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Household Food Insecurity, Growth and Development of Preschool Children: Evidence From Rural Pakistan

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ABSTRACT

Household food insecurity (HFI) remains a challenge globally and is recognized as a risk factor for poor child nutritional outcomes for infants and young children. However, few studies have evaluated the associations of HFI with the growth and development of preschool children. This study assessed the association of HFI with growth and development outcomes among preschool-aged children in rural Pakistan and explored potential differences in the magnitude of the associations by child gender and early childhood care and education (ECCE) intervention. Anthropometric and child development data from 2795 children aged 4.5–5.5 years enroled in a cluster-randomized stepped-wedge trial of the Youth Leaders for Early Childhood Assuring Children are Prepared for School intervention were collected across four districts in rural Sindh. HFI was assessed using the Household Food Insecurity Access Scale, and child development was measured by the International Development and Early Learning Assessment (IDELA) and a battery of executive functions tasks. Multilevel mixed-effects models were utilized to investigate the associations between HFI and height-for-age (HAZ), weight-for-age (WAZ), BMI-for-age z scores and child development scores. Increasing levels of HFI were associated with lower child WAZ, lower total IDELA scores and lower emergent literacy scores (p values for trend < 0.05). No significant association was observed between HFI and executive functioning. Gender and ECCE intervention status did not modify the relationship between HFI and child growth and development outcomes ($p > 0.05$). Future research should investigate the synergistic potential of nutrition and ECCE programmes to improve outcomes for children and families in rural Pakistan and similar resource-scarce settings. The trial is registered with ClinicalTrials.gov (NCT03764436).

1 | Introduction

The Sustainable Development Goals call for all countries to ensure universal access to safe and nutritious food (Target 2.1) and to end all forms of malnutrition by 2030 (Target 2.2), which have galvanized action to counter household food insecurity (HFI) globally (United Nations 2015). However, recent estimates indicate that the number of people experiencing severe HFI declined from nearly 924 million in 2021 to about 864 million in 2023—a reduction of roughly 60 million people, the majority of whom reside in low- and middle-income countries (LMICs) and 20% of whom are children under the

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Summary

- Household food insecurity (HFI) in rural Pakistan was significantly associated with lower height-for-age and weight-for-age *z* scores among preschool-aged children.
- HFI was also found to be associated with lower total school readiness scores and emergent literacy scores.
- The potential role of early childhood care and education programmes providing nutrition supplementation should be explored in food-insecure settings.

age of 5 years (FAO et al. 2024). Research has demonstrated the importance of the first 5 years of life as a sensitive period in the life course, impacting physical health and growth, neuropsychological outcomes, educational attainment and productivity well into adulthood (Berens et al. 2017; Lanier et al. 2018). HFI during this sensitive period may have negative associations with child growth and development (Schmeer and Piperata 2017).

Evidence from cross-sectional and longitudinal studies on the role of HFI in growth and development conducted in LMICs, including Nigeria, Kenya, Ethiopia, India, Peru and Vietnam, has predominantly focused on child under 3 years of age, and has found that children from food-insecure households experienced significantly poorer nutritional status and delayed gross and fine motor development (Dercon and Singh 2013; Humphries et al. 2015; Mutisya et al. 2015; Olodu et al. 2022). A systematic review of 30 studies examining the relationship between HFI and undernutrition in children under 5 years across LMICs found a stronger association between HFI and stunting and underweight as compared with wasting (Lye et al. 2023). Although this review included studies from children below the age of 5 years, a majority were younger than 3 years old, often without disaggregation by age. Given that the amount and type of food required to meet nutritional needs varies with age and that growth rates differ by age, the impacts of HFI on preschool-aged children may differ from those observed in infants and young children under 3 years of age.

