

A Videotaped Study of Interaction Duration and Early Childhood Development in Rural China

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Abstract

Recent studies have begun to explore the relationship between caregiver-child interaction and early childhood development in rural China. However, accurately measuring these interactions, particularly regarding their duration, presents considerable challenges. This study investigates the effects of caregiver-child interaction duration on early childhood development in rural China, analyzing 488 caregiver-child dyads through 10-minute videotaped home play. Children were assessed for cognition, language, motor, and social-emotional abilities using the Caregiver Reported Early Development Instrument (CREDI). Findings indicate that interaction durations are generally brief, particularly when the primary caregiver is the grandmother. The interaction duration was found to be a significant mediator in the relationship between caregiver type and the children's development across 4 domains. Less educated grandmothers and mothers had significantly greater disparity in interaction duration compared to more educated caregivers. Findings suggest that future interventions should emphasize increasing effective interaction duration, especially for less educated grandmothers, to improve early childhood development.

Keywords: Videotaped home play, Caregiver-child interaction duration, Early childhood development, Rural China

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1. Introduction

The significance of early life development for human capital investment is well-documented in prior research, with the first three years of life being particularly crucial. Nobel Laureate in Economics James Heckman's research underscores that the highest return on human capital investment occurs between the ages of 0-3 years (Carneiro & Heckman, 2003; Heckman et al., 2013). Furthermore, early childhood development is a predictor of numerous adulthood outcomes, including physical health (Campbell et al., 2014; Heckman, 2007), income levels (Gertler et al., 2014; Huggett et al., 2011), social mobility (Heckman & Mosso, 2014), and various other welfare metrics (Cunha & Heckman, 2007; Heckman, 2006).

Caregiver-child interactions play a vital role in early childhood development. Previous research has demonstrated that enriching these interactions can stimulate early developmental outcomes (Black et al., 2017; Francesconi & Heckman, 2016). Studies in psychology that involve observing and coding caregiver-child interactions have found that positive involvement can benefit children's subsequent cognitive development (Dodici et al., 2003; Feldman et al., 1996; Tamis-LeMonda et al., 2004), as well as their literacy and language skills (Tomasello & Farrar, 1986; Yoder & Warren, 1999), motor abilities (Beckwith et al., 1976; Cohen & Beckwith, 1979), and social behaviors (Chazan-Cohen et al., 2009).

Previous studies in psychology have explored the correlation between the duration of caregiver-child interactions and the development of early childhood abilities. Tomasello & Todd (1983) utilized maternal diary records and monthly videotaped sessions of mothers playing with their one-year-olds, revealing that infants engaged in more joint interactions with their mothers tended to have significantly larger vocabularies. Similarly, Carpenter et al. (1998) observed that for infants aged 9 to 15 months, the time spent in joint activities with their mothers was a predictor of the development of gestural and verbal communication skills. However, the specifics of caregiver-child interaction duration remain largely unexplored in rural China.

China's rapid urbanization over the past decade has brought to light several challenges, notably the predicament of left-behind children in rural areas. Seeking better employment opportunities, many rural parents have migrated to cities, entrusting their young children to the care of grandparents. Reports released by the All-China Women's Federation showed that there were more than 61 million left-behind children in rural China in 2013, which was three times higher than the estimated number in 2000 (ACWF, 2013). Recent studies have identified developmental delays in language, cognition, and social-emotional skills among children under three years old in these rural areas (Luo et al., 2019; Wei et al., 2015; Yue et al., 2017). Growing concerns suggest that grandmothers, often with lower levels of education, may not provide care equivalent to that of mothers, which could account for observed disparities in child-rearing practices (Yue et al., 2018).

Recent investigations into caregiver-child interactions and early childhood development in rural China have utilized questionnaires to collect data. Researchers, through queries such as "Did you tell your child stories yesterday?" and "Did you play with your child yesterday?", have characterized daily caregiver-child activities in rural households (Luo et al., 2019; Yue et al., 2019). However, while questionnaires capture the occurrence of interactions, they fall short in precisely measuring their duration. This limitation has resulted in scant research on the impact of interaction length on early childhood development within this demographic.

This paper aims to bridge this knowledge gap by employing videotaping and coding techniques to quantify the duration of caregiver-child interactions and to investigate its influence on early childhood development across different caregiving scenarios in rural China. Toward this end, we pose three research questions: 1) What is the extent of caregiver-child interaction duration in rural settings, particularly contrasting mother-child and grandmother-child pairings? 2) How does the duration of caregiver-child interaction influence the link between various caregivers and early childhood development? 3) To what extent does a caregiver's educational background moderate the effects of interaction duration?

