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Original Research

The effect of a community-based, integrated and nurturing care intervention on early childhood development in rural China

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ABSTRACT

Objectives: This study investigated whether an integrated, community-based and nurturing care intervention led to a reduction in the prevalence of suspected neurodevelopmental delay in children. The study also considered how the programme could be sustained to promote early development in children aged under 3 years in the poorest areas of rural China.

Study design: A quasi-experimental design was applied, with data collection before and after a 2-year programme implementation, in both intervention and comparison (control) areas.

Methods: From July 2014, the Integrated Early Childhood Development (IECD) programme was implemented in poverty-stricken areas in four counties of China. Nurturing care intervention focusing on five components (child health, nutrition, responsive care, protection and early learning support) was delivered mainly by the village early childhood development centre and township/village clinic. Another two counties of similar per capita gross domestic product, geographical characteristics, under-five mortality rate, under-five underweight prevalence and ethnicity to the four programme counties were selected as the comparison and received no IECD programme intervention. The Ages & Stages Questionnaire was used to evaluate the neurodevelopmental outcome of children; the overall suspected developmental delay (SDD) referred to any developmental delay in the communication, gross-motor, fine-motor or problem-solving or personal-social domains of the questionnaire. Children underwent anthropometric measurements and haemoglobin concentration testing through peripheral blood. Face-to-face interviews of caregivers were conducted to collect intervention use, cognitive stimulation and child-protection

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behaviours. A difference-in-differences regression approach, adjusting for confounding factors, was applied to estimate intervention impact on the neurodevelopmental outcomes in the children. Path analysis was employed to examine the mediating effects of growth, nutrition status, cognitive stimulation and child-protection behaviours through which the IECD intervention predicted children's developmental health.

Results: In total, 2953 children aged under 3 years and their caregivers were enrolled at baseline, and 2745 child-caregiver pairs completed the postintervention assessment. Prevalence of overall SDD was reduced by 18% (from 37% at baseline to 19% at post-intervention) in intervention counties, which is a significant difference compared with the 10% reduction in control counties (from 30% to 20%), with an adjusted odds ratio of 0.69 (95% confidence interval: 0.54–0.89). Consistent findings were found across domains. Path analysis indicated that the effect of the intervention on promoting developmental health was mediated by multiple nurturing care-associated factors, including cognitive stimulation frequency, positive discipline, length-for-age growth and haemoglobin concentration.

Conclusions: The community-based integrated intervention could significantly prevent developmental delay in children aged under 3 years in rural China.

Introduction

Although early childhood development (ECD) is gaining increasing attention globally, 249 million children aged below 5 years in low- and middle-income countries are still at elevated risk of poor developmental outcomes, and around 7% (17 million) of these children are from China.[1] Growing evidence shows that suboptimal childhood development may exacerbate inequity and poverty by lowering subsequent educational attainment and reducing adult productivity and earnings, thus leading to intergenerational transmission of poverty.[2,3] Considerable global evidence supports improving ECD through the reduction of single, sector-specific risk factors[4–6] and the increment of protective factors.[7,8]

However, the known risk factors usually do not occur in isolation but coexist, especially in poor areas.[2,9] Integrated approaches, compared with single interventions, were shown to be more efficient in promoting childhood development and preparing children for school enrolment.[10–15] The first 3 years of life are the most important phase for brain sculpting because of the rapid brain-cell and neuron-networking development during this period. At this age, it is critical for infants and toddlers to be provided with adequate nutrition, appropriate care and cognitive stimulation. Thus, the overarching concept of 'nurturing care', addressing health, nutrition, security and safety, responsive caregiving and learning needs of early life recently emerged as the priority intervention approach for the well-being of physical, socio-emotional and language-cognitive development in children. Nurturing care is not only important in promoting the development of young children but also protects young children from the worst effects of adversity by lowering their stress levels and by encouraging emotional and cognitive coping mechanisms.[16,17]

Although previous community-based, randomised trials integrating one or two new interventions to enhance psychological and neurocognitive development were found to be especially beneficial, how to deliver such a comprehensive package of critical services efficiently and effectively to support families providing nurturing care, especially in rural settings, remains a challenge. To date, few studies have rigorously assessed the additive effects of combined health, nutrition, early stimulation and child protection services to promote child health and development in developing countries.[18–20]

In China, scattered community efforts were operated by a single government agency for early development,[21,22] mainly in developed areas. Most other early development studies were health care–focused and did not adequately address parenting education and psychosocial support for parents of children aged below 3 years.[23–30] Furthermore, supporting access for all children to necessary early development and protection services has been listed as one of the priorities in the Healthy China 2030 Agenda. However, around 50% of children in China live in rural areas;[31] thus, rigorously evaluated, efficient and effective comprehensive service models for early development in rural areas are greatly needed.

In 2014, an innovative Integrated Early Childhood Development (IECD) programme, delivering a cross-sectoral package of nurturing care-supporting interventions, was initiated in four poverty-stricken areas of China. This quasi-experimental study was conceived to evaluate the effectiveness of the package of nurturing care interventions in decreasing the prevalence of suspected developmental delay (SDD) among children after 2 years of implementation.

