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Research Paper

Is participation in the target poverty alleviation program associated with early childhood development? Evidence from Southwest China

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ABSTRACT

Significant efforts have been made globally to alleviate poverty and achieve sustainable development. While the economic benefits and improved living standards from such programs are well-documented, their impact on early childhood development (ECD) remains less understood. This study investigated whether participation in China's Targeted Poverty Alleviation (TPA) program, which was designed as a sustainable livelihood initiative, was associated with ECD in different domains, beyond its primary goal of poverty alleviation. Additionally, it explored the potential mediating roles of parental investment and parental care. The sample included 1,415 families with children aged 18–42 months (632 girls) from 33 remote and mountainous towns in southwestern China, of which 432 families had participated in the TPA program. All families had been lifted out of absolute poverty during the data collection period. Children's development was assessed using the Chinese version of the Bayley Scales of Infant and Toddler Development, Third Edition. Hierarchical linear modeling revealed a positive association between TPA participation and children's socio-emotional development, with the presence of parental care identified as a significant mediator. These findings suggest that TPA participation, by facilitating parental care, supports children's socio-emotional development. This study highlights the importance of integrating parenting-friendly strategies into poverty alleviation programs to enhance both household economic security and ECD outcomes in low-income families.

Early childhood development (ECD) forms the foundation for lifelong learning, equipping children with essential skills for personal well-being, academic success, and social interactions later in life (Victora et al., 2008). Investments in ECD have been shown to yield substantial returns for both individuals and societies (Heckman et al., 2013). This is particularly essential in low- and middle-income countries (LMICs), where approximately 250 million children under five are at risk of not achieving their full developmental potential (Lu et al., 2016).

China's role as an LMIC has undergone significant transformation over the past few decades, marked by rapid economic development, extensive poverty alleviation efforts, and an expanding global influence. Once regarded as a low-income country, China is now classified as an upper-middle-income country by the World Bank (World Bank, 2024). A cornerstone of this transformation has been the implementation of the Targeted Poverty Alleviation (TPA) program, one of the most ambitious initiatives aimed at eradicating absolute poverty, defined as a per capita annual income below ¥2,300 (approximately $325) (National Bureau of Statistics of China, 2023).

Given the global evidence underscores the effectiveness of household poverty reduction programs in improving early developmental outcomes across cognitive, language, motor, and social-emotional domains (Carraro & Ferrone, 2023), this study investigated whether participation in the TPA program was associated with holistic early development in these domains among children from low-income families in China, as well as the potential mechanisms underlying such associations. This exploration is particularly pertinent as nearly 17 million children under the age of five in China were at risk of developmental delays due to their families' low-income status as of 2021 (UNICEF China, 2021).

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1. Poverty alleviation and ECD

1.1. Types of poverty alleviation programs

The United Nations Sustainable Development Goals (SDGs) identify "No Poverty" as the first goal for sustainable development (United Nations, 2015). In response, diverse poverty alleviation programs have been implemented worldwide to address socio-economic challenges and help households escape poverty. These programs employ strategies such as financial subsidies, employment opportunities, and agricultural training (Ayoo, 2022). Given the critical role of ECD in breaking the cycle of poverty (Attanasio et al., 2022), researchers and policymakers are increasingly focused on supporting ECD in children from impoverished backgrounds.

Poverty alleviation programs are generally categorized into Cash Transfer (CT) programs and Sustainable Livelihood (SL) programs. CT programs involve direct monetary transfers to beneficiaries and are widely used to provide immediate financial relief for poor households (Carraro & Ferrone, 2023). In contrast, SL programs adopt a more comprehensive approach, combining monetary assistance with capacity building, such as skill training, provision of in-kind assets, and supply chain linkages, to promote long-term income generation (Sulaiman et al., 2016). Although SL programs are more complex and costly to implement, they emphasize sustainable development through skill-building and income growth (Balasubramanian et al., 2024).

The TPA program in China is an example of an SL program. It combines economic empowerment with livelihood safeguards such as housing, healthcare, and education, offering a holistic and sustainable approach to poverty alleviation.

1.2. The Effectiveness of SL Programs on ECD

Elements of SL programs play a significant role in supporting ECD by addressing critical social and economic factors that influence a child's well-being. For instance, improved access to income and resources enables families to provide adequate nutrition, healthcare, and sanitation, which are essential for a child's physical and cognitive development (Bandiera et al., 2022). Moreover, educating and training parents enhances their knowledge of child-rearing practices (Guarnieri & Rainer, 2021), fostering a nurturing and supportive environment for young children. Financial stability achieved through SL programs also reduces family stress and conflict (Afridi et al., 2016; Field et al., 2021), leading to more stable home environments that benefit children. Additionally, investments in community infrastructure and education often result in the establishment of facilities that provide young children with opportunities for cognitive and social growth (Rodriguez, 2022). By addressing these interconnected factors, SL programs aim not only to alleviate poverty but also to create healthier and more resilient conditions, which are necessary for holistic ECD.

However, there is limited direct evidence on the effectiveness of SL programs in improving ECD outcomes. This study aimed to address this gap by examining whether participation in the TPA program, an SL program implemented in rural China, was associated with improved ECD outcomes. Furthermore, we explored whether changes in family child-rearing environments, influenced by TPA participation, mediated the relationship between household participation in the TPA program and ECD.

1.3. The TPA program in China

Since initiating economic reforms in 1978, China has experienced rapid economic growth. However, this growth has been uneven, disproportionately benefiting eastern coastal and urban areas, while rural and interior regions lagged behind. Although significant poverty reduction efforts dramatically reduced poverty levels, these efforts often relied on generic strategies and were less effective in addressing the root causes of persistent poverty in specific areas (Chang et al., 2022). By 2014, more than 70 million rural Chinese still lived below the official poverty line, earning less than USD 2.3 per day (Zhou et al., 2023).

