

# Do Psychosocial Stimulation, Parental Distress and Early Childhood Education Enrollment Show Different Associations with Early Childhood Development Outcomes for Boys and Girls?

Findings from a Phone Survey in Pakistan

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## Abstract

This study examined whether psychosocial stimulation, parental distress, and enrollment in pre- primary education had different associations with early child development outcomes for boys and girls in Pakistan. Using data from a nationally representative phone survey in Pakistan, it assessed these relationships for two cohorts of children—those aged 0–35 months and those aged 36–72 months. The study found that among very young children (0–35 months), lower parental distress and higher psychosocial stimulation were strongly associated with better child development for both boys and girls. Girls were more sensitive to higher levels of parental distress and lower levels of psychosocial stimulation than boys. On average, girls in the sample fared worse compared to boys in their developmental

outcomes in the context of low levels of stimulation and high levels of parental distress. Among the older age cohort (36–72 months), lower psychosocial stimulation and higher parental distress were each similarly associated with lower child development outcomes, regardless of child gender. Access to early childhood education was associated with better child development outcomes for both genders. The results confirm existing evidence that early learning opportunities in the first six years of life are important supports for promoting early child development for all children and suggest that girls aged 0–35 months in this sample may be uniquely sensitive to psychosocial stimulation and parental distress.

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**Do Psychosocial Stimulation, Parental Distress and Early Childhood Education Enrollment Show Different Associations with Early Childhood Development Outcomes for Boys and Girls? Findings from a Phone Survey in Pakistan<sup>♦</sup>**

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## Introduction

The importance of children's early development for subsequent educational attainment, economic productivity and lifelong health has been captured in a wide body of literature which explores the risk and protective factors associated with early child development (ECD) (Walker et al., 2011; McDonald et al., 2016; Donald et al., 2019). Risk factors often include poverty, lack of maternal education, and the health of the caregiver and child (Donald et al., 2019; McDonald et al., 2016). Protective factors often include enrollment in early childhood education (ECE), engaging and responsive interactions, and supportive social connections. These studies underscore the complex ways that risk and protective factors influence ECD. Fewer studies, however, have empirically examined the role that child gender plays within these relationships.

Studies examining differences in ECD by child gender at the country, regional, and global levels have typically found either no significant differences or small to moderate differences favoring girls (Lu et al., 2020; McCoy et al., 2016; Rey-Guerra et al., 2023). Early differences can last and manifest in differences in primary school performance, as was found in rural Indonesia (Nakajima et al., 2019). Associations of early risk and protective factors with ECD (Donald et al., 2019) and later outcomes for education and health (Stith et al., 2003; Hamil-Luker and O'Rand, 2007) vary by gender, with effects favoring boys or girls differently based on exposure type, outcomes, and geographic context. Therefore, investigating the relationship between child gender, exposure to risk and protective factors, and development in the early years may yield important insights about long-term gender inequities in human development outcomes.

Understanding these patterns is crucial for ensuring gender equitable outcomes for children from a life-course perspective, particularly in settings where this research remains limited. Untangling the relationships of ECD and child gender is complicated by numerous interrelated factors, including links to biological processes; social processes, such as gendered caregiving and peer norms and expectations; and even country-level measures of gender inequality (Rey-Guerra et al., 2023)—all of which vary across countries and sociocultural contexts.

In Pakistan, stark gender inequities persist in employment, education, and training (World Bank, 2023). As of 2018, only 23% of women participated in the labor force compared to 81% of men (World Bank, 2023). As of 2019, more girls aged 5-16 were out of school than boys (37% vs. 25%, respectively), and boys spent on average 1.4 more years in school than girls (World Bank, 2023). Although ECE enrollment is low for all children aged 3-5 years, with a national average enrollment rate of 19% as of 2020, across provinces enrollment rates are between 1 and 3 percentage points lower for girls (Tomlinson et al., 2023). A prior study examined associations between risk and protective factors with child development and school readiness outcomes in Pakistan, finding strong associations between better child outcomes and higher levels of psychosocial stimulation and lower levels of parental distress. However, relationships with gender remain unexplored (Hentschel et al., 2023) in part because of the complexity of the interconnections among ECD, risk and protective factors, and child gender. A study in rural Sindh examined gender differences in the associations of ECD outcomes with measures of brain activity and found that brain activity and verbal ability were positively related in 48-month-old girls but not boys. The authors present several possible explanations for this including biological, environmental, or sociocultural factors, but call for future research to examine these relationships (Tarullo et al., 2017).

This study contributes to the existing evidence base by exploring whether child gender moderates the association between ECD outcomes and three risk and protective factors for which

there is strong evidence of direct effects on these outcomes in Pakistan: parental distress, psychosocial stimulation, and ECE enrollment.

### **Understanding risk and protective factors**

We first summarize what is known about the relationship between the risk factor of parental distress and protective factors of psychosocial stimulation and ECE enrollment with respect to child development outcomes, emphasizing evidence for differential distributions and effects on ECD outcomes by gender, both globally and within Pakistan.

#### ***Parental distress***

Globally there is strong consensus that parental distress poses a risk to children's development outcomes (Ahun et al., 2018; Downey & Coyne, 1990; Fisher et al., 2012; Goodman et al., 2011; Walker et al., 2011; McDonald et al., 2016; Sweeney & MacBeth, 2016). Studies from Pakistan, though limited, have confirmed these associations; for example, a study in rural Rawalpindi identified significant associations between maternal depression and increased instance of child mental health problems at 7 years of age (Maselko et al., 2016).

Less evidence exists regarding differences in effects of parental distress on ECD outcomes by child gender. A recent global meta-analysis synthesizing results from 12 studies examining differences in the association between maternal depression and children's cognitive development by child gender found that the overall association was significant for boys [Hedges'  $g = -0.36$  (95% CI:  $-0.60$  to  $-0.11$ )], but not among girls [ $-0.17$  (95% CI:  $-0.41$  to  $0.07$ )] (Ahun et al., 2020). Explanations offered for the overall higher levels of sensitivity to maternal depression among boys pointed to potential protective effects of the maturational advantage in cognitive skill development (e.g., developing earlier reading skills) that has been identified for girls, which may buffer against negative effects (Ahun et al., 2020). However, only six of the studies examined outcomes in early childhood (i.e., age 5 years or below; Murray et al., 1996; Paquin et al., 2020; Cornish et al., 2005; Donald et al., 2019; Nolvi et al., 2018; Sharp et al., 1995), and findings regarding heterogeneity of effects by child gender varied across these studies. Additionally, a study from Pakistan found that the correlation between prenatal maternal depression and child mental health problems at age 7 was stronger for boys than girls (Maselko et al., 2016).

With respect to paternal depression, research is more limited. A prior systematic review found paternal depression to similarly be negatively associated with child behavior outcomes, though none of the included studies were conducted in low- or middle-income countries (Sweeney & MacBeth, 2016). The most common pathways through which paternal depression negatively influenced child outcomes were negative parenting behaviors, such as hostility and negative expressiveness, and marital conflict (Sweeney & MacBeth, 2016). Existing studies do not show consistent patterns by child gender (Sweeney & MacBeth, 2016). However, evidence from the U.K. suggests that young boys may be more vulnerable to the effects of paternal depression than young girls, specifically when examining conduct problems and difficult temperament (Hanington et al., 2009; Ramchandani et al., 2005; Ramchandani et al., 2008).

#### ***Psychosocial Stimulation***

A large, global evidence base indicates the importance of psychosocial stimulation (defined as developmentally-appropriate interactive activities, such as play, singing, and talking (Britto et al., 2017b)) in promoting child wellbeing and development in the early years (Cabrera et al., 2020; Cuartas et al., 2023; Jeong et al., 2016). Evidence from Pakistan has similarly identified significant

positive associations between psychosocial stimulation and a range of ECD outcomes (Avan et al., 2014; Armstrong-Carter et al., 2021). Yet global survey data that measure psychosocial stimulation—with minimum adequate levels of stimulation represented by the presence of four or more stimulating activities with a child in the past 3 days—suggest that in South Asia, levels of minimum adequate stimulation are low: on average, just 41% of children receive adequate stimulation from maternal caregivers, 12% from paternal caregivers, and 23% from other caregivers, signaling a broader need for increased stimulation for young children (Cuartas et al., 2020).

Few studies from South Asia have examined differences in psychosocial stimulation by child gender. A study in Bangladesh found that girls experienced higher levels of certain aspects of stimulation (i.e., responsiveness, encouragement, emotional, and learning opportunities) relative to boys (Hossain et al., 2018), though children were slightly older (aged 8 years) and authors caution that the magnitude of this association was substantively low.

