



## Paths of social-emotional development before 3 years old and child development after 5 years old: Evidence from rural China

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### ABSTRACT

**Background:** Social-emotional development during the first three years of life is associated with later social-emotional development and cognitive development. In rural China, research has found large shares of children under age three are developmentally delayed, yet little is known about the paths of social-emotional development before age 3 or how developmental paths predict later social-emotional skills and cognitive skills. **Aims:** To investigate the paths of child social-emotional development during ages 0–3 and examine how different paths predict social-emotional development and cognitive development at preschool age.

**Methods:** Three waves of longitudinal panel data from 1245 children in rural Western China was collected. Child social-emotional development was measured by the Ages and Stages Questionnaire: Social-Emotional. Child cognitive development was measured by the Bayley Scales of Infant Development and by the Wechsler Preschool and Primary Scale of Intelligence-Fourth Edition. Four paths of child social-emotional development were classified: “never” social-emotionally delayed; “persistently” social-emotionally delayed; “improving,” or “deteriorating.”

**Results:** 331 (27%) were never social-emotionally delayed; 373 children (30%) were persistently social-emotionally delayed; 149 children (12%) experienced improving social-emotional development; and 392 children (31%) experienced deteriorating social-emotional development. Children who were never social-emotionally delayed or who were on an “improving” path had higher social-emotional development at preschool age ( $p < .01$ ). Children who were persistently social-emotionally delayed ( $p < .5$ ) and on a deteriorating path ( $p < .01$ ) had lower social-emotional development at preschool age. Children on the persistently delay path also were shown to have lower levels of cognitive development at preschool age ( $p < .01$ ).

**Conclusions:** Different paths of child social-emotional development before age 3 are associated with different social-emotional and cognitive development at preschool age.

### 1. Introduction

Early childhood has been identified as an important window for child development. Due to high brain plasticity at this age, a child's early experiences have a unique and powerful influence on a child's cognitive ability, social-emotional skills, health, and the organizational structure of the brain [1–3]. Theoretical and empirical research has established that basic social-emotional skills developed in the earliest years of life form the foundation for the development of more complex skills later in childhood [4,5]. For this reason, infants who have delayed social-emotional development during the first three years of childhood

frequently display problem behavior later in life and experience social maladaptation, school maladjustment, and poor school performance [6–8].

The literature demonstrates that the prevalence of social-emotional delays in early childhood are common, albeit wide ranging, throughout the world [9,10]. In the literature, social-emotional development is measured either by parent-reported measurements [11–13] or by observational scales [9,14]. Many studies defined the delay of a child as one with a social-emotional score of 1 or more SDs below the mean of a reference population whose developmental trajectory is expected to be [15–17]. This definition is in line with the guidelines of the Bayley

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Scales of Infant Development (BSID), which conventionally defines children with a score of more than 1 SD below the normative sample mean as mildly delayed in their development [18]. Using 1 SD below the normative mean as a cut-off to capture all severities of developmental impairment is also in line with definitions from the Global Research on Developmental Disabilities Collaborators and the American Association on Intellectual and Developmental Disabilities [19]. Research teams in developed countries have found that rates of social-emotional delay in children under 5 years old is between 5% and 26% [11,14,20]. In developing countries, similar research shows that the rates of social-emotional delay can be even higher, ranging from 4% to 58% [12,13].

When assessing the formation of social-emotional skills, which have been shown to affect later-in-life social-emotional skills and cognitive abilities, research shows that the years when children are 0 to 3 are decisive [3,21–23]. The literature shows that social-emotional development before age 3 can predict social-emotional development and school readiness of children when they reach the preschool years (ages 4 to 5) [24–27]. For example, research in Australia finds that a child's social behavior at 5 years of age can be predicted by his or her social-emotional skills at 2 years of age [26].

The literature shows that the social-emotional skills of a child before the age of 3 years is dynamic [28–30]. For example, a U.S. study that followed children aged 12 to 40 months for a year-long period demonstrated that a significant share of children who were developing normally in terms of their social-emotional skills experienced a deterioration of their social-emotional development, from not delayed to delayed, during the study period [28]. Another study, conducted in Thailand, showed that the social-emotional status of the 1- to 3-year old children who participated in the study improved over the period of observation [29].

Because social-emotional development is dynamic over the first several years of life, the paths of social-emotional development before age 3 might be as important as the actual level of development at age 3 to later-in-life social-emotional and cognitive skills. To the best of knowledge, however, most research in this area has focused on middle childhood to early adolescence, whereas there is limited research on infants to preschoolers. A Dutch longitudinal study found that different paths of social-emotional development (from age 4 to 18 years) had different associations with young-adult social-emotional outcomes [31]. Specifically, a deteriorating path was associated with a higher level of mental health problems and lower educational attainment in young adulthood. In a U.S. longitudinal study, paths of social-emotional development from toddlerhood to age 9 were associated with a child's academic and social functioning through age 12. The study showed that children on a path characterized by a persistent delay in social-emotional abilities had more behavioral problems later in life. In contrast, if a child was initially delayed but transitioned to an improving path, that child had a better ability to adjust socially at age 12 [32].