2. Method

2.1 Sample Selection

The field survey was conducted in a poverty-stricken county in Jiangxi Province, which had a middle economic level in relation to all poverty-stricken counties across China in 2018. Three out

of sixteen towns in this county were randomly selected as sample towns, and a comprehensive list of all the villages from each sample town was obtained with the assistance of local officials. There were ten, nine, and eight villages in the three sample towns, respectively. All the children that were between 6 and 30 months of age and lived in the villages were included in the field survey. To identify the difference between mothers and grandmothers in their interaction with their children, this study only includes families where either the mother or the grandmother is the primary caregiver. The primary caregiver is defined as the person living in the same household who was primarily responsible for the child's care. Thus, 488 caregiver-child dyads are included in this study. The distribution of caregiver-child dyads in three sample towns are shown in Table 1.

Ethical approval for this study was obtained from Peking University Institutional Review Board (PU IRB). The grant number is IRB00001052-17056.

2.2 Data Collection

Prior to the field survey, fifty enumerators were recruited and underwent a comprehensive 5-day training program. This training covered an overview of the survey process, communication techniques, questionnaire handling, and videotaping protocols, along with simulation exercises to prepare for potential challenges. In the field, enumerators worked in pairs to visit each family and gather three categories of data: the duration of caregiver-child interactions, the child's developmental milestones, and demographic details.

2.2.1 Caregiver-Child Interaction Duration

Fifty enumerators worked in pairs and were led into the rural households by the local officials. The local officials helped us in explaining the goal and process of this survey to the caregivers in local dialect to make sure they fully understand. Before the survey started, our enumerators would play some warm-up activities such as chatting with the caregiver or playing hide and seek with the child, in order to get acquaintance with the household and create a comfortable environment for the survey.

For the study, each caregiver-child dyad was videotaped during a 10-minute play session at home, using a standard set of kitchen toys provided to address the potential absence of toys. Caregivers were instructed to interact with their children as they would typically do. The videotaping focused solely on the dyad, ensuring that no one else, such as siblings, neighbors, or enumerators, was within the frame. Additionally, enumerators refrained from speaking to or guiding the participants during the session. These recordings were subsequently coded by trained analysts for detailed examination.

In coding the videos, segments were classified as either interactive or non-interactive. Interactive segments were identified by the presence of verbal communication, gestures, movements, or emotional engagement from either party. Non-interactive segments lacked such exchanges. An interactive segment commenced with an interaction signal and concluded when either individual began playing independently or if both ceased interaction for over 10 seconds. The endpoint of an interactive segment simultaneously marked the beginning of a non-interactive segment, and the reverse was also true. The cumulative duration of all interactive segments within the 10-minute session constituted the caregiver-child interaction duration.

To guarantee coding consistency, we adopted and adapted a coding system from established models (Robinson & Eyberg, 1981; Landry et al., 2006) to fit our study's goals. We compiled a detailed coding manual with code listings, definitions, and procedural guidelines. Coders were trained using this manual and practice videos. To measure intercoder reliability, 5% of the videos were coded by all coders concurrently. The resulting Cronbach's alpha coefficient was 0.85 for interaction durations, signifying high consistency in line with recognized standards (Nunnally, 1978).

2.2.2 Early Childhood Development

In this study, child development across cognitive, language, motor, and social-emotional domains is assessed using the Caregiver Reported Early Development Instrument (CREDI). Developed by the Harvard Graduate School of Education, CREDI is a culturally adaptive and globally applicable instrument tailored for children under three years old (McCoy et al., 2017, 2019). It consists of 108 multiple-choice items spanning key developmental domains. Respondents select

from 'yes,' 'no,' or 'unsure' for each item, tailored to the child's age in months. The assessment is discontinued if 'no' is answered consecutively for five items; otherwise, the caregiver completes all items. Children's development is evaluated using norm-referenced z-scores, based on a standardized scoring system as defined in Equation (1)

$$Z = \frac{Raw_{sample} - Raw_{CREDI}}{\sigma_{age}} \quad (1)$$

Z-scores are short for the norm-referenced standardized scores. Raw_{sample} is the average raw score of the sample children. Raw_{CREDI} is the average raw score of the CREDI reference children of the same age (in month), i.e., the international norm. σ_{age} is the age-specific standard deviation. A norm-referenced standardized score between -2 to 2 roughly translates to a region where 95% of the scores from the same-age reference group are located (McCoy et al., 2018).

2.2.3 Demographic Information

We gathered demographic data using survey questionnaires that covered a range of variables: the primary caregiver's identity (mother or grandmother), caregiver attributes (age, education), child specifics (age in months, gender, low birthweight under 2500 grams, sibling presence), migrant parent details (age, education), and household characteristics (receipt of minimum livelihood guarantee from the government).