Even fewer studies have examined whether the strength of the associations between ECD and psychosocial stimulation varies by child gender. Evidence for moderation by child gender from a recent study in rural Sindh is mixed: at age 4 years, home stimulation had a significant positive association with verbal skills for boys, but not for girls. However, there was no significant interaction between child gender and stimulation in predicting executive function skills (Rathore et al., 2023).

### ***Early Childhood Education (ECE) Enrollment***

There is substantial support indicating that ECE is positively associated with outcomes for children's early learning and development (Rao et al., 2021). Meta-analytic findings from the US also indicate that ECE is associated with a number of desirable medium- and longer-term outcomes, including reduced special education placement ( $d=0.33$  SD), reduced grade retention ( $d=0.26$  SD), and increased high school graduation ( $d=0.24$  SD) (McCoy et al., 2017).

In Pakistan, ECE enrollment rates are low, with estimates across provinces ranging from 5.2 (Balochistan Province) to 27 percent (Punjab Province) (Tomlinson et al., 2023). Findings from a recent study found that children enrolled in ECE had higher rates of on-track development compared to children who were not enrolled (74 vs 52 percent respectively for Punjab in 2017-2018) (Tomlinson et al., 2023). There was also evidence of emerging gender disparities in ECE enrollment rates, with lower enrollment rates by one to three percentage points among girls across provinces (Tomlinson et al., 2023).

Despite widespread agreement surrounding the benefits of ECE for children's development, less is known regarding effects of ECE enrollment by gender. A 2016 meta-analysis synthesizing findings across 36 reports from the US examined differences in the effects of ECE on a range of outcomes and found a statistically significant gender difference in cognitive and achievement outcomes that slightly favored girls (cognitive outcomes: 0.32 SD and 0.29 SD; achievement outcomes: 0.22 SD and 0.18 SD, for girls and boys respectively). However, the study identified larger effects for boys than girls on longer-term school outcomes (e.g., grade retention, special education classification) ( $-0.04$  SD for girls and  $0.36$  SD for boys) (Magnuson et al., 2016). Other evaluations of US-based programs have similarly found variation in the types of longer-term outcomes experienced by boys and girls (McCoy et al., 2017; Heckman et al., 2010; Schweinhart et al., 2005).

### **This study**

This study examines the potential moderating role of child gender in the association between ECD outcomes and selected risk and protective factors. The factors studied here are those for which there is prior evidence of direct effects on ECD outcomes in Pakistan (Hentschel et al., 2023). Specifically, this study focuses on children from two age cohorts: ages 0-35 months and 36-72 months. It examines the extent to which child gender moderates the associations of parental distress (risk factor), psychosocial stimulation (protective factor) and enrollment in ECE (protective factor) with ECD outcomes. This study seeks to address the following research questions:

1. How does the distribution of key risk and protective factors and relevant demographics vary by child gender for children aged 0-35 months and 36-72 months?
2. Are the relationships between risk and protective factors and early child development outcomes moderated by child gender for children aged 0-35 months and 36-72 months?

Given the dearth of evidence surrounding this topic in the Pakistani context, this study is exploratory in nature and aims to inform future investigations of early influences of child gender on ECD in Pakistan.

## **Methods**

### **Procedure**

This paper uses data from a nationally representative phone survey in Pakistan conducted by Gallup Pakistan from December 2021 to February 2022.<sup>1</sup> Data were collected by phone due to health protocol restrictions in place during the COVID-19 pandemic. Participants included caregivers with at least one child aged 72 months or younger. For each participant, one focal child was selected. Focal child selection was stratified according to child gender (ensuring a 1:1 ratio of boys to girls) and age (ensuring a 1:1 ratio of 0-35-month-olds to 36-72-month-olds). Participants were identified using random digit dialing (RDD) of mobile phones, drawing on Pakistan's four telecom providers with active numbers. Interviewers made up to three calls to reach individuals identified through RDD. Upon accepting the invitation to participate, individuals were administered a screening questionnaire, followed by the full survey. Interviewers recorded all answers on a tablet using Survey CTO. Post-stratified weighting was applied to ensure the sample was generalizable to the national population. Weights were created using strata for province and region (urban/rural). A detailed overview of study procedures was previously published (Hentschel et al., 2023).

### **Analytic sample**

In total, 3,907 individuals were contacted, of whom 448 declined to participate, 438 completed the interview in-part, and 3,021 completed the interview in full. The final representative sample of households across four provinces included 2,852 participants from Punjab (n=1,301), Sindh (n=425), Khyber Pakhtunkhwa (n=903), and Balochistan (n=223), comprising 1,366 caregivers of children aged 0-35 months and 1,486 caregivers of children aged 36-72 months.<sup>2</sup>

### **Missing data**

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<sup>1</sup> All authors previously received certification in protecting human subjects in research, and survey protocols/procedures followed relevant local rules and protocols.

<sup>2</sup> Some observations were dropped as they were not geographically representative.

There was minimal missingness in the data among the final sample of 2,852 participants. We imputed all missing data using the `-mi impute chained-` command in Stata 17 to create 30 complete, imputed datasets on which multivariate regression analyses were conducted ( $n=2,852$ ). Missingness at the item and outcome level was low, ranging from 0 – 5%. Logit models indicated that missingness was not associated with observed covariates and outcomes, with one exception.<sup>3</sup> Separate datasets were imputed for each child age group (0-35 months and 36-72 months). Following procedures recommended by White et al. (2010), within each age group, our models allowed for separate imputations by child gender to minimize bias in exploring interactions with child gender.

## Measures

### *Child development outcomes*

#### *Early child development*

Early child development, defined as the essential physical, motor, cognitive, social-emotional and language skills that children develop early in life (Britto, 2017a), was measured for children aged 0-35 months using the short-form Caregiver-Reported Early Development Instrument (CREDI) (McCoy et al., 2018), a 20-item culturally and linguistically neutral questionnaire assessing four domains of development: motor, language, cognition, and social-emotional development. The tool has previously been tested for feasibility and validity and has been used in the Pakistani context (Hentschel et al., 2023; McCoy et al., 2019). Yes/no items were completed by the respondent caregiver about the focal child, asking about developmentally appropriate skills specific to one of six age groups: 0–5, 6–11, 12–17, 18–23, 24–29, and 30–35 months. De-identified data were scored using the CREDI Scoring App (McCoy et al., 2018). Non-yes/no responses are treated as missing, and observations with fewer than 5 yes/no responses do not receive a score from the app. Scores were standardized by age group, and differences in scores were interpreted in standard deviation units. Internal consistency for each age group was adequate (Cronbach's alpha coefficient ranging from 0.62 to 0.94).

#### *School readiness*

School readiness, defined as children's development and early learning skills across multiple dimensions of development relevant for school entry, including early academic skills, social-emotional development, and motor development (Snow, 2006; Wolf et al., 2017), was assessed for children aged 36-72 months using adapted items from the Measuring Early Learning Quality and Outcomes (MELQO)-Measure of Development and Early Learning (MODEL) Teacher/Caregiver report (UNESCO, 2017) following expert guidance to ensure socio-cultural relevance. The tool included 25 yes/no questions completed by the respondent caregiver about the child to evaluate school readiness skills across three subdomains: math knowledge and skills, language and literacy knowledge and skills, and socio-emotional development. Twenty of the 25 items are included in the Anchor Items for Measurement of Early Childhood Development (AIM-ECD) tool (World Bank, 2022) which has previously been administered across Pakistan (Ansari et al., 2024). 'Don't know' responses were treated as missing. Based on the distribution of missingness, minimum

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<sup>3</sup> Missingness in the MELQO-MODEL domain scores for language and literacy knowledge and skills and socio-emotional development was associated with lower psychosocial stimulation z-scores. No associations with missingness were found at the item level.

thresholds to receive domain scores were set: 4/6 items with yes/no responses for math, 8/10 for language, and 6/9 for socio-emotional development. Overall scores were computed only if all domain scores were present. Internal consistency across the three subdomains was adequate (Cronbach's alpha coefficients of 0.79 (math), 0.94 (language), and 0.81(socio-emotional development)).

### ***Risk Factor***

#### ***Parental distress***

A survey-specific measure was used to assess participants' level of distress in the previous 15 days. This included five yes/no questions asking if the participant found it difficult to be affectionate to their child, had been more irritated or angry than usual, found it difficult to sleep, was nervous or anxious, or had been unable to control their worry. Scores ranged from 0 – 5, with 5 indicating the highest level of distress. 'Don't know' responses were treated as missing. Based on the distribution of missingness, the minimum threshold to receive a score was 3/5 items with yes/no responses. Internal consistency was adequate (Cronbach's alpha coefficient of 0.87).

