What Predicts Preschoolers' Math Skills? The Role of Paternal Education, Age, SES, and Preschool Attendance

Kerem Avci - Balikesir University - Türkiye 0000-0002-8050-9469
Emine Ferda Bedel - Çanakkale Onsekiz Mart University - Türkiye 0000-0001-6498-7586

Recepción: 19.11.2025 | Aceptado: 26.11.2025

Correspondencia a través de **ORCID**: Kerem Avci **0000-0002-8050-9469**

Citar: Avci, K, & Bedel, EF (2025). What Predicts Preschoolers' Math Skills? The Role of Paternal Education, Age, SES, and Preschool Attendance. *REIDOCREA, 14*(47), 683-697.
Financiación: This study was funded by Çanakkale Onsekiz Mart University Scientific Research Projects Coordination Unit. - Este estudio fue financiado por la Unidad de Coordinación de Proyectos de Investigación Científica de la Universidad Çanakkale Onsekiz Mart.
This study was produced from the master's thesis of the first author under the supervision of the second author.
Área o categoría del conocimiento: Early Childhood Education

Abstract: This study examined the mathematical abilities of preschool children aged 44 to 66 months, regarding variables such as gender, age, handedness, birth order, family socioeconomic status (SES), and preschool attendance. The sample comprised of 288 children attending public preschools. Data were collected using the Test of Early Mathematics Ability–Third Edition (TEMA-3) and a demographic questionnaire. Results indicated that maternal education level is a more powerful and statistically significant predictor of children's early-math abilities compared to paternal education. While higher paternal education is descriptively associated with higher math scores, this relationship does not acquire statistical significance. According to regression analysis age, SES, and preschool attendance significantly predicted mathematical ability. On the contrary, gender, birth order, and handedness were not among the significant predictors.

Keyword: Early Math Ability

Introduction

Young children differ significantly in their early mathematical abilities, with some demonstrating a higher level of preparedness and readiness to engage with foundational mathematical concepts upon entering school (Elliott& Bachman, 2018).While early mathematical skills are strong predictors of later success in mathematics (Cirino et al., 2018; Clements & Sarama, 2020; Dearing et al., 2009; Jordan et al., 2009; Lopez et al., 2007; Peng et al., 2019; Ten Braak et al., 2022), several individual and contextual factors have been identified that influence their development. These factors include age (Baroody & Lai, 2007; Baroody et al., 2009; Elliott& Bachman, 2018; MacDonald & Murphy, 2021; Ribner et al., 2023), gender (Johnson et al., 2022; Klein et al., 2010; Lee et al., 2011; Lenes et al., 2022; Penner & Paret, 2008), socioeconomic status (Cahoon et al., 2017; Dougles & Rittle-Johnson, 2024; Huntsinger et al., 2016; Kumaş & Ergül, 2021; Napoli & Purpura, 2018; Niklas & Schneider, 2014; Zippert & Rittle-Johnson, 2020), parents' educational level, parents' engagement in mathematics learning activities with their children, early childhood education experience (Cirino et al., 2018; Ten Braak et al., 2022), birth order (Desoete, 2008), and hand preference (Cheyne et al., 2009; Johnston et al., 2009; Sala et al., 2017). Examining the impact of these factors, research findings suggest that children's mathematical skills tend to improve by age (Baroody & Lai, 2007; Baroody et al., 2009; MacDonald & Murphy, 2021; Ribner et al., 2023; Unutkan, 2003, 2007). While studies indicate no significant gender differences in mathematical abilities during early years (Girelli, 2023; Johnson et al., 2022; Klein et al., 2010; Lenes et al., 2022; Unutkan, 2003, 2007), it is noted that boys tend to perform better in mathematics in later years of life (Lee et al., 2011; Penner & Paret, 2008).

Another crucial factor in the development of children's mathematical skills is socioeconomic status. Studies show that children from lower socioeconomic backgrounds tend to lag behind those from higher socioeconomic backgrounds in terms of mathematical skills (Güven, 1998; James-Brabham et al., 2023: Kandır & Tümer, 2013; Unutkan, 2007). Nevertheless, it is emphasized that children from socioeconomically and socioculturally disadvantaged families can quickly close the gap with their peers through mathematics interventions during the preschool period (Clements & Sarama, 2008; Dearing et al., 2009; Kumaş & Ergül, 2021; Niklas et al., 2016; Oğul & Arnas, 2022; Oktay & Güven, 1998; Starkey et al., 2004; Starkey et al., 2022; Zippert & Rittle-Johnson, 2020). Additionally, several studies have pointed out the specific influence of mothers' educational levels on their children's mathematical achievement, likely due to their role as primary caregivers (Dougles & Rittle-Johnson, 2024; Lenes et al., 2022; Tan et al., 2020; Zadeh et al., 2010). In addition to their educational level, parents' engagement in mathematics learning activities at home (for example, reading books that include mathematical concepts, playing board and card games, watching television programs, counting while placing plates on the tables, weighing while shopping, etc.) shown to be effective in supporting the development of math skills in their children (Cahoon et al., 2017; Huntsinger et al., 2016; Lu et al., 2025; Mayer et al., 2023; Napoli & Purpura, 2018; Niklas & Schneider, 2014; Starkey et al., 2004; Young-Loveridge, 2004). Research consistently indicates a link between birth order and mathematical ability. Desoete (2008) found that first-borns generally perform better in arithmetic than only children and last-borns, with middle children in larger families sometimes excelling. More recently, Houmark (2023) presented a similar finding, noting that first-born children tend to outperform later-born siblings in mathematics and reading. While the issue of how handedness relates to mathematical ability is controversial (Sala et.al, 2017), hand preference is also considered a factor potentially related to cognitive and mathematical development (Annett, 2013; Casey et al., 1992; Crow et al., 1998). Whether a child is right-handed or left-handed may influence their mathematical performance (Casey et al., 1992; Cheyne et al., 2009; Johnston et al., 2007, 2009; Sala et al., 2017). Annett (1985) suggested that individuals with a dominant right-hand preference may exhibit lower performance in spatial reasoning—and consequently in mathematical tasks—than their peers. Research also shows that the mathematical skills acquired during preschool education have a direct impact on children's future performance in mathematics throughout their academic journey (Cirino et al., 2018; Jordan et al., 2009; Lopez et al., 2007; Mazzocco & Thompson, 2005; Ten Braak et al., 2022). It was consistently demonstrated that children who attend preschool education tend to have more advanced mathematical skills than those who do not (Cirino et al., 2018; Jordan et al., 2009; Lopez et al., 2007; Mazzocco & Thompson, 2005; Ten Braak et al., 2022). Likewise, educational programs tailored to children's developmental characteristics have been shown to significantly enhance their mathematical abilities (Ayvacı, 2010; Clements & Sarama, 2008; Kartal, 2007; Kumaş & Ergül, 2021; Tarım & Artut, 2004).