2.3 Statistical Model

To align with our research objectives, we constructed models for mediation and moderated-mediation effects. First, we examined a simple mediation model using ordinary least squares regression and the bootstrap method. Following Baron & Kenny (1986) and Judd & Kenny (1981), we propose a simple mediation model consisting of Equations (2) and (3), as follows:

$$Duration_i = a_0 + a_1 * Caregiver_i + \gamma_1 * Z_i + \varepsilon_{1i} \quad (2)$$

$$ECD_i = b_0 + b_1 * Duration_i + c * Caregiver_i + \gamma_2 * Z_i + \varepsilon_{2i} \quad (3)$$

$Duration_i$ is the mediator, which stands for caregiver-child interaction duration. $Caregiver_i$ is child i 's primary caregiver (mother or grandmother). ECD_i is the early childhood development of child i , including CREDI scores of cognition, language, motor, and social emotion. Z_i accounts for the covariates, which include characteristics of the children, caregivers, and households, as well as the fixed effects of coders and villages. ε_{1i} and ε_{2i} are error terms. The product $a_1 b_1$ is the mediation effect.

We then followed Preacher et al. (2007) and developed the moderated mediation model, comprising Equations (4) and (5):

$$\begin{aligned} Duration_i &= a_0 + a_1 * Caregiver_i + a_2 * Edu_care_i + a_3 * Caregiver_i * Edu_care_i + \gamma_3 * Z'_i + \varepsilon_{3i} \\ &= (a_0 + a_2 * Edu_{care_i}) + (a_1 + a_3 * Edu_{care_i}) * Caregiver_i + \gamma_3 * Z'_i + \varepsilon_{3i} \end{aligned} \quad (4)$$

$$\begin{aligned} ECD_i &= b_0 + b_1 * Duration_i + c'_1 * Caregiver_i + c'_2 * Edu_care_i + c'_3 * Caregiver_i * Edu_care_i \\ &\quad + \gamma_4 * Z'_i + \varepsilon_{4i} \\ &= (b_0 + c'_2 * Edu_{care_i}) + (c'_1 + c'_3 * Edu_{care_i}) * Caregiver_i + b_1 * Duration_i + \gamma_4 * Z'_i + \varepsilon_{4i} \end{aligned} \quad (5)$$

The moderator, Edu_care_i , is the education level of caregivers. The product term $Caregiver_i * Edu_care_i$ denotes the product of the key independent variable and the moderator. Z'_i accounts for the covariates. ε_{3i} and ε_{4i} are error terms. The product term $(a_1 + a_3 * Edu_{care_i})b_1$ indicates the moderated mediation effect of the caregiver's education level. The moderated-mediation model is depicted in Figure 1.

We computed three types of 95% confidence intervals—BC (bias-corrected), BCa (bias-corrected and accelerated), and percentile method confidence intervals—to evaluate the statistical significance of the mediation effect $a_1 b_1$ and the moderated mediation effects $(a_1 + a_3 * Edu_{care_i})b_1$. The BC method adjusts for bias, while the BCa method compensates for both bias and the skewness of bootstrap estimates, enhancing the robustness of standard error estimates (Efron, 1987; MacKinnon et al., 2004). A mediation or moderated-mediation effect is deemed statistically

significant if its confidence interval excludes zero. All statistical analyses were performed using Stata 15.0.

3. Results

3.1 Descriptive Statistics

The definition of variables and summary statistics by different caregivers are shown in Table 2. Note that the caregiver-child interaction duration was 4.443 minutes on average, which is less than half of the 10 minutes. The average duration of the mother-child interaction was 4.858 minutes, which was 0.926 minutes longer than the average duration for the grandmother-child interaction. Therefore, grandmothers tended to interact less than mothers with their children in our rural sample.

Negative scores indicated poorer early childhood development compared to the international norms for the same age group (measured in months). As shown in Table 2, the children of our study had poorer early developmental abilities comparing to the international norm. More specifically, children raised by their grandmothers had lower CREDI scores in cognition ($-0.554 < -0.155$), language ($-0.497 < -0.066$), motor ($-0.270 < -0.020$), and social emotion ($-0.330 < 0.080$) than those raised by their mothers (see Figure 2).

Figure 3 shows the correlation between caregiver-child interaction duration and CREDI scores of children. The longer the caregiver-child interaction duration, the higher the CREDI scores for cognition, language, motor, and social emotion, indicating better early development of the corresponding domains. If the caregiver and child interacted for roughly less than 7 minutes, children had poorer early developmental abilities compared to international norms.

3.2 Tests of Mediation Effects

To better assess the mediation effects, we applied the bootstrap resampling method, following MacKinnon et al. (2004) and Shrout & Bolger (2002). Bootstrap results of the mediation analysis are based on 1000 resampling. See Table 3. Point estimates for the mediation effects a_1b_1 are 0.049 (SE=0.026) when the dependent variables are cognition, 0.059 (SE=0.036) when language, 0.046 (SE=0.030) when motor, and 0.062 (SE=0.031) when social emotion. Furthermore, neither of the corresponding percentile, BC, and BCa 95% confidence intervals include zero, which proves that caregiver-child interaction durations significantly mediate the relationship between different caregivers and the cognitive, language, motor, and social-emotional development of children. In other words, the mother-child interaction duration was significantly longer than the grandmother-child interaction duration, which is related to significantly higher scores for cognition, language, motor, and social emotion in children.

