Early Childhood Research Quarterly 53 (2020) 355–369

Contents lists available at ScienceDirect

Early Childhood Research Quarterly

Teacher qualifications and development outcomes of preschool children in rural China

Lei Wang [a], Ruirui Dang [b], Yu Bai [c,d,*], Siqi Zhang [b], Buyao Liu [b], Lijuan Zheng [b], Ning Yang [b], Chuyu Song [b]

[a] International Business School, Shaanxi Normal University, Shaanxi, China
[b] Center for Experimental Economics of Education, Shaanxi Normal University, Shaanxi, China
[c] School of Economics, Minzu University of China, China
[d] China Institute for Vitalizing Border Areas and Enriching the People, China

ARTICLE INFO

Article history:
Received 18 June 2019
Received in revised form 18 May 2020
Accepted 26 May 2020

Keywords:
Preschool children
Teacher qualifications
Child development
Rural China

ABSTRACT

In the preschool period, interactions between teachers and children are an essential input for healthy development. However, it is not well understood how the qualifications of preschool teachers contribute to child development during the preschool period, and previous international studies have returned mixed results. We drew on data from a longitudinal study of 1031 preschool children age 49–65 months in rural China to examine the associations between teacher qualifications and the development of preschool children. The findings showed that 36% of preschool children in the sample are developmentally delayed. Overall, teacher qualifications (education level, specialization in early childhood education, professional ranking, experience and training) were significantly associated with preschool-age child developmental outcomes. Teacher professional ranking and educational attainment were positively and significantly correlated with two measures of child language development, but a degree specialized in early childhood education was negatively related to vocabulary acquisition. No significant correlations were found between teacher experience or teacher training and child developmental outcomes. The study concludes that policymakers should encourage highly educated and professionally ranked teachers to serve in rural preschools in order to improve the development of preschool children.

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1. Introduction

In rural China, research has shown high rates of developmental delays in infants and toddlers age 0–3 years, with nearly half of children exhibiting delays in cognition and language (Wang et al., 2019; Wei et al., 2015; Yue et al., 2017). These high rates of developmental delays may have devastating effects on China's economic growth and development. If such delays persist through childhood and into adulthood, it may lead to lower levels of academic attainment and lower-quality employment (Attanasio, Cattan, Fitzsimons, Meghir, & Rubio-Codina, 2015; Heckman, Moon, Pinto, Savelyev, & Yavitz, 2010; Knudsen, Heckman, Cameron, & Shonkoff, 2006; Schweinhart et al., 2005). Moreover, if such delays impact a large enough share of the future labor force, this may in turn prevent China's smooth transition into a skills-based economy (Guo & Qu, 2019; Kharas & Kohli, 2011).

For China's rural children, preschool may be the one compensatory chance to improve their developmental outcomes. The nervous systems of young children develop rapidly in the first three years, but the process of skills development continues through age five (Grantham-McGregor et al., 2007; Knudsen et al., 2006). These dynamics make the first years of preschool (age 3–5 years) a key period for enhancing the development of cognitive, language and social-emotional skills—especially for children who enter this age developmentally behind their peers (Grantham-McGregor et al., 2007; Hou, 2013; Knudsen et al., 2006). Studies have shown that both the home environment and the quality of preschool education play important roles in child development during the preschool years (Baker & Milligan, 2010; Bono, Francesconi, Kelly, & Sacker, 2016; Currie & Almond, 2011; Kariger et al., 2012; Villena-Rodán & Ríos-Aguilar, 2012). In the home, children who receive better family care and higher levels of stimulation from caregivers showing significantly better cognitive and non-cognitive development (Attanasio et al., 2015; Bornstein, Putnick, Lansford, Deater-Deckard, & Bradley, 2015; Fiorini & Keane, 2014; Hart &

* Corresponding author at: School of Economics, Minzu University of China, China Institute for Vitalizing Border Areas and Enriching the People, 27 Zhongguancun South Avenue Beijing 100081, China.
E-mail address: yubai@muc.edu.cn (Y. Bai).

https://doi.org/10.1016/j.ecresq.2020.05.015
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Risley, 1995; Lugo-Gil & Tamis-LeMonda, 2008; Maholmes & King, 2012; Shonkoff et al., 2012; Tomopoulos et al., 2006). Unfortunately, studies have shown that home environment is very poor in rural China (Luo et al., 2017; Wang et al., 2019; Yue et al., 2017).

In addition to the home, preschool education is also demonstrated to be foundational for lifelong development. Research has found that preschool attendance is associated with higher academic test scores of children when they are in school and can reduce the chance of grade repetition during elementary school (Burger, 2010; Currie & Thomas, 1999; Howes et al., 2008; Montie, Xiang, & Schweinhart, 2006). A strong preschool foundation is also important for overall educational attainment, as well as adult employment and income (Ramey & Ramey, 1998; Schweinhart et al., 2005). This means that the development of cognitive and noncognitive skills during preschool is an important factor in human capital accumulation (Heckman et al., 2010; Schweinhart & Weikart, 1990).

In recognition of the key role of preschool education in a nation's overall effort to improve human capital, researchers and policy makers in China have emphasized the importance expanding preschool education as part of China's educational reform (Luo & Li, 2010a). In 2010, the central government declared that by 2020, 95% of Chinese children should receive at least one year of preschool education and 75% of children should receive three years of preschool education (MOE, 2010). These policies have rapidly expanded rates of preschool attendance and enrollment: from 2009 to 2016, the gross national preschool enrollment rate increased from 50.1% to 77.4% (Wu, 2017). In addition, the Ministry of Education (MOE) has required that a quality evaluation of preschools be conducted by the local county-level Bureaus of Education (BOE) once every three to five years (MOE, 2017a, 2017b), including evaluations of preschool facilities, teachers, school management systems, child services, and early childhood development. Although the evaluations are not publically available, they may affect preschools to improve educational quality.

Unfortunately, in this rapid expansion, teacher qualifications—especially in rural preschools—have not always been able to keep up. Only 61.9% of full-time preschool teachers in rural China had obtained a vocational university degree or above (Hui & Yang, 2018), and teachers in rural areas tend to have significantly lower levels of training and experience than their urban counterparts (Wang, 2017). A recent study in rural Shaanxi province found that in most rural preschools, only the principals had participated in a city-level training, and most teachers had never participated in any training (Lai, Xue, & Yang, 2015). Additionally, preschool teachers in rural areas tend to be young, and the share of experienced teachers is small (Lai et al., 2015).

In recent years, there have been efforts to improve the standard of preschool teacher qualifications. Beginning in 2000, China's central government published "Implementation Measures for Regulating Teacher Qualifications", a policy brief which included concrete measures to improve preschool teacher qualifications across China. This brief states that preschool teachers should have a degree in early child education from at least a preschool teacher training college or vocational university (MOE, 2000). In China, preschool teacher training colleges are upper secondary schools that recruit students from junior high. Vocational universities, in contrast, provide tertiary education to students that have graduated from upper secondary school. In preschool teacher training colleges, all students specialize in early childhood education. In vocational universities and above, students may choose to pursue a degree in early childhood education. Additionally, in 2011, the Ministry of Education standardized the qualifying examination for preschool teachers and added content regarding professional ethics and basic literacy, education knowledge and application, and childcare knowledge and ability (Yu, 2013).

In its proposal to expand preschool education, the state also proposed to expand preschool teacher training, aiming to offer national-level training to 10,000 preschool principals and outstanding teachers by 2013 and expand the national-level teacher training program to include all full-time preschool principals and teachers by 2015 (The State Council of China, 2010). China's national-level teacher training is a training program for public preschool, primary and middle school teachers across the country. The program trains teachers in basic theory, teaching methodology and class management, with a special focus on rural teachers. The training for preschool teachers includes short-term training (10–20 days) and long-term training (3 months). Preschool teachers attend training classes held in universities or qualified training organizations. The training contents include three dimensions: professional ethics and basic literacy (e.g., teacher–child relationship construction and teacher mental health), education knowledge (e.g., knowledge of child mental health and child development), and professional application (e.g., class management, activities organization, and relationship building with parents and communities) (MOE, 2010).

