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ORIGINAL PAPER

Parental Migration and Rural Left-Behind Children's Mental Health in China: A Meta-Analysis Based on Mental Health Test

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Abstract Parental migration has been an important predictor of left-behind children's developmental outcomes. Based on the ecological model of rural left-behind children's development, we systematically reviewed studies related to rural left-behind children's mental health in China and investigated left-behind children's mental health and its influencing factors. Thirty-two studies involving 28,629 participants met the inclusion criteria were included in our meta-analysis to compare mental health of left-behind children and non-left-behind children. Twenty-two studies involving 8,634 participants were included in gender difference meta-analysis. The results indicated that left-behind children report more mental health problems than non-left-behind children, left-behind girls were confronted with higher level of mental health problems than left-behind boys, left-behind children in primary school and junior high school reported more mental health problems than those in senior high school, and self-guardian children have more serious mental health problems than children guarded by grandparents, former generation, and single parent. Implications for future practice were analyzed from family, school, and government perspectives.

Keywords Left-behind children · Mental health test · Meta-analysis · Gender · Family functioning

Introduction

During past thirty years, China has experienced great economic change owing to the reform and opening up policy. Following the steps of urbanization and industrialization, a large number of agricultural labor force flow into cities and become migrant workers. Among which, some have to leave their children at rural hometown for different reasons. With the great increase of stay-at-home children in recent ten years, the number has reached 58,000,000 yielding the "left-behind children" group (as is indicated in China's Sixth Census data conducted in 2010), accounting for 37.7 % of rural children and 21.9 % of the total number of Chinese children (All-China Women's Federation 2013).

Numerous studies in recent 15 years have found that parents' migration affected left-behind children's mental health in a passive way (Gao et al. 2010; Qin and Albin 2010; Wen and Lin 2012). However, the differences of mental health between left-behind children and non-left-behind children have not always been reported and its strength varies across studies (Zhang 2013; Zhao and Liu 2010; Zhou et al. 2005). A previous systematic review has summarized the mental health status of left-behind children compared with non-left-behind children and indicated that the comparison result is still mixing (Zhang et al. 2011). Therefore, it is crucial to conduct a systematic and comprehensive meta-analysis to synthesize and compare the mental health status of left-behind children and non-left-behind children and to have better understanding of the

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current status of left-behind children's mental health (Wen and Lin 2012).

Left-behind children refer to children under 18 years old who cannot live with both parents because one or both of their parents work outside for at least 6 months and they are left at home in rural areas (Duan and Zhou 2005; Wu 2004; Zhang et al. 2011). These children were evidenced to bear the social cost of parental migration.

Theoretically, Zhao and Shen (2010) have put forward an ecological model to describe the factors that influence left-behind children's development (Supplementary Fig. 1). This model indicated that the developmental outcome of rural left-behind children is in essence the result of dynamic relationship between individual function and surrounding ecological environment. Thus, to deal with the developmental problem of left-behind children in China is to handle the relation between environment and individual development. The complex ecological environment of left-behind children was categorized into proximal and distal environment based on the conceptual proximity. Generally, distal environment factors were those social functional factors and major life events without specific functional significance to the person, such as parent-absent types, guardian types, and family socioeconomic status; while proximal environment factors were factors of personal meanings, such as children's direct daily experience, roles, and their interaction with others. Except for the distal and proximal environment factors, personal characteristics are also very important for left-behind children's developmental outcomes. Personal characteristics were those psychological factors in microsystem that directly affected an individual's developmental outcome, such as cognitive appraisal of life events and personality types. The distal factors, proximal factors, and personal characteristics all together account for the protective and risk factors of children's developmental outcomes. What's more, the relations among proximal, distal environment factors, personal characteristics, and children's development would be affected by children's demographical characters such as age and gender (Zhao and Shen 2010).

Empirically, many studies have compared mental health between left-behind children and non-left-behind children and resulted in inconsistent conclusions. Most studies evidenced that mental health of left-behind children were not optimistic. For example, some cross-sectional studies showed that left-behind children had more psychopathology and less prosocial behaviors than non-left-behind children, and were more vulnerable to anxiety and depressive symptoms (Fan et al. 2010; Liu et al. 2009; Pan and Liu 2010). A meta-analysis of self-concept among left-behind children showed that left-behind children scored lower in global self-concept than their common counterparts (Wang et al. 2015). However, some studies showed opposite results. For example, Zhao and Liu (2010) indicated that being left at home didn't significantly predict children's depression and self-esteem. What's more, other studies indicated that left-behind children didn't show worse psychological well-being than their control counterparts, but the subpopulations of left-behind children were at potential risks of mental health problems (Tao et al. 2014). First, gender difference of left-behind children's mental health exists. For example, Zhao et al. (2015) suggested that left-behind boys had more mental health problems than girls, while Wang (2011) used the same measure but found opposite results. Second is about age group differences of left-behind children's mental health. Zhao et al. (2015) suggested that high school left-behind students had more psychological problems than primary school students; while Yang et al. (2009) supported the opposite result. Other studies found that both primary school and middle school student would encounter different mental health problems and they did not show significant differences (Hu and Zhu 2015).