Considering the foundational role of early mathematical skills in long-term academic achievement (Clement & Sarama, 2020; Cirino et al., 2018; Jordan et al., 2009; Lopez et al., 2007; Mazzocco & Thompson, 2005; Napoli & Purpura, 2018; Niklas & Schneider, 2014; Ten Braak et al., 2022), it is important to investigate not only these competencies but also the factors that shape their development, such as age (Baroody et al., 2009; MacDonald & Murphy, 2021; Ribner et al., 2023), gender (Johnson et al., 2022; Klein et al., 2010; Lee et al., 2011; Lenes et al., 2022), birth order (Desoete, 2008; Houmark, 2023), handedness (Cheyne et al., 2009; Johnston et al., 2009; Sala et al., 2017), SES (Cahoon et al., 2017; Dougles & Rittle-Johnson, 2024; Huntsinger et al., 2016; Napoli & Purpura, 2018; Niklas & Schneider, 2014; Zippert & Rittle-Johnson, 2020) and preschool attendance (Clements & Sarama, 2008; Cirino et al., 2018; Jordan et al., 2009; Lopez et al., 2007; Ten Braak et al., 2022). A thorough understanding and conceptualization of these influences is necessary for informing preschool education practices and for creating focused and evidence-based practices that support children's ongoing academic success. Therefore, a detailed investigation of early mathematical skills is crucial, as these skills lay the foundation of fundamental concepts and competencies that children rely on during their later school experiences. Likewise, it is also essential to examine the individual, environmental, and socioeconomic factors that relate to these skills, leading to a better understanding of children's mathematical development and enhancing the effectiveness of educational practices.

The present study aims to examine the mathematical skills of children aged 48–66 months in relation to selected demographic variables. The research seeks to address the following questions:

1. What are the descriptive statistics of children's TEMA-3 Form-A scores based on demographic variables, including gender, age, socioeconomic status, preschool education experience, birth order, hand preference, number of siblings, and parental education levels?
2. How do age and mother's education level, as well as their interaction, affect children's mathematical ability scores measured by the TEMA-3 Form-A?
3. How do age and father's education level, as well as their interaction, affect children's mathematical ability scores measured by the TEMA-3 Form-A?
4. To what extent do independent variables—including gender, age, birth order, hand preference, socioeconomic status, and preschool education experience—predict children's total scores on the TEMA-3 Form-A?

Method

Research Design

This study employed a descriptive survey model, which is a quantitative research method. The survey model is defined as "a research approach aiming to describe a past or present situation as it exists" (Karasar, 2016, p.79). These types of studies aim to describe the views or characteristics of a population, with data collected from a sample based on responses to posed questions (Büyüköztürk et al., 2010, p.231). Johnson and Christensen (2019) categorize survey research under three main headings: retrospective, longitudinal, and cross-sectional. This descriptive study aims to examine the mathematical skills of children aged 48–66 months based on selected variables by capturing a snapshot of the current situation and collecting data at a single point in time. Accordingly, the research employs cross-sectional survey design (Johnson & Christensen, 2019).

Participants

The population of this study consists of children aged 48 to 66 months who were enrolled in official preschools affiliated with the Ministry of National Education in the central district of Balıkesir, Turkey. Within the scope of the study, a total of 288 children (146 boys, 142 girls) were included in the sample. These children were selected through random sampling from among those attending 10 preschools chosen using a convenience sampling method. Among the children who voluntarily participated in the study, 50.7% were boys and 49.3% were girls. Regarding age distribution, 25% were between 48–53 months, 29.9% between 54–59 months, and 45.1% between 60–66 months. In terms of birth order, 59.4% were first-born, 24.3% second-born and 2.4% third-born or later. When examining hand preference, 67.4% of the children were right-handed, 6.6% left-handed, and 13.2% used both hands. In terms of preschool education experience, 15.6%

received prior preschool education, while 71.9% had not. Regarding mothers' education levels, 5.9% were primary school graduates, 11.5% were middle school graduates, 31.3% were high school graduates, 17.9% held an associate degree, and 23.6% held a bachelor's degree. A similar distribution was observed among fathers: 4.5% were primary school graduates, 9.0% were middle school graduates, 28.5% held a high school diploma, and 23.6% held a bachelor's degree. Socioeconomically, 45.1% of families were classified as middle SES, followed by 21.2% in the high SES group and, %19.1 with the low SES.

Data Collection Tools

Data were gathered using two instruments: the researcher-developed General Information Form and the Test of Early Mathematics Ability–Third Edition (TEMA-3), Form A. The TEMA-3 was administered directly to the children, while the General Information Form was completed by parents. Prior to data collection, ethical approval was obtained from the Provincial Directorate of National Education. Teachers distributed the parent forms, which included the General Information Form and a consent form for voluntary participation, to the families of participating children.

General Information Form: The form consists of questions concerning the child's age, gender, number of siblings, birth order, prior preschool education experience, hand preference (left, right or both), and parents' age, educational level, and SES.

The Test of Early Mathematics Ability – 3 (TEMA – 3): The first version of the Test of Early Mathematics Ability (TEMA) was developed by Ginsburg and Baroody (1983) to evaluate the mathematical abilities of young children aged 3 to 8 years and 11 months. The following revisions in the test resulted in the development of the TEMA-2 and TEMA-3, which targeted to increase the number of test items particularly suitable for preschool-aged children and to improve the test's clarity and usability (Ginsburg & Baroody, 2003).

The standardization and adaptation of the TEMA-3 for Turkish were carried out by Erdoğan (2006). In the reliability analysis, test–retest reliability coefficients were found to be .90 for Form-A to Form-A, .88 for Form-A to Form-B, .90 for Form-B to Form-B, and .90 for Form-B to Form-A. For criterion validity, mathematical ability levels of 6-year-old age group were employed as an external benchmark. Test results demonstrated that children with high ability ($M = 23.00$) scored significantly higher than those with low ability ($M = 8.00$), and teacher assessments supported these differences. All together, these findings suggest that TEMA-3 is effective in distinguishing between children with strong and weak mathematical skills (Erdoğan, 2006). Internal consistency reliability, tested using the Kuder–Richardson Formula 20 (KR-20), was reported to be .92 for Form-A and .93 for Form-B (Erdoğan, 2006). In the current study, the internal consistency coefficient (KR-20) for TEMA-3 Form-A was calculated to be .949, which aligns with the reliability values reported for the original version of the test (Form A = .94, Form B = .96; Ginsburg & Baroody, 2003).

