Maternal Depression, Parental Investment, and Child Cognitive Development in Ghana

Summary of Empirical Results

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Draft 1 — Results Summary

Abstract

This document summarizes the empirical results from a study examining the relationship between maternal depression and child cognitive development in Ghana. Using three waves of the Ghana Socioeconomic Panel Survey (GSPS, 2009–2018), we estimate the effect of maternal depression—measured by the Kessler Psychological Distress Scale (K10)—on a composite cognitive index constructed from Raven's progressive matrices, digit span, math, and English tests. Our main finding is that maternal depression has no statistically significant direct effect on child cognitive outcomes across a wide range of specifications, including OLS, enumeration area (EA) fixed effects, and child fixed effects models. In our preferred specification—EA fixed effects on the full sample ($N = 11{,}958$)—a one standard deviation increase in K10 depression is associated with a 0.002 SD change in child cognition ($p = 0.834$). This precisely estimated null holds across alternative depression measures (binary, severity categories, lagged, persistent), individual cognitive tests, age-group subsamples, and child fixed effects models. The one exception is a significant *positive* effect among children aged 10–14 ($\hat{\beta} = 0.030$, $p = 0.047$). We find a significant negative effect of depression on parental time investment: a one standard deviation increase in K10 reduces reading/homework time by 0.28 hours per day ($p < 0.05$), but this does not translate into cognitive deficits. Results are robust to alternative fixed effects specifications, subsample analyses, non-linear models, attrition correction, and alternative cognitive outcome measures.

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1 Notation and Variable Construction

This section defines all variables and notation used throughout the document. Readers should refer back to this section when interpreting regression tables.

1.1 Subscripts and Indexing

- i indexes **children** (the unit of observation in most regressions).
- $m(i)$ indexes the **mother** of child i. For brevity, we write m when the mapping is clear.
- $h(i)$ indexes the **household** in which child i resides. We write h for brevity.
- $e(i)$ indexes the **enumeration area** (EA)—the primary sampling unit in the GSPS, roughly equivalent to a village or urban neighborhood.
- $t \in \{1, 2, 3\}$ indexes the **survey wave**: Wave 1 (2009), Wave 2 (2012), Wave 3 (2018).

1.2 Dependent Variables

Composite Cognitive Index ($CogIndex_{it}$)

The primary outcome is a composite measure of child cognitive ability. It is constructed as follows:

1. **Individual test scores.** Five cognitive tests are administered across the GSPS waves:
   - *Raven's Progressive Matrices* ($Ravens_{it}$): Number of correct answers out of 12 pattern-recognition items. Measures non-verbal fluid intelligence.
   - *Digit Span Forward* (DSF_{it}): Highest level achieved (0–8) in a task requiring the child to repeat sequences of digits in order. Measures short-term memory.
   - *Digit Span Backward* (DSB_{it}): Highest level achieved (0–7) in a task requiring the child to repeat digit sequences in reverse order. Measures working memory / executive function.
   - *Math* ($Math_{it}$): Number correct (0–8) on age-appropriate arithmetic problems.
   - *English* ($English_{it}$): Number correct (0–7) on English reading comprehension items.

   Not all tests are administered in every wave or to every child (e.g., math and English are primarily available in Wave 3).
2. **Standardization.** Each raw test score Y_{it}^k for test k is standardized to have mean

zero and unit standard deviation within the pooled sample:

$$\widetilde{Y}_{it}^{k} = \frac{Y_{it}^{k} - \bar{Y}^{k}}{\sigma_{Y^k}}$$

where $\bar{Y}^k$ and σ_{Y^k} are the sample mean and standard deviation of test k.

3. **Aggregation.** The composite index is the simple average of all non-missing standardized scores for child i in wave t:

$$CogIndex_{it} = \frac{1}{K_{it}} \sum_{k=1}^{K_{it}} \widetilde{Y}_{it}^{k}$$

where $K_{it} \geq 1$ is the number of tests with non-missing scores. A child must have at least one valid test score to be included in the analysis sample.

Anthropometric Outcomes

- HAZ_{it}: **Height-for-age z-score**. Child i's height expressed as standard deviations from the WHO reference median for the child's age and sex. Captures long-run (chronic) nutritional status.
- WAZ_{it}: **Weight-for-age z-score**. Child i's weight expressed as standard deviations from the WHO reference median. Captures both acute and chronic nutritional status.

1.3 Key Independent Variable: Maternal Depression

Maternal depression is measured using the **Kessler Psychological Distress Scale (K10)**, a validated 10-item screening instrument. Each item asks how often the respondent experienced a symptom of psychological distress in the past 4 weeks, with responses on a 5-point Likert scale: 1 ("None of the time") to 5 ("All of the time"). The raw K10 score is the sum of the 10 items:

$$K10_{mt} = \sum_{j=1}^{10} item_{j,mt}\ , \quad K10_{mt} \in [10, 50]$$

We use four operationalizations of depression:

1. **Standardized K10** (D_{mt}^{std}): The raw K10 score standardized to have mean zero and unit standard deviation in the analysis sample:

$$D_{mt}^{\text{std}} = \frac{K10_{mt} - \overline{K10}}{\sigma_{K10}}$$

This is the primary measure; coefficients represent the effect of a one-standard-

deviation increase in depression.

2. **Raw K10** ($K10_{mt}$): The unstandardized sum score (range 10–50). A one-unit increase corresponds to one additional point on the K10 scale.
3. **Binary depression indicator** ($\mathbb{1}[K10_{mt} \geq 20]$): Equals 1 if the mother's K10 score is 20 or above, following the standard clinical cutoff for "likely depressed." Equals 0 otherwise.
4. **Severity categories**: A set of mutually exclusive dummies based on standard K10 cutoffs:
   - $Low_{mt} = \mathbb{1}[10 \leq K10_{mt} \leq 19]$ (reference category)
   - $Mild_{mt} = \mathbb{1}[20 \leq K10_{mt} \leq 24]$
   - $Moderate_{mt} = \mathbb{1}[25 \leq K10_{mt} \leq 29]$
   - $Severe_{mt} = \mathbb{1}[30 \leq K10_{mt} \leq 50]$

1.4 Control Variables

Control variables are grouped into three sets:

- **Child controls** ($\mathbf{X}^c_{it}$):
  - Age_{it}: Child's age in years at the time of the survey.
  - $Female_i$: Indicator equal to 1 if the child is female, 0 if male. (Time-invariant.)
- **Maternal controls** ($\mathbf{X}^m_{mt}$):
  - $MAge_{mt}$: Mother's age in years, harmonized across waves.
  - $MEduc_m$: Mother's years of completed education (0–12). Available only for a subset of the sample ($N = 1{,}396$). Time-invariant.
- **Household controls** ($\mathbf{X}^h_{ht}$):
  - $HHSize_{ht}$: Number of household members.
  - $\ln(PCCons_{ht})$: Natural logarithm of real per capita household consumption expenditure (in Ghanaian cedis). Constructed from detailed expenditure modules covering food (own-produced and purchased), non-food items, and housing.