More recently, the Ministry of Education introduced a professional ranking system for preschool teachers, which measures the qualifications and ability of teachers and ties each teacher's salary to his or her professional ranking (Wang, 2018). Under this system, teachers start as unranked and can advance through five ranks depending on their performance, with standards of performance enumerated within the ranking protocol. Officials in the local bureau of education are in charge of approving promotion to higher levels of rankings. Local county-level officials also set quotas for the number of teachers who can receive a certain rank within each school. This means that of the teachers who meet the criteria for a professional ranking, only a certain proportion of teachers will be selected to receive a professional ranking at each ranking level. Teachers who have already received a ranking are revaluated every 3–5 years, which means that they need to continue to perform well to maintain their ranking and salary level.

How should improving teacher qualifications be expected to impact the developmental outcomes of preschool children? Although the link between teacher classroom practices and child cognitive development, language, and literacy has been established in the theoretical and empirical literature (Curby et al., 2009; Mashburn et al., 2008; National Early Literacy Panel, 2008; Yoshikawa et al., 2013), the relationship between preschool teacher qualifications and child development outcomes is less well understood and the findings are mixed. Some found that teacher qualifications were positive predictors of child development (Barnett, 2003; Hanushek, 1992; Son, Kwon, Jeon, & Hong, 2013; Whitebook, 2003). For example, studies of preschool children in the United States have found that teacher education level is positively associated with children's cognitive and language development (Burchinal et al., 2000; Loeb, Fuller, Kagan, & Carrol, 2004), as well as literacy and mathematic skills (Brown, Molfese, & Molfese, 2008). In contrast, other studies found null associations between any measures of teacher qualifications—education level, major, or credentials—and the development of young children (Early et al., 2006; Lin & Magnuson, 2018). Lin and Magnuson (2018), for example, found that teacher qualifications, including professional trainings, education level and specialization in early childhood education, were not associated with children's outcomes. China's National Institute of Medicine (IOM) and National Research Council (NRC) (2015) have also found that typical higher education degrees, especially BA degrees, do not lead to improved child outcomes. An analysis of seven childcare and preschool evaluation programs across the United States conducted by Early et al. (2007) found that while some programs showed positive correlations between the teacher qualifications and child development,

others showed no correlations at all. Specifically, none of the seven programs found an association between teacher education and children's receptive language skills, while two programs reported associations with reading skills, and only one study found associations with math skills. The authors speculated that exogenous factors, such as the teacher preparation system or market forces, may be responsible for the observed lack of correlation.

One possible reason for the mixed nature of the literature is that previous studies have not assessed child development outcomes before children reach preschool. This means that past studies have been unable to isolate the effects of teacher qualifications on development during the preschool years specifically. We found only three studies that drew on longitudinal data to assess preschool-age children development. One study, by Howes et al. (2008), averaged child development outcomes collected at different periods of preschool to create a single outcome variable of child development, which means that their analysis did not assess child development outcomes before preschool. Two additional studies, by Lin and Magnuson (2018) and Early et al. (2006), did control for child development at the baseline of the respective studies; however, the baseline child development outcomes for both studies were collected during preschool, which means that although baseline development was controlled for, the results did not specifically isolate development during the preschool period.

Even fewer studies have examined correlations between teacher qualifications and the developmental outcomes of preschool-age children in developing regions such as rural China. In China, the literature has mainly focused on describing the qualifications of rural teachers (Hui & Yang, 2018; Lai et al., 2015; Shan, 2018) or the differences in teacher qualifications between rural and urban areas (Li, 2018). One study of teacher qualification and development outcomes using a mixed sample of preschool children from urban and rural China found that the process quality of preschool education (measured by teaching activities) was significantly correlated with child development outcomes (Hou, 2013). However, the rural sample used in this study was from relatively wealthy areas on the eastern coast of China and could not be considered representative of rural areas with fewer resources. Additionally, this study did not look at the role that teacher qualifications may have played in the development of preschool children. To our knowledge, no study of rural China has examined the relationship between preschool teacher qualifications and child development outcomes.

The overall goal of this study is to describe preschool age child development outcomes and teacher qualifications in rural China, and isolate the relationship between teacher qualifications and child development during the preschool period. In pursuit of this goal, we address three research questions. Question 1: what are the developmental outcomes of preschool children in rural China, and how do rates of delay at preschool age compare to rates of delay in toddlerhood? Question 2: after controlling for developmental outcomes before preschool, how do teacher qualifications in aggregate correlate to the developmental outcomes of preschool children? Question 3: which measures of teacher qualifications are most strongly linked to improved child development outcomes? We hypothesize that after controlling for developmental outcomes in early childhood (age 3), teacher qualifications will overall show a positive relationship to child development outcomes.

2. Methods

2.1. Sample selection

The data presented in this study were collected in 11 nationally-designated poverty counties located in the Qinba Mountain Area. The Qinba Mountain Area, which spans across six provinces in central and western China, is a remote mountainous region prone to natural disasters. As of 2017, there are about 3 million people living in the 11 counties included in our sample, with a population density of 93 people per square kilometer (Shaanxi Provincial Bureau of Statistics, 2018b). The Qinba Mountain Area is also one of China's poorest regions. In 2013, the per capita GDP of the region was $1275 (RMB 7896), far lower than the national per capita GDP of $7057 (RMB 43,684) (NBS, 2017). Additionally, of the 75 counties in the region, nearly all are designated as poverty counties by the central government of China (The State Council Leading Group Office of Poverty Alleviation and Development, 2012).[1] Due to its mountainous geographical features which make farming difficult, secondary industry contributes the most to the region's economic output (Shaanxi Provincial Bureau of Statistics, 2018a).

The data were drawn from a longitudinal study of early childhood health and development, conducted by the authors and their collaborators, beginning in 2013. This longitudinal study tracked the developmental outcomes of a cohort of children over three survey waves from age 6–11 months, to age 49–65 months, allowing us to examine their development over time. This also allows us to control for development prior to preschool, giving us more precision to examine the role of teacher qualifications in preschool-age development.

At the beginning of this study, in 2013, the research team followed a rigorous multistage cluster sampling design to select the baseline sample. First, all townships (the middle level of administration between county and village) were selected to participate in the study. There were two exceptions to this rule: we excluded the one township in each county that housed the county seat, and we excluded any townships that did not have any villages with a population of 800 or more. In total, according to these criteria, 174 townships were included in the study. In each of the townships included, we then randomly selected two villages. With the help of the local family planning offices, in each village we obtained a list of all registered births between March 2012 and May 2013 and included all children within the desired age range (6–11 months) for inclusion in our study. The mean age of sample children at baseline was 9 months. Of the families that were contacted to be in the study, virtually all families agreed to participate.

Following the initial baseline survey wave in 2013, we conducted a follow-up survey in April 2015, when sample children were 21–30 months old. In 2017, we conducted an additional follow-up survey, during which we tracked 87.5% of the children from the baseline sample. At the time of the second follow-up, the sample children were aged 49–65 months (or 4–5 years old). Ninety-two percent (92%) of the children in the 2017 follow-up survey were attending preschool, while 8% were not enrolled in preschool. We included all children attending preschool in the study sample of this paper, totaling 1031 children. We also included all preschools that had enrolled sample children. In each school, we selected all teachers who were responsible for the classes that included at least one of the sample children for inclusion in the study. In total, our study sample included 1031 children and 583 preschool teachers in 347 preschools.

