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Parental migration and self-reported health status of adolescents in China: a cross-sectional study

Parental Migration and Self-Reported Health Status of Adolescents in China: A Cross-Sectional Study

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Abstract

Background. Over 100 million children are parented by migrant workers in China. The aim of this study was to investigate how self-reported adolescent physical and mental health are associated with parental migration.

Methods. Based on cross-sectional data of 13996 students in 112 schools drawn from a nationally representative sample of middle school students in China, this study used self-reported measures for adolescent physical and mental health. Ordered logistic regression was used for the analysis of self-reported physical health, and linear regression was used for the analysis of self-reported mental health, both adjusting for socio-economic covariates and school fixed effects, to determine how adolescent health is associated with parental migration.

Findings. In urban areas, migrant adolescents were physically healthier (OR=1.19, 95% CI: 1.03–1.36), and similarly mentally healthy (b=-0.07, 95% CI: -0.37–0.23), compared to urban adolescents from intact families; in rural areas, left-behind adolescents were less physically (OR=0.84, 95% CI: 0.76-0.94) and mentally (b=0.45, 95% CI: 0.24-0.66) healthy than rural-intact adolescents, holding other variables constant. Left-behind adolescents had less close parent-adolescent relationships than rural-intact adolescents with both father (OR=0.63, 95% CI: 0.56-0.71) and mother (OR=0.62, 95% CI: 0.54, 0.70).

Interpretation. Our study highlights a great need for health interventions aimed at left-behind adolescents in China and globally, and the important roles of parent-adolescent relationships in addressing the health needs of left-behind adolescents.

Funding. None.

Research in context

Evidence before this study

We searched PubMed, EconLit, OVID, EBSCO for literature in English and the China National Knowledge Infrastructure (CNKI) for literature in Chinese, using the terms "internal migration" OR "migrant children" OR "left-behind", AND "physical health" OR "mental health" OR "adolescent health". While parental migration may improve a household's financial situation through higher income or remittances, growing evidence points to a link between parental migration and adverse social, educational, and emotional outcomes of children in the Chinese context.

Added value of this study

Previous studies mostly focus separately on physical health, mental health, migrant children or left-behind children. Using the same dataset, this study offers a fuller picture by examining how parental migration is associated with both physical and mental health of adolescents, for both migrant adolescents who migrate together with parents to urban areas, and left-behind adolescents who stay behind in rural areas. This study further investigates the role of parent-adolescent relationships linking parental migration and adolescent health.

Implications of all the available evidence

This study highlights a great need for health interventions aimed at left-behind children in rural China, and the importance of parent-adolescent relationships in adolescent health development.

Introduction

China's economic reforms since 1978 has brought about one of the largest population movements in human history from rural to urban areas. Official estimates classify 287 million workers in urban China as rural migrant workers in 2017, accounting for over one fifth of its entire population.[1] Many of them have another identity---parents. As a result of this massive-scale migration in China, more than 100 million children have at least one migrant parent, account for more than a third of the child population in China.[2] About one third (34 million) of these children migrate together with parents into urban areas. The remaining two thirds (69 million) are left behind in rural areas while one or both of their parents work in urban areas.[1]

Parental migration can have wide-ranging and long-lasting consequences for adolescent health, whether they are migrating together with parents or being left behind by parents. These consequences can be negative or positive, depending on the channels through which parental migration effects take place. On the one hand, parental migration may hinder adolescent development in various ways. Adolescence is a transitional stage of physical and mental development. It is a key developmental stage for brain maturation with acquisition of the emotional and cognitive abilities enabling smooth transition to adulthood.[3-5] This is a crucial stage when parental care is critical for laying down the foundation for adult health. Changing home environment and parental absence due to migration can have detrimental effects on children's cognitive and non-cognitive development.[6,7] Second, social environment is a major factor that shapes adolescent health.[8] Migrating with parents into a new environment can be associated with loss of existing social networks and challenges with fitting into the new social environment.[9,10] The lack of social support could hamper adolescent development, particularly socio-emotional development. Moreover, migrant parents are more likely to be faced with economic and social stress themselves,[11-13] thus are less likely to provide warm and supportive

care for their children. Lastly, poor access to healthcare could be another issue facing migrant children.

On the other hand, parental migration may improve a households financial situation through higher income or remittances, which could positively affect adolescent health.[14,15] For migrant children, migration from rural to urban areas may lead to new life perspectives, and enhanced health-related lifestyles.[16] The net effect of parental migration on migrant health thus depends on the relative magnitudes of positive and negative effects.

Studying the link between parental migration and adolescent health carries more importance in the Chinese setting, where the population of children affected by parental migration is at an unparalleled level. There is growing evidence that parental migration is linked with adverse emotional, social, and educational outcomes of children in the Chinese context.[17–20] For migrant children, existing evidence suggests that they are less likely to be enrolled in school compared with local urban children.[21] Substantial evidence has demonstrated that discrimination is one of the stressors for migrant children in urban areas.[22,23] Furthermore, migration-related perceived discrimination is negatively associated with migrant children's psychological adjustments.[24,25] In rural areas, various evidence also points to adverse health outcomes for left-behind children. They are more likely to suffer from malnutrition or become ill.[26–28] Moreover, left-behind children experience more mental health issues than non-left-behind children.[29,30]

Building on the existing evidence, we make several contributions to the literature. First, we provide a more complete picture of the links between parental migration and adolescent health using a new dataset. We examine the associations of parental migration with both physical and mental health, for both migrant adolescents and left-behind adolescents. Existing literature has examined the effects of parental migration on health for migrant and left-behind children separately due to data limitation,[18] which presents some difficulties in synthesizing the

evidence. We use recent large-scale nationally-representative data to investigate recent developments. To our knowledge, this is the first study that uses the data from the China Education Panel Survey—a national representative survey, to explore the effect of parental migration on adolescent health across China under a comprehensive analytic framework. Second, we narrow our analysis by focusing on within-school variations, to achieve a "like-for-like" comparison. Third, we investigate a potential mechanism through which parental migration might be correlated with adolescent health, by examining the roles of relationships between adolescents and migrant parents in this process.