In contrast to the evidence for child growth, there is less evidence pointing to the relationship between HFI and child development outcomes. The majority of research on the role of nutrition and HFI with development in LMICs has focused on anthropometric measures among young children with few studies on preschool-aged children. A meta-analysis of 68 studies across 29 LMICs found a robust positive association between linear growth during the first 2 years of life and later cognitive and motor development, with a pooled estimate of a +0.22 SD increase in cognition for each unit increase in height-for-age (HAZ) in early childhood (Sudfeld et al. 2015). However, a recent review of 21 studies from 13 LMICs found only modest associations beyond age two, with a +0.01 SD increase in cognition and +0.05 SD in language, and no associations with motor or socioemotional outcomes (Upadhyay et al. 2024). Studies from Kenya and rural Bangladesh found that HFI was associated with poor child gross motor and language development among children under 2 years of age (Milner et al. 2018; Saha et al. 2010). Among 8–12-year-old children, studies from rural China and India showed that HFI was associated with significantly lower academic achievement (Aurino et al. 2019; Hannum et al. 2014). In addition, a systematic review by Gallegos et al. (2021) of 17 studies from high-income countries found that HFI was most consistently associated with behavioural outcomes in children below 12 years, particularly increased externalizing behaviours (e.g., aggression and hyperactivity), while evidence for associations with cognitive, socioemotional, or internalizing outcomes (e.g., anxiety and depression) was mixed or inconclusive. To the best of our knowledge, only one study in Ghana (Aurino et al. 2020) has examined the association between HFI and development outcomes among 1333 preschool-aged children and found that HFI was associated with reductions of 0.11 SD in literacy, 0.15 SD in numeracy and 0.23 SD in short-term memory.

The relationship between HFI and child nutrition and development outcomes may also vary based on gender and access to early childhood care and education (ECCE). Male children generally are more vulnerable to undernutrition in terms of growth faltering in situations of food scarcity than female children (Baig-Ansari et al. 2006; Marcoux 2002; Thurstans et al. 2020, 2022). The mechanisms underlying these gender differences include complex interactions of social, environmental and genetic factors; however, their magnitude and direction have been shown to differ across different countries and contexts (Thurstans et al. 2020, 2022). For instance, studies from Ethiopia and Kenya found HFI was associated with a greater risk for stunting and wasting among boys under 5 years of age compared with girls (Olack et al. 2011; Samuel et al. 2022), while research in Madagascar and Pakistan found varying gender differences in stunting by age and urbanicity, with females in certain scenarios (e.g., older age groups and urban squatter settlements) facing greater risks of malnutrition as a consequence of HFI (Baig-Ansari et al. 2006; Rakotomanana et al. 2017). Furthermore, although no studies to our knowledge have explored the modifying effects of ECCE enrolment on HFI and early child development (ECD) outcomes, research on theoretical pathways suggests that food-insecure households may invest fewer resources in ECCE (and subsequent lower likelihood of participation in ECCE programmes) to prioritise basic food needs (Johnson and Markowitz 2018). In addition, it remains unclear whether gains from ECCE and other protective early childhood interventions might buffer against the adverse impacts of food insecurity on ECD outcomes, or if these gains diminish within food-insecure populations.

In the Pakistani context, the majority of studies on HFI have focused on child nutritional and anthropometric outcomes, and a few studies have evaluated the association with child behavioural outcomes (Baig-Ansari et al. 2006; Obradović et al. 2016; Hentschel et al. 2024). A study in Karachi, Pakistan's capital, found that HFI was associated with poor behavioural outcomes in 3–11-year-old children (Shah and Hussain 2019). A study in rural Pakistan found that HFI experienced by 4-year-old children, the vast majority of whom were out of organized ECCE programmes, was linked with higher rates of later externalizing behaviour problems (Finch et al. 2018). However, all of these studies (with the exception of Obradović et al. 2016) used caregiver-reported outcomes for child development (with either one dimension of development or only an overall score), and few children included in the studies attended preschool. In

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addition, most of the evidence has focused on educational or behavioural outcomes and not on other important developmental domains. Finally, the role of HFI in possibly undermining the potential benefits of protective and promotive ECD interventions, such as ECCE, has not been adequately studied.

The primary aim of our study was to examine the association of HFI with child growth and development outcomes among 4.5–5.5-year-old children in rural Pakistan. We also explored whether the magnitude of the associations was modified by gender or by exposure to an ECCE intervention. This analysis was intended to provide a more comprehensive understanding of potential variations in the relationship between HFI and child outcomes, informing targeted interventions for early childhood policies and programmes that contribute to efforts to reduce HFI.