At the time of the baseline survey in 2013, all sample children and families lived in rural villages. By the time of the follow-up survey in 2017, 60.3% of the sample children and families had moved to larger towns or counties (at least during the week, when preschools were in session) in order for parents to work or for children to be

[1] In China, nationally-designated poverty counties are areas that have been recognized by the central government as low income areas in greater need of government support. The threshold for poverty county status is an annual per capita income of less than 2300 RMB, or about one US dollar per person per day (The State Council Leading Group Office of Poverty Alleviation and Development, 2012).

able to attend preschool (since a large share of the preschools were in towns or county seats). Of the 1031 children in our sample, 368 lived in rural villages, 540 lived in towns and 123 lived in a county seat. Of the 583 preschool teachers and 347 preschools in our sample, 174 teachers at 148 schools were located in rural villages, 305 teachers at 146 schools were located in towns, and 104 teachers at 53 schools were located in a county seat.

However, there was some attrition throughout the study. Between the baseline survey in 2013 and the second follow-up survey in 2017, 265 of the original 1802 children (14.7%) attrited, leaving a sample size of 1537. Of these, 1517 households finished the second follow-up survey, while 20 households (1.3%) declined to participate. Among the remaining 1517 children in the sample, 1403 children were attending preschool. We successfully surveyed all principals of the preschools that sample children were attending, as well as all preschool teachers that were identified as teachers of sample children. Because we controlled for Bayley test scores when children were 21–30 months, there were 1031 children included in the study sample of this paper due to the attrition in the wave of 2015 (when children were 21–30 months).

2.2. Ethical review

This study received ethical approval from the Stanford University Institutional Review Board (IRB) (Protocol ID 25734), and from the Sichuan University Ethical Review Board (Protocol ID 2013005-01). All participating caregivers gave their oral consent for both their own and their infant's involvement in the study.

2.3. Data collection

The data used in this study were collected during the baseline survey in 2013, as well as during two follow up survey waves conducted in April 2015 and June 2017. During the baseline survey, teams of trained enumerators collected socioeconomic information from all sample households by interviewing the primary caregiver of each sample child.[2] Each child's primary caregiver was identified and administered a detailed survey on child characteristics and household characteristics, including the child's age (months), the child's gender (1 = male; 0 = female), time the child has been in preschool (months), whether the child is an only child (1 = yes; 0 = no), whether the mother completed high school (1 = yes; 0 = no) and household asset value.[3] The exact age of each child was obtained from his or her birth certificate.

In 2015, when sample children were 21–30 months of age, we assessed development outcomes using the Bayley Scales of Infant Development (BSID). The BSID is an internationally-recognized, scaled test for children under 30 months (Bayley, 1974). It is considered the "gold standard" of infant development tests due to its sensitivity to differences in early developmental outcomes across diverse contexts (Hamadani et al., 2010; Nahar et al., 2009). This test is extensively used in the psychological literature and is listed by the American Psychiatric Association as a standard way to diagnose certain developmental disorders (American Psychiatric Association, 2000). This test was formally adapted to the Chinese language and environment in 1993 and scaled according to an urban Chinese sample (Yi, Luo, Yang, & Wan, 1993). At the time of our survey, the BSID was the only version of the test adapted to the Chinese language and environment, and it had been used in child development studies throughout urban China (Bao, Sun, & Wei, 1999; Wu, Sheng, Shao, & Zhao, 2011).

The BSID produces two indices: a mental development index (MDI) and a psychomotor development index (PDI). The MDI measures memory, habitation, problem solving, early number concepts, generalization, classification, vocalizations, and language. The PDI measures fine and gross motor skills (Bayley, 1969). In the Chinese version of the BSID, both the MDI and PDI have an inter-rater reliability of 0.99, a high test-retest reliability rate (0.82 for the MDI; 0.88 for the PDI); both indices also have a high parallel forms reliability (0.85 for the MDI; and 0.87 for the PDI), indicating that test scores are consistent even when the methods or instruments used vary (Yi, 1995).

The BSID was administered by trained testers who underwent a formal week-long training course including 2.5 days of field training. The test was administered 1-on-1 in the household of each child using a standardized set of toys and detailed scoring sheet. Caregivers were present but were not allowed to assist children during the administration of the BSID. The BSID takes into consideration each child's age in days, as well as whether he or she was premature at birth. These two factors, combined with the child's performance on a series of tasks using the standardized toy kit, contribute to the establishment of the MDI and PDI.

The MDI and PDI, and scores for each behavioral item, were assessed according to the grading method described in the Manual for the Bayley Scales of Infant Development (Bayley, 1969; Yi et al., 1993). Scores on each index can range between 50 and 150, and both indices are scaled to have an expected mean of 100 and standard deviation (SD) of 16. Children with scaled index values below 80 are considered delayed. We use the BSID scores from this survey wave as a control variable in our subsequent analysis.

In June 2017, all children in our sample had entered preschool. At this time, we collected data on our main outcome variables: preschool-age child development outcomes. Because the children were over 30 months of age at this time, the BSID was no longer a valid instrument to measure developmental outcomes. Therefore, the research team used the Chinese version of the Wechsler Preschool and Primary Scale of Intelligence-Fourth Edition (WPPSI-IV) to measure developmental outcomes in the third survey wave. The WPPSI-IV was developed for children ages 2.5–7 in response to an increasing need for instruments to assess the development of preschoolers (Wechsler, 2012). The Chinese version of the WPPSI-IV was formally adapted to the Chinese language and environment in 2014 and scaled according to a Chinese standardized sample from urban and rural areas (Li, Zhu, & Wechsler, 2014).[4]

The WPPSI-IV contains 13 subtests, which are summed into one Full-Scale Intelligence Quotient (FSIQ), as well as five Primary Indexes and four Ancillary Indexes. The Primary Indexes include Verbal Comprehension, Visual Spatial, Fluid Reasoning, Working Memory, and Processing Speed. The Ancillary Indexes include Vocabulary Acquisition, Nonverbal, General Ability, and Cognitive Proficiency. The Chinese version of WPPSI-IV test has high reliability, with a reliability coefficient of 0.96 for the FSIQ and between 0.85 and 0.94 for the index sores. The internal consistency coefficients for the indices are also high, ranging from 0.74 to 0.91 (Li et al., 2014). Children with scaled index values below 85 are considered developmentally delayed.

[2] In this paper, primary caregiver refers to the family member who is most responsible for the child's care at the time of the survey. For over 98% of the children in our sample, the primary caregiver was either the child's mother or paternal grandmother.

[3] The household assets index was constructed using polychoric principal component analysis based on the following variables: tap water, toilet, water heater, washing machine, computer, internet, refrigerator, air conditioner, motor or electronic bicycle, and car.

[4] The sample is based on a stratified sample of 756 Chinese children. The data is based on the demographic characteristics and census data of China in 2010, taking into account four key independent variables (age, gender, parental education and living area of the child).