Methods

Study setting

The IECD programme was initiated in 40 poverty-stricken villages, located in Songtao County and Liping County in Guizhou Province and Fenxi County and Lin County in Shanxi Province, with 10 villages in each county. The IECD

programme counties (see Fig. 1) included four out of 592 counties on China's list of national-level poverty-stricken areas.[32] The intervention villages were selected based on the following criteria: (i) being within reachable distance (by car) from the county capital; (ii) having at least 50 resident children aged below 3 years; and (iii) having sufficient caregivers who were willing to participate.

Another two counties (Pan County in Guizhou Province and Fangshan County in Shanxi Province) [Fig. 1], which had no IECD programme intervention, were selected as the comparison areas based on criteria of similar per capita gross domestic product, geographical characteristics, under-five mortality rate, under-five underweight prevalence and ethnicity to the programme counties. In the two comparison counties, we further selected all villages with similar reachable distance by car from the county capital, numbers of resident children aged below 3 years and caregivers with similar willingness to participate.

Finally, a total of 40 intervention villages and 43 comparison villages were included in the evaluation surveys (see Fig. 2).

Study design and population

A quasi-experimental design with different baseline and postintervention survey samples was employed to compare changes in the study outcomes between intervention and comparison villages. Changes in identified study outcomes were assessed in a baseline survey from July to September in 2013 and a postintervention survey between July and September in 2016, respectively, using the same enrolment and data collection methods.

All children aged 0–35 months at the time of the survey, and their primary caregivers in selected villages were eligible for participation in the evaluation. Primary caregivers were defined as those who provided care for more than half the time to the child.

IECD intervention

Starting in July 2014, in addition to the national basic public health service package, an integrated, cross-sectoral and community-based package of nurturing care interventions was provided to all children aged below 3 years in the intervention villages. Five nurturing care intervention components (child health, nutrition, responsive care, protection and early learning support) were delivered through the village ECD centre and township/village clinic. The components were age appropriate for the child and were complemented by a Mobile Resource Unit (MRU) providing parent training and education. The intervention activities were characterised by children and caregivers both being involved, and interaction between children and caregivers was encouraged, rather than just involving children playing alone or cognitive stimulation provided by professional staff to children alone. In the comparison villages, only the national

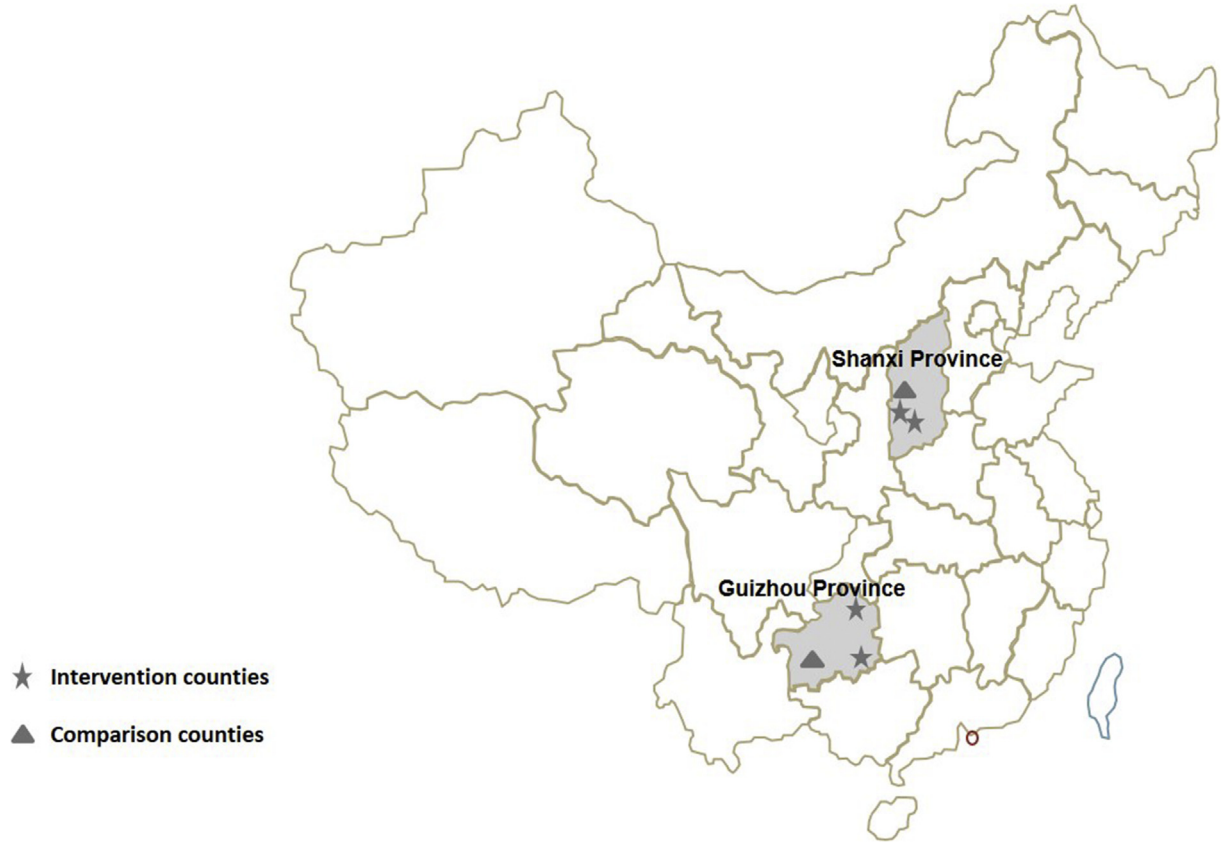

Fig. 1 – Location of intervention and comparison counties of the Integrated Early Childhood Development (IECD) programme.