### ***Protective factors***

#### ***Psychosocial stimulation***

Psychosocial stimulation in the home environment was assessed using the Early Learning Indicator Tool (Hentschel et al., *in preparation*). The tool includes 14 yes/no questions regarding the availability of playthings in the home and the amount of caregiver-provided engaging interactions in the last 24 hours. The tool was previously developed and used in Pakistan, and there is evidence supporting its validity in this context (Hentschel et al., 2023; Hentschel et al., *in preparation*). Scores range from 0 -14, with 14 indicating the highest level of psychosocial stimulation. Internal consistency was adequate (Cronbach's alpha coefficient of 0.85).

#### ***Early childhood education (ECE) enrollment***

Early childhood education (ECE) enrollment was assessed for focal children aged 36-72 months by asking respondents an open-ended item regarding where the child attends school. Responses included the pre-primary service provided in public schools ("*Katchi*"), pre-primary, ECE, play group, and preparatory class.

### ***Socio-demographics***

The moderating variable, child gender, was recorded based on the participant's report of whether the focal child was male or female. Additional socio-demographic variables served as covariates. Maternal and paternal education levels were grouped into two categories: completed less than a primary school education and completed primary school or higher. Maternal and paternal educational attainment levels were collected for all children. Rural residence was recorded based on the participant's report of whether they lived in an urban or rural area. To assess household size, participants were asked the question "How many people are there in your household?" and answers were recorded as a count of the total number of household members; individual-level data on household members were not collected. Participants also reported their province of residence, the respondent's gender, the child's age, and the household's average monthly expenditure on the mobile phone. Monthly expenditure on a mobile phone was used as a proxy measure for income

because directly asking about income was gauged to be both a sensitive question and potentially difficult to report in the context of irregular income streams.

### **Statistical Analysis**

All analyses were conducted in Stata Version 17.0. Survey probability weights were applied. For all regression analyses, we used Stata's 'svy' prefix to account for the complex survey design, employing linearized standard errors. Analyses were conducted separately by child age group, as child development outcomes were measured differently for the two age groups (i.e., CREDI for children ages 0-35 months and MELQO-MODEL for children ages 36-72 months). Additionally, examining these age groups separately has a conceptual justification, in that prior qualitative evidence from rural communities in Pakistan has found that children's experiences of individual, family and household, community, social and cultural factors can vary as the child ages and becomes increasingly mobile and independent (Jeong et al., 2018). This includes how mothers and fathers differently engage with their children (Jeong et al., 2018). Disaggregating by child age allowed us to more precisely explore the relationship between child gender and key risk and protective factors across the early childhood period.

Risk and protective factors were selected a priori informed by literature indicating associations of variables of interest with child development outcomes in Pakistan and globally (Hentschel et al., 2023; Rathore et al., 2023; Rahman et al., 2003; Tomlinson et al., 2023). Province, child age, caregiver gender and monthly expenditure on mobile phone (a proxy for income) were also identified a priori as covariates given existing evidence in the Pakistan context (Hentschel et al., 2023). We additionally controlled for sociodemographic variables including maternal and paternal education, rural residence, and household size. Descriptive statistics and bivariate associations of child development outcomes, risk and protective factors, and demographics with child gender were first summarized within each age group in the non-imputed data. Bivariate relationships were explored using Pearson chi squared tests for categorical and dichotomous variables and unadjusted Ordinary Least Squares (OLS) linear regression for continuous variables. We adjusted for multiple hypothesis testing by computing sharpened false discovery rate (FDR) q-values for each of the bivariate associations (Benjamini et al., 2006; Anderson, 2008).

To answer research question 2, we conducted an initial exploratory analysis running separate multivariate OLS linear regression models for each risk or protective factor (henceforth factor) to examine whether child gender is a moderator in the association between the factor and child development outcomes in the imputed datasets. Prior to imputation, z-scores were computed for variables for school readiness, psychosocial stimulation, and parental distress using survey-weighted means and standard deviations to support interpretation of coefficients. A separate regression analysis was conducted for each factor. Model 1 contained the risk or protective factor and child gender as discrete predictors and child development as the outcome, adjusted for socio-demographic covariates. Model 2 additionally included the interaction between the factor and child gender. We adjusted for multiple hypothesis testing across interaction terms within each age group by computing sharpened false discovery rate (FDR) q-values (Benjamini et al., 2006; Anderson, 2008).

Lastly, we used multivariate OLS regression to simultaneously test associations of child gender, risk or protective factors and their interactions with child development outcomes in a fully interacted model. For each age group, direct effects of all independent variables on ECD were first

examined in Model 1, and all interaction terms with child gender were subsequently included in Model 2.

Interactions from the fully interacted model were further examined by calculating simple slopes and plotting marginal means of child development scores for boys and girls at varying levels of the risk/protective factor (i.e., at values of 0 or 1 for dichotomous variables and from -1 to 1 standard deviations below and above the mean for standardized continuous variables).

## Results

### **Descriptive statistics and bivariate associations of key variables with child gender**

Table 1 summarizes the descriptive statistics and bivariate associations in order to understand how the distribution of key risk and protective factors and relevant demographics varied by child gender for children aged 0-35 months and 36-72 months. Estimated ECE enrollment in our sample was higher (35%) than estimates from the 2019-2020 Pakistan Social and Living Standards Measurement (PSLM) (19%). The estimate of the percentage of the population residing in rural areas aligns with findings from other national surveys (United Nations Population Division's World Urbanization Prospects, 2018). Distributions of child development outcomes and risk and protective factors showed no significant differences by child gender for either age group. Initially, unadjusted results indicated a higher proportion of male caregiver respondents for boy children (84%) compared to girl children (79%) in the older age group. However, this difference was not statistically significant after adjusting for multiple hypothesis testing. Overall, in the sample, a majority of caregiver respondents were male (78%). Additionally, in both age groups, the average age of girls was slightly younger (~1 month) compared to boys, and households with girls had a marginally lower mean monthly expenditure on mobile phone compared to those with boys, though these differences were not statistically significant.

### **Associations between risk/protective factors and child development, and variation by child gender**

Appendix Table I presents results from multivariate regression analyses where each risk and protective factor is examined separately. Table 2 provides results from multivariate regression analyses that simultaneously evaluate all the risk and protective factors together. Figures 1-3 summarize the results using marginal effects.

#### ***Parental distress***

In the analysis for younger children (0-35 months), Appendix Table I Model 1 demonstrates a negative direct association of parental distress ( $\beta = -0.12$ ,  $p < 0.001$ ) with early child development (ECD). Appendix Table I Model 2 indicates this direct association was further qualified by a significant interaction between parental distress and child gender interaction ( $\beta = -0.13$ ,  $p = 0.031$ ), where the negative association between parental distress and child development was stronger for girls than boys. The interaction term remained significant after adjusting for multiple hypothesis testing. Table 2 presents results after accounting for other risk and protective factors. Here, Model 1 confirms the negative association between parental distress and early child development ( $\beta = -0.09$ ,  $p < 0.001$ ) and Table 2 Model 2 further indicates a stronger negative association with parental distress for girls relative to boys ( $\beta = -0.12$ ,  $p = 0.008$ ).

To further probe this interaction, Figure 1 shows the marginal effects of parental distress on early childhood development outcomes for boys and girls based on the estimates in Table 2

Model 2. As seen in Figure 1, among children aged 0-35 months, parental distress had a negative association with ECD for girls ( $\beta = -0.16, p < 0.001$ ). On average, a one standard deviation increase in parental distress corresponded to a 0.16 standard deviation decrease in the CREDI z-score for girls, after adjusting for risk/protective factors and socio-demographic characteristics. In contrast, for boys, though still negative, this association was smaller in magnitude and not statistically significant ( $\beta = -0.04, p = 0.138$ ). As Figure 1 demonstrates, among the younger cohort, the difference in ECD between boys and girls widened as parental distress scores increased. Specifically, on average girls aged 0-35 months in the sample had lower ECD outcomes compared to boys at high levels of parental distress.

In examining associations among older children (36-72 months), we found no relationship between parental distress and ECD, nor did this association vary by child gender.

### ***Psychosocial stimulation***

For younger children (0-35 months), Appendix Table I Model 1 findings reveal a strong positive direct association between psychosocial stimulation and early child development ( $\beta = 0.54, p < 0.001$ ). Appendix Table I Model 2 further shows that this positive association was stronger for girls than for boys, as indicated by a significant interaction between psychosocial stimulation and female child gender ( $\beta = 0.10, p = 0.043$ ). The interaction term remained significant after adjusting for multiple hypothesis testing across models. These patterns persisted after adjusting for other risk and protective factors, as presented in Table 2. Here, Model 1 confirms the positive association between stimulation and child development scores for both genders ( $\beta = 0.54, p < 0.001$ ), and Model 2 indicates an even stronger positive association for girls ( $\beta = 0.09, p = 0.049$ ).

