The Influence of Family Structure on the Non-cognitive Ability of Rural Adolescents

Abstract:

Aims: This study explores the diverse impacts of family structure on rural Chinese adolescents' non-cognitive skills using longitudinal data from the China Education Panel Survey (CEPS).

Instrument & Methods: Leveraging two waves of the China Education Panel Survey (2013–2015) on 5,111 rural adolescents, we refine family structure typology into four categories—dual‐parent, mother-only, father-only, and non-parent (skip‐generation) households. Non-cognitive skills are quantified via culturally adapted Big-Five dimensions, with principal-component scores standardized on a 0–1 scale. Departing from resource-deterministic models, we incorporate psychosocial covariates—sibling interactions, intergenerational role modeling, and emotional reciprocity—and apply multilevel linear regressions, alongside subgroup analyses for only-child status and grandparental cohabitation, to disentangle structural and emotional pathways. Stata software was used to analyse data.

Findings: Compared with dual-parent households, mother-only, father-only, and non-parent (skip-generation) families show 1.99%, 2.15%, and 2.52% lower non-cognitive scores (p < 0.01), particularly in emotional stability and cooperation. Maternal care exerts stronger protection than paternal care, and grandparental co-residence only partially offsets maternal absence.

Conclusion: Dual-parent residency yields the highest non-cognitive outcomes. Parental absence—especially maternal—significantly undermines adolescents' emotional stability and cooperative skills. These findings point to the need for psychosocial interventions: bolster maternal caregiving support, provide targeted grandparent training, and integrate non-cognitive skill development into school and community programs.

Keywords: Family structure; Non-cognitive skills; Rural adolescents; Skip-generation parenting

Introduction

Social and policy background

Widespread and complex transformations are occurring in Chinese family structures. According to statistics, the divorce rate has increased by 36% over the past twenty years (from 1.91‰ in 2000 to 2.6‰ in 2022), which is driving China's number of single-parent families above 24 million; while rural populations are experiencing the unwanted consequences of urbanization — the displacement of sixty million children into grandparents' homes (1) — the practice is increasingly formalized as skip-generation parentification. Such configurations run counter to deteriorating scores on mental health measures: fourteen percent and forty percent adolescents display signs of depression and severe depression(2). Within the myriad of nuclear family configurations—remarried, grandparent-assisted, lone parents—the pertinent question remains: through which pathways do they reshape adolescents' resilience, cooperative capacities, and emotional wellbeing? The answer bears upon cultivating China's "population quality dividend", central to the country's developmental calculus.

We see these questions manifested within policy realms: the "Double Reduction" realigns pedagogic burdens toward the home; the Family Education Promotion Law institutes directives regarding adolescents' psychological welfare. Crucially, the 2023 Action Plan for Strengthening Student Mental Health released by seventeen ministries recognizes the aforementioned changes in family structure as potential mental health risk factors. But these policies remain crippled by conceptual conservatism. They rest upon fixed notions of what counts as a family unit, and consequently overlook structural multiplicity — in particular, single-parent dynamics, skip-generation dependency, nuclear or extended arrangements. This failure engenders serious gaps in evidence. For example, what psychosocial channels mediate those structural impacts? How might socioeconomic gradients and the rurality divide impact outcomes? Without such information, governance risks deploying broken pieces against systemic wholes. In parallel, academic scholarship also reflects similar deficiencies. Prevalent inquiry anchored to family capital theory reduces its influences to economic pipelines and repositories(3–5); in so doing, it occludes structure's self-will. A study tracking a sample of Chinese children growing up under rural extended family settings reveals that such relationships can partly compensate for cooperative skills deficiency—but only when elders receive adequate education(6–8). Consequently, two analytical limitations become apparent. First, measurement systems tend to depend on simplistic "intact/broken" classifications, failing to account for the differences between maternal and paternal absences and the intricate division of roles among siblings. Second, explanatory frameworks cling to overly straightforward linear "structure-resource-outcome" sequences, disregarding the emotional factors at play—such as adolescents' emotional reactions to conflict resolution, reciprocal learning processes, competition within sibling bonds, and the influence of role models in brother-sister interactions—as well as the inherent competitive interdependence in sibling pairs. Although official bodies focus on financial measures, delving into the emotional dimensions of family dynamics might offer more significant insights into these complexities.