Parent-absent types and guardian types as two distal factors were important factors contributing to left-behind children's mental health problems. First, parents' migration usually includes three types: father-absent, mother-absent and both-parents-absent. Father-absent and mother-absent together called single-parent-absent. Parents' absence in children's growth may result in serious physical and mental health problems (Loeber and Stouthamer-Loeber 1986). Second, guardian type was also an important factor affecting left-behind children's mental health (Hu 2008; Su 2008). For example, Hu (2008) showed that children raised by grandparents, single parent (either father or mother), former generation (like uncles) or children themselves all predicted serious problems in eight subscales and global score of Mental Health Test. Especially, mental health of self-guardian left-behind children was the worst of all.

Previous studies examining mental health of left-behind children have used different measures, such as Mental Health Inventory of Middle-school students (MMHI), Symptom Checklist 90 (SCL-90), Strength and Difficulties Questionnaire (SDQ) and Mental Health Test (MHT). A meta-analysis of left-behind children's mental health based on SCL-90 indicated that migration affected the mental health of left-behind children in a passive way (Qin and Albin 2010). Though SCL-90 has been one of the widely used measures to test psychological distress in clinical research, it is not more popularly used in measuring left-behind children's mental health. A systematic study indicated that MHT had been one of the most popularly used measure in examining mental health of left-behind children till 2011(Zhang, et al. 2011).

MHT was revised from Japanese scholar Kurt Suzuki's "anxiety tendency test" to evaluate psychological problems

and psychopathological symptoms among Chinese adolescents and has proven to be of good reliability and validity (Zhou 1991). A total of 100 items formed one validity subscale (10 items) and eight content subscales including learning anxiety (15 items), interpersonal anxiety (10 items), lonely tendency (10 items), self-blame tendency (10 items), over-sensitive tendency (10 items), physical symptoms (15 items), panic tendency (10 items), and impulsive tendency (10 items). Participants were asked to respond "yes" or "no" to every item. Those who answered "yes" would get 1 point and "no" get 0 point. Those responses with score above 7 in validity subscale were removed because the high score in validity subscale is an indicator of social desirability effect, that is, the student may have a false response for better grades. The global score was calculated by adding the scores in eight subscales and it ranged from 0 to 90. The higher global score indicated more mental health problems. Generally, global score above 56 indicated higher level of mental health problems and lower than 21 indicated lower level of mental health problems; global score above 65 would be detected as mental health problem. Eight subscales represent mental health in different dimensions, and score above 8 in subscales indicated high level of mental health problems in specific dimension.

Previous studies have extensively examined left-behind children's mental health using MHT and resulted in inconsistent results. For example, Zhou et al. (2008) indicated that left-behind children were more vulnerable to mental health problems compared with their counterparts; while Zhang (2013) didn't find significant difference on MHT between left-behind children and non-left-behind children. Thus, a comprehensive meta-analysis based on MHT is necessary to have better knowledge of left-behind children's mental health.

The current meta-analysis focused on solving the following questions by integrating and analyzing previous literature. First, we compared the global score and subscale scores of MHT between left-behind children and non-left-behind children, and investigated the study and sample characteristics that might moderate the differences including districts, publication quality, sampling, and age groups. Second, we examined possible factors that affected left-behind children's mental health including gender, age group, parent-absent types, and guardian types.

Method

Search Strategy

We obtained studies through both Chinese and English language databases published from 2000 to 2015 (last search performed on November 2015). First, Chinese language journals and sources were searched electronically in Chinese National Knowledge Infrastructure (CNKI), Wanfang Database and VIP databases; second, English language journals were searched in PubMed Database, Google Scholar and Web of Science. The keyword "left-behind children" ("Liu shou er tong" in Chinese) and "mental health" ("Xin li jian kang" in Chinese) were used to search in Chinese language databases. The keywords used in English language database searching include "left-behind children" "stay-at-home children" "left-over children" or "parent-absent students", "guarded children", "parental migration", "hometown-remaining children", "rural children left" AND "mental health", "psychological well-being". We also e-mailed most published authors in our database to request their published and unpublished work. Finally, we examined the reference lists of prior reviews of left-behind children's mental health and the articles included in our database to identify other possible articles for inclusion.