Figure 2 presents the marginal effects of psychosocial stimulation on child development for boys and girls, based on estimates from Table 2 Model 2. Figure 2 illustrates that for the younger cohort (0-35 months), psychosocial stimulation was strongly positively associated with child development for both genders, but this association was statistically significantly stronger for girls. Girls were more sensitive to changes in psychosocial stimulation compared to boys: a one standard deviation increase in psychosocial stimulation corresponded to an average 0.56 standard deviation increase in the CREDI z-score for girls ( $\beta = 0.56, p < 0.001$ ), compared to a 0.49 standard deviation increase for boys ( $\beta = 0.49, p < 0.001$ ), after adjusting for risk/protective factors and socio-demographic characteristics. Figure 2 illustrates that gender differences in average ECD outcomes among children aged 0-35 months were apparent at lower levels of psychosocial stimulation. Within the younger cohort, on average ECD was lower for girls in the sample compared to boys in contexts of low psychosocial stimulation.

Following a similar pattern, Appendix Table I Model 1 shows a strong positive direct association between psychosocial stimulation and school readiness scores for older children (aged 36-72 months), although the magnitude was slightly smaller compared to that seen for younger children ( $\beta = 0.33, p < 0.001$ ). Table 2 Model 1 confirms this association remained significant even after adjusting for other risk/protective factors ( $\beta = 0.31, p < 0.001$ ). For older children, however, this association did not significantly vary by child gender.

### ***Enrollment in Early Childhood Education***

Among older children, Appendix Table I Model 1 demonstrates a strong positive direct relationship between enrollment in ECE and school readiness outcomes ( $\beta = 0.42, p < 0.001$ ). This association remained robust even after controlling for other risk and protective factors, as

evidenced in Table 2 Model 1 ( $\beta = 0.38$ ,  $p < 0.001$ ). Additionally, these data showed no significant interactions between ECE enrollment and child gender (see Figure 3).

## Discussion

The presence and patterns of gender disparities across domains in the early years of life have not been well explored in Pakistan. This study contributes to the knowledge base not only by exploring differences in distributions of risk and protective factors and outcomes by child gender, but also by investigating how a child's gender may moderate differential outcomes in the early years. Our findings indicate that distributions of ECD outcomes and risk or protective factors were similar for both boys and girls. Equally low levels of psychosocial stimulation for boys and girls support findings from prior work that overall levels of minimum adequate stimulation in South Asian populations are low (Cuartas et al., 2020). Levels may be particularly low in the present sample, given it comprises about 80% father caregivers, who on average provide lower levels of stimulation for children relative to other caregivers in the region (Cuartas et al., 2020). Average levels of parental distress were also similar by child gender, though under-reporting of potentially sensitive topics should be considered. Overall ECE enrollment rates in our sample were higher compared to the 2019-2020 PSLM survey (35% vs. 19%, respectively). Average enrollment rates were also slightly higher in our sample for girls than boys (two percentage point gap), though this was not statistically significant. The differences in the two survey results may be attributed to requirements for phone access for participation in the current survey. This approach systematically excludes the population in Pakistan that does not have a mobile phone (6%), typically those in the lowest wealth brackets (Pakistan Bureau of Statistics, 2021). Additionally, PSLM data were collected in 2019-2020 while the present data were gathered in late 2021/early 2022.

With respect to the second research question, we found some variables had strong positive associations regardless of child age and gender (psychosocial stimulation, ECE enrollment) and some associations were negative and further moderated by gender (parental distress, with girls showing greater sensitivity at ages 0-35 months than boys). Higher psychosocial stimulation was consistently and positively associated with better child development outcomes for both girls and boys and across both age cohorts. This was true even after controlling for relevant covariates, underscoring its powerful role in favorable child development. While psychosocial stimulation was a strong predictor of ECD outcomes for both girls and boys in the younger cohort (0-35 months), the slope for girls was marginally steeper. In other words, girls experienced lower ECD outcomes on average than boys when psychosocial stimulation levels were low. Among children aged 36-72 months, gender did not moderate the results; the presence of adequate stimulation was equally highly predictive of positive school readiness outcomes for both boys and girls. Results differ from prior work in rural Sindh, where stimulation was positively associated with verbal skills for 4-year-old boys but not for girls, and no differences in child gender were observed in associations between stimulation and executive functioning (Rathore et al., 2023). This discrepancy could stem from differences in measurement or outcome of focus. Rathore et al. used direct observation and mother-reports in the Home Observation for Measurement of the Environment Inventory (HOME; Caldwell & Bradley, 1984) to assess psychosocial stimulation and focused on verbal skills and executive function. In contrast, the current study uses phone-based caregiver-reports of stimulation and a multidimensional ECD outcome. Nonetheless, findings corroborate existing research affirming the essential role of psychosocial stimulation for

supporting ECD for all young children (Cuartas et al., 2023; Jeong et al., 2016; Avan et al., 2014; Armstrong-Carter et al., 2021).

Among the older cohort ECE enrollment significantly predicted ECD levels for both boys and girls. This is consistent with prior meta-analytic estimates which did not identify substantively meaningful differences by child gender in the effects of ECE on ECD outcomes (Magnuson et al., 2016). Future research in Pakistan should probe associations between ECE and longer-term school and learning outcomes, which have shown differences by child gender in other contexts (Magnuson et al., 2016; McCoy et al., 2017; Heckman et al., 2010; Schweinhart et al., 2005).

The composite index of parental distress used in this study was comprised of items measuring various aspects of psychological wellbeing (i.e., presence or absence of irritability, sleeplessness, worry, nervousness, and lack of ability to show affection) that collectively significantly impact parents' capacity to provide high-quality nurturing and responsive care to their young children. Current results confirm previous findings showing that parent psychological distress is a risk to child development in the earliest years; conversely, psychological health and wellbeing among parents is associated with better early childhood outcomes (Ahun et al., 2018; Goodman et al., 2011; Sweeney & MacBeth, 2016; Crnic et al., 2005; Semeniuk et al., 2023). This finding held true for both boys and girls aged 0-35 months in the current sample, yet the association was even stronger for girls than boys. That is, girls in the youngest group were more sensitive than boys to parental distress in ways detrimental to their development—although it is important to underscore that boys were also sensitive to parental distress. This pattern diverges from existing research in other contexts, which suggests that young boys may be more vulnerable to effects of maternal depression (Ahun et al., 2018). One explanation for these differences is that our sample primarily consists of fathers, and the differences in associations between paternal distress and ECD by child gender are less well-documented across contexts (Sweeney & MacBeth, 2016). After controlling for covariates, there was no significant relationship between parental distress among children aged 36-72 months. The lack of significance between parental distress and child outcomes in the older group may reflect the wider range of experiences to which children are privy by the preschool years, including interactions within and beyond the household, such as attendance in preschool (Jeong et al., 2018). We probed this hypothesis in our data by re-running analyses restricted to children not in ECE, though the association between parental distress and school readiness was still null.

These results suggest that when girls participate in opportunities for early learning and ECE, on average they accumulate benefits to the same degree as boys during the early childhood period. The lack of substantively different associations by gender for psychosocial stimulation and ECE enrollment for the older age group suggest that the presence of these factors is largely protective for all young children in Pakistan. Given the finding that psychosocial stimulation had a marginally stronger association with ECD for girls in the younger cohort, indicating lower ECD outcomes on average for girls compared to boys when psychosocial stimulation levels were low, attention should be afforded to ensuring girls' access to early learning opportunities in Pakistan, both through parenting support programs enhancing psychosocial stimulation at home and through greater access to high-quality ECE classrooms. Research points to evidence that general interventions to increase educational access in low- and middle-income countries lead to gains for girls that are comparable to girl-targeted interventions, suggesting that girls will benefit if Pakistan increases access to learning opportunities for all young children (Evans & Yuan, 2019).

The consistent, positive direct effects of psychosocial stimulation across both age groups affirmed its role as a crucial protective factor for child development. Its impact on child

development irrespective of child gender among the older age group and with some heterogeneity by gender in the younger age group illustrates the need for interventions to start early (from pregnancy), and they may protect against gender-based differences in development and school readiness levels emerging later in life. As yet, large-scale parenting education programs promoting psychosocial stimulation from pregnancy to 3 years are missing in Pakistan. While research in Pakistan and other South Asian countries such as India, Nepal, and Bangladesh have proven the effectiveness of supportive parenting programs on early stimulation and responsive care in improving ECD (Aboud et al., 2013; ARNEC, 2019; Devercelli et al., 2022; Hamadani et al., 2019; Yousafzai et al., 2014), there is need to expand these programs to scale.

