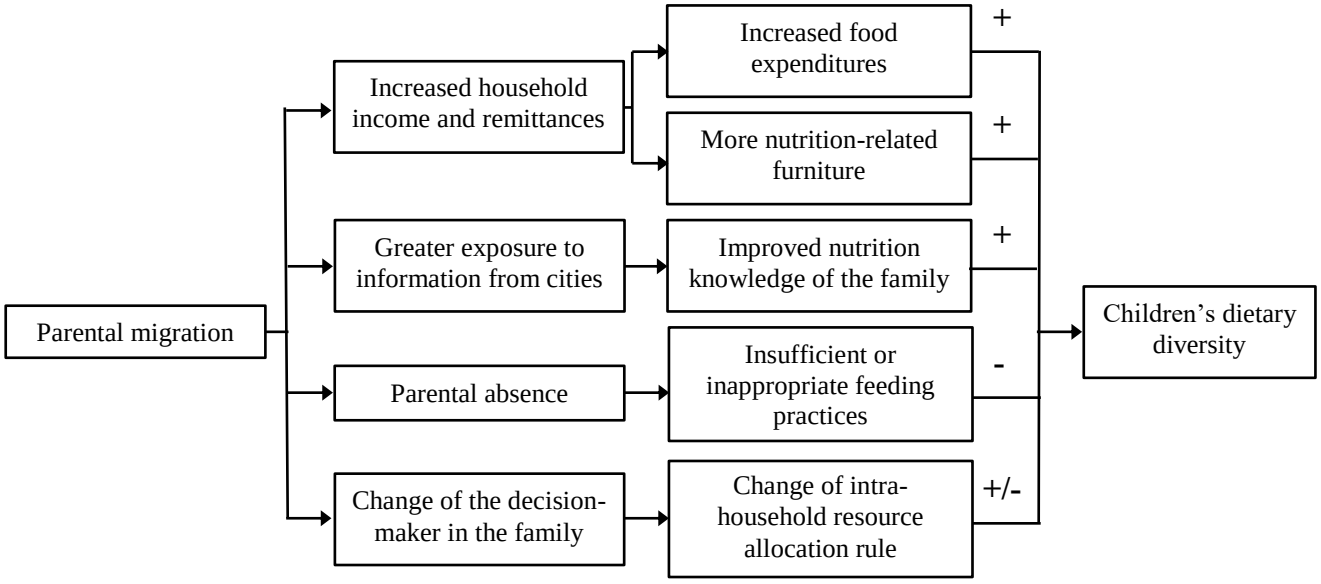
On the other side, parental absence may lead to inadequate nutrition supervision for these young children if there is no perfect substitution for parental care. It may be even worse when grandparents, who have experienced the Great Famine in China, take over as the primary caregiver of the child. They tend to attach too much importance to starchy foods and overlook protein-source foods when feeding their grandsons and granddaughters (Zhang et

al., 2015). Therefore, the dietary diversity of left-behind children could be adversely affected.

The fourth channel of how parental migration affects children's health is the change of household decision-maker, though it can be either good or bad for children's dietary diversity. If one parent migrates, the other one will either increase or reduce the nutritional investment in children if they have different preferences and perceptions about parenting. For example, Antman (2011) provides evidence suggesting that while the father migrates to the U.S., the resident decision-maker tends to shift resources toward girls, resulting in a greater fraction of investment spent on girls relative to boys. Moreover, if grandparents who generally lack education and tend to spoil the grandkids gain the decision-making authority, the children's food consumption is highly possible to alter (Liu et al., 2019).

The above four impact channels between parental migration and children's dietary diversity are summarized in Figure 1. The net effect of parental migration depends on the relative magnitudes of these conflicting impacts.

Figure 1. Impact Channels between Parental Migration and Children's Dietary Diversity



3. Data and variables

Data

We use the data from the primary survey of a preschool nutrition pilot program conducted in the Xiangxi Autonomous Prefecture, locating in the south-central region of China. With support from the World Food Program (WFP), the survey took place in September 2018 in two nationally designated poverty counties where rural per capita disposable income in 2017 is close to the national level in 2012 (Chen et al., 2019). The survey covered 26 kindergartens from 15 villages, of which 10 preschools were in Longshan County while 16 were in the other Yongshun County. We surveyed the caregivers of all the children attending any one of these preschools at the survey time and obtained 1,334 questionnaires with completed answers. In addition, the team interviewed 28 preschool principals, 142 teachers, 26 kitchen managers. We collected rich individual-, household- and preschool-level information.