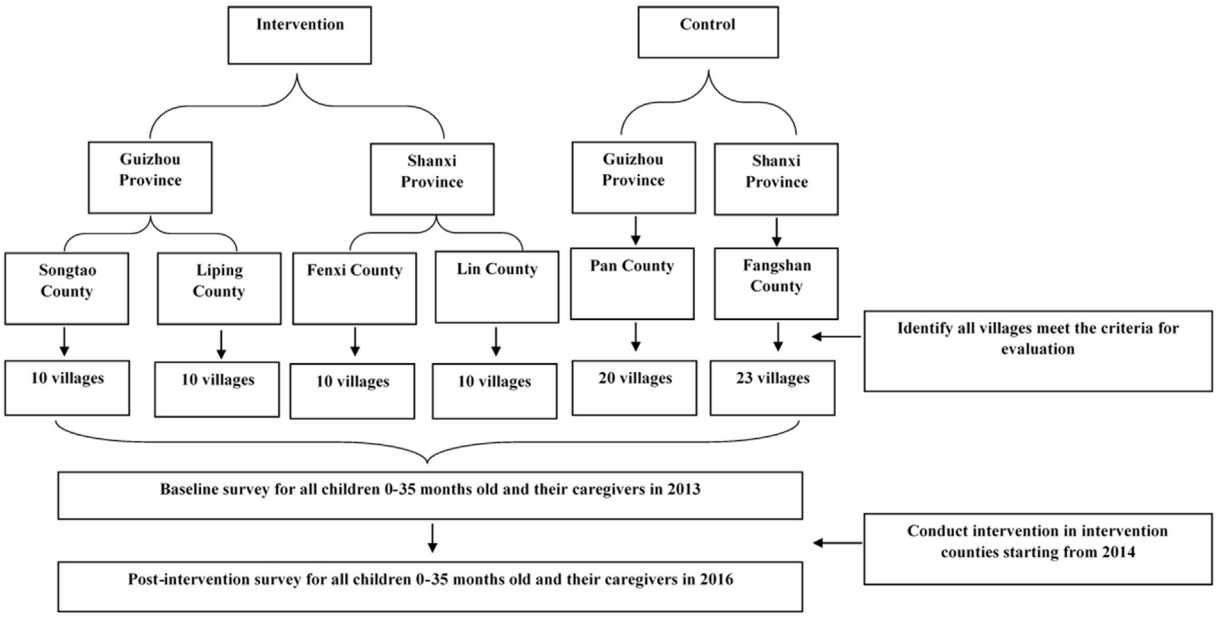

Fig. 2 – The Integrated Early Childhood Development (IECD) programme evaluation profile in rural China.

basic public health services were provided without the IECD programme interventions.

In each intervention village, an ECD centre, which was open to all children aged below 3 years, was set up to provide early stimulation interventions by age-appropriate group sessions of caregiver-child play activities and reading to children 3–4 days a week. The centres were usually located at the village administration office or in the village kindergartens or schools and equipped with storybooks, toys, touchscreens and other group activity materials to accommodate play activities of young children with their caregivers. One full-time volunteer was recruited to facilitate the activities at the ECD centres, with the following selection criteria: (i) having completed at least 8 years of school education; (ii) having parenting experience; and (iii) being familiar with the village, preferably living in the same village.

The township/village clinic of each intervention village provided child age-appropriate ECD counselling on health, nutrition and responsive care for families when they bring their children to visit for routine basic public health services, including immunisation and physical check-ups. The World Health Organisation/United Nations International Children's Emergency Fund Care for Child Development package was used as the counselling tool to help families build stronger relationships with their children and solve problems in caring for their children at home through play and communication activities.[33] Ying Yang Bao, a daily intake package of soybean-based micronutrient fortified powders,[34] was also delivered upon a visit to promote complementary feeding for children aged 6–24 months.

An MRU that included at least two professionals with expertise in maternal and child health (one in early stimulation and one in child protection) was established and equipped with training materials and a vehicle in each intervention county. These professionals, who were from the local Health Bureau, Women's Federation and Civil Affairs Bureau, worked as a team to provide rotation services with bi-monthly visits to each village. At the time of the visit, parenting training in ECD and protection, including prevention of violent discipline and child neglect, and training for village programme staff were provided and based in the village ECD centre.

At the county level, a multisectoral working mechanism, usually headed by the county (vice) governor, was established to manage, coordinate and support all community leaders and workers.