Furthermore, given that parents' distress and depression levels in Pakistan are high (Atif et al., 2021; Fisher et al., 2012; Henstchel et al., 2023), increased access to mental health care for parents during the perinatal and early years could promote improved child development levels for all children and for girls in particular. Interventions through health systems in Pakistan have been proven effective at improving parental wellbeing and child development levels (Yousafzai et al., 2014; Yousafzai et al., 2015).

The use of existing community-based structures and delivery mechanisms that have strong local linkages have demonstrated positive results. Research across South Asia (Nahar et al., 2012; Andrew et al., 2020; Hamadani et al., 2019) has found community-based psychosocial stimulation initiatives that model play activities and beneficial caregiving approaches improved child-rearing practices of mothers and the quality of home environments. In Pakistan, the Lady Health Worker (LHW) Program could be one platform to leverage for operationalizing similar interventions. Recruiting local community members and respected health care workers has also been established as a successful approach (Rabanni et al., 2023; Yousafzai et al., 2014; Yousafzai et al., 2018). Mobilizing trained facilitators (such as LHWs) to impart parenting support could greatly benefit both children and parents, especially in vulnerable and hard-to-reach communities.

This study contributes to the limited knowledge base around ECD in Pakistan by shedding light on the presence and patterns of risk and protective factors and child outcomes as moderated by gender in the early years. Notably, the study focuses on a representative sample of households across four provinces, even during the era of COVID-19 closures, providing a rare snapshot of a uniquely stressful time. However, there are caveats that may limit the generalizability of the study. Data were collected during the pandemic. As such, additional research is needed to examine how the dynamics reported here may have changed in the aftermath of the pandemic. Because of the phone-based nature of data collection, responses were based on caregiver-report rather than direct observation (e.g., the psychosocial stimulation tool was developed for in-person data collection and adapted for the current study). Methodological reliance on access to a phone for participation in this survey systematically excluded the 6 percent of Pakistan that does not have a mobile phone (Pakistan Bureau of Statistics, 2021), and, because men are more likely than women to own and manage phones in Pakistani households, a large share of respondents in this survey were men who may not have been the target child's primary caregiver. As such, the data were most often not collected from the primary caregiver, and caregiver variables, such as parental distress, were most often paternal distress instead of maternal distress.

Other constraints in measurement should also be noted. For example, the measure for parental distress was developed for use in the survey and no additional evidence for validity is available, though Cronbach's alpha coefficient estimates indicate adequate internal consistency. Additionally, the measure of psychosocial stimulation focuses on activities conducted in the previous 24 hours, which may vary depending on the caregiver's scheduling or day of the week of

data collection. Moreover, given the nature of this phone survey, we were unable to capture the quality of ECE among children that were attending. Furthermore, given the periodic COVID-19-related partial and full school closures in the years preceding the study (Nagesh et al., 2022), rates of ECE enrollment do not necessarily reflect consistent attendance (particularly as only about 7% of those attending had access to virtual ECE services). We used a proxy measure for income, which was average monthly mobile expenditure; however, this proxy may not accurately reflect income levels, loss of income in the recent past, or socioeconomic status. Similarly, the proxy measure for household size may not accurately map onto nuclear versus extended family structure or represent older-sibling effects. The study did not allow us to parse the roles of birth order, siblings and family structure directly, an area befitting future research, especially for effects on girls. Future research may also examine how attitudes towards child gender influence caregiving behaviors and child outcomes. Additionally, we did not have district- or village-level data to examine potential COVID-19 shocks at a more granular level. Statistical approaches allowed for associational inference only rather than causal conclusions, particularly in light of the above limitations regarding omitted variables and measurement and design constraints. Lastly, this analysis is cross-sectional and therefore unable to explore how early investments and relationships may differentially be associated with future outcomes by child gender. Future studies could apply longitudinal designs to better understand the dynamic nature of these relationships.

## **Conclusion**

Our study examined the moderating role of child gender in the associations between parental distress, ECE enrollment, and psychosocial stimulation and ECD across two age cohorts. We found that higher parental distress had a negative association with ECD outcomes for very young children, with girls experiencing worse ECD outcomes than boys in the context of high levels of parental distress—although both boys and girls were sensitive to these distress levels. We also found that higher psychosocial stimulation had a strong, positive association with ECD across both age groups. This relationship was moderated by child gender among the youngest children, in which girls' ECD outcomes were marginally lower than boys' in instances of low stimulation. Finally, we found that ECE is strongly positively associated with ECD regardless of gender.

Our findings reaffirm the importance of investing in the psychosocial wellbeing of caregivers of young children and suggest that supports may be particularly beneficial for caregivers of girls in the earliest years in this context. This study also reinforces the need for early learning opportunities for young children under age 6. Results suggest that girls may especially benefit from efforts to raise parental awareness of the importance of stimulating environments. Taken together, our findings signal that investing in improved and scaled early learning opportunities, including nurturing and responsive interactions through stimulation and enrollment in high-quality ECE settings, can be promising strategies for fostering better ECD and later achievement outcomes in Pakistan for all children. Careful attention to child gender differences within this context may further enhance benefits, and further research on how to best support the wellbeing of female and male caregivers in their roles as providers of nurturing care to their young children is warranted.

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**Table 1. Descriptive Statistics and bivariate associations for Child Development Outcomes, Risk and Protective Factor Variables, and Covariates with Child Gender<sup>a</sup>**

|                                                                                         | Full<br>Sample<br>(N=2,852) | Children aged 0-35 months<br>N=1,366 |                   |                   | Children aged 36-72 months<br>N=1,486 |                        |                        |
|-----------------------------------------------------------------------------------------|-----------------------------|--------------------------------------|-------------------|-------------------|---------------------------------------|------------------------|------------------------|
|                                                                                         |                             | Overall<br>N=1,366                   | Boys<br>N=761     | Girls<br>N=605    | Overall<br>N=1,486                    | Boys<br>N=835          | Girls<br>N=651         |
| <b><i>Child development outcomes</i></b>                                                |                             |                                      |                   |                   |                                       |                        |                        |
| CREDI z-score, M (SE) <sup>c</sup>                                                      | NA                          | 0.00<br>(0.03)                       | 0.04<br>(0.04)    | -0.04<br>(0.05)   | NA                                    | NA                     | NA                     |
| School readiness score, M (SE) <sup>d</sup>                                             | NA                          | NA                                   | NA                | NA                | 16.64<br>(0.19)                       | 16.44<br>(0.26)        | 16.88<br>(0.28)        |
| <b><i>Risk factor</i></b>                                                               |                             |                                      |                   |                   |                                       |                        |                        |
| Parental distress <sup>e</sup> , M (SE)                                                 | 1.65<br>(0.04)              | 1.62<br>(0.05)                       | 1.63<br>(0.07)    | 1.60<br>(0.08)    | 1.68<br>(0.06)                        | 1.67<br>(0.08)         | 1.70<br>(0.08)         |
| <b><i>Protective factors</i></b>                                                        |                             |                                      |                   |                   |                                       |                        |                        |
| Psychosocial stimulation <sup>f</sup> , M (SE)                                          | 7.24<br>(0.08)              | 6.40<br>(0.12)                       | 6.41<br>(0.15)    | 6.39<br>(0.18)    | 7.99<br>(0.10)                        | 7.88<br>(0.13)         | 8.14<br>(0.16)         |
| Enrolled in ECE <sup>g</sup> , %                                                        | NA                          | NA                                   | NA                | NA                | 35.71%                                | 34.84%                 | 36.79%                 |
| <i>Of those in ECE, attending virtually at time of survey<sup>g</sup>, %</i>            | NA                          | NA                                   | NA                | NA                | 6.85%                                 | 5.45%                  | 8.49%                  |
| <b><i>Socio-demographics</i></b>                                                        |                             |                                      |                   |                   |                                       |                        |                        |
| Enrolled in primary school <sup>g</sup> , %                                             | NA                          | NA                                   | NA                | NA                | 13.49%                                | 14.48%                 | 12.27%                 |
| <i>Of those in primary school, attending virtually at time of survey<sup>g</sup>, %</i> | NA                          | NA                                   | NA                | NA                | 6.68%                                 | 8.81%                  | 3.58%                  |
| Respondent caregiver gender, %                                                          |                             |                                      |                   |                   |                                       |                        |                        |
| Male                                                                                    | 78.48%                      | 74.86%                               | 76.14%            | 73.27%            | 81.78%                                | 84.45% <sup>**b</sup>  | 78.48% <sup>** b</sup> |
| Female                                                                                  | 21.52%                      | 25.14%                               | 23.86%            | 26.73%            | 18.22%                                | 15.55% <sup>** b</sup> | 21.52% <sup>** b</sup> |
| Child age in months, M (SE)                                                             | 35.07<br>(0.48)             | 13.41<br>(0.29)                      | 13.89<br>(0.40)   | 12.81<br>(0.41)   | 54.81<br>(0.35)                       | 55.41<br>(0.46)        | 54.07<br>(0.52)        |
| Average monthly expenditure on mobile phone (Pakistani Rupees), M (SE)                  | 400.80<br>(11.77)           | 405.10<br>(17.47)                    | 414.22<br>(22.47) | 393.81<br>(27.47) | 396.88<br>(15.90)                     | 421.35<br>(22.62)      | 366.64<br>(21.90)      |
| Province, %                                                                             |                             |                                      |                   |                   |                                       |                        |                        |
| Punjab                                                                                  | 53.46%                      | 52.24%                               | 51.07%            | 53.70%            | 54.58%                                | 54.23%                 | 55.00%                 |
| Sindh                                                                                   | 23.27%                      | 24.34%                               | 24.75%            | 23.83%            | 22.30%                                | 21.05%                 | 23.85%                 |

