The Effect of Parental Migration on Early Childhood Nutrition of Left-Behind Children in Rural China

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Abstract

Background: More than one-third of children under 3 years old are left behind at home due to parental migration in rural China, and we know very little about early childhood nutrition of left-behind children (LBC) because of the dearth of research. This study examined the impact of parental migration on early childhood nutrition of LBC in rural China. Methods: We used repeat cross-sectional data of rural children aged 6–35 months in six counties of northern and southern China, who participated in two surveys in 2013 and 2016 respectively. The length, weight, and hemoglobin concentration were measured by trained health-care workers blinded to parental migration status. Generalized linear regressions and multivariate logistic regressions were employed to explore the association between parental migration and child nutritional outcomes at each time point. Results: 2,336 and 2,210 children aged 6–35 months were enrolled in 2013 and 2016 surveys, respectively. The risk of stunting, underweight, and wasting among the children decreased from 2013 to 2016. Children of migrant fathers performed as well as or better than children of non-migrants on these indicators. Children of migrant parents performed slightly worse in 2013, but equal or slightly better in 2016 on these indicators compared with children of non-migrants and migrant fathers. Children aged 6–17 months of migrant parents had a significantly lower risk of anemia than those living with their mothers or with both parents. Conclusions: Parental migration is not detrimental and even beneficial to early childhood nutrition of LBC in rural China. Programs for LBC are recommended to continue to focus on nutrition but pay more attention to other important health issues.

Background

Migration affects the families of about 1 billion migrants globally [1]. In China, since the reform and opening-up in the 1980s, a large number of rural residents have migrated from their homes to cities in search of better employment opportunities. However, because of the unstable income, unfriendly settlement policies, and limited access to public services (such as education and health care), most labor migrants leave their children at their homes in the countryside with another parent or other family members. In 2015, 40.51 million rural children were left behind due to parental migration, accounting for 29.4% of all rural children and 15% of all children in China [2].

Nutritional status of left-behind children, as one of their most important health outcomes, has drawn a lot of attention of researchers and policy-makers. The studies in this field conducted over the last three decades have yielded conflicting results. Most studies found that left-behind children were more likely to be stunted, underweight, or wasted compared with other children [3-11], but others found that left-behind children performed similarly to, or even better than, non-left-behind children on these anthropometric indicators [12-15]. In addition, some studies identified a higher risk of anemia among left-behind than non-left-behind children [16, 17], but another work found no such difference [14]. A recent systematic review and meta-analysis of these studies done from 1994 to September 2018, 82% of which were conducted in China, found that, compared with non-left-behind children, left-behind children had a significantly increased risk of wasting and stunting, but a similar risk of underweight and anemia [18].

Updating the data is necessary in consideration of the confusing findings and the possible shift in the impact of parental migration on child nutrition with social and economic development. In addition, despite the growing number of studies in this field, some notable gaps in our knowledge remain. Firstly, most studies on nutrition of left-behind children focused on school-age children; few included infants and young children. The findings from school-age children cannot be simply generalized to younger children because of the considerable differences in growth trajectories and living environment. Studies have provided strong evidence that undernutrition in the first 3 years of life has a long-term negative effect on an individual's health and development in subsequent childhood and adulthood, and intervention is problematic once this window has passed [19-21]. Therefore, further research is needed to take a clear picture of early childhood nutrition of left-behind children to allow policy makers and health-care providers to optimize policy orientation and resource allocation, particularly in rural China, where 38.1% of children under 3 years old experience separation from one or both parents due to parental migration [2]. Secondly, most previous studies did not determine the impacts of different parental migration status on child nutrition. The limited evidence available suggests that maternal or both-parental migration may be more detrimental to child nutrition than paternal migration [16, 22].

In this study, we examined the impact of parental migration status on the nutrition of children aged 6–35 months in rural China using repeated cross-sectional data. This study will enhance our understanding of the nutritional status of left-behind children and the need for special interventions in early childhood and, by providing evidence for identifying health-related policy priorities, will enable the development of cost-effective interventions to improve the well-being of vulnerable populations.

Methods

Design and participants

We used repeated cross-sectional data comprising two surveys conducted in in six counties of northern and southern China in 2013 and 2016, respectively. The first survey was conducted prior to an early childhood development program in six countries of two provinces from July to September 2013: Songtao, Liping, and Pan Counties in Guizhou Province, and Fenxi, Lin, and Fangshan Counties in Shanxi Province [23]. In each county, a clustered random sampling method was used to select villages that met the following criteria: reachable by car from the county capital, ≥ 50 resident children under 3 years of age, and a sufficient number of caregivers willing to participate in the survey. Finally, totals of 83 control villages were included in the study. All children under 3 years old and their caregivers in these villages were eligible for participation in the survey. The second survey was conducted in the same villages from July to September 2016 by the same method, and the participants were another group of children under 3 years old at this survey time who were not included in the first survey.

Children aged 6–35 months at the time of the surveys with non-migrant parents (NLBC), migrant fathers (FLBC), or both migrant parents (PLBC) were included in this study. Children under 6 months old and those with only migrant mothers were not included because of the small number of such children. Twins, single-parent children, and children with serious diseases or disabilities were excluded from this analysis.

Measure

Face-to-face interviews with caregivers were conducted by uniformly trained local health workers. Data were immediately input, saved, and transmitted to statisticians by means of an electronic questionnaire application, which had a basic logic and integrity-checking function to enable investigators to correct errors and supplement omissions in time.

Basic characteristics

The following sociodemographic characteristics of the children and their caregivers were collected: (a) child gender, age, preterm, and ethnicity; and (b) caregiver's relationship to the child, gender, age, and educational attainment. Depression among caregivers was measured using Zung's self-rating depression scale (ZSDS), which is validated and used worldwide and consists of 20 items representing depressive features with a total score ranging from 20 to 80 [24]. ZSDS was administered by trained interviewers, and a ZSDS score of < 50 was defined as depression. Household economic status was measured by the number of the following household electrical appliances and vehicles owned: telephone, washing machine, refrigerator, and TV in 2013; and telephone, washing machine, refrigerator, TV, motorcycle, tricycle, and car in 2016. Low household economic status was defined as owning fewer than three and four of these items in 2013 and 2016, respectively.

Some children in Songtao, Liping, Fenxi, and Lin counties received the interventions of the early childhood development program from 2014. Therefore, two variables related to the interventions were measured and controlled for as confounding factors in the analysis of the 2016 survey data. The first virable is the frequency of consumption of Yingyangbao supplements (a package of soybean-based complementary food supplements), which was classified as (1) never supplemented, (2) ever supplemented but none in the past week, (3) 0–6 packages in the past week, and (4) ≥ 7 packages in the past week. The second is the frequency of nutritional consultations with health-care workers in the past 6 months, which was classified as: never, less than once per month, and one or more per month.