Data Collection and Analysis

Data were collected using two different measurement tools: (1) the researcher-designed General Information Form, and (2) the Test of Early Mathematics Ability–Third Edition (TEMA-3), Form A. After obtaining the required approvals from the Ministry of National Education (MoNE), teachers were asked to distribute the General Information Form and informed consent forms to the families of participating children. The TEMA-3 Form A was administered individually to the children by trained researchers. While voluntary consent was returned from all 288 families, only 252 (87.50%) of the General Information Forms were fully completed and returned to the researcher. The TEMA-3 Form-A was individually administered through face-to-face interviews to all 288 children in the sample. Each test session lasted approximately 15 to 30 minutes per child. During test administration, care was taken to ensure a quiet environment free from distractions, and each child was assessed in a separate room to maintain individual focus. The data gathered through the General Information Form and the TEMA-3 assessment were analyzed using IBM SPSS Statistics version 20.0. Demographic data pertaining to the children and their families were summarized using descriptive statistics. A reliability analysis was conducted, and the correlation between children's raw scores and standardized mathematics ability scores on TEMA-3 Form A was examined. Descriptive statistics were calculated for the dependent variable (mathematics ability score) and independent variables including gender, age, preschool education experience, hand preference, number of siblings, birth order, parental education levels, household income, and socio-economic status. To examine whether age and mother's education level had a statistically significant effect on mathematics ability scores, a Two-Way ANOVA was conducted. In addition, a composite variable for socio-economic status (SES) was created using principal component analysis, incorporating mother's education, father's education, and total family income. This SES variable was used as an independent variable in the regression analysis. A multiple regression analysis was performed to assess the predictive power of independent variables—gender, age, preschool education, hand preference, number of siblings, birth order, and SES—on mathematics ability scores. Assumptions for regression analysis were checked and met, including: Normality, Multicollinearity (Tolerance: .861–.994; VIF: 1.007–1.155), Independence of errors (Durbin-Watson = 1.864), Normal distribution of residuals, and Homoscedasticity.

Potential outliers were assessed using Mahalanobis Distance ($p > .001$) and Cook's Distance (.0001–.02915), with no significant outliers detected. Examination of the distribution of the mathematics ability scores indicated an approximately normal distribution, with a skewness of 0.01 and a kurtosis of -0.97. The mean score was 91.65, the standard deviation was 17.8, and the range was 79. Finally, the effect size of the regression model was calculated and reported using Cohen's f^2 (Cohen, 1988), in accordance with APA 7 reporting guidelines.

Results

This section presents the reliability analysis of the TEMA-3 test and the correlation between raw scores and mathematical ability scores. Then, in line with the research questions, descriptive statistics for mathematical ability scores by independent variables are provided. Following this, results from two-way ANOVA analyses examining mathematical ability scores by age and mother's education level, as well as by age and father's education level, are reported. Finally, the regression analysis of mathematical ability scores and independent variables is presented.

Reliability Analysis of the TEMA-3 Test and Association between Raw Scores and Mathematical Ability Scores

Table 1 presents the results of the internal consistency reliability analysis conducted for the TEMA-3 Form-A.

Table 1.
Internal Consistency Reliability of TEMA-3 Form-A

Form Type	Cronbach's Alpha	Total Number of Items
Form-A	.949	72

The internal reliability of the test calculated using the Kuder–Richardson Formula 20 (KR-20), yielded a coefficient of .949. This suggests that the scale demonstrates a strong level of internal consistency. These findings align closely with the original standardization results (Form-A α = .94; Form-B α = .96; Ginsburg & Baroody, 2003) as well as with the outcomes from the Turkish adaptation (Form-A α = .92; Form-B α = .93; Erdoğan, 2006). In addition, a Pearson correlation analysis was conducted to assess the relationship between children’s raw scores and their computed mathematical ability scores. Results of this analysis are presented in Table 2.

Table 2.
Correlation Between Math Ability Scores and Raw Scores

	1.Math-Ability Score	2.Raw Score
1. Mathematical Ability Score	1.00	.91**
2. Raw Score	91**	1.00

Note: N = 288, p<.01
Pearson correlation coefficients are presented. A two-tailed significance test was used.

As indicated in Table 2, there is a strong and statistically significant positive correlation between children's raw scores and their standardized mathematical ability scores ($r = .91$, $p < .01$). This finding implies that higher raw scores are closely associated with higher derived ability scores.

Descriptive Statistics for Mathematical Ability Scores by Independent Variables

Descriptive statistics regarding the children's mathematical ability scores obtained from the TEMA-3 test and the independent variables are presented in Table 3.

Table 3.
Descriptive Statistics for Mathematical Ability Scores by Independent Variables

Variable	n	M	Sd
Total Sample	288	91.65	17.78
Gender			
Male	146	91.38	19,05
Female	142	92.61	16.63
Age Group (months)			
48-53	72	91.14	15.78
54-59	86	86.47	17.53
60-66	130	95.77	18.18
Preschool Attendance			
Did not attended	207	89.85	17.48
Attented	45	100.80	17.07
Birth Order			
First-born	171	91.44	18.28
Second born	70	93.27	17.06
Third-born	16	85.00	16.56
Handedness			
Left	19	89.95	17.64
Right	194	92.69	18.20
Both	38	88.16	16.39
Mother’s Education			
Primary school	17	85.60	16.14
Middle school	33	81.68	16.35
High school	90	91.10	16.41
Associate degree	30	92.69	17.96
Bachelor’s degree	68	99.67	18.02
Graduate degree	13	89.15	17.00
Father’s Education			
Primary school	13	81.23	16.69
Middle school	26	85.57	15.75
High school	82	90.72	18.17
Associate degree	36	93.72	15.30
Bachelor’s degree	68	95.62	18.67
Graduate degree	21	96.96	17.443
Socioeconomic Status (SES)			
Low	55	83.59	16.48
Middle	130	93.30	17.04
High	61	96.82	18.45

Descriptive statistics were used to explore how children's mathematical ability scores varied across different demographic characteristics. The mean score on the TEMA-3 Form-A was 91.65 (SD = 17.78). Gender-based comparisons showed that girls (M = 92.61, SD = 16.63) slightly outperformed boys (M = 91.38, SD = 19.05). Regarding age groups, the highest average scores were found among children aged 60–66 months (M = 95.77, SD = 18.18), while those in the 54–59-month group recorded the lowest (M = 86.47, SD = 17.53). Interestingly, children aged 48–53 months (M = 91.14, SD = 15.78) outscored the 54–59-month group. Preschool attendance appeared to have a notable impact, with children who had received preschool education scoring substantially higher (M = 100.80, SD = 17.07) than those without such experience (M = 89.85, SD = 17.48). In terms of birth order, second-born children achieved the highest mean (M = 93.27, SD = 17.06), followed by first-borns (M = 91.44, SD = 18.28), while children born third or later scored the lowest (M = 85.00, SD = 16.56). Hand preference also showed some variation: right-handed children scored highest (M = 92.69, SD = 18.20), followed by left-handed (M = 89.95, SD = 17.64) and ambidextrous children (M = 88.16, SD = 16.39). Parental education levels were generally associated with higher scores. For mothers, children of university graduates had the highest mean (M = 99.67, SD = 18.02), though children of mothers with postgraduate degrees scored slightly lower (M = 89.15, SD = 17.00). A similar pattern was observed for fathers: children of postgraduate-educated fathers had the highest mean scores (M = 96.96, SD = 17.44), followed by those whose fathers held bachelor's (M = 95.62, SD = 18.67) and associate degrees (M = 93.72, SD = 15.30). Lastly, socioeconomic status (SES)—calculated based on parental education and household income—was positively linked with mathematical performance. Children from high-SES families had the highest mean scores (M = 96.82, SD = 18.45), followed by those from middle- (M = 93.30, SD = 17.04) and low-SES backgrounds (M = 83.59, SD = 16.48).