The measurement of dietary diversity

Dietary diversity (DD) is widely used by many as a proxy of dietary quality (Stein, 2018; Steyn et al., 2006; Torheim et al., 2004; Ruel, 2003a; Hatloy et al., 1998). It is fairly straightforward, simply counting the number of foods or food groups consumed over a certain period (FAO, 2010; Hoddinott and Yohannes, 2002; Ruel, 2003b). The more food groups consumed implies higher dietary quality.

To measure children's dietary diversity, we calculate children's Dietary Diversity Score (DDS) by counting the number of food groups that they have consumed in the previous 24 hours. Foods are divided into nine food groups following the Guidelines for measuring household and individual dietary diversity developed by the Food and Agriculture Organization of the United Nations[1]. To make the score more valid to reflect the real diet patterns, we make some additional considerations during the data collection. Firstly, we choose a 24-h recall method to minimize memory biases as they tend to be larger if a longer reference period is used. Secondly, the survey starts and also ends within September to avoid atypical cases since it is not a booming time for festivals. Thirdly, we are capable to fully capture a preschooler's whole-day diet patterns by integrating diet records from the preschool

[1] Nine food groups are starchy staples; dark green leafy vegetables; vitamin A rich fruits and vegetables; other fruits and vegetables; organ meat; meat and fish; eggs; legumes, nuts and seeds; and milk and milk products.

with those from home since we investigate not only the primary caregiver but also the kitchen manager of the preschool. They both answered questions like “Did the child eat staple foods such as rice soup, porridge, noodles, steamed bun, or rice” according to their recalls on the children’s diet at home or school.

We also construct two alternative DDS to reflect children’s dietary diversity. One is DDS based on three 24-H diet records and the other is DDS weighted by the frequency of intake. The former is to expand the reference period from one day to three days, including yesterday, last Friday and last Sunday. The latter measure is also based on three 24-H diet records and additionally considers the frequency for the child to eat this kind of food. The frequency means the number of days that the child has eaten this kind of food during these three days. After adding up the frequency of each food group, we then build up the new weighted DDS index.

Parental migration status

Another key variable of interest is the status of parental migration. Following the definition specified by China's National Bureau of Statistics, we build up a parental migration status only if the parent went out to seek employment for at least 6 months over the last year based on data from the household roster. The six-month cutoff makes it possible to exclude two exceptional cases. One is short-time migration, which may contaminate the results since it is different from long-run migration situations we are concerned about. The other one is recent or contemporary return, which may cause underreport of parental migration and therefore lead to inaccurate estimates of the effects of parental migration on children’s dietary diversity.

In most cases of this study, we define parental migration if at least one parent migrates. That is, the dummy indicator for parental migration status equals one as long as at least one parent migrates. As it is shown in Table 1, children with at least one parent migrating to the cities in our sample accounts for 70%, supporting that parental migration is a prevailing phenomenon. However, it may be a concern that the effects of parental migration are different between children with one migrated parent and children with two migrated parents. Consequently, we also use an alternative definition that the dummy indicator for parental migration status equals to one only if parents are both migrated. Using the latter definition, the proportion of left-behind children reduces to 46%.