To address absolute poverty in rural China and align with the United Nations' Sustainable Development Goals (SDGs) on poverty reduction, the Chinese government officially launched the TPA program nationwide in 2013. Households with a per capita annual income below ¥2,300 were identified as TPA recipients by local governments. Unlike traditional poverty reduction measures, the TPA program emphasized precision and tailored solutions to fit the specific circumstances of different regions and individuals. Its goal was to eradicate absolute poverty while ensuring sustainable income growth (Sun et al., 2021).

The TPA program adopted a collaborative approach, mobilizing resources from various stakeholders, including public enterprises, private companies, governments, and non-governmental organizations. Local governments conducted detailed field surveys and assessments to create databases of poor households, identified the causes of poverty, and determined the most effective support strategies. Based on the needs of participants, the individualized TPA support covered five key aspects: sustainable agricultural or non-agricultural industrial development, employment assistance, household relocation from remote to accessible regions, education support, and social security network (Tang et al., 2022).

Despite the individualized support, the program maintained universal exit criteria. Households exited the TPA program once they met benchmarks, i.e., achieving a stable per capita annual income above ¥4,000 (approximately $565) and little likelihood of falling back into poverty (Zhou et al., 2023). Because of these tailored interventions, the type of assistance received and the duration of participation varied among households.

By 2020, the TPA program achieved its goal of eliminating absolute poverty, lifting nearly 100 million people out of poverty since its inception (National Bureau of Statistics of China, 2024). The program's effectiveness has been widely documented. For example, participation in the TPA program led to a household income increase of 16.4 % to 19.6 % (Chang et al., 2022). Other benefits include improvements in employment promotion (Li et al., 2021), narrowing of the urban-rural income gap (Tang et al., 2022), and enhanced subjective well-being (Zhou et al., 2023). Most importantly, the TPA program significantly contributed to the sustainable livelihoods of poor families in rural China (Li et al., 2021).

1.4. Enhanced child-rearing environments as potential mediators

Family is a key component of the microsystem, the most immediate system in Bronfenbrenner's bioecological model, and it plays a central, foundational role in ECD (Bronfenbrenner & Morris, 2006). Changes in the family parenting environment, particularly material investments and the quality of parent-child interactions, are significant contributors to socio-economic status-related achievement gaps in early childhood (Mistry et al., 2010; Long et al., 2017; Vasilyeva et al., 2018). These factors are often used to explain the effectiveness of poverty reduction programs, such as CT programs, on ECD outcomes (Premand & Barry, 2022). In this study, we focus on two potential mediators directly influenced by participation in the SL program: parental care and parental investment.

1.4.1. Parental care as a potential mediator

Household poverty can result in the absence of parental care due to parents working away from home or maintaining intensive work schedules (Khanam & Khan, 2023). In rural China, this has given rise to the long-standing phenomenon of "left-behind children", where children remain in rural areas while their parents migrate to urban centers in search of employment opportunities to alleviate household poverty (Wang et al., 2022). By 2020, it was estimated that 14.93 million children under the age of five in rural China were left behind (UNICEF

China, 2023). These children are typically cared for by grandparents, other relatives, or, in some cases, older siblings.

Children raised by their parents tend to show significantly better outcomes in early literacy, numeracy, socio-emotional, and motor skills than children cared for by others. For example, in Bangladesh, children raised in parental care performed better in these domains compared to left-behind children (Khanam & Khan, 2023). Similar trends are observed in rural China. Bai et al. (2022) found that left-behind children in six provinces of West-Central China experienced a 6 % higher prevalence of cognitive delays compared to children raised by their parents. Similarly, Yue et al. (2020) reported an 8.2 % increase in cognitive delays for left-behind children under the age of three. Li et al. (2021) also identified significantly lower performance in language, motor, and socio-emotional development among left-behind children. These developmental gaps are largely attributed to differences in the quality of care environments. Caregivers, often grandmothers, in rural China tend to have lower levels of knowledge about nurturing care (Yue et al., 2020) and engage in fewer interactions with children (Bai et al., 2022), resulting in poorer developmental outcomes for left-behind children (Li et al., 2021).

As an SL initiative, the TPA program emphasizes long-term solutions over immediate monetary support by enhancing the assets and capabilities of recipient households (Li et al., 2021). Through tailored interventions such as vocational training and local industry development, the TPA program enables parents to remain in rural areas with their families instead of migrating to urban centers for work. Zhan et al. (2020) found that resettlement programs aimed at providing job opportunities and vocational training in rural China increased household income and reduced the number of children left behind. Similarly, Wang et al. (2022) reported that more school-age children were able to live with their parents, following participation in the TPA program.

The TPA program has shown promise in addressing the issue of left-behind children, with over 1.5 million rural children under the age of two gaining access to parental care as a result of the program (Lyu et al., 2024). Despite these positive developments, there is limited research on how the TPA program specifically supports ECD. In this study, we examined the mediating role of parental care by investigating whether participation in the TPA program was directly associated with an increased likelihood of parental care, and whether this increased parental care, in turn, promoted preschool children's early development.

1.4.2. Parental investment as a potential mediator

The Family Investment Model (FIM) (Becker et al., 2016) highlights the critical role of parental investment, both financial resources and time engagement, in fostering an environment conducive to ECD. Families living in poverty often face financial constraints that limit their ability to provide educational materials, learning activities, and health care, contributing to early achievement gaps (Sun et al., 2016). In addition, a lack of parenting knowledge among poor families further restricts their ability to invest in their children's development (Del Boca et al., 2016).