Outcomes measured and other data collection

The outcome indicator, measured in children at baseline and postintervention, was prevalence of neurodevelopmental delay, which was assessed by trained investigators through the nationally validated Chinese version of the Ages & Stages Questionnaire (ASQ), third edition.[35] China's national ASQ norm, developed for the Chinese population, was used to determine developmental status.[36] The ASQ includes questions to assess age-specific developmental status in the communication, gross-motor, fine-motor, problem-solving and personal-social domains. SDD in a certain domain was defined as a domain score lower than two standard deviations from the cut-off point in that domain, according to the national norm. Overall, SDD was defined as a delay in any one of five domains of the ASQ.

To examine the effect of intervention exposure on neurodevelopmental outcome and the underlying mechanism through which the intervention improved early development, we collected frequency of ECD centre and township/village clinic-based intervention use in the postintervention survey, as well as mediating indicators that related to the process of five components of intervention: child health, nutrition, responsive care, protection and early learning support. Peripheral blood haemoglobin concentration was measured through HemoCue201+ (HemoCue AB Inc.) for children.

Anthropometric measurements were taken to calculate the length-for-age Z score in children.[37] The investigators also administered face-to-face interviews with caregivers, with a structured questionnaire to collect data on demographic characteristics of the children, the caregivers and their families, as well as other factors that may impede or facilitate early child development. Cognitive stimulation was defined as a caregiver engaging in any of the following activities to promote early learning in the past 3 days: (1) read books to or looked at picture books with child; (2) told stories to child; (3) sang songs to or with child, including lullabies; (4) took the child outside the home, compound, yard or enclosure; (5) played with child; and (6) named, counted or drew things to or with child. Positive discipline was defined as the caregiver explaining to the child why a certain behaviour was wrong, to teach the child the right behaviour or to address a behaviour problem in the past month.[38]

Statistical analyses

Descriptive analyses, including median and proportion, were used when appropriate. The Z test was used to compare proportions between intervention and comparison villages. A median test was used to compare the caregivers' age distribution. Difference-in-differences (DID) logistic regression was used to compare the change of prevalence of SDD over time between intervention and comparison groups. Similar DID logistic regression models were also applied to the age group–stratified analyses of the effect of the intervention on the prevalence of suspected overall developmental delay for children aged 0–5 months, 6–11 months, 12–17 months, 18–23 months, 24–29 months and 30–35 months. Because the data collected in this study were independently pooled, cross-sectional data from two child-caregiver samples, we coded the time period as baseline = 0 and postintervention = 1, we coded the area as comparison = 0 and intervention = 1 and made an interaction term (time × area). The intervention effect of interest was the interaction between time and area group.[39] Effect size was presented using an adjusted odds ratio (aOR) with a 95% confidence interval (CI) after adjusting for the children's age, gender, family income, living with single parent and left behind status and their caregiver's gender, age, ethnicity, relationship to child and education level. Similar DID logistic regression models were also applied to the age group–stratified analyses. We used Structural Equation Modelling (SEM) to conduct path analysis to test underlying mechanisms. Missing data were handled using the maximum likelihood method. All tests were two-tailed, and $P < 0.05$ was considered significant. IBM SPSS Statistics 20.0 was used in data analyses, and Amos 23.0 was used for SEM.

Results

Study population

In total, 2953 and 2745 child-caregiver pairs were recruited at the baseline and postintervention time frames, respectively; this consisted of 1468 and 1384 pairs in the intervention villages and 1485 and 1361 pairs in the comparison villages at baseline and postintervention, respectively.

No significant differences in children's age and gender distribution were observed between intervention and comparison villages in the postintervention time frame. With the exception of caregiver education (72% in intervention villages having middle school or higher education vs 61% in comparison villages), more risk factors were accumulated in intervention than in comparison villages at the postintervention time frame, with more left-behind children (58% vs 42%, $P < 0.001$), higher levels of poverty with per capita annual net incomes of $US 343 or lower in the previous year of the survey (68% vs 27%, $P < 0.001$) and fewer interviewed caregivers being parents (79% vs 84%, $P < 0.05$) or of Han ethnicity (61% vs 65%, $P < 0.05$). Similar demographic characteristics were observed at the baseline. Although there were more male caregivers (18% vs 14%, $P < 0.05$) and fewer children living with a single parent (defined as divorced or widowed) (3% vs 8%, $P < 0.05$) in intervention villages than in comparison villages at baseline, the absolute differences were small (Table 1).

Intervention use

In the intervention villages, 66% of children (887/1348) received at least one instance of ECD centre services in the month preceding the postintervention survey. Among children who had ever used ECD centre services, 14% (110/767), 28% (214/767) and 27% (204/767) of children went to the ECD centre for free activities with a frequency of 3–4 times a week, 1–2 times a week and 1–2 times a month, respectively. Among the children born after the IECD programme launch, only 31% of children who had their first active intervention visit (i.e. participating in the ECD centre activities) were aged below 6 months old. More children (45%) had their first active intervention visit when they were 6–11 months old, whereas 24% of children had no active intervention visit until they were 1 year old. A total of 97% (1003/1033) of children received at least one instance of township/village clinic-based services in the year preceding the postintervention survey. Among children aged 6–23 months, 88% had received Ying Yang Bao at some stage from their township/village clinic. However, only 50% of them had four or more packages per week as recommended.