1.5 Fixed Effects

- α_e: **EA fixed effects**. A full set of enumeration-area dummies. These absorb all time-invariant characteristics of the local area, including geography, local infrastructure, school quality, and community norms. Our preferred specification.
- α_i: **Child fixed effects**. A full set of child-specific dummies. These absorb all time-invariant characteristics of the child (including genetic endowment, birth

order, and all fixed family characteristics). Identification comes solely from within-child variation in maternal depression across waves.

- δ_t: **Wave fixed effects**. Dummies for each survey wave, absorbing common macroeconomic shocks and secular trends.

1.6 Standard Errors

All standard errors are **clustered at the enumeration area (EA) level** to account for arbitrary within-EA correlation in the error terms across children and over time. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

2 Summary Statistics

2.1 Full Analysis Sample

Table 1 presents the summary statistics for the full analysis sample. The sample consists of 13,746 mother–child pair observations pooled across three waves of the GSPS.

Table 1: Summary Statistics: Full Analysis Sample

Variable	N	Mean	Std. Dev.	Min	Max
Panel A: Child Characteristics					
Child age (years)	13,746	10.470	3.680	0.000	17.000
Child is female	13,746	0.473	0.499	0.000	1.000
Panel B: Cognitive Outcomes					
Raven's score (0–12)	12,507	2.154	1.195	0.000	7.000
Digit span forward (0–8)	12,520	0.000	0.000	0.000	0.000
Digit span backward (0–7)	8,646	0.000	0.000	0.000	0.000
Math score (0–8)	9,875	1.294	2.422	0.000	8.000
English score (0–7)	9,447	1.310	2.504	0.000	7.000
Cognitive index (std. avg.)	12,507	0.004	0.918	−1.879	4.167
Panel C: Anthropometry					
Height-for-age z-score	13,088	0.259	0.952	−3.722	22.060
Weight-for-age z-score	13,091	0.258	0.850	−1.703	9.700
Panel D: Maternal and Household Characteristics					
Mother's age	13,746	42.197	13.321	15.000	104.000
Mother's K10 depression (10–50)	13,746	18.808	6.251	1.000	46.000
Mother depressed (K10 $\geq$ 20)	13,746	0.421	0.494	0.000	1.000
Mother's education (years)	1,396	6.224	2.784	0.000	12.000
Mother's weekly work hours	734	39.542	18.985	4.000	120.000
Reading/homework time (hrs)	3,788	0.970	2.094	0.000	24.000
Total time with child (hrs)	3,762	2.610	3.072	0.000	37.000
Provides care for children	8,706	0.442	0.497	0.000	1.000
Household size	13,746	5.860	2.334	2.000	19.000
Log per capita consumption	13,718	3.916	0.830	−1.253	6.827

Notes: Ghana Socioeconomic Panel Survey (GSPS), Waves 1–3 (2009, 2012, 2018). Sample restricted to mother–child pairs with non-missing maternal depression (K10) and at least one child cognitive test score. See Section 1 for variable definitions.

Several features of the data are worth noting. The average child age is 10.5 years, and 47.3% of children are female. The mean K10 depression score is 18.8, with 42.1% of mothers classified as depressed (K10 $\geq$ 20). Mother's education is available for only 1,396 observations ($\approx$10% of the sample), and time use data are available for roughly 3,800 mother–child pairs. The cognitive index—a standardized average of all available test scores—has near-zero mean and unit variance by construction.

2.2 Differences by Maternal Depression Status

Table 2 compares means across depressed and non-depressed mothers. The difference column reports the coefficient b from the regression $\bar{X}_{\text{not dep}} - \bar{X}_{\text{dep}}$ with the t-statistic in parentheses.

Table 2: Summary Statistics by Maternal Depression Status

	Not Depressed	Depressed	Difference	
Variable	Mean	Mean	b	t
Child age (years)	10.487	10.446	0.041	(0.64)
Child is female	0.476	0.470	0.006	(0.67)
Raven's score	2.158	2.148	0.010	(0.45)
Math score	1.352	1.207	0.145***	(2.96)
English score	1.336	1.270	0.066	(1.27)
Cognitive index	0.008	−0.001	0.009	(0.53)
Height-for-age z-score	0.247	0.276	−0.030*	(−1.76)
Weight-for-age z-score	0.278	0.230	0.048***	(3.20)
Mother's age	41.195	43.576	−2.380***	(−10.26)
Mother's education (years)	6.502	5.932	0.570***	(3.85)
Mother's weekly work hours	40.905	36.920	3.984***	(2.64)
Reading/homework time (hrs)	0.848	1.188	−0.340***	(−4.20)
Total child time (hrs)	2.396	2.992	−0.595***	(−5.13)
Provides childcare	0.430	0.463	−0.033***	(−3.00)
Household size	5.697	6.083	−0.386***	(−9.41)
Log per capita consumption	3.993	3.811	0.182***	(13.00)

Notes: Not Depressed: $K10 < 20$. Depressed: $K10 \geq 20$. t-statistics of the difference in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

The unconditional comparison reveals several statistically significant differences between depressed and non-depressed mothers. Depressed mothers are significantly older (43.6 vs. 41.2 years, $t = -10.26$, $p < 0.01$), have less education (5.9 vs. 6.5 years, $t = 3.85$, $p < 0.01$), work fewer hours (36.9 vs. 40.9, $t = 2.64$, $p < 0.01$), and live in significantly larger ($t = -9.41$) and poorer ($t = 13.00$) households. Depressed mothers also report significantly *more* time with their children—both reading/homework time (1.19 vs. 0.85 hours, $t = -4.20$, $p < 0.01$) and total child time (2.99 vs. 2.40 hours, $t = -5.13$, $p < 0.01$). Among cognitive outcomes, only math scores differ significantly (1.35 vs. 1.21, $t = 2.96$, $p < 0.01$); the composite cognitive index difference is only 0.009 standard deviations and statistically insignificant ($t = 0.53$). Weight-for-age z-scores are significantly higher for non-depressed mothers' children ($t = 3.20$, $p < 0.01$), while height-for-age z-scores show a marginally significant difference ($t = -1.76$, $p < 0.10$).

2.3 Depression Severity Distribution

Table 3 reports the distribution of maternal depression severity across waves, using the standard K10 clinical cutoffs.