Child breastfeeding and dietary intakes

As recommended in the Indicators for Assessing Infant and Young Child Feeding Practices by the World Health Organization (WHO) [25], a 24-hour reported food recall was performed to assess breastfeeding and the dietary intake of the following seven food groups: (a) grains, roots and tubers, (b) legumes and nuts, (c) dairy products, (d) flesh foods (meat or fish), (e) eggs, (f) vitamin-A rich fruits and vegetables, and (g) other fruits and vegetables. The following indicators were calculated: (1) breastfeeding indicators: children ever breastfed and duration of breastfeeding (only children weaned from breastfeeding). (2) dietary indicators: meal frequency (frequency of dairy, solid, semi-solid, and soft food intake during the previous day) and dietary diversity (number of food groups children consumed during the previous day).

Nutritional outcomes

The length, weight, and peripheral blood hemoglobin (Hb) concentration of the children were measured using standard procedures by uniformly trained health-care workers who were blinded to the above interview information. Children were weighed twice in light clothes without shoes using an electronic weight scale with 0.01 kg accuracy. Their recumbent, barefooted, and bareheaded lengths were measured twice using a standard infant length scale with 0.1 cm accuracy. A third measurement was performed if the two measurements differed by 1.0 cm or more for length and 0.5 kg or more for weight. The Hb concentration of the children was measured using HemoCue201+ (HemoCue AB Inc.). The length-for-age Z score (LAZ), weight-for-age Z score (WAZ), and weight-for-length Z score (WLZ) were calculated according to the WHO Child Growth Standards [26]. Children with a LAZ of < -2 were considered to be stunted, those with a WAZ of < -2 were considered to be underweight, and children with a WLZ of < -2 were considered to suffer wasting. According to the WHO guidelines, Hb concentration was adjusted for altitude, and an altitude-adjusted Hb concentration of < 11 g/dL was used to define anemia [27].

Statistical analysis

To double validate any associations and take into account the effect of time, we analyzed the data of the two time points independently. Univariate analysis was first conducted to compare the basic characteristics and nutritional outcomes according to parental migration status by t-test and Mann-Whitney U test for continuous variables and chi-squared test for categorical variables.

Generalized linear regressions were performed to analyze the differences in the LAZ, WAZ, and WLZ scores according to parental migration status at each time point, after controlling for county, child gender, age, preterm and ethnicity in 2013, as well as additional two intervention variables in 2016. Household economic status and caregiver’s relationship to the child, gender, age, and educational attainment were not controlled for because they were severely collinear with parental migration status and were strongly considered as mediators of the effects of parental migration on child nutrition. For categorical nutritional outcomes (stunting, underweight, and wasting), multivariate logistic regressions were employed after controlling for the same covariates as above.

Similar multivariate analysis was performed on Hb concentration and anemia for children aged 6–17 and 18–35 months, respectively, based on the cut-off at the age of 18 months determined in a preliminary analysis: the differences in Hb concentration and anemia between children with different parental migration status varied before and after this age.

Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) software 20.0 (SPSS, Inc., Chicago, IL). A two-tailed p-value of < 0.05 was taken to reflect statistical significance.

Results

Study population

In total, 4,546 children aged 6–35 months (2,336 in 2013 and 2,210 in 2016) were included in this study. They consisted of 1,285 and 1,089 NLBC, 819 and 784 FLBC, and 232 and 337 PLBC in 2013 and 2016, respectively.

The characteristics of the children are presented in Table 1. In 2013 and 2016, NLBC and FLBC had similar median ages (19–20 months), but were 2–4 months younger than PLBC. The gender of the children and the frequency of premature birth did not differ significantly according to parental migration status.

The characteristics of the caregivers were similar in the two surveys. NLBC and FLBC were primarily cared for by their mothers. The maternal median age was 26–27 years and about 70% of mothers were educated to a middle school or higher level. More than 95% of PLBC were cared for by their grandparents (median age around 50 years), and less than one third of the caregivers were educated to a middle school or higher level (21.5% in 2013 and 31.1% in 2016). In 2013, The caregivers of PLBC had a significantly higher risk of depression than the caregivers of FLBC or NLBC (prevalence of 50.6%, 37.1%, and 40.0%, respectively). The risk of depression among the caregivers in 2016 was lower than that in 2013, and the prevalence of depression among the caregivers of NLBC, FLBC, and PLBC was 35.9%, 31.8%, and 38.0%, respectively (Table 1).

FLBC had a higher household economic status than NLBC and PLBC in 2013, but there was no significant difference in 2016. PLBC had a lower household economic status than NLBC and FLBC in both 2013 and 2016 (Table 1).

Breastfeeding and dietary intake

Child breastfeeding and dietary intake are presented in Figure 1. More than 85% of children were breastfed, and there was no significant difference according to parental migration status in 2013 and 2016. PLBC had a shorter duration of breastfeeding than FLBC and NLBC (10.82 *vs.* 11.89 and 12.26 months in 2013, and 9.98 *vs.* 12.28 and 11.31 months in 2016 respectively), and in 2016, FLBC had a longer duration of breastfeeding than NLBC. Dietary diversity of children increased from 2013 to 2016, irrespective of their parental migration status. In 2013, FLBC had slightly higher meal frequency and dietary diversity than NLBC, but in 2016, the differences were of lesser magnitude or absent. Compared with NLBC and FLBC, FLBC had higher meal frequency and dietary diversity at 6–17 months but slightly lower meal frequency and dietary diversity at 18–35 months.

Nutritional outcomes

Figure 2 shows the LAZ, WAZ, and WLZ scores of the children with different parental migration status and the results of univariate analysis. FLBC had significantly higher LAZ (-0.57 *vs.* -0.89, $p < 0.01$) and

WAZ (-0.19 *vs.* -0.46, $p < 0.01$) scores in 2013 and significantly higher WAZ scores (-0.19 *vs.* -0.31, $p < 0.05$) in 2016 compared with NLBC. PLBC had significantly lower LAZ scores than FLBC in both 2013 (-1.07 *vs.* -0.57, $p < 0.01$) and 2016 (-0.83 *vs.* -0.61, $p < 0.05$), but no significant difference in LAZ scores between PLBC and NLBC was found. In addition, PLBC had significantly lower WAZ (-0.77 *vs.* -0.46 and -0.19, $p < 0.01$) and WLZ (-0.24 *vs.* 0.10 and 0.19, $p < 0.01$) scores in 2013 but similar scores in 2016 compared with NLBC and FLBC.