Table 1 Descriptive Statistics of Key Variables, 2018

Variables	Description	Mean	SD	Min	Max
Outcome variable					
DDS[1]	Dietary diversity score of the child; [0, 9]	5.77	1.22	1	9
DDS based on Three 24-H Records	Dietary diversity score based on three 24-H diet records; [0, 9]	6.93	0.99	3	9
DDS Weighted by Frequency of Intake	Dietary diversity score weighted by the frequency of intake; [0, 27]	16.01	3.10	7	27
Key explanatory variable					
Parental migration 1	At least one parent migrated out for six months in the past year (1=yes, 0=no)	0.70	0.46	0	1
Parental migration 2	Both parent migrated out for six months in the past year (1=yes, 0=no)	0.46	0.50	0	1
Instrumental variable					
Proportion of migrant-sending households	Proportion of sample households within the township with at least one migrated household member	0.80	0.11	0.37	1
Child characteristics					
Age	(month)	54.84	11.76	22.70	80.37
Girl	(1=yes, 0=no)	0.48	0.50	0	1
Non-Han Minority	(1=yes, 0=no)	0.89	0.31	0	1
Picky Eater	(1=yes, 0=no)	0.46	0.50	0	1
Household characteristics					
Father has at least junior high school degree	(1=yes, 0=no)	0.55	0.50	0	1
Mother has at least junior high school degree	(1=yes, 0=no)	0.58	0.49	0	1
Special family	One or both of the parents are absent due to divorce, death or other reasons (1=yes, 0=no)	0.08	0.27	0	1
Siblings	Number of siblings of the child.	0.90	0.77	0	5
Preschool characteristics					
Public preschool	(1=yes, 0=no)	0.21	0.41	0	1
Enrollment	Number of children enrolled in the preschool	126.05	50.89	30	220
Student-teacher ratio	Enrollment divided by the number of teacher in the preschool	22.80	7.09	7.86	31.67
Kitchen manager's education	Kitchen manager has at least senior high school diploma (1=yes, 0=no)	0.21	0.40	0	1
Obs		1,334			

Source: The authors' own survey

Table 2 shows the results of descriptive statistics comparing children with at least one migrated parent to children with both parents around. The average dietary diversity score of children with at least one migrated parent is 5.75, slightly less than 5.82, the score of children with both parents around. However, the difference of the dietary diversity score between

[1] Each child consumed starchy food in the reference period so that DDS actually varies from 1 to 9 in this study.

these two groups is statistically insignificant. Table 2 also compares children with and without migrated parents on some individual-, household- and preschool-level variables and the results show that these two groups are different in many ways. Children with at least one migrated parent are elder than children with both parents around. They also seem to live in a less wealthy household considering the number of durable assets in the household and their parents are likely to be less educated. In addition, they generally tend to attend preschools with a smaller scale of enrollment and a lower student-teacher ratio. To control these observable differences between children with and without migrated parents, we include them in the following specifications as control variables.

Table 2 Comparison of groups with Migrated Parent and Non-Migrated Parent, 2018

	At least one parent migrated (1)	No parent migrated (2)	Difference= (1) - (2) [p-value] (3)
DDS	5.75 (1.18)	5.82 (1.29)	-0.07 [0.30]
Child characteristics			
Age	55.53 (11.72)	53.22 (11.71)	2.31 [0.00]
Girl	0.49 (0.50)	0.48 (0.50)	0.01 [0.86]
Non-Han minority	0.88 (0.32)	0.90 (0.30)	-0.02 [0.33]
Picky eater	0.45 (0.50)	0.48 (0.50)	-0.03 [0.32]
Household characteristics			
Father has at least junior high school degree	0.52 (0.50)	0.62 (0.49)	-0.09 [0.00]
Mother has at least junior high school degree	0.54 (0.50)	0.67 (0.47)	-0.13 [0.00]
Special family	0.08 (0.27)	0.08 (0.27)	0.00 [0.79]
Pieces of durable assets	5.37 (2.59)	7.00 (2.72)	-1.63 [0.00]
Siblings	0.89 (0.78)	0.92 (0.75)	-0.03 [0.46]
Preschool characteristics			
Public preschool	0.20 (0.40)	0.22 (0.42)	-0.02 [0.40]
Enrollment	123.03 (50.98)	133.16 (50.02)	-10.13 [0.00]
Student-teacher ratio	22.45 (7.09)	23.62 (7.04)	-1.17 [0.01]
Kitchen manager's education	0.20 (0.40)	0.22 (0.41)	-0.02 [0.53]
Obs	936	398	

Source: the authors' own survey

4. Empirical model

To estimate the effects of parental migration on children's dietary diversity, we model the following regression:

$$\mathrm{DDS}_i = \alpha_1 + \beta_1 PM_i + \delta_1 X_i + \varepsilon_i \quad (1)$$

where DDS_i is the dietary diversity score of the child i. PM_i is a binary variable that indicates parental migration status, equaling 1 if at least one of the parents migrate and 0 if not. X_i is a vector of child, household and preschool control variables. Child characteristics include age, gender, ethnicity and whether the child is a picky eater. Household

characteristics include whether father or mother has completed junior high school, the number of siblings, pieces of durable goods and whether mother or father is absent due to escape, divorce, or pass-away. And preschool characteristics are the information of the preschool the child i attend, including enrollment, student-teacher ratio, the education level of its kitchen manager and whether it is public. The reason to consider preschool characteristics into regression models is to control the variation of preschool meals. And ε_i is an error term.