Inclusion Criteria

Studies were selected based on the following eligibility criteria: (a) Presence of at least two groups of data for the convenience of comparison, including the mental health scores of left-behind children and non-left-behind children, left-behind boys and girls, left-behind children in different age groups, left-behind children with different parental styles and guardianship styles; (b) Presence of MHT; (c) Published between 2000 and 2015; (d) Presence of appropriate statistics including means (M), standard differences (SD) and sample population (n). However, in some cases, Supplementary Information to calculate effect size was supplied by the authors of the synthesized reports.

Coding of Study Characteristics

Relevant characteristics of the reports were coded by two independent raters. Disagreements between coders were resolved by discussion and further examination of the reports. We coded studies for characteristics of the report, including the following information: (a) the first author's surname (year of publication), (b) year of data collection, (c) types of publication (article or dissertation), (d) publication quality (categorized into Chinese Social Sciences Citation Index (CSSCI) articles = 1, Excellent master's thesis paper = 2, Ordinary magazine articles = 3), (e) sample sizes of left-behind children and non-left-behind children, (f) percentage of left-behind girls among all left-behind children (%girl in LBC), (g) specific province of data collection, (h) district (East, Middle, and West China), (i) sampling (simple random sampling = 1, stratified sampling = 2, cluster sampling = 3, stratified sampling and

cluster sampling = 4), and (j) age group (primary school = 1, junior high school = 2, senior high school = 3, and mixed/not given = 4). If the descriptions of study were unclear or key characteristics were missing, we contacted authors to obtain the information necessary for coding. If this was not possible or if the information was unavailable, we coded the variable as "N/A".

Analytic Strategy

We used means, standard deviations and sample number to estimate effect size (d), confidence interval (CI) and homogeneity statistics (Q). We performed analyses using fixed- and random-effects procedures. After computing effect sizes for each reported outcome, we computed an average effect size indicating overall difference.

Results

Characteristics of the Studies

Searching of the above databases and sources yielded 38 articles using MHT to examine mental health of left-behind children. The articles were published over a span exceeding 10 years from 2006 to 2015. Characteristics of these 38 articles were summarized in Table 1. The flowchart of review process was shown in Supplementary Fig. 2.

Mental Health of Left-Behind Children and Non-Left-Behind Children

The literature search finally identified a total of 38 studies related to left-behind children's mental health. Among these studies, 25 studies reported the global scores of left-behind children and non-left-behind children. We first compared global mental health score between left-behind children and non-left-behind children and estimated effect sizes using Cohen's d coefficient for left-behind and non-left-behind children divided by the pooled standard deviation. The homogeneity analysis showed that $Q(24) = 331.24$, $p < 0.001$, indicating that the samples did not share a common effect size; also, a substantial portion of the between-study variance might be explained by true between-study differences rather than sampling error ($I^2 = 92.75$). Consequently, we chose random-effect model to report effect size. The results showed that left-behind children had higher scores of mental health than non-left-behind children, $d = 0.40$, $SE_d = .05$ ($k = 25$; $N = 23{,}659$; 95 %CI = [0.30, 0.51]). The results of effect size and heterogeneity analysis were shown in Table 2. The forest plot for random-effect meta-analysis of the difference between left-behind and non-left-behind children's mental health was shown in Supplementary Fig. 3.

Then we evaluated the existence of publication bias. The funnel plot was shown in Supplementary Fig. 4. The classic fail-safe N indicated that the publication is not perfectly symmetrical and indicated the existence of publication bias. The Rosenthal fail-safe analysis indicated that 3085 studies would be required to bring down the cumulative significance of effect size to non-significance.

Next, we compared the differences of mental health between left-behind and non-left-behind children in eight subscales. Thirty-one studies were included in the comparison in two subscales (Learning anxiety, LA and Interpersonal anxiety, IA), and 32 studies were included in the comparison in the other six subscales. The results indicated that left-behind children scored significantly higher in all eight subscales than non-left-behind children. The effect size and heterogeneity analysis results were shown in Table 2.