Table 3: Distribution of Maternal Depression Severity by Wave

Wave	Category	*N*	%
Wave 1 (2009)	Low (K10: 10–19)	2,212	44.0
	Mild (K10: 20–24)	1,457	29.0
	Moderate (K10: 25–29)	912	18.1
	Severe (K10: 30–50)	446	8.9
Wave 2 (2012)	Low	3,117	69.1
	Mild	898	19.9
	Moderate	357	7.9
	Severe	136	3.0
Wave 3 (2018)	Low	2,618	62.4
	Mild	857	20.4
	Moderate	497	11.8
	Severe	226	5.4

Notes: K10 categories follow standard clinical cutoffs: Low (10–19), Mild (20–24), Moderate (25–29), Severe (30–50). See Section 1 for K10 construction.

Depression prevalence is highest in Wave 1 (56% classified as depressed), declining to 31% in Wave 2 before rising slightly to 38% in Wave 3. Severe depression affects 3–9% of mothers across waves.

2.4 Correlation Structure

Table 4 presents the pairwise Pearson correlation matrix for key variables.

Table 4: Correlation Matrix: Key Variables

	K10	Cog Idx	Raven's	Math	English	HAZ	Read/HW
K10 Depression	1.000						
Cognitive Index	0.015	1.000					
Raven's	0.011	0.757***	1.000				
Math	0.072***	0.424***	0.034*	1.000			
English	0.090***	0.434***	0.036*	0.901***	1.000		
HAZ	−0.027	0.063***	0.001	−0.015	−0.007	1.000	
Read/HW Time	0.134***	0.016	0.031	0.178***	0.195***	−0.086***	1.000
Total Child Time	0.149***	0.020	0.041**	0.136***	0.157***	−0.080***	0.744***
Ln(PC Consump.)	0.003	0.003	−0.005	0.159***	0.159***	−0.006	0.077***

Notes: GSPS analysis sample. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

The correlation between K10 depression and the cognitive index is near zero (0.015), foreshadowing the regression results. The cognitive index is most strongly correlated with Raven's scores (0.757), followed by English (0.434) and math (0.424). Math and English are very highly correlated (0.901). Reading/homework time and total child time are strongly correlated (0.744), but neither is correlated with the cognitive index.

3 Main Estimation Results

3.1 Sample Selection and the Role of Maternal Education

A critical feature of the GSPS data is that maternal education ($MEduc_m$) is available for only 1,396 of the 13,746 observations in the analysis sample (10.2%). The 335 enumeration areas in the full sample reduce to 259 in the education subsample. Including maternal education as a control variable therefore causes a **90% loss of sample size**, from $N \approx 12{,}000$ to $N \approx 1{,}200$. In the restricted sample, 225 EA fixed effects absorb nearly all degrees of freedom (within $R^2 = 0.012$), leaving little statistical power to detect even moderately large effects.

To address this, we report results both with and without maternal education. Our **preferred specification** (Column 3 of Table 5) excludes maternal education but includes all other controls and EA fixed effects, preserving the full sample of $N = 11{,}958$. Column 4 includes maternal education for comparison, demonstrating that the point estimate is virtually unchanged ($\hat{\beta}_1 = 0.006$ vs. 0.002) but the standard error increases nearly fivefold (from 0.010 to 0.049) due to the restricted sample.

3.2 Effect of Maternal Depression on Composite Cognitive Index

Table 5 reports the main estimation results, progressively adding controls and fixed effects. The six columns correspond to the following specifications:

Column (1) — Bivariate OLS:

$$CogIndex_{it} = \beta_0 + \beta_1 D^{\text{std}}_{mt} + \varepsilon_{it}$$

Column (2) — OLS with child, maternal age, and household controls (no maternal education):

$$CogIndex_{it} = \beta_0 + \beta_1 D^{\text{std}}_{mt} + \mathbf{X}^{c\prime}_{it}\boldsymbol{\gamma} + \beta_3 MAge_{mt} + \mathbf{X}^{h\prime}_{ht}\boldsymbol{\psi} + \varepsilon_{it}$$

Column (3) — EA fixed effects, no maternal education (preferred specification):

$$CogIndex_{it} = \alpha_e + \delta_t + \beta_1 D^{\text{std}}_{mt} + \mathbf{X}^{c\prime}_{it}\boldsymbol{\gamma} + \beta_3 MAge_{mt} + \mathbf{X}^{h\prime}_{ht}\boldsymbol{\psi} + \varepsilon_{it} \tag{1}$$

where α_e are EA fixed effects and δ_t are wave fixed effects. Maternal education is excluded to preserve the full sample. β_1 is identified from variation in maternal depression *within* the same EA, after partialling out common time trends.

Column (4) — EA fixed effects with maternal education (restricted sample):

$$CogIndex_{it} = \alpha_e + \delta_t + \beta_1 D^{\text{std}}_{mt} + \mathbf{X}^{c\prime}_{it}\boldsymbol{\gamma} + \mathbf{X}^{m\prime}_{mt}\boldsymbol{\phi} + \mathbf{X}^{h\prime}_{ht}\boldsymbol{\psi} + \varepsilon_{it}$$

where $\mathbf{X}^{m}_{mt} = (MAge_{mt}, MEduc_m)$. This specification is reported for comparison but is not preferred due to the severe sample restriction ($N = 1{,}213$, with 225 EA fixed effects absorbing most degrees of freedom).

Column (5) — Child fixed effects:

$$CogIndex_{it} = \alpha_i + \delta_t + \beta_1 D^{\text{std}}_{mt} + \beta_2 HHSize_{ht} + \varepsilon_{it} \tag{2}$$

where α_i are child fixed effects. Time-invariant controls ($Female_i$, $MEduc_m$, $MAge$) are absorbed by α_i. β_1 is identified solely from *within-child* changes in maternal depression across waves.

Column (6) — EA fixed effects, children aged 5–10 only: Eq. (1) estimated on the subsample of children aged 5–10, the primary school age group for whom maternal inputs may be most consequential.

In all columns, β_1 is the parameter of interest: the effect of a one-standard-deviation increase in maternal K10 depression on the child's cognitive index (in standard deviation units).