3.3 Tests of Moderated-Mediation Effects

The moderated mediation model was developed by setting the caregiver's education level as the moderator and then adding the interaction term of the moderator and key independent variable. As displayed in Section 2.3, the product term $(a_1 + a_3 * Edu_care_i)b_1$ indicated the moderated mediation effect of the caregiver's education level. When this level was under middle school (i.e., $Edu_care_i = 0$), the point estimate of the moderated mediation effect $(a_1 + a_3 * Edu_care_i)b_1 = (a_1 + a_3 * 0)b_1 = a_1b_1$. When the caregiver's education level was middle school and above (i.e., $Edu_care_i = 1$), the point estimate $(a_1 + a_3 * Edu_care_i)b_1 = (a_1 + a_3 * 1)b_1 = (a_1 + a_3)b_1$.

Table 4 presents the bootstrap results of the moderated mediation effects. As shown in the table, the moderated-mediation effects $(a_1 + a_3 * Edu_care_i)b_1$ were stronger and significant when the caregiver's education level fell under middle school. Point estimates of moderated-mediation effects were 0.056 (SE=0.033) when the dependent variable was cognition, 0.068 (SE=0.041) when language, 0.052 (SE=0.033) when motor, and 0.071 (SE=0.037) when social emotion. Furthermore, the corresponding percentile, BC, BCa 95% confidence intervals did not include zero when the caregiver's education level was under middle school. However, the moderated-mediation effects $(a_1 + a_3 * Edu_care_i)b_1$ were weaker and insignificant when the caregiver's education level was middle school and above, and the corresponding percentile, BC, BCa 95% confidence intervals did include zero. Therefore, the caregiver's education level significantly moderated the strength of the

mediation effects of caregiver-child interaction durations in the relationship between different caregivers and the early cognitive, language, motor, and social-emotional development of children.

For a clearer understanding of the moderated mediation effects, Figure 4 illustrates the disparities in interaction durations between mother-child and grandmother-child dyads, with consideration for the caregivers' educational attainment. Caregivers lacking middle school education exhibited more pronounced variances in interaction durations between mother-child and grandmother-child pairs than their counterparts with more education. The mediated effects were more substantial among caregivers with lower educational levels. Consequently, enhancing the educational status of caregivers could lead to more significant gains in children's early development outcomes—through increased durations of caregiver-child interactions—especially when the caregiver is a grandmother as opposed to a mother.

4. Discussion

The study of caregiver-child interactions in rural settings has traditionally relied on questionnaires to collect data about whether and what types of interactions occur—for instance, if the caregiver read to, sang with, or played with the child the day prior to the survey (Luo et al., 2019; Wei et al., 2015; Yue et al., 2017). This method, however, does not yield detailed and precise information, such as the duration of the interactions. In contrast, our study employed a methodology of videotaping and coding, which allowed for precise measurement of the duration of interactions, thereby minimizing measurement errors and deepening our understanding of caregiver-child interaction patterns in rural China.

Moreover, our study noted that the durations of interaction in rural caregiver-child dyads during home play were notably brief. Prior research has proposed various explanations for this phenomenon. Yue et al. (2017) hypothesized that the demanding nature of farm and household tasks could contribute to the restricted time caregivers in rural areas spend with their children. Wei et al. (2015) reported that a significant majority (75.0%) of rural children lacked access to books, and a considerable portion (10.4%) did not possess toys, highlighting the stark deficit of educational resources available to these children. Furthermore, the limited interactions may be attributed to the caregivers' characteristics, such as a deficiency in parenting knowledge (Luo et al., 2019) and misconceptions about child-rearing practices (Wei et al., 2015). Our research contributes to these findings by demonstrating that even when provided with toys and designated playtime, rural caregivers still engaged only briefly with their children. This suggests that, beyond material provisions, time availability, misconstrued parental beliefs, and inadequate parenting education, there may be an underlying deficiency in effective parenting skills that contributes to the limited duration of caregiver-child interactions.

The findings of this study reveal a positive correlation between the duration of caregiver-child interactions and the multifaceted aspects of early childhood development. This supports previous psychological research indicating that increased interaction time between mothers and infants is associated with more extensive vocabularies (Tomasello & Todd, 1983) and advanced early gestural and verbal communication skills (Carpenter et al., 1998). However, these studies primarily focused on the relationship between interaction duration and specific developmental domains, such as language. The current study broadens the scope, establishing a connection between interaction duration and various developmental domains, and offers empirical evidence within the unique setting of rural China.

