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Parental beliefs and mediation co-mediate the SES effect on chinese preschoolers' early digital literacy: A chain-mediation model

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Abstract
Digital technologies are increasingly integrated into the daily lives of young children. However, disparities in access and use quality, known as the 'digital divide,' persist. Parents play a crucial role in narrowing this divide during early childhood, but the underlying mechanisms remain inconclusive. This study investigates how family socioeconomic status (SES) influences Chinese preschoolers' digital literacy and how parental beliefs and parental mediation mediate this relationship. A sample of 2272 parents of young children from central China completed the *Home Digital Practices Survey* (HDPS). The PROCESS results revealed the following: (1) Family SES, parental beliefs, and parental mediation significantly predicted preschoolers' digital literacy; (2) Parental beliefs and parental mediation co-mediated the impact of family SES on digital literacy; (3) Positive parental beliefs and mediation strategies were associated with better digital literacy outcomes for preschoolers. The findings have implications for parental education and highlight the importance of considering family context in promoting digital literacy among young children.

Keywords Digital divide · Digital literacy · SES effect · Parent · Preschooler

The term 'digital divide' was coined by American newspapers when reporting the findings published by the *National Telecommunications and Information Administration* (NTIA, 1995). Since the turn of this millennium, social workers and scholars have widely adopted and firmly established this concept, referring to the "division between people who have access and use of digital media and those who

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do not" (van Dijk, 2020, p.1). The nature of this 'digital divide' lies in the inequality in access and skills between those with and without digital access and use, which are often described using the term 'literacy' (van Dijk & van Deursen, 2014; van Dijk, 2020). Unlike traditional literacy related to reading and writing, digital literacy is considered an essential concept in the context of digital technologies (Kumpulainen et al., 2020; van Dijk, 2020).

A recent systematic review of 50 digital divide studies published during 2017–2021 identified nine categories of influential factors: infrastructure, technology types, personal elements, rights, sociodemographic, socioeconomic status (SES), digital training, social support, and large-scale events (Lythreatis et al., 2022). This finding highlights that SES contributes to the digital divide, specifically affecting the inequality of digital literacy between those with and without digital access and use. Additionally, a recent study examining Finnish children's home digital literacy practices found that parental rules and values play a role in shaping digital literacy (Kumpulainen et al., 2020). However, empirical studies exploring how Chinese parents influence their children's digital literacy remain scarce. To address this research gap, this study examined the mechanism through which SES impacts Chinese preschoolers' digital literacy using a large sample size.

1 Socioeconomic status and children's digital literacy

Digital literacy (DL) is a complex concept that has changed over time (Feerrar, 2019). According to UNICEF (2019, p.31), this concept refers to "the set of knowledge, skills, attitudes, and values that enable children to confidently and autonomously play, learn, socialize, prepare for work, and participate in civic action in digital environments". Digital literacy is an umbrella term that includes knowledge, skills, attitudes, and values needed to use various digital devices for learning, communication, entertainment, and creation. DL is a 21st-century skill (Binkley et al., 2012) and a vital competence for children's academic and future development in this 'digital era' (Dong et al., 2021; Siddiq et al., 2016). Therefore, in the last decade, many international institutions and nations have produced important reports, policy documents, and frameworks about digital literacy (e.g., Carretero et al., 2017; OECD, 2018; UIS, 2018; UNICEF, 2019). Meanwhile, many studies have examined the predictive factors of children's DL (e.g., Fraillon et al., 2014) and how DL impacts children's development, such as academic performance and well-being (Cox & Marshall, 2007; OECD, 2015). However, more attention has been paid to school-aged children because they are 'researchable' (Behnamnia et al., 2020), with less attention being paid to preschoolers' DL (Kumpulainen et al., 2020; Livingstone, 2016; Livingstone et al., 2017).

Many influential factors might contribute to young children's digital literacy development, such as the child's age (Dong et al., 2021; Liang et al., 2021; Marsh, 2016), family structure (Cingel & Krcmar, 2013; Gou & Dezuanni, 2018; Nikken & de Haan, 2015), and socioeconomic status (SES), (e.g., Hatlevik et al., 2015; Kumpulainen et al., 2020; Liang et al., 2021; Sin, 2015). Among these contributors, family socioeconomic status has been explored extensively (Nikken & Opree,

2018). Generally, SES is measured by three metrics: family income, parents' highest educational level, and most elevated occupational status (Villalba, 2014), corresponding with the economic, cultural, and social capital in Bourdieu's social-cultural capital theory (Bourdieu, 1984). Some scholars have found a positive relationship between SES and digital literacy (Aesaert & van Braak, 2015; Lazonder et al., 2019; Liang et al., 2021; Siddiq et al., 2017; Zhong, 2011). For example, Liang et al. (2021) investigated the digital literacy of 642 Grade 3 children in Hong Kong. They found that children with lower SES scores were less likely to develop digital competencies than their counterparts with higher SES scores. However, others claimed that there was inadequate evidence to support that lower SES contributes to less digital literacy (Tondeur et al., 2011; van Braak & Kavadias, 2005). For example, Tondeur et al. (2011, p. 161) investigated 1241 school children's digital competencies in Flanders. They found that differences in digital competencies are "not sufficiently marked to deduce that low SES contributes to fewer ICT competencies". An important reason for the inconsistent result is the mechanism or pathway through which SES impacts children's digital literacy. Although many studies have examined the direct effect of family SES on children's digital literacy (e.g., Dong et al., 2021; Lazonder et al., 2019; Liang et al., 2021), few studies have investigated the indirect effects, leaving those possible moderators and mediators unexplored. This neglect has made the underlying mechanism of this SES effect still uncertain. Therefore, this study aims to address this research gap with a large sample of Chinese preschoolers by testing the following hypothesis:

H1. Socioeconomic Status (SES) is significantly associated with preschoolers' digital literacy (DL).