As with the BSID, the WPPSI-IV was administered by trained enumerators who underwent a formal week-long training course including 2.5 days of field training. The test was administered 1-on-1, either at home or in the child's preschool, using a standardized set of toys and detailed scoring sheet. Neither caregivers nor teachers were allowed to assist the child during the administration of the WPPSI-IV.[5]

In addition to the WPPSI-IV, we conducted structured interviews with each teacher and each principal with teacher survey form and principal survey form respectively. All teachers and principals that we followed in the final survey wave completed the forms. The teacher survey collected data on whether teacher completed vocational university or higher (1 = yes; 0 = no), whether they had specialized in early childhood education (1 = yes; 0 = no).[6] We also collected data on whether each teacher had a professional ranking (1 = yes; 0 = no), which refers to the level of promotion a teacher has reached.[7] Additionally, we collected data on each teacher's teaching experience (years) and whether they had received at least one training on early childhood education (1 = yes; 0 = no), as well as data on each teacher's age (years) and gender (1 = male; 0 = female). Finally, we interviewed the principal of each preschool to determine whether the preschool was affiliated with a primary school (1 = yes; 0 = no) as well as school fees per semester (RMB). Preschools affiliated with a primary school were established to provide preschool education in areas that did not have the resources to open independent preschools and did not have any existing public preschools. To achieve its goal that 95% of children will attend at least one year of preschool by 2020 (MOE, 2010), the central government of China has required that each town should have at least one public preschool (MOE, 2018b). Although many rural preschools have been built, areas of concentrated poverty often lack the resources to build a stand-alone preschool. In those cases, preschools were established in existing surplus school buildings, or other educational spaces in rural primary schools. However, it is important to note that although the preschools affiliated with a primary school have physical links to the primary schools, the preschool resources are used only by the preschool itself. Additionally, as affiliated preschools are located in the poorest areas, they usually charge lower fees than independent preschools. Table A1 provides more information on the affiliated and independent preschools in our study sample.

2.4. Statistical approach

Our analytic approach is comprised of three parts, each of which addresses one of our three research questions. First, we address Question 1: what are the developmental outcomes of preschool children in rural China? To do so, we report the mean and standard deviation (SD) of FSIQ and subscale scores for the sample (Table 2). Additionally, following WPPSI-IV standards that set a scaled score of 85 as the cutoff for delay, we also report the prevalence of developmental delays at preschool age (Table 2).

Second, we address Question 2: after controlling for developmental outcomes before preschool, how do teacher qualifications correlate to child development at preschool age? To answer this question, we first created an aggregate measure of teacher qualifications by constructing a teacher qualification index using iterated principal factor analysis of the measures of teacher qualifications. We estimated each measure of teacher qualifications by a dedicated measurement system based on the methods of Sylvia et al. (2018). After estimating each measure of teacher qualifications separately, we estimated a final qualification index score for each teacher in the sample using the Bartlett scoring method (Bartlett, 1937). We then conducted a regression of the correlations between this aggregate measure of teacher qualifications and child development outcomes while controlling the individual, household and preschool characteristics of each child, including the child's gender, age, BSID score at 21–30 months, time in preschool, whether the child is an only child, mother's educational level, household asset index, teacher's age and gender, whether the preschool was affiliated with a primary school, and school fees per semester. We accounted for clustering at the preschool level and control for WPPSI-IV tester fixed effects (Table 3).

Finally, we address Question 3: which measures of teacher qualifications are most strongly linked to improved child development outcomes at preschool age? To answer this question, we conduct a regression of each individual measure of teacher qualifications (education level, specialization in early childhood education, professional ranking, experience and training) and child development outcomes, controlling for the individual, household and preschool characteristics listed above (Table 4). We then compare the significance and relative "strength" (magnitude) of the correlations between each measure of teacher qualifications and child development outcomes in our sample.

3. Results

This section presents the results of our descriptive and correlational analyses. First, we present the descriptive statistics for the children, households, teachers and preschools in our sample. Second, we describe the developmental outcomes of our sample children. Third, we measure the associations between teacher qualifications and preschool-age child development outcomes. Finally, we identify which teacher qualifications are most highly associated with improving preschool-age child development outcomes.

3.1. Child, household, teacher, and preschool characteristics

The basic socioeconomic and demographic characteristics of the study participants were reported in Table 1. When looking at the characteristics of our sample children and households, the data show that the average age of children was 57 months. Slightly more than half (51%) of sample children were male, which reflects the overall gender ratio in China (NBS, 2018). The average MDI score and PDI score of the sample children (collected when children were between 21 and 30 months) were 81.36 and 103.07 respectively (Table B1), which was similar to previous studies conducted in China's rural areas (Wang et al., 2019; Yue et al., 2017). The percent of children whose MDI scores were less than −1 SD and −12 SD were 54% and 30%, respectively, and the percent of children whose PDI scores were less than −11 SD and −12 SD were 16% and 4%, respectively (Table B1). This indicates that the MDI levels of development

[5] For both the BSID and WPPSI-IV, in order to ensure the validity of test results, the research team invited experts to conduct standardized training on test materials, time limits, environment creation and scoring guidance. In addition, experienced testers were paired with new testers during field training to increase their experience and understanding. For more information about the training enumerators underwent prior to this study, please see Luo et al. (2017).

[6] There is some correlation between specialization in early childhood education and teacher education level. Preschool teachers who have attended preschool teacher training colleges receive a degree that is specifically designated for early childhood education, and therefore all graduates of preschool teacher training colleges are specialized. In other programs such as vocational universities, students may choose whether or not to specialize in early childhood education as part of a teaching degree.

[7] Teachers in China are subject to a system of promotions where they advance through five ranks depending on their performance (with standards of performance enumerated within the ranking protocol). Under the condition of meeting these basic standards, a certain proportion of teachers will be selected to issue a professional ranking according to their professional level. In this paper, teachers who have been selected and identified as level 3 or above are defined as having a professional ranking.

Table 1
Summary statistics for children, households, teachers and preschools.

		Full sample Mean (SD)(1)	Village Mean (SD)(2)	Town Mean (SD)(3)	County Mean (SD)(4)
Child variables					
(1)	Child age (months)	57.11	57.29	56.96	57.19
		(3.38)	(3.23)	(3.44)	(3.52)
(2)	Male child (1 = yes, 0 = no)	0.51	0.51	0.51	0.50
		(0.50)	(0.50)	(0.50)	(0.50)
(3)	Time in preschool (months)	14.85	13.79	15.25	16.21
		(7.32)	(7.10)	(7.30)	(7.69)
(4)	Bayley score at 21–30 months	81.36	79.24	81.75	86.02
		(21.85)	(21.23)	(21.71)	(23.39)
Household variables					
(5)	Mother completed high school (1 = yes, 0 = no)	0.16	0.12	0.17	0.26
		(0.37)	(0.33)	(0.38)	(0.44)
(6)	Only child (1 = yes, 0 = no)	0.38	0.29	0.42	0.45
		(0.48)	(0.45)	(0.49)	(0.50)
(7)	Household asset index	−0.03	−0.25	0.07	0.23
		(1.19)	(1.17)	(1.19)	(1.16)
Teacher variables					
(8)	Teacher age (years)	31.94	35.39	29.71	31.41
		(9.14)	(11.35)	(6.95)	(6.76)
(9)	Male teacher (1 = yes, 0 = no)	0.06	0.11	0.03	0.02
		(0.24)	(0.32)	(0.18)	(0.15)
(10)	Completed vocational university or higher (1 = yes, 0 = no)	0.54	0.39	0.62	0.63
		(0.50)	(0.49)	(0.49)	(0.49)
(11)	Has specialized in early childhood education (1 = yes, 0 = no)	0.36	0.24	0.41	0.46
		(0.48)	(0.43)	(0.49)	(0.50)
(12)	Has a professional ranking (1 = yes, 0 = no)	0.35	0.29	0.38	0.46
		(0.48)	(0.45)	(0.48)	(0.50)
(13)	Experience (years)	5.08	6.33	4.02	6.04
		(6.04)	(8.55)	(3.38)	(5.15)
(14)	Training (1 = has received at least one training on early childhood education, 0 = not trained)	0.80	0.68	0.86	0.87
		(0.40)	(0.47)	(0.35)	(0.34)
Preschool variables					
(15)	Affiliated with a primary school (1 = yes, 0 = no)	0.36	0.71	0.18	0.07
		(0.48)	(0.45)	(0.39)	(0.26)
(16)	Fees per semester (RMB)	1110.25	744.33	1164.56	1966.54
		(635.43)	(382.01)	(501.78)	(837.42)
	Observations	1031	368	540	123

Notes: Descriptive statistics of child, household, teacher, and preschool when children were 49–65 months of age in villages, towns, and county seats. Multi-period tracking data source is author's survey. Column 1 shows the mean and standard deviation of each characteristic for the full sample. Columns 2–4 show the mean and standard deviation of each characteristic for the village, town and county sample respectively. Household asset index constructed using polychoric principal components on the following variables: tape water, toilet, water heater, washing machine, computer, internet, fridge, air conditioner, motor or electronic bicycle, and car. Bayley score at 21–30 months is the child's Bayley cognitive score when the author performed a Bayley test on the sample. Fees per semester contains tuition fee and other fees such as food, bus and insurance.

among sample children during infancy and toddlerhood were low, while the PDI levels of development were normal. Because the rate of delay for PDI is comparable to a healthy population, we do not discuss PDI in the rest of our analysis.