Furthermore, the findings also indicate the mediation effects of caregiver-child interaction duration in the relationship between different caregivers and early childhood development. Mothers typically engage in longer periods of interaction with their children, which is subsequently linked to more favorable developmental outcomes in cognitive, language, motor, and social-emotional domains. This mediation effect is supported by theoretical frameworks and aligns with previous research suggesting that the influence of caregivers on early development is modulated by factors such as home environment (Petrill et al., 2004), socioeconomic status (Barrett & Turner, 2005), parental investment (Zhong et al., 2020), parenting practices (Zhong et al., 2021), and caregiver mental health (He et al., 2020; Petterson & Albers, 2001). The insights provided by this study regarding the mediating effects of interaction duration contribute valuable knowledge to the growing body of research on the mechanisms underlying early childhood development.

Our research provides new insights into how the education level of caregivers influences the development of children in rural China. While other studies have often just factored in the

caregiver's education when looking at different aspects of raising children, such as how they feed them or how they behave as parents, our study goes a step further. We explore how the caregiver's education can change the way that different caregivers, like mothers or grandmothers, spend time with the children and how this time spent together can affect the children's growth and learning. This gives us a clearer picture of the real-life situations of families in rural areas.

This study has two policy implications. Firstly, it's important for caregivers in rural areas to actively engage with their children during playtime at home. Simply supervising or having brief interactions isn't enough. More consistent and meaningful engagement is needed. Secondly, any efforts to boost the early development of children in rural China should emphasize the quality and quantity of caregiver-child interactions. It's critical to equip rural caregivers with the knowledge and skills they need to nurture their children effectively. Moreover, targeted support and education should be provided to rural grandmothers, particularly those who have not had as much formal education. This could help bridge gaps and improve developmental outcomes for children in these communities.

We acknowledge that there are some limitations in this study. Initially, due to the cross-sectional nature of the data, our findings are limited to correlations between caregiver-child interaction duration and early childhood development, and causality cannot be established. Additionally, interaction duration is but one facet of the broader spectrum of caregiver-child interaction quality. Further inquiry is required to deepen our understanding of the daily interactions between caregivers and children in rural Chinese households. Such research would contribute to the foundation for more nuanced and focused early childhood services.

5. Conclusion

In summary, this research employed video recording and subsequent analysis to quantify the length of caregiver-child interactions, exploring its significance in the context of different caregiver roles and the implications on early childhood development. The study uncovered that caregivers in rural areas generally engage in brief interactions with their children. Specifically, grandmothers were observed to spend less time interacting with their children compared to mothers, which was associated with the children's lower performance across cognitive, language, motor, and social-emotional domains. The gap in interaction times between mother-child and grandmother-child pairings was more pronounced among caregivers with lower educational levels. To enhance early childhood development in rural China, interventions should prioritize increasing the duration of caregiver-child interactions during daily activities, with particular focus on supporting grandmothers who have lower educational attainment.

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CRedit authorship contribution statement:

Yuting Chen: Methodology, Validation, Formal analysis, Writing - original draft, Writing - review & editing. Jingjing Gao: Project administration, Writing - review & editing. Yang He: Software, Writing - review & editing. Tianyi Wang: Supervision, Visualization, Writing - review & editing. Chengfang Liu: Writing - review & editing. Renfu Luo: Conceptualization, Resources, Writing - review & editing, Investigation, Funding acquisition.

Declaration of Competing Interest:

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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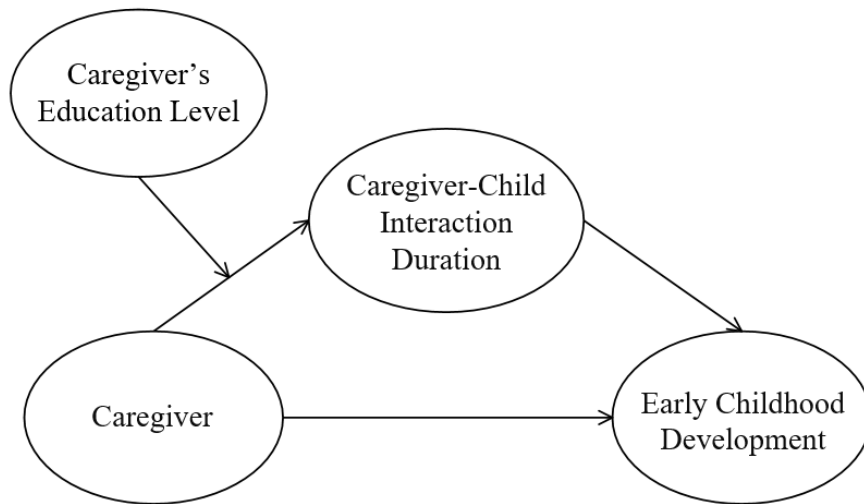