Children in poverty are less likely to own stimulating toys or books and are often deprived of engaging home learning activities compared to children from more advantaged families (Owen et al., 2023). For instance, 62 % of caregivers from poor families in China reported having no books for their children at home, and only 18 % reported reading to their children (Wang et al., 2019).

SL programs, with their comprehensive and tailored assistance, have the potential to not only improve household cash flow but also enhance productivity and sustainable development. With increased resources and capabilities, SL program recipients may make more informed decisions about allocating materials and time to support ECD (Afridi et al., 2016). For example, Premand and Barry (2020) found that families participating in Nepal's national safety net project, an SL program offering health education, parenting support, and health services, were more likely to invest in family well-being, including nutrition, health, psychosocial stimulation, and child protection. Similar findings were reported from India's National Rural Employment Guarantee Scheme, where program participation led to increased investment in child development (Afridi et al., 2016).

It is important to note that while parental investment is broadly associated with positive ECD outcomes, its impact may vary depending on the specific domain of ECD. For instance, parental investment in cognitively stimulating activities, such as reading, storytelling, or providing educational materials, is likely to have a more pronounced impact on children's cognitive development (Ma et al., 2023). The effects of parental investment on parent-child interactions, emotional support, might be more closely related to children's socio-emotional development and establishment of a secure attachment (Mountain et al., 2017). Similarly, physical development may be influenced by parental investment in adequate nutrition, healthcare, and opportunities for physical activity (Lappan et al., 2020).

The TPA program, through its targeted and sustainable assistance to families under the national poverty line, has the potential to positively influence parental investment behaviors. Beyond merely increasing income, the program aims to enhance recipients' ability to allocate resources effectively across various aspects of family and child well-being. This study explored the pathways linking TPA program participation to changes in parental investment and, subsequently, to different domains of ECD, to achieve a nuanced understanding of how poverty alleviation efforts influenced ECD through parental investment as well as whether certain domains were more or less sensitive to this mediating mechanism.

1.5. The present study

This study investigated whether participation in the TPA program in rural China was associated with children's ECD across multiple domains, including cognitive, language, motor, and social-emotional development. Furthermore, it examined whether parental care and parental investment mediated these relationships. It was hypothesized that participation in the TPA program would be associated with higher levels of ECD across all domains, given the program's focus on supporting families' sustainable development. Additionally, both parental care and parental investment were expected to mediate this relationship, reflecting the role of supportive family environments in fostering ECD. The findings of this study provide valuable insights into how poverty alleviation strategies can generate multifaceted benefits for young children, extending beyond immediate economic improvements. These results aim to inform the design of more effective and comprehensive social programs that address poverty, while also promoting the ECD of children living in poverty.

2. Method

2.1. The research sites

This study was conducted in six low-income counties located in remote mountainous areas of Southwest China. Among these counties, five were classified as severely economically disadvantaged, with a higher proportion of families participating in the TPA program compared to the sixth county. All households participating in the TPA program had successfully met the program's exit benchmarks before 2020.

In 2022, when this study was conducted, the average per capita annual income of rural residents in these counties was ¥15,158 (approximately US$2,106), with a range from ¥12,749 (US$1,779) to ¥23,691 (US$3,241). This income level was approximately 20 % lower than the national average of ¥20,133 (US$2,797) for the same year (National Bureau of Statistics of China, 2024), highlighting the persistent economic challenges faced by the region during the study period.

China's administrative system organizes towns as subordinate to counties, and villages as subordinate to towns. To refine the research sites within these counties, 33 towns were selected with the assistance of local government officials. These towns were chosen because they were representative of the counties' low-income levels and demonstrated a strong willingness to collaborate on this project. This careful selection process ensured that the research sites accurately reflected the economic conditions of the broader region while also enabling effective cooperation with local stakeholders.

2.2. Participants

Participants in this study were recruited from the 33 selected towns. In each town, five villages located in the most remote and mountainous areas were randomly selected. Using a list of children born between 2019 and 2020 provided by the local family planning office, ethical informed consent letters were sent to the parents of these children, and only those who agreed to participate were included in the study. As this study represents the first wave of a large-scale longitudinal project, only children who were not yet enrolled in pre-primary education were recruited for Wave 1 data collection.

A total of 1,685 signed consent forms were received from parents. Of these, 75 participants were excluded because they did not report their TPA program participation status. Another 155 children were excluded because their parents either declined or were unable to provide information on parental investment, parental care, or child and family characteristics. Additionally, 40 children were excluded for not completing child assessment sessions. Importantly, no significant differences were found between the excluded and retained participants with respect to child age, gender, or parental education.

The final analytic sample consisted of 1,415 children, of whom 783 were boys, and their primary caregivers. Among the caregivers, 904 were mothers, 191 were fathers, and 304 were grandparents. A total of 423 of the children came from families that had previously participated in the TPA program.

The educational attainment of parents was generally low. Nearly half of the mothers (49 %) reported primary school as their highest level of education, while 27 % had completed junior high school, 13 % had completed high school, and only 11 % had attended college. Fathers tended to have slightly higher levels of education, with 41 % completing junior high school and 10 % attending college. Household income levels were also low. A total of 86 % of families reported a per capita annual income below the national average of ¥20,133 (US$2,797), and 62 % of families reported incomes below ¥10,000 (US$1,396). Further demographic details of the participants are summarized in Table 1.

Table 1
Descriptive statistics of all study variables.