Understanding the paths should be especially relevant in the case of developing countries, where the rates of social-emotional and cognitive developmental delays are high [12,33,34]. In a series on early childhood development, Grantham-McGregor et al. combined country-level data from UNICEF and the World Bank and estimated that 219 million children (39%) under the age of 5 in low- and middle-income countries were not reaching their cognitive and/or social-emotional developmental potential. McCoy [12] also estimated that, in 2010, 80.8 million children (36.8%) aged 3 and 4 in low- and middle-income countries had low levels of cognitive and/or social-emotional development.

In rural China, social-emotional delay of children under age 5 is a systemic problem; around 37% of children in a systematic review of more than 4000 young children in 11 studies were found to have delayed social-emotional development [15]. For children under 3 years old in rural China more than one-third have delayed social-emotional development [13,35–37]. The rate of social-emotional developmental delay of children aged 0–3 is higher in Western China, ranging from 39% to 58% [37–43]. For rural children of preschool age (ages 4 to 6 years

old), the rates of social-emotional developmental delays are also high, ranging from 34% to 37% [44–46].

Although studies of the levels and changes in the levels of social-emotional development among children in rural China have been conducted, our knowledge of social-emotional development is largely based on looking separately at infants, toddlers, and preschoolers through cross-sectional research that focuses on the individuals in the different ranges of ages [13,35,44,45]. Little is known, however, about the paths of social-emotional development when children are between 0 and 3 years old. To our knowledge, there also is no study of how the path of social-emotional development during the ages of 0–3 is associated with later cognitive and social-emotional development of children (e.g., to preschool age, 4 to 5 years old). The current study contributes to the theoretical literature not only in confirming the part of the literature that shows that social-emotional development in the earliest years is predictive of developmental skills later in childhood, but also in showing that the paths of social-emotional development before age 3 are associated with different levels of development later in childhood.

## 2. Current study

The goal of this study is to identify the paths of social-emotional development in children before age 3 in rural Western China and explore how these paths are able to predict social-emotional and cognitive development at preschool age. The following research questions guided the present study:

1. What are the different paths of social-emotional development during ages 0–3? Based on the literature, we expect that the children in our study can be classified into four paths: (a) “never” social-emotionally delayed, (b) “persistently” social-emotionally delayed, (c) “improving,” or (d) “deteriorating.”
2. How do the paths of social-emotional development before age 3 predict social-emotional and cognitive development at preschool age? We hypothesize that children on different paths will show different levels of cognitive and social-emotional development when they reach preschool age.
3. To what extent does the level of social-emotional development at age 3 and before predict social-emotional skills and cognitive skills at preschool age? We expect that children on the Never Delayed path have higher levels of development when compared with children on other paths (i.e. Improving, Persistently, or Deteriorating).

## 3. Methods

### 3.1. Sample, data collection, and procedure

We examined 1245 children and their primary caregivers from a longitudinal study conducted in 11 counties in rural Western China. The population in these counties is almost entirely (99%) ethnically Han. The ethnicity of 91% of China's population also is Han [47]. The children were aged 6–12 months at the first survey wave. As seen in Table 1, among the sample children, slightly over half (51%) were male, and 24% had siblings. Only 5% of the children were born prematurely. For the sample households, the mother was the primary caregiver for 85% of the children. According to the data, in the other sample households the grandmother typically acted as a main caregiver. When examining the characteristics of the sample's mothers/caregivers, it was found that 62% were young mothers (age  $\leq 25$  years) and 28% did not have 9 years of education. The protocol required participating caregivers to give oral consent for the involvement of their infants and themselves. We informed the participants that their participation was purely voluntary and of the risks involved. The study was approved by the university Ethics Committee.

We collected data in 11 Qinba Mountain area counties. The data are longitudinal in nature and contain information on children and

**Table 1**  
Characteristics of sample children, 6–12 months ( $N = 1245$ ).

Characteristic	Frequency ( $n$ )	Percentage/mean $\pm$ SD
Child characteristics		
Sex		
Male	640	51.4%
Female	605	48.6%
Child is premature		
Yes	58	4.7%
No	1187	95.3%
Child has siblings		
Yes	298	23.9%
No	947	76.1%
Household characteristics		
Mother is primary caregiver		
Yes	1058	85.0%
No	187	15.0%
Maternal age		
Age < 25	476	38.2%
Age $\geq$ 25	769	61.8%
Maternal education level (years)		
<9	348	28.0%
$\geq$ 9	897	72.0%
Family asset index	1245	$-0.1 \pm 1.2$

households. China's government has designated the Qinba Mountain area as a contiguous poverty-stricken area [48]. GDP per capita in the study area was US\$1275 (RMB 7896) in 2013 which was less than China's overall GDP per capita (US\$7057 or RMB 43,684; [49]). The Qinba Mountain area comprises 75 counties, and almost all have been named by China's government as poverty counties [48].

A multistage cluster sampling design was used to select the sample in 2013. For the study, all townships in the 11 Qinba Mountain area counties were sampled. Excluded from the sample, however, were townships without any villages that exceeded a population count of 800 and townships in each county that held a county seat. Following the sampling criteria, the study included 174 townships. Then, two villages from each township were randomly selected. Finally, a list of all registered children born between March 2012 and May 2013 from each sample village was obtained with help from local family planning offices. Infants with known diseases or disabilities were excluded from the study sample. The study included all infants in the target age range of 6–12 months who did not have known diseases or disabilities. The final sample size was 1802 children.

Two follow-up surveys (the first in April 2015, and the second in 2017) were completed after the initial baseline survey was conducted in 2013. The final sample used in this study includes the 1245 children and their families who participated in the study's three survey waves.