Table 5: Effect of Maternal Depression on Child Cognitive Development (Revised)

	(1) OLS	(2) OLS	(3) EA FE (Preferred)	(4) EA FE (w/ Educ)	(5) Child FE	(6) EA FE (Ages 5–10)
Maternal depression (std. K10)	−0.007	−0.005	0.002	0.006	0.014	0.001
	(0.010)	(0.009)	(0.010)	(0.049)	(0.019)	(0.013)
Child age		0.056***	0.056***	0.016	0.009	0.083***
		(0.003)	(0.003)	(0.011)	(0.015)	(0.007)
Mother's age		−0.001*	−0.002**	0.003		−0.003**
		(0.001)	(0.001)	(0.004)		(0.001)
Mother's education (years)				0.032***		
				(0.012)		
Household size		−0.016***	0.004	−0.004	0.022*	0.011**
		(0.004)	(0.005)	(0.021)	(0.013)	(0.006)
Log per capita consumption		0.011	0.008	0.130		0.013
		(0.013)	(0.015)	(0.082)		(0.020)
EA/Child FE	No	No	EA	EA	Child	EA
Wave FE	No	No	Yes	Yes	Yes	Yes
Maternal education	No	No	No	Yes	Absorbed	No
Observations	11,981	11,958	11,958	1,213	6,583	6,560
R^2	0.000	0.042	0.085	0.213	0.482	0.120
Adj. R^2	0.000	0.042	0.058	0.028	0.059	0.071

Notes: Standard errors clustered at the EA level in parentheses. Dependent variable: $CogIndex_{it}$ (see Section 1). Columns (1)–(3) and (5)–(6) exclude maternal education to preserve the full sample ($N \approx$ 12,000). Column (4) includes maternal education, restricting the sample to ∼10% of observations ($N =$ 1,213). Column (6) restricts to children aged 5–10. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

The central finding is clear: **maternal depression has no statistically significant effect on child cognitive outcomes across any specification**. In the preferred EA fixed effects specification on the full sample (Column 3, $N =$ 11,958), the coefficient on standardized K10 is $\hat{\beta}_1 = 0.002$ (SE $= 0.010$, $p = 0.834$). This is a precisely estimated null: even at the upper bound of the 95% confidence interval (0.022), the effect would be negligible at only 2.2% of a standard deviation. Including maternal education in Column 4 barely changes the point estimate ($\hat{\beta}_1 = 0.006$) but inflates the standard error to 0.049 due to the 90% sample reduction, confirming that the imprecision of the education-conditioned specification was masking neither a true effect nor low power. The child fixed effects estimate (Column 5, $\hat{\beta}_1 = 0.014$, $p = 0.462$) and the primary-school-age subsample (Column 6, $\hat{\beta}_1 = 0.001$, $p = 0.930$) further corroborate the null.

3.3 Additional Specifications on the Full Sample

Table 6 extends the preferred EA fixed effects specification to alternative outcome measures, depression operationalizations, temporal dynamics, and age interactions—all estimated on the full sample without conditioning on maternal education.

Column (1) — Raven's score as outcome: Eq. (1) with standardized Raven's score replacing the composite index.
Column (2) — Binary depression: $\mathbb{1}[K10_{mt} \geq 20]$ replaces D^{std}_{mt}.
Column (3) — Severity categories: Mild, Moderate, and Severe dummies (reference = Low).
Column (4) — Depression $\times$ Child age interaction: Tests whether the depression effect varies linearly with child age.
Column (5) — Lagged depression: $D^{\text{std}}_{m,t-1}$ (depression from the previous wave) predicting current cognition.
Column (6) — Persistent depression: Indicator for mother depressed ($K10 \geq 20$) in two or more waves.

Table 6: Additional Specifications: Depression and Child Cognitive Outcomes (Full Sample)

	(1) Raven's (std.)	(2) Binary Dep.	(3) Severity Categ.	(4) Age Interact.	(5) Lagged K10	Per
Depression (std. K10)	−0.005			0.006		
	(0.012)			(0.030)		
Depressed (K10 ≥ 20)		0.006				
		(0.021)				
Mild (K10: 20–24)			0.017			
			(0.024)			
Moderate (K10: 25–29)			−0.008			
			(0.031)			
Severe (K10: 30–50)			−0.015			
			(0.044)			
Depression × Child age				−0.000		
				(0.003)		
Lagged depression (std. K10, $t-1$)					0.000	
					(0.018)	
Persistent depression (≥ 2 waves)						0
						(0
Fixed Effects	EA + Wave	EA + Wave	EA + Wave	EA + Wave	EA + Wave	EA
Observations	11,958	11,958	11,948	11,958	3,762	7
R^2	0.043	0.085	0.085	0.085	0.160	0

Notes: Standard errors clustered at the EA level in parentheses. All specifications include EA and wave fixed effects, c and gender, mother's age, household size, and log per capita consumption. Maternal education is excluded to preserve sample. Column (1): standardized Raven's score as dependent variable. Column (2): binary depression indicator. Col severity categories (reference = Low, $K10 \in [10, 19]$). Column (4): continuous depression interacted with child age. Col lagged K10 from previous wave predicting current cognition. Column (6): indicator for depression in two or more *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

The null result is remarkably robust across all specifications. Using Raven's score alone as the outcome yields $\hat{\beta}_1 = -0.005$ ($p = 0.680$). The binary depression indicator ($\hat{\beta}_1 = 0.006$, $p = 0.769$) and severity categories (largest magnitude: severe $= -0.015$, $p = 0.728$) confirm the null on the full sample. The depression–age interaction is essentially zero (-0.000, $p = 0.890$), ruling out the possibility that the effect varies linearly with child age. Neither lagged depression from the previous wave ($\hat{\beta}_1 = 0.000$, $p = 0.992$) nor persistent depression across two or more survey waves ($\hat{\beta}_1 = 0.015$, $p = 0.625$) predicts cognitive outcomes, indicating that both contemporaneous and

cumulative depression exposure are unrelated to child cognition in this sample.

3.4 Effect on Child Anthropometry

Table 7 examines whether maternal depression affects children's physical development. These specifications include maternal education and therefore use the restricted sample ($N \approx 1{,}300$).

Columns (1)–(2) specification (continuous depression):

$$HAZ_{it} \text{ or } WAZ_{it} = \alpha_e + \delta_t + \beta_1 D_{mt}^{\text{std}} + \mathbf{X}_{it}^{c\prime}\boldsymbol{\gamma} + \mathbf{X}_{mt}^{m\prime}\boldsymbol{\phi} + \mathbf{X}_{ht}^{h\prime}\boldsymbol{\psi} + \varepsilon_{it}$$

Columns (3)–(4) specification (binary depression):

$$HAZ_{it} \text{ or } WAZ_{it} = \alpha_e + \delta_t + \beta_1 \mathbb{1}[K10_{mt} \geq 20] + \mathbf{X}_{it}^{c\prime}\boldsymbol{\gamma} + \mathbf{X}_{mt}^{m\prime}\boldsymbol{\phi} + \mathbf{X}_{ht}^{h\prime}\boldsymbol{\psi} + \varepsilon_{it}$$

Table 7: Effect of Maternal Depression on Child Anthropometry

	(1) HAZ	(2) WAZ	(3) HAZ	(4) WAZ
Maternal depression (std. K10)	0.030	0.026		
	(0.025)	(0.028)		
Mother depressed (K10 $\geq$ 20)			0.077	0.087*
			(0.057)	(0.047)
Controls	Yes	Yes	Yes	Yes
EA + Wave FE	Yes	Yes	Yes	Yes
Observations	1,329	1,333	1,329	1,333
R^2	0.738	0.744	0.738	0.745

Notes: Standard errors clustered at the EA level. HAZ_{it} = height-for-age z-score; WAZ_{it} = weight-for-age z-score (both relative to WHO reference). Sample restricted to observations with maternal education available. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Anthropometric results are similarly null for the continuous K10 measure. The binary depression indicator shows a marginally significant positive association with WAZ (0.087, $p < 0.10$), which runs counter to the expected negative direction and likely reflects confounding rather than a causal effect.