|                                           | Full<br>Sample<br>(N=2,852) | Children aged 0-35 months<br>N=1,366 |                |                | Children aged 36-72 months<br>N=1,486 |                |                |
|-------------------------------------------|-----------------------------|--------------------------------------|----------------|----------------|---------------------------------------|----------------|----------------|
|                                           |                             | Overall<br>N=1,366                   | Boys<br>N=761  | Girls<br>N=605 | Overall<br>N=1,486                    | Boys<br>N=835  | Girls<br>N=651 |
| Khyber Pakhtunkhwa                        | 17.27%                      | 17.58%                               | 17.91%         | 17.18%         | 16.98%                                | 18.56%         | 15.03%         |
| Baluchistan                               | 6.00%                       | 5.84%                                | 6.28%          | 5.29%          | 6.15%                                 | 6.16%          | 6.12%          |
| Maternal education level                  |                             |                                      |                |                |                                       |                |                |
| Less than primary                         | 46.74%                      | 43.64%                               | 44.76%         | 42.25%         | 49.56%                                | 51.28%         | 47.44%         |
| Primary or higher                         | 53.26%                      | 56.36%                               | 55.24%         | 57.75%         | 50.44%                                | 48.72%         | 52.56%         |
| Paternal education level                  |                             |                                      |                |                |                                       |                |                |
| Less than primary                         | 29.17%                      | 27.06%                               | 28.37%         | 25.44%         | 31.10%                                | 33.07%         | 28.67%         |
| Primary or higher                         | 70.83%                      | 72.94%                               | 71.63%         | 74.56%         | 68.90%                                | 66.93%         | 71.33%         |
| Living in rural area, %                   | 63.76%                      | 61.25%                               | 61.10%         | 61.44%         | 66.05%                                | 67.21%         | 64.61%         |
| Number of people in the household, M (SE) | 8.94<br>(0.10)              | 8.82<br>(0.14)                       | 8.71<br>(0.17) | 8.96<br>(0.22) | 9.05<br>(0.14)                        | 9.16<br>(0.18) | 8.91<br>(0.20) |

\*p<0.05 \*\*p<0.01 \*\*\*p<0.001. SE = linearized standard error. ECE = early childhood education.

<sup>a</sup> All estimates are weighted. Asterisks represent unadjusted p-values. <sup>b</sup> Sharpened false discovery rate q-values (Benjamini et al., 2006; Anderson, 2008) were additionally calculated to adjust for multiple hypothesis testing. Associations were not statistically significant at the < 0.05 level after adjustments (q-value=0.098). <sup>c</sup> Child development for children aged 0-35 months was assessed using the Caregiver-Reported Early Development Instrument. Scores are standardized by age. <sup>d</sup> School readiness for children aged 36-72 months was assessed using the Measuring Early Learning Quality and Outcomes (MELQO)-Measure of Development and Early Learning (MODEL) Teacher/Caregiver report. Scores range from 0-25, with higher scores reflecting higher school readiness levels. <sup>e</sup> Parental distress scores range from 0-5, where higher scores indicated higher levels of distress. <sup>f</sup> Psychosocial stimulation scores range from 0-14, where higher scores indicate higher levels of psychosocial stimulation in the home. <sup>g</sup> Only collected for children aged 36-72 mos.

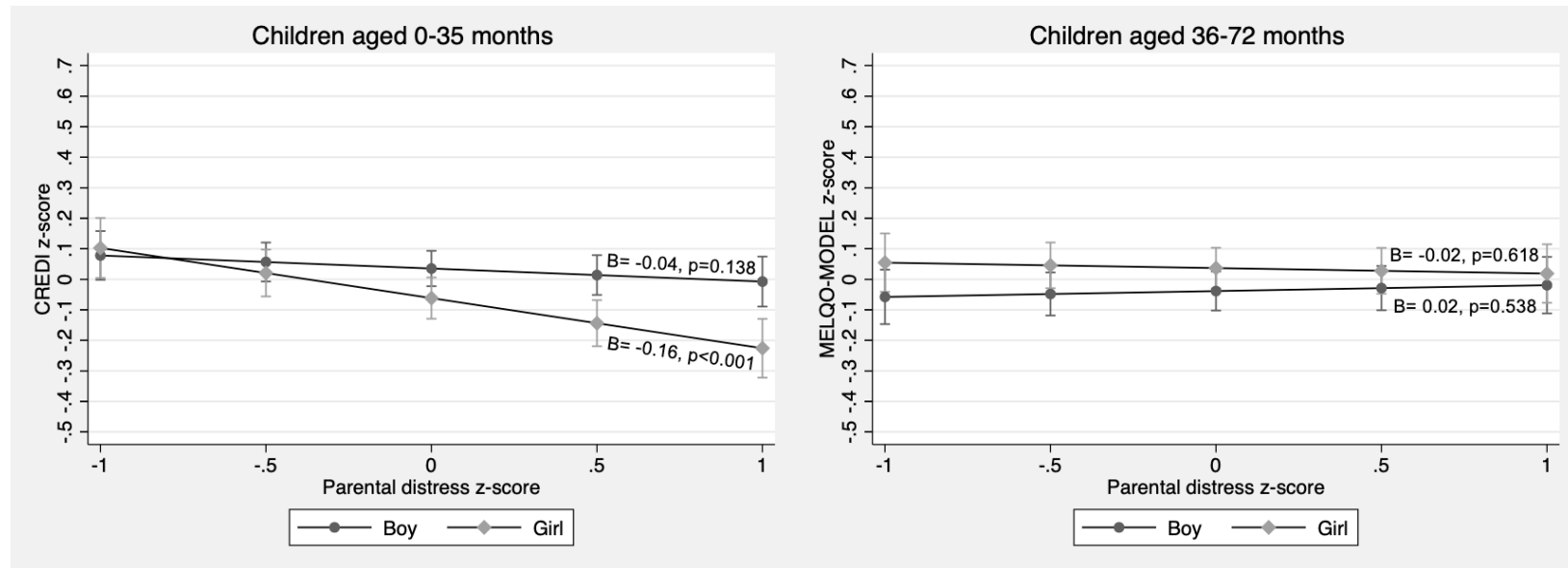
**Table 2. Results from multivariate linear regression models examining all risks and protective factors together**

| Variable <sup>a</sup>                          | Child development (CREDI z-score) among children aged 0-35 months (N=1,366) |               |         |               | School readiness z-scores (MELQO-MODEL) among children aged 36-72 months (N=1,486) |               |          |               |
|------------------------------------------------|-----------------------------------------------------------------------------|---------------|---------|---------------|------------------------------------------------------------------------------------|---------------|----------|---------------|
|                                                | Model 1                                                                     |               | Model 2 |               | Model 1                                                                            |               | Model 2  |               |
|                                                | $\beta$                                                                     | Linearized SE | $\beta$ | Linearized SE | $\beta$                                                                            | Linearized SE | $\beta$  | Linearized SE |
| Constant                                       | 0.13                                                                        | 0.09          | 0.13    | 0.09          | -1.89***                                                                           | 0.13          | -1.89*** | 0.13          |
| Female child gender                            | -0.09*                                                                      | 0.05          | -0.08   | 0.04          | 0.07                                                                               | 0.05          | 0.06     | 0.06          |
| Parental distress                              | -0.09***                                                                    | 0.02          | -0.04   | 0.03          | 0.00                                                                               | 0.02          | 0.02     | 0.03          |
| Psychosocial stimulation                       | 0.54***                                                                     | 0.02          | 0.49*** | 0.03          | 0.31***                                                                            | 0.03          | 0.33***  | 0.04          |
| Enrolled in ECE                                | --                                                                          | --            | --      | --            | 0.38***                                                                            | 0.05          | 0.36***  | 0.07          |
| Parental distress X Female child gender        |                                                                             |               | -0.12** | 0.05          |                                                                                    |               | -0.04    | 0.05          |
| Psychosocial stimulation X Female child gender |                                                                             |               | 0.09*   | 0.05          |                                                                                    |               | -0.04    | 0.06          |
| Enrolled in ECE X Female child gender          |                                                                             |               | --      | --            |                                                                                    |               | 0.06     | 0.10          |

Model 1 presents direct associations of all risk and protective factors and child gender on child development outcomes and Model 2 additionally includes an interaction with child gender for each risk/protective factor for children aged 0-35 month and 36-72 months. Models additionally control for monthly phone expenditure, province, child age, respondent caregiver gender, maternal education, paternal education, rural residence, and household size (not shown). \*  $p < 0.05$  \*\*  $p < 0.01$  \*\*\*  $p < 0.001$ . SE = linearized standard error. ECE = early childhood education.