2 Parental beliefs in the relationship between ses and children's digital literacy

Previous studies have revealed that parental beliefs (PB) significantly predicted young children's digital literacy (Dong et al., 2021; Griffith, 2023; Lauricella et al., 2015). Due to the lasting debate over digital use in early childhood, parents hold different views on young children's digital use at home. Parents with positive views tend to believe that early digital use and literacy are essential for child development, such as enhancing future opportunities and academic development (Ofcom, 2017; Smahelova et al., 2017), and they are comfortable with and even encourage young children to use various digital devices at home. As a result, their children have more opportunities to actively use a range of digital devices for play and learning and, in turn, grow up as 'digital natives' (Prensky, 2001) rather than passive digital users. Consequently, more and more young children actively engage in multimodal practices using digital technologies for play and learning in their homes rather than passive technology users (Ozturk & Ohi, 2019).

In contrast, some parents hold negative views of young children's digital use at home. They have concerns about the potential risks of early digital use on children's health and well-being (Cao et al., 2021; Dong et al., 2020; Jiang & Monk, 2015).

Therefore, they tend to employ various approaches, such as technical/interaction restrictions and monitoring (Livingstone & Helsper, 2008), to regulate or manage children's multimodal digital use at home (Livingstone & Helsper, 2008). Accordingly, their children's opportunities to use digital technologies are limited. A large-scale survey confirmed that parents' attitudes significantly predicted children's TV, computer, and tablet usage (Lauricella et al., 2015).

Moreover, SES is an antecedent factor of parental beliefs. Nikken and Opree (2018) have investigated 1029 parents of children (between 1 and 9 years old) and suggest SES may influence how parents value the role of digital technology for themselves and their children. For example, lower-income families prefer watching television together over screens individually (Clark, 2012). In contrast, higher-income parents may highly value adopting the latest high-tech digital media at home and offering children more opportunities to develop digital literacy (Nikken & Opree, 2018). Thus, parental beliefs may mediate between family SES and children's digital literacy. Accordingly, we hypothesized that:

H2. Parental Beliefs (PB) mediate the relationship between family SES and preschoolers' DL.

3 Parental mediation in the relationship between SES and children's digital literacy

Parental mediation (PM) refers to a set of strategies that parents employ to regulate their children's digital use, aiming to maximize the advantages and minimize the disadvantages of today's media-rich environment (Livingstone & Helsper, 2008). Livingstone and Helsper (2008) have identified four main types of parental mediation of children's internet use: (1) active co-use, parents discussing the internet content or online activities with children and conjoint their online activity; (2) restrictive mediation, parents implementing social rules to ban or restrict children's digital activities; (3) technical restrictions, parents filtering or blocking specific software (e.g., email, adverts) to regulate children's internet activities; and (4) monitoring, parents checking-up or monitoring the child's online activity after children's internet use. Furthermore, by investigating 792 Dutch parents of children between 2 and 12 years, Nikken and Jansz (2014) found two new parental mediation strategies in children's internet use: 'supervision' and 'technical safety guidance.' In a qualitative analysis of 2491 Chinese parents' narratives of their views on young children's digital use, Cao et al. (2022) confirmed four types of parental mediation in the Chinese context: active mediation, supervision, co-use or co-view, and restrictive mediation. Cao and Li (2023) have recently proposed new parental mediation strategies in a digital well-being model of young children: set rules, design, and support.

Parental mediation significantly predicted young children's digital literacy (Dong et al., 2021). Nikken and Schols (2015) found that young children's digital skills and digital activities strongly correlated with parental mediation styles. Similarly, based on the in-depth analysis of two young children's (2 years old) daily digital use at home, Kumpulainen et al. (2020) suggested that interaction

with adults meaningfully would foster young children's positive digital use. Kumpulainen and Gillen (2017) reviewed 33 studies published from 2005 to 2015. They found that the opportunities for young children to use and learn from digital technologies varied depending on how parents would frame digital use and family interactions with digital technologies. Thus, parental mediation is vital in shaping young children's digital literacy (Dong et al., 2021).

Moreover, SES is an antecedent factor of parental mediation, as parents with higher income and higher qualifications employ more mediation strategies (Livingstone et al., 2015; Gou & Dezuanni, 2018) and adopt more advanced technologies to structure children's digital environment (Nikken & Schols, 2015). In contrast, parents with a lower SES were found to need more skills and experience more difficulty scaffolding their children's media use (Kumpulainen and Gillen, 2017). They preferred restrictive mediation strategies (Livingstone et al., 2015). Thus, parental mediation may mediate between family SES and children's digital literacy. Accordingly, we hypothesized that:

H3. Parental mediation (PM) mediates the relationship between family SES and preschoolers' DL.