2 | Methods

2.1 | Study Design and Data Collection

This study utilized data from a stepped wedge cluster-randomized trial of Youth Leaders for Early Childhood Assuring Children are Prepared for School (LEAPS), a youth-led ECCE intervention in rural Pakistan (Yousafzai et al. 2025). The study was conducted from 3 December 2018 to 30 June 2021. The primary aim of the trial was to evaluate the impact of the LEAPS programme on children's school readiness. The trial was implemented in 99 clusters (defined at the village level) in four districts within rural Sindh, Pakistan: Dadu, Khairpur, Naushahro Feroze and Sukkur. Study village clusters were required to have primary schools run by the Pakistan National Commission for Human Development (NCHD). Female Community Youth Leaders (CYLs) aged 18–24 years were trained to provide quality preschool education in villages with no other ECCE programmes. Exclusion criteria included: clusters from the LEAPS pilot trial, lack of eligible female youth leaders, safety and security concerns, lack of appropriate space for the preschool, or closure of NCHD primary school. Stratified randomization was applied to a total of 99 clusters. The LEAPS intervention was introduced to clusters in a randomized sequence at three timepoints (step) over the course of the 31-month trial. At each of the three steps, 33 clusters transitioned from the control condition to the LEAPS intervention condition.

Data were collected through population-based cross-sectional surveys at baseline before implementation of LEAPS (round one/baseline, January–April 2019) and at the end of each step to evaluate the impact of LEAPS interventions (round two, August–November 2019; round three, February–March 2020 and June–August 2020; round four/endline, December 2020–March 2021). Given the use of population-based repeated cross-sectional surveys, random samples of children aged 4.5–5.5 years were drawn in each round; children who had aged out of the window were replaced by younger peers. Consequently, total N varies by round and does not reflect attrition. Assessments were conducted by a team of locally recruited female assessors with at least a bachelor's level education and prior experience in early childhood data collection. All assessors received a 10-day structured training on field protocols and assessment tools at baseline, followed by a 1-day refresher before each round. Each round of data collection involved a team of approximately 20 assessors. Assessments took place in the child's home. A caregiver (typically the mother) was present during all assessments and provided informed consent before participation. The study assessors collected data on the child and caregiver characteristics, sociodemographic status of the household, household food security level, preschool readiness, executive function (EF) and child anthropometry (including height, weight, head circumference and midupper arm circumference) through household visits at all four-time points.

At each survey time point, assessors used a random number generator to select and enrol approximately 11 children from each cluster across all clusters for a targeted sample of 1089 children. Data for a total of 3858 children ($n = 3852$ with complete International Development and Early Learning Assessment [IDELA] data) were collected. Some children were randomly sampled two or more times, given the design of the repeated population-based surveys ($n = 1064$). For children who were surveyed multiple times, we only used data from the first time the child was surveyed. The resulting sample size across rounds was a total of 2795 children. The survey included children regardless of their participation status in the LEAPS intervention. Children with severe health conditions or disabilities were excluded from the evaluation. Study assessors used a list of children living in the cluster provided by the NCHD to identify study participants. The age of children (4.5–5.5 years) and residence were verified against local birth registries and through household visits. Further details of the intervention description and study methodology can be found in the LEAPS study protocol paper (Yousafzai et al. 2021). The trial is registered with ClinicalTrials.gov (NCT03764436).

2.1.1 | Food Security

The Household Food Insecurity Access Scale (HFIAS) (Coates et al. 2007), validated as a food access tool for multicountry use (Gebreyesus et al. 2015; Knueppel et al. 2010; Mohammadi et al. 2012), including in Lahore, Pakistan (Pervaiz et al. 2022), was used to assess the prevalence of HFI in the population survey. The HFIAS consists of two question types: (1) occurrence and (2) frequency of occurrence of a specific condition associated with the experience of food insecurity ever occurred during the previous 4 weeks (30 days). Each severity question was followed by a frequency-of-occurrence question, which asks how often a reported condition occurred during the previous 4 weeks. Each occurrence question was scored as 1 (yes) or 0 (no). Each frequency-of-occurrence question was scored as 0 (not at all), 1 (rarely—once or twice in the past 4 weeks), 2 (sometimes—3–10 times in the past 4 weeks), or 3 (often—more than 10 times in the past 4 weeks). The HFIAS responses were used to classify households into four food insecurity levels: food secure, or mild, moderately and severely food insecure.

2.1.2 | Growth and Development Outcomes

Anthropometric measures were collected for all children using standardized procedures. Trained data collectors measured

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child weight to the nearest 0.1 kg (Seca 877 Digital Flat Scale, Hamburg, Germany) and height to the nearest 0.1 cm (ShorrBoard, Olney, MD, USA). Weight and height measures were taken twice and averaged, following standard measurement protocols (Cogill 2001). Continuous z scores for child HAZ, weight-for-age (WAZ) and BMI-for-age (BMIZ) were calculated using the World Health Organization's (WHO) Child Growth Standards (0–5 years) and the WHO Growth Reference for School-Aged Children and Adolescents (5–19 years) (de Onis 2007). Stunting, underweight and thinness were defined as a HAZ, WAZ and BMIZ of two or more standard deviations (SDs) below the WHO population median, respectively.