Demographic data on the child and the child's household were collected by teams of trained enumerators from the primary caregiver of each sample child. The primary caregiver was identified as the individual who was most responsible for the child's daily caregiving. The research team also collected information that were used to create variables that could define the sample's children. The survey data were used to create variables on the child's age (in months), his or her sex, if the child was premature, and if the sample child had brothers or sisters. The survey team requested that the household provide them information from the child's birth certificate on the age of the child or his/her birth status (either premature or not). Data on maternal age, maternal education level, and the family asset index of each household were collected as a way to define each household's characteristics. Using polychoric principal component analysis on the survey-based information on whether a household had access to tap water, a toilet with running water, a water heater, a washing machine, a computer, the Internet, a refrigerator, air conditioning, a motorcycle or electronic bicycle, and/or an automobile, we constructed a family asset index.

### 3.2. Measures

#### 3.2.1. Social-emotional development

We assessed the social-emotional development skills of the sample children in all three survey waves, using the Ages and Stages Questionnaire: Social-Emotional (ASQ:SE). The ASQ:SE is a validated instrument to identify social-emotional problems in children aged 3–66 months [50]. The ASQ:SE assesses different types of child behavior at different ages, including the ability of the child to calm down, the propensity of the sample individuals to be able to accept directions, the ability of him/her to demonstrate feelings towards others, skills for communicating their feelings as well as others (e.g., the ability to initiate social responses to parents/others and how to rejoin on one's own initiative). The primary caregivers were asked to indicate whether the child exhibits these behaviors “most of the time,” “sometimes,” or “never.” Depending on the desirability of the behavior, answers are scored 0, 5, or 10 points. An additional 5 points are given for items for which the respondent indicates that the behavior is of concern to the primary caregiver. According to the Manual of the ASQ:SE, there are different cutoffs of the scores for different age ranges ([50]; Appendix Table A1). Scores higher than the cutoff set for different ages are considered to be indicative of social-emotional problems (Appendix Table A1). In 2017, the ASQ:SE was culturally modified and normalized in China. The Chinese version of the ASQ:SE scale has a test-retest reliability of 0.94, and item reliability by age ranges from 0.94 to 0.96 [51].

#### 3.2.2. Cognitive development

Our research team used two separate scales to measure cognition. Two measures were needed because, when children were different ages (three or below; or four and above), there were different cognitive scales that were used for cognitive assessments. We used the first version of the BSID to assess the cognitive development of sample children aged 6–12 months and 22–30 months (assessed during the first and second survey waves, respectively). For children under 30 months old, the BSID is an internationally recognized scaled test [52–54]. In 1993, the BSID test was formally adapted to the Chinese language and culture. This adapted test also was scaled to an urban Chinese sample [55]. At the time of our survey, the BSID was the only version of the test adapted to the Chinese language and cultural environment, and it had been used in a number of child development studies throughout China [56,57]. The mental development index (MDI) calculated by the BSID is used to measure a child's early number concepts, habituation, memory, generalization, problem solving, classification, vocalizations, and language [58]. The MDI in the Chinese-adapted BSID test includes a test-retest reliability of 0.82, an inter-rater reliability of 0.99, and a parallel-forms reliability of 0.85 [59].

The cognitive development of sample children aged 49–65 months was measured using the Chinese-adapted Wechsler Preschool and Primary Scale of Intelligence-Fourth Edition (WPPSI-IV) test during the third survey wave. Used to assess the cognitive functioning of 30–91-month-old children, the WPPSI-IV is an individually administered, standardized, normative test [60], and is one of the most widely used tests for assessing cognitive abilities [60,61]. In 2010, the WPPSI-IV was adapted to the Chinese language and scaled to a standardized sample from urban and rural China [62], and research across China has employed the WPPSI-IV since this adaptation [63,64]. There are five subtests in the WPPSI-IV: verbal comprehension, visual spatial, fluid reasoning, working memory, and processing speed. A Full-Scale Intelligence Quotient (FSIQ) is a composite score based on the results from the five subtests. The composite score is a summary of cognitive ability across a diverse set of domains. The reliability coefficient for the FSIQ of the Chinese-adapted WPPSI-IV test is 0.96.

Using a standardized set of toys and a detailed scoring sheet, the trained testers administered the BSID and the WPPSI-IV one on one to each child during the third survey wave. When conducting BSID

assessments, the trained testers assessed each child in his or her home. When the testers conducted the WPPSI-IV assessments, children were either at preschool or their home. The trained testers administered all tests independently without any assistance from caregivers or teachers.

### 3.3. Data analysis

For each survey wave, we separately standardized the ASQ:SE raw score, BSID cognitive raw scores, and WPPSI-IV cognitive raw scores. Through calculating age-adjusted standardized scores, computed by first subtracting age-specific means and then dividing by age-specific standard deviations (which were estimated using non-parametric regression methods), we were able to account for the scores that inherently increase with age. Normally distributed standardized scores, which have a mean of zero across each age range, were computed using this approach.

Children were sorted into four categories based on the path of their social-emotional development from infancy (6–12 months) to toddlerhood (22–30 months), an approach used by Cheng [65] and Witt [66]. The four categories are (a) “never” social-emotionally delayed—children showed no social-emotional delay at either 6–12 months or 22–30 months; (b) “persistently” social-emotionally delayed—children showed social-emotional delay at both 6–12 months and 22–30 months; (c) “improving”—children showed social-emotional delay at 6–12 months but no longer showed social-emotional delay by 22–30 months; or (d) “deteriorating”—children were not delayed at 6–12 months but were shown to have developed social-emotional delay by 22–30 months.