4 The co-mediation effect of parental beliefs and parental mediation

Previous studies have confirmed a significant correlation between PB and PM (Dong et al., 2021); parents with more positive perspectives about the pedagogical use of digital technology tend to encourage children to use and perceive digital devices as essential tools for learning. In contrast, parents with less positive views of digital media do not promote their children's digital use, not even for pedagogical purposes, frequently restricting digital use time. Therefore, their children use the devices for a limited time and primarily for leisure activities (Brito et al., 2017).

According to sociocultural theories (Vygotsky, 1978), child development, including digital literacy and the accompanying learning opportunities, is mediated by many factors, such as specific rules, objectives, and family structures (Kumpulainen et al., 2020). Thus, family SES may influence young children's digital literacy through various factors, such as parental beliefs and mediation. Previous studies have proven that parental beliefs and mediation are essential mediators between SES and several child development outcomes, such as young children's school readiness (Lohndorf et al., 2021), teenagers' life satisfaction (Liu et al., 2022) and sociality (Ho et al., 2021). Accordingly, we hypothesized that SES, DL, PB, and PM may present a chain modal relationship; that is, SES impacts DL through PB and PM. Therefore, we hypothesized:

H4. Parental Beliefs (PB) and Parental Mediation (PM) co-mediate the relationship between family SES and preschoolers' digital literacy (DL) (Fig. 1).

5 The context of this study

We examined the hypothesized model (see Fig. 1) with Chinese preschoolers because China has the most significant number of digital children. According to a recent report by *China Internet Network Information Center* (CNNIC, 2023), the internet penetration rate has reached 75.6%. Therefore, young children in China nowadays have plenty of opportunities to be exposed to digital devices in early childhood. For instance, in a central Chinese city, about 84% of surveyed families with young children owned more than three smartphones; 70.4% of these families owned more than two computers (Dong et al., 2021); and 92.8% of young children in central China have experienced online learning during Covid-19 pandemic (Dong et al., 2020).

There are three levels of the 'digital divide': (1) the 'access divide': the digital inequalities in whether have or no access to the internet; (2) the 'literacy divide': unequal opportunities for the promotion of digital skills; and (3) the 'outcome divide': whether or not individuals could use digital technologies to gain benefit outcomes (Livingstone et al., 2021). China has universalized digital access countrywide (CNNIC, 2023; Dong et al., 2021), indicating a weak 'access divide.' However, a recent study has found that Chinese children's digital literacy was predicted by family income (Dong et al., 2021), indicating the potential existence of a 'literacy divide.' This level of 'digital divide' may correlate with wealth stratification, developmental opportunities, and quality of life (Bartikowski et al., 2017). Thus, it is critical and meaningful to understand its mechanism and to provide empirical evidence for policymaking and early intervention. Accordingly, this study endeavored to understand how parental beliefs and mediation mediate SES effect on Chinese preschoolers' digital literacy. In particular, we examined the following hypotheses to verify the theoretical model presented in Fig. 1.

H1. Socioeconomic Status (SES) is significantly associated with preschoolers' digital literacy (DL).
H2. Parental Beliefs (PB) mediate the relationship between family SES and preschoolers' DL.

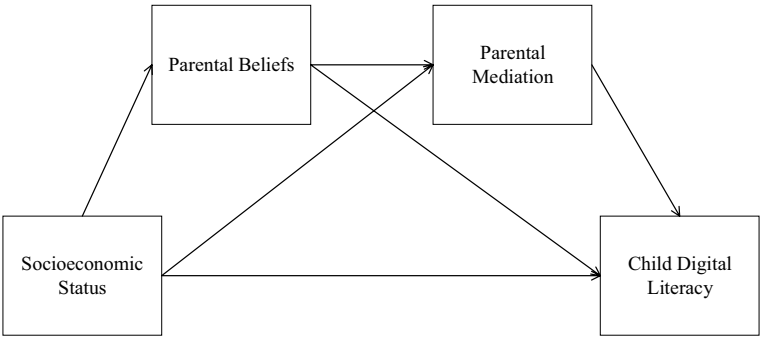

Fig. 1 The Hypothesized Mediation Model

H3. Parental mediation (PM) mediates the relationship between family SES and preschoolers' DL.
H4. Parental Beliefs (PB) and Parental Mediation (PM) co-mediate the relationship between family SES and preschoolers' digital literacy (DL) (Fig. 1).

6 Method

6.1 Sample

This study analyzed the data from a large-scale research project that surveyed 2272 parents of preschoolers with the *Home Digital Practice Survey (HDPS)* to understand their home digital practice in central China (Dong et al., 2021). This study focused on the three subscales of HDPS, comprising 1876 samples with preschoolers aged 3 to 6 years old. Among the selected samples, most respondents were mothers (79.6%), and few were fathers (18.5%). Most of the participants (65.7%) were aged between 26–35 years, few of them were aged between 36–45 years (29.2%), and very few of them were more than 46 years (2.3%) or under 25 years (2.8%). There were slightly more boys (51.2%) than girls (48.8%); each child-age group had more than 200 samples. 46% of the participants were in urban areas, and 54% were in rural areas (35.2% in counties and 18.9 in villages) (Table 1).