Impact on child developmental outcome

Reductions in prevalence of overall SDD were observed in both intervention and comparison villages over time. In the intervention villages, the prevalence of overall SDD decreased from 37% at baseline to 19% at postintervention, an 18% absolute reduction. In comparison villages, the prevalence of overall SDD decreased from 30% at baseline to 20% at postintervention, a 10% absolute reduction. However, the DID logistic regression analysis showed that the degree of reduction was significantly larger in intervention villages than that in comparison villages. Children in the intervention villages had significantly lower odds of overall SDD (aOR = 0.69, 95% CI: 0.54–0.89). Consistent findings were found across domains. Children in the intervention villages had significantly lower odds of SDD in the communication (aOR = 0.69, 95% CI:

Table 1 – Characteristics of children aged 0–35 months and their families at 2013 baseline and 2016 postintervention survey, Guizhou and Shanxi Province, China.

Characteristic	Time	Comparison villages [% (n/N)][a]	Intervention villages [% (n/N)][a]	P-value
Male gender of children	Baseline	57% (844/1485)	57% (835/1468)	0.980
	Postintervention	57% (769/1361)	55% (754/1384)	0.286
Median age of children, months	Baseline	18	18	0.266
	Postintervention	19	19	0.660
Caregiver is parent	Baseline	92% (1360/1485)	82% (1207/1468)	<0.001
	Postintervention	84% (1142/1361)	79% (1091/1384)	0.001
Male gender of caregiver	Baseline	14% (209/1485)	18% (257/1468)	0.011
	Postintervention	12% (159/1361)	12% (168/1384)	0.712
Median age of caregiver, years	Baseline	26	27	<0.001
	Postintervention	28	28	0.013
Han ethnic of caregiver	Baseline	68% (1016/1485)	60% (876/1468)	<0.001
	Postintervention	65% (890/1361)	61% (850/1384)	0.031
Middle school or higher education in caregiver	Baseline	61% (904/1485)	69% (1010/1468)	<0.001
	Postintervention	61% (835/1361)	72% (992/1384)	<0.001
Children living with single parent[b]	Baseline	8% (114/1485)	3% (36/1468)	<0.001
	Postintervention	5% (61/1361)	3% (47/1383)	0.144
Left-behind children[c]	Baseline	35% (521/1485)	53% (782/1468)	<0.001
	Postintervention	42% (574/1361)	58% (799/1384)	<0.001
Poverty[d]	Baseline	42% (505/1199)	61% (680/1118)	<0.001
	Postintervention	27% (362/1348)	68% (822/1202)	<0.001

[a] Data are % (n/N) unless otherwise indicated; n is numerator number of persons, and N is total number of persons of each group.
[b] Single parent is defined as divorced parent or widowed parent.
[c] Left-behind is defined as living apart from either one or both parents during the survey period.
[d] Poverty is defined as per capita net incomes of RMB 2300 ($US 343) or lower in the family in the previous year of the survey.

0.48–0.98), gross-motor (aOR = 0.65, 95% CI: 0.44–0.97), fine-motor (aOR = 0.40, 95% CI: 0.27–0.59), problem-solving (aOR = 0.50, 95% CI: 0.34–0.73) and personal-social domains (aOR = 0.58, 95% CI: 0.37–0.91) [Table 2].

Stratified DID logistic regression analysis by age group showed that there were no significant reductions in overall SDD in intervention villages compared with comparison villages in either younger (<12 months) or older (≥24 months) age groups of children. The significant differences were found only among children aged 12–17 months (aOR = 0.31, 95% CI: 0.16–0.59) and children aged 18–23 months (aOR = 0.44, 95% CI: 0.24–0.81) (Table 3).

Table 2 – Effect of the intervention on change of prevalence of suspected developmental delay[a] among children aged 0–35 months from 2013 baseline to 2016 postintervention survey, Guizhou and Shanxi Province, China.

Domain	Time	Comparison villages [% (n/N)][b]	Intervention villages [% (n/N)][b]	aOR (95% CI)	P-value
Communication	Baseline	13% (193/1470)	18% (255/1457)		
	Post intervention	8% (103/1353)	7% (99/1374)		
	Postbaseline change	−6%	−10%	0.69 (0.48–0.98)	0.041
Gross motor	Baseline	11% (155/1465)	15% (224/1455)		
	Postintervention	6% (77/1353)	6% (84/1374)		
	Postbaseline change	−5%	−9%	0.65 (0.44–0.97)	0.035
Fine motor	Baseline	12% (174/1443)	19% (271/1444)		
	Postintervention	7% (99/1353)	6% (76/1374)		
	Postbaseline change	−5%	−13%	0.40 (0.27–0.59)	<0.001
Problem solving	Baseline	11% (161/1458)	19% (268/1446)		
	Postintervention	7% (96/1353)	7% (89/1374)		
	Postbaseline change	−4%	−12%	0.50 (0.34–0.73)	<0.001
Personal-social	Baseline	8% (122/1468)	15% (222/1452)		
	Postintervention	4% (55/1353)	5% (67/1374)		
	Postbaseline change	−4%	−10%	0.58 (0.37–0.91)	0.017
ASQ	Baseline	30% (426/1434)	37% (531/1447)		
Overall development	Postintervention	20% (265/1353)	19% (260/1374)		
	Postbaseline change	−10%	−18%	0.69 (0.54–0.89)	0.005