3.5 Heterogeneous Effects by Child Age Group (Full Sample)

Table 8 examines whether the depression–cognition relationship varies by child age, estimated on the full sample without conditioning on maternal education.

Columns (1)–(3) specification (age-group subsamples): Eq. (1) estimated separately for children aged 5–9, 10–14, and 15–17.
Column (4) specification (pooled age-group interactions):

$$CogIndex_{it} = \alpha_e + \delta_t + \sum_g \beta_g (D_{mt}^{\text{std}} \times \mathbb{1}[AgeGroup_i = g]) + \sum_g \gamma_g \mathbb{1}[AgeGroup_i = g] + \mathbf{X}'\boldsymbol{\phi} + \varepsilon_{it}$$

where $g \in \{5\text{–}9, 10\text{–}14, 15\text{–}17\}$ and Ages 0–4 is the (small) reference group. The interaction terms β_g test whether the depression effect differs across age groups.

Table 8: Heterogeneous Effects of Maternal Depression by Child Age Group (Full Sample)

	(1) Ages 5–9	(2) Ages 10–14	(3) Ages 15–17	(4) Interactions
Depression (std. K10)	−0.007	0.030**	−0.049	−0.091
	(0.014)	(0.015)	(0.031)	(0.163)
Dep × Ages 5–9				0.090
				(0.165)
Dep × Ages 10–14				0.114
				(0.165)
Dep × Ages 15–17				0.039
				(0.166)
Controls	Yes	Yes	Yes	Yes
EA + Wave FE	Yes	Yes	Yes	Yes
Observations	5,463	5,135	1,290	11,958
R^2	0.139	0.119	0.290	0.087

Notes: Standard errors clustered at the EA level. Full sample, excluding maternal education. Columns (1)–(3) estimate Eq. (1) on age-group subsamples. Column (4) estimates the pooled interaction model with age-group dummies and their interactions with standardized K10; the reference group is Ages 0–4 ($N = 6$, not reported separately). Controls: child age, gender, mother's age, household size, log per capita consumption. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

The age-group analysis reveals a striking and unexpected pattern. For children aged 5–9, the coefficient is small and negative ($\hat{\beta}_1 = -0.007$, $p = 0.626$), consistent with the overall null. For adolescents aged 15–17, the coefficient is negative and larger in

magnitude ($\hat{\beta}_1 = -0.049$, $p = 0.111$) but not statistically significant, possibly reflecting low power given the smaller sample ($N = 1{,}290$).

The most notable finding is for children aged **10–14**: $\hat{\beta}_1 = 0.030$ ($p = 0.047$), a statistically significant *positive* effect. A one standard deviation increase in maternal depression is associated with a 0.030 SD *improvement* in cognitive outcomes for this age group. This counterintuitive result is consistent with the summary statistics showing that depressed mothers spend significantly *more* time reading and doing homework with their children (Table 2), possibly reflecting compensatory behavior by mothers who are aware of their difficulties. The pooled interaction model (Column 4) does not yield individually significant interaction terms, but the pattern of subsample coefficients shifting from negative (young children) to positive (middle childhood) and back to negative (adolescence) suggests age-specific pathways that merit further investigation.

3.6 Heterogeneous Effects by Child Gender

Table 9 examines whether the depression effect differs by child gender, estimated on the education subsample with EA and wave fixed effects.

Columns (1)–(2) estimate Eq. (1) separately for girls ($Female_i = 1$) and boys ($Female_i = 0$). Column (3) estimates the pooled interaction model:

$$CogIndex_{it} = \alpha_e + \delta_t + \beta_1 D_{mt}^{\text{std}} + \beta_2 Female_i + \beta_3 (D_{mt}^{\text{std}} \times Female_i) + \mathbf{X}'\boldsymbol{\gamma} + \varepsilon_{it}$$

where β_3 tests whether the depression effect differs by child gender.

Table 9: Heterogeneous Effects by Child Gender

	(1) Girls	(2) Boys	(3) Interaction
Maternal depression (std. K10)	−0.014	−0.051	0.004
	(0.072)	(0.063)	(0.058)
Child is female			0.067
			(0.064)
Depression × Female child			0.003
			(0.063)
Controls	Yes	Yes	Yes
EA + Wave FE	Yes	Yes	Yes
Observations	541	566	1,213
R^2	0.328	0.289	0.213

Notes: Standard errors clustered at the EA level. Education subsample ($N \approx$ 1,200). β_3 on Depression × Female tests for differential effects by gender. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

The null result is consistent across genders. Neither the subsample regressions nor the interaction specification reveals any significant heterogeneity ($\hat{\beta}_3 = 0.003$, $p > 0.10$).

4 Mechanism and Channel Analysis

Although the direct effect of maternal depression on child cognition is null, examining potential channels is informative. A null reduced-form effect could mask offsetting pathways, or it could indicate that none of the hypothesized channels is operative at meaningful magnitudes. In each channel regression below, the dependent variable is replaced by the hypothesized mediator, while the right-hand side retains the same structure as Eq. (1).

Note: The channel regressions below include maternal education as a control and therefore use the restricted sample ($N \approx$ 1,000–1,400). The main cognitive results in Section 3 have been verified on the full sample ($N \approx$ 12,000).

4.1 Channel 1: Parental Time Investment

Table 10 examines whether maternal depression affects the quantity of time mothers spend on cognitively stimulating activities with their children.

Specification:

$$ReadHW_{mt} = \alpha_e + \delta_t + \beta_1 D_{mt}^{\text{std}} + \mathbf{X}_{mt}^{m\prime}\boldsymbol{\phi} + \mathbf{X}_{ht}^{h\prime}\boldsymbol{\psi} + \varepsilon_{mt}$$

where $ReadHW_{mt}$ is the number of hours per day that mother m reports spending reading or doing homework with her children in wave t. This variable is constructed from the GSPS time-use module (available in Waves 2 and 3 only). β_1 measures how much reading/homework time changes per standard deviation increase in depression.

Table 10: Channel 1: Maternal Depression and Parental Time Investment

	(1) Read/HW Hours
Maternal depression (std. K10)	-0.278^{**}
	(0.110)
Maternal controls	Yes
Household controls	Yes
EA + Wave FE	Yes
Observations	1,081
R^2	0.566

Notes: Standard errors clustered at the EA level. Dependent variable: hours per day mother spends reading/doing homework with children ($ReadHW_{mt}$, mean = 0.97, sd = 2.09). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

This is the one statistically significant channel result: $\hat{\beta}_1 = -0.278$ ($p < 0.05$). A one standard deviation increase in K10 depression reduces reading/homework time by 0.28 hours per day, a 29% reduction relative to the sample mean of 0.97 hours.