Two-Way ANOVA Analysis for Mathematical Ability Scores by Age and Mother's Education Level

Preliminary descriptive results indicated that children aged 48–53 months outperformed those aged 54–59 months in mathematical ability. Additionally, children whose mothers held postgraduate degrees had slightly lower average scores (M = 89.15). To assess whether these observed differences were statistically significant, a two-way analysis of variance (ANOVA) was conducted with age group and maternal education level as independent variables (see Table 4).

Table 4.
Summary of Results from a Two-Way ANOVA: Child Math Ability by Age and Maternal Education

Source	SS	df	MS	F	p	Partial η^2
Age	5157.31	2	2578.65	9.60	.000	.076
Mother's Education	7992.03	5	1598.41	5.95	.000	.113
Age × Mother's Education	3314.31	10	331.43	1.23	.270	.050
Error	62570.61	233	268.54			
Total	219807.00	251				

Note. SS = sum of squares; df = degrees of freedom; MS = mean square.
Age × Mother's Education refers to the interaction effect. p values are based on two-tailed tests p <.05 indicates statistical significance. Partial η^2 indicates effect size for each factor.

The two-way ANOVA revealed a significant main effect of age on children's mathematical ability scores, $F(2, 233) = 9.60$, $p < .001$, partial $\eta^2 = .076$, indicating that mathematical ability significantly increases with age. The main effect of maternal education level was also statistically significant, $F(5, 233) = 5.95$, $p < .001$, partial $\eta^2 = .113$.Bonferroni-adjusted post hoc comparisons showed that children whose mothers held bachelor's degrees scored significantly higher than those whose mothers had completed primary school ($p = .005$), middle school ($p < .01$), or high school ($p < .05$). However, no significant differences were observed between the bachelor's degree group and those with associate or postgraduate degrees ($p > .05$). Additionally, scores of children whose mothers held postgraduate degrees did not differ significantly from any other group ($p > .05$). Post hoc tests also indicated that children aged 60–66 months scored significantly higher than those aged 54–59 months ($p = .001$). No other age group differences were statistically significant ($p > .05$). The interaction between age and maternal education level was not statistically significant, $F(10, 233) = 1.23$, $p = .270$, partial $\eta^2 = .050$.

Two-Way ANOVA Analysis for Mathematical Ability Scores by Age and Father's Education Level

Descriptive findings suggested that children's mathematical ability scores varied across age groups and father's education levels. Specifically, children aged 60–66 months appeared to perform better than their younger peers, while those whose fathers had a postgraduate degree did not show the highest mean scores. To determine whether these differences were statistically significant, a two-way analysis of variance (ANOVA) was conducted with age group and paternal education level as independent variables (see Table 5).

Table 5.
Summary of Two-Way ANOVA Results for Children's Mathematical Ability by Age and Father's Education

Source	SS	df	MS	F	p	Partial η^2
Age	3542.39	2	1771.19	6.05	.003	.050
Father's Education	2174.49	5	434.90	1.49	.195	.032
Age × Father's Education	3296.92	10	329.69	1.13	.343	.047
Error	66720.26	228	292.63			
Total	216010.90	246				

Note. SS = sum of squares; df = degrees of freedom; MS = mean square.
Age × Father's Education refers to the interaction effect. p values are based on two-tailed tests p <.05 indicates statistical significance. Partial η^2 indicates effect size for each factor.

Two-way ANOVA was conducted to examine the joint effects of age and father's education level on children's mathematics ability scores. The main effect of age on children's mathematical ability scores was statistically significant, $F(2, 228) = 6.05$, $p < .01$, with a moderate effect size (partial $\eta^2 = .050$). Post hoc comparisons using the Tukey HSD test indicated that children aged 60–66 months ($M = 95.77$, $SD = 18.18$) scored significantly higher than those aged 54–59 months ($p < .01$). No significant differences were found between the 60–66 and 48–53-month age groups, or between the 54–59 and 48–53-month groups ($p > .05$). However, the main effect of father's education level on children's math scores was not statistically significant, $F(5, 228) = 1.49$, $p > .05$, partial $\eta^2 = .032$. Although the descriptive statistics show a trend of increasing scores with higher paternal education, the Tukey HSD test did not detect any statistically significant differences among the education groups ($p > .05$). Additionally, the interaction between age and father's education level was not statistically significant, $F(10,228) = 1.13$, $p = .343$, $\eta^2 = .047$. Therefore, the relationship between father's education level and math ability does not significantly vary by age group.

Regression Analysis of Mathematical Ability Scores and Independent Variables

This section presents the results of the regression analysis conducted to examine the relationship between children's scores on the TEMA-3 Form-A and independent variables including gender, age (in months), preschool attendance, hand preference, total number of children in the family, birth order, and SES (see Table 6).

Table 6.
Regression Analysis Results Between Children's TEMA-3 Form-A Scores and Various Variables

Step	Variable	B	SE B	β	t	p	R^2	ΔR^2	Tolerance	VIF	Cohen's f^2
1	Constant	54.62	12.71	—	4.30	< .001	.037	.037	—	—	.038
	Gender	1.11	2.26	.03	0.49	.625			1.000	1.000	
	Age (in months)	0.62	0.21	.19	2.98	.003			.992	1.008	
	Birth Order	-0.17	2.18	.01	0.08	.939			.992	1.009	
2	Constant	55.34	12.72	—	4.35	< .001	.050	.013	—	—	.052
	Gender	1.14	2.26	.03	0.50	.615			.994	1.007	
	Age (in months)	0.64	0.21	.20	3.06	.002			.984	1.017	
	Birth Order	-0.66	2.19	-.02	-0.30	.763			.974	1.027	
	Left-Handed	-4.47	4.29	-.07	-1.04	.299			.961	1.040	
	Ambidextrous	-5.13	3.18	-.10	-1.62	.108			.977	1.024	
3	Constant	49.94	12.31	—	4.06	< .001	.122	.072	—	—	.139
	Gender	2.70	2.21	.08	1.22	.223			.968	1.033	
	Age (in months)	0.69	0.20	.21	3.45	.001			.980	1.021	
	Birth Order	-0.81	2.11	-.02	-0.38	.704			.973	1.027	
	Left-Handed	-7.05	4.17	-.11	-1.69	.092			.942	1.061	
	Ambidextrous	-4.12	3.07	-.08	-1.34	.181			.971	1.029	
	SES	4.94	1.12	.28	4.42	< .001			.949	1.053	
4	Constant	59.30	12.79	—	4.64	< .001	.143	.021	—	—	.166
	Gender	2.62	2.18	.07	1.20	.231			.968	1.033	
	Age (in months)	0.52	0.21	.16	2.45	.015			.866	1.155	
	Birth Order	-1.13	2.10	-.03	-0.54	.589			.969	1.032	
	Left-Handed	-6.46	4.14	-.10	-1.56	.120			.939	1.065	
	Ambidextrous	-4.11	3.04	-.08	-1.35	.177			.971	1.029	
	SES	4.51	1.12	.25	4.03	< .001			.926	1.080	
	Preschool Attendance	7.35	3.04	.16	2.42	.016			.861	1.162	

Note. B = unstandardized regression coefficient; SE B = standard error of B; β = standardized coefficient; t = t-test statistic; p = significance value; VIF = variance inflation factor; R^2 = variance explained by the model; ΔR^2 = change in R^2 between steps; Cohen's f^2 = effect size. All p values are based on two-tailed tests.