	TPA Participants (n = 423)		Non-TPA Participants (n = 992)		F /Chi-square Tests
	n (%)	M (SD)	n (%)	M (SD)	
Demographics					
Child Age (months)		31.42 (5.09)		31.79 (5.31)	F (1,1413) = 1.23, p = .23
Gender (number of boys)	228 (53.90)		527 (53.125)		χ^2 = 0.07, p = 0.79.
Mother's years in school		5.91 (3.82)		8.52 (4.33)	F (1,1413) = 115.96, p = .00
Father's years in school		6.60 (3.29)		9.05 (3.62)	F (1, 1413) = 143.22, p = .00
Family income (thousands of RMB)		8.61 (7.75)		13.77 (13.16)	F (1,1413) = 56.72, p = .00
Parental Care					
With parental care	352 (84.16)		681 (68.645)		χ^2 = 36.15, p = .00
Parental Investment					
Purchasing picture books in the past three months		1.12 (0.36)		1.33 (0.76)	F (1,1413) = 30.67, p = .00
Purchasing toys in the past three months		4.11 (1.02)		3.88 (1.13)	F (1,1413) = 12.67, p = .00
Time (minutes) to parental engagement in home learning activities		57.54 (69.23)		55.92 (76.30)	F (1,1413) = .14, p = .71
ECD					
Cognitive scores		97.65 (12.23)		100.16 (12.83)	F (1,1413) = 11.61, p = .00
Language scores		97.09 (13.42)		100.96 (15.20)	F (1,1413) = 20.51, p = .000
Motor scores		106.49 (15.14)		107.14 (15.38)	F (1,1413) = .53, p = .47
Social-emotional scores		88.88 (12.57)		86.32 (12.19)	F (1,1413) = 12.89, p = .00
With cognitive delay	221 (52.48)		446 (44.76)		χ^2 = 7.10, p = .01
With language delay	189 (44.68)		389 (39.21)		χ^2 = 3.67, p = .06
With motor delay	38 (8.98)		56 (5.65)		χ^2 = 5.33, p = .02
With social-emotional delay	261 (61.70)		681 (69.76)		χ^2 = 8.75, p = .01

2.3. Measures

2.3.1. Early childhood development

The Chinese version of the Bayley Scales of Infant and Toddler Development – Third Edition (Bayley-III) (Xu et al., 2011) was used to assess young children's development across multiple domains. The Bayley-III (Bayley, 2006) is a comprehensive, gold-standard tool designed to evaluate the developmental functioning of infants and toddlers aged 0 to 42 months. It has been widely validated and is recognized for its reliability and validity in assessing various aspects of ECD. The Chinese version of the Bayley-III has been validated for use with rural Chinese populations, demonstrating good psychometric properties (Yue et al., 2020).

Four scales of the Bayley-III were used in this study. The Cognitive Scale (91 items; α = .92) evaluates information processing, counting, and number skills; the Language Scale (97 items; α = .96) assesses children's receptive and expressive communication skills; the Motor Scale (138 items; α = .93) assesses children's precision of small muscle movement and gross movement skills; and the Social-Emotional Scale (35 items; α = .91) measures children's ability to interact with others and manage emotions. The Cognitive, Language, and Motor Scales were administered individually with children by trained assessors, while the Social-Emotional Scale was completed by primary caregivers in individual interviews based on their observations and knowledge of children.

Assessors were recruited from undergraduate and postgraduate students majoring in education or related fields. All assessors underwent rigorous training sessions over the course of a week, which included group instruction and pilot assessments. Each trainee was required to achieve an inter-rater reliability score of at least .90 with the two trainers, who served as the gold standard for scoring consistency.

Given that the family language in most households included in this study was a local dialect, the research team recruited a group of students from vocational schools at different counties to serve as interpreters. They translated the administration language (Putonghua) into the local dialect during the test administration process as needed. Approximately

one-third of the child assessment sessions required assistance from the interpreter, ensuring accurate communication and comprehension during the testing process.

For data analysis, both the composite scores of each scale and the developmental delay status (Yes/No) for each domain, which was determined according to the provided norms, were used. This approach ensured a comprehensive evaluation of children's early developmental functioning across cognitive, language, motor, and social-emotional domains.

2.3.2. Participation in the TPA program

The primary caregivers provided information on whether their household had been identified as a TPA participant and reported the types of support they had received during their participation. However, substantial variations in the content, intensity, and dosage of support across households made it difficult to obtain detailed and consistent information about the specific provisions of the TPA program. As a result, only the participation status (Yes = 1, No = 0) was considered for the purposes of this study.

2.3.3. Presence of parental care

The primary caregivers provided information on whether the child's mother and father were involved in the child's daily childcare. If the child was reported as being cared for by their mother or father (rather than grandparents, other relatives, or being left behind), the presence of parental care was coded accordingly.

2.3.4. Parental investment in ECD

Both material and time investments in ECD were considered in this study. Material investment refers to parents' monetary expenditures supporting children's early learning and development. Since the purchase of picture books and toys are two primary forms of material investment in rural Chinese families (Ma et al., 2023), two items from the Home Observation for Measurement of the Environment Inventory were used to assess this dimension. Specifically, parents reported the quantity of picture books (rated from 1 = scarce to 5 = abundant) and toys (rated from 1 = scarce to 5 = abundant) they had purchased in the past three months.

Time investment was measured based on the amount of time parents spent engaging in six typical home learning activities with their children. These activities included reading, storytelling, singing, playing, taking the child outdoors, and counting, as reported by the primary caregivers over the past three days. These items, adapted from the Multiple Indicator Cluster Surveys, are commonly used to capture cognitive and socio-emotional caregiving practices of parents in low- and middle-income countries (Sun et al., 2016). Instead of asking parents how often they engaged in these activities, they were asked to report the duration (in minutes) of their engagement in each activity to better capture their time investment. The Cronbach's alpha for these items was 0.78, indicating acceptable internal consistency.