Among the families in our sample, only 16% of mothers had completed high school. This is consistent with other studies conducted in rural western China (Luo et al., 2015; Yue et al., 2016) and points to the relatively low levels of schooling among families in the Qinba Mountain Area. About 38% of children had no siblings. This is because the central government has begun to relax its one-child policy in recent years (The Central People's Government of the People's Republic of China, 2013), and in 2016, the sample area of this study began to implement a comprehensive two-child policy, allowing two children to be born to a family (Standing Committee of Shaanxi Provincial People's Congress, 2016). Additionally, the average household asset index was slightly higher than previous studies in rural western China (Wang et al., 2019). However, the household asset index in our sample was far lower than the average rural household asset index across different rural communities in China (including not only western rural China, but also rural communities in China's central plains, rural migrant communities in urban China, and rural resettlement communities in townships) (Wang et al., 2019). This is because the sample households are all from the nationally-designated poverty counties, which have significantly lower income levels than other counties or regions in the country.

Looking at the characteristics of preschool teachers and preschools, the data showed that the average age of preschool teachers in our sample was 32 years old, and almost all sample teachers (94%) were female. This is very similar to the proportion of female teachers in preschool education in China overall (92%) (MOE, 2017a, 2017b). Just over one third (36%) of preschools in our sample were affiliated with primary schools. On average, the tuition and other fees (e.g., food, transportation and insurance) were $163 (RMB 1110) per semester for each child, which is far lower than the national average level of public preschools, which generally charge $533–1066 (RMB 3600–7200) per semester (China Industry Information, 2017).

When looking at the qualifications of teachers in our sample, we found that overall, a large proportion of sample teachers were underqualified by the standards set by the Ministry of Education (MOE, 2010). Only 54% of sample teachers had a vocational university degree or above, far lower than the national average announced by the Ministry of Education in 2017 (79%) (MOE, 2018a). Even fewer sample teachers had specialized in early childhood education (36%), which also was below the national average announced by the Ministry of Education in 2013 (64%) (MOE, 2015a). Additionally,

Table 2
WPPSI-IV scores of sample children in rural China, $n = 1031$.

		Mean	SD	Range	Developmental delay (score < −1 SD)
		(1)	(2)	(3)	(4)
(1)	Full Scale IQ (FSIQ)	89.12	11.75	57–131	0.36
(2)	Verbal Comprehension Index	90.56	11.78	53–137	0.33
(3)	Visual Spatial Index	93.31	11.70	61–145	0.22
(4)	Fluid Reasoning Index	90.03	12.33	55–133	0.31
(5)	Working Memory Index	93.10	12.43	45–137	0.28
(6)	Processing Speed Index	93.33	11.82	52–133	0.21
(7)	Vocabulary Acquisition Index	92.47	10.81	58–144	0.20
(8)	Nonverbal Index	78.11	8.93	50–113	0.76
(9)	General Ability Index	90.03	11.44	51–139	0.31
(10)	Cognitive Proficiency Index	91.77	12.13	44–134	0.27

Notes: Child's WPPSI-IV scores when children were 49–65 months of age. Multi-period tracking data source is author's survey. Column 1–2 show the mean and standard deviation of each dimension of WPPSI-IV score for the full sample respectively. Column 3 shows the range of each dimension of WPPSI-IV score for the full sample respectively. Column 4 shows the percentage of children who scored less than 85 (one standard deviation below the normal mean).

just over one third (35%) of the sample teachers had received a professional ranking. Although this rate appeared low, it was actually higher than national average reported by the Ministry of Education of 25%, as well as higher than the averages in both urban areas (26%) and rural areas (24%) (MOE, 2018a). However, the teachers in our sample were relatively inexperienced: the average preschool teaching experience was 5 years. In contrast, the majority of teachers (80%) had received at least one professional training; this is mainly due to the national preschool teacher training policy which aimed to offer trainings to all preschool teachers by 2015 (MOE, 2010).

3.2. Preschool-age development outcomes

The developmental outcomes of the 1031 children in our sample were shown in Table 2. For all of dimensions, the mean scores were lower than the mean of 100 found in a healthy population. The mean WPPSI-IV score of sample children was 89.1 (SD = 11.8) for Full Scale IQ. Of the five Primary Indexes, the mean scores were 90.6 (SD = 11.8) for Verbal Comprehension, 93.3 (SD = 11.7) for Visual Spatial, 90.0 (SD = 12.3) for Fluid Reasoning, 93.1 (SD = 12.4) for Working Memory, and 93.3 (SD = 11.8) for Processing Speed. As for the four Ancillary Indexes, the data show that the mean scores were 92.5 (SD = 10.8) for Vocabulary Acquisition, 78.1 (SD = 8.9) for Nonverbal, 90.0 (SD = 11.4) for General Ability, and 91.8 (SD = 12.1) for Cognitive Proficiency. In addition to overall low levels development, children showed high rates of delays (scaled index values below 85) in each dimension.

3.3. Preschool teacher qualifications and preschool-age child development outcomes

Table 3 shows the correlations between preschool teacher qualifications and the developmental outcomes of the preschool children in our sample. After accounting for child, household, teacher and preschool characteristics, we found that teacher qualifications were significantly correlated with two developmental indexes: Verbal Comprehension and Vocabulary Acquisition. Specifically, a one-SD increase in teacher qualifications correlated to an increase in Verbal Comprehension by 0.59 points (significant at 10%), and an increase in Vocabulary Acquisition by 0.61 points (significant at 10%).

3.4. Which teacher qualifications are most important for preschool-age child development?

Table 4 shows the correlations between each dimension of teacher qualifications and child development outcomes. We found that teacher education and professional ranking were significantly correlated with language development. Children whose teachers had completed vocational university or above scored 1.33 points higher in Verbal Comprehension and 1.32 points higher in Vocabulary Acquisition than children whose teachers had not completed at least vocational university (both significant at 10%). In addition, we found that professional ranking was significantly correlated with Full Scale IQ, language (Verbal Comprehension and Vocabulary Acquisition) and General Ability scores. Specifically, children with teachers who had received a professional ranking scored 1.33 points higher in Full Scale IQ (significant at 10%), 2.43 points higher in Verbal Comprehension (significant at 1%), 2.23 points higher in Vocabulary Acquisition (significant at 1%), and 1.73 points higher in General Ability (significant at 5%). However, we find that children whose teachers have specialized in early childhood education scored 1.58 points lower in Vocabulary Acquisition than those who did not have specialized in early childhood education (significant at 5%). Finally, we find no correlations between teacher experience or teacher training and child development outcomes.