aOR, adjusted odds ratio; ASQ, Ages & Stages Questionnaires; CI, confidence interval.
[a] Suspected developmental delay is defined as a domain score lower than two SD (standard deviation) of the cut-off point in the Chinese national norm in that domain. Suspected overall developmental delay is defined as a delay in any one of five domains of the ASQ, including communication, gross motor, fine motor, problem solving and personal-social domain.
[b] Data are % (n/N) unless otherwise indicated; n is numerator number of persons, and N is total number of persons of each group.

Table 3 – Effect of the intervention on change of prevalence of suspected overall developmental delay[a] by age group from 2013 baseline to 2016 postintervention survey, Guizhou and Shanxi Province, China.

Age group	Time	Comparison villages [% (n/N)][b]	Intervention villages [% (n/N)][b]	aOR (95% CI)	P-value
0–5 months	Baseline	43% (76/179)	49% (89/181)		
	Postintervention	22% (39/181)	27% (39/143)		
	Postbaseline change	−21%	−22%	1.08 (0.53–2.19)	0.831
6–11 months	Baseline	35% (90/258)	36% (100/278)		
	Postintervention	17% (37/218)	20% (51/259)		
	Postbaseline change	−18%	−16%	1.02 (0.55–1.90)	0.946
12–17 months	Baseline	28% (69/246)	39% (95/244)		
	Postintervention	24% (53/223)	15% (32/221)		
	Postbaseline change	−4%	−25%	0.31 (0.16–0.59)	<0.001
18–23 months	Baseline	26% (71/278)	38% (114/301)		
	Postintervention	18% (48/268)	15% (43/294)		
	Postbaseline change	−8%	−23%	0.44 (0.24–0.81)	0.008
24–29 months	Baseline	21% (56/272)	31% (73/233)		
	Postintervention	13% (31/243)	16% (35/220)		
	Postbaseline change	−8%	−15%	0.73 (0.36–1.45)	0.725
30–35 months	Baseline	32% (64/201)	29% (60/210)		
	Postintervention	26% (57/220)	25% (60/237)		
	Postbaseline change	−6%	−3%	1.16 (0.62–2.16)	0.652

aOR, adjusted odds ratio; CI, confidence interval.

[a] Suspected developmental delay is defined as a domain score lower than two SD (standard deviation) of the cut-off point in the Chinese national norm in that domain. Suspected overall developmental delay is defined as a delay in any one of five domains of Ages & Stages Questionnaires, including communication, gross motor, fine motor, problem solving and personal-social domain.

[b] Data are % (n/N) unless otherwise indicated; n is numerator number of persons, and N is total number of persons of each group.

Path analysis on the effect of the intervention package

Path analysis showed the effects of both clinic-based and ECD centre-based intervention exposure on developmental outcome. Higher ECD centre intervention exposure and higher clinic exposure improved the ASQ score through increasing frequency of cognitive stimulation and positive discipline behaviour at home and increasing length-for-age Z score and haemoglobin concentration (Fig. 3). The model exhibited an excellent fit, minimum discrepancy/degrees of freedom = 2, root mean square error of approximation = 0.03 (90% CI: 0.02–0.04), comparative fit index = 0.95, normed fit index = 0.93 and incremental fit index = 0.96.

Specifically, the effect of the ECD centre-based intervention use was mediated by multiple mediators, including cognitive stimulation, positive discipline and length-for-age Z score. A positive correlation was observed between ECD centre-based intervention exposure and mediators and also between mediators and the ASQ score. The effect of clinic-based intervention use was mediated by haemoglobin concentration; the higher exposure yielded higher haemoglobin concentration and further improved developmental outcome.

Among all mediators, cognitive stimulation had the largest effect on the ASQ score, with standardised correlation coefficient $\beta = 0.21$, $P < 0.001$, followed by positive discipline ($\beta = 0.19$, $P < 0.001$), length-for-age Z score ($\beta = 0.13$, $P < 0.001$) and haemoglobin concentration ($\beta = 0.04$, $P = 0.037$) [Fig. 3].

Discussion

This quasi-experimental study was designed to measure the effects of an integrated cross-sectoral package of early childhood nurturing care, supporting services on child developmental outcomes in rural China. The results of this study indicated that after 2 years of implementation, the intervention significantly reduced the suspected overall and domain-specific early developmental delay among children aged less than 3 years, after adjustment for confounding factors. The impact of the intervention package was mediated through multiple processes, including cognitive stimulation, positive discipline, length-for-age growth and haemoglobin concentration.