6.2 Measures

This is a parent-report survey containing a demographic battery and six sub-scales. The demographic battery has 12 items: family members, child age, parent's educational level and occupation, and family income. Its six sub-scales include (1) home digital resource (HDR); (2) multimodal digital practice of young children; (3) children's digital literacy (DL); (4) parental digital co-use; (5) parental beliefs of children's digital use (PB); and (6) parental mediation in children's digital usage (PM). All six subscales reported high reliability, with Cronbach's α between .781 and .918 (Dong et al., 2021).

Socioeconomic status (SES) In this study, measures used to characterize SES included annual household income (HI), parents' highest level of education (PE), and parents' highest (social) level of occupation (PO). These variables were measured in the demographic battery of the parental questionnaire. The assessment of HI had eleven different response options, and the responses were coded into 1-11 levels to reflect the economic status of the participant (1= below 30 thousand RMB per year, 2 = 30-50 thousand RMB per year…, and 11 = beyond 500 thousand RMB per year). The original assessment of PE had six response options corresponding to six educational qualification levels (1 = Primary or below, 2 = Junior Secondary, 3 = High School, 4 = College/Associate Degree, 5 = Bachelor degree, and 6 = Postgraduate degree). Both parents' educational levels were asked to report in the questionnaire, and the highest value was used. The assessment of PO had 10 response options according to the classification of Chinese social and occupational levels

Table 1 Demographic Information

Variables	Groups	N(%)
Age of respondent	20-25 years	52(2.8)
	26-30 years	496(26.4)
	31-35 years	737(39.3)
	36-40 years	351(18.7)
	41-45 years	197(10.5)
	46-50 years	24(1.3)
	50-	19(1)
Role of respondent	Father	347(18.5)
	Mother	1493(79.6)
	Other	36(1.9)
Age of child	3 years	478(25.5)
	4 years	636(33.9)
	5 years	527(28.1)
	6 years	235(12.5)
Gender of child	Boy	960(51.2)
	Girl	916(48.8)
Number of Children in the family	One child	533(28.4)
	Two children	1174(62.6)
	Three children	149(7.9)
	Four children or more	20(1.1)
Number of adults in the family	1	51(2.7)
	2	656(35)
	3	350(18.7)
	4	668(35.6)
	5 or more	151(8)
Location	Urban area	862(45.9)
	Countries	660(35.2)
	Villages and towns	354(18.9)
Father education level	Primary or below	17(0.9)
	Junior Secondary	333(17.8)
	High School	480(25.6)
	College/Associate Degree	516(27.5)
	Bachelor degree	488(26)
	Postgraduate degree	37(2)
Mother education level	Primary or below	19(1)
	Junior Secondary	348(18.6)
	High School	482(25.7)
	College/Associate Degree	465(24.8)
	Bachelor degree	534(28.5)
	Postgraduate degree	27(1.4)

Table 1 (continued)

Variables	Groups	N(%)
Father occupation	Unemployed	193(10.3)
	Famer	129(6.9)
	Worker	58(3.1)
	Business Service	382(20.4)
	Personally owned business	154(8.2)
	Public service	352(18.8)
	Professionals	205(10.9)
	Managers	131(7)
	Private enterprise	176(9.4)
	Officials	96(5.1)
Mother Occupation	Unemployed	122(6.5)
	Famer	74(3.9)
	Worker	16(0.9)
	Business Service	400(21.3)
	Personally owned business	146(7.8)
	Public service	265(14.1)
	Professionals	271(14.4)
	Managers	102(5.4)
	Private enterprise	115(6.1)
	Officials	365(19.5)
Family annual income	Under ¥30,000	327(17.4)
	¥30,000-¥59,000	514(27.4)
	¥60,000-¥89,000	444(23.7)
	¥90,000-¥119,000	283(15.1)
	¥120,000-¥159,000	150(8)
	¥160,000-¥209,000	85(4.5)
	¥210,000-¥259,000	28(1.5)
	¥260,000-¥309,000	24(1.3)
	¥310,000-¥399,000	8(0.4)
	¥400,000-¥499,000	5(0.3)
	¥500,000 or more	8(0.4)

(Lu, 2010). These options were coded into 1-10 levels to reflect the social status of participants: 1 = Unemployed, 2 = Farmer, 3 = Worker, 4 = Business Service, 5 = Personal owned business, 6 = Public service, 7 = Professionals, 8 = Managers, 9 = Private enterprise, 10 = Officials. The composite SES score was calculated by summing up HI, PE, and PO; hence, SES in this study is a continuous variable with a score range between 3 and 27.

Preschoolers' Digital Literacy (DL) Preschoolers' digital literacy was assessed by the third subscale of *HDPS*, comprising four constructs and 19 items. The participants were asked to rate their children's digital literacy level using TV, PC, touch screen, and AI on a five-point Likert scale. Their options were scored from 1 to 5 to reflect children's digital literacy in multimodal digital use (1 = incapable, 2 = need help, 3 = not sure, 4 = independent, 5 = skillful). The final DL was calculated by averaging the scores of each item; hence, the score of DL ranged from 1 to 5.