The above can be estimated using a typical OLS regression method. However, the results could be biased due to the endogeneity of parental migration. Firstly, reverse causality occurs if parents consider children's dietary diversity when they make their out-migration decisions. Instinctively, earning more money to improve the diversity of household meals may be one of the motivations for parents to migrate. In this case, the results of OLS regressions cannot truly expose the effect of parental migration on children's dietary diversity. Secondly, due to unobservable factors that simultaneously influence the migration decision of parents and also the dietary diversity of children, the results of OLS are biased. For example, parents who care more about children's nutrition development are more likely to migrate to earn more money for the children and also devote more attention and effort to improve children's dietary diversity. In that case, roughly compare the dietary diversity scores of the children with migrated parents and that of children with both parents around may overestimate the positive effect of parental migration. Given another scenario that a family suffers from unobservable shocks, the children may be offered a poor diet while parents migrate to enhance the family's resistance against shocks, which leads to exaggerated negative effects of parental migration on children's dietary diversity by the OLS method.

To count for the above endogeneity issue, we seek for a variable that affects parental migration status but does not influence children's dietary diversity independently to serve as an instrumental variable. Following the previous literature (eg. Ning and Chang, 2013; Chang et al., 2011; Meyerhoefer and Chen, 2010), we instrument parental migration status using the social network of migrants from the same community, which proves to be highly associated with personal migration decisions. Theoretically speaking, if a group of people in the community have previously migrated out, the costs of others' migration are probably to be reduced by getting the information about transportations and jobs shared by these pioneers. And the proportion of these people can be considered as an indicator to measure the size of a community's social network, highly relating to the out-migration decisions of people living

within the community. For this reason, we calculate the proportion of migrant-sending households in the village excluding the household which child i belong to and use it as an instrumental variable of parental migration[1]. Our identifying assumption is that the proportion of migrant-sending households in the village influences parents' out-migration decisions, whereas it does not directly link to children's dietary diversity, given that a vector of child, household and preschool control variables have been taken into consideration. The equation used to calculate the proportion of migrant-sending households in the village which child i belongs to is as follows:

$$\mathrm{IV}_i = \begin{cases} \frac{\sum_{j=1}^{N_i} PM_j - 1}{N_i - 1} & if\ PM_i = 1 \\ \frac{\sum_{j=1}^{N_i} PM_j}{N_i - 1} & if\ PM_i = 0 \end{cases} \quad (2)$$

Where N_i indicates the total household number of the village to which child i belongs. We then apply the IV method in addition to the ordinary regression model. The first stage goes as follow:

$$PM_i = \alpha_2 + \gamma IV_i + \theta X_i + \varepsilon_{\mathrm{i}} \quad (3)$$

And the second stage:

$$\mathrm{DDS}_i = \alpha_3 + \beta_2 \widehat{PM}_{\iota} + \delta_2 X_i + \varepsilon_i \quad (4)$$

5. Estimation results

Table 3 presents OLS and IV estimates on parental migration and children's dietary diversity scores. We start with the OLS estimations of Equation (1), assuming parental migration as an exogenous independent variable. The estimation results, shown in panel A of Table 3, suggest an insignificantly negative correlation between parental migration and children's dietary diversity scores.

As discussed in Section 4, the OLS estimates presented are subject to the potential endogeneity of parental migration. To address this issue, we then re-estimate Equations (3) and (4) and presented the results in the next two panels of Table 3. The first-stage regressions in Panel C examine the strength of our instrument by excluding weak instrument problems. As the results showed, the instrumental variable exhibits a strong and positive association between the proportions of migrant-sending households in the township with parental

[1] A household will be regarded as a migrant-sending household as long as any adults of the household migrated for seeking a job.

migration. The F statistics of the specifications are all larger than the rule of thumb value of 10, indicating that the instrument is not weak (Staiger and Stock, 1997). In the second stage, contrary to the findings from OLS estimations, we find a significantly positive relationship between parental migration and children's dietary diversity scores. IV estimate in Column (1), Panel B shows that parental migration will increase 2.5 points of children's dietary diversity scores, and that in Column (2), Panel B suggests the coefficient will be even larger if the model is adjusted with control variables, equals nearly 5 points. Both coefficients are significant at the 1% level of significance.