All questions were administered through one-on-one interviews, as many parents faced difficulties reading the questionnaire. An interpreter was present during the interviews to assist parents who did not understand Putonghua. Approximately 45 % of the interviews required assistance from the interpreter.

2.3.5. Covariates

In the parent questionnaire, demographic information of the family, including parents' years of educational, annual household per capita annual income (thousands of RMB), as well as children's age and gender (boy =1). They were treated as covariates in the analyses.

2.4. Procedures

With the assistance of local governments, informed consent to participate in the study was obtained from the parents of children within the targeted age groups at the research sites. Data collection was conducted between May 2022 and August 2023. Each interview session lasted approximately three to four hours and covered various aspects related to family functioning and parenting practices. Only parents' responses to questions regarding parental care, parental investment, and relevant demographic information were analyzed in this study.

The individual child assessments using the Bayley-III were conducted in the children's homes by trained assessors. A total of 97 assessors were trained specifically for administering the Bayley-III and were assigned to different towns during data collection. Each child assessment session lasted approximately 90 to 150 minutes, with two 10-minute breaks provided during the session. Children were allowed to withdraw from the assessment at any time if they or their parents requested. Upon completion of the preliminary data analysis, all participants were provided with a brief report on their child's performance.

2.5. Analytical approach

We first calculated the Intraclass Correlation Coefficient (ICC) and the Design Effect (DEFF) to assess the degree of nestedness in the data. According to Cohen (1988), an ICC greater than 0.059 typically warrants the use of multilevel modeling. However, even when the ICC is lower than 0.059, a DEFF greater than 2 suggests the necessity of multilevel modeling for data analysis (Asparouhov & Muthén, 2019). The ICCs and DEFFs for all children's outcome variables (subscale scores and delay status across developmental domains) indicated the need for multilevel modeling (see Supplementary Material).

Separate Hierarchical Linear Models (HLM) were constructed for the raw scores in each developmental domain to examine the relationship between TPA participation and ECD across domains, while controlling for potential covariates. Additionally, a series of Multilevel Generalized Linear Models were developed to account for non-normal distributions and heteroskedastic errors (Hox et al., 2017), focusing on whether household TPA participation was associated with the delay status of children's development in different domains. Model fit was assessed using the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR). Following Hu and Bentler (1999), a good model fit was indicated by CFI and TLI values above 0.90 and RMSEA and SRMR values below 0.08. All analyses were conducted using Mplus 8, and the model equations are provided in the Supplementary Material.

Multilevel Structural Equation Modelling (MSEM) was conducted to investigate the mediating roles of parental care and parental investment in the relationship between TPA participation and children's developmental outcomes, including both developmental levels and delay status across domains. MSEM enables the simultaneous estimation of multiple mediating pathways while explicitly modeling measurement error, providing greater flexibility, precision, and depth for complex multilevel mediation analyses. Posterior Predictive Checking (PPC) was used to evaluate model fit, with a Posterior Predictive P-Value closer to 0.5 indicating better model fit (Asparouhov & Muthén, 2019; Lynch, 2007).

3. Results

3.1. Descriptive analysis

Table 1 presents descriptive statistics for the key variables for both the TPA participants and non-TPA participants. Years in school for mothers ($M = 5.91$, $SD = 3.82$), years in school for fathers ($M = 6.60$, $SD = 3.29$), per capita annual family income in thousands of RMB ($M = 8.61$, $SD = 7.75$) of children participating in the TPA program were significantly lower than those in the non-participating TPA program group (years in school for mothers: $M = 8.52$, $SD = 4.33$; years in school for fathers: $M = 9.05$, $SD = 3.62$; per capital annual family income in thousands of RMB: $M = 13.77$, $SD = 13.16$). The frequency of purchasing picture books was also significantly lower in the participating

TPA program group ($M = 1.12$, $SD = 0.36$) than in the non-participating TPA program group ($M = 1.33$, $SD = 0.76$), but the percentage of parental care (84.2 %) and the frequency of purchasing toys ($M = 4.11$, $SD = 1.02$) were significantly higher than in the non-participating TPA program group (percentage of parental care: 68.6 %, frequency of purchasing toys: $M = 3.89$, $SD = 1.13$).

TPA participation was negatively correlated to years in school for parents ($r_{mother} = -.27$, $p < .01$; $r_{father} = -.30$, $p < .01$), per capita annual family income ($r = -.19$, $p = <.01$), and the frequency of purchasing picture books ($r = -.14$, $p < .01$). However, TPA participation was positively correlated to the frequency of purchasing toys ($r = .08$, $p = <.01$) and the likelihood of receiving parental care ($r = 0.16$, $p < .01$). Finally, TPA participation was positively correlated to the Bayley subscale scores on children's socio-emotional development ($r = .09$, $p < .01$), a healthy developmental status (not delayed) in this domain ($r = -.08$, $p < .01$), and the likelihood of being delayed in both cognitive and motor domains (Cognitive Development Delay: $r = .07$, $p < .01$; Motor Development Delay: $r = .06$, $p < .05$), but negatively correlated to the Bayley subscale scores of cognitive ($r = -.09$, $p < .01$), language development ($r = -.11$, $p < .01$). Correlations among the variables are included in Supplementary Material.

3.2. Participation in the TPA program and ECD

Table 2 summarizes the results of HLMs examining the relationship between TPA participation and early development in different domains. The results indicated that participation in the TPA program only significantly predicted children's socio-emotional development as measured by the Bayley scale score ($\gamma = .14$, $SE = .03$, $p < .01$) and the delay status of children's socio-emotional development ($\gamma = -.12$, $SE = .04$, $p < .01$).

