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## Original Research

# Effects of early comprehensive interventions on child neurodevelopment in poor rural areas of China: a moderated mediation analysis

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## ABSTRACT

**Objectives:** To examine the effects of early comprehensive interventions on home environment and child neurodevelopment among children younger than 3 years in poor rural areas of China, as well as the underlying mediating and moderating mechanisms.

**Study design:** Non-randomized intervention study was conducted among 216 children aged 0–3 years in Shanxi province of China. Based on a 2 × 2 factor design, children in Lin and Fenxi County were assigned to an intervention group with duration less than 1 year ( $n = 26$ ) or an intervention group with duration longer than 1 year ( $n = 82$ ), while children in Fangshan County served as a control group with duration less than 1 year ( $n = 30$ ) or a control group with duration longer than 1 year ( $n = 78$ ).

**Methods:** The control group received national public health services (NPHS), while the intervention group received NPHS plus comprehensive interventions covering health, nutrition, early psychosocial stimulation, and child protection. Home environment (Infant-Toddler Home Observation for Measurement of the Environment [HOME]) and child neurodevelopment (Ages and Stages Questionnaire [ASQ]) were measured by observation and interview with mothers after the intervention program.

**Results:** The intervention group showed significantly higher overall HOME, organization, learning materials, and involvement than the control group, only for a duration longer than 1 year. Children in the intervention group performed better in overall ASQ, fine motor, problem-solving, and personal-social than children in the control group. Moderated mediation analyses indicated that there were significantly indirect effects of treatment on overall ASQ through overall HOME, organization, and involvement only when the duration was longer than 1 year.

**Conclusions:** Early comprehensive interventions longer than 1 year improve home environment and promote child neurodevelopment among children younger than 3 years in

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poor rural areas. What is more, effects of early comprehensive interventions longer than 1 year on child neurodevelopment were mediated by home environment.

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## Introduction

Early childhood from birth to 3 years is a critical period for child neurodevelopment, during which a child completes most of the cognitive, language, motor, and social-emotional development along with rapid development of the brain.<sup>1</sup> Supportive and stimulating home environment promotes child development,<sup>2,3</sup> whereas family risk factors exert adverse effects on child development.<sup>4,5</sup> What is more, family risk factors may influence child development through home environment.<sup>6,7</sup> Evidence shows that the supply of adequate nutrition, supportive and stimulating home environment, and social protection for children aged 0–3 years is crucial for child neurodevelopment.<sup>8,9</sup>

Children living in poor rural areas are more likely to experience multiple risk factors, including poverty, food insecurity, malnutrition, parental life stress and psychopathology symptoms, inadequate cognitive stimulation, deprivation of learning resources, and low quality of child care.<sup>10,11</sup> These risk factors exert pervasive negative effects on children's development, such as physical health, cognitive and social-emotional development, and academic achievement, which restrain the children from reaching their developmental potential.<sup>12</sup>

Rural children are more vulnerable than their urban counterparts. The prevalence of stunting among children aged 6–24 months was 32.27% in a study conducted in poor rural areas of Hubei province in China.<sup>13</sup> The prevalence of stunting in children from poor rural areas of China was twice the prevalence in rural children, which was approximately three to four times higher than the prevalence in urban children.<sup>11</sup> As for neurodevelopment, the rates of developmental delay in five areas among children aged 1 month to 36 months were between 4.4% and 8.5% using the Ages and Stages Questionnaire (ASQ) in a general population sample.<sup>14</sup> In comparison, the percentages of developmental delay in five domains of ASQ were between 27.7% and 42.5% among children in rural areas of India and were between 11.5% and 21.4% among children in poor rural areas of Shanxi and Guizhou province in China.<sup>1,11</sup> Thus, children from poverty-stricken areas warrant urgent attention and early interventions.

Early comprehensive interventions combining different interventions have been found to exert beneficial effects on child neurodevelopment among children in multirisk families. For example, 1-year comprehensive interventions covering health, nutrition, and early psychosocial stimulation were successful in promoting cognitive development for children younger than 2 years in rural India.<sup>15</sup> Also, in another study, 1-year comprehensive interventions comprising psychosocial stimulation and nutrition supplementation, using home visits and group meetings delivery strategy, were

effective in improving cognitive development for children younger than 2 years in rural Bangladesh.<sup>16</sup> Furthermore, comprehensive programs have been found to promote early child neurodevelopment over single intervention programs such as child-focused or parent-focused interventions in developing countries.<sup>17</sup>

However, there has been limited evidence of the effects of early comprehensive interventions on child neurodevelopment for children younger than 3 years in China, especially in poor rural areas. What is more, the underlying mechanisms by which early comprehensive interventions improve child neurodevelopment remain largely unexplored. As for mediating process, although comprehensive interventions have been found to promote home environment, less attention has been paid to the mediating role of home environment between comprehensive interventions and child neurodevelopment.<sup>18,19</sup> As regards the moderating process, the effects of early childhood development programs may be moderated by intervention duration. There is evidence that comprehensive interventions with a duration longer than 1 year are often associated with better intervention outcomes.<sup>20</sup>

The aims of the present study were to: (1) investigate the effects of early comprehensive interventions on home environment and child neurodevelopment among children younger than 3 years in poor rural areas of Shanxi province in mainland China, taking into consideration the intervention duration; and (2) explore the underlying mechanisms through which early comprehensive interventions impact child neurodevelopment by examining the mediating effect of home environment and the moderating effect of intervention duration.

## Methods

### Study design and participants

The present study is based on the Integrated Early Childhood Development (IECD) project in poor rural areas of China. All children younger than 3 years in Lin, Fenxi, and Fangshan County of Shanxi province (northern China) were eligible for the study. Exclusion criterion was children with functional disabilities (e.g. impairment of vision, hearing, or walking). All the three counties are on the government's list of poverty-stricken counties and have similar socio-economic development level. Lin and Fenxi counties were selected as pilot sites. Thus, children in Lin and Fenxi County were assigned to intervention groups, while children in Fangshan County served as the control group.

A total of 244 families participated in the present study. Twenty-eight children were excluded from this analysis because their outcome data were measured by observation and interview with non-mother respondents. There were

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