Theoretical Framework for the Influence of Family Structure on Non-cognitive Abilities

Family structure, as a central context in adolescent socialization, has long been studied across education, sociology, and psychology for its impact on non-cognitive skills. Traditional research

grounded in family capital theory emphasizes economic capital (income, assets) and cultural capital (parental education, cultural practices) as primary drivers of youth development(9–12). Yet this framework struggles to explain paradoxical findings: adolescents from economically disadvantaged rural extended families often exhibit greater emotional stability than urban nuclear households(13), while adolescents in high-income single-parent families show lower cooperative tendencies than those in low-income intact families(14–16). Such evidence suggests structural influences operating independently of material resources. Family systems theory offers fresh insights by highlighting the structural effects of role allocation, intergenerational dynamics, and emotional support networks. For example, multi-generational households may strengthen cooperative skills through kinship bonds, but intergenerational parenting conflicts could hinder autonomy(17,18). Social capital theory further posits that family structure modulates non-cognitive skill development through network density (e.g., sibling count) and relational quality (e.g., parent-child communication frequency): only children might develop weaker resilience due to absent sibling rivalry, though intensive parental interaction could offset this deficit(19–21). Collectively, these theories outline a three-tiered "structure-interaction-competence" pathway, though empirical validation of specific mechanisms remains limited. Recent advancements in life course theory(22) have illuminated the dynamic effects of family structural changes — such as divorce or the birth of a second child — on non-cognitive skill development. Empirical studies reveal a marked decline in adolescents' emotional stability during the initial phase of parental divorce(23–25), though long-term adaptation may occur through new support systems formed during family reorganization(26,27). While these findings collectively outline a three-tiered "structure-interaction-ability" framework, critical gaps persist in empirically validating its underlying mechanisms.

Research progress and core controversy

Measurement of structural typology

Prevailing studies often employ simplistic "intact versus single-parent" classifications, overlooking structural heterogeneity. The absence of parents can manifest in various forms: fatherless households are associated with reduced perseverance(28), while families lacking maternal presence exhibit a stronger correlation with emotional instability(29). Similarly, studies on skip-generation caregiving frequently neglect the educational disparities among grandparents (30,31). Although grandparents with higher education levels may mitigate emotional detachment through intellectual engagement, those with lower educational backgrounds might inadvertently foster dependency by overprotecting their grandchildren.

Attribution of action path

The existing literature overstates the allocative mechanism, while underestimating emotional interaction dynamics. The economics of extended families could be offset by intergenerational tensions, and the dialogue frequency between nuclear families is good for logic but bad for decision-making independence because it causes frequent intervention(32,33). There are conflicting evidence regarding role modeling: some show that responsibility spillover through older sibling effect(34), others see less cooperation as they compete for resources(35).

Theoretical breakthrough in this study

Three critical limitations persist in existing research: First, binary static classifications ("intact vs. broken") fail to differentiate maternal/paternal absence effects or grandparent education levels in skip-generation care. Second, mechanistic explanations overrely on economic capital, neglecting

psychosocial pathways like emotional reciprocity and intergenerational modeling. Third, policy designs treat families as homogeneous units, lacking structural nuance. These gaps hinder explanations for paradoxical outcomes (e.g., rural extended families' emotional stability advantages) and impede evidence-based interventions.

This study addresses these gaps through theoretical synthesis and methodological innovation. First, we develop a multidimensional family structure typology using CEPS longitudinal data to distinguish guardianship types (dual/single-parent). Second, moving beyond resource determinism, we examine mechanisms in non-traditional structures like multi-child and skip-generation households. Third, we advocate shifting policy focus from economic compensation to capacity-building interventions, such as maternal custody support and grandparent caregiver training. By integrating CEPS multi-source data, refined parameter operationalization, and multilevel modeling, this framework systematically evaluates family structure's heterogeneous impacts and contextual boundaries.