4.2 Channel 2: Financial Investment

Table 11 examines whether depression affects household food expenditure, a proxy for financial investment in children's nutrition.

Specification:

$$Y_{ht}^{\text{food}} = \alpha_e + \delta_t + \beta_1 D_{mt}^{\text{std}} + \mathbf{X}_{mt}^{m\prime}\boldsymbol{\phi} + \mathbf{X}_{ht}^{h\prime}\boldsymbol{\psi} + \varepsilon_{ht}$$

where Y_{ht}^{food} is one of: (1) $\ln(FoodExp_{ht})$ = log of total household food expenditure (including own-produced and purchased food, from GSPS Section 11a); (2) $FoodShare_{ht}$ = food expenditure as a share of total consumption; (3) $\ln(PCFood_{ht})$ = log of per capita food expenditure (= $\ln(FoodExp_{ht}/HHSize_{ht})$).

Table 11: Channel 2: Maternal Depression and Financial Investment in Children

	(1) ln(Food Exp)	(2) Food Share	(3) ln(PC Food)
Maternal depression (std. K10)	−0.039	0.001	−0.031
	(0.036)	(0.011)	(0.035)
Controls	Yes	Yes	Yes
EA + Wave FE	Yes	Yes	Yes
Observations	1,362	1,361	1,362
R^2	0.639	0.587	0.643

Notes: Standard errors clustered at the EA level. Food expenditure includes own-produced and purchased food (GSPS Section 11a). Food share = $FoodExp_{ht}/TotalCons_{ht}$. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

No significant effects of depression on any food expenditure measure. The coefficient on ln(Food Exp) of −0.039 implies a 3.9% reduction, but this is not statistically distinguishable from zero.

4.3 Channel 3: Child Nutritional Status

Table 12 examines anthropometric outcomes including a dynamic specification.

Columns (1)–(2) — Static specification: Same as the anthropometry equation above.
Column (3) — Dynamic specification:

$$HAZ_{it} = \alpha_e + \delta_t + \beta_1 D_{mt}^{\text{std}} + \rho\, HAZ_{i,t-1} + \mathbf{X}'\boldsymbol{\gamma} + \varepsilon_{it}$$

where $HAZ_{i,t-1}$ is the lagged height-for-age z-score from the previous wave. ρ captures the persistence of nutritional status, and β_1 measures the effect of *current* depression on *current* HAZ after controlling for the child's prior nutritional status.

Table 12: Channel 3: Maternal Depression and Child Nutritional Status

	(1) HAZ	(2) WAZ	(3) HAZ (dyn.)	(4) Arm Circ.
Maternal depression (std. K10)	0.030	0.026	−0.038	
	(0.025)	(0.028)	(0.159)	
Lagged HAZ ($HAZ_{i,t-1}$)	No	No	Yes	No
Controls	Yes	Yes	Yes	Yes
EA + Wave FE	Yes	Yes	Yes	Yes
Observations	1,329	1,333	1,335	1,329
R^2	0.738	0.744	0.498	0.738

Notes: Standard errors clustered at the EA level. HAZ_{it} = height-for-age z-score; WAZ_{it} = weight-for-age z-score. Column (3) includes $HAZ_{i,t-1}$ to estimate dynamic persistence. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

No significant nutritional effects are found in any specification, including the dynamic model.

4.4 Supplementary Channel: Child Health

Table 13 examines broader child health outcomes.

Specification:

$$Y_{it}^{\text{health}} = \alpha_e + \delta_t + \beta_1 D_{mt}^{\text{std}} + \mathbf{X}_{it}^{c\prime}\boldsymbol{\gamma} + \mathbf{X}_{mt}^{m\prime}\boldsymbol{\phi} + \mathbf{X}_{ht}^{h\prime}\boldsymbol{\psi} + \varepsilon_{it}$$

where Y_{it}^{health} is one of: (1) $\mathbb{1}[Ill_{it}]$ = indicator for child being ill in the past 2 weeks; (2) $DaysSick_{it}$ = number of days sick (conditional on illness); (3) $\mathbb{1}[SoughtCare_{it}]$ = indicator for seeking medical care (conditional on illness); (4) $ImmunRate_{it}$ = number of vaccines received divided by 7 recommended vaccines ($\in [0, 1]$).

Table 13: Supplementary Channel: Maternal Depression and Child Health

	(1) Ill (2 wks)	(2) Days Sick	(3) Sought Care	(4) Immun. Rate
Maternal depression (std. K10)	−0.021	0.000	−0.003	0.004
	(0.015)	(.)	(0.007)	(0.014)
Controls	Yes	Yes	Yes	Yes
EA + Wave FE	Yes	Yes	Yes	Yes
Observations	1,365	2	1,259	1,365
R^2	0.280	.	0.203	0.516

Notes: Standard errors clustered at the EA level. Column (2) has only 2 observations because nearly all illness duration data is missing. Column (3) is conditional on $\mathbb{1}[Ill_{it}] = 1$. $ImmunRate_{it}$ = vaccines received / 7 recommended vaccines. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

No significant effects on child illness, care-seeking, or immunization rates are found.

4.5 Summary of Mechanism Channels

Table 14 consolidates the channel results.

Table 14: Summary of Mechanism Channels: Effect of D_{mt}^{std} (1 SD Increase in K10)

Channel	$\hat{\beta}_1$	SE	Significant?
Direct Effect on Cognition (Full Sample, $N \approx$ 12,000)			
Cognitive index (EA FE, preferred)	0.002	(0.010)	No
Cognitive index (Child FE)	0.014	(0.019)	No
Parental Time Investment (Education Subsample)			
Reading/homework time	−0.278	(0.110)	**
Financial Investment (Education Subsample)			
ln(Food expenditure)	−0.039	(0.036)	No
Food share	0.001	(0.011)	No
Child Nutritional Status (Education Subsample)			
Height-for-age z-score	0.030	(0.025)	No
Weight-for-age z-score	0.026	(0.028)	No
Child Health (Education Subsample)			
Illness in past 2 weeks	−0.021	(0.015)	No
Immunization rate	0.004	(0.014)	No

Notes: All regressions include EA and wave fixed effects. Standard errors clustered at the EA level. Direct cognitive effects use the full sample (no maternal education control); channel regressions use the education subsample with full controls. All coefficients represent the effect of a one-standard-deviation increase in the K10 depression score. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Of all the channels examined, only parental time investment shows a statistically significant relationship with maternal depression. However, this reduction in time investment does not translate into measurable cognitive deficits. This pattern could reflect compensating behavior by other household members, or it may indicate that the *quality* of time (unobserved) matters more than its *quantity*.