Finally, we examined the influence of moderators on the difference of mental health between left-behind children and non-left-behind children. Homogeneity of variance tests revealed no significant heterogeneity across studies of different publication quality, districts, and sampling methods (all $p > .05$). A homogeneity of variance test revealed that age group significantly moderate the difference of mental health between left-behind children and non-left-behind children, $Q(2) = 6.740$, $p = .03$, the proportion of total variability explained by heterogeneity was high, $I^2 = 92.75\,\%$. Compared with non-left-behind children, left-behind children in primary school performed the worst in MHT, $d = 0.88$, $SE_d = .27$ ($k = 4$; $N = 4{,}187$; 95 %CI = [0.35, 1.41]), followed by children in junior high school, $d = 0.47$, $SE_d = .13$ ($k = 6$; $N = 1{,}837$; 95 %CI = [0.23, 0.72]), and then those in mixed or unclear age group, $d = 0.28$, $SE_d = .05$ ($k = 15$; $N = 17{,}635$; 95 %CI = [0.19, 0.36]).

Gender Difference of Left-Behind Children's Mental Health

Twenty-two studies met the criteria of comparison of global scores between left-behind boys and girls. Among which, 20 studies were included in 7 subscales (except Lonely tendency, LT) comparison between left-behind boys and girls and 19 studies were included in LT subscale comparison between left-behind boys and girls.

We compared global mental health score between left-behind boys and girls. The results showed that left-behind boys had lower scores than left-behind girls, $d = -0.27$, $SE_d = .06$ ($k = 22$; $N = 8{,}634$; 95 %CI = [−0.39, −0.15]). The heterogeneity analysis showed that $Q(21) = 159.28$, $p < .001$, indicating that the samples did not share a common effect size; also, a substantial portion of the

Table 1 Main codes and Input Values for left-behind children's mental health meta-analysis (k=38)

ID	Study	Year collected	Types of publication	Publication quality	N(LBC/NLB)	%girl in LBC	Province	District	Sampling	Age group
1	Cao et al. (2009)	N/A	Article	3	414/NA	50.72 %	Shandong	E	3	4
2	Cheng (2009)	N/A	Article	3	3185/2903	N/A	Anhui	M	2	4
3	Du (2009)	N/A	Dissertation	2	455/NA	52.97 %	Anhui	M	2	2
4	Feng and Huang (2011)	N/A	Article	3	145/125	44.14 %	Guizhou	W	1	2
5	Gao et al. (2011)	N/A	Article	3	1115/1192	N/A	Jiangsu	E	4	1
6	Ge et al. (2009)	N/A	Article	3	145/61	47.59 %	Sichuan	W	1	2
7	Guo and Huang (2011)	N/A	Article	3	174/106	N/A	Hunan	M	3	2
8	He et al. (2006)	N/A	Article	3	94/117	47.87 %	Hunan	M	1	4
9	Hu (2008)	N/A	Dissertation	2	470/NA	44.04 %	Jiangxi	M	3	4
10	Hu and Chen (2012)	N/A	Article	3	279/NA	48.39 %	Sichuan	W	N/A	4
11	Hu and Zhu (2015)	2012	Article	1	179/199	N/A	Hunan	M	3	4
12	Huang and Li (2007)	N/A	Article	1	570/133	N/A	Jiangxi	M	2	4
13	Jiang (2010)	N/A	Article	3	802/NA	52.49 %	Anhui	M	N/A	4
14	Jin et al. (2009)	N/A	Article	1	748/531	41.18 %	Jiangsu	E	4	4
15	Jin et al. (2010)	N/A	Article	1	748/NA	41.18 %	Jiangsu	E	4	4
16	Liu and Jin (2010)	N/A	Article	3	89/103	N/A	Liaoning	E	N/A	1
17	Liu (2011)	N/A	Article	1	187/465	N/A	Guangxi	M	3	4
18	Liu and Chen (2009)	N/A	Article	3	508/382	N/A	Shaanxi	W	1	4
19	Liu (2007)	N/A	Dissertation	2	147/127	39.86 %	Henan	M	3	2
20	Long (2008)	N/A	Article	3	320/NA	49.39 %	Guangxi	M	N/A	3
21	Ma and Jin (2010)	N/A	Article	3	102	40.20 %	Anhui	M	2	1
22	Ma and Liu (2010)	N/A	Article	3	512/132	N/A	Henan	M	2	4
23	Su (2008)	N/A	Dissertation	2	226/213	46.90 %	Hunan	M	3	4
24	Wang (2009)	N/A	Article	3	457/307	45.51 %	Jiangxi	M	N/A	4
25	Wang (2010)	N/A	Article	3	610/636	51.30 %	Henan	M	N/A	1
26	Wang et al. (2011)	2010	Article	1	472/368	49.36 %	Shaanxi	W	3	2
27	Wang (2011)	N/A	Article	3	75/42	N/A	Anhui	M	2	4
28	Wei et al. (2008)	N/A	Article	3	358/NA	54.47 %	Guangxi	M	N/A	2
29	Wu (2009)	N/A	Dissertation	2	203/239	N/A	Sichuan	W	1	1
30	Xiong (2013)	N/A	Article	3	312/261	42.95 %	Hunan	M	1	4
31	Yang et al. (2009)	N/A	Article	3	578/335	N/A	Hebei	E	N/A	4
32	Yue et al. (2006)	N/A	Article	3	363/NA	50.96	Zhejiang	E	3	4
33	Zeng and Zeng (2008)	N/A	Article	N/A	NA	46.24 %	Jiangxi	M	N/A	2
34	Zhao et al. (2008)	N/A	Article	3	385/446	52.47 %	Shandong	E	3	4
35	Zhao et al. (2015)	N/A	Article	3	410/435	45.37 %	Shandong	E	4	4
36	Zhao (2015)	N/A	Dissertation	2	1390/1131	N/A	Anhui	M	3	4
37	Zhao (2009)	N/A	Article	3	268/260	N/A	Henan	M	N/A	2
38	Zheng (2014)	N/A	Article	1	156/123	N/A	Hubei	M	3	2