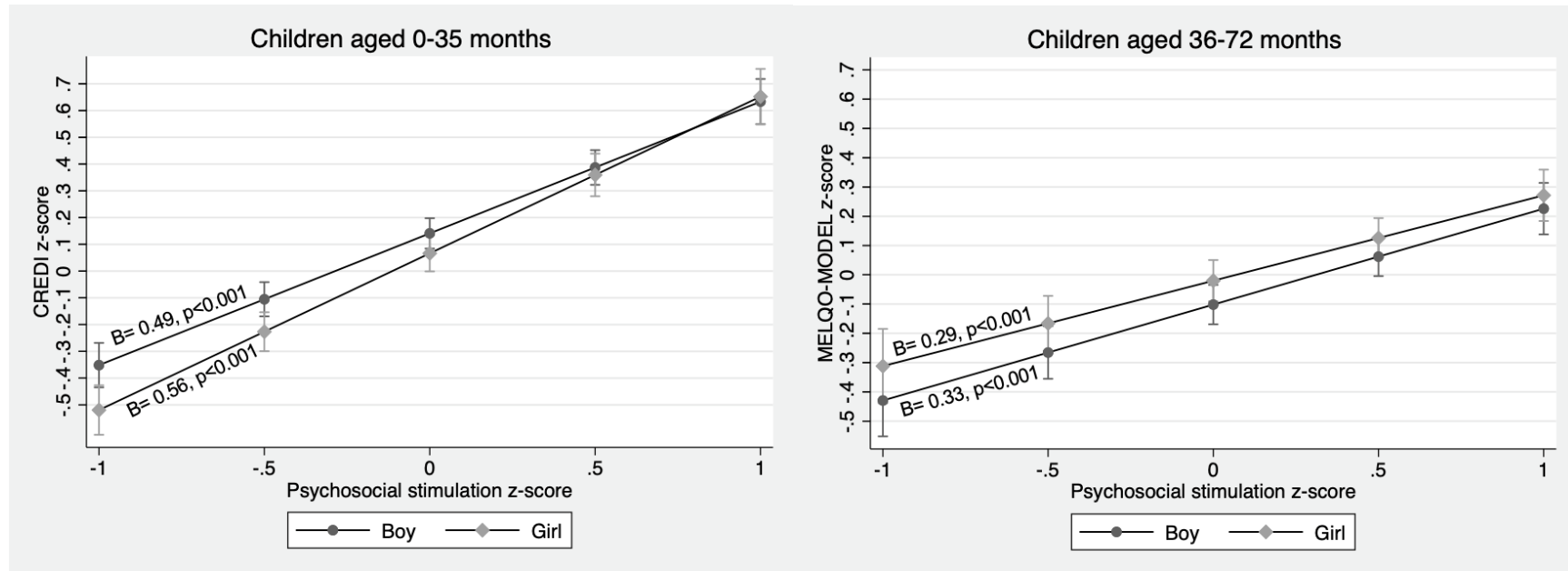
<sup>a</sup> Parental distress scores and psychosocial stimulation scores were mean centered and standardized for regression analyses. Asterisks represent unadjusted  $p$  values.

**Figure 1. Marginal effects of parental distress on child outcomes for boys and girls in both cohorts**



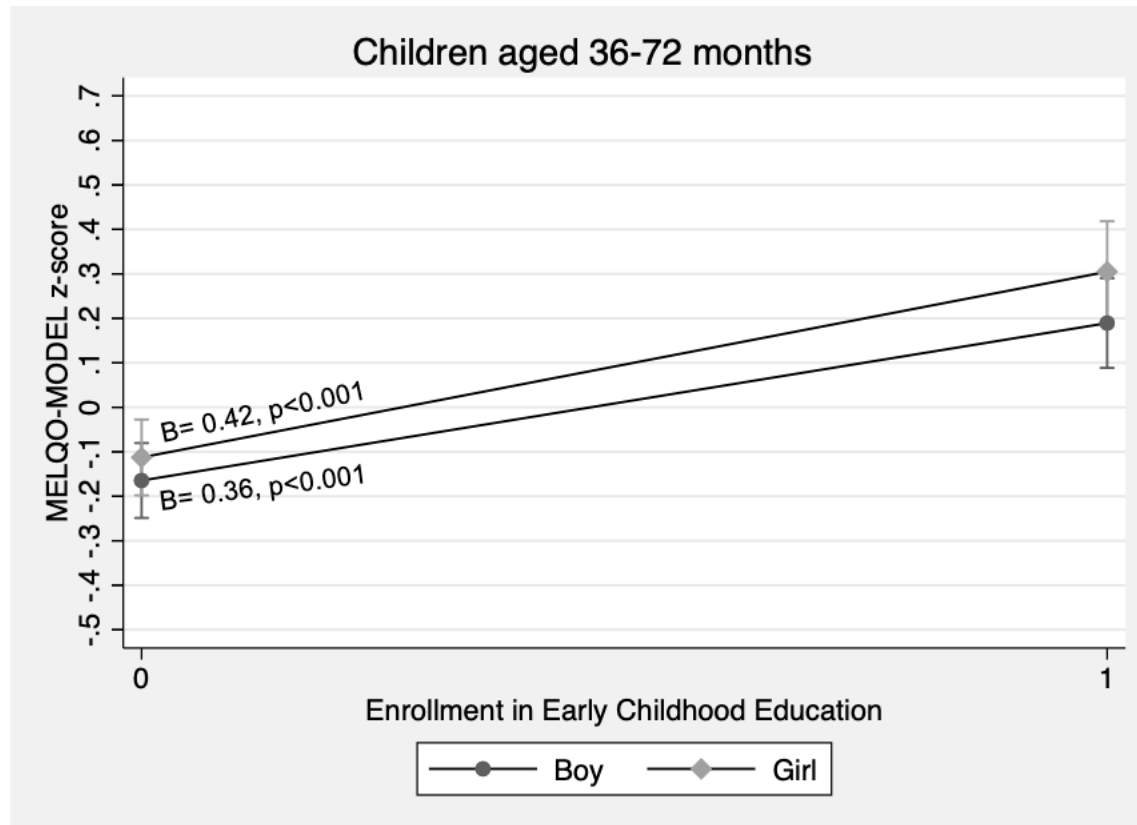
[left] Two-way interaction between child gender and parental distress z-scores predicting child development, measured in CREDI z-scores, for children aged 0-35 months. Depicts the estimated marginal means for CREDI z-score by gender for parental distress z-scores 1 SD below the mean (low parental distress) to 1 SD above the mean (high parental distress). [right] Two-way interaction between child gender and parental distress z-scores predicting school readiness, measured in MELQO-MODEL z-scores, for children aged 36-72 years. Depicts the estimated marginal means for MELQO-MODEL z-score by gender for parental distress z-scores 1 SD below the mean (low parental distress) to 1 SD above the mean (high parental distress). Plots use estimates from the fully interacted model in Table 2 Model 2 for the respective age group.

**Figure 2. Marginal effects of psychosocial stimulation on child outcomes for boys and girls in both cohorts**



[left] Two-way interaction between child gender and psychosocial stimulation z-scores predicting child development, measured in CREDI z-scores, for children aged 0-35 months. Depicts the estimated marginal means for CREDI z-score by gender for psychosocial stimulation z-scores 1 SD below the mean (low levels of psychosocial stimulation in the household) to 1 SD above the mean (high levels of psychosocial stimulation in the household). [right] Two-way interaction between child gender and psychosocial stimulation z-scores predicting school readiness, measured in MELQO-MODEL z-scores, for children aged 36-72 years. Depicts the estimated marginal means for MELQO-MODEL z-score by gender for psychosocial stimulation z-scores 1 SD below the mean (low levels of psychosocial stimulation in the household) to 1 SD above the mean (high levels of psychosocial stimulation in the household). Plots use estimates from the fully interacted model in Table 2 Model 2 for the respective age group.