Study Design

Data Source and Sample Processing

This study employs longitudinal data from the China Education Panel Survey (CEPS), incorporating both the 2013-2014 baseline and 2014-2015 follow-up waves. All data processing and statistical analyses were conducted using Stata/MP 17.0 (StataCorp LLC, College Station, TX). To ensure temporal consistency, we performed exact matching of participants across survey waves using Stata's -reclink- command with unique student identifiers (IDS), retaining only rural students present in both waves (n=5,111 after quality control).

The data integration process leveraged Stata's -merge- and -joinby- commands to combine four data sources: student self-reports (ID_stu), parent questionnaires (ID_par), homeroom teacher evaluations (ID_tch), and school administrative records (ID_sch). We implemented Stata's -mi- commands to evaluate missing data patterns, with Little's MCAR test (-mcartest- user-written command) confirming missing completely at random patterns (x^2 =18.34, p=0.12). Cases exceeding 30% missingness on core parameters (family structure, non-cognitive skills) were excluded using Stata's -drop- if- conditional statements.

For sample representativeness assessment, we employed Stata's -teffects- suite to calculate inverse probability weights, with all standardized mean differences (<0.10) verified using the -stddiff- package. The -svyset- command established appropriate survey weights for subsequent analyses. This comprehensive Stata-based workflow ensured rigorous data management and preparation for our analytical models.

Parameter Definition

Explained parameter: Non-cognitive Ability

Non-cognitive skills were operationalized via the Big Five personality model, a widely validated framework in Chinese adolescent research(36). The five dimensions—conscientiousness, extraversion, agreeableness, openness, and emotional stability—were measured as follows: First, principal component analysis (PCA) was applied to questionnaire items within each dimension. All constructs demonstrated adequate sampling adequacy (KMO >0.6) and significant Bartlett's tests (p<0.05). Second, PCA-derived factor scores were standardized to a 0–1 scale. Third, dimension scores were averaged, with higher values indicating stronger non-cognitive skills. See Appenndix for item mapping details.

Core Explanatory parameter: Family Structure Type

Family structure was measured using the 2013–2014 CEPS item: "Which immediate family members currently do NOT reside with the child?" Following established protocols(37,38), we implemented two operationalizations: (1) A binary parameter (0=dual-parent residency; 1=other, including single-parent or non-parent residency); (2) A four-category parameter: 1=dual-parent, 2=mother-only, 3=father-only, 4=non-parent residency (e.g., skip-generation care). Dual-parent households served as the reference group in all analyses.

Control parameter

Covariates were categorized as follows: Student: age, gender, singleton status; Parental: maternal/paternal education levels, parental relationship status; Household: economic status, educational expectations, log-transformed extracurricular expenditure; School: log-transformed per-student funding, college admission rate. Regions were included to control for geographic heterogeneity.

Findings

Reference Regression

Table 1 presented the multivariate regression results examining the association between family structures and rural adolescents' non-cognitive skills development. The analysis employed a linear regression model with robust standard errors, controlling for demographic and socioeconomic covariates. Key findings are summarized as follows:

Adolescents in non-parent-resident households exhibited significantly lower non-cognitive skills compared to their dual-parent counterparts (β =-0.025, SE=0.006, t=-4.36, p<0.01), representing a 2.5% reduction in standardized non-cognitive scores.Mother-only households showed a statistically significant negative association (β =-0.020, SE=0.006, t=-3.12, p=0.002), though the magnitude was marginally smaller than non-parent households.

The effect size for father-only households (β =-0.022, SE=0.010, t=-2.18, p=0.029) approached statistical significance but demonstrated wider confidence intervals, likely due to smaller sample size (n=193, 3.78% of total).

The regression model demonstrated satisfactory explanatory power, with an adjusted R^2 of 0.104 (R^2 =0.111), indicating that approximately 10.4% of the variance in non-cognitive skills was attributable to the specified predictors. The root mean square error (R=0.050) further confirmed model adequacy. The sample comprised 5,111 adolescents, with the majority (72.59%, n=3,710) residing in dual-parent households. Non-parent households constituted 14.03% (n=717), while mother-only and father-only arrangements represented 9.61% (n=491) and 3.78% (n=193) respectively.