Methods

Data Source and Study Sample

The China Education Panel Survey (CEPS) is an ongoing school-based large-scale survey conducted by the National Survey Research Center at Renmin University of China. The baseline survey in the 2013-14 academic year included 19487 middle school students who were either in 7th grade or 9th grade in the 2013-2014 academic years, and collected information about their demographic characteristics, migration status, health status and social relationships. It applied a stratified, multistage sampling design with probability proportional to size, and randomly selected a school-based, national representative sample from 28 counties, across 31 provinces in mainland China. The stratification of sampling process ensures that urban sample, rural sample and migrant sample have been selected proportionally based on China's reality. Further waves were planned to follow the 7th grade students for 30 years.

This study conducted a cross-sectional secondary data analysis by using information drawn from the baseline survey. 13996 participants were included in the analysis. At the time of the survey, the majority of the participants were aged between 12 and 16 (See Appendix Figure A1). We split the sample into urban and rural subsamples for our analysis, based on urban/rural

classification of the administrative area. The urban sample included 6846 participants, who were either migrant adolescents or adolescents from intact urban families with both parents present. The rural sample included 7150 participants who were either left-behind adolescents or adolescents from intact rural families with both parents present. The remaining 5492 respondents were excluded from this study due to not belonging in above categories or missing data.

Variable Construction: Outcomes

Physical health was self-reported by the adolescent on a scale of 1 (very bad) to 5 (very good). Mental health was assessed through a shortened version of the Center for Epidemiological Studies Depression Scale (CES-D)[31]. These included 5 items---depression, dejection, unhappiness, boredom, and sadness, and participants were asked to rate each item as to how often they felt that way. Detailed wording of these item was included in Appendix Table A1. The responses ranged from 1 (none of the time) to 5 (all of the time). Cronbach's alpha for these five items was 0.858 in our study, which indicated a good reliability[32]. Responses to these five questions were aggregated to construct the mental health measure, ranging from 5 to 25, with higher scores indicating worse mental health conditions.

Parent-adolescent relationship was included as another outcome, to better understand its role in the relationship between parental migration and adolescent mental health. These were constructed based on the following question: "How is your relationship with your mother/father?" Variables are measured on a 1 to 3 scale, with 1 = "not close" , 2= "not too close nor too far" and 3 ="very close".

Variable Construction: Migration Status

Based on migration status, adolescents with migrant parents were divided into two categories: migrant adolescents and left-behind adolescents. Migrant adolescents are those who live in

urban areas with their rural migrant parents, while left-behind adolescents are those who live in rural areas with one or both parents absent from home. This information was derived from the urban/rural area classification of the administrative area, the current *hukou* status of the adolescent (*hukou* is China's household registration system, which is closely linked with local social welfare such as eligibility for health insurance), and the question in the student questionnaire: "Do you live with your parents currently?" In recent years the government gradually relaxed the *hukou* restrictions in some areas, but a local *hukou* remains a significant socio-economic status indicator, especially in large cities.[33,34] In urban areas, adolescents were classified into migrant adolescents (rural *hukou*, living with migrant parents) and urban-intact adolescents (urban hukou, living with both parents). In rural areas, adolescents were classified into left-behind adolescents (rural *hukou*, with one or both parents absent) and rural-intact adolescents (rural *hukou*, living with both parents). These groupings were summarised in Appendix Table A2.

Variable Construction: Covariates

A series of covariates were included in the analysis, including the participant's age, gender, grades (grade 7 or 9), household income and parents' education level. More details were provided in Appendix Table A3.

Data Analysis

Ordered logistic and linear regression models were conducted to analyse the association of adolescent health and parental migration, with a health indicator (or parent-adolescent relationship) as the dependent variable, and a migrant status variable (migrant or left-behind adolescent) as the key independent variable, adjusting for socio-economic covariates and school fixed effects. In doing so, our aim was to compare the health status (or parent-adolescent relationship) of adolescents with migrant parents, to that of an appropriate comparison group,

conditional on socio-economic covariates and school fixed effects. For migrant adolescents, the comparison group is local urban adolescents in intact families where both parents are present. For left-behind adolescents, the comparison group is local rural adolescents in intact families where both parents are present.

Controlling for socio-economic covariates was motivated out of the concern of selection bias in parental migration. It is possible that parents were more likely to bring adolescents with them if their children were healthier. In addition, parents who chose to migrate may be healthier, and these biological characteristics could be inherited by their children. In these cases, estimates could be downward biased due to positive selection into migration. Controlling for socio-economic status of the adolescents and their parents would help alleviate these concerns. Moreover, there existed wide variations in economic development and healthcare provision across regional areas in China, and migrants were more likely to come from less developed regions and flow into more developed regions; failure to take these into account may also confound the results. By controlling for school fixed effects, we eliminated differences across schools (and hence regional areas) and focused the comparison between different groups within the same school.

In the analysis, two key comparisons were made to explore the association of parental migration and adolescent health: in urban areas, migrant adolescents were compared against urban-intact adolescents; in rural areas, left-behind adolescents were compared against rural-intact adolescents. While it would be interesting to also compare migrant adolescents against rural-intact or left-behind adolescents, our research design based on school fixed effects meant this was not possible, as migrant adolescents and rural-intact (or left-behind) adolescents were not in the same schools by sampling design.

Ordered logistic regression models were used to examine associations between migration status and physical health or relationships with parents. The association between migration status and

mental health was examined through linear regressions. Robust standard errors were applied in all models to address heteroskedasticity issues. All regressions included the same set of independent variables: an indicator of migrant status (migrant adolescent indicator for the urban sample, and left-behind adolescent indicator for the rural sample), sex, age and its squared term, mother's education level, father's education level, family income level, and school grade. Analyses were performed in STATA 14.0.