ECD outcomes were assessed using (1) the IDELA and (2) EFs tasks. The IDELA measures children's school readiness, across four developmental domains with 22 subdomains: emergent math ($n = 7$ items), social–emotional, skills ($n = 5$ items), emergent literacy ($n = 6$ items) and motor development ($n = 5$ items). Sample tasks include identifying letters and numbers, comparing object sizes, sorting by shape or colour, recalling and retelling story details, naming familiar objects and animals, and demonstrating early writing skills, such as drawing a person or writing one's name. Social–emotional items assess the child's ability to identify emotions, explain feelings and respond to peer conflict scenarios. The IDELA tool was reliably used in the LEAPS pilot trial (Yousafzai et al. 2018). Most items have a score range of 0–1 (1 = Correct; 0 = Incorrect/Do not Know) with a few exceptions where an actual number needs to be written in the scoring sheet as per the IDELA Administration Guide. The four core domain scores were generated by averaging the percent correct for each domain and the overall IDELA score by taking the average of the four core domain scores using the graded response model recommended by the tool developers. Higher IDELA scores reflected better outcomes.

EFs were measured using a battery of assessments for each of the EF constructs: working memory, cognitive flexibility and inhibitory control. The use of these EF tools has been validated in rural Pakistan (Obradović et al. 2019). Corsi Block-Tapping test is an assessment of a child's working memory skills, scoring up to 4 points based on sequence recall accuracy. Inhibitory control was assessed by the Peg Tap and Kock-Tap tests, with scores ranging from 0 to 16 based on the accuracy across 16 items. The Dimensional Change Card Sort measures a child's cognitive flexibility with five sub-scores: two for separated level trials (pre- and post-switch) and two for integrated level trials (pre- and post-switch), each ranging from 0 to 6 points, and one for border version trials, ranging from 0 to 12 points. The Head Toes Knees Shoulders task evaluated general executive functioning skills, for up to 40 points across two sections. For all EF assessments, higher scores reflect better outcomes. IDELA and EF scores were internally standardized.

2.2 | Statistical Analysis

Descriptive analyses were presented to describe the characteristics of our sample population. We used generalized linear mixed-effects models (GLMMs) with identity links to estimate multivariable-adjusted mean differences in continuous child HAZ, WAZ and BMIZ by HFI categories. Similar GLMMs were also used to estimate standardized mean differences in IDELA and EF scores by HFI categories. We also investigated associations of HFI with the binomial outcomes of stunting, thinness and underweight using GLMMs with a log link and binomial variances to estimate relative risks. All models included a fixed effect for survey round and random effect for the village cluster to account for clustering due to the sampling design. We were interested in both individual categories of HFI as well as examining trends in the strength of associations by HFI severity. A p value for trend was calculated by regressing a value (0, 1, 2, 3) for each of the four HFI categories on the outcome of interest. Multivariable models included covariates for potential confounders based on a literature review of factors that may be associated with food insecurity as well as the growth and development of children and included: child age in years (4.5–5 and 5–5.5 years), child sex (male and female), birth order (first, second–fourth, fifth or more), maternal and paternal educational attainment (no formal schooling, some primary and completed primary school), family structure (joint/extended and nuclear) number of children in the household (1, 2–3, 4–5, 6 or more), household wealth quintile (first, second, third, fourth and fifth quintiles) randomization to LEAPS ECCE intervention (yes and no) and survey round (first, second, third and fourth).

We then explored effect modification by child gender and by randomization to LEAPS for all study outcomes. Multivariable models with interaction terms were used to assess the potential for effect modification and the statistical significance of interaction was assessed using the likelihood ratio test. All p values were 2-sided with a $p < 0.05$ considered statistically significant. A complete case analysis was conducted since the percentage of data missing for all variables was < 5%. All analyses were performed in Stata Version 17.

2.3 | Ethics Statement

All protocol, consent forms and data collection tools were reviewed and approved by the Institutional Review Board of the Harvard T. H. Chan School of Public Health, Boston, MA, USA (Protocol #: IRB18-1149); the Ethics Review Committee at Aga Khan University Karachi, Pakistan (5473-Ped-ERC-18); and the National Bioethics Committee Pakistan, Islamabad, Pakistan (Reference: No.4-87/NBC-334-Y2-Extension/19/). All participants and legal guardians provided informed consent to participate.