**Figure 3. Marginal effects of early childhood education enrollment on child outcomes for boys and girls in the older cohort**



Two-way interaction between child gender and early childhood education enrollment predicting child development, measured in MELQO-MODEL z-scores, for children aged 36-72 years. Depicts the estimated marginal means for MELQO-MODEL z-score by gender for children enrolled in ECE (1) and not enrolled (0). Plots use estimates from the fully interacted model in Table 2 Model 2.

## Appendix.

**Table I. Multivariate linear regression models examining risk and protective factors separately.**

|                                       |                                                | Outcome: Child development (CREDI z-score) among children aged 0-35 months (N=1,366) |      |                     |      | Outcome: School readiness z-scores (MELQO-MODEL) among children aged 36-72 months (N=1,486) |      |                    |      |
|---------------------------------------|------------------------------------------------|--------------------------------------------------------------------------------------|------|---------------------|------|---------------------------------------------------------------------------------------------|------|--------------------|------|
|                                       |                                                | Model 1                                                                              |      | Model 2             |      | Model 1                                                                                     |      | Model 2            |      |
| Variable <sup>a</sup>                 |                                                | $\beta$                                                                              | SE   | $\beta$             | SE   | $\beta$                                                                                     | SE   | $\beta$            | SE   |
| <i>Risk Factor</i>                    |                                                |                                                                                      |      |                     |      |                                                                                             |      |                    |      |
| Parental distress <sup>c</sup>        | Constant                                       | -0.27*                                                                               | 0.11 | -0.27*              | 0.11 | -2.09***                                                                                    | 0.14 | -2.09***           | 0.14 |
|                                       | Female child gender                            | -0.09                                                                                | 0.06 | -0.09               | 0.06 | 0.10                                                                                        | 0.05 | 0.10               | 0.05 |
|                                       | Parental distress                              | -0.12***                                                                             | 0.03 | -0.07               | 0.04 | -0.00                                                                                       | 0.03 | 0.01               | 0.04 |
|                                       | Parental distress X Female child gender        |                                                                                      |      | -0.13* <sup>b</sup> | 0.06 |                                                                                             |      | -0.03 <sup>b</sup> | 0.05 |
|                                       |                                                |                                                                                      |      |                     |      |                                                                                             |      |                    |      |
| <i>Protective Factors</i>             |                                                |                                                                                      |      |                     |      |                                                                                             |      |                    |      |
| Psychosocial stimulation <sup>d</sup> | Constant                                       | 0.11                                                                                 | 0.09 | 0.10                | 0.09 | -2.00***                                                                                    | 0.13 | -2.00***           | 0.13 |
|                                       | Female child gender                            | -0.09*                                                                               | 0.05 | -0.07               | 0.05 | 0.08                                                                                        | 0.05 | 0.09               | 0.05 |
|                                       | Psychosocial stimulation                       | 0.54***                                                                              | 0.02 | 0.49***             | 0.03 | 0.33***                                                                                     | 0.03 | 0.34***            | 0.04 |
|                                       | Psychosocial stimulation X Female child gender |                                                                                      |      | 0.10* <sup>b</sup>  | 0.05 |                                                                                             |      | -0.02 <sup>b</sup> | 0.06 |
|                                       |                                                |                                                                                      |      |                     |      |                                                                                             |      |                    |      |
| Enrolled in ECE <sup>e</sup>          | Constant                                       | --                                                                                   | --   | --                  | --   | -1.97***                                                                                    | 0.13 | -1.95***           | 0.14 |
|                                       | Female child gender                            | --                                                                                   | --   | --                  | --   | 0.09                                                                                        | 0.05 | 0.04               | 0.07 |
|                                       | Enrolled in ECE                                | --                                                                                   | --   | --                  | --   | 0.42***                                                                                     | 0.05 | 0.36***            | 0.07 |
|                                       | Enrolled in ECE X Female child gender          | --                                                                                   | --   | --                  | --   |                                                                                             |      | 0.13 <sup>b</sup>  | 0.10 |
|                                       |                                                |                                                                                      |      |                     |      |                                                                                             |      |                    |      |

Separate regression models were conducted for each risk and protective factor in the imputed data. Model 1 includes the risk/protective factor and child gender as predictors and child development as the outcome. Model 2 additionally includes the interaction of the risk/protective factor and female child gender. Analyses were conducted for each child age group separately. All analyses were adjusted for monthly phone expenditure, province, child age, respondent caregiver gender, maternal education, paternal education, rural residence, and household size (not shown). \* $p < 0.05$  \*\* $p < 0.01$  \*\*\* $p < 0.001$ . SE = linearized standard error. ECE= early childhood education.

<sup>a</sup> School readiness (MELQO-MODEL) scores, parental distress, and psychosocial stimulation were mean centered and standardized for regression analyses. <sup>b</sup> Asterisks represent unadjusted p values. As a robustness check, sharpened false discovery rate q-values (Benjamini et al., 2006; Anderson, 2008) were calculated to adjust for multiple hypothesis testing for the interaction terms across models within age group. The parental distress X female child gender [q-value=0.045] and psychosocial stimulation X female child gender [q-value=0.045] interaction terms remained significant at the  $< 0.05$  level post-adjustment for children aged 0-35 months. <sup>c</sup> Higher parental distress scores indicate higher levels of distress. <sup>d</sup> Higher psychosocial stimulation scores indicate higher levels of psychosocial stimulation in the home. <sup>e</sup> ECE enrollment status was only assessed for children aged 36-72 months.

**Table II. Results from multivariate linear regression models examining all risks and protective factors together, complete case analysis**

| Variable <sup>a</sup>                          | Child development (CREDI z-score) among children aged 0-35 months (N=1,339) |               |         |               | School readiness z-scores (MELQO-MODEL) among children aged 36-72 months (N=1,396) |               |          |               |
|------------------------------------------------|-----------------------------------------------------------------------------|---------------|---------|---------------|------------------------------------------------------------------------------------|---------------|----------|---------------|
|                                                | Model 1                                                                     |               | Model 2 |               | Model 1                                                                            |               | Model 2  |               |
|                                                | $\beta$                                                                     | Linearized SE | $\beta$ | Linearized SE | $\beta$                                                                            | Linearized SE | $\beta$  | Linearized SE |
| Constant                                       | 0.13                                                                        | 0.09          | 0.13    | 0.09          | -1.89***                                                                           | 0.13          | -1.88*** | 0.13          |
| Female child gender                            | -0.09*                                                                      | 0.05          | -0.08   | 0.05          | 0.07                                                                               | 0.05          | 0.06     | 0.06          |
| Parental distress                              | -0.09***                                                                    | 0.02          | -0.04   | 0.03          | 0.00                                                                               | 0.02          | 0.02     | 0.03          |
| Psychosocial stimulation                       | 0.54***                                                                     | 0.02          | 0.49*** | 0.03          | 0.31***                                                                            | 0.03          | 0.33***  | 0.04          |
| Enrolled in ECE                                | --                                                                          | --            | --      | --            | 0.39***                                                                            | 0.05          | 0.36***  | 0.07          |
| Parental distress X Female child gender        |                                                                             |               | -0.12** | 0.05          |                                                                                    |               | -0.04    | 0.05          |
| Psychosocial stimulation X Female child gender |                                                                             |               | 0.10*   | 0.05          |                                                                                    |               | -0.04    | 0.06          |
| Enrolled in ECE X Female child gender          |                                                                             |               | --      | --            |                                                                                    |               | 0.07     | 0.10          |

Regression models were run on the original data using complete case analysis, employing listwise deletion to handle missing data. Model 1 presents direct associations of all risk and protective factors and child gender on child development outcomes and Model 2 additionally includes an interaction with child gender for each risk/protective factor for children aged 0-35 month and 36-72 months. Models additionally control for monthly phone expenditure, province, child age, respondent caregiver gender, maternal education, paternal education, rural residence, and household size (not shown). \*  $p < 0.05$  \*\*  $p < 0.01$  \*\*\*  $p < 0.001$ . SE = linearized standard error. ECE = early childhood education.

<sup>a</sup> Parental distress scores, psychosocial stimulation scores, and household size were mean centered and standardized for regression analyses. Asterisks represent unadjusted p values.