Ethical Approval Statement

This study is a secondary analysis of de-identified data collected by other researchers, and is exempt from ethical approval.

Role of funding

None.

Results

Summary Statistics

We followed STROBE guidelines for cross-sectional studies in reporting the results. Table 1 presented the summary statistics of the variables by parental migration status for the urban and rural samples separately. For the total 13,996 participants, average age was 13.9 years old (±1.34 years) and 50.1% of them were girls. 49.5% were in 7th grade at the time of survey. 15.4% had fathers with primary education or lower, 45.3% with lower secondary education, 24.8% with upper secondary education, and the remaining 14.6% with tertiary education. Mother's education was 24.8% primary education or below, 42.5% lower secondary, 20.6% upper secondary, and 12.1% tertiary. In terms of family income, 20.7% reported "low", 73.4% "medium", and 5.9% "high". For physical health, in the urban sample, 77.0% of urban-intact adolescents reported being in "good" (35.4%) or "very good" (41.6%) physical health, and

77.4% of migrant adolescents reported so (34.7% "good" and 42.7% "very good"). In the rural sample, 71.3% of rural-intact adolescent reported being in "good" (35.6%) or "very good" (35.7%) health, while 65.1% of left-behind children reported so (35.8% "good" and 29.3% "very good"). For mental health, in the urban sample, average score for urban-intact adolescents was 10.24 (SD ±4.45), and that for migrant adolescents was 10.36 (SD ±4.21). In the rural sample, average score for rural-intact adolescents was 10.27 (SD ±3.76), and that for left-behind adolescents was 10.95 (SD ±3.91). On relationship with father, 63.6% of all participants reported "very close", 32.9% "average", and 3.5% "not close". On relationship with mother, 74.3% of all participants reported "very close", 23.8% "average", and 1.9% "not close".

Migrant Adolescents vs Urban-Intact

Table 2 reported the results for comparing migrant adolescents with urban-intact adolescents, conditional on covariates and school fixed effects, for physical health (column 1), mental health (column 2), relationship with father (column 3), and relationship with mother (column 4). In terms of physical health, the odds of migrant adolescents being physically healthier (being in groups greater than k, relative to being in groups less than or equal to k, k = 1 to 5), was 1.19 (95% CI: 1.03–1.36) times that of urban-intact adolescents, holding other variables constant. As for mental health, the coefficient on being a migrant adolescent was -0.07 (95% CI: -0.37–0.23), that is, migrants adolescents did not have significantly different mental health status than urban-intact adolescents (p=0.65), holding everything else constant. On relationships with parents, the odds ratio for migrant adolescents having closer relationships with father relative to urban-intact adolescents was 0.93 (95% CI: 0.81-1.08), and that for relationships with mother was 0.94 (95% CI: 0.80-1.11).

Covariates mattered to varying degrees across the four outcomes. Compared to males, females had worse physical health (OR=0.77, 95% CI: 0.70-0.84), similar mental health (b=0.09, 95%

CI: -0.12-0.29), similar relationship with father (OR=1.05, 95% CI: 0.95-1.17), and better relationship with mother (OR=1.23, 95% CI: 1.10-1.38). Quadratic age trends were significant for all four outcomes. Family background variables, including a number of indicators of parental education levels and family income levels, significantly predicted at least one of the four outcomes. Grade differences were significant for mental health (b=0.56, 95% CI: 0.17-0.95) and relationship with father (OR=0.81, 95% CI: 0.66-0.98).

Left-behind vs Rural-Intact

Regression analysis results for the comparison between left-behind adolescents and rural-intact adolescents were presented in Table 3. Analyses of rural sample reflected that left-behind adolescents had worse physical and mental health status, and less close parent-adolescent relationships, compared with their rural-intact peers. In terms of physical health, the odds of left-behind adolescents being physically healthier was 0.84 (95% CI: 0.76-0.94) times that of rural-intact adolescents; in terms of mental health, left-behind adolescents had worse mental health by 0.45 points (95% CI: 0.24-0.66) than rural-intact adolescents. In terms of relationships with parents, the odds ratio for left-behind adolescents having closer relationships with father relative to rural-intact adolescents was 0.63 (95% CI: 0.56-0.71), and that for relationships with mother was 0.62 (95% CI: 0.54-0.70).

Compared to males, females had worse physical health (OR=0.81, 95% CI: 0.74-0.89), worse mental health (b=0.39, 95% CI: 0.22-0.57), worse relationship with father (OR=0.84, 95% CI: 0.76-0.92), and better relationship with mother (OR=1.14, 95% CI: 1.02-1.28). Quadratic age trends were significant for all outcomes except physical health. Family background variables, including a number of indicators of parental education levels and family income levels, significantly predicted at least one of the four outcomes. Grade differences were significant for all four outcomes.

Discussion

Consistent with previous literature, this study finds evidence that parental migration is detrimental to left-behind adolescents' health development.[27-30] This finding is also line with existing international evidence, and evidence on other development outcomes.[17-20] Set against the global trend of migration, particularly within and from low and middle income countries, this suggests that there is a cost associated with health of left-behind children that is not sufficiently compensated by the benefits of migration.[35] Countries like China, Philippines have recognized that health issues of left-behind children is one of the major costs of migration[18,36]. Addressing the health needs of left-behind children will be a key task for policy makers globally. Our study presents a contrasting picture for two groups of children parented by migrants: migrant adolescents and left-behind adolescents. Our analysis did not find that migrant adolescents lag behind urban adolescents from intact families in terms of physical and mental health. Recent *hukou* policy relaxed restrictions on access to local public services and welfare to some extent, which made it easier for migrants to bring their children with them to some urban areas.[35] However, it should be noted that considerable barriers remain in the *hukou* system, particularly in large cities.[33,34] Our results suggest that making it easier for migrants to bring their children with them would reduce the health costs imposed on children by parental migration.