Note. Publication quality: *1* CSSCI, *2* excellent master's thesis paper, *3* ordinary magazine; *N(LBC/NLB)* sample sizes of left-behind children and non-left-behind children; Age group: *1* primary school, *2* junior high school, *3* senior high school, *4* mixed (junior high and senior high, junior high and primary school, or primary and middle school) or not given**;** Province: *E* East China, *W* West China, *M* Middle China; Sampling: simple random sampling = 1, stratified sampling = 2, cluster sampling = 3, stratified sampling and cluster sampling = 4

between-study variance might be explained by true between-study differences rather than sampling error (I^2 = 86.82). The results of effect size and heterogeneity analysis as well as forest plot for global score of mental health were shown in Supplementary Table 1 and Supplementary Fig. 5.

We then evaluated the existence of publication bias. The funnel plot was shown in Supplementary Fig. 6. The classic fail-safe N indicated that the publication is not perfectly symmetrical and indicated the existence of publication bias. The Rosenthal fail-safe analysis indicated that the required

Table 2 Meta-analysis result of mental health between left-behind children and non-left-behind children

			Effect size			Heterogeneity analysis	
measure	*k*	*N*	*d*	SE_d	95 %CI	*Q*	I^2
MHT	25	23,659	0.40	0.05	.299, .508	331.235***	92.754
LA	31	28,355	0.67	0.14	.367, .926	3563.424***	99.158
IA	31	28,355	0.67	0.14	.399, .940	3358.089***	99.107
LT	32	28,629	0.77	0.14	.497, 1.050	3646.421***	99.150
ST	32	28,629	0.54	0.15	.259, .826	3812.885***	99.187
OT	32	28,629	0.58	0.13	.312, .839	3340.006**	99.072
PS	32	28,629	0.87	0.01	.584, 1.147	3759.607***	99.175
PT	32	28,629	0.51	0.13	.248, .775	3335.147***	99.071
IT	32	28,629	0.82	0.15	.539, 1.105	3815.603***	99.188

Note. *MHT* global score in MHT measure, *LA* learning anxiety, *IA* interpersonal anxiety, *LT* lonely tendency, *ST*.self-blame tendency, *OT* over-sensitive tendency, *PS* physical symptoms, *PT* panic tendency, *IT* impulsive tendency. $^*p < .05$, $^{**}p < .01$, $^{***}p < .001$

number of studies that would bring a mean effect of 0 is 669. These results indicated that publication bias did not substantially influence our meta-analysis.

After the comparison of global score across gender, we compared the gender differences of mental health in eight subscales. The results indicated that left-behind boys scored significantly lower than left-behind girls in six subscales including interpersonal anxiety, self-blame tendency, over-sensitive tendency, physical symptoms, panic tendency and impulsive tendency, while learning anxiety and lonely tendency didn't show significant gender difference. The effect size and heterogeneity analysis results were shown in Supplementary Table 1.