Parental Beliefs (PB) The parental beliefs were assessed by the fifth sub-scale of *HDPS,* including eight items measuring parental beliefs on young children's digital use at home. Among the eight items, six are positive statements (items 1-5 and item 7), such as "digital devices are suitable for young children to use"; and two are negative ones (items 6 and 8), such as "the use of digital devices is harmful to the health of young children." All six positive statements were scored on a six-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = tend to disagree, 4 = tend to agree, 5 = agree, and 6 = strongly agree), a higher score means a more positive view of young children's digital use. In contrast, the two negative statements were scored from 1 to 6 in reverse (1 = strongly agree, 2 = agree, 3 = tend to agree, 4 = tend to disagree, 5 = disagree, and 6 = strongly disagree), and a higher score means a more positive view. The mean scores of the eight items were calculated as the PB composite score, ranging from 1 to 6.

Parental Mediation (PM) Parental mediation was assessed by the sixth sub-scale of *HDPS*, comprising eight items that measure parental mediation practices in young children's digital use at home on a six-point Likert scale. These items were constructed based on previous studies and represented four types of parental mediation: restrictive mediation (items 1 and 8), active mediation (items 2, 3, 4, and 5), co-use (item 6), and supervision (item 7) (Livingstone & Helsper, 2008; Nikken & Janz, 2014; Smahelova et al., 2017). Participants' options were scored from 1 to 6, corresponding to the rank from never to always (1 = never, 2 = rarely, 3 = less, 4 = sometimes, 5 = often, 6 = always) to reflect parents' mediating frequency in young children's digital use. The mean scores of the eight items were calculated as the PM composite score, ranging from 1 to 6.

6.3 Statistical analyses

Statistical analyses were conducted by SPSS 24.0. Three steps of statistical analysis were employed in this study. First, descriptive and correlation analyses were conducted to explore the relationship between SES, DL, PB, and PM. Second, chain-mediation analysis was performed by PROCESS 4.1 in SPSS (model 6) to assess the mediation role of PB and PM in the relationship between SES and preschoolers' digital literacy. Third, correlation analysis was conducted between DL and each PB and PM item, to further explore which PB and PM might affect preschoolers' digital literacy more.

7 Result

7.1 Common method bias

Considering all measures in this study were parent-reported scales, we tested the common method bias by Harman's single-factor method. The result reveals that the eigenvalues of seven common factors were greater than one. The first of these factors has explained 28.39% (less than 40%) of the variance, indicating no significant common method bias existed in this study.

7.2 Descriptive analysis and correlation analysis

The mean and standard deviation of family socioeconomic status (SES), preschoolers' digital literacy (DL), parental beliefs (PB), and parental mediation (PM) were shown in Table 2. First, the mean of SES is 13.54, with a standard deviation of 2.70. The skewness and Kurtosis are .160 and .811, respectively, within the acceptable ranges (Kline, 2011). Second, preschoolers in this study have a relatively low level of digital literacy (mean = 2.22, SD = 0.78); most preschoolers (83.0%) scored 3 or below (score range from 1 to 5), which means the majority of children's in this study need adults' help to operate digital devices. Third, the mean score of PB indicates parents' slightly negative position on young children's digital use (mean = 3.23, SD = 0.78), 57.7% of participants hold a relatively negative view on young children's digital use (mean score below the median value 3.5), and 36.8 % of parents have fairly positive beliefs on young children's digital use (mean score beyond the median value 3.5). Last, the mean score of PM indicates a relatively high level of parental mediation (mean = 4.22, SD = 1.10); 78.3% of participants in this study scored beyond the median value of 3.5 in PM.

In addition, correlation analyses indicate a significant correlation between digital literacy (DL) and family SES ($r = .117$, $p < .01$), parental beliefs (PB) ($r = .270$, $p < .01$), and parental mediation (PM) ($r = .270$, $p < .01$). Meanwhile, family SES significantly correlated with PB ($r = .050$, $p < .05$) and PM ($r = .094$, $p < .01$). In addition, parental beliefs and parental mediation were significantly correlated with each other ($r = .314$, $p < .01$) (Table 2).

Table 2 Means and Standard Deviations of SES, DL, PB, and PM and Correlations between them

	Mean	*SD*	SES	DL	PB	PM
SES	13.54	2.70				
DL	2.22	0.78	.117**			
PB	3.23	0.78	.050*	.270**		
PM	4.22	1.10	.094**	.270**	.314**	

***p < .01, *p < .05.* SES is family socioeconomic status, DL is preschoolers' digital literacy, PB is parental beliefs toward preschoolers' digital use, and PM is parental mediation in preschoolers' digital use.