Figure 1: Moderated-Mediation Model

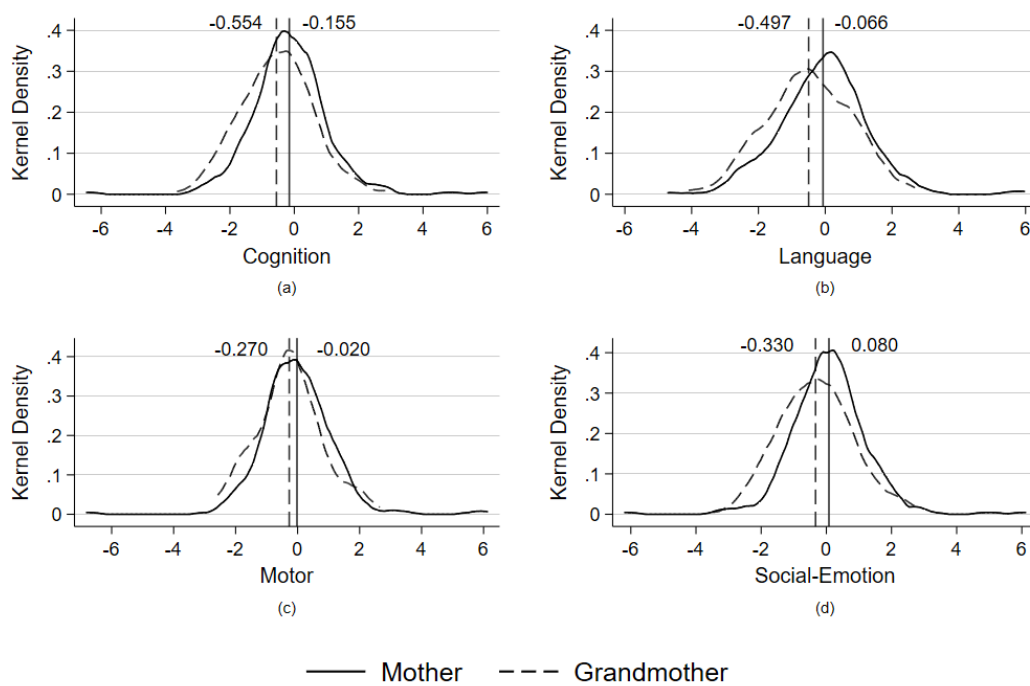


Figure 2: Density Distributions of CREDI Scores of Children Raised by Mothers and Grandmothers

Data Source: Authors' Survey

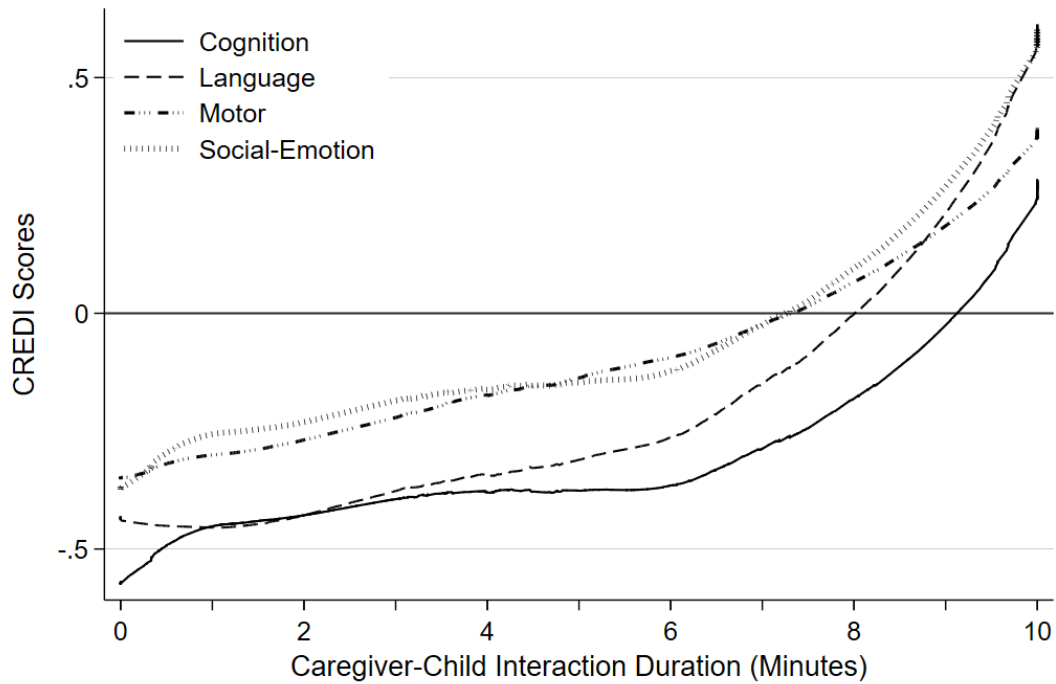


Figure 3: The Correlations Between Caregiver-Child Interaction Duration and CREDI Scores of Children