The prevalence of stunting among NLBC, FLBC, and PLBC was 19.0%, 11.8%, and 18.6% in 2013, and 13.4%, 8.9%, and 15.4% in 2016, respectively; results of univariate analysis showed FLBC had significantly lower risks of stunting than NLBC and PLBC in both 2013 and 2016 ($p < 0.01$). The prevalence of underweight among NLBC, FLBC, and PLBC was 9.2%, 6.5%, and 12.1% in 2013, and 4.3%, 4.0%, and 3.0% in 2016, respectively; results of univariate analysis showed FLBC had significantly lower risks of underweight than NLBC ($p < 0.05$) and PLBC ($p < 0.01$) in 2013, but no significant differences were found among them in 2016. the prevalence of wasting among NLBC, FLBC, and PLBC was 3.3%, 3.3%, and 5.2% in 2013, and 1.6%, 1.8%, and 0.6% in 2016, respectively. No significant differences in risk of wasting were found among children with different parental migration status (Figure 2).

Table 2 shows the results of multivariate analysis on these anthropometric indicators. After controlling for the confounding factors, FLBC had significantly higher LAZ (adjusted mean difference: 0.13, 95%CI: 0.01, 0.26) and lower risk of stunting (OR 0.73, 95%CI: 0.56, 0.96) than NLBC in 2013, but no such significant differences were found in 2016. No other significant differences in these indicators were found by multivariate analysis between children with different parental migration status.

Figure 3 shows the Hb concentration and the prevalence of anemia of children aged 6–35 months. FLBC and NLBC had similar hemoglobin concentrations at 6–35 months in 2013 and 2016. While PLBC had 0.6–0.8 g/dL significantly higher Hb concentrations than FLBC and NLBC at 6–17 months.

The prevalence of anemia among NLBC, FLBC, and PLBC aged 6–17 months was 61.5%, 63.6%, and 43.1% in 2013, and 66.2%, 60.1%, and 42.5% in 2016, respectively. PLBC had a significantly lower risk of anemia than FLBC and NLBC ($p < 0.05$). The prevalence of anemia among NLBC, FLBC, and PLBC aged 18–35 months was 32.7%, 36.0%, and 32.2% in 2013, and 29.8%, 35.8%, and 32.9% in 2016, respectively, and there was no significant difference according to parental migration status (Figure 3).

Table 3 shows the results of multivariate analysis on the Hb concentration and the risk of anemia. The results further supported the association found in the univariate analyses: significantly higher Hb concentration and lower risk of anemia was found in PLBC at 6–17 months ($p < 0.05$) but not at 18–35 months when compared with FLBC and NLBC at the same age group; no significant difference in the Hb concentration and the risk of anemia was found between NLBC and FLBC.

Discussion

Early childhood nutrition is important, as it lays the foundation for health in later life. In the context of rapid development and large-scale rural-to-urban migration in China, we evaluated the early childhood nutrition of rural left-behind children using latest and reliable data. Our work not only extends the observations to children of younger age but also improves our understanding of the association between parental migration status and child nutrition in the current social context.

The estimated risk of stunting, underweight, and wasting among left-behind infants and toddlers in rural China in this study is consistent with previous reports [10, 15, 16]. A study using the data of 6,136 children aged 0–3 years in central and western China in 2010–2011 showed that the prevalence of stunting among NLBC, FLBC, and PLBC was 16.4%, 15.1%, and 16.6%, respectively [15]. A national survey of the nutritional status of rural left-behind children under 7 years old was conducted from 2008–2009 and enrolled a total of 7,585 left-behind children and 7,557 non-left-behind children from 13 provinces of China. The results showed that the prevalence of stunting among under-7-year-old children with non-migrant, one, and both migrant parents was 16.3%, 14.9%, and 17.9%, that of underweight was 7.6%, 7.2%, and 8.3%, and the prevalence of wasting was 3.3%, 3.1%, and 3.4%, respectively [16]. These estimates are similar to the results from the 2013 survey in our study.

The results demonstrated the improved nutrition of rural children aged in recent years. From 2013 to 2016, the risk of undernutrition decreased among children aged 6–35 months in the surveyed areas: the prevalence of stunting dropped by one third, and the prevalence of underweight and wasting by half. The gap in early childhood nutrition between children with different parental migration status has narrowed. Child dietary intake has also been greatly improved. Except for the obvious substitution of dietary intake for breastfeeding among children of migrant parents before 18 months of age, the difference in dietary intake among children with different parental migration decreases. In contrast to the earlier stereotype that the left-behind children have worse nutrition than non-left-behind children, our findings highlight the benefits of parental migration on early childhood nutrtion of rural children. Paternal migration is associated with improved early childhood nutrition of rural children; both-parental migration may be detrimental to early childhood nutrition of rural children in earlier years, but not in recent years.

Little research has been done on the mechanism of parental migration affecting child nutrition, but several factors may contribute to the impact, such as household economic status, and caregiver's educational level, and physical and mental health. In our study, Both FLBC and NLBC were primarily cared for by their mothers with similar maternal educational level, but compared with NLBC, FLBC had better household economic status in 2013, which may account for their decreased risk of undernutrtion. In 2016, FLBC had similar household economic status to NLBC, and the differences in the risk of undernutrition between them were of lesser magnitude than those in 2013. Increased depressive symptoms among left-behind mothers due to separation from their husbands may also be detrimental to child nutrition, but in contrast to earlier findings [28, 29], we didn't find a significantly increased risk of depression among left-behind mothers than those in intact families in our surveys.

PLBC are typically cared for by grandparents who are usually less educated and more likely to be depressed than the mothers of FLBC and NLBC. In addition, we found families with migrant parents may be poorer than families with non-migrant parents or with only migrant fathers. These cumulative risk factors may contribute to the decreased HAZ, WAZ, and WHZ scores and the increased risk of stunting, underweight, and wasting of PLBC compared with FLBC and NLBC in the 2013 survey. We found markedly increased educational level and decreased risk of depression among the caregivers of PLBC from 2013 to 2016, which may account for why PLBC performed poorer in 2013 but better in 2016 in weight-related indicators than NLBC and FLBC. More convenient remote communications facilitated by smartphone applications in recent years may also play an important role in these changes. Frequent migrant-caregiver communication may not only allow migrant parents to monitor child feeding but also improve the caregivers' mental health [28-32].