Table 3 Standardized Total, Direct and Indirect Effects, and 95% Confidence Intervals

Pathway	Estimate	*SE*	Ratio	95% Confidence Interval	
				Lower	Upper
SES->PB->DL	0.099	0.038	15.33%	0.028	0.173
SES->PM->DL	0.046	0.018	7.12%	0.015	0.084
SES->PB->PM->DL	0.021	0.009	3.25%	0.006	0.040
Total indirect effect	0.167	0.049	25.85%	0.071	0.263
Direct effect	0.479	0.118	74.15%	0.247	0.712
Total effect	0.646	0.126	100%	0.398	0.894

PB = parental beliefs toward preschoolers' digital use; PM = parental mediation in preschoolers' digital use; DL = preschoolers' digital literacy

7.3 Relationship between SES and DL: A chain–mediating effect analysis

As a significant correlation was found between digital literacy and SES, PB, and PM, a chain-mediation model was established to assess the mediation effect of PB and PM. The variance inflation factors of all predictors ranged from 1.02 to 1.34, less than five, demonstrating appropriateness for further mediation analysis. We employed Model 6 from the PROCESS to examine the mediating effects (Bootstrap sample size = 5000. confidence interval = 95%).

The result indicated that family SES positively predicted preschoolers' digital literacy (β = .089, p < .001), parental beliefs (β = .050, p < .01), and parental mediation (β = .078, p < .001). Meanwhile, parental beliefs and parental mediation positively predicted preschoolers' digital literacy (β = .204 and .198, respectively, p < .001). In addition, parental beliefs positively predicted parental mediation (β = .311, p < .001). Significant indirect effects attributed to parental beliefs and mediation were associated with the relationship between family SES and preschoolers' digital literacy (indirect effect = 0.167, p < .001). Parental beliefs and parental mediation played an incomplete mediating role between SES and preschoolers' digital literacy, and the mediating effect accounted for 25.85% of the total effect (Table 3).

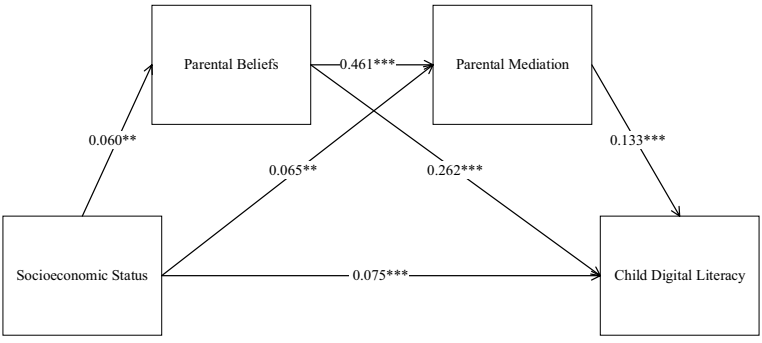

Fig. 2 The Chain Mediation Model with Standardized Path Coefficients

Table 4 Correlations between Preschoolers' DL and Each Item of PB and PM

	Item ordinal	items	*r*
Parental beliefs	4	Young children should learn to use digital technologies	0.328
	7	Digital use is beneficial for young children's future learning or development	0.305
	5	Digital use is beneficial for young children's social interaction	0.283
	2	Digital use is beneficial for early learning and development	0.277
	3	Digital technologies are appropriate for young children to use	0.272
	1	Young children have the right to access and use digital technologies	0.265
	8	Digital use reduces the chances that young children's hands-on activities	-0.215
	6	Digital use is harmful to young children's health	-0.179
Parental mediation	2	I explain or demonstrate the use of digital technologies for my children	0.287
	5	I guide children to use digital technologies	0.261
	6	I use digital technologies with my children	0.253
	4	I select appropriate digital activities or content for my children	0.224
	3	I talk to my children about the pros and cons of using digital technologies	0.214
	1	I set rules or requirements for my children when they use digital technologies	0.195
	8	I monitor and manage my children's use of digital technologies	0.161
	7	I am present while my children use digital technologies	0.109

N=1876. All items correlated with preschoolers' DL at a significant level of .01.

Specifically, the chain mediation effect consisted of indirect effects arising from three pathways. The first pathway via SES→PB→DL, with a significant indirect effect of 0.099 ($p < .001$), contributed 15.33% to the total effect of SES on preschoolers' digital literacy. The second pathway, via SES→PM→DL, with a significant indirect effect of 0.046 ($p < .001$), contributed 7.12% to the total effect. Finally, the third pathway via SES→PB→PM→DL with a significant indirect effect of 0.021 ($p < .001$) contributed 3.25% to the total effect. The path model is shown in Fig. 2.

7.4 Effects of parental beliefs and mediation

To further explore which parental belief and mediation strategy are beneficial for preschoolers' digital literacy, a correlation analysis between preschoolers' digital literacy and each item of parental beliefs and mediation was conducted. As shown in Table 4, all parental beliefs and mediation items were significantly associated with preschoolers' digital literacy. First, parents' positive position in young children's digital use (item 4) and the belief that digital use is beneficial for young children's future learning or development (item 7) had the highest correlation effect on preschoolers' digital literacy ($r = .328$ and .305 respectively). In contrast, parents' concern about the reduced chances of hands-on activities (item 8) and the harm to young children's health (item 6) caused by digital use had a negative correlation with preschoolers' digital literacy ($r =$- .215 and -.179, respectively). Second, parents' active co-use mediation, such as explanation or demonstration (item 2), guidance (item 5), and co-use (item 6), had a higher correlation effect on preschoolers' digital literacy ($r = .287$, .261, and .253, respectively). Nevertheless, parents' restrictive mediation strategies, such as setting rules (item 1), monitoring (item 8), and supervision (item 7), had relatively low correlation effect on preschoolers' digital literacy ($r = .195$, .161, and .109, respectively).