The parental migration calculus embedded the rational calculus toward maximizing household welfare, resulting in situations where economic precarity leads families to prioritize current livelihood security over investment decisions, trading emotional stewardship for monetary stability. Alternatively, households emphasizing psychosocial capital might curtail migratory pathways in favor of sustaining involvement with schooling, which results in stratified access to kinship resources and subsequently manifests in measurable differences in adolescents' non-cognitive competencies across single versus two-parent structures.

When considering gendered caregiving architecture, cultural scripts codified mothers into chief nurturing authorities - architects of emotional scaffolding and behavioral regulation -- while fathers assumed fiscal provisioning roles. Rural paternal labor patterns, whether agrarian or non-agrarian, constrained childcare temporal investments through protracted labor practices. As such, the

asymmetrical distribution of developmental labor explained why non-cognitive penalties attached to maternal absence are greater than paternal absence. The empirical consensus corroborated this directionality, with adolescents in lone-parent/nonparent configurations demonstrating statistically lower competencies relative to those in dual parent-family formations.

Table 1. Regression findings

Dependent Parameter	Independent parameters	Frequency	B	SE	t	p-Value
Non-cognitive ability	parents live with their children	3710(72.59)	-0.023	0.005	-5.02	<0.01
	Only mother	491(9.61)	-0.020	0.006	-3.12	0.002
	Only father	193(3.78)	-0.022	0.010	-2.18	0.029
	Neither of parents	717(14.03)	-0.025	0.006	-4.36	<0.01
	Adjusted R2=0.104; R2=0.111; R=0.050					

Further Analysis

The Only Child or not

Regression analyses showed that family structure impacts non-cognitive skills differently for only children and those with siblings. For only children, non-cognitive outcomes remained stable with at least one parent present, but full parental absence leaded to a sharp decline (β =-0.0545, p<0.001), highlighting vulnerability. In contrast, non-only children faced deficits even with partial parental absence, with mother-only (β =-0.0245, p<0.001) and father-only (β =-0.0249, p<0.01) households showing negative effects. Surprisingly, full parental absence had a lesser impact on non-only children (β =-0.0185, p<0.001), likely due to sibling support. These findings suggested distinct risk profiles: only children suffered from social support gaps during full parental absence, while non-only children were more dependent on daily familial interaction. Policy should focus on community support for only children in migrant families and strengthen caregiving for siblings with absent parents.

Table 2. Heterogeneity Analysis（If the only child）

Parameter	Non-cognitive ability			
	The only child(1409)		Non-only child(3702)	
	B	p-Value	B	p-Value
Whether parents live with their children	-0.023	0.024	-0.021	<0.01
Only mother	-0.003	0.856	-0.025	<0.01
Only father	-0.014	0.433	-0.0249	0.043
Neither of parents	-0.055	<0.01	-0.0185	0.003

Whether Grandparents Live Together

Regression results revealed that grandparents critically moderate the effects of family structure. In

binary models, parental absence had a stronger negative impact on non-cognitive abilities when grandparents co-reside (β=-0.0205, p<0.001) compared to when they do not (β=-0.0157, p<0.001), suggesting that grandparental care may exacerbate, rather than mitigate, developmental risks in parent-absent households.

In mother-only households, grandparental co-residence partially offset negative effects: maternal care without grandparents correlated with modest skill deficits (β=-0.0133, p<0.1), while co-residence further reduces effect size and significance (β=-0.0117, ns). In father-only households, grandparental support was even more critical; paternal care alone resulted in non-significant deficits (β=-0.0166, ns), but cohabitation with grandparents almost nullified negative effects (β=-0.0016, ns).

By contrast, non-parent households with grandparental care showed the most pronounced deficits (β=-0.0269, p<0.001 vs. β=-0.0189, p<0.01), highlighting grandparents' limited ability to fully substitute for parental roles, likely due to generational gaps in parenting styles and constrained caregiving capacity.

In sum, grandparental support could partially buffer the loss of maternal care but is less effective when the father is absent, and largely insufficient when both parents are away. These findings suggested that in rural areas, single-mother households supported by grandparents may better sustain adolescents' non-cognitive development, whereas single-father and non-parent households require additional social support and targeted interventions.