The risk of anemia has remained high among children under 3 years old in rural China. In the 2013 and 2016 surveys, one third of the children aged 18–35 months were anemic, consistent with previous estimates [10, 33]. However, the alarmingly high risk of anemia was found among children aged 6–17 months: about 60% of children living with mothers or both parents and about 40% of children of migrant parents were anemic. Children aged 6–17 months of migrant parents had a significantly lower risk of anemia compared with those living with their mothers or with both parents. Earlier weaning because of maternal migration may account for this lower risk of anemia among children of migrant parents. Although breastfeeding promotes the growth and development of children, studies also reveal that prolonged breastfeeding is associated with decreased dietary intakes and a higher risk of anemia in infants and young children over 6 months of age [34-38]. This association was not significant at > 18 months of age when most non-left-behind children are also weaned.

Our study has implications for the formulation of programs and policy to improve child health and development in rural China. The Chinese government provides special social services for left-behind children as one of the goals of the National Program of Action for Child Development in China (2011–2020) [39]. Left-behind children have long been considered to be more vulnerable to nutritional deficiency than other children, but our study refutes this view. Due to social and economic development, left-behind children have equal or slightly better nutrition than non-left-behind children, as shown in our latest survey. Therefore, programs and policy designed to promote the well-being of left-behind children should pay more attention to other important issues such as psychological and behavioral development. However, this does not mean reducing attention to the nutrition of rural children. Programs that support all rural infants and toddlers are still needed because of their high risk of anemia and stunting. Mothers are still advised to accompany their children in early childhood given the important health impact of breastfeeding, but appropriate feeding guidance should be provided to them.

Our study has some strengths as well as limitations. Two large-sample surveys in the same areas were performed to examine the association between parental migration status and early childhood nutrition of children. In each survey, well-established and validated methods were used to measure child nutritional status by investigators blinded to parental migration status and the basic characteristics of the children and their caregivers. The interventions of the early childhood development program may confound the analysis of the 2016 survey data, but we controlled for related variables in the regression analyses. This study is also limited by its cross-sectional design. In addition, the generalizability of the results is limited because all participants were from poverty-stricken rural areas of northern and southern China.

In summary, this study provides information on the changes over time of early childhood nutrition of left-behind children in rural China, and provides new evidence that parental migration is no longer detrimental and even beneficial to the nutrition of these children. Although future programs for left-behind children should continue to focus on nutrition, they should also pay more attention on other important health issues such as mental health. Further research is needed to develop a clearer and full-scale picture of the impact of parental migration on the well-being of left-behind children of all ages.

Abbreviations

FLBC: Left-behind children with migrant fathers; Hb: Hemoglobin; LAZ: Length-for-age Z score; LBC: Left-behind children; NLBC: Non-left-behind children; PLBC: Left-behind children with both migrant parents; WAZ: Weight-for-age Z score; WHO: World Health Organization; WLZ: Weight-for-length Z score; ZSDS: Zung's self-rating depression scale

Declarations

Ethics approval and consent to participate

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the Ethics Review Board of Peking University (approval number IRB00001052-16034). Written informed consent was obtained from all caregivers before data collection.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

H.S conceptualized and designed the study, drafted the initial manuscript, and reviewed and revised the manuscript; J.Z and X.W designed the data collection instruments, collected data, and reviewed and revised the manuscript; Y.D, C.Z, and X.H reviewed and revised the manuscript. All authors have seen and approved the final manuscript and have contributed significantly to the work.

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References

1. International Organization for Migration: **World migration report 2018**. In. Geneva, Switzerland: International Organization for Migration; 2018.
2. National Bureau of Statistics of China, UNICEF China, UNFPA China: **Population Status of Children in China in 2015: Facts and Figures**. In.; 2017.
3. Li C, Yang N, Zhang H: **Investigation of Physical Development among Left-behind Children in Rural Areas in Western Hunan Province**. *Chinese General Practice* 2011, **14**(3C):1000-1002,1005.
4. Mo X, Xu L, Luo H, Wang X, Zhang F, Tobe RG: **Do different parenting patterns impact the health and physical growth of 'left-behind' preschool-aged children? A cross-sectional study in rural China**. *Eur J Public Health*, **26**(1):18-23.
5. Ning M, Chang H-H: **Migration decisions of parents and the nutrition intakes of children left at home in rural China**. *Agric Econ* 2013, **59**(10):467-477.
6. Tao S, Yu L, Gao W, Xue W: **Food preferences, personality and parental rearing styles: analysis of factors influencing health of left-behind children**. *Qual Life Res* 2016, **25**(11):2921-2929.
7. Tian X, Ding C, Shen C, Wang H: **Does Parental Migration Have Negative Impact on the Growth of Left-Behind Children?-New Evidence from Longitudinal Data in Rural China**. *Int J Environ Res Public Health* 2017, **14**(11):1308.
8. Zhang N, Becares L, Chandola T: **Does the timing of parental migration matter for child growth? A life course study on left-behind children in rural China**. *BMC public health* 2015, **15**:966.

9. Zhang N, Becares L, Chandola T: **A multilevel analysis of the relationship between parental migration and left-behind children's macronutrient intakes in rural China**. *Public Health Nutr* 2016, **19**(11):1913-1927.
10. Chen C, He W, Wang Y, Deng L, Jia F: **Nutritional Status of Children during and post-Global Economic Crisis in China**. *Biomed Environ Sci* 2011, **24**(4):321-328.
11. Liu W, Li S, Gai R: **Status and influencing factors of growth and development among rural left-behind preschool children in Shandong province**. *China Journal of Public Health* 2015, **31**(5):628-631.
12. Lu S, Lin Y-T, Vikse JH, Huang C-C: **Well-being of migrant and left-behind children in China: Education, health, parenting, and personal values**. *Int J Soc Welf* 2016, **25**(1):58-68.
13. Mu R, Brauw Ad: **Migration and young child nutrition: evidence from rural China**. *J Popul Econ* 2015, **28**(3):631-657.
14. Zhou C, Sylvia S, Zhang L, Luo R, Yi H, Liu C, Shi Y, Loyalka P, Chu J, Medina A *et al*: **China's Left-Behind Children: Impact Of Parental Migration On Health, Nutrition, And Educational Outcomes**. *Health Aff* 2015, **34**(11):1964-1971.
15. Ban L, Guo S, Scherpbier RW, Wang X, Zhou H, Tata LJ: **Child feeding and stunting prevalence in left-behind children: a descriptive analysis of data from a central and western Chinese population**. *Int J public health* 2017, **62**(1):143-151.
16. Mou J-s, Luo J-y, Li Y-p, Shuai Z-r, Liu X-h: **Study on the nutritional status and determinants among rural stranded children in China**. *Zhonghua liu xing bing xue za zhi* 2009, **30**(5):439-443.
17. Peng X-C, Luo J-Y, Yao K-B, Hu R-S, Du Q-Y, Zhu M-Y: **The status on care and nutrition of 774 children staying in rural areas while parents were in towns**. *Zhonghua liu xing bing xue za zhi* 2008, **29**(9):860-864.
18. Fellmeth G, Rose-Clarke K, Zhao C, Busert LK, Zheng Y, Massazza A, Sonmez H, Eder B, Blewitt A, Lertgrai W *et al*: **Health impacts of parental migration on left-behind children and adolescents: a systematic review and meta-analysis**. *Lancet* 2018, **392**(10164):2567-2582.
19. Black RE, Allen LH, Bhutta ZA, Caulfield LE, de Onis M, Ezzati M, Mathers C, Rivera J: **Maternal and child undernutrition: global and regional exposures and health consequences**. *Lancet* 2008, **371**(9608):243-260.
20. Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L, Sachdev HS: **Maternal and child undernutrition: consequences for adult health and human capital**. *Lancet* 2008, **371**(9609):340-357.
21. Bhutta ZA, Ahmed T, Black RE, Cousens S, Dewey K, Giugliani E, Haider BA, Kirkwood B, Morris SS, Sachdev HP *et al*: **What works? Interventions for maternal and child undernutrition and survival**. *Lancet* 2008, **371**(9610):417-440.
22. Guo Q, Sun W, Wang Y: **Effect of Parental Migration on Children's Health in Rural China**. *Rev Dev Econ* 2017, **21**(4):1132-1157.
23. Zhou S, Zhao C, Huang X, Li Z, Ye R, Shi H, Zhao Q, Zhou Y, Chen X, O'Sullivan M *et al*: **The effect of a community-based, integrated and nurturing care intervention on early childhood development in rural China**. *Public Health* 2019, **167**(2019):125-135.