8 Discussion

The present study introduces and validates a chain mediation model involving parental beliefs and mediation practices using a large-scale sample from Central China. Our findings indicate that socioeconomic status (SES) significantly predicts preschoolers' digital literacy, and parental beliefs and mediation jointly mediate this relationship. Specifically, parents' positive beliefs and active co-use of digital technologies with their preschoolers are positively correlated with the children's digital literacy. These results support all the hypotheses proposed in our study. In the following section, we will delve into how parental beliefs and mediation jointly mediate the impact of SES on preschoolers' digital literacy.

8.1 SES effect: The 2nd level of digital divide in chinese preschoolers

The findings of this study reveal a significant effect of socioeconomic status (SES) on preschoolers' digital literacy, thereby supporting Hypothesis 1. This result aligns

with previous research conducted on school-age children by Lazonder et al. (2019) and Liang et al. (2021). Notably, our study sheds light on the existence of a second level of the digital divide among Chinese preschoolers, differentiating families based on SES. Despite the Chinese government's efforts to promote educational informatization through digital infrastructure and resource development over the past decade (Ministry of Education, 2018), our study confirms that this second level of the digital divide persists even among very young children across various family backgrounds. This may be attributed to two primary reasons.

Firstly, government policies do not actively support the digital use and digital literacy development of preschoolers. For instance, during the initial outbreak of COVID-19, the Chinese government mandated that students in universities, high schools, secondary schools, and primary schools engage in "online learning" (Ministry of Education, 2020). However, kindergartens and preschools were explicitly "forbidden" from conducting online teaching (Ministry of Education, 2020), primarily due to concerns about the potential harm of digital use on young children's health. These concerns appear well-founded, as numerous studies have demonstrated that inappropriate digital use can indeed have adverse effects on young children's well-being and health (Allers et al., 2021; Hutton et al., 2020; Li et al., 2021; Ricci et al., 2020; Tychsen & Foeller, 2020). Moving forward, both research endeavors and educational practices should focus on supporting young children's digital literacy development while simultaneously mitigating the potential risks associated with digital technology use.

Second, the rapid economic prosperity of the Chinese brings huge social division between families (Li, 2021), causing a strong divide in digital resources, educational resources, and social capital. Thus, children from higher SES families have access to the newest digital technologies (Nikken & Opree, 2018) and are supported by their well-educated parents when they use digital technologies. Besides, children from higher SES families can realize the value of digital technologies by observing parents' and their communities' beneficial digital use and engaging in meaningful digital use earlier than their counterparts. As the "21st-century skill" (Binkley et al., 2012) and a vital competency in the 'digital era' (Siddiq et al., 2017), digital literacy is important for children's future learning and employment, especially for those with lower SES. Therefore, the Chinese government should consider how to narrow the second level of the digital divide by supporting parents to improve parental beliefs and parental mediation, which will be discussed in the following subsections.

8.2 Parental beliefs and mediation co-mediate the SES effect

This study found that parental beliefs and parental mediation co-mediate the relationship between family SES and preschoolers' digital literacy, supporting Hypotheses 2, 3, and 4. First, parental beliefs mediated the relationship between family SES and preschoolers' digital literacy, supporting Hypothesis 2. This means parents with higher family SES backgrounds tend to hold more positive beliefs about preschoolers' digital use and, thus, could predict the higher level of preschoolers' digital literacy. This result is consistent with the previous studies

(Lauricella et al., 2015; Livingstone et al., 2015; Ofcom, 2017; Ozturk & Ohi, 2019). Second, parental mediation mediated the relationship between family SES and preschoolers' digital literacy, supporting Hypothesis 3 and further confirming the results of previous studies (Livingstone et al., 2015; Nikken & Opree, 2018). This means that parents with higher family SES tend to employ more strategies (e.g., explaining, demonstrating, guiding, co-using) to regulate preschoolers' digital use at home and support their children to develop relevant operating skills in using various digital technologies (Gou & Dezuanni, 2018). Third, parental beliefs significantly predicted parental mediation in preschoolers' digital use. Lastly, a partial chain-mediation role was found for parental beliefs and the parental mediation between the relationship between family SES and the digital literacy of preschoolers, supporting Hypothesis 4.

Drawing from Bourdieu's social-capital theory, we recognize that a family's affinity with digital technologies is influenced by systematic distinctions in parents' social, cultural, and economic capital. These distinctions lead to variations in parental beliefs and mediation practices regarding young children's digital use (Nikken & Opree, 2018). When combined with available home digital resources, these beliefs and mediation practices create what Johnson and Puplampu (2008) refer to as the Ecological Techno-Subsystem within the home environment. Within this subsystem, young children interact with digital technologies daily, gaining distinct opportunities for developing digital literacy. However, this study found that family socioeconomic status (SES) might play a crucial role in shaping these opportunities. Lower SES families may have fewer resources and less exposure to positive beliefs about digital use. Consequently, their children face limitations in accessing the necessary experiences for developing digital literacy. To address this inequality issue, governments and educators must prioritize narrowing the digital divide in early childhood. Empowering parents might be the key. By shifting parental beliefs about young children's digital use and supporting the development of effective mediation strategies, we can enhance digital literacy outcomes for all children, regardless of their socioeconomic background.