Studies from Pakistan,[40] the Caribbean,[41] Jamaica[42] and Bolivia[19] showed improved developmental outcomes from integrated interventions. However, these studies focused on simple combination services such as enhanced nutrition based on routine health services, whereas only a few studies[43,44] integrated services from multiple sectors. The Integrated Family-Based Early Childhood Development programme on child survival, development, protection and participation in Thailand showed that after 2 years of intervention, home environment, developmental performance and intelligence quotient (IQ) scores of children in the intervention villages were all significantly improved compared with the comparisons.[45] One of the important elements of that programme was the family development volunteer, who was the liaison between families and all other service providers. Each volunteer worked with only five families intensively in different locations, such as home visitation and even chatting at the market. However, in the current study sites, each volunteer needed to serve about 50 families. In this study, the ECD centre, which is a fixed working station, proved to be effective in situations with large populations. In addition, the Thailand model relied significantly on international agencies' support, including UNICEF, Save The Children USA and Christian Children's Foundation, with some areas being mainly implemented by non-governmental agencies. As the

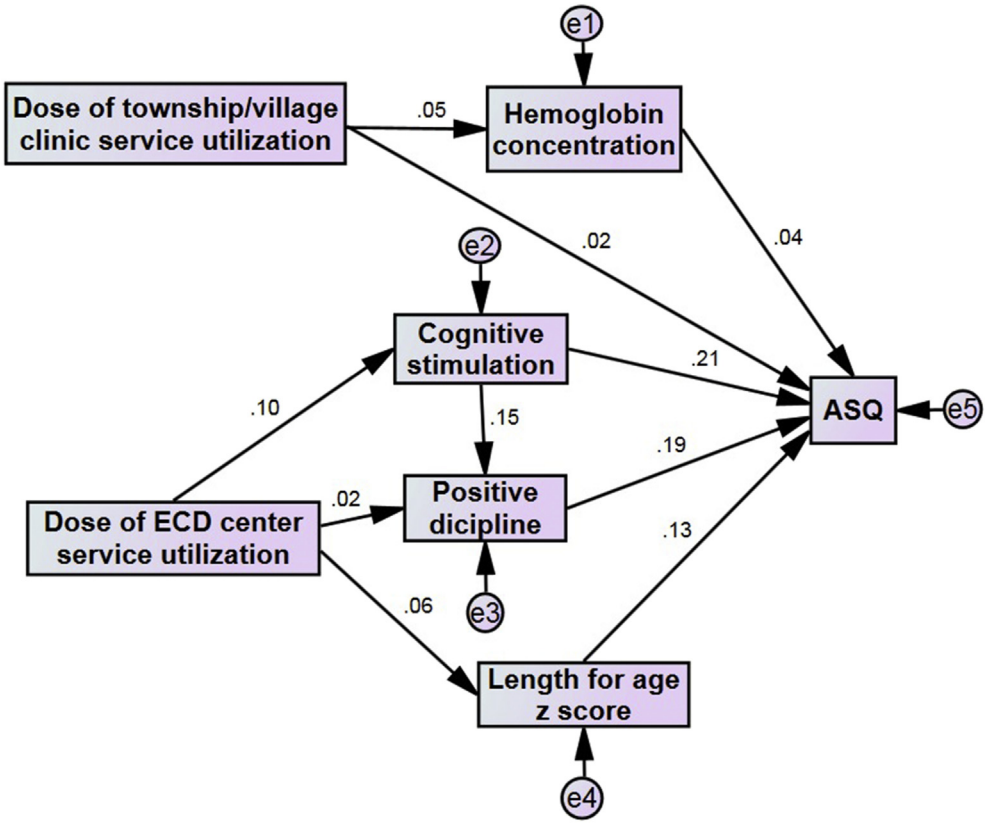

Fig. 3 – Path analysis of the effect of Integrated Early Childhood Development (IECD) intervention exposure on developmental score. ASQ, Ages & Stages Questionnaire; ECD, early childhood development. Rectangles represent observed or measured variables. e1 through e5 are residual or error variances that also cause response variation in each corresponding observed or measured variable. The values associated with each path are standardized regression coefficients.

authors pointed out, more effort was needed to ensure the sustainability and efficiency of this model. Another government-led ECD initiative in the Philippines, adopting an integrated, multisectoral approach to delivering a combination of services that included centre-based (e.g. day care centres and health stations) and home-based (family day care programmes and home visits by health workers) interventions demonstrated significant improvements in cognitive, social, motor and language development of children who resided in ECD programme areas compared with those in non-programme areas.[44] To link the centre-based and home-based services, a new position, the child development worker (CDW), was created. CDWs were responsible for complementing the roles of midwives and health workers in providing food and nutritional supplements and monitoring children's health status as well as for community-based parent education about ECD. In China and other countries with a well-established grassroots health services system, better leveraging of the strength of the existing system is important and more sustainable. There were other reports about programmes adopting similar strategies, although they were lacking rigorous evaluation.[46] The current study suggests adding the value of evaluating such kinds of demonstration programmes. This study first showed the significant effectiveness of a comprehensive package of nurturing care interventions on ECD outcomes among disadvantaged children in China. Such human service system reorientation efforts are important, especially in rural areas of China, where the vast majority of children are deprived of substantial and necessary development services. Thus, this study provided a good model and increased confidence to cohere strength from different systems to deliver key ECD services efficiently to children aged below 3 years.