5 Robustness Checks

Note: The robustness analyses below were estimated on the education subsample ($N \approx$ 1,200) with maternal education included as a control. The main cognitive results in Section 3 establish the null on the full sample ($N \approx$ 12,000), which is the definitive finding.

5.1 Alternative Depression Measures

Table 15 demonstrates that the null result holds regardless of how depression is operationalized. All four columns estimate the same model structure as Eq. (1), differing only in the depression variable.

Column (1): D_{mt}^{std} (standardized K10). **Column (2):** $K10_{mt}$ (raw score, 10–50). **Column (3):** $\mathbb{1}[K10_{mt} \geq 20]$ (binary). **Column (4):** $Mild_{mt}$, $Moderate_{mt}$, $Severe_{mt}$ (severity dummies; reference = Low).

Table 15: Robustness: Alternative Depression Measures

	(1) Std. K10	(2) Raw K10	(3) Binary	(4) Categories
K10 (standardized)	0.006			
	(0.049)			
K10 (raw, 10–50)		0.001		
		(0.008)		
Depressed (K10 $\geq$ 20)			0.013	
			(0.094)	
Mild (K10: 20–24)				0.027
				(0.107)
Moderate (K10: 25–29)				-0.003
				(0.127)
Severe (K10: 30–50)				-0.110
				(0.153)
Controls	Yes	Yes	Yes	Yes
EA + Wave FE	Yes	Yes	Yes	Yes
Observations	1,213	1,213	1,213	1,208
R^2	0.213	0.213	0.213	0.210

Notes: Standard errors clustered at the EA level. Dependent variable: $CogIndex_{it}$. Education subsample with full controls. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

5.2 Alternative Fixed Effects Specifications

Table 16 varies the fixed effects structure while keeping the same control set.

Specifications:

- Column (1): Pooled OLS — no fixed effects.
- Column (2): EA FE (α_e) + Wave FE (δ_t) — preferred.
- Column (3): District FE (α_d) + Wave FE.

- Column (4): Region × Wave FE ($\alpha_r \times \delta_t$).
- Column (5): Household FE (α_h) + Wave FE — identifies from within-household, across-sibling variation.
- Column (6): Child FE (α_i) + Wave FE — Eq. (2).

Table 16: Robustness: Alternative Fixed Effects Specifications

	(1) Pooled	(2) EA FE	(3) District	(4) Region×	(5) HH FE	(6) Child FE
Depression (std. K10)	−0.003	0.006	0.010	0.006	0.011	0.017
	(0.032)	(0.049)	(0.035)	(0.049)	(0.015)	(0.018)
Observations	1,242	1,213	1,237	1,213	11,319	6,583
R^2	0.008	0.213	0.112	0.213	0.286	0.478

Notes: Standard errors clustered at the EA level. Dependent variable: $CogIndex_{it}$. Columns (5)–(6) have larger N because time-invariant maternal controls are absorbed by the fixed effects, allowing more observations. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

The depression coefficient is insignificant across all six specifications, ranging from −0.003 to 0.017.

5.3 Subsample Analyses

Table 17 estimates Eq. (1) on six mutually exclusive subsamples.

Subsample definitions:

- Urban / Rural: Based on the EA's urban/rural classification in the GSPS sampling frame.
- Poor / Non-Poor: Split at the wave-specific median of $\ln(PCCons_{ht})$.
- No Education / Some Education: Based on $MEduc_m = 0$ vs. $MEduc_m > 0$.

Table 17: Robustness: Subsample Analyses

	(1) Urban	(2) Rural	(3) Poor	(4) Non-Poor	(5) No Educ	(6) Some Educ
Depression (std. K10)	0.095	−0.054	−0.084	0.069	0.000	−0.010
	(0.081)	(0.065)	(0.115)	(0.062)	(.)	(0.050)
Observations	453	760	538	626	11	1,200
R^2	0.228	0.211	0.309	0.264	0.498	0.215

Notes: Standard errors clustered at the EA level. All models include EA and wave FE. "No Educ" ($N = 11$) is uninformative due to extreme sample size. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

The null result holds across all subsamples with adequate sample size.

5.4 Additional Robustness Checks

- **Value-added model** (Table 22 in All_Tables.pdf). Estimated in first differences:

$$\Delta CogIndex_{it} = \beta_0 + \beta_1 \Delta D^{\text{std}}_{mt} + \beta_2 Age_{it} + \beta_3 Female_i + \delta_t + \varepsilon_{it}$$

  where Δ denotes the change between consecutive waves. $\hat{\beta}_1 = 0.012$ (SE $=$ 0.019), confirming the null in first differences.

- **Placebo and falsification tests** (Table 23). Three tests:
  1. *Reverse causality*: $D^{\text{std}}_{m,t+1} = \alpha_e + \delta_t + \beta_1 CogIndex_{it} + \mathbf{X}'\boldsymbol{\gamma} + \varepsilon$. Tests whether child cognition predicts *future* maternal depression. $\hat{\beta}_1 = 0.025$ (SE $= 0.030$) — not significant.
  2. *Temporal precedence*: $CogIndex_{i,t+1} = \alpha_e + \delta_t + \beta_1 D^{\text{std}}_{mt} + \mathbf{X}'\boldsymbol{\gamma} + \varepsilon$. Tests whether *current* depression predicts *future* cognition. $\hat{\beta}_1 = 0.040$ (SE $= 0.058$) — not significant.
  3. *Placebo outcome*: $Height^{15\text{–}17}_{it} = \alpha_e + \delta_t + \beta_1 D^{\text{std}}_{mt} + \mathbf{X}'\boldsymbol{\gamma} + \varepsilon$, restricting to adolescents aged 15–17 whose height is largely determined before the survey. $\hat{\beta}_1 = -1.336$ (SE $= 2.345$) — not significant.

- **Non-linear effects** (Table 24). Four functional forms:
  1. *Quadratic*: adds $(D^{\text{std}}_{mt})^2$. Neither the linear (0.028) nor quadratic (-0.025) term is significant.
  2. *Tercile dummies*: $Tercile2_{mt}$ and $Tercile3_{mt}$ (most depressed). Neither significant.
  3. *Quintile dummies*: None of the four quintile indicators is significant.
  4. *Linear spline*: Allows different slopes below and above $K10 = 20$:

$$CogIndex_{it} = \ldots + \beta_{\text{low}} \cdot K10_{mt} \cdot \mathbb{1}[K10_{mt} < 20] + \beta_{\text{high}} \cdot K10_{mt} \cdot \mathbb{1}[K10_{mt} \geq 20] + \ldots$$

     Neither slope is significant ($\hat{\beta}_{\text{low}} = 0.009$, $\hat{\beta}_{\text{high}} = -0.005$).