4. Discussion

Past theoretical and empirical literature has demonstrated that stimulating interactions between adults and children are the key drivers of both cognitive and non-cognitive development (Denham, Renwick, & Holt, 1991; O'Connor, Sigman, & Kasari, 1993; Silvén, Niemi, & Voeten, 2002; Sirois, Bernier, & Lemelin, 2019). In the preschool period, interactions between teachers and children are an essential input for healthy development (Early, Maxwell, Ponder, & Pan, 2017; Guo, Piasta, Justice, & Kaderavek, 2010; Howes et al., 2008; Weyns, Colpin, Engels, Doumen, & Verschueren, 2019). However, it is not well understood how the qualifications of teachers contributes to child development during the preschool period specifically, and previous international studies have retuned mixed results.

This study examines the relationship between teacher qualifications and the development outcomes of preschool-age children in rural China. Using data from a longitudinal study of 1031 rural preschool children aged 49–65 months, as well as data from 583 preschool teachers in 347 preschools, we describe the developmental outcomes of rural preschool children and identify correlations between the qualifications of preschool teachers and

Table 3
Correlations between teacher's qualification and child WPPSI-IV scores using OLS, $n = 1031$.

	Full Scale IQ (FSIQ)	Verbal Comprehension Index	Visual Spatial Index	Fluid Reasoning Index	Working Memory Index	Processing Speed Index	Vocabulary Acquisition Index	Nonverbal Index	General Ability Index	Cognitive Proficiency Index
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Teacher qualification	0.458	0.592*	0.605	0.517	−0.221	−0.003	0.611*	0.232	0.542	−0.090
	(0.369)	(0.345)	(0.377)	(0.448)	(0.436)	(0.369)	(0.341)	(0.298)	(0.361)	(0.386)
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Cluster	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Tester fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Adj. R-sq.	*0.353*	*0.291*	*0.220*	*0.192*	*0.154*	*0.185*	*0.323*	*0.274*	*0.321*	*0.221*

Notes: Data source is author's survey. The WPPSI-IV contains 13 subtests, which are summed into one Full-Scale Intelligence Quotient (FSIQ), as well as five Primary Indexes and four Ancillary Indexes. The Primary Indexes include Verbal Comprehension, Visual Spatial, Fluid Reasoning, Working Memory, and Processing Speed. The Ancillary Indexes include Vocabulary Acquisition, Nonverbal, General Ability, and Cognitive Proficiency. Teacher qualification is constructed using factor analysis. Controls include child age, child gender, Bayley score at 21–30 months, time in preschool (in months), whether mother completed high school, whether the child is an only child, household asset index, teacher age, teacher gender, whether preschool is affiliated with a primary school and preschool fees per semester. We also control for WPPSI-IV tester fixed effects. All standard errors account for clustering at the preschool level.

* Significance at 10%.

child development outcomes during the preschool years, controlling for developmental outcomes prior to preschool. Additionally, we identify which individual teacher qualifications were most highly associated with the development of preschool children.

4.1. Preschool-age development outcomes

Overall, the rates of delay among our sample were much higher than one would see in healthy populations. In our sample, 36% of children showed delays in FSIQ (where delay is defined as a score of more than one SD below the healthy mean score of 100). This is significantly higher than urban China, where studies show that only 9.5% of preschool-age children exhibit delays (Li et al., 2011). However, it is consistent with the high rates of delay found in other developing countries, including Brazil, Chile, and Jamaica (Galván, Uauy, Corvalán, López-Rodríguez, & Kain, 2013; Santos et al., 2008; Walker, Chang, Younger, & Grantham-Mcgregor, 2010), indicating that problem of developmental delays during the preschool years remains prevalent among developing regions around the world.

It is important to note that the rates of delay among sample children were slightly lower than the rates of delay among children ages 0–3 in rural western China, which studies have found to be as high as 50% (Wang et al., 2019; Yue et al., 2017). It was also lower than the rates of delay among our sample when children were 21–30 months old (54%). This suggests that a share of children who had experienced delays in early childhood did achieve more normal developmental outcomes by the time they were surveyed in preschool. However, the rates of delay among our preschool-aged sample were still much higher than that of a healthy population, meaning that many children did not overcome early childhood delays while they were in preschool.

4.2. Preschool teacher qualifications and preschool-age child development outcomes

The data show that, overall, preschool teacher qualifications were significantly correlated with two developmental indexes (Verbal Comprehension and Vocabulary Acquisition) after controlling for child, household, teacher and preschool characteristics. Specifically, we found that teacher qualifications were correlated with an increase in Verbal Comprehension by 0.59 points and an increase in Vocabulary Acquisition by 0.61 points. Compared to the results of previous studies using WPPSI-IV in East Asia, the magnitudes of our results are large enough to be considered meaningful. A study of correlations between adaptive behavior and cognitive ability in Taiwan, for example, found positive correlations with FSIQ and four cognitive index scores, with magnitudes ranging from 0.21 to 0.54 points (Chang, Lung, Yen, & Yang, 2013). Another study using WPPSI-IV scores to examine the effect of deworming on cognition in rural China found magnitudes of correlation to be around 0.18 points (Liu et al., 2017). Compared to these studies, the magnitudes of the correlations found in our sample are relatively large.

These results show that children with more qualified preschool teachers tend to have better developmental outcomes, particularly in terms of language development. This may be because better qualified teachers are more likely to provide children with richer language environments and better teacher–child interactions. The literature on child development and language acquisition has shown that children develop language skills by engaging in conversations in which adults offer stimulating responses to what children say (Galasso, Carneiro, Cunha, López-García, & Corporation, 2015). Additionally, previous studies have found that teacher–student interactions are related to better language development in preschool children, and that emotional support provided by teachers can significantly improve vocabulary acquisition (Guo et al., 2010; Howes et al., 2008; Mashburn et al., 2008). In our sam-

Table 4
Correlations between different teacher's qualifications and WPPSI-IV scores using OLS, $n = 1031$.

		Full Scale IQ	Verbal Comprehension Index	Visual Spatial Index	Fluid Reasoning Index	Working Memory Index	Processing Speed Index	Vocabulary Acquisition Index	Nonverbal Index	General Ability Index	Cognitive Proficiency Index
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1)	Completed vocational university or higher (1 = yes, 0 = no)	0.968	1.331*	1.213	1.010	−0.425	0.126	1.319*	0.445	1.123	−0.103
		(0.743)	(0.697)	(0.774)	(0.897)	(0.886)	(0.744)	(0.691)	(0.603)	(0.725)	(0.790)
	Adj. R-sq.	*0.353*	*0.292*	*0.220*	*0.192*	*0.153*	*0.185*	*0.323*	*0.274*	*0.321*	*0.221*
(2)	Has specialized in early childhood education (1 = yes, 0 = no)	−0.178	−0.805	0.632	0.244	−0.036	0.654	−1.576**	0.114	−0.416	0.330
		(0.772)	(0.811)	(0.870)	(0.899)	(0.872)	(0.765)	(0.714)	(0.602)	(0.786)	(0.801)
	Adj. R-sq.	*0.352*	*0.290*	*0.218*	*0.191*	*0.153*	*0.185*	*0.324*	*0.273*	*0.320*	*0.221*
(3)	Has a professional ranking (1 = yes; 0 = no)	1.329*	2.431***	0.362	0.641	−0.013	0.465	2.234***	0.352	1.731**	0.223
		(0.784)	(0.795)	(0.871)	(0.886)	(0.905)	(0.836)	(0.681)	(0.631)	(0.770)	(0.872)
	Adj. R-sq.	*0.354*	*0.297*	*0.218*	*0.191*	*0.153*	*0.185*	*0.327*	*0.274*	*0.323*	*0.221*
(4)	Experience (years)	0.031	0.036	−0.011	0.052	−0.037	−0.022	−0.005	0.018	0.065	−0.033
		(0.058)	(0.051)	(0.068)	(0.085)	(0.082)	(0.070)	(0.071)	(0.051)	(0.058)	(0.071)
	Adj. R-sq.	*0.352*	*0.289*	*0.218*	*0.191*	*0.153*	*0.185*	*0.320*	*0.274*	*0.320*	*0.221*
(5)	Training (1 = has received at least one training on early childhood education, 0 = not trained)	−0.121	0.763	−0.853	−0.488	−0.502	0.428	0.570	−0.591	−0.145	−0.008
		(0.746)	(0.760)	(0.858)	(0.925)	(0.959)	(0.818)	(0.798)	(0.604)	(0.746)	(0.818)
	Adj. R-sq.	*0.352*	*0.290*	*0.219*	*0.191*	*0.153*	*0.185*	*0.320*	*0.274*	*0.319*	*0.221*
	Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Cluster	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Tester fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Notes: Data source is author's survey. Controls include child age, child gender, Bayley score at 21–30 months, time in preschool (in months), whether mother completed high school, only child, household asset index, teacher age, teacher gender, whether preschool is affiliated with a primary school and fees per semester.
We also control for WPPSI-IV tester fixed effects. All standard errors account for clustering at the preschool level.