This study further contributed to solidifying the evidence of the mediation effect of family processes and suggested the possible multiple-route mechanism through which early intervention functioned. Previous studies revealed the mediation role of one or two family process factors. The Turkish Early Enrichment Project tested three categories of early childhood care environments (educational nursery school, custodial day care and home care) by two levels of home intervention (mother training and no mother training). After 2 years of intervention, evaluation data showed that involving mother training in any kind of environment of child care was significantly better than the no-mother-training approach in children's IQ, analytical triad performance and language testing score.[43] In rural Pakistan, a 2-year responsive stimulation intervention programme from birth showed that the

quality of home stimulation and maternal scaffolding behaviours were the underlying mechanisms through which the responsive stimulation intervention uniquely predicted children's verbal intelligence, performance intelligence and executive functioning.[47] Our finding reinforced the utility of this integrated community service model. However, our study results showed that length-for-age Z score and haemoglobin concentration had relatively smaller effects on developmental score, possibly for two reasons. First, the daily intake of Ying Yang Bao, the most active intervention targeting nutrition and growth, was suboptimal. Second, the counselling services were relatively passive, without additional active follow-up or promotion efforts to reinforce the effect on promoting child-feeding behaviours at home.

Previous reports showed that programmes with longer exposure, increased frequency of contact, a well-designed structured curriculum and that targeted younger and vulnerable children tended to generate greater effects on child development.[48] This study found the significant intervention effect on the developmental outcome only in the age groups between 12 and 24 months, which further implied the importance of consistent and early exposure with enough time for the intervention. The older children appeared to have benefited less than the children between 12 and 24 months because for many of them during their first year, the IECD programme had not yet started. Furthermore, it is very possible that even fewer parents sought such services during their child's early life at the beginning of the programme launch. The older children lacked enough early exposure and would be less amenable to change in their developmental status. Thus, interventions need to be provided as early as possible. For the youngest children (i.e. those aged less than 12 months), we postulate that they would not yet have had sufficient exposure to the IECD intervention.

This practical model may have implications for how to leverage locally limited resources to implement the national policy of ECD in China and other countries. This study showed the feasibility of mobilising multiple sectors' resources to provide nurturing care support for families in rural areas of China. Integrated nurturing care has scaled up in recent years.[49] It is recognised that integrating new services into an existing programme would be cost effective.[12] However, the implementation met with the awkward reality that in poor rural areas of China, community service capacities are often weak. No single sector was able to provide all necessary services alone. This study provided a feasible, community-based service model in rural areas, involving an array of providers from different sectors, such as village doctors, volunteers, early-stimulation professionals, maternal and child health professionals and social workers, thus supporting families to provide comprehensive nurturing care. The MRU, as the multisectoral working mechanism, plays the pivotal role in quality assurance of the community services. In areas with limited resources, the MRU could provide professional staff from different sectors at the county level and regularly reach out to the most remote villages for hands-on training.

The results should be interpreted with caution. First, this was not a cohort design; the participants were from two cross-sectional surveys of children and caregivers, which decreased the power to detect the effects of interventions. Second, we were not able to capture the full picture of the mediating effects of each component of the intervention in the path analysis. For example, it is challenging to measure the frequency of responsive care at home. Thus, it is unclear whether intervention had an impact on responsive-care behaviour at home and the effect size of responsive-care behaviour on developmental outcome. Third, the quality of each service implementation was unknown, especially that of the counselling service provided in clinics. In addition, caregivers' compliance with the instructions following the intervention at home may vary over time and is thus difficult to estimate its impact. The real intervention effect may be enlarged if the compliance rate could be further increased, such as increasing the feeding practice for Ying Yang Bao, given to only 50% of children aged 6–23 months. These children had four or more packages per week as recommended. Thus, we were not able to evaluate the influence of service quality on the developmental outcome.

Conclusions

Our study suggests that integrated, multisectoral and community nurturing care supporting intervention could significantly prevent developmental delay in disadvantaged children in China. It is a promising programme to mitigate risk and promote ECD in China's poorest areas.

Author statements

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Ethical approval

Ethical clearance for all aspects of the study was obtained from the Ethics Review Board of Peking University, with approval number IRB00001052-16034. Written informed consent was obtained from caregivers before data collection.

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Competing interests

The authors have declared that no competing interests exist.

Author contributions

R.S., C.Z., Q.Z., X.H., Y.Z., X.C., M.S., R.P. and K.M. conceived and designed the intervention; X.W., J.Z., Z.L., R.Y. and S.Z. as the external evaluation team and C.Z., X.H. and R.S. as program and evaluation experts, who conceived and designed the evaluation study; X.W., J.Z., Z.L., R.Y., S.Z. and H.S. implemented the evaluation data collection and analysed the data; S.Z. and C.Z. wrote the draft of the manuscript; all authors helped revise the manuscript. All authors have seen and approved the final manuscript and have contributed significantly to the work.

Data availability statements

The questionnaires (in Chinese) and raw data supporting the conclusions of this manuscript will be made available by the authors, without undue reservation, to any qualified researcher.

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