3.3. The mediating role of parental care and parental investment

Given that TPA participation was only found to be associated with children's socio-emotional development in terms of both the subscale score and the norm-referenced delay status, the multilevel mediating analyses were only conducted for these two outcome variables. As shown in Fig. 1, the MSEM for children's Bayley subscale score of socio-emotional development found a significant mediating effect of parental care, but not of parental time or material investment, in the relationship between TPA participation and socio-emotional development (indirect effect = .257, $p < .01$; 95 % confidence interval = [0.043,0.492]; PPP = 0.500). Although TPA participation, parental care, toy purchase, and parental time investment were significantly associated with children's socio-emotional development, TPA participation was only significantly associated with parental care. The MSEM further identified significant mediating effects of parental care in the relationship between TPA participation and whether the children were vulnerable to socio-emotional delay (see Fig. 1) (indirect effect = -.012, $p < .01$; 95 % confidence interval = [-0.023, -0.004]; PPP= .429).

4. Discussion

This study explored whether households' participation in the TPA program, a comprehensive SL poverty alleviation initiative in rural China, was associated with children's ECD across various domains, extending beyond its primary focus on poverty reduction. The findings revealed that TPA participation was significantly associated with children's socio-emotional development. Furthermore, parental care was identified as a mediating factor in the relationship between TPA participation and children's socio-emotional development.

4.1. TPA participation and ECD in different domains

It was unexpected to find that TPA participation was only positively associated with children's socio-emotional development. Specifically, children from households participating in the TPA program demonstrated better socio-emotional development and were less likely to experience developmental delays, even when holistic development across multiple domains was considered. One key feature of the TPA program is its focus on providing long-term economic stability and sustainability for families (Sun et al., 2021), which can significantly improve the home environment by enhancing stability, security, and access to resources for children. Increased economic stability within households likely reduces stress levels among adults and fosters a more nurturing environment, contributing to improved family dynamics that support children's socio-emotional development (Khanam & Khan, 2023). In contrast, non-TPA participant families, despite having better baseline resources, may experience greater economic instability or insecurity. Without the tailored support provided by the TPA program, these families might face higher parental stress levels, which can negatively affect children's socio-emotional development (Cucinella et al., 2022).

Interestingly, our findings did not reveal a significant association between TPA participation and children's cognitive or language

Table 2
Multilevel analyses for understanding the associations between households' TAP participation and ECD in different domains.

	ECD in Four Domains (Bayley -III Scale Scores)				ECD Delay Status in Four Domains			
	CD *γ(SE)*	LD *γ(SE)*	MD *γ(SE)*	SED *γ(SE)*	CD *γ(SE)*	LD *γ(SE)*	MD *γ(SE)*	SED *γ(SE)*
Intercept	31.98** (6.03)	21.36** (4.37)	35.89** (8.51)	19.83** (2.38)	7.04** (1.64)	10.78** (2.65)	8.29** (2.18)	7.28** (1.10)
TPA participation	-.03 (.05)	-.01 (.03)	.04 (.03)	.14** (.03)	.01 (.04)	-.04 (.02)	.03 (.03)	-.12** (.04)
Child age	.11** (.03)	.19** (.04)	.12** (.03)	.09** (.03)	-.07* (.04)	-.19** (.04)	-.10** (.03)	-.07* (.03)
Child gender	-.06 (.03)	-.06 (.03)	-.05 (.03)	-.04 (.02)	.04 (.03)	.04 (0.03)	-.04 (.03)	.07** (.02)
Years in school (mother)	.17** (.03)	.17** (.04)	.14** (.04)	.14** (.03)	-.18** (.04)	-.14** (.04)	-.07* (.04)	-.08 (.04)
Years in school (father)	.01 (.03)	.05 (.03)	.06 (.05)	-.004 (.03)	.02 (.03)	-.02 (.03)	-.01 (.04)	-.02 (.04)
Family income	.05 (.03)	.04 (.04)	-.05 (.03)	.10** (.03)	-.06 (.03)	-.04 (.02)	-.01 (.02)	-.09** (.04)
Residual	.94** (.02)	.91** (.02)	.96** (.01)	.95** (.01)	.96** (.01)	.94** (.01)	.98** (.01)	.96** (.01)
Model fit index								
ICC	.046	.061	.031	.097	.054	.043	.036	.079
CFI	.998	.999	1.000	.999	.998	.999	1.000	.998
TLI	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
RMSEA	.000	.000	.000	.000	.000	.000	.000	.000
$SRMR_{within}$	.003	.002	.001	.003	.003	.003	.001	.003
$SRMR_{between}$	.007	.007	.013	.006	.001	.000	.001	.002

Notes. CD = Cognitive Development; LD = Language Development; MD = Motor Development; SED = Socio-Emotional Development. SE = Standard Error. Standardized estimates are reported. MLR estimation was used. * $p < .05$
** $p < .01$.