One concern is that township characteristics affect children's dietary diversity and simultaneously influence parents' decisions of migration, which may lead to biased estimates of parental migration if overlooked. Township characteristics like public service, infrastructure and transportation are important factors for someone who lives in this township to decide whether to migrate or not. In addition, they directly affect the dietary diversity of the residents living in this community. For example, if the township lies in the deepest backwoods, the traffic and time costs for a person who lives here to migrate are sizable so that some of them unable to afford initial investment for settling in the destination will be unlikely to go out. Moreover, due to expensive transportation costs, people in this township will mainly consume local food rather than food coming from outsides, which may hinder children from consuming diversified meals, especially in the off-seasons.

We try to address this by controlling township characteristics in the regression model, including distance to the county government, the population, the paddy area, the dryland area and farmers' yearly income per capita of the town in which child i lives. The results adjusted by township characteristics are shown in Column (3), Table 3. The strong positive effects remain, showing parental migration will increase nearly 4 points of children's dietary diversity scores and the coefficient is significant at the 1% level in Column (3), Panel B. The magnitude is slightly smaller than the result shown in Column (2), Panel B. The slight decrease in the coefficient is reasonable. Given that better economic and transportation conditions of the village mean more opportunity to migrate and indicate more access to get diversified meals, the magnitude of the positive effect of parental migration becomes smaller after controlling township characteristics.

Table 3 OLS and IV Estimation Results on the Impact of Parental Migration on Children's Dietary Diversity Scores (DDS)

	DDS	DDS	DDS
	(1)	(2)	(3)
Panel A: OLS			
Parental migration	-0.076	-0.028	-0.024
	(0.087)	(0.082)	(0.081)
Constant	5.822***	5.800***	5.831***
	(0.097)	(0.458)	(0.472)
R-squared	0.001	0.039	0.087
Panel B: IV			
Parental migration	2.511***	4.880***	4.175***
	(0.587)	(1.061)	(1.102)
Constant	4.006***	0.298	1.255
	(0.405)	(1.490)	(1.543)
Panel C: First stage			
Proportion of migrant-sending households	0.792***	0.555***	0.552***
	(0.096)	(0.099)	(0.112)
First stage F statistic	68.25	31.53	24.47
Underidentification test	7.106***	5.763**	7.141***
Child characteristics	NO	YES	YES
Household characteristics	NO	YES	YES
Preschool characteristics	NO	YES	YES
Township characteristics	NO	NO	YES
Observations	1334	1334	1334

Note: *** p<0.01, ** p<0.05, * p<0.1; Robust standard errors clustered at the class level are in parentheses; Other than specifications of Panel C whose dependent variable is parental migration, the dependent variable of each specification is DDS.

We also concern that the effects may be different between the children who have one parent migrated and the children who have both parents migrated. Therefore, we next use an alternative definition to measure parental migration status. That is, the dummy indicator for parental migration status equals 1 only if both parents are migrated. The results are shown in Table 4. IV estimates, which are shown in Column (2) and Column (4) of Table 4, remain positive and significant, indicating that the earlier results are valid.

Table 4 IV Estimation Results for Both Parents Migrated

	IV			
	First Stage	Second Stage	First Stage	Second Stage
	(1)	(2)	(3)	(4)
Parental migration		3.837***		6.528***
		(1.020)		(2.097)
Proportion of migrant-sending households	0.519***		0.353***	
	(0.075)		(0.088)	
Child characteristics	NO	NO	YES	YES
Household characteristics	NO	NO	YES	YES
Preschool characteristics	NO	NO	YES	YES
Township characteristics	NO	NO	YES	YES
Constant	0.039	4.020***	0.239	1.638
	(0.058)	(0.452)	(0.145)	(1.587)
R-squared	0.012		0.173	
First stage F statistic		48.35		16.00
Underidentification test		6.794***		5.815**
Number of observations	1334	1334	1334	1334

Note: *** p<0.01, ** p<0.05, * p<0.1; Robust standard errors clustered at the class level are in parentheses.