24. Zung WW: **A SELF-RATING DEPRESSION SCALE**. *Arch Gen Psychiatry* 1965, **12**:63-70.
25. WHO, UNICEF, USAID, AED, UCDAVIS, IFPRI: **Indicators for assessing infant and young child feeding practices**. In.: World Health Organization; 2010.
26. WHO Multicentre Growth Reference Study Group: **WHO Child Growth Standards: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: Methods and development**. Geneva: World Health Organization; 2006.
27. WHO: **Haemoglobin Concentrations for the Diagnosis of Anaemia and Assessment of Severity. Geneva: Vitamin and Mineral Nutrition Information System**. Geneva, Switzerland: World Health Organization (WHO/NMH/NHD/MNM/11.1); 2011.
28. Graham E, Jordan LP, Yeoh BSA: **Parental migration and the mental health of those who stay behind to care for children in South-East Asia**. *Soc Sci Med* 2015, **132**(2015):225-235.
29. Chen F, Liu H, Vikram K, Guo Y: **For Better or Worse: The Health Implications of Marriage Separation Due to Migration in Rural China**. *Demography* 2015, **52**(4):1321-1343.
30. Lu Y, Yeung JW-J, Liu J, Treiman DJ: **Migration and children's psychosocial development in China: When and why migration matters**. *Soc Sci Res* 2019, **77**(2019):130-147.
31. Thapa DK, Visentin D, Kornhaber R, Cleary M: **Migration of adult children and mental health of older parents 'left behind': An integrative review**. *PloS one* 2018, **13**(10):e0205665.
32. Song Q: **Aging and separation from children: The health implications of adult migration for elderly parents in rural China**. *Demogr Res* 2017, **37**:1761-1792.
33. Xin Q, Chen B, Yin D, Xiao F, Li R, Yin T, Yang H, Zheng X, Wang L: **Prevalence of Anemia and its Risk Factors among Children under 36 Months Old in China**. *J Trop Pediatr* 2017, **63**(1):36-42.
34. Dalili H, Baghersalimi A, Dalili S, Pakdaman F, Hassanzadeh Rad A, Abbasi Kakroodi M, Rezvany SM, Koohmanaei S: **Is there any relation between Duration of breastfeeding and anemia?** *Iran J Ped Hematol Oncol* 2015, **5**(4):218-226.
35. Pasricha SR, Black J, Muthayya S, Shet A, Bhat V, Nagaraj S, Prashanth NS, Sudarshan H, Biggs BA, Shet AS: **Determinants of anemia among young children in rural India**. *Pediatrics* 2010, **126**(1):e140-149.
36. Torsvik IK, Markestad T, Ueland PM, Nilsen RM, Midttun O, Bjorke Monsen AL: **Evaluating iron status and the risk of anemia in young infants using erythrocyte parameters**. *Pediatr Res* 2013, **73**(2):214-220.
37. Wang F, Liu H, Wan Y, Li J, Chen Y, Zheng J, Huang T, Li D: **Prolonged Exclusive Breastfeeding Duration Is Positively Associated with Risk of Anemia in Infants Aged 12 Months**. *J Nutr* 2016, **146**(9):1707-1713.
38. Hipgrave DB, Fu X, Zhou H, Jin Y, Wang X, Chang S, Scherpbier RW, Wang Y, Guo S: **Poor complementary feeding practices and high anaemia prevalence among infants and young children in rural central and western China**. *Eur J Clin Nutr* 2014, **68**(8):916-924.

39. **the National Program of Action for Child Development in China (2011—2020)** [http://www.nwccw.gov.cn/2017-05/12/content_155807.htm]