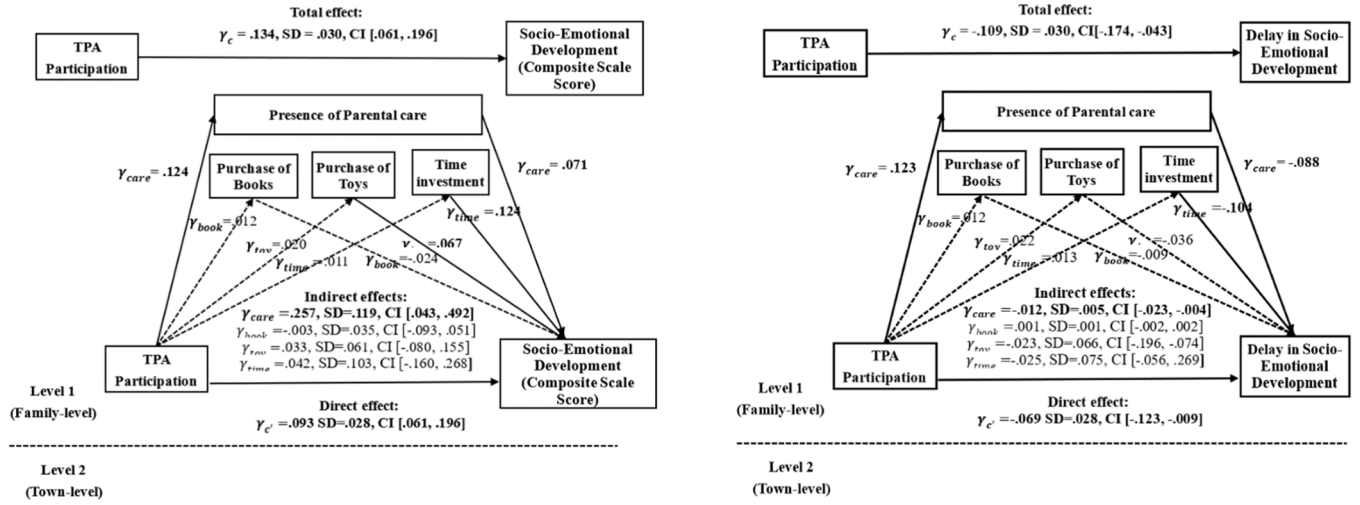

Fig. 1. Mediating analyses with parental investment and presence of parental care as mediating variables between TPA participation and children's socio-emotional development.

Note: Summaries report Bayesian estimation results for multilevel mediation models of parental care (PPP= .500 for the composite scale score model; PPP= .429 for the delay status model) and parental investment (PPP= .427 for the composite scale score model; PPP= .406 for the delay status model). Significant coefficients are standardized path coefficients that take into account covariates of child characteristics. Dashed lines indicate nonsignificant relations, and solid lines indicate significant relations. Significant effects are highlighted in bold.

development. This suggests that early cognitive and language development may depend more on the quality of educational inputs than on economic security. Previous research indicates that a stimulating home learning environment and high-quality parent-child interactions are key to fostering early cognitive and language development (Briones et al., 2021). However, targeted educational interventions were not a primary focus of the TPA program, which may explain the lack of association in these domains.

Nevertheless, it is also possible that the benefits of TPA participation for cognitive and language development may emerge at a later stage, as cognitive complexity and educational achievements often manifest after foundational socio-emotional skills are established (Briones et al., 2021; Owen et al., 2023). Additionally, studies suggest that families receiving poverty alleviation support tend to prioritize meeting basic needs, such as housing, utilities, clothing, and food, before allocating resources to educational tools or programs (Ayoo, 2022). As their immediate needs are met and living conditions improve, these families may later redirect resources toward educational inputs, potentially enhancing children's cognitive and language development over time. Longitudinal studies are therefore needed to examine the long-term relationship between TPA participation and cognitive and language development.

The literature on poverty alleviation programs and children's cognitive and language development presents mixed findings. For instance, Hawkinson et al. (2013) and Gaitz & Schurer (2017) reported negative associations between participation in poverty alleviation programs and children's cognitive skills, while Paxson and Schady (2010) and Macours et al. (2012) found positive associations. In contrast, our study did not identify any significant relationship between TPA participation and children's cognitive or language development. Differences in research design (e.g., randomized control trials versus cross-sectional designs), the nature of poverty alleviation programs (e.g., CT versus SL), and measurement approaches for children's developmental outcomes may all contribute to these discrepancies.

Similarly, no significant association was found between TPA participation and children's motor development. This may be due to the relatively higher level of motor development among children in the study. As shown in Table 1, the mean subscale score for motor development was 106.9 (with 100 as the cutoff score for healthy development, Robertson, 2011), and the prevalence of delays in motor development was low (6.6 %) compared to delays in cognitive (47.1 %), language (40.8 %), and socio-emotional development (66.7 %). Despite limited access to toys or learning materials, children in rural areas often have ample time and space for outdoor play, regardless of TPA participation. Outdoor play is known to benefit motor development (Wood et al., 2020), which may explain the lack of association between TPA participation and motor development.

The differences in associations between TPA participation and children's development across domains may also be related to the measurement approaches used. In this study, children's cognitive, language, and motor development were assessed using the Bayley-III through individual assessment tasks. While these tasks were designed to be game-based and assessors were trained to establish rapport with children, the assessment sessions may have been stressful for two- to three-year-olds in rural areas, especially when interacting with unfamiliar assessors. Such stress may have influenced children's performance, particularly in the cognitive and language domains.

In contrast, socio-emotional development was evaluated based on parental reports collected through one-on-one interviews, often with the help of interpreters. These interviews were likely less stressful for parents compared to the children's individual assessment sessions, enabling parents to provide detailed information about their child's socio-emotional development based on daily observations. This approach seemed to work effectively even for parents with limited education or challenges in understanding the questionnaire. Future research should address these challenges by developing innovative, culturally sensitive, and stress-free assessment methods for children in remote and rural areas.

4.2. The potential mediators in the association between TPA participation and children's socio-emotional development

This study further investigated the potential mediating roles of parental care and parental investment (time investment and material investment) in the association between TPA participation and children's socio-emotional development. The findings revealed that parental care was the only significant mediator, partially explaining the relationship between TPA participation and children's socio-emotional development.