We then use two alternative DDS measures to address the possible concern that the DDS used above is not sound enough to reflect children's dietary diversity. The results for these two DDS measures are shown in Table 5. Column (2) shows that the positive effect of parental migration becomes smaller, only adding nearly 1 point to children's dietary diversity scores but the impact is still statistically significant. The large decrease of the coefficient compared to that in Table 3 may attribute to the memory bias which is more likely to occur when the reference period extends. In addition, column (4) shows a sound and positive effect of parental migration on children's dietary diversity after considering the frequency of intake (the coefficient equals 4.7), which means parental migration does largely improve children's dietary diversity scores and the effects are not accidental and unstable.

Table 5 IV Estimation Results for the Two Alternative DDS

	DDS based on Three 24-H Records		DDS Weighted by the Frequency	
	IV	IV	IV	IV
	(1)	(2)	(3)	(4)
Parental migration	1.130***	1.153*	3.100***	4.681**
	(0.409)	(0.655)	(1.142)	(2.191)
Control characteristics	NO	YES	NO	YES
First stage F statistic	68.25	24.47	68.25	24.47
Underidentification test	7.106***	7.141***	7.106***	7.141***
Number of observations	1334	1334	1334	1334

Note: *** p<0.01, ** p<0.05, * p<0.1; Robust standard errors clustered at the class level are in parentheses; Control variables include individual-, household-, preschool- and township-level characteristics.

We examine the effects of parental migration on children's consumption of each food group to see how children's dietary patterns change when parent migrates. To achieve this objective, we replace the dependent variable with each food group except starchy staples in Equation. (4). As is shown in Table 6, the results suggest that parental migration will increase the probability for left-behind children to consume some kinds of nutritious food. Parental migration may raise the possibility for the child to consume vitamin A-rich fruits and vegetables. In addition, these children are more likely to consume eggs as well as milk and milk products. Foods that belong to these groups, either plant-based or animal-based, are all key sources of vitamin A (FAO, 2010). Moreover, parental migration also led the left-behind children to likely consume more legumes, nuts and seeds.

Table 6 IV Results for Different Food Groups

	Dark green leafy vegetables	vitamin A rich fruits and vegetables	Other fruits and vegetables	Organ meat	Meat and fish	Eggs	Legumes, nuts and seeds	Milk and milk products
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Parental migration	0.080	1.368***	0.030	0.125	0.005	0.971**	0.598*	0.886***
	(0.396)	(0.443)	(0.192)	(0.093)	(0.027)	(0.493)	(0.337)	(0.304)
Control variable	YES	YES	YES	YES	YES	YES	YES	YES
First stage F statistic	24.47	24.47	24.47	24.47	24.47	24.47	24.47	24.47
Underidentification test	7.141***	7.141***	7.141***	7.141***	7.141***	7.141***	7.141***	7.141***
Observations	1334	1334	1334	1334	1334	1334	1334	1334

Note: *** p<0.01, ** p<0.05, * p<0.1; Robust standard errors clustered at the class level are in parentheses; Control variables include individual-, household-, preschool- and township-level characteristics

6. Concluding remarks

Parental migration is expected to exert both positive and negative effects on the dietary diversity of children who are left behind. The net effects of parental migration on children's dietary diversity is largely an empirical one. In this paper, we explore the net effects of parental migration on children's dietary diversity, based on a cross-sectional dataset collected in two nationally designated poverty counties in Xiangxi, province of Hunan, China. Since the migration decisions of parents may depend on unobservable household characteristics that also affect children's dietary diversity, we instrument parental migration with the proportion of households with migrated labor force at the township level. We find a significantly positive effect of parental migration on children's dietary diversity. Particularly, we find parental migration will increase the possibility for children to consume nutritious foods such as vitamin A-rich fruits and vegetables, eggs, milk products, legumes, nuts and seeds. Our study helps to better understand the positive effects of parental migration on children's health outcomes found in previous studies.

As dietary diversity is critical to children's nutrition, our findings that establish a positive relationship between parental migration and children's dietary diversity have important policy implications. It highlights the policy relevance to look at the role of labor migration in reducing childhood malnutrition. In many developing countries suffering high rates of childhood malnutrition, supportive policies for labor migration may make a difference in improving the nutrition of most vulnerable children. Furthermore, since childhood malnutrition brings many drastic adverse effects on human capital accumulation, these policies also have profound implications for poverty reduction and social development of the country. In particular, the outbreak of COVID-19 has hit hard on labor migration and remittance flows. Actions should be taken immediately to monitor and alleviate the adverse impact of a decline of labor migration and remittances on children's dietary diversity and nutrition in developing countries.

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