Tables

Table 1 Characteristics of the children and caregivers

Characteristics	2013 survey			2016 survey		
	NLBC (n=1285)	FLBC (n=819)	PLBC (n=232)	NLBC (n=1089)	FLBC (n=784)	PLBC (n=337)
County, n (%)						
Lin	181 (14.1)	110 (13.4) [†]	14 (6.0) [‡§]	150 (13.8)	98 (12.5) [†]	21 (6.2) [‡§]
Fenxi	157 (12.2)	242 (29.5)	7 (3.0)	113 (10.4)	239 (30.5)	71 (21.1)
Fangshan	229 (17.8)	170 (20.8)	17 (7.3)	191 (17.5)	114 (14.5)	20 (5.9)
Songtao	120 (9.3)	28 (3.4)	43 (18.5)	100 (9.2)	29 (3.7)	37 (11.0)
Liping	100 (7.8)	74 (9.0)	110 (47.4)	109 (10.0)	87 (11.1)	76 (22.6)
Pan	498 (38.8)	195 (23.8)	41 (17.7)	426 (39.1)	217 (27.7)	112 (33.2)
Child sex, n (%)						
Male	727 (56.6)	467 (57.0)	121 (52.2)	601 (55.2)	440 (56.1)	169 (50.1)
Female	558 (43.4)	352 (43.0)	111 (47.8)	488 (44.8)	344 (43.9)	168 (49.9)
Child age (months), median (25^{th}, 75^{th})	20 (13, 27)	19 (11, 27)	23 (17, 28) [‡§]	20 (12, 27)	20 (12, 27)	22 (18, 29) [‡§]
Preterm children, n (%)						
No	1246 (97.0)	795 (97.1)	230 (99.1)	1035 (95.0)	737 (94.0)	326 (96.7)
Yes	39 (3.0)	24 (2.9)	2 (0.9)	54 (5.0)	47 (6.0)	11 (3.3)
Ethnicity, n (%)						
Han	850 (66.1)	620 (75.7) [†]	65 (28.0) [‡§]	695 (63.8)	579 (73.9) [†]	174 (51.6) [‡§]
Minority	435 (33.9)	199 (24.3)	167 (72.0)	394 (36.2)	205 (26.1)	163 (48.4)
Relationship of caregivers to the child, n (%)						
Parents	1243 (96.7)	776 (94.7)	0 (0.0) [‡§]	1048 (96.2)	733 (93.5) [†]	0 (0.0) [‡§]
Grandparents	39 (3.0)	42 (5.1)	229 (98.7)	39 (3.6)	47 (6.0)	321 (95.3)
Others	3 (0.2)	1 (0.1)	3 (1.3)	2 (0.2)	4 (0.5)	16 (4.7)
Caregiver sex, n (%)						
Male	250(19.5)	10 (1.2) [†]	45 (19.4) [§]	151 (13.9)	22 (2.8) [†]	58 (17.2) [§]
Female	1035 (80.5)	809 (98.8)	187 (80.6)	938 (86.1)	762 (97.2)	279 (82.8)
Caregiver age (years) , median (25^{th}, 75^{th})	27 (24, 31)	26 (24, 30)	51 (48, 56) [‡§]	27 (24, 32)	27 (24, 31)	52 (47, 56) [‡§]
Education attainment of caregivers, n (%)						
High school or above	165 (12.9)	123 (15.0)	8 (3.4) [‡§]	218 (20.0)	158 (20.2)	18 (5.3) [‡§]
Middle school	694 (54.0)	462 (56.4)	42 (18.1)	560 (51.4)	423 (54.0)	87 (25.8)
Primary school	343 (26.7)	186 (22.7)	66 (28.4)	249 (22.9)	162 (20.7)	104 (30.9)
Illiteracy	83 (6.5)	48 (5.9)	116 (50.0)	62 (5.7)	41 (5.2)	128 (38.0)
Depression among caregivers [a], n (%)						
No	727 (60.0)	494 (62.9)	114 (49.4) [‡§]	692 (64.1)	533 (68.2)	209 (62.0) [§]
Yes	485 (40.0)	291 (37.1)	117 (50.6)	388 (35.9)	249 (31.8)	128 (38.0)
Household economic status [b], n (%)						
Low	180 (14.0)	79 (9.6) [†]	44 (19.0) [§]	157 (14.4)	122 (15.6)	89 (26.4) [‡§]
High	1104 (86.0)	740 (90.4)	188 (81.0)	932 (85.6)	661 (84.4)	248 (73.6)

NLBC, non-left-behind children; FLBC, left-behind children with migrant fathers; PLBC, left-behind children with both migrant parents

[a] 73 NLBC, 34 FLBC and 1 PLBC in 2013, and 9 NLBC and 2 FLBC in 2016 missed the information of depression among caregivers

[b] 1 NLBC in 2013 and 1 FLBC in 2016 missed the information of household economic status

[†] FLBC *vs.* NLBC $p < 0.05$; [‡] PLBC *vs.* NLBC $p < 0.05$; [§] PLBC *vs.* FLBC $p < 0.05$

Table 2 Multivariate analysis for comparision of nutritional outcomes among children with different parental migration status

	2013		2016	
	Adjusted mean difference / OR (95%CI)	*p* value	Adjusted mean difference / OR (95%CI)	*p* value
Length-for-age Z score				
FLBC *vs.* NLBC	**0.13 (0.01, 0.26)**	**0.031**	0.01 (-0.09, 0.12)	0.820
PLBC *vs.* NLBC	0.08 (-0.13, 0.28)	0.459	0.06 (-0.08, 0.20)	0.395
PLBC *vs.* FLBC	-0.02 (-0.23, 0.19)	0.833	0.05 (-0.09, 0.19)	0.499
Weight-for-age Z score				
FLBC *vs.* NLBC	0.11 (-0.01, 0.22)	0.063	0.02 (-0.07, 0.11)	0.607
PLBC *vs.* NLBC	0.07 (-0.12, 0.25)	0.476	0.09 (-0.03, 0.21)	0.158
PLBC *vs.* FLBC	-0.02 (-0.22, 0.18)	0.843	0.07 (-0.06, 0.19)	0.289
Weight-for-length Z score				
FLBC *vs.* NLBC	0.02 (-0.08, 0.12)	0.732	0.02 (-0.07, 0.11)	0.732
PLBC *vs.* NLBC	0.04 (-0.13, 0.21)	0.642	0.09 (-0.03, 0.21)	0.163
PLBC *vs.* FLBC	0.03 (-0.15, 0.20)	0.769	0.08 (-0.05, 0.20)	0.234
Stunting				
FLBC *vs.* NLBC	**0.73 (0.56, 0.96)**	**0.024**	0.73 (0.53, 1.01)	0.058
PLBC *vs.* NLBC	0.79 (0.53, 1.19)	0.258	0.99 (0.68, 1.43)	0.950
PLBC *vs.* FLBC	1.08 (0.70, 1.68)	0.719	1.35 (0.89, 2.04)	0.156
Underweight				
FLBC *vs.* NLBC	0.77 (0.54, 1.09)	0.136	1.03 (0.63, 1.67)	0.913
PLBC *vs.* NLBC	1.14 (0.69, 1.87)	0.612	0.52 (0.25, 1.08)	0.080
PLBC *vs.* FLBC	1.49 (0.86, 2.55)	0.151	0.51 (0.24, 1.09)	0.081
Wasting				
FLBC *vs.* NLBC	1.02 (0.61, 1.71)	0.938	1.28 (0.61, 2.65)	0.515
PLBC *vs.* NLBC	1.23 (0.59, 2.56)	0.581	0.38 (0.09, 1.73)	0.213
PLBC *vs.* FLBC	1.20 (0.55, 2.62)	0.640	0.30 (0.07, 1.38)	0.123

NLBC, non-left-behind children; FLBC, left-behind children with migrant fathers; PLBC, left-behind children with both migrant parents

Table 3 Multivariate analysis for comparision of hemoglobin concentration and risk of anemia by parental migration status