Our results also suggest parental migrations poses a risk to worsened parent-adolescent relationships. Adolescence is a key period for the development of socio-emotional skills,[4,9] and dealing with a new social environment or the absence of a parent can be challenging. Close parent-child relationships play an essential protective role in protecting adolescents on mental health outcomes.[37] Lack of interactions with and prolonged separations from parents damage parent-child relationships and result in mental health issues. In the case of left-behind

adolescents, the emotional bonds, once damaged, may not be restored even when migrant parents return.

This study has a number of strengths. First, to our knowledge, this study offers a comprehensive picture of the relationship between parental migration and adolescent health, by using national level data to investigate the effects on adolescents' physical and mental health, for both migrant adolescents and left-behind adolescents. Second, this study has tried carefully to eliminate confounding factors due to socio-demographic differences and environmental factors at county and school levels. Furthermore, this study also investigates the role of parent-adolescent relationships, to better understand the mechanisms through which parental migration affects adolescent health.

Several limitations of this study should be noted. First, while the CEPS sample was representative of middle school students in China, only two school grades (7 and 9) were observed. The majority of the participants were aged between 12 and 16, which is only part of the age span in childhood and adolescence. Data covering a longer age span would be needed to understand the full picture of migrant and left-behind children. Second, we used self-reported health status as dependent variables. These measures are subject to reporting bias and measurement error. Future research would benefit from using more objective measures of health status, both physical and mental, to shed more light on these findings. Lastly, while we tried to account for socio-demographic and regional/school environmental factors, there are likely still omitted variables due to the self-selection nature of parental migration decision.

In conclusion, our study highlights a great need for health interventions aimed at left-behind children. This is a vulnerable group that is more prone to physical and mental health issues due to absence of one or both parents. Although this study was done in the Chinese context, rising migration is a global phenomenon, and addressing the health needs of left-behind children is a

global issue. Further, this study calls for parents and caretakers to pay attention to fostering and maintaining close parent-adolescent relationships.

While this study presented cross-sectional evidence in adolescence, evidence on the long-term effects of parental migration over the life course remains limited. The CEPS is ongoing longitudinal survey aimed to tracked individuals for 30 years. With data available, future research would benefit from taking a life course perspective in this line of research.

Declaration of Interests

None.

Contributors Statement

AZ and EM conceived the study. AZ selected the data source and designed the methodology, WL provided data management and statistical analysis and wrote the first draft, based on which AZ and EM provided critical revisions. All authors approved the final version of the article.

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Funding Sources

References

1. China National Bureau of Statistics. *2017 nian nongmingong jiance diaocha baogao [Migrant worker monitoring survey report 2017].*; 2018.

2. UNICEF. *Highlights of Population Status of Children in China in 2015.* The United Nations Children's Fund (UNICEF); 2018.

3. Blakemore S-J, Choudhury S. Development of the adolescent brain: implications for executive function and social cognition. *J Child Psychol Psychiatry.* 2006;47(3-4):296-312.

4. Parker JG, Gottman JM. Social and emotional development in a relational context: Friendship interaction from early childhood to adolescence. In: *Peer Relationships in Child Development.* Wiley series on personality processes. Oxford, England: John Wiley & Sons; 1989:95-131.

5. Paus T. Mapping brain maturation and cognitive development during adolescence. *Trends Cogn Sci.* 2005;9(2):60-68.

6. Gottfried AW. *Home Environment and Early Cognitive Development: Longitudinal Research.* Academic Press; 2013.

7. Zhang H, Behrman JR, Fan CS, Wei X, Zhang J. Does parental absence reduce cognitive achievements? Evidence from rural China. *J Dev Econ.* 2014;111:181-195.

8. Irwin LG, Siddiqi A, Hertzman G. *Early Child Development: A Powerful Equalizer.* Human Early Learning Partnership (HELP) Vancouver, BC; 2007.

9. Berry JW, Phinney JS, Sam DL Ed, Vedder P, eds. *Immigrant Youth in Cultural Transition: Acculturation, Identity, and Adaptation Across National Contexts.* London: Psychology Press; 2014.

10. Yeh CJ. Age, acculturation, cultural adjustment, and mental health symptoms of Chinese, Korean, and Japanese immigrant youths. *Cultur Divers Ethnic Minor Psychol.* 2003;9(1):34-48.

11. Cui X, Rockett IR, Yang T, Cao R. Work stress, life stress, and smoking among rural–urban migrant workers in China. *BMC Public Health.* 2012;12(1):979.

12. Li X, Stanton B, Fang X, Lin D. Social Stigma and Mental Health among Rural-to-Urban Migrants in China: A Conceptual Framework and Future Research Needs. *World Health Popul.* 2006;8(3):14-31.

13. Nikoloski Z, Zhang A, Hopkin G, Mossialos E. Self-reported Symptoms of Depression Among Chinese Rural-to-Urban Migrants and Left-Behind Family Members. *JAMA Netw Open.* 2019;2(5):e193355.

14. Carletto C, Covarrubias K, Maluccio JA. Migration and child growth in rural Guatemala. *Food Policy.* 2011;36(1):16-27.

15. Hildebrandt N, McKenzie DJ, Esquivel G, Schargrodsky E. The Effects of Migration on Child Health in Mexico. *Economía*. 2005;6(1):257-289.

16. Toyota M, Yeoh BSA, Nguyen L. Bringing the 'left behind' back into view in Asia: a framework for understanding the 'migration–left behind nexus.' *Popul Space Place*. 2007;13(3):157-161.

17. Antman FM. The impact of migration on family left behind. In: Constant AF, Zimmermann KF, eds. *International Handbook on the Economics of Migration*. Cheltenham, UK: Edward Elgar; 2013:293–308.

18. Wang L, Mesman J. Child Development in the Face of Rural-to-Urban Migration in China: A Meta-Analytic Review. *Perspect Psychol Sci J Assoc Psychol Sci*. 2015;10(6):813-831.