Age Difference of Left-Behind Children's Mental Health

We compared mental health of left-behind children of primary school, junior high, and senior high school. First, we compared the mental health between primary school and junior high school left-behind children. The present study included 4 studies comparing age differences of global mental health score between primary school and junior high school left-behind children and 5 studies comparing age differences in eight subscales. The heterogeneity analysis of global score showed that $Q(3) = 25.01$, $p<.001$, indicating that a substantial portion of the between-study variance might be explained by true between-study differences rather than sampling error ($I^2 = 88.00$). Thus, random-effect model was adopted to test pooled effect size and result showed that $d = 0.02$, $SE_d = .13$ ($k = 4$; $N = 2199$; 95 %CI = [−0.23, 0.28]). The comparison of eight subscales across two age groups all showed no significant differences. Second, we compared mental health of junior high and senior high school students and didn't find significant difference on global score. However, left-behind children in junior high school scored significantly higher than senior high school students in LA, ST, and PT subscales. Third, we compared mental health of primary and senior high school left-behind children. Children in these two age groups didn't score significantly different on global score, but left-behind children in primary school had more symptoms in LA, IA, and PT subscales and fewer symptoms in IT subscale. The results of effect size and heterogeneity analysis and the forest plot for global score of mental health were shown in Supplementary Tables 2 to 4 and Supplementary Fig. 7.

Mental Health of Single-Parent-Absent and Both-Parents-Absent Left-Behind Children

Eight studies were included in the comparison of mental health between single-parent-absent and both-parents-absent left-behind children (Cao et al. 2009; Ge et al. 2009; Hu 2008; Su 2008; Wang 2011; Wei et al. 2008; Zhao et al. 2008; Zhao 2009). We calculated the mental health score of left-behind children in single-parent-absent group by combining father-absent and mother-absent data. First, we compared the global score of mental health between single-parent-absent and both-parents-absent left-behind children. The heterogeneity analysis showed that $Q(7) = 27.79$, $p<.001$, $I^2 = 74.81$. Thus, random-effect model was adopted to test pooled effect size and results showed that $d = -0.18$, $SE_d = .09$ ($k = 8$; $N = 2494$; 95 %CI = [−0.36, 0.01]). The result of effect size and heterogeneity analysis was shown in Supplementary Table 5. Supplementary Fig. 8 showed the forest plot for global score of mental health. Then we evaluated the existence of publication bias. The classic fail-safe *N* indicated that the publication is not perfectly symmetrical and indicated the existence of publication bias. The Rosenthal fail-safe analysis indicated that another 24 studies were required to bring a mean effect to non-significance. These results indicated that publication bias has influence on our meta-analysis. Second, we tested the mental health subscale scores in

single-parent-absent and parents-absent groups and didn't find significant differences in eight subscales.

Mental Health of Left-Behind Children Across Different Guardian Types

The literature review resulted in 5 studies examining mental health of left-behind children in different guardian type families, among which, 2 studies that didn't report sample numbers were deleted. The final studies included in meta-analysis were 3 studies (Hu 2008; Huang and Li 2007; Su 2008). First, we compared global mental health score of grandparents guardian and single-parent guardian left-behind children. The heterogeneity analysis showed that $Q(3) = 3.01$, $p = .22$, $I^2 = 33.53$. Thus, fixed-effect model was adopted to test pooled effect size. The fixed-effect model showed that $d = 0.07$ ($k = 3$; $N = 972$; 95 %CI = [−0.10, 0.24]), indicating children guarded by grandparents and single-parent didn't report significant difference in mental health global measure. Then we compared global mental health score of grandparents guardian and former-generation guardian left-behind children. Two studies fit the inclusion criteria were included. The heterogeneity analysis showed that $Q(1) = .07$, $p = .79$, $I^2 = .000$. Thus, fixed-effect model was adopted to test pooled effect size and the fixed-effect model indicated that $d = -0.06$ ($k = 2$; $N = 628$; 95 %CI = [−0.25, 0.13]). The comparison between former-generation guardian and single-parent guardian children showed significant difference, the fixed-effect model showed that $d = 0.22$ ($k = 2$; $N = 628$; 95 %CI = [0.04, 0.40]). The heterogeneity analysis showed that $Q(1) = 2.07$, $p = .15$, $I^2 = 51.69$. The comparison between single-parent guardian and self-guardian showed significant difference in MHT global score, as the fixed-effect model showed that $d = -0.35$ ($k = 2$; $N = 412$; 95 %CI = [−0.61, −0.10]), the heterogeneity analysis showed that $Q(1) = 3.17$, $p = .08$, $I^2 = 68.44$. The comparison between grandparents guardian and self-guardian showed no significant differences, $d = 0.16$ ($k = 2$; $N = 704$; 95 %CI = [−0.06, 0.38]). Finally, we compared former-generation guardian and self-guardian and the results showed that $d = -0.17$ ($k = 2$; $N = 257$; 95 % CI = [−0.44, 0.11]). The comparison results were shown in Supplementary Tables 6 to 11.