Collinearity diagnostics indicated no violations, with Tolerance values all above .861 and VIF values below 1.162, suggesting low multicollinearity. Residual diagnostics (Durbin–Watson = 1.864) supported the assumption of independent errors. Examination of Mahalanobis distances and Cook's distances revealed no influential outliers. Regression analysis was conducted in 4 steps.

In the first step of the regression model, gender, age in months, and birth order were included as predictors. The overall model was not statistically significant, $R = .192$, $R^2 = .037$, $p>.05$. Among the predictors, only age in months significantly predicted mathematical ability scores, $\beta = .189$, $t = 2.978$, $p<.01$. Gender and birth order did not significantly contribute to the variance in scores. The effect size of the model was small to moderate (Cohen's $f^2 = .038$). In the second step, hand preference (right-handed, left-handed, and ambidextrous) was added to the model. The updated model remained non-significant, $R = .223$, $R^2 = .050$, $\Delta R^2 = .013$, $p> .05$. Once again, age in months was the only significant predictor, $\beta = .195$, $t = 3.059$, $p< .01$. Handedness, gender, and birth order were not significant. The effect size remained small to moderate (Cohen's $f^2 = .052$). In the third step, the composite variable for socioeconomic status (SES) was added. This led to a statistically significant improvement in model fit, $R = .350$, $R^2 = .122$, $\Delta R^2 = .072$, $p< .01$. Both SES, $\beta = .276$, $t = 4.420$, $p< .001$, and age in months, $\beta = .212$, $t = 3.447$, $p < .01$, significantly predicted mathematical ability scores. Gender, birth order, and hand preference were not significant. The model's effect size was moderate (Cohen's $f^2 = .139$). In the final step, preschool attendance was added to the model. This addition resulted in a statistically significant increase in explained variance, $R = .379$, $R^2 = .143$, $\Delta R^2 = .021$, $p< .05$. Significant predictors included age in months, $\beta = .159$, $t = 2.449$, $p < .05$; SES, $\beta = .252$, $t = 4.031$, $p< .001$; and preschool attendance, $\beta = .157$, t

= 2.418, $p < .05$. Gender, birth order, and hand preference remained non-significant. The final model had a moderate effect size (Cohen's $f^2 = .166$).

Discussion

This study examined the mathematical skills of children aged 48 to 66 months in relation to various predictors, including age, gender, birth order, handedness, SES, preschool attendance, and parental education level. As noted earlier, previous studies have reported associations between mathematical ability and some of these demographic variables (e.g., Girelli, 2023; Houmark, 2023; Lenes et al., 2022); however, the present study is noteworthy for its comprehensive approach in examining multiple predictors simultaneously. Both ANOVA analyses showed that age was a significant predictor of children's mathematical ability scores. Consistently, mathematical ability improved significantly with age, regardless of the parent's educational background. Descriptive statistics indicated a trend of increasing scores with higher maternal education levels. The effect of maternal education was statistically significant, revealing that children's math scores varied across different maternal education levels. Specifically, children whose mothers held bachelor's degrees scored significantly higher than those whose mothers had completed only primary, middle, or high school. However, no significant differences were observed between the bachelor's degree group and those with associate or postgraduate degrees, which may be attributed to the smaller number of participants in these latter groups. In terms of paternal education, although descriptive statistics suggested increasing math scores with higher paternal education, this tendency did not reach statistical significance. This indicates that the relationship between fathers' education levels and children's math ability did not significantly vary by age group. The regression analysis revealed that age, SES and preschool attendance were significant predictors of children's mathematical ability. Among these, SES had the strongest effect, underscoring the critical role of environmental and economic factors. Preschool attendance also made a meaningful contribution, further supporting the importance of early childhood education. In contrast, demographic variables such as gender, birth order, and handedness were not significant predictors of children's mathematical scores.

These findings are generally consistent with and overlap previous research. Gender was not a significant predictor of mathematical performance, aligning with some earlier studies (Clements et al., 1999; Entwisle & Alexander, 1990; Girelli, 2023; Johnson et al., 2022; Klein et al., 2010; Lenes et al., 2022). Although some research has suggested that boys may outperform girls as they grow older (Lee et al., 2011; Penner & Paret, 2008), such gender differences were not observed in the present study. Similarly, birth order did not significantly predict mathematical performance. While some studies have suggested that birth order may influence parental investment and cognitive development (Houmark, 2023; Lehmann et al., 2018; Pavan, 2016; Price, 2008; Zajonc & Markus, 1975), others have found no significant effects (Bulut-Pedük, 2007; Dikici, 2002), which is consistent with the current findings. Handedness was likewise unrelated to math ability. While earlier studies reported links between handedness and cognitive skills (Annett, 2013; Casey et al., 1992; Crow et al., 1998), more recent research has pointed to a complex and moderated relationship (Sala et al., 2017). Contrary to previous studies (Douglas and Ritte-Johnson, 2024; Feige et al., 2025), it was observed that the father's level of education did not affect children's mathematical skills. The reason for this may be that in Türkiye, the primary caregiver is mostly the mother, and fathers do not have much control over their children's educational processes. This study contributes to the growing body of evidence that handedness, gender, birth order and father education level have limited impact on early mathematical development, although continued research is recommended to clarify these relationships.

In contrast, age, SES, and preschool education experience consistently emerged as key factors associated with mathematical ability. These results align with existing literature emphasizing the importance of age-related improvements, SES, environmental resources, and educational exposure in early mathematics (Aslan, 2004, 2011; Baroody & Lai, 2007; Baroody et al., 2009; Cahoo et al., 2000; Develi & Orbay, 2002; Dursun, 2009; Elliott & Bachman, 2018; Ergün, 2003; James-Brabham et al., 2023: Jordan et al., 2006; Kandır & Orçan, 2009; Lu et al., 2025; Muñez et al., 2021; Niklas et al., 2016; Ndijuye & Benguye, 2023; Oğul & Arnas, 2022; Silver& Libertus, 2022; Starkey et al., 2022). Age-related improvements in math skills correspond with developmental expectations in early childhood and are well-documented (Baroody & Lai, 2007; Laski & Sieger, 2007; MacDonald & Murphy, 2021). Similarly, some studies indicate a significant interaction between parental education and child outcomes (Lu et al., 2025; Oğul & Arnas, 2022), no interaction effect was found in this study between age and maternal education. Socioeconomic status was a strong predictor of math performance, which is in line with substantial prior research identifying SES as a key determinant of academic success, including in mathematics (Clements & Sarama, 2008; Dearing et al., 2009; Kandır & Tümer, 2013; Melhuish et al., 2008; Niklas et al., 2016; Oğul & Arnas, 2022). Preschool education also significantly contributed to mathematical ability scores, supporting the findings from studies that emphasizes the benefits of early education in developing foundational mathematical skills (Baroody & Lai, 2007; Clements & Sarama, 2020; Cirino et al., 2018; Lopez et al., 2007; MacDonald & Murphy, 2021; Ten Braak et al., 2022). Finally, maternal education level was found to have a significant influence on children's mathematical ability scores, which is generally linked to the quality of the home learning environment, positively influencing the academic outcomes (Lenes et al., 2022; Tan et al., 2020; Zadeh et al., 2010). Mothers' playing a greater role in children's early educational experiences may help explain this relation. Especially considering the increasing level of education of mothers in our country and their awareness of preschool education, the level of education of mothers may have a greater impact on the development of children in the years to come. To conclude, the results of this study indicate that children's mathematical abilities improve with age and are significantly influenced by socioeconomic status, preschool attendance, and maternal education level.