19. Wen M, Lin D. Child Development in Rural China: Children Left Behind by Their Migrant Parents and Children of Nonmigrant Families. *Child Dev*. 2012;83(1):120-136.

20. Zhou C, Sylvia S, Zhang L, et al. China's Left-Behind Children: Impact Of Parental Migration On Health, Nutrition, And Educational Outcomes. *Health Aff Proj Hope*. 2015;34(11):1964-1971.

21. Liang Z, Chen YP. The Educational Consequences of Migration for Children in China. In: *Investing in Human Capital for Economic Development in China*. WORLD SCIENTIFIC; 2010:159-179.

22. Fang X, Fan X, Liu Y. Perceived Discrimination and Loneliness: Moderating Effects of Coping Style Among Migrant Children. *Psychol Dev Educ*. 2008;24(4):93-99.

23. Lin X-Y, Fang X-Y, Liu Y, Lan J. The Effect Mechanism of Stigma Perception on Mental Health Among Migrant Children in Beijing: The Effect Mechanism of Stigma Perception on Mental Health Among Migrant Children in Beijing. *Acta Psychol Sin*. 2009;41(10):967-979.

24. Chen L, Su S, Li X, Tam CC, Lin D. Perceived discrimination, schooling arrangements and psychological adjustments of rural-to-urban migrant children in Beijing, China. *Health Psychol Behav Med*. 2014;2(1):713-722.

25. Xiang X, Wong DFK, Hou K. The impact of perceived discrimination on personality among Chinese migrant children: The moderating role of parental support. *Int J Soc Psychiatry*. 2018;64(3):248-257.

26. Schmeer K. Father absence due to migration and child illness in rural Mexico. *Soc Sci Med 1982*. 2009;69(8):1281-1286.

27. de Brauw A, Mu R. Migration and the overweight and underweight status of children in rural China. *Food Policy*. 2011;36(1):88-100.

28. Li Q, Liu G, Zang W. The health of left-behind children in rural China. *China Econ Rev*. 2015;36:367-376.

29. Gao Y, Li LP, Kim JH, Congdon N, Lau J, Griffiths S. The impact of parental migration on health status and health behaviours among left behind adolescent school children in China. *BMC Public Health*. 2010;10(1):56.

30. Zhao F, Yu G. Parental Migration and Rural Left-Behind Children's Mental Health in China: A Meta-Analysis Based on Mental Health Test. *J Child Fam Stud*. 2016;25(12):3462-3472.

31. Radloff LS. The CES-D Scale: A Self-Report Depression Scale for Research in the General Population[J]. *Applied Psychological Measurement*. 1997;1(3):385-401.

32. Tavakol M, Dennick R: Making sense of Cronbach's alpha. *Int J Med Edu.* 2011; 2:53–55.

33. Song, Y. What should economists know about the current Chinese hukou system? *China Economic Review*. 2014; 29:200-212.

34. Treiman D J. The "difference between heaven and earth": Urban‐rural disparities in well-being in China. *Research in Social Stratification & Mobility*. 2012;30(1):0-47.

35. Fellmeth G, et al. Health impacts of parental migration on left-behind children and adolescents: a systematic review and meta-analysis. *The Lancet.* 2018; 392(1016):2567-2582.36. Asis M. Living with migration: experiences of left-behind children in the Philippines. *Asian Population Studies.* 2016;2(1):45-67.

37. Zhao J, Liu X and Wang M. Parent–child cohesion, friend companionship and left-behind children's emotional adaptation in rural China. *Child Abuse & Neglect*. 2015; 48:190-199.

Table 1. Summary statistics

Variable	Total Sample (N=13996)	Urban Sample		Rural sample	
		Urban-intact adolescents (N=5259)	Migrant adolescents (N=1587)	Rural-intact adolescents (N=5126)	Left-behind adolescents (N=2024)
Gender (%)					
Male	49.9	48.8	51.9	49.4	52.8
Female	50.1	51.2	48.1	50.6	47.2
Grade (%)					
Grade 7	49.5	49.5	58.9	46.1	50.7
Grade 9	50.5	50.5	41.1	53.9	49.3
Age	13.9±1.34	13.8±1.3	14.0±1.3	14.0±1.3	14.0±1.4
Father's education level (%)					
Primary education and below	15.4	6.5	20	19.6	24
Lower secondary education	45.3	26.5	53.9	57.1	57.3
Upper secondary education	24.8	33.1	21.7	20.2	17.3
Tertiary education	14.6	33	4.3	3	1.4
Mother's education level (%)					
Primary education and below	24.8	10.3	35.2	30.2	40.4
Lower secondary education	42.5	29.5	49	52.5	45.8
Upper secondary education	20.6	31	13.6	15.2	12.8
Tertiary education	12.1	29.1	2.2	2.1	1
Family income (%)					
Low	20.7	10.6	18.7	26.1	34.8
Medium	73.4	81	76	69.1	62.3
High	5.9	8.4	5.3	4.8	2.9
Physical health (%)					
Very poor	0.6	0.6	0.7	0.5	0.4
Not very good	3.6	3.3	3	3.4	5.2
Average	22.6	19.2	18.9	24.8	29.3
Good	35.4	35.4	34.7	35.6	35.8
Very good	37.8	41.6	42.7	35.7	29.3
Mental Health	10.37±4.07	10.24±4.45	10.36±4.21	10.27±3.76	10.95±3.91
Relationship with father (%)					
Not close	3.5	3.4	2.8	2.5	6.8
Average	32.9	30.4	40.1	31.6	37.1
Very close	63.6	66.2	57.1	65.9	56.1
Relationship with Mother (%)					
Not close	1.9	1.4	2.2	1.2	4.7
Average	23.8	21.4	30.1	22.4	29
Very close	74.3	77.2	67.7	76.4	66.3

Notes: Values in means±SD.
Source: Authors' calculation based on the China Educational Panel Survey (CEPS).