Discussion

The present meta-analysis comprehensively reviewed studies regarding left-behind children's mental health using the measure of MHT in recent 15 years. Consistent with previous studies (Li et al. 2015; Sun et al. 2015), our results indicate that parental migration is a risk factor for children's mental health as left-behind children scored significantly higher on global measure and eight subscales than non-left-behind children. Both single-parent-absent and both-parents-absent children show deteriorated mental health performance but they didn't show significant differences in mental health global scale and eight subscales. What's more, self-guardian left-behind children showed the most serious mental health problems among four guardian types, followed by former-generation guardian, grandparents guardian and single-parent guardian children in turn.

Based on the ecological model of rural left-behind children's development (Zhao and Shen 2010), parental migration is a risk factor for children's healthy development and takes effect directly or indirectly via the interaction of a series of proximal environment factors (family and school) and personal characteristics. From family perspective, the mental health problem of left-behind children lies in the change of family functioning after parental migration. Family functioning, as a process for family members to interact with each other, can enhance emotional bonds of family members and contribute to family members' physical, mental and social development (Lanigan 2009). However, parental migration has greatly reduced family communication, affective expression and parental involvement, which are important dimensions of family functioning (Slinner and Steinhauer 2000). First, parental migration has reduced quantity and quality of family communication. The migrant parents usually work for the whole day and have limited time and energy to make phone calls with their children. An investigation showed that 88 % of parents' communication with left-behind children is by making phone calls, among which 60 % of parents' communication with left-behind children focused on inquiring about school performance, telling children to be obedient to parent, grandparents, former-generation or teachers, and asking children to take care of their own physical health and safety. Parents seldom concern about children's psychological and emotional needs, nor do children share many of their emotional problems with parents (Duan et al. 2014). That is, the quantity and quality of parent–child communication cannot be guaranteed yet. The lack of affective expressions increases children's loneliness and makes it difficult for children to establish direct and close emotional connection with parents (Su et al. 2013). Second, the economic pressure caused by low family income and unstable work would increase parents' depression and marital conflict, and in turn greatly affect the quantity and quality of parental involvement (Conger et al. 1992). The reduced parental involvement would place children at great risk of neglect and unsupportive family environment and increase left-behind children's vulnerability to disruptions in psychological functioning, especially emotional problems and social competence (Repetti et al. 2002).

From school perspective, school environment is of great significance to left-behind children's psychological well-

being, among which, peer acceptance and rejection are important predictors of left-behind children's mental health. Studies have evidenced that left-behind children are exposed to more peer rejection, which significantly increased their aggressive behavior, loneliness, and school disengagement; while peer acceptance is a protective factor for left-behind children's loneliness and school engagement (Zhao et al. 2008, 2013). In addition, due to the increasing reports on left-behind children's conduct and behavioral problems, left-behind children are treated as "problematic children" in schools. The stigma increases left-behind children's perceived discrimination including speech discrimination and behavior discrimination and increases their behavioral problems such as avoidance, withdrawal, attack, and breaking disciplines (Zhang et al. 2015).

Our results also indicated that left-behind girls had more mental health problems than left-behind boys based on MHT. Since MHT focused more on internal psychological problems, our result indicates that left-behind girls show more internal mental health problems than left-behind boys. This is consistent with previous studies indicating that left-behind girls tend to have lower self-concept, less happiness and satisfaction, and more emotional problems than left-behind boys (Wang et al. 2015; Zhou et al. 2005). Another possible explanation is that children with same-sex parenting are more vulnerable to family stressors than opposite-sex parenting (Laursen et al. 1998; Leinonen et al. 2003). Since 1,761 single-parent-absent children and 733 both-parents-absent children are involved in the present meta-analysis, more than two thirds of children live with their single parent, mostly mother, in rural areas. This may increase the risk of mother–daughter conflict and result in left-behind girls' increased mental health problems.