	2013		2016	
	Adjusted mean difference / OR (95%CI)	*p* value	Adjusted mean difference / OR (95%CI)	*p* value
Hemoglobin concentration (g/dL)				
6-17 months				
FLBC *vs.* NLBC	-0.08 (-0.29, 0.14)	0.480	0.06 (-0.18, 0.30)	0.634
PLBC *vs.* NLBC	**0.53 (0.10, 0.96)**	**0.016**	**0.75 (0.35, 1.15)**	**0.000**
PLBC *vs.* FLBC	**0.60 (0.15, 1.04)**	**0.009**	**0.71 (0.29, 1.12)**	**0.001**
18-35 months				
FLBC *vs.* NLBC	-0.07 (-0.22, 0.09)	0.383	-0.07 (-0.27, 0.13)	0.478
PLBC *vs.* NLBC	0.05 (-0.18, 0.29)	0.665	-0.12 (-0.36, 0.11)	0.306
PLBC *vs.* FLBC	0.10 (-0.15, 0.35)	0.449	-0.10 (-0.35, 0.15)	0.426
Anemia				
6-17 months				
FLBC *vs.* NLBC	1.13 (0.84, 1.52)	0.408	0.80 (0.58, 1.09)	0.160
PLBC *vs.* NLBC	**0.47 (0.27, 0.85)**	**0.012**	**0.39 (0.23, 0.65)**	**0.000**
PLBC *vs.* FLBC	**0.42 (0.23, 0.76)**	**0.005**	**0.49 (0.29, 0.82)**	**0.008**
18-35 months				
FLBC *vs.* NLBC	1.17 (0.91, 1.52)	0.224	1.17 (0.89, 1.53)	0.272
PLBC *vs.* NLBC	1.00 (0.67, 1.50)	0.991	1.00 (0.72, 1.39)	0.994
PLBC *vs.* FLBC	0.85 (0.56, 1.31)	0.467	0.86 (0.61, 1.21)	0.377

NLBC, non-left-behind children; FLBC, left-behind children with migrant fathers; PLBC, left-behind children with both migrant parents

Figures

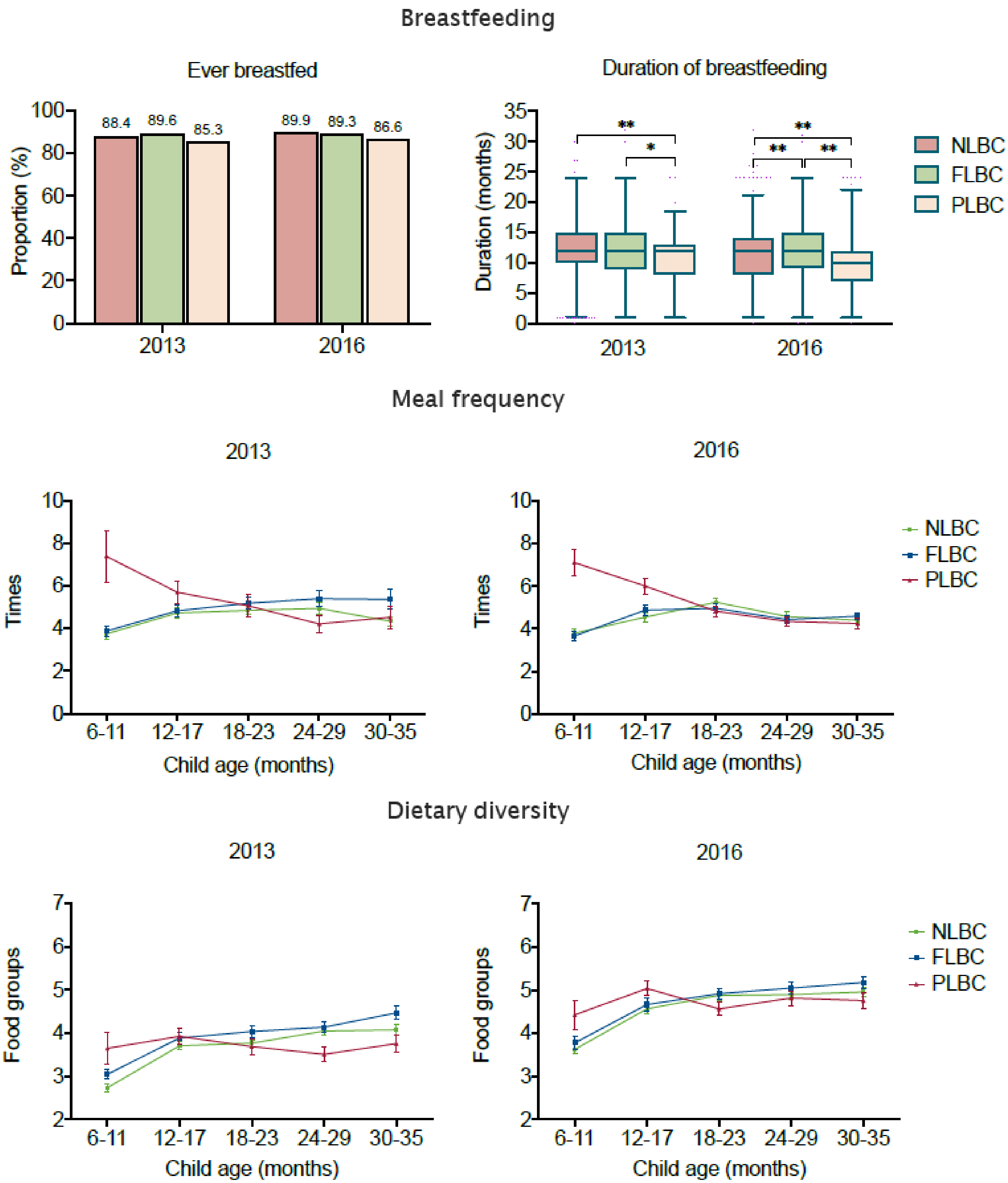

Figure 1

Breastfeeding and dietary intake of children with different parental migration status NLBC, non-left-behind children; FLBC, left-behind children with migrant fathers; PLBC, left-behind children with both migrant parents The central mark on each box indicates the median, and the bottom and top edges of the box indicate the 25th and 97.5th percentiles, respectively. The whiskers extend to the 2.5th and 97.5th percentiles. The symbols and bars on the line chart indicate the mean and the standard error of mean, respectively.