8.3 Changing parental beliefs and enhancing active mediation

First, this study has demonstrated a positive association between parental beliefs and preschoolers' digital literacy. Specifically, three types of parental beliefs were found to be positively correlated with preschoolers' digital literacy: (1) Beliefs About Access: Parents who believed that young children should have the right to access and use digital technologies; (2) Beliefs About Appropriateness: Parents who considered digital use appropriate for young children; (3) Beliefs About Values or Effects: Parents who believed that early digital use could benefit children's present and future development, including learning and social interaction. These beliefs align with three levels of opportunities for young children's digital engagement: access, usage, and beneficial outcomes. Consequently, fostering positive parental beliefs can enhance opportunities for children's early digital experiences. Nevertheless, it is crucial to maintain a balanced perspective regarding early digital use. While

recognizing its potential benefits, we must also acknowledge the associated risks. These risks include obesity (Dowden and Healey, 2021), sleep disturbance (Ricci et al., 2020), postural effects, visual disorders (Tychsen & Foeller, 2020), and potentially hindering cognitive and brain development (Hutton et al., 2020) and executive functions (Li et al., 2021). Therefore, promoting effective parental mediation strategies is essential to mitigate these risks and ensure a healthy digital environment for young children.

Second, this study highlights the effectiveness of active mediation and co-use in cultivating young children's digital literacy compared to restrictive mediation. This finding is consistent with Kumpulainen et al. (2020), who suggested that interaction with adults in a meaningful way would foster children's positive digital use. Active mediation involves interactive strategies such as discussing the pros and cons of digital use, selecting appropriate content, explaining technology usage, and guiding children's interactions (Livingstone and Helsper, 2008; Nikken & Jansz, 2014). Co-use refers to parents using digital technologies alongside their children. These positive and supportive mediation approaches serve as scaffolding for young children's understanding and operation of digital technologies. In contrast, restrictive mediating strategies like setting rules or monitoring demonstrated a significant but weak correlation with young children's digital literacy. Previous studies (Cao and Li, 2023; Dong et al., 2020) have indicated that Chinese parents often lack knowledge and skills related to mediating their young children's digital use. Therefore, parent education programs should be developed and implemented to promote positive mediation strategies to enhance parents' proficiency in digital parenting.

9 Conclusion, limitations, and implications

In summary, this study yielded several significant findings related to the digital literacy of Chinese preschoolers. First, this study established a significant association between socioeconomic status (SES), parental beliefs, parental mediation, and preschoolers' digital literacy. These factors collectively contribute to children's proficiency in navigating digital technologies. Second, parental beliefs and mediation played a co-mediating role in the relationship between family SES and digital literacy among Chinese preschoolers. Specifically, parents' positive beliefs about digital use and their effective mediation strategies jointly influenced children's digital literacy outcomes. Third, positive parental beliefs and effective mediation strategies correlate positively with higher levels of digital literacy among preschoolers. Understanding the interplay between socioeconomic factors, parental attitudes, and mediation practices is essential for promoting digital literacy in early childhood. By fostering positive beliefs and providing guidance to parents, we can enhance children's digital competencies regardless of their family background.

While this study contributes valuable insights into preschoolers' digital literacy, it also has several notable limitations, which warrant consideration for future research. First, the study primarily investigated the "operational" dimension of digital literacy, overlooking the less common but equally important "critical" digital literacy . Future studies should explore both dimensions to gain a comprehensive

understanding of young children's digital competencies. Second, the participants were sampled from central China, which may limit the generalizability of findings to all Chinese preschoolers. To enhance representativeness, future research should include participants from diverse regions across China. Third, the survey-based nature of this study introduces a potential socially desirable bias due to parental reports. Families with limited access to digital technologies might be underrepresented in the sample. Researchers should pay more attention to this group and consider alternative data collection methods (such as observation or experimental tasks) to triangulate findings.

Nevertheless, this study has several important implications for policymakers, educators, and parents. First, the confirmation of the second level of the digital divide in early childhood implies that governments should prioritize addressing this divide and develop guidelines to inform parents and educators about effective strategies. Second, the confirmation of co-mediating role of parental beliefs and mediation in shaping preschoolers' digital literacy highlights a potential pathway for narrowing the digital divide. Supporting parents by fostering positive beliefs and providing effective mediation strategies can contribute to bridging this gap. Third, the finding that positive parental beliefs and active co-use mediation strategies significantly correlate with better digital literacy outcomes implies that efforts should focus on shifting parents' negative perceptions of early digital use and guiding them toward adopting positive mediation practices. This means, early intervention through digital parenting education programs is essential for bridging the digital divide. By working collaboratively with young children and their parents, we can ensure equitable access to digital literacy skills from an early age.

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Declarations

Conflicts of Interest No potential conflict of interest was reported by the author(s).

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