Table 3. Heterogeneity Analysis (If live with grandparents)

| Parameter | Non-cognitive ability | | | |
| | Grandparents at home(3371) | | Non-grandparent at home(1708) | |
	B	p-Value	B	p-Value
Whether parents live with their children	-0.016	<0.01	-0.0205	<0.01
Only mother	-0.013	0.053	-0.012	0.311
Only father	-0.017	0.155	-0.002	0.917
Neither of parents	-0.019	0.026	-0.0269	<0.01

Discussion

This study systematically reveals the heterogeneous impacts of family structures on rural adolescents' non-cognitive skills and the mechanisms defining their developmental boundaries. Beyond reaffirming family structure's central role, it advances theoretical understanding by deconstructing pathways of non-cognitive ability formation.

Consistent with Cui and Xu's study(40), we find that adolescents in intact dual-parent families fare best in non-cognitive domains, whereas parental absence undermines emotional stability and cooperation more severely.. Crucially, intra-structural heterogeneity emerges: family structure operates through the interaction of guardianship roles, emotional reciprocity, and cultural capital. Maternal absence inflicts greater setbacks than paternal absence reflecting gendered caregiving dynamics rooted in rural "motherhood scripts" (41). Fathers prioritize economic provision and

behavioral control, while grandparents rely on outdated educational norms emphasizing obedience, often creating emotional rifts in non-cognitive development, particularly in emotional stability and cooperation(41–44). These findings challenge family capital theory's economic determinism, suggesting emotional capital may yield greater marginal returns than material resources.

Family structure's impact must be contextualized within life-course dynamics. The duration, cause (e.g., divorce, labor migration, death), and timing of parental absence jointly shape non-cognitive trajectories. Labor migration-induced absence initially triggers acute separation anxiety (<6 months), but after 24 months, some adolescents adapt through alternative support networks such as peer bonds and teacher mentorship(45,46). This nonlinearity introduces the concept of resilience thresholds—points beyond which external support mitigates structural deficits—challenging linear "absence-duration = harm" assumptions(47). Although divergent maternal and paternal roles are clarified, their interplay across dynamic processes warrants longitudinal exploration.

Although some studies(48) observe academic benefits from grandparent co-residence, our results indicate that, in rural contexts, elders' lower educational attainment and traditional norms may intensify non-cognitive deficits under parental absence, which align with Xu's study(49). This difference may stem from China's unique national conditions. Physical and cognitive limitations could also hinder grandparental supervision of adolescents' out-of-school activities, such as internet use and peer interaction, thus impeding self-regulation. Effective intergenerational support requires strengthening caregiver competencies rather than assuming co-residence itself ensures quality caregiving.

Finally, sibling interdependencies expose notable subcohort divergences. Consistent with broader evidence of sibling effects, a study of rural children in northwest China demonstrates two countervailing mechanisms—"interaction‐engagement" versus "resource dilution"—at work as sibling count changes(50). When only one sibling is present, enhanced communication and emotional support ("interaction--engagement") confer measurable advantages in psychological well‐being and academic performance compared to only-children; however, once families have two or more siblings, competition for parental attention and material resources ("resource dilution") leads to significant declines in both domains. Integrating these dynamics into our findings, we see that in multi-child households under migration pressures, elder-sibling caregiving can indeed foster early cooperative skills and emotional maturity (the "interaction--engagement" effect), but this benefit is counterbalanced by increased role strain and scarce resources when sibling numbers exceed one. This nuanced view cautions against assuming uniformly protective effects of sibling social capital, underscoring that both the quality of interaction and the quantity of siblings jointly shape non-cognitive outcomes.

Recommendation

The study's limitations offer important directions for future research. First, the CEPS data lack granularity in measuring family structure heterogeneity, failing to distinguish causes of parental absence or capture dynamic changes. Future studies could integrate in-depth interviews to develop multidimensional structural indices. Second, while this study centers on rural populations, urban family structures—such as highly educated single-parent or DINK families—may operate differently, warranting comparative research. Moreover, the measurement of non-cognitive skills needs greater cultural specificity: reliance on the Big Five model risks overlooking traits like "familial responsibility" and "collectivist ethics." Future scales should integrate Confucian cultural elements. Finally, the two-

wave CEPS limits long-term analysis; linking it with CFPS could track the persistence of non-cognitive skills into adulthood.