These results underscore the irreplaceable role of parental presence in creating an environment conducive to healthy emotional

development during early childhood (Bai et al., 2022; Khanam & Khan, 2023; Yue et al., 2020). Consistent with prior research, our findings suggest that TPA participation increased the proportion of households with parental care by providing local employment opportunities, which, in turn, reduced the likelihood of children being left behind (Zhan et al., 2020). Parental presence is fundamental for offering basic care, supervision, emotional support, and guidance, which are critical for young children. More importantly, the presence of a parent provides a sense of stability and security that is vital for fostering socio-emotional development during early years (Powell et al., 2013).

Interestingly, neither parental time nor material investment emerged as significant mediators in the association between TPA participation and children's socio-emotional development. This finding offers nuanced insights into applying the FIM (Becker et al., 2016) to support ECD. While our data indicated that parental time investment was significantly correlated with children's cognitive, language, motor, and socio-emotional development, which reinforces previous evidence on the importance of dyadic early learning activities for young children in low- and middle-income countries (Sun et al., 2016), time investment was not correlated with TPA participation in this study. This suggests that parents in remote and mountainous areas of China may rarely engage in early learning activities at home. These findings highlight the absence of parenting support elements within the TPA program, which may have limited its potential to support ECD.

Parental material investment, operationalized in this study as the purchase of toys and books for children, also presented interesting patterns. TPA participation was positively associated with the purchase of toys but negatively associated with the purchase of books. Furthermore, while the purchase of books (but not toys) was significantly correlated with children's language development, the purchase of toys was correlated with socio-emotional development.

According to the FIM (Becker et al., 2016), increased economic stability should enable parents to invest in resources such as books and toys, which serve as stimulating materials to support ECD. However, the observed patterns of material investment may reflect differing parental priorities or values regarding early learning materials. Households that did not participate in the TPA program may have higher educational aspirations due to their higher education levels and income, leading them to prioritize books for their educational value. Reading books is often associated with long-term developmental benefits for children (Ma et al., 2023). In contrast, TPA participants may place less emphasis on, or be less aware of, the long-term educational benefits of books. Instead, they may prioritize meeting children's immediate needs or preferences, viewing toys as more directly beneficial for children's happiness and emotional well-being.

As Del Boca et al. (2016) noted, the absence of effective guidance and monitoring mechanisms for resource allocation is a critical factor limiting the impact of poverty alleviation programs on ECD. This is consistent with the TPA program, which focused primarily on improving household nutrition, health, employment opportunities, and educational equity (Tang et al., 2022; Wang et al., 2022). Expanding the scope of such programs to include educational and developmental components, particularly those aimed at enhancing parenting knowledge and practices, could better equip participating families to leverage resources in ways that maximize developmental benefits for children. By incorporating parenting support and educational interventions, poverty alleviation programs like TPA could more effectively promote holistic ECD for children from low-income settings.

4.3. Limitations and future directions

To the best of our knowledge, this study is the first to examine whether participation in the TPA program is associated with ECD in remote and mountainous areas of China. The findings provide valuable evidence on whether and how participation in an SL-type TPA program is related to ECD, beyond its primary goal of poverty alleviation. However, the results should be interpreted with caution due to the following limitations.

Firstly, this study employed a cross-sectional design, which prevents the establishment of causal relationships between TPA participation and ECD outcomes. Future research should consider adopting longitudinal designs or randomized controlled trials to provide direct evidence on whether TPA participation leads to improved socio-emotional development and whether it contributes to children's cognitive, language, and motor development over time.

Secondly, the absence of baseline data on ECD prior to TPA participation limits our ability to assess developmental progress or changes attributable to the program. While follow-up longitudinal studies could observe developmental trajectories of children from different households, the lack of baseline data remains a constraint in evaluating the effectiveness of the TPA program on ECD outcomes.

Thirdly, the study's focus on low-income households in remote and mountainous areas in Southwest China limits the generalizability of the findings. Caution should be exercised when attempting to generalize these results to other settings, populations, or regions with different socio-economic, cultural, or environmental contexts.

Fourthly, due to the complexity and diversity in the provision of support for each participant household, this study was unable to gather data on the detailed support each household received or the duration of their participation. As a result, we could not compare the effectiveness of different intervention approaches or evaluate whether the dosage or duration of the intervention influenced outcomes.

Finally, this study only explored two potential mechanisms, i.e., parental care and parental investment, in explaining the association between TPA participation and ECD. Future studies should examine other critical mediators or mechanisms, such as parental mental health and access to community resources, as these are also potential outcomes of poverty alleviation programs and play an essential role in children's development. For instance, research indicates that alleviating economic difficulties improves parents' psychological well-being, which, in turn, fosters more supportive parenting practices and positively impacts ECD (Cucinella et al., 2022).

Despite these limitations, this study offers important insights into the complexities of assessing whether, and how, participation in the TPA program is associated with ECD in affected households. Our findings confirm the value of the TPA as an SL program and demonstrate that children's socio-emotional development is more readily enhanced by improvements in household economic security and adult well-being compared to other domains of ECD. More importantly, the availability of parental care plays a critical role in fostering children's socio-emotional development. These findings underscore the importance of integrating parenting-friendly strategies into poverty alleviation initiatives and considering the broader family ecology when designing such interventions. By doing so, the benefits of improved economic status can extend beyond financial stability to encompass the holistic development of children and the sustainable well-being of families.

CRediT authorship contribution statement

Li Huang: Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Conceptualization. **Jin Sun:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Formal analysis, Conceptualization. **Ling Li:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Li Cao:** Writing – review & editing.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ecresq.2025.08.007.

Data availability

The data that has been used is confidential.

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