Data Source: Authors' Survey

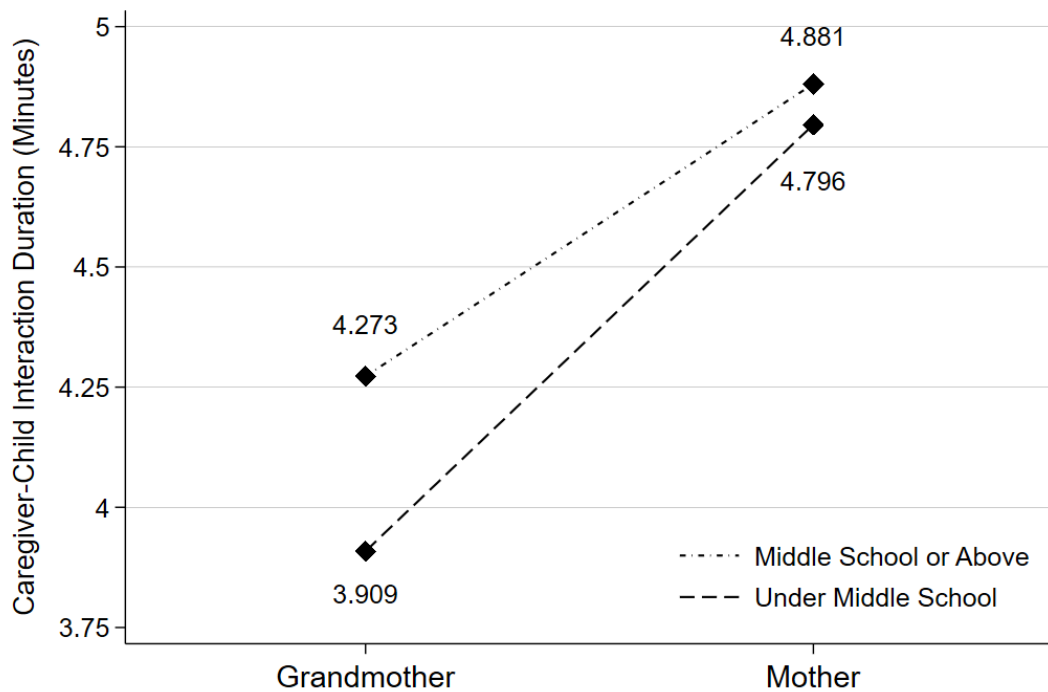


Figure 4: Caregiver-child Interaction Duration Predicted by Different Caregivers Moderated by Caregiver's Education Levels

Data Source: Authors' Survey

Table 1 Distribution of Primary Caregivers in Sample Towns

Primary Caregiver	Town A	Town B	Town C	Total
Mother	87 (60.4%)	89 (56.7%)	93 (50.3%)	269 (55.1%)
Grandmother	57 (39.6%)	68 (43.3%)	92 (49.7%)	219 (44.9%)

Data Source: Authors' Survey

Table 2 Summary Statistics by Caregivers

Variable	All Sample (1)	Mother (2)	Grandmother (3)	P-value H ₀ : (2)=(3)
Cognition	-0.33 (1.17)	-0.16 (0.07)	-0.55 (0.07)	0.00***
Language	-0.26 (1.32)	-0.07 (0.08)	-0.50 (0.09)	0.00***
Motor	-0.13 (1.14)	-0.02 (0.07)	-0.27 (0.07)	0.02**
Social-emotion	-0.10 (1.18)	0.08 (0.07)	-0.33 (0.08)	0.00***
Interaction duration	4.44 (3.12)	4.86 (0.20)	3.93 (0.19)	0.00***
Caregiver's education level	0.43 (0.50)	0.73 (0.03)	0.06 (0.02)	0.00***
<i>(1=middle school and above, 0=below middle school)</i>				
Caregiver's age	40.90 (14.15)	29.01 (0.28)	55.51 (0.39)	0.00***
Child's gender <i>(1=male, 0=female)</i>	0.52 (0.50)	0.52 (0.03)	0.51 (0.03)	0.70
Child's age in months	17.38 (6.50)	16.23 (0.41)	18.79 (0.40)	0.00***
Child's birth weight	0.04 (0.19)	0.05 (0.01)	0.02 (0.01)	0.10*
<i>(1=low birth weight, 0=normal birth weight)</i>				
Child has siblings <i>(1=yes, 0=no)</i>	0.61 (0.49)	0.68 (0.03)	0.53 (0.03)	0.00***
Migrant parents' ages	30.33 (4.56)	31.32 (0.31)	29.10 (0.23)	0.00***
Migrant parents' education levels	0.80 (0.40)	0.87 (0.02)	0.72 (0.03)	0.00***
<i>(1=middle school and above, 0=below middle school)</i>				
Poverty <i>(1=yes, 0=no)</i>	0.13 (0.34)	0.12 (0.02)	0.15 (0.02)	0.38