Table 2. Associations of parental migration and adolescent health in urban areas (N=6846)

Independent Variable	Dependent Variable =			
	(1) Physical Health (OR)	(2) Mental Health (b)	(3) Relationship with Father (OR)	(4) Relationship with Mother (OR)
Migrant status				
Urban-intact adolescent	Reference	Reference	Reference	Reference
	-	-	-	-
Migrant adolescent	1.19**	-0.07	0.93	0.94
	[1.03, 1.36]	[-0.37, 0.23]	[0.81, 1.08]	[0.80, 1.11]
Sex				
Male	Reference	Reference	Reference	Reference
	-	-	-	-
Female	0.77***	0.09	1.05	1.23***
	[0.70, 0.84]	[-0.12, 0.29]	[0.95, 1.17]	[1.10, 1.38]
Age				
Age	0.25***	2.06***	0.48*	0.26***
	[0.13, 0.52]	[0.59, 3.53]	[0.23, 1.03]	[0.11, 0.62]
Age squared	1.05***	-0.06**	1.02*	1.04***
	[1.02, 1.07]	[-0.12, -0.01]	[1.00, 1.05]	[1.01, 1.07]
Mother's education level				
Primary	Reference	Reference	Reference	Reference
	-	-	-	-
Lower secondary	1.12	-0.56***	1.11	1.33***
	[0.97, 1.30]	[-0.90, -0.21]	[0.95, 1.30]	[1.12, 1.59]
Upper secondary	1.09	-0.73***	1.19*	1.40***
	[0.92, 1.31]	[-1.14, -0.33]	[0.98, 1.44]	[1.13, 1.74]
Tertiary	1.16	-0.93***	1.35**	1.97***
	[0.94, 1.44]	[-1.41, -0.45]	[1.07, 1.70]	[1.51, 2.57]
Father's education level				
Primary	Reference	Reference	Reference	Reference
	-	-	-	-
Lower secondary	1.16*	-0.24	1.29***	1.15
	[0.97, 1.39]	[-0.64, 0.15]	[1.07, 1.55]	[0.94, 1.42]
Upper secondary	1.1	-0.06	1.33***	1.13
	[0.90, 1.33]	[-0.52, 0.39]	[1.08, 1.64]	[0.89, 1.43]
Tertiary	0.99	0.09	1.38***	1.14
	[0.79, 1.24]	[-0.43, 0.61]	[1.08, 1.75]	[0.87, 1.50]
Family income level				
Low	Reference	Reference	Reference	Reference
	-	-	-	-
Medium	1.39***	-0.52***	1.01	1.03
	[1.20, 1.62]	[-0.85, -0.18]	[0.86, 1.19]	[0.86, 1.23]
High	1.96***	-0.73***	1.07	1.04
	[1.58, 2.44]	[-1.23, -0.24]	[0.84, 1.37]	[0.79, 1.37]

Grade

	(1)	(2)	(3)	(4)
Grade 7	Reference	Reference	Reference	Reference
	-	-	-	-
Grade 9	0.94	0.56***	0.81**	0.96
	[0.79, 1.12]	[0.17, 0.95]	[0.66, 0.98]	[0.76, 1.20]
School fixed effects	Yes	Yes	Yes	Yes

Notes: Models (1), (3), and (4) were estimated with ordered logit models, and model (2) was estimated with least squares. All models include school fixed effects. Odds ratios (OR) were reported for ordered logistic models and coefficients (b) were reported for linear regression. 95% confidence intervals (CI) were reported in brackets. Robust standard errors were applied.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 3. Associations of parental migration and adolescent health in rural areas (N=7150)

Independent Variable	Dependent Variable =			
	(1) **Physical Health**	**(2)** **Mental Health**	**(3)** **Relationship with Father**	**(4)** **Relationship with Mother**
	(OR)	**(b)**	**(OR)**	**(OR)**
Migrant status				
Rural-intact adolescent	Reference	Reference	Reference	Reference
	-	-	-	-
Left-behind adolescent	0.84***	0.45***	0.63***	0.62***
	[0.76, 0.94]	[0.24, 0.66]	[0.56, 0.71]	[0.54, 0.70]
Sex				
Male	Reference	Reference	Reference	Reference
	-	-	-	-
Female	0.81***	0.39***	0.84***	1.14**
	[0.74, 0.89]	[0.22, 0.57]	[0.76, 0.92]	[1.02, 1.28]
Age				
Age	0.75	1.10*	0.49**	0.35***
	[0.41, 1.37]	[-0.10, 2.30]	[0.25, 0.97]	[0.17, 0.74]
Age squared	1.01	-0.04*	1.03**	1.04***
	[0.99, 1.03]	[-0.08, 0.01]	[1.00, 1.05]	[1.01, 1.06]
Mother's education level				
Primary	Reference	Reference	Reference	Reference
	-	-	-	-
Lower secondary	1.06	-0.25**	1.1	1.21***
	[0.95, 1.18]	[-0.47, -0.04]	[0.98, 1.25]	[1.05, 1.39]
Upper secondary	1.1	-0.23	1.38***	1.27**
	[0.93, 1.29]	[-0.56, 0.10]	[1.13, 1.68]	[1.02, 1.58]
Tertiary	1.23	-0.06	0.9	1
	[0.84, 1.80]	[-0.92, 0.81]	[0.59, 1.36]	[0.63, 1.61]
Father's education level				
Primary	Reference	Reference	Reference	Reference
	-	-	-	-
Lower secondary	1.17**	-0.18	1.18**	1.17**
	[1.03, 1.31]	[-0.42, 0.05]	[1.04, 1.35]	[1.02, 1.35]
Upper secondary	1.23**	-0.38**	1.29***	1.41***
	[1.05, 1.43]	[-0.70, -0.07]	[1.08, 1.55]	[1.15, 1.72]
Tertiary	1.36*	-0.43	1.25	1.31
	[0.96, 1.91]	[-1.12, 0.26]	[0.83, 1.87]	[0.83, 2.05]
Family income level				
Low	Reference	Reference	Reference	Reference
	-	-	-	-
Medium	1.38***	-0.55***	1.19***	1.29***
	[1.24, 1.53]	[-0.76, -0.35]	[1.06, 1.34]	[1.14, 1.47]
High	2.09***	-0.19	1.32*	1.64***