Recommendations

Educational support programs that include at-home activities can engage parents in helping their children develop fundamental mathematical skills. These programs may help close the gap between children from different socio-economic backgrounds. Additionally, experimental studies that implement targeted interventions in preschool settings could address developmental differences and improve outcomes for children from disadvantaged backgrounds.

Further research, such as longitudinal studies, could provide a deeper understanding of how demographic variables and other factors connect to mathematical abilities over time and whether some interventions can effectively close the gap between children from different socio-economic backgrounds. Additionally, experimental studies with targeted interventions in preschool settings could help determine the impact on outcomes for children from disadvantaged backgrounds.

Limitations and Future Directions

A limitation of this study is its cross-sectional design, which prevents establishing causal relationships. Future studies are encouraged to employ longitudinal approaches to more comprehensively examine the long-term impacts of socioeconomic status, preschool education, and related factors on children's mathematical skills. Moreover, studies that include larger and more diverse sample groups would help clarify the role of age and other demographic variables in mathematical development. Investigating the interaction between socio-economic status and other predictors, such as parental involvement or the quality of preschool education, would further enrich our understanding of early mathematical skills development.

Funding Information

This study was funded by Çanakkale Onsekiz Mart University Scientific Research Projects Coordination Unit.

Ethics and Consent to Participate

This study was carried out with the permission numbered 9191664/605.01/836008, Balıkesir Provincial Directorate of National Education. The authors declare that the rules determined by the Committee on Publication Ethics (COPE) were followed throughout the entire process of the study. Parents were informed before collecting data from children, and data were collected from the children of parents who signed the voluntary participation form for the study.

References

Annett, M (1985). Left, right, hand and brain: The right shift theory. London: Lawrence Erlbaum.

Annett, M (2013). Handedness and brain asymmetry: The right shift theory. Psychology Press.

Aslan, D (2004). Anaokuluna devam eden 3-6 yaş grubu çocuklarının temel geometrik şekilleri tanımalarının ve şekilleri ayırt etmede kullandıkları kriterlerin incelenmesi (Publication No. 146022) [Master dissertation, Çukurova University]. YÖK Tez.

Aslan, D (2011). 3-6 yaş çocuklarda kategorizasyon, çapraz sınıflandırma ve çıkarım yapma becerilerinin incelenmesi (Publication No. 299874) [Doctoral dissertation, Çukurova University]. YÖK Tez.

Ayvacı, HŞ (2010). Okul öncesi dönem çocuklarının bilimsel süreç becerilerini kullanma yeterliliklerini geliştirmeye yönelik pilot çalışma. Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi, 3(2), 4–19.

Baroody, AJ, & Lai, M (2007). Preschoolers' understanding of the addition–subtraction inverse principle: A Taiwanese sample. Mathematical Thinking and Learning, 9(2), 131–171. https://doi.org/10.1080/10986060709336813

Baroody, AJ, …, & Baroody, AE (2009). Preschoolers' understanding of subtraction-related principles. Mathematical Thinking and Learning, 11(1–2), 41–60. https://doi.org/10.1080/10986060802583956

Bulut-Pedük, Ş (2007). Altı yaş grubundaki çocuklara çoklu zeka kuramına dayalı olarak verilen matematik eğitiminin matematik yeteneğine etkisinin incelenmesi. (Publication No. 196491) [Doctoral dissertation, Ankara University]. YÖK Tez.

Chao, SJ, …, & Woodward, JA (2000). The effects of physical materials on kindergartners' learning of number concepts. Cognition and Instruction, 18(3), 285-316.

Cahoon, A, …, & Simms, V (2017). Parents' views and experiences of the informal and formal home numeracy environment. Learning, Culture and Social Interaction, 15, 69-79. https://doi.org/10.1016/j.lcsi.2017.08.002

Casey, MB, ..., & Nuttall, RL (1992). Spatial ability as a predictor of math achievement: The importance of sex and handedness patterns. Neuropsychologia, 30(1), 35–45. https://doi.org/10.1016/0028-3932(92)90012-B

Cheyne, CP, ..., & García-Fiñana, M (2009). The effect of handedness on academic ability: A multivariate linear mixed model approach. Laterality, 15(4), 451–464. https://doi.org/10.1080/13576500902976956

Cirino, PT, ..., & Macdonald, KT (2018). Longitudinal predictors of the overlap between reading and math skills. Contemporary Educational Psychology, 54, 99–111. https://doi.org/10.1016/j.cedpsych.2018.06.002

Clements, DH, ..., & Sarama, J (1999). Young children's concepts of shape. Journal for Research in Mathematics Education, 30(2), 192–212. https://doi.org/10.2307/749610

Clements, DH, & Sarama, J (2008). Experimental evaluation of the effects of a research-based preschool mathematics curriculum. American Educational Research Journal, 45(2), 443–494. https://doi.org/10.3102/0002831207312908

Clements, DH, & Sarama, J (2020). Learning and teaching early math: The learning trajectories approach (2nd ed.). Routledge.

Cohen, JE (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Lawrence Erlbaum Associates. https://doi.org/10.4324/9780203771587

Crow, TJ, ..., & Leask, S (1998). Relative hand skill predicts academic ability: Global deficits at the point of hemispheric indecision. Neuropsychologia, 36(12), 1275–1282. https://doi.org/10.1016/S0028-3932(98)00039-6

Dearing, E, ..., & Taylor, BA (2009). Does higher quality early childcare promote low-income children's math and reading achievement in middle childhood? Child Development, 80(5), 1329–1349. https://doi.org/10.1111/j.1467-8624.2009.01336.x

Desoete, A (2008). Do birth order, family size and gender affect arithmetic achievement in elementary school? Electronic Journal of Research in Educational Psychology, 6(14), 135–156. https://doi.org/10.25115/ejrep.v6i14.1274

Develi, MH, & Orbay, K (2002). İşlem öncesi dönem çocuklarında sayı kavramının gelişimi üzerine. Proceedings of the 2002 V. Ulusal Fen Bilimleri ve Matematik Kongresi (p. 222). Middle East Technical University.