* Significance at 10%.
** Significance at 5%.
*** Significance at 1%.

ple, it is possible that more qualified teachers are more likely to engage in and encourage conversation with children, leading to greater gains in child language development.

4.3. Which teacher qualifications are most important for preschool-age child development?

When we examine the correlations between individual teacher qualifications and child development outcomes, we find a great deal of variation across measures of teacher qualifications. First, the degree level of teachers is significantly and positively correlated with language development (Verbal Comprehension and Vocabulary Acquisition). Specifically, children whose teachers completed vocational university or higher score 1.33 points higher in Verbal Comprehension and 1.32 points higher in Vocabulary Acquisition compared to children whose teachers have a degree from a preschool teacher training college, academic high school or even lower.

This finding contradicts previous studies from the United States, which have found no significant correlations between teacher education levels and child language outcomes (Early et al., 2007). This may be due to the fact that rural Chinese children start preschool with lower levels of language development than children in the United States (as shown by the high rates of delay at 21–30 months), so the same inputs may have produced greater results. It is also possible that teachers with vocational university or higher degrees have better language skills than teachers who have only completed preschool teacher training colleges or academic high school. Previous studies have shown that teachers with higher levels of education engage in more frequent language play and language activities in class than teachers with lower education levels (Guo et al., 2010; Howes et al., 2008; Whitebook, 2003). Since preschool teacher training colleges and academic high schools are both secondary schools and generally recruit from junior high schools, graduates from those colleges and schools may not have developed high-level language skills (Zhang, 2019). In addition, preschool teacher training colleges in China have been found to be of low educational quality (Xu & Chen, 2016; Zhao, 2007). In other words, preschool teachers with degrees from vocational universities or higher may be better skilled in language and have better knowledge of how to interact with children to stimulate their language development compared to teachers with lower degrees.

In addition, teacher professional ranking is significantly and positively correlated with FSIQ, as well as Verbal Comprehension, Vocabulary Acquisition, and General Ability. Because professional rankings are intended to denote better teaching quality (MOE, 2015b), it is not surprising that we find professional ranking to be correlated with better child development outcomes; however, the results of our study confirm that professional ranking evaluations do identify teachers with better teaching quality. Additionally, because teachers are re-evaluated every three to five years and can lose their only chance to increase their corresponding salary if they receive a poor performance evaluation (Li, Lu, & Jin, 2017; MOE, 2015b), professionally-ranked teachers may be incentivized to exert more effort in the classroom in order to maintain their ranking thus to increase their salary.

In contrast, we find a negative correlation between specialization in early childhood education and language development: children whose teachers had specialized in early childhood education scored lower in Vocabulary Acquisition by 1.58 points. From Table C1, we can also see that teachers with specialization in early childhood education were significantly less likely to have received a professional ranking, indicating that teachers who had specialized in early childhood education were less likely to be recognized for their teaching quality. One possible explanation is that degree programs in early childhood education may not provide preschool teachers with the necessary skills to support child development. Teachers specialized in early childhood education in rural China usually have received these degrees from preschool teacher training colleges. As mentioned above, past studies have found that these institutions have overall poor educational quality (Xu & Chen, 2016; Zhang, 2019; Zhao, 2007). Additionally, traditional programs of specialization in early childhood education in China have tended to focus on theoretical knowledge rather than practical skills used in the classroom (Huang, 2019). In both cases, teachers specialized in early childhood education may be unprepared for classroom interactions with young children, which may explain why teachers with childhood education specialization appear to be less effective in supporting child development.

Finally, teacher experience and teacher training were not significantly correlated with any dimensions of child development outcomes. The insignificant relationship between teacher experience and child development is consistent with the findings previous studies (Cornor, Son, Hindman, & Morrison, 2005; Son et al., 2013). Similarly, although the insignificant relationship between teacher training and child development may appear surprising, in fact it is consistent with studies of teacher training programs in China and internationally, which have found that teacher training does not impact student cognition or academic performance (Lu et al., 2017; Yoshikawa et al., 2015). These studies have posited that teacher trainings may not actually improve the teaching knowledge or skills of teachers, and that in low-income contexts, teachers may not be able to apply new knowledge in the classroom due to limited resources, both of which may be true for our sample.

4.4. Implications

The results of this study have several implications for both policymakers and researchers in rural China. First, considering the high rates of developmental delays among preschool-age children in our sample and other rural areas of China, policymakers must increase their attention toward improving the developmental outcomes of rural preschool aged children. Our findings show that educational attainment and professional rankings are significantly correlated with better child development outcomes, particularly in terms of language development. We therefore recommend that policymakers develop incentives to encourage highly educated teachers to serve in China's rural preschools. Salary increases, bonuses, or other forms of teaching incentives may make rural preschool teaching an attractive choice for qualified teachers who may otherwise choose to work in urban preschools. In addition, school districts can use professional ranking evaluations to identify and encourage high-quality teachers, as well as identify and offer remedial education or training to teachers with lower teaching quality.

Additionally, our findings show that preschool children whose teachers have specialized in early childhood education had worse development outcomes than children of teachers without early childhood education specialization. This indicates that early childhood education specialization programs may not provide preschool teachers with the necessary skills to promote healthy child development. Early childhood education specialization programs should therefore be reevaluated to determine which areas can be improved to support healthy child development. Similarly, our finding that teacher trainings were uncorrelated with preschool child development outcomes suggests that preschool teachers were not receiving effective training that can be incorporated into classroom processes to improve child outcomes. Therefore, we recommend that preschool teacher trainings in China be revaluated in terms of content and structure to be made more actionable and effective in rural preschool classrooms. Studies have shown that teacher-enacted practices in the classroom can significantly increase language and cognitive development in young children (Curby

et al., 2009; Mashburn et al., 2008; National Early Literacy Panel, 2008; Yoshikawa et al., 2013), and studies have indicated that training in teacher-enacted practices is especially effective for preschool teachers with little or no theoretical background in early childhood development (Heisner & Lederberg, 2011).

5. Conclusion

We acknowledge three limitations of this study. First, this study was only able to identify correlations between teacher qualifications and the development outcomes of preschool children. Although we used longitudinal panel data on child development to control for developmental outcomes before preschool, we only had one period of data for teacher qualifications. Second, this study did not assess the classroom or process quality of preschool teachers, which has been recognized in the literature as potential mechanisms through which teachers impact child development. Third, although this study controlled for household variables to reduce estimation bias, we were unable to include detailed measures of the home environment. Future research should draw on longitudinal panel data of teacher qualifications, teacher–student interactions and child development outcomes to assess the causal chain through which teacher qualifications may impact both teaching practices and child development outcomes. Our research team is also planning to follow the children in this study into primary school to see if the qualifications of preschool teachers are still relevant for child development, as well as school achievement. In addition, future research should focus on both home and preschool environments to explore their respective contributions to developmental outcomes among preschool-age children.