Data Source: Authors' Survey

*** p < 0.01, ** p < 0.05, * p < 0.1.

Table 3 Multivariate Regression of the Mediation Effects

Variables	Duration	Cognition	Language	Motor	Social emotion
Interaction duration		0.050*** (0.015)	0.061*** (0.017)	0.047*** (0.014)	0.063*** (0.014)
Caregiver (1=mother, 0=grandmother)	0.975** (0.463)	0.067 (0.158)	0.283 (0.181)	0.058 (0.118)	0.138 (0.171)
Caregiver's education level (1=middle school and above, 0=below middle school)	-0.014 (0.346)	0.247* (0.138)	0.174 (0.176)	0.107 (0.108)	0.201 (0.155)
Caregiver's age (1=65 years old and above, 0=less than 65 years old)	-0.484 (0.790)	-0.167 (0.374)	-0.170 (0.502)	-0.168 (0.245)	-0.061 (0.365)
Child's age in months	0.092*** (0.019)	-0.033*** (0.010)	0.016* (0.009)	-0.010 (0.009)	-0.022** (0.010)
Child's gender (1=male, 0=female)	0.042 (0.327)	-0.318** (0.134)	-0.451*** (0.123)	-0.277* (0.138)	-0.364** (0.142)
Child's birth weight (1=low birth weight, 0=normal)	0.546 (0.744)	-0.838*** (0.193)	-0.655* (0.360)	-0.812*** (0.211)	-0.709*** (0.189)
Child had siblings (1=yes, 0=no)	-0.611 (0.373)	-0.058 (0.110)	-0.048 (0.117)	-0.023 (0.124)	-0.054 (0.121)
Migrant parents' ages	-0.008 (0.036)	0.003 (0.015)	-0.006 (0.017)	0.000 (0.015)	-0.003 (0.013)
Migrant parents' education level (1=middle school and above, 0=below middle school)	0.452 (0.461)	0.415*** (0.132)	0.422** (0.163)	0.436*** (0.120)	0.446*** (0.136)
Poverty (1=yes, 0=no)	-0.004 (0.419)	-0.091 (0.108)	0.071 (0.155)	-0.060 (0.142)	-0.105 (0.120)
Coder FE	Yes	Yes	Yes	Yes	Yes
Village FE	Yes	Yes	Yes	Yes	Yes
Observations	488	488	488	488	488
R ²	0.225	0.190	0.181	0.153	0.185

Notes: Table 2 reports the regression results indicated by Eq. (1) – (2). Standard errors present in parentheses are clustered at the village level.

*** p < 0.01, ** p < 0.05, * p < 0.1.

Table 4 Bootstrap Results of Mediation Analysis

Dependent Variable	Point Estimate	S.E.	95% Confidence Interval		
			Percentile	BC	BCa
Cognition	0.049**	0.026	(0.006,0.108)	(0.011,0.120)	(0.011,0.120)
Language	0.059**	0.036	(0.008,0.146)	(0.010,0.162)	(0.010,0.162)
Motor	0.046**	0.030	(0.005,0.122)	(0.005,0.124)	(0.005,0.124)
Social emotion	0.062**	0.031	(0.009,0.129)	(0.013,0.139)	(0.013,0.139)

Note: (i) Table 2 reports the bootstrap estimates of mediation effects of caregiver-child interaction duration. The dependent variables are CREDI scores of children's cognition, language, motor, and social emotion. The mediator is caregiver-child interaction duration. The key independent variable is the caregiver (mother or grandmother). The point estimate a_1b_1 measures the mediation effects in Eq. (2) – (3).

(ii) Bootstrap standard errors are based on resampling with 1000 replications.

(iii) *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 5 Bootstrap Results of Moderated-Mediation Analysis

Dependent Variable	Value of Moderator	Point Estimate	S.E.	95% Confidence Interval		
				Percentile	BC	BCa
Cognition	0	0.056**	0.033	(0.007,0.137)	(0.011,0.144)	(0.011,0.141)
	1	0.021	0.042	(-0.057,0.111)	(-0.046,0.130)	(-0.049,0.130)
Language	0	0.068**	0.041	(0.004,0.159)	(0.007,0.170)	(0.007,0.169)
	1	0.025	0.049	(-0.073,0.120)	(-0.065,0.128)	(-0.068,0.127)
Motor	0	0.052**	0.033	(0.002,0.132)	(0.006,0.147)	(0.006,0.147)
	1	0.019	0.040	(-0.060,0.113)	(-0.049,0.132)	(-0.050,0.126)
Social emotion	0	0.071**	0.037	(0.009,0.155)	(0.016,0.164)	(0.016,0.164)
	1	0.026	0.049	(-0.078,0.123)	(-0.075,0.126)	(-0.078,0.123)

Note: (i) Table 5 reports the bootstrap estimates of moderated mediation effects of caregiver's education level. The dependent variables are CREDI scores of children's cognition, language, motor, and social emotion. The mediator is caregiver-child interaction duration. The key independent variable is the caregiver (mother or grandmother). The moderator is caregiver's education level. The point estimate $(a_1 + a_3 * Edu_care_i)b_1$ measures the moderated mediation effect in Eq. (4) – (5).

(ii) Bootstrap standard errors are based on resampling with 1000 replications.

(iii) *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.