Dikici, A (2002). Orff tekniği ile verilen müzik yeteneğinin matematik yeteneğine etkisinin incelenmesi (Publication No. 120179) [Doctoral dissertation, Ankara University]. YÖK Tez

Douglas, AA, & Rittle-Johnson, B (2024). Parental early math support: The role of parental knowledge about early math development. Early Childhood Research Quarterly, 66, 124-134. https://doi.org/10.1016/j.ecresq.2023.10.003

Dursun, Ş (2009). İlköğretim birinci sınıf öğrencilerinin matematiksel becerilerinin okul öncesi eğitimi alma ve almama durumuna göre karşılaştırılması. Kuram ve Uygulamada Eğitim Bilimleri, 9(4), 1691–1715.

Elliott, L, & Bachman, HJ (2018). SES disparities in early math abilities: The contributions of parents' math cognitions, practices to support math, and math talk. Developmental Review, 49, 1–15. https://doi.org/10.1016/j.dr.2018.08.001

Entwisle, DR, & Alexander, KL (1990). Beginning school math competence: Minority and majority comparisons. Child development, 61(2), 454-471. https://doi.org/10.1111/j.1467-8624.1990.tb02792.x

Erdoğan, S (2006). Altı yaş grubu çocuklarına drama yöntemi ile verilen matematik eğitimin matematik yeteneğine etkisinin incelenmesi (Publication No. 182715) [Doctoral dissertation, Ankara University]. YÖK Tez

Ergün, S (2003). Okul öncesi eğitimi eğitimi alan ve almayan birinci sınıf öğrencilerinin matematik yetenek ve başarılarının karşılaştırmalı olarak incelenmesi (Publication No. 133583) [Doctoral dissertation, Marmara University]. YÖK Tez

Feige, P, …, & Oppermann, E (2025) Impact of mothers' and fathers' math self-concept of ability, child-specific beliefs and behaviors on girls' and boys' math self-concept of ability. PLoS ONE 20(2): e0317837. https://doi.org/10.1371/journal.pone.0317837

Ginsburg, H, & Baroody, A (1983). Test of early mathematics ability. Pro-Ed: Austin.

Ginsburg, H, & Baroody, A (2003). Test of early mathematics ability-third edition. Journal of Psychoeducational Assessment, 24(1), 85–91. https://doi.org/10.1177/0734282905282839

Girelli, L (2023). What does gender has to do with math? Complex questions require complex answers. Journal of Neuroscience Research, 101, 679-688. https://doi.org/10.1002/jnr.25056

Güven, Y (1998). Kız ve erkek çocuklarda matematik yeteneği ve matematik başarısı konusunda okulöncesi ve ilkokul (ilköğretim) öğretmenlerinin görüşlerinin değerlendirilmesi. M.Ü. Eğitim Bilimleri Dergisi, 10, 121–138.

Houmark, MA (2023). First among equals? How birth order shapes child development (No. 119325). University Library of Munich, Germany.

Huntsinger, CS, ..., & Luo, Z (2016). Parental facilitation of early mathematics and reading skills and knowledge through encouragement of home-based activities. Early Childhood Research Quarterly, 37, 1-15. https://doi.org/10.1016/j.ecresq.2016.02.005

James-Brabham, E, ..., & Blakey, E (2023). How do socioeconomic attainment gaps in early mathematical ability arise? Child Development, 94(6), 1550–1565. https://doi.org/10.1111/cdev.13947

Johnson, T, ..., & Levine, SC (2022). Spatial and mathematics skills: Similarities and differences related to age, SES, and gender. Cognition, 218, 104918. https://doi.org/10.1016/j.cognition.2021.104918

Johnson, RB, & Christensen, L (2019). Educational research: Quantitative, qualitative, and mixed approaches. Sage Publications.

Johnston, DW, …, & Shields, MA (2007). "Handedness, Time Use and Early Childhood Development." IZA Discussion Paper No. 2752. Institute for the Study of Labor, Bonn, Germany.

Johnston, DW, ..., & Shields, MA (2009). Nature's experiment? Handedness and early childhood development. Demography, 46(2), 281–301. https://doi.org/10.1353/dem.0.0053

Jordan, NC, ..., & Locuniak, MN (2006). Number sense growth in kindergarten: A longitudinal investigation of children at risk for mathematics difficulties. Child Development, 77(1), 153–175. https://doi.org/10.1353/dem.0.0053

Jordan, NC, …, & Locuniak, MN (2009). Early math matters: Kindergarten number competence and later mathematics outcomes. Developmental Psychology, 45(3), 850. https://doi.org/10.1037/a0014939

Kandır, A, & Orçan, M (2009). Alt ve üst sosyo-ekonomik düzeydeki ailelerin beş-altı yaş çocuklarının erken öğrenme becerilerinin bazı değişkenler yönünden incelenmesi. Kuramsal Eğitimbilim, 2(1), 1–13.

Kandır, A, & Koçak-Tümer, NB (2013). Farklı sosyo-ekonomik düzeydeki beş-altı yaş çocuklarının erken öğrenme becerilerinin incelenmesi. Sosyal Politika Çalışmaları, 13(7), 45–60. https://doi.org/10.21560/spcd.91139

Karasar, N (2016). Bilimsel araştırma yöntemi: Kavramlar, ilkeler, teknikler. Ankara: Nobel Yayınevi

Kartal, H (2007). The effect of mother-child education program which is one of the early childhood education programs on cognitive development of six age children. Elementary Education Online, 6(2), 234–248.

Klein, PS, …, & Hakak-Benizri, S (2010). Mathematical thinking of kindergarten boys and girls: Similar achievement, different contributing processes. Educational Studies in Mathematics, 73(3), 233–246. https://doi.org/10.1007/s10649-009-9216-y

Kumas, ÖA, & Ergül, C (2021). Effectiveness of the Big Math for Little Kids Program on the Early Mathematics Skills of Children with Risk Group. Athens Journal of Education, 8(4), 385-400. https://doi.org/10.30958/aje.8-4-3

Laski, EV, & Siegler, RS (2007). Is 27 a big number? Correlational and causal connections among numerical categorization, number line estimation, and numerical magnitude comparison. Child Development, 78(6), 1723–1743. https://doi.org/10.1111/j.1467-8624.2007.01087.x

Lee, J, …, & Hegar, RL (2011). Mathematics skills in early childhood: Exploring gender and ethnic patterns. Child Indicators Research, 4, 353–368. https://doi.org/10.1007/s12187-010-9088-9

Lehmann, JK, …, & Vidal-Fernandez, M (2018). The early origins of birth order differences in children's outcomes and parental behavior. Journal of Human Resources, 53(1), 123–156. https://muse.jhu.edu/article/684445

Lenes, R, ..., & Idsøe, T (2022). The role of mother's education and child gender for children's vocabulary and math skills in the transition from early childhood education and care to first grade in Norway. European Early Childhood Education Research Journal, 30(3), 403–422. https://doi.org/10.1080/1350293X.2022.2055101