This study makes two key contributions to the literature. First and foremost, our study is the first to isolate the relationship between teacher qualifications and child development outcomes during the preschool period, while controlling for development prior to preschool. Second, this is the first study conducted in rural China to analyze the connection between teacher qualifications and the development outcomes of preschool children. Our study offers important insights into the role that preschool teachers can play in child development in low-income rural contexts. This is particularly important for developing regions, where child developmental delays are prevalent and may impact future economic and social development. Our results also offer insights into how policymakers can improve preschool education to reduce developmental delays and support human capital accumulation.

Funding

This work was supported by 111 Project (B16031); the National Social Science Foundation of China (17BJY201); the National Natural Science Foundation of China (71703084, 71803108); and Shaanxi Normal University (JSJY2017021, JSJY2017020).

Conflict of interest

None.

Author statement

Lei Wang: Conceptualization, Methodology, Writing–Review & Editing, Supervision. **Ruirui Dang**: Investigation, Formal analysis, Writing–Original Draft, Visualization. **Yu Bai**: Software, Validation, Methodology, Funding acquisition. **Siqi Zhang**: Investigation, Resources, Project administration. **Buyao Liu**: Investigation. **Lijuan Zheng**: Investigation. **Ning Yang**: Investigation. **Chuyu Song:** Data curation.

Uncited references

MOE (2012) and Wechsler (1967).

Acknowledgement

Many people assisted to make this project and paper possible. In particular, we would like to acknowledge Sarah-Eve Dill for her work in editing.

Appendix A. Background on preschool teacher qualifications in rural China

In the past three decades, China has improved its preschool system in many ways. Policy changes have raised the standards for teacher qualifications in areas such as teacher education, certification, ranking and training. In this section, we will describe the development of the current set of preschool teacher qualification standards, focusing specifically on teacher educational background, training, and the professional ranking system.

A.1. Education requirements

Policies regarding preschool teacher education are built on the 1989 brief, titled "Regulation on Preschool Management", released by the State Education Commission.[8] This brief states that preschool teachers should have a degree in early child education from at least a preschool teacher training college or vocational university. In China, a preschool teacher training college recruits students who have graduated from junior high school, and is therefore considered upper secondary education. A vocational university recruits students who have graduated from senior high schools, and can be considered tertiary education. In 1993, the central government released the "Teacher Law of the People's Republic of China," which made the contents of the 1989 brief into law. Specifically, this law requires that all preschool teachers pass a preschool teacher certification, and that anyone that plans to take the exam must have obtained a degree from preschool teacher training college or above (MOE, 1993). In other words, beginning in 1993, preschool teachers are legally required to hold a degree from a preschool teacher training college, vocational university or higher in order to be qualified for their position.

However, despite the longstanding law, there are many teachers in rural preschools who do not have a degree either from a preschool teacher training college or from a vocational university. According to a study by Luo and Li (2010b), 10.1% of preschool teachers have less than 9 years education, meaning that they have not completed junior high school. Additionally, among those preschool teachers who do meet the educational requirements, a significant share have relatively low levels of education. In a recent study of preschool teachers in rural areas, Feng (2019) found that about 29% rural preschool teachers have not obtained a senior high school-level education.

A.2. Professional ranking

The professional ranking system is an evaluation system that assigns teachers to different professional levels or positions based on their performance. Under this system, teachers start as unranked and can advance through five ranks depending on their performance, with standards of performance enumerated within the

[8] The State Education Commission was established in 1985, and its main responsibilities were dealing with education policy making and education activities organizing. In 1998, it became the Ministry of Education.

Table A1
Characteristics of preschools affiliated with a primary school and independent preschools.

		Affiliated preschool	Non-affiliated preschool
(1)	Distribution		
	Village	104	44
	Township	32	114
	County	4	49
(2)	Public preschools (%)	91.4	54.1
(3)	Child-teacher ratio	23:1	23:1
(4)	Average numbers of classes per preschool	2	7
(5)	Fees per semester (RMB)	780	1295

Table B1
BSID scores of sample children at 21–30 months, $n = 1031$.

		Mean (SD) (1)	Min (2)	Max (3)	Rate of delay (Index score < −1 SD) (4)	Rate of delay (Index score < −2 SD) (5)
(1)	Mental Development Index (MDI)	81.36 (21.85)	49	150	0.54	0.30
(2)	Psychomotor Development Index (PDI)	103.07 (19.46)	49	150	0.16	0.04

Note: Data source is author's survey. Following the BSID manual, infants who failed to achieve the minimum MDI or PDI score of 50 were assigned a score of 49.

Table C1
Correlation between different dimensions of teacher qualifications, $n = 1031$.

		(1)	(2)	(3)	(4)	(5)
(1)	Completed vocational university or higher (1 = yes, 0 = no)	1.00				
(2)	Has specialized in early childhood education (1 = yes, 0 = no)	0.15***	1.00			
(3)	Has a professional ranking (1 = yes, 0 = no)	0.28***	−0.22***	1.00		
(4)	Experience (years)	−0.18***	−0.05*	0.07**	1.00	
(5)	Training (1 = has received at least one training on early childhood education, 0 = not trained)	0.29***	0.13***	0.18***	0.04	1.00

* Significance at 10%.
** Significance at 5%.
*** Significance at 1%.

Table D1
Teacher ranking structure and corresponding salary system.

Ranking title	Senior title				Middle title						Primary title		
Ranking level	Full senior teacher				Senior teacher			First-grade teacher			Second-grade teacher		Third-grade teacher
Professional technical position	1	2	3	4	5	6	7	8	9	10	11	12	13
Monthly salary (Yuan)	6665	5157	4558	3915	3405	3005	2773	2440	2174	2007	1819	1797	1675

ranking protocol. According to a policy brief released by the Ministry of Education in 2015 (MOE, 2015c), the five ranks are divided into three rank titles. The lowest title is the primary title, which includes the lowest two ranks. Above the primary rank title is the middle rank title, which similarly has two ranks. The senior title is the highest title and has only one rank, which is the highest rank a preschool teacher can achieve (Table D1).

Virtually every preschool teacher is trying for a higher ranking, as these rankings offer corresponding salary raises and professional development opportunities. Officials in the local bureau of education are in charge of approving promotions to higher levels of rankings. Each year, the county-level education bureau will set up a ranking committee, whose main responsibility is to check the requirements and evaluate the performance of each teacher applying for a ranking. The number of available ranking positions in each year is set by county-level education bureau based on the existing ranking position structure of each preschool. For example, if the preschool has many teachers but few teachers with senior ranking, then many more senior ranking position will be available for that school in that year. Additionally, teachers who have already received a ranking are revaluated every 3–5 years to determine whether their ranking will be maintained and whether their salary will be raised.

A.3. Preschool teacher training

In China, there are different levels of teacher training programs for preschool teachers, including national-level, provincial-level, and county-level. China's national-level teacher training is a training program for all public preschool, primary and middle school teachers across the country. The goal of the program is to improve the quality of teachers in terms of basic theory, teaching methodology, and class management, with a special focus on rural teachers. The training for preschool teachers includes both a short-term training (10–20 days) and a long-term training (3 months) and trainings are held by universities or qualified training organizations. The training contents include three dimensions: professional ethics and basic literacy (including teacher–child relationship construction and teacher mental health), education knowledge (including knowledge on child mental health and child development), and applied knowledge (including class management, activities organization, and relationship building with parents and communities) (MOE, 2010).

For the provincial-level and county-level teacher training programs, there is no general standard for the training curriculum or organization. Each county or province can set their own training activities based on the circumstances of preschools teachers and perceived needs.

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