Associations between the four paths of social-emotional development before age 3 and social-emotional skills at preschool age were examined. We constructed the following model using ordinary least squares (OLS) to examine the associations:

$$\text{Social Emotional Skills}_i = \beta_0 + \beta_1 \text{Path}_i + X_i + u_i, \quad (1)$$

where the standardized ASQ:SE score of child  $i$  at preschool age is represented by *Social Emotional Skills* <sub>$i$</sub> . The path of social-emotional development of child  $i$  is represented by the dummy variable *Path* <sub>$i$</sub> , equaling 1 when a child is in the path of interest, and 0 otherwise. For example, *Path* <sub>$i$</sub>  is equal to 1 for “never,” and 0 otherwise when examining the association of never having a social-emotional delay before age 3 to the ASQ:SE score at preschool age. All other paths are compared in this way, using the *Path* <sub>$i$</sub>  variable. The child characteristics of each sample child (age, sex, whether the child was born prematurely, and whether the child has siblings) and household characteristics of each sample household (the primary caregiver, mother's age, maternal educational level, and family asset index) are captured by the term  $X_i$ , a vector of covariates. An error term is represented by the term  $u_i$ . In addition, baseline ASQ:SE scores, county-fixed effects, and time-fixed effects are all controlled for.

We estimated any associations between the paths of social-emotional development during age of 0–3 and social-emotional skills at preschool age with the use of an OLS regression approach with an alternative specification. We used the following model:

$$\text{Social Emotional Skills}_i = \beta_0 + \beta_1 \text{Path\_vector}_i + X_i + u_i, \quad (2)$$

where the standardized ASQ:SE score of child  $i$  at preschool age is represented by *Social Emotional Skills* <sub>$i$</sub> , the dependent variable. To measure whether the child had a persistently delayed, improving, or deteriorating path, the variable *Path\_vector* <sub>$i$</sub> , a vector of three dummy variables, was used. To measure the other three path groups against a reference group, the never-delayed path was chosen as the reference. A vector of covariates of child and household characteristics are represented by the variable  $X_i$ , and the error term is represented by the variable  $u_i$ , all of which are used in Eq. (1). We also control for baseline ASQ:SE scores, county-fixed effects, and time-fixed effects.

We estimated any associations between the four paths of social-emotional development before age 3 and cognitive skills at preschool

age using the following OLS regression model:

$$\text{Cognitive Skills}_{i(\text{preschool})} = \beta_0 + \beta_1 \text{Path\_vector}_i + X_i + u_i, \quad (3)$$

where the standardized FSIQ score of child  $i$  at preschool age is represented by *Cognitive Skills* <sub>$i(\text{preschool})$</sub> , the dependent variable. The rest of the notation used is analogous to the notation in Eq. (2). We also control for county-fixed effects and time-fixed effects.

We estimated the associations between preschool-age social-emotional skills and child social-emotional skills at different age levels (measured before the child was preschool age). The OLS regression model is as follows:

$$\text{Social Emotional Skills}_{i(\text{preschool})} = \beta_0 + \beta_1 \text{Social Emotional Skills}_{i(j)} + X_i + u_i, \quad (4)$$

where the standardized ASQ:SE score of child  $i$  at preschool age is represented by *Social Emotional Skills* <sub>$i(\text{preschool})$</sub> . The independent variable, *Social Emotional Skills* <sub>$i(j)$</sub> , represents the standardized ASQ:SE score of child  $i$  in infancy, which we use to evaluate the association between social-emotional skills at preschool age and in infancy. The independent variable also is used to represent the standardized ASQ:SE score of child  $i$  in toddlerhood, which we use to examine the associations between social-emotional skills at preschool age and in toddlerhood. As in Eqs. (1) and (2), a vector of covariates of child and household characteristics is represented by the variable  $X_i$ , and the error term is represented by the variable  $u_i$ . We also control for county-fixed effects and time-fixed effects.

Finally, we constructed an OLS model to investigate the associations between preschool cognitive skills and social-emotional skills at different age ranges (measured in infancy or toddlerhood). The OLS model used is as follows:

$$\text{Cognitive Skills}_{i(\text{preschool})} = \beta_0 + \beta_1 \text{Social Emotional Skills}_{i(j)} + X_i + u_i. \quad (5)$$

The standardized FSIQ score of child  $i$  at preschool age is represented by the dependent variable *Cognitive Skills* <sub>$i(\text{preschool})$</sub> , while the standardized ASQ:SE score of child  $i$  at different age ranges (i.e. infancy or toddlerhood) is represented by the independent variable, *Social Emotional Skills* <sub>$i(j)$</sub> . A vector of covariates of child and household characteristics is represented by the variable  $X_i$ , and the error term is represented by variable  $u_i$ , as is the case in Eq. (1). We also control for county-fixed effects and time-fixed effects.

## 4. Results

### 4.1. Child social-emotional development

Table 2 presents the results of the social-emotional development scales of the sample individuals at the times when they were less than 18 months (infants); 2 to 3 years old (toddlers); and 4 to 5 years old (preschool-aged children). The results of the analysis demonstrate that a significant share of the sample experienced social-emotional delay over time. Specifically, the rate of delay increased significantly from 42%, when the sample children were infants (6 to 12 months), to 61% when the sample children were toddlers (22 to 30 months;  $p < .01$ ). In the case of the sample individual that reach preschool age (49 to 65 months), more than half experienced social-emotional delay (52%).