Lopez, EM, …, & Reese, L (2007). Preschool antecedents of mathematics achievement of Latinos: The influence of family resources, early literacy experiences, and preschool attendance. Hispanic Journal of Behavioral Sciences, 29(4), 456–471. https://doi.org/10.1177/0739986307305910

Lu, L, …, & Laski, EV (2025). Home math environment as a mediator of socioeconomic differences in early math skills: A study of Chinese families from disparate backgrounds. Developmental Psychology, 61(3), 417–431. https://doi.org/10.1037/dev0001918

MacDonald, A, & Murphy, S (2021). Mathematics education for children under four years of age: A systematic review of the literature. Early Years, 41(5), 522–539. https://doi.org/10.1080/09575146.2019.1624507

Mayer, SE, ..., & Shah, R (2023). Boosting Parent-Child Math Engagement and Preschool Children's Math Skills: Evidence from an RCT with Low-Income Families. Economics of Education Review, 95, 102436. https://doi.org/10.1016/j.econedurev.2023.102436

Mazzocco, MM, & Thompson, RE (2005). Kindergarten predictors of math learning disability. Learning Disabilities Research & Practice, 20(3), 142–155. https://doi.org/10.1111/j.1540-5826.2005.00129.x

Melhuish, EC, ..., & Malin, A (2008). Preschool influences on mathematics achievement. Science, 321, 1161–1162. https://doi.org/10.1126/science.1158808

Muñez, D, …, & Lee, K (2021). Socioeconomic status, home mathematics environment and math achievement in kindergarten: A mediation analysis. Developmental Science, 24(6), e13135. https://doi.org/10.1111/desc.13135

Napoli, AR, & Purpura, DJ (2018). The home literacy and numeracy environment in preschool: Cross-domain relations of parent–child practices and child outcomes. Journal of Experimental Child Psychology, 166, 581-603. https://doi.org/10.1016/j.jecp.2017.10.002

Ndijuye, LG, & Benguye, ND (2023). Home environment, early reading, and math: A longitudinal study on the mediating role of family SES in transition from pre-primary to grade one. International Journal of Educational Development, 98, 102751. https://doi.org/10.1016/j.ijedudev.2023.102751

Niklas, F, …, & Tayler, C (2016). Improving preschoolers' numerical abilities by enhancing the home numeracy environment. Early Education and Development, 27(3), 372–383. https://doi.org/10.1080/10409289.2015.1076676

Niklas, F, & Schneider, W (2014). Casting the die before the die is cast: The importance of the home numeracy environment for preschool children. European Journal of Psychology of Education, 29(3), 327-345. https://doi.org/10.1007/s10212-013-0201-6

Oğul, İG, & Arnas, YA (2022). Understanding home math environments and math talks of children with low and middle socioeconomic status. Participatory Educational Research, 9(4), 53–70. https://doi.org/10.17275/per.22.79.9.4

Oktay, A, & Güven, Y (1998). Sosyo-kültürel faktörlerin matematik yeteneği ile ilişkisi üzerine bir araştırma. Proceedings of the 1998 VII. Ulusal Eğitim Bilimleri Kongresi (pp. xx–xx). Konya: Selçuk Üniversitesi.

Pavan, R (2016). On the production of skills and the birth-order effect. Journal of Human Resources, 51(3), 699–726.

Peng, P, …, & Lin, X (2019). A meta-analysis on the relation between fluid intelligence and reading/mathematics: Effects of tasks, age, and social economic status. Psychological Bulletin, 145(2), 189. https://doi.org/10.1037/bul0000182

Penner, AM, & Paret, M (2008). Gender differences in mathematics achievement: Exploring the early grades and the extremes. Social Science Research, 37(1), 239–253. https://doi.org/10.1016/j.ssresearch.2007.06.012

Price, J (2008). Parent-child quality time: Does birth order matter? The Journal of Human Resources, 43(1), 240–265.

Ribner, A, …, & Libertus, ME (2023). Exploring effects of an early math intervention: The importance of parent–child interaction. Child Development, 94, 395–410. https://doi.org/10.1111/cdev.13867

Sala, G, …, & Gobet, F (2017). The relationship between handedness and mathematics is non-linear and is moderated by gender, age, and type of task. Frontiers in Psychology, 8, 948. https://doi.org/10.3389/fpsyg.2017.00948

Silver, AM, & Libertus, ME (2022). Environmental influences on mathematics performance in early childhood. Nature reviews psychology, 1(7), 407-418. https://doi.org/10.1038/s44159-022-00061-z

Starkey, P, ..., & Thomas, J (2022). Effects of early mathematics intervention for low-SES pre-kindergarten and kindergarten students: A replication study. Educational Research and Evaluation, 27(1–2), 61–82. https://doi.org/10.1080/13803611.2021.2022316

Starkey, P, …, & Wakelley, A (2004). Enhancing young children's mathematical knowledge through a pre-kindergarten mathematics intervention. Early Childhood Research Quarterly, 19(1), 99–120. https://doi.org/10.1016/j.ecresq.2004.01.002

Tan, TX, …, & Li, G (2020). Maternal education and Chinese first graders' performance in language and literacy and math: Role of home environment. Early Childhood Education Journal, 48(2), 243–252. https://doi.org/10.1007/s10643-019-00986-w

Tarım, GK, & Artut, DP (2004). Okul öncesi çocuklarda kubaşık çalışmalarda toplama ve çıkarma becerilerinin kazandırılması. Eğitim Araştırmaları, 17, 210–220.

Ten Braak, D, ..., & Størksen, I (2022). Why do early mathematics skills predict later mathematics and reading achievement? The role of executive function. Journal of Experimental Child Psychology, 214, 105306. https://doi.org/10.1016/j.jecp.2021.105306

Unutkan, ÖP (2003). Marmara İlköğretime Hazıroluş Ölçeği'nin geliştirilmesi ve standardizasyonu (Publication No. 133582) [Doctoral dissertation, Marmara University]. YÖK Tez.

Unutkan, ÖP (2007). Okul öncesi dönem çocuklarının matematik becerileri açısından ilköğretime hazır bulunuşluğunun incelenmesi. Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 32, 243–254.

Young-Loveridge, JM (2004). Effects on early numeracy of a program using number books and games. Early Childhood Research Quarterly, 19(1), 82–98. https://doi.org/10.1016/j.ecresq.2004.01.001

Zadeh, ZY, …, & Ungerleider, C (2010). How home enrichment mediates the relationship between maternal education and children's achievement in reading and math. Early Education and Development, 21(4), 568–594. https://doi.org/10.1080/10409280903118424

Zajonc, RB, & Markus, GB (1975). Birth order and intellectual development. Psychological Review, 82(1), 74–88. https://doi.org/10.1037/h0076229

Zippert, EL, & Rittle-Johnson, B (2020). The home math environment: More than numeracy. Early Childhood Research Quarterly, 50, 4-15. https://doi.org/10.1016/j.ecresq.2018.07.009