	[1.65, 2.65]	[-0.75, 0.37]	[0.99, 1.78]	[1.17, 2.28]
Grade				
Grade 7	Reference	Reference	Reference	Reference
	-	-	-	-
Grade 9	0.87*	0.41**	0.64***	0.69***
	[0.74, 1.02]	[0.10, 0.73]	[0.53, 0.76]	[0.57, 0.84]
School fixed effects	Yes	Yes	Yes	Yes

Notes: Models (1), (3), and (4) were estimated with ordered logit models, and model (2) was estimated with least squares. All models include school fixed effects. Odds ratios (OR) were reported for ordered logistic models and coefficients (b) were reported for linear regression. 95% confidence intervals (CI) were reported in brackets. Robust standard errors were applied.
*** p<0.01, ** p<0.05, * p<0.1

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1,3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6-7
Objectives	3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	7-8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-9, Appendix
Bias	9	Describe any efforts to address potential sources of bias	9-11
Study size	10	Explain how the study size was arrived at	7-8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9, Appendix
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9-11
		(*b*) Describe any methods used to examine subgroups and interactions	9-11
		(*c*) Explain how missing data were addressed	8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	11

Results

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11-12
		(b) Indicate number of participants with missing data for each variable of interest	11-12
Outcome data	15*	Report numbers of outcome events or summary measures	11-12
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12-13
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A

Discussion

Key results	18	Summarise key results with reference to study objectives	14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15
Generalisability	21	Discuss the generalisability (external validity) of the study results	15-16

Other information

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Online Appendix

Additional tables and figure are provided in this appendix.

Table A1. Questions used to construct the mental health scale

| Item	Responses
During the last week, how often did you feel frustrated?	(1) None of the time (2) A little of the time (3) Some of the time (4) Most of the time (5) All of the time
During the last week, how often did you feel depressed?	(1) None of the time (2) A little of the time (3) Some of the time (4) Most of the time (5) All of the time
During the last week, how often did you feel unhappy?	(1) None of the time (2) A little of the time (3) Some of the time (4) Most of the time (5) All of the time
During the last week, how often did you feel bored?	(1) None of the time (2) A little of the time (3) Some of the time (4) Most of the time (5) All of the time
During the last week, how often did you feel sad?	(1) None of the time (2) A little of the time (3) Some of the time (4) Most of the time (5) All of the time

Table A2. Grouping of Adolescent Based on Parental Migration Status

| Rural/urban area	Categorization
Rural sample (N=7150)	Rural-intact adolescent: Rural *hukou*, living in a rural area with both parents (N=5126)
	Left-behind adolescent: Rural *hukou*, living in a rural area, with one or both parents absent (N=2024)
Urban sample (N=6846)	Migrant adolescent: Rural *hukou*, living in an urban area with migrant parents (N=1587)
	Urban-intact adolescent: Urban *hukou*, living in urban area with both parents (N=5259)

Table A3. Definition of variables

Variables	Description
Physical health	Scale 1-5; 1 = very bad; 5 = very good
Mental health	Scale 5-25; higher score indicating bad mental health
Migrant adolescent	Binary; 1 = migrant adolescent; 0 = urban-intact adolescent
Left-behind adolescent	Binary; 1 = left-behind adolescent; 0 = rural-intact adolescent
Age	The age of adolescents measured in years
Female	Binary; 1 = female; 0 = male
Grade9	Binary; 1 = 9th grade; 0 = 7th grade
Mother's education level: primary	Binary; 1 = primary education and below; 0 = other levels
Mother's education level: lower secondary	Binary; 1 = lower secondary education; 0 = other levels
Mother's education level: upper secondary	Binary; 1 = upper secondary education; 0 = other levels
Mother's education level: tertiary	Binary; 1 = tertiary education; 0 = other levels
Father's education levels	4 binary variables similarly constructed as above
Family income level: low	Binary; 1 = low; 0 = other levels
Family income level: low	Binary; 1 = medium; 0 = other levels
Family income level: low	Binary; 1 = high; 0 = other levels
Relationship with mother	The relationship between adolescent and mother; categorical; 0 = not close; 1 = average; 2 = close
Relationship with father	The relationship between adolescent and father; categorical; 0 = not close; 1 = average; 2 = close