### 4.2. Paths of child social-emotional development

Table 3 reports the portion of sample individuals that were determined to belong to one of the four path categories of social-emotional development between infancy (1 year old) and toddlerhood (3 years old). Of the 1245 children in the full sample, 331 (27%) were *never* social-emotionally delayed; 373 children (30%) were *persistently* social-emotionally delayed; 149 children (12%) experienced *improving* social-

**Table 2**  
Social-emotional development of rural young children in different age ranges ( $N = 1245$ ).

Development	Infancy	Toddlerhood	Preschool age	Difference (1)–(2)	Difference (1)–(3)	Difference (2)–(3)
	Mean (SD)	Mean (SD)	Mean (SD)	p-Value	p-Value	p-Value
	(1)	(2)	(3)	(4)	(5)	(6)
Social-emotional score	45.8 (26.94)	71.2 (39.13)	81.1 (45.56)	<0.01	<0.01	<0.01
Rate of delay	42% (0.49)	61% (0.49)	52% (0.50)	<0.01	<0.01	<0.01

Note. Social-emotional scores are from the Ages & Stages Questionnaires: Social-Emotional (ASQ:SE) scores of children. Children who score higher than the cutoff set for different age are considered to be delayed in social-emotional development.

**Table 3**  
Paths of child social-emotional development from infancy to toddlerhood ( $N = 1245$ ).

Path	Infancy	Toddlerhood	Frequency (n)	Percentage
Never	No	No	331	26.6%
Persistently	Yes	Yes	373	30.0%
Improving	Yes	No	149	12.0%
Deteriorating	No	Yes	392	31.4%

emotional development; and 392 children (31%) experienced *deteriorating* social-emotional development. The results of comparisons of demographic characteristics between the different paths can be found in [Appendix Table A2](#).

**4.3. Associations between paths of social-emotional development before age 3 and social-emotional development and cognitive development at preschool age**

In each column of [Table 4](#), the results are based on the approach defined in Eq. (1) that compares the ASQ:SE scores of preschool-age children who were in each of the social-emotional path categories (never delayed, persistently delayed, improving, deteriorating) to the other children in the sample (which would be a combination of children in the other three path categories). The findings indicate that children who never experienced social-emotional delay before age 3 had significantly lower ASQ:SE scores at preschool age than did children from any of the other three path categories. Children with improving social-emotional development between infancy and toddlerhood also scored lower than the remainder of the children. In contrast, children with persistent social-emotional delays and those whose social-emotional development had deteriorated between infancy and toddlerhood had significantly higher ASQ:SE scores at preschool age when they were compared to the

**Table 4**  
Association between social-emotional scores at preschool age and path of child social-emotional development from infancy to toddlerhood ( $N = 1245$ ).

Path	Standardized ASQ:SE scores at preschool age			
	(1)	(2)	(3)	(4)
Never (1 = never, 0 = otherwise)	-0.19** (0.07)			
Persistently (1 = persistently, 0 = otherwise)		0.16* (0.07)		
Improving (1 = improving, 0 = otherwise)			-0.27** (0.09)	
Deteriorating (1 = deteriorating, 0 = otherwise)				0.21** (0.06)
Baseline ASQ:SE scores	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
County-fixed effects	Yes	Yes	Yes	Yes
Time-fixed effects	Yes	Yes	Yes	Yes
R-squared	0.07	0.07	0.07	0.07

\*  $p < .05$ .  
\*\*  $p < .01$ .

remaining children.

Column 1 of [Table 5](#) provides the associations between the paths of social-emotional development before age 3 and social-emotional development at preschool age, using Eq. (2), in which we regressed a variable that represents children (before 3 years old) who belonged to the persistently delayed, improving, and deteriorating path categories based on ASQ:SE scores of preschool-age children, using the never-delayed path category as the reference group. The results show that, compared to children on the never-delayed path, the sample individuals (before they were 3 years of age) that were on the persistent delay path and those on the deteriorating development path had ASQ:SE scores that were higher than when the sample individuals were in preschool (by 0.19 SD and 0.24 SD, respectively). Nevertheless, the findings do not show any significant differences in standardized ASQ:SE scores when comparing children who were on the improving path and those who were on the never-delayed path.

Column 2 of [Table 5](#) provides the associations between the path category of the children's social-emotional development before age 3 and the levels of cognitive development when the children were preschool age. To do so, the research team used regression analysis to assess how those children that were on the persistently delayed, improving, and deteriorating paths helped determine the FSIQ scores of the sample individuals that were in preschool. Note in carrying out this analysis, we used the children on the never-delayed path as the group that were used for comparison. The findings indicate that, in contrast to the sample individuals that were on a never-delayed path, the sample children on the persistent delay path for social-emotional development (before 3 years of age) were shown to have lower scores on the FSIQ scales than the sample individuals that were in preschool age (0.22 SD;  $p$ -value < .01). In addition, when the analysis examined those individuals that had never experienced social-emotional delay before age 3, children on

**Table 5**  
Association between social-emotional scores and cognitive scores at preschool age and path of child social-emotional development from infancy to toddlerhood ( $N = 1245$ ).