- **Attrition correction** (Table 25). Inverse probability weighting (IPW):
  1. Estimate a logit model for panel continuation: $\Pr(\text{observed in wave } t+1 \mid \mathbf{Z}_{it})$ using depression, age, education, household size, consumption, and wave.
  2. Compute IPW weights: $w_{it} = 1/\hat{p}_{it}$, trimmed at the 1st and 99th percentiles.
  3. Re-estimate Eq. (1) using w_{it} as analytical weights.

Result: $\hat{\beta}_1 = 0.008$ (SE $= 0.049$), virtually identical to the unweighted estimate of 0.006.

- **Alternative cognitive outcomes** (Table 26). Estimates Eq. (1) replacing $CogIndex_{it}$ with: (1) standardized Raven's score only ($\hat{\beta}_1 = -0.001$, SE $= 0.012$); (2) verbal composite = average of standardized math and English scores ($\hat{\beta}_1 = 0.006$, SE $= 0.049$). Both null.

- **Alternative standard error clustering** (Table 27). Eq. (1) re-estimated with: (1) EA clustering (baseline); (2) household clustering; (3) district clustering; (4) two-way (EA $\times$ wave) clustering. Point estimates are identical ($\hat{\beta}_1 = 0.006$); standard errors range from 0.043 (household) to 0.049 (EA).

6 Summary of Findings and Discussion

Table 18 consolidates the key findings across all analyses.

Table 18: Summary of Key Findings

Analysis	Key Result	$\hat{\beta}_1$	Sig.?
Main Estimation — Full Sample ($N \approx$ 12,000, EA FE, no educ)			
Cog index (EA FE, pref.)	Precisely estimated null	0.002	No
Cog index (OLS)	Null	−0.005	No
Cog index (Child FE)	Null	0.014	No
Cog index (ages 5–10)	Null	0.001	No
Main Estimation — Education Subsample ($N \approx$ 1,200)			
Cog index (EA FE, w/ educ)	Null, large SE	0.006	No
Additional Specifications (Full Sample)			
Raven's score only	Null	−0.005	No
Binary depression	Null	0.006	No
Severity: severe	Null	−0.015	No
Dep. × age interact.	Null interaction	−0.000	No
Lagged depression	Null	0.000	No
Persistent depression	Null	0.015	No
Heterogeneity by Age (Full Sample)			
Ages 5–9	Null	−0.007	No
Ages 10–14	**Significant positive**	**0.030**	**
Ages 15–17	Suggestive negative	−0.049	No
Anthropometry (Education Subsample)			
HAZ (std. K10)	Null	0.030	No
WAZ (binary dep.)	Marginal positive	0.087	*
Mechanism / Channels (Education Subsample)			
Read/HW time	**Significant negative**	−0.278	**
Food expenditure	Null	−0.039	No
Food share	Null	0.001	No
HAZ	Null	0.030	No
Child illness	Null	−0.021	No
Immunization	Null	0.004	No
Robustness (Education Subsample)			
Alt. FE (6 specs)	All insignificant	—	No
Subsamples (6 groups)	All insignificant	—	No
Value-added (Δ) model	Null	0.012	No
IPW attrition correction	Unchanged	0.008	No
Non-linear (4 specs)	All insignificant	—	No
Alt. clustering (4 types)	All insignificant	—	No

Notes: Main estimation results from the preferred specification (Eq. 1: EA + wave FE, full sample, no maternal education). Additional specifications, heterogeneity by age, and mechanism channels as indicated. $\hat{\beta}_1$ is the coefficient on the depression measure (see Section 1). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

The main takeaways from the analysis are as follows.

1. **Maternal depression has no significant direct effect on child cognitive development.** In the preferred EA fixed effects specification on the full sample ($N = 11{,}958$), the coefficient on standardized K10 depression is $\hat{\beta}_1 = 0.002$ (SE $= 0.010$, $p = 0.834$). This precisely estimated null—with a 95% CI of $[-0.018, 0.022]$—rules out effects larger than 2.2% of a standard deviation. The null holds across all alternative specifications: pooled OLS, child fixed effects, alternative depression measures (binary, severity categories, lagged, persistent), and individual cognitive tests.

2. **The null is not an artifact of sample selection.** An important methodological finding is that conditioning on maternal education—available for only 10% of the sample—reduces sample size from ∼12,000 to ∼1,200 without meaningfully changing the point estimate (0.006 vs. 0.002). The full-sample EA fixed effects specification provides far greater statistical power (SE $= 0.010$ vs. 0.049) and should be the preferred specification. The null result established on the full sample is definitive.

3. **One exception: a significant positive effect for children aged 10–14.** Among children aged 10–14 ($N = 5{,}135$), a one standard deviation increase in maternal depression is associated with a 0.030 SD *improvement* in cognitive scores ($p = 0.047$). This counterintuitive finding is consistent with the unconditional evidence that depressed mothers spend significantly more time reading and doing homework with their children (Table 2: 1.19 vs. 0.85 hours, $p < 0.01$), possibly reflecting compensatory parental investment among mothers of school-age children. For younger children (ages 5–9), the coefficient is small and negative (-0.007, $p = 0.626$); for adolescents aged 15–17, the coefficient is more negative (-0.049, $p = 0.111$) but not significant.

4. **Depression does reduce parental time investment.** The one significant channel finding is that maternal depression reduces reading and homework time with children by 0.28 hours per day ($p < 0.05$), representing a 29% reduction from the mean. This is consistent with theoretical predictions that depression reduces the quality and quantity of parental engagement.

5. **The time investment reduction does not translate into cognitive deficits.** Despite the significant reduction in parental time, children's cognitive outcomes are unaffected on average. Possible explanations include: (a) compensating investments by other household members (consistent with the relatively large household size of 5.9 and the extended family structure common in Ghana); (b) low

marginal productivity of additional parental time in this context; (c) the possibility that *quality* of engagement (unobserved) matters more than *quantity*; or (d) the counteracting positive association between depression and time investment for school-age children, as suggested by the age-heterogeneity results.

6. **No other channels show significant effects.** Food expenditure, child nutritional status, child illness, care-seeking behavior, and immunization rates are all unrelated to maternal depression in this sample.

7. **Results are robust across an extensive battery of checks.** The null finding survives alternative depression measures, six fixed effects specifications, six subsample splits, non-linear models (quadratic, terciles, quintiles, spline), a value-added model, attrition correction via IPW, alternative cognitive outcome measures, and four standard error clustering approaches.

Data: Ghana Socioeconomic Panel Survey (GSPS), Waves 1–3 (2009, 2012, 2018). Combined $N = 13{,}746$ mother–child pairs; preferred EA FE sample $N = 11{,}958$ (full sample, no education control); education subsample $N \approx 1{,}213$.
Standard errors: Clustered at the enumeration area (EA) level throughout.
Complete results: Available in the `rersults/Draft1_Feb2026/All_Tables.pdf` document (Tables 1–27).