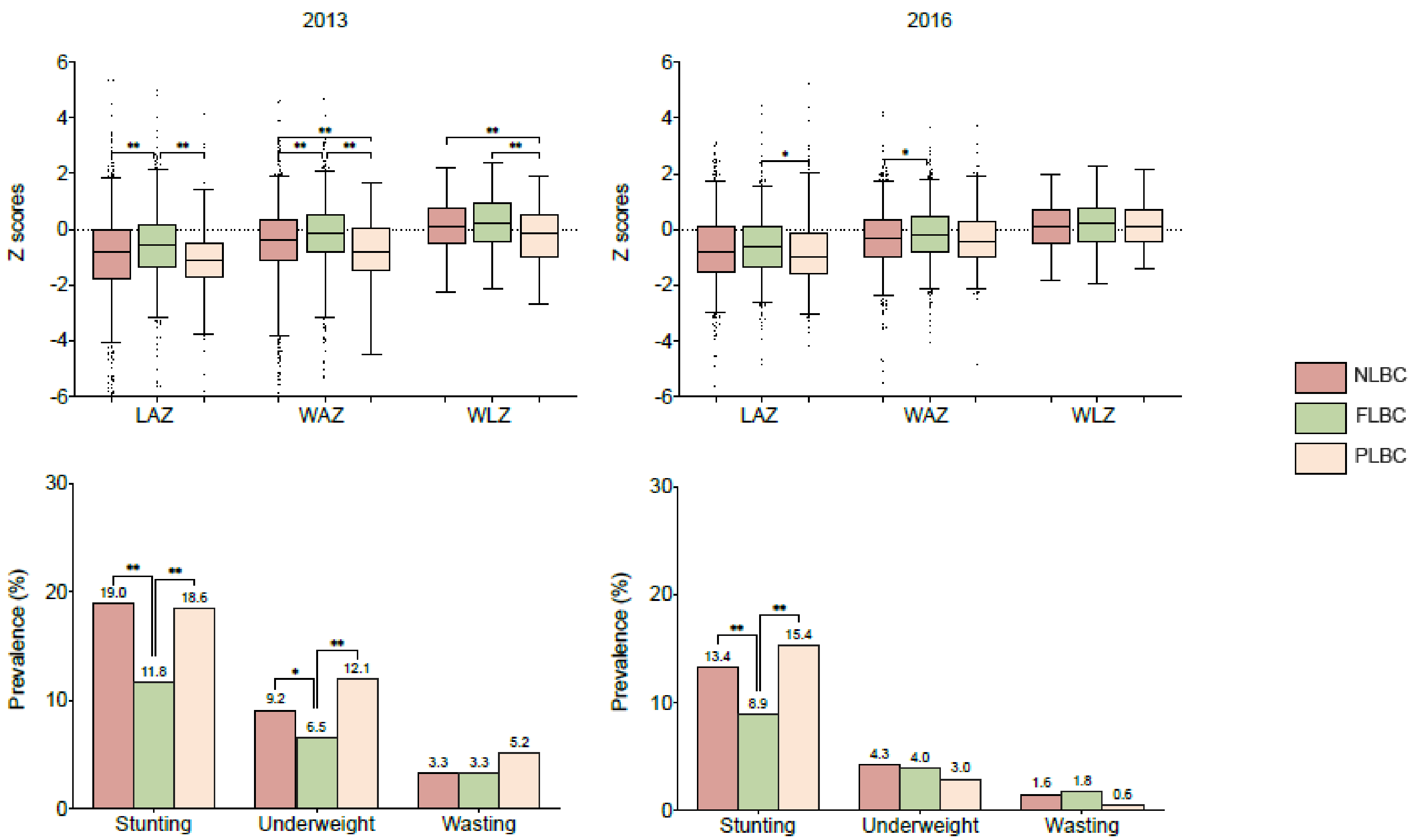

Figure 2

Nutritional outcomes of children aged 6–35 months with different parental migration status NLBC, non-left-behind children; FLBC, left-behind children with migrant fathers; PLBC, left-behind children with both migrant parents; LAZ, Length-for-age Z score; WAZ, Weight-for-age Z score; WLZ, Weight-for-length Z score The central mark on each box indicates the median, and the bottom and top edges of the box indicate the 25th and 75th percentiles, respectively. The whiskers extend to the 2.5th and 97.5th percentiles. * p <0.05; ** p < 0.01

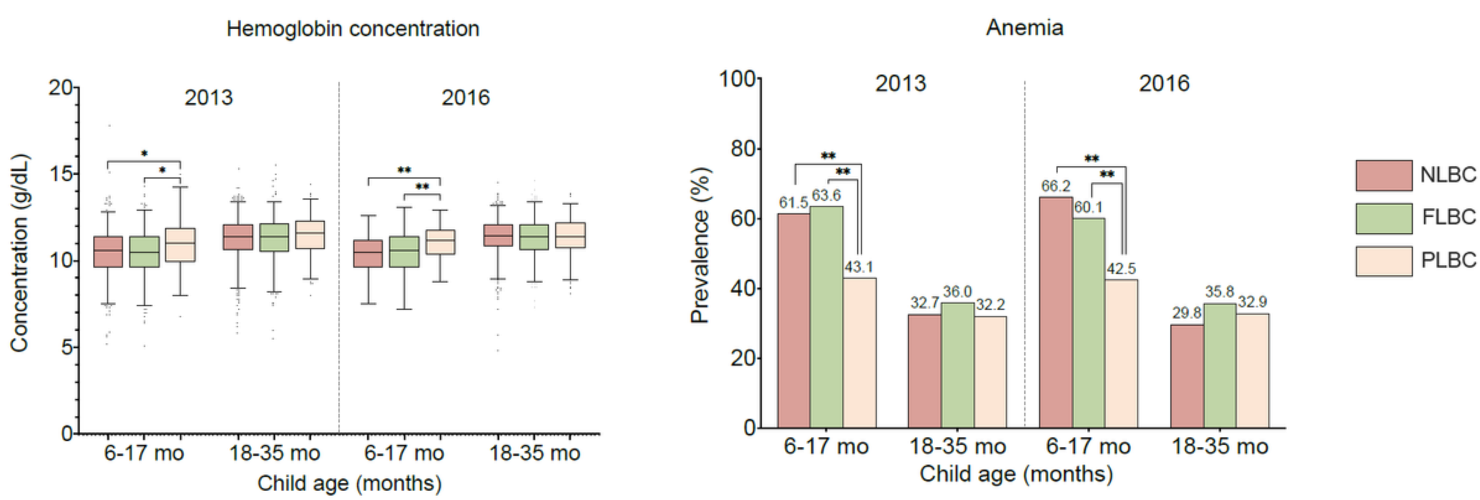

Figure 3

The hemoglobin concentration and prevalence of anemia of children with different parental migration status NLBC, non-left-behind children; FLBC, left-behind children with migrant fathers; PLBC, left-behind children with both migrant parents The central mark on each box indicates the median, and the bottom and top edges of the box indicate the 25th and 75th percentiles, respectively. The whiskers extend to the 2.5th and 97.5th percentiles. * $p < 0.05$; ** $p < 0.01$