Path	Standardized ASQ:SE scores at preschool age (1)	Standardized FSIQ scores at preschool age (2)
Persistently (1 = persistently, 0 = otherwise)	0.19* (0.09)	-0.22** (0.07)
Improving (1 = improving, 0 = otherwise)	-0.11 (0.11)	-0.18 (0.09)
Deteriorating (1 = deteriorating, 0 = otherwise)	0.24** (0.07)	-0.12 (0.07)
Baseline ASQ:SE scores	Yes	Yes
Controls	Yes	Yes
County-fixed effects	Yes	Yes
Time-fixed effects	Yes	Yes
R-squared	0.08	0.18

\*  $p < .05$ .  
\*\*  $p < .01$ .

improving and deteriorating paths of social-emotional development before age 3 had lower FSIQ scores at preschool age; however, no statistically significant differences were found.

We also examined the associations between child and household characteristics and the paths of the social-emotional development of the sample children. The results show that younger children, girls, preterm children, and children with older mothers are more likely to not have been delayed in their social-emotional development or to have improving social-emotional development (rather than experiencing persistent social-emotional delay or deteriorating social-emotional development) (Appendix Tables A3 and A4).

#### 4.4. Associations between social-emotional development and cognitive development at preschool age and in infancy and toddlerhood

Columns 1 and 2 of Table 6 provide the levels (rather than paths) of social-emotional development in infancy (when the sample child was 1 year old) and toddlerhood (when the sample child was 3 years old) to the levels of social-emotional development at preschool age, using Eq. (4). The results reveal that the standardized ASQ:SE scores in infancy and toddlerhood were significantly and positively associated with standardized ASQ:SE scores at preschool age. Specifically, a 1-SD rise in the score using the standardized ASQ:SE scale when the sample individual was an infant (6 to 12 months) was associated with a 0.15-SD ( $p$ -value < .01) increase in the standardized ASQ:SE score at preschool age. In the case of the sample individuals that were toddlers (22 to 30 months), the results show that when the standardized ASQ:SE scores rose by 1 standard deviation there was an associated rise of 0.19-SD ( $p$ -value < .01) in the standardized ASQ:SE scores at preschool age.

Columns 3 and 4 of Table 6 present the results of the analysis of the association between social-emotional scores (measured as levels, not paths) in infancy and toddlerhood and cognitive scores at preschool age, using Eq. (5). The results demonstrate that the standardized ASQ:SE scores in infancy were negatively and significantly associated with standardized FSIQ scores at preschool age. Specifically, when the results found that a 1 standard deviation rise in the ASQ:SE score in infancy (6 to 12 months), it was associated with a 0.08-SD ( $p$ -value < .01) decrease in the standardized FSIQ score at preschool age. The standardized ASQ:SE scores in toddlerhood also were negatively associated with standardized FSIQ scores at preschool age; however, the association was not statistically significant.

## 5. Discussion

The findings of this study show that the rate of social-emotional delay is high when a child is in infancy (42%), toddlerhood (61%), and preschool age in rural China (52%). The findings are in line with

**Table 6**

Associations between social-emotional scores and cognitive scores at preschool age and in infancy and toddlerhood ( $N = 1245$ ).

Variable	Standardized ASQ:SE scores at preschool age		Standardized FSIQ scores at preschool age	
	(1)	(2)	(3)	(4)
Standardized social-emotional scores (in infancy)	0.15** (0.03)		-0.08** (0.03)	
Standardized social-emotional scores (in toddlerhood)		0.19** (0.03)		-0.02 (0.03)
Baseline MDI scores	Yes	No	Yes	No
MDI scores at age 3	No	Yes	No	Yes
Controls	Yes	Yes	Yes	Yes
County-fixed effect	Yes	Yes	Yes	Yes
Time-fixed effect	Yes	Yes	Yes	Yes
R-squared	0.07	0.08	0.18	0.27

\*\*  $p < .01$ .

prior studies in rural China. The findings of these studies showed that 35% to 58% of infants and toddlers are social-emotionally delayed [13,35,37–43], and 34% to 63% of children at preschool age are social-emotionally delayed [40,44,45]. Our results, along with the extant literature, indicate that the issue of social-emotional delay in the first five years of life is widespread in rural China.

The results also demonstrate that a large portion of children in our sample had persistently delayed (30%) or experienced deteriorating (31%) social-emotional development before age 3, while only a small share (12%) saw their social-emotional development improve from infancy to toddlerhood. These findings suggest that rural children in our sample who were social-emotionally delayed in infancy (42%) were less likely to recover from social-emotional delay when they had become a toddler (22 to 30 months). The findings also indicate that, if we do nothing with children who suffered social-emotional delay in their infancy, they will be more likely to have social-emotional delay persistently through their entire early childhood (at least through preschool).

Our data reveal that different paths of child social-emotional development before age 3 were associated with different child social-emotional developmental outcomes at preschool age. Children who never experience social-emotional delay or children who were on the improving social-emotional path had significantly higher social-emotional developmental outcomes at preschool age. In contrast, children who were persistently delayed in social-emotional development and those on deteriorating social-emotional path had lower social-emotional developmental outcomes at preschool age. These findings are consistent with previous international studies [31,32], which found that different paths of social-emotional development in early childhood affect later-in-life social-emotional skills differently. Children who were on a deteriorating path of social-emotional development at toddlerhood were more likely to have worse social-emotional skills at adolescence or adulthood, compared to children who were on a never-delayed path.