From a policy perspective, this study suggests moving from "structural fixes" to "systemic optimization." Priorities include enhancing maternal caregiving participation through tax incentives, flexible local jobs, and remote interaction hubs in schools. Legal standards for custody decisions should also better support maternal guardianship. To strengthen intergenerational support, township schools could train grandparents in emotion regulation and parenting, while communities establish after-school programs led by retired teachers or social workers. Finally, educational reforms should embed non-cognitive skill development—such as teamwork in vocational training, resilience activities in physical education, and comprehensive assessments of emotional regulation and accountability.

Appendix

Table 4. Measurement of Non-cognitive Ability parameters

Big Five Personality	CEPS correspondence question	parameter assignment
Affinity	Most of my classmates are friendly to me.	Strongly disagree =1, strongly disagree =2, strongly agree =3, strongly agree =4
	I often take part in the activities organized by my school or class.	Strongly disagree =1, strongly disagree =2, strongly agree =3, strongly agree =4
	I feel close to the people at this school.	Strongly disagree =1, strongly disagree =2, strongly agree =3, strongly agree =4
Conscientiousness	I would go to school even if I wasn't feeling well.	Strongly disagree =1, strongly disagree =2, strongly agree =3, strongly agree =4
	Even if I don't like the job, I will try my best to do it.	Strongly disagree =1, strongly disagree =2, strongly agree =3, strongly agree =4
	Even if the homework takes a long time, I will finish it as soon as possible.	Strongly disagree =1, strongly disagree =2, strongly agree =3, strongly agree =4
Emotional stability	Have you felt depressed in the past seven days?	Always =1, often =2, sometimes =3, rarely =4, never =5
	Have you felt unhappy in the past seven days?	Always =1, often =2, sometimes =3, rarely =4, never =5
	Have you felt that your life has not been interesting in the past seven days?	Always =1, often =2, sometimes =3, rarely =4, never =5
	Have you felt sad or sad in the past seven days?	Always =1, often =2, sometimes =3, rarely =4, never =5
Independence	Ask parents if the child can express their opinions clearly.	Very inconsistent =1, not very consistent =2, more consistent =3, very consistent =4
	Ask the parents if the child's responsiveness is very quick.	Very inconsistent =1, not very consistent =2, more consistent =3, very consistent =4

Extraversion	Ask parents if the child can learn new things quickly.	Very inconsistent =1, not very consistent =2, more consistent =3, very consistent =4
	Ask parents if the child is curious about new things.	Very inconsistent =1, not very consistent =2, more consistent =3, very consistent =4
	I am very shy.	Strongly agree =1, strongly agree =2, strongly disagree =3, strongly disagree =4
	I often sit alone rather than with others.	Strongly agree =1, strongly agree =2, strongly disagree =3, strongly disagree =4
	When I'm with my classmates or peers, I don't talk much. I listen to them most of the time	Strongly agree =1, strongly agree =2, strongly disagree =3, strongly disagree =4

Table 5. Descriptive Statistics

parameter	N	Mean	p50	SD	Min	Max
non-cognitive abilities	5111	0.689	0.691	0.134	0.147	1
Whether parents live at home (dichotomy)	5111	0.274	0	0.446	0	1
Whether parents live at home (quartering)	5111	1.592	1	1.077	1	4
Parental marital status	5111	0.925	1	0.263	0	1
the only child or not	5111	1.724	2	0.447	1	2
Parental investment in education	5111	1.369	0	2.849	0	11.51
Parental educational expectation	5111	6.723	7	1.645	1	9
Paternal education	5111	3.473	3	1.461	1	9
Maternal education	5111	3.188	3	1.429	1	9
Family economic status	5111	2.816	3	0.623	1	5
Gender	5111	0.529	1	0.499	0	1
School enrollment rate	5111	0.142	0	0.349	0	1