Figure A1. Age distribution of participants
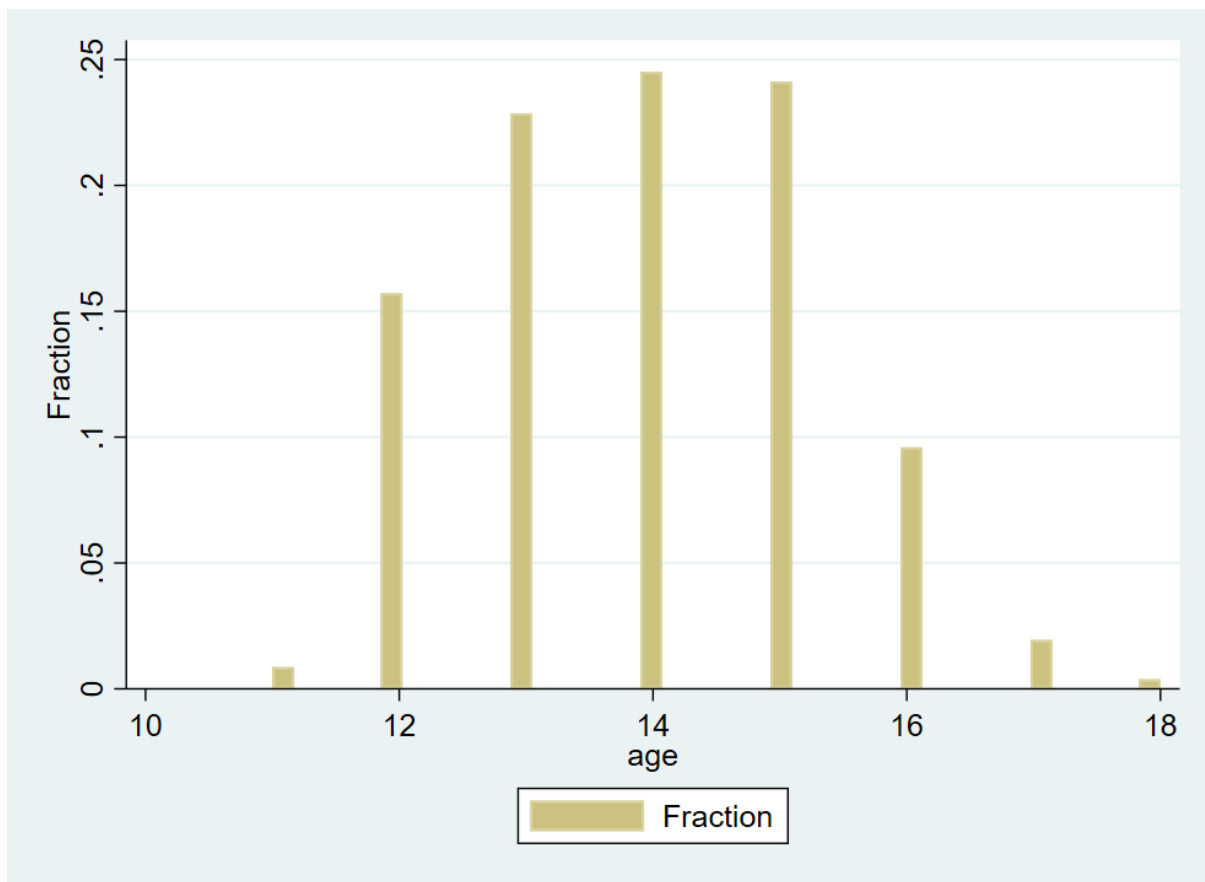
Notes: This histogram plots the fractions of ages of the participants.

Figure A2. Density plot of mental health variable
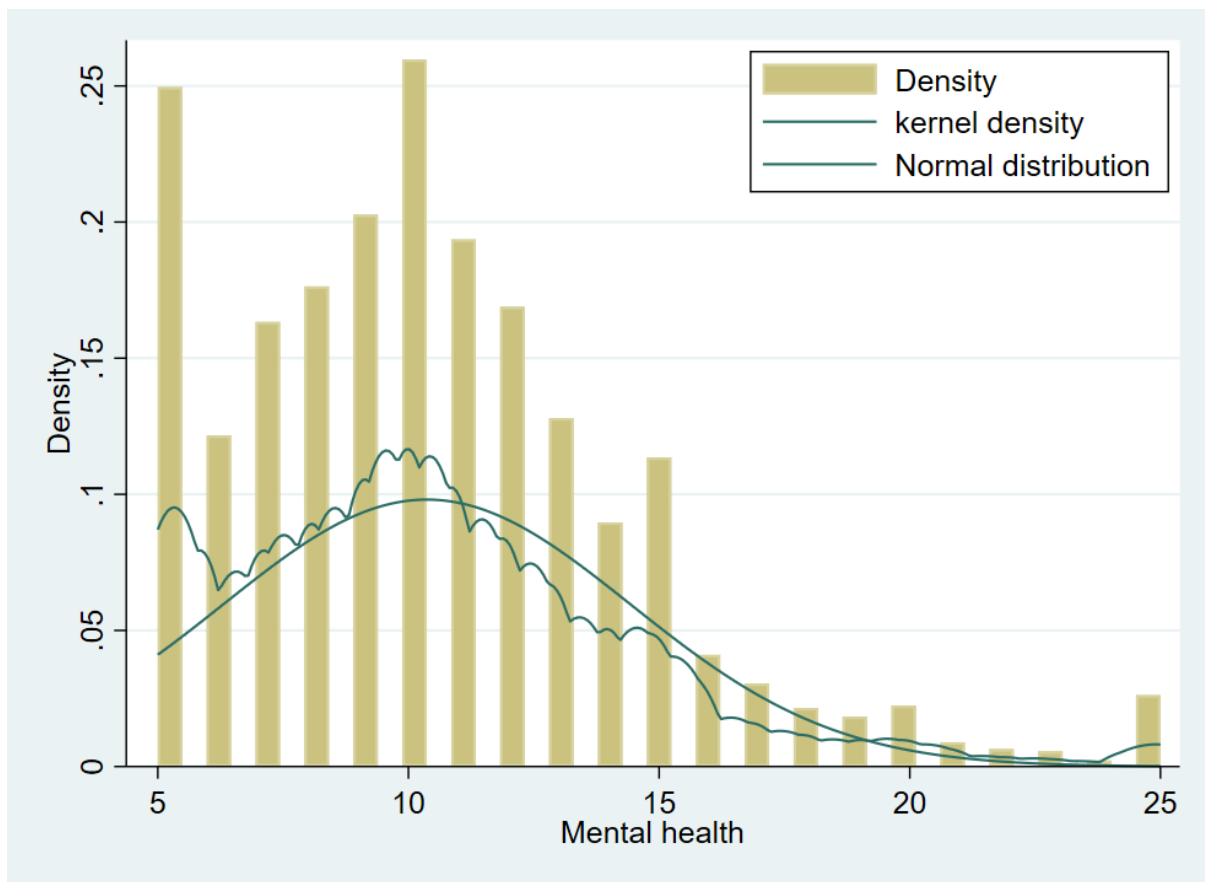
Notes: This histogram plots the density distribution of the mental health variable. Kernel density and a normal distribution are also plotted.