The finding that preterm children are more likely to be in Improving or Never paths rather than Persistently or Deteriorating paths is inconsistent with prior studies [67]. One of the possible underlying reasons of the inconsistency is that the study by Delobel-Ayoub et al. [67] focused on very preterm children (22–32 weeks gestation) and they found that the social-emotional issues of such children were not easily treatable. In our study, the social-emotional delays of the preterm children (31–36 weeks gestation) are generally considered to be more treatable, and the preterm children can benefit from mother/infant emotional connection and family support, according to prior studies [68–72]. When having young children with such treatable conditions, it may be that parents tend to make more efforts in taking care of their preterm children both in terms of their health and other domains of child development.

The results also show that the level of social-emotional development before age 3 can predict the level of social-emotional development at preschool age. In fact, the prediction of social-emotional development before age 3 to the social-emotional development at preschool age is the same as the prediction of paths of social-emotional development before age 3. This finding is in keeping with previous studies of the associations between social-emotional development in early childhood and at preschool age [24–27]. The finding suggests that monitoring the path of child social-emotional development or paying attention to child social-emotional development at different ages has significant meaning for the development of the child (that is, assuming action can be taken to rectify the delays). In the case of rural China, where our study finds that 31% of children have deteriorating social-emotional development before age 3, monitoring developmental paths in early childhood may be even more important, as it could help to identify the most vulnerable children and provide them with some type of intervention in a timely manner.

Finally, we determined the associations between child social-emotional paths before age 3 and child cognitive development at preschool age and the associations between child social-emotional development before age 3 and child cognitive development at preschool age.

The results indicate that children with persistent social-emotional delay during the first three years of life had worse levels of cognitive development when they were at preschool age compared to children who were on a never-delayed path. In addition, low levels of social-emotional development in infancy suggests that the same child will have a low level of cognitive development at preschool age. These findings are in line with previous research that found that social-emotional development in infancy is positively and significantly associated with school readiness scores at preschool age [25]. The findings suggest that it may be worth paying attention to measures of the social-emotional development of children at an early age of the child (i.e., as early as infancy and through toddlerhood) so that those families who have children that are delayed may be able to invest in their child's social-emotional development.

This study makes three contributions to the literature. First, using a population-based sampling method and reliable child developmental measurements, we drew data from a longitudinal set of survey data with a large sample size. The size of the data set and its time-series nature enhance the validity of the findings. Second, our analysis appears to be the first research initiative to examine the paths of child social-emotional development before age 3 and the associations between these paths and measures of outcomes of preschool-age development (both cognitive and social-emotional development) in rural China. The findings fill the gap in the literature on the state of the paths of child social-emotional development and its prediction of developmental outcomes later in life in rural China. Finally, this study examined the association between child social-emotional development before age 3 and child development (both cognitive and social-emotional developmental outcomes at preschool age) in rural China. The findings of this study could help researchers and policymakers to be aware of the importance of social-emotional development at an early stage of life and to implement timely interventions aimed at reducing the rate of child social-emotional delay in the early years of life.

Beyond the research's contribution, the research team also has identified two limitations. First, the cognitive developmental outcomes of the sample children were measured using the BSID, which was the only version adapted to Chinese language and cultural environment at the time of the current study. However, due to the psychometric properties of the BSID, we could not separate out cognitive and language development of the sample children, which may lead to a certain degree of measurement errors. Second, even though the analysis traces the paths of development of the social-emotional abilities from the time the sample individuals were infants until the time they were in preschool, the data collection efforts occurred in three separate waves. This means, of course, that there were substantial time periods (up to two years) between the survey waves. Because of this, we acknowledge that we may not be estimating the exact share of children that had social-emotional delays; in fact, the real level of social-emotional delay through early childhood may have been higher. In addition, although the research team spent considerable effort to choose random representative samples in the study area (China's Qinba Mountain area), it is clear that the findings of the study are not representative of rural China in general. In the future, research teams may want to study these different social-emotional development paths during early childhood by using samples

from other sub-populations across rural China.

## 6. Conclusion

In this study, we identified the paths of child social-emotional development before age 3 in rural Western China and explored how these paths can help to predict social-emotional skills and cognitive skills at preschool age. The study found that 44% of children were social-emotionally delayed in infancy (6–12 months), 61% were delayed in toddlerhood (22–30 months), and 52% were delayed at preschool age (49–65 months). In addition, 31% of children were on a deteriorating social-emotional path from infancy to toddlerhood, whereas only 12% were on an improving path. Children on the persistently-delayed path of social-emotional development before age 3 had significantly lower social-emotional and cognitive scores when they were 5 years old (or preschool age), compared to children on a never-delayed path. In contrast, children on an improving path showed no difference in either their preschool aged levels of social-emotional or cognitive development when compared with children that were on a never-delayed path. The results show that the path of social-emotional development before age 3 and the level of social-emotional development itself before age 3 can predict not only the level of social-emotional development at preschool age but also the level of cognitive development at preschool age.

The results of this study have several implications for policymakers and researchers. Considering the high rates of child social-emotional and cognitive delays in the first five years of life in rural China, policymakers need to take action to help rural families to improve the social-emotional development of their children at an early age. More importantly, policymakers need to find systematic solutions to these problems occurring in early childhood, such as implementing formal parenting training programmes across all rural areas of the nation. Based on our findings that the paths of child social-emotional development before age 3 and social-emotional development itself before age 3 can predict child development (both cognition and social-emotional) at preschool age in rural China, it is clear that encouraging families to be aware of and to measure the level of child social-emotional development at an early age are important steps for improving child social-emotional development. It is also important to implement timely interventions for children with social-emotional delays, especially for those from vulnerable, rural communities.