However, our result didn't indicate that left-behind boys' mental health status is more optimistic than girls'. It has been generally agreed that girls tend to have more internal problems such as depression and anxiety, while boys show more external and behavioral problems such as physical attack and juvenile delinquency (Sánchez-Queija et al. 2016). A study used SDQ to measure children's psychological and behavioral outcomes and found that left-behind girls have more emotional problems than boys, while boys have more conduct problems, hyperactivity problems and peer relationship problems than girls (Hu et al. 2014). Another study showed that left-behind boys report higher level of loneliness than girls while left-behind girls report higher level of anxiety than boys (Zhou et al. 2005). Consequently, the interventions of left-behind children's mental health should take gender difference into consideration.

As to the age group differences of left-behind children's mental health, our results indicate that left-behind children in primary school and junior high school have more mental health problems than senior high school students. A previous meta-analysis has suggested that left-behind children in primary school have lower self-concept and higher anxiety than those in middle school (Wang et al. 2015). In line with the meta-analysis, our result suggest that attention should be paid to children's age at parental-absence time since children would encounter more mental health problems when parents leave home at their early age than when parents leave home during their late adolescence.

Implications for Future Research and Limitations

In summary, our study adds to previous findings for more comprehensive understanding of left-behind children's mental health, which can deepen our understanding of influence factors of left-behind children's mental health and help us make targeted design for mechanism detecting and effective interventions. Theoretically, our meta-analysis supports the ecological model of left-behind children and revealed some distal environment factors and moderators as either protective or risk factors. Since the distal environment factors take effect via proximal environment factors and the interaction between proximal environment factors and personal characteristics, future studies should further explore the process underlying the protective and risk factors.

Practically, it necessitates more effort and work from family, schools, and government for the improvement of the status of left-behind children's mental health. First, parents should increase high-quality parental involvement and effective parent-child communication. Due to parental migration, the direct face-to-face communication between parents and children has been greatly reduced. However, the rapid development of internet allows parent–child communication through new technology formats, such as voice chat, video chat, and sending emails. These internet technologies have made it possible to create and maintain family bonds in spite of geographical distance (Carvalho et al. 2015). Targeting the present situation of low degree and quality of parent–child communication and parental involvement, parents may consider taking advantage of the internet technology to increase high-quality parental involvement and effective parent–child communication instead of ineffective dialog. Meanwhile, more family intervention activities should be conducted to help parents learn effective parenting skills to increase effective parent–child interactions.

Second, parents are encouraged to have more virtual activities with their children. Taking part in family activities like shopping, chatting, and eating together can greatly increase adolescents' perceived social support and decrease the risk of internet addiction (Gunuc and Dogan 2013). However, parental migration makes it difficult for children to establish direct and close emotional connection with parents. Since internet technology makes family members

virtually present and helps to maintain family intimacy (Bacigalupe and Lambe 2011), it is suggestive that internet technology should be better used to increase family virtual interaction to strengthen emotional bond.

Third, as an important place for children's learning and daily life, school is very crucial to left-behind children and should be well established to help improve these children's mental health. Specifically, schools are encouraged to have better management mechanism of left-behind children, create friendly and harmonious school atmosphere, and offer targeted mental health activities for left-behind children. Teachers should play a role of bridge to unite left-behind children and their parents as well as peers together, that is, home-school association should be strengthened to improve parental cohesion and peer relationships. In order to strengthen home-school association, teachers should play a key role in contacting left-behind children's parents and encouraging more parental emotional connections with children. For example, teachers work as surrogate parents in some areas of China. These surrogate parents would take care of children's life, learning and mental health and conduct regular communications with their parents or nurtures.

Finally, the present plight of left-behind children's developmental problems urges government to put forward more targeted policies to strengthen the care and protection of left-behind children. For example, it is necessary to improve rural education policy and enhance basic education for children in rural areas, strengthen the guardianship and supervision system and to provide judicial protection procedures for left-behind children.

It should be noted that our study has some limitations needed to be considered in future research. First, we only included MTH in the present study and might excluded important information based on other measures, future studies should pay more attention to comprehensive understanding of left-behind children's mental health status using different measures. Second, based on the ecological model of left-behind children's development, the distal environment factors, proximal environment factors, and personal characteristics would work together to affect children's developmental outcomes, so future studies are expected to reveal the mechanism underlying left-behind children's mental health problems. Finally, the number of studies included in the comparison between single-parent-absent and both-parents-absent families, different guardianship styles and age-groups were limited, which greatly confined the effect size of the results.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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*Reference marked with an asterisk indicate studies included in the meta-analysis

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