## CRedit authorship contribution statement

**Lei Wang:** Conceptualization, Methodology, Writing—Original, Draft Preparation Writing—Review & Editing, Project Administration. **Yifei Chen:** Formal Analysis, Writing—Original Draft Preparation, Writing—Review & Editing. **Siqi Zhang:** Data Curation, Writing—Review & Editing. **Scott Rozelle:** Conceptualization, Methodology, Writing—Review & Editing, Supervision.

## Declaration of competing interest

None declared.

## Appendix A

### Appendix Table A1

Applicable scope and cutoff score of each ASQ:SE questionnaire interval set by the Manual of the ASQ:SE.

Questionnaire interval	Applicable range	Cutoff score
6 months	3–8 months	45
12 months	9–14 months	48
18 months	15–20 months	50

(continued on next page)

**Appendix Table A1** (continued)

Questionnaire interval	Applicable range	Cutoff score
24 months	21–26 months	50
30 months	27–32 months	57
36 months	33–41 months	59
48 months	42–53 months	70
60 months	54–65 months	70

**Appendix Table A2**

Demographic statistics between different path of child social-emotional development from infancy to toddlerhood.

	Never or improving (1)	Persistently or deteriorating (2)	Diff. (1)–(2) (3)
<b>Child characteristics</b>			
Age	9.14 (1.81)	9.65 (1.78)	<0.01
Male (1 = yes)	0.47 (0.50)	0.54 (0.50)	0.02
Premature (1 = yes)	0.07 (0.25)	0.03 (0.18)	<0.01
Have siblings (1 = yes)	0.26 (0.44)	0.22 (0.42)	0.13
<b>Household characteristics</b>			
Primary caregiver (1 = mother)	0.88 (0.33)	0.83 (0.37)	0.03
Maternal age (1 = above 25 years old)	0.66 (0.47)	0.59 (0.49)	0.02
Maternal education level (1 = 9 years or higher)	0.72 (0.45)	0.72 (0.45)	0.89
Family asset index	0.04 (1.20)	–0.11 (1.15)	0.04
County fixed effect	Yes	Yes	
Time fixed effect	Yes	Yes	
Observations	480	765	

**Appendix Table A3**

Multivariate analysis of the association between characteristics and path of child social-emotional development from infancy to toddlerhood.

	Never or improving (0 = persistently or deteriorating)	
	$\beta$ (1)	ME (2)
<b>Child characteristics</b>		
Age	–0.08** (0.02)	–0.03** (0.01)
Male (1 = yes)	–0.18* (0.07)	–0.06* (0.03)
Premature (1 = yes)	0.54** (0.18)	0.19** (0.06)
Have siblings (1 = yes)	0.05 (0.10)	0.02 (0.03)
<b>Household characteristics</b>		
Primary caregiver (1 = mother)	0.14 (0.11)	0.05 (0.04)
Maternal age (1 = above 25 years old)	0.18* (0.08)	0.07* (0.03)
Maternal education level (1 = 9 years or higher)	–0.02 (0.09)	–0.01 (0.03)
Family asset index	0.06 (0.04)	0.02 (0.01)
County fixed effect	Yes	Yes
Time fixed effect	Yes	Yes
Observations	1245	1245

*Note.* Column 1 presents coefficients and standard errors (in parentheses) from the probit regression. Column 2 presents marginal effects from the same probit regression, where 1 = “never” or “improving” and 0 = “persistently” or “deteriorating” when child’s age is from 6 to 12 months (infancy) to 22 to 30 months (toddlerhood). All regressions control for county fixed effects and time fixed effects.

\*  $p < .05$ .\*\*  $p < .01$ .**Appendix Table A4**

Multivariate analysis of the association between characteristics and Improving path of child social-emotional development from infancy to toddlerhood.

	Improving (0 = persistently or deteriorating)	
	$\beta$ (1)	ME (2)
Child characteristics		
Age	-0.03 (0.03)	-0.01 (0.01)
Male (1 = yes)	-0.18 (0.10)	-0.04 (0.02)
Premature (1 = yes)	0.67** (0.23)	0.15** (0.05)
Have siblings (1 = yes)	-0.06 (0.14)	-0.01 (0.03)
Household characteristics		
Primary caregiver (1 = mother)	0.03 (0.14)	0.01 (0.03)
Maternal age (1 = above 25 years old)	0.19 (0.11)	0.04 (0.03)
Maternal education level (1 = 9 years or higher)	0.05 (0.12)	0.01 (0.03)
Family asset index	0.02 (0.05)	0.00 (0.01)
County fixed effect	Yes	Yes
Time fixed effect	Yes	Yes
Observations	914	914

Note. Column 1 presents coefficients and standard errors (in parentheses) from the probit regression. Column 2 presents marginal effects from the same probit regression, where 1 = "improving" and 0 = "persistently" or "deteriorating" when child's age is from 6 to 12 months (infancy) to 22 to 30 months (toddlerhood). All regressions control for county fixed effects and time fixed effects.

\*  $p < .05$ .\*\*  $p < .01$ .**References**

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