3 | Results

The child, caregiver and household characteristics of the study sample are presented in Table 1. The mean ± SD age of children was 4.9 ± 0.4 years, and female children made up half of the sample (49.4%). The majority of mothers had no formal schooling (83.4%), while over half of fathers in the sample had completed at least primary school (51.1%). The mean ± SD number of children in the household was 5.0 ± 2.3, and 66.9% of the population reported the household had an extended family composition.

HFI varied in the population with 39.1% of the children being food secure, 15.8% mildly food insecure, 32.3% moderately food

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TABLE 1 | Characteristics of the study population of 4.5–5.5-year-old children ($n = 2795$).

Child characteristics	
Survey round (n, %)	
Round 1 (December 2018–February 2019)	1089 (39.0%)
Round 2 (March 2019–August 2019)	577 (20.6%)
Round 3 (September 2019–August 2020)	538 (19.3%)
Round 4 (September 2020–March 2021)	591 (21.1%)
Randomized to LEAPS intervention (n, %)	1114 (40.0%)
Age in years (mean, SD)	4.9 (0.4)
Female (n, %)	1381 (49.4%)
Birth order (mean, SD)	
First	567 (20.3%)
Second–fourth	951 (47.5%)
Fifth+	901 (32.2%)
HAZ (mean, SD)	−1.5 (1.1)
Stunting (n, %)	947 (33.9%)
WAZ (mean, SD)	−1.5 (0.9)
Underweight (n, %)	762 (27.4%)
BMIZ (mean, SD)	−0.7 (0.9)
Thinness (n, %)	221 (7.9%)
Mother's characteristics	
Age in years (mean, SD)	33.5 (6.8)
Educational attainment (n, %)	
No formal schooling	2331 (83.4%)
Some primary	111 (4.0%)
Completed primary school	353 (12.6%)
Occupation	
Housewives	2283 (81.7%)
Handicraft	340 (12.2%)
Daily paid worker	122 (4.4%)
Other	50 (1.8%)
Father's characteristics	
Education level (n, %)	
No formal schooling	1250 (44.7%)
Some primary	118 (4.2%)
Primary completed (grade 5)	616 (22.0%)
Middle school completed (grade 8)	750 (26.8%)
Main occupation (n, %)	
Farmer	756 (27.1%)
Industrial worker	347 (12.4%)
Daily paid worker	835 (29.9%)
Other	857 (30.7%)
Household characteristics	
Number of children in the household (mean, SD)	5.0 (2.3)
Family structure (n, %)	
Joint/extended family	1869 (66.9%)
Nuclear family	926 (33.1%)
Household wealth index (n, %)	
1st quintile	568 (20.3%)
2nd quintile	566 (20.3%)
3rd quintile	555 (19.7%)
4th quintile	557 (19.9%)
5th quintile	549 (19.6%)
Household food security (n, %)	
Food secure	1093 (39.1%)
Mildly food insecure	441 (15.8%)
Moderately food insecure	902 (32.3%)
Severely food insecure	359 (12.8%)

Abbreviations: BMIZ, BMI-for-age; HAZ, height-for-age; LEAPS, Youth Leaders for Early Childhood Assuring Children are Prepared for School; WAZ, weight-for-age.

insecure and 12.8% had severe food insecurity. The mean (SD) HAZ, WAZ and BMIZ for children in the sample were −1.5 (1.1), −1.5 (0.9) and −0.7 (0.9), respectively. Further, 33.9% of the children in the sample were stunted (HAZ < −2), 27.4% were underweight (WAZ < −2) and 7.9% of children were thin (BMIZ < −2). These differences in sample sizes across survey rounds reflect the design described in the methods section and fieldwork disruptions caused by COVID-19 restrictions.

3.1 | Growth Outcomes

The relationships of HFI categories with child HAZ, WAZ and BMIZ are shown in Table 2. In the multivariable models, increasing HFI categories were associated with lower WAZ (p-trend, 0.02), but there was no association with HAZ (p-trend, 0.09) or with BMIZ (p-trend, 0.35). However, severe food insecurity was associated with −0.15 lower HAZ (95% CI, −0.28, −0.02) and 0.14 lower WAZ (95% CI, −0.25, −0.04) z scores as compared with food-secure children. HFI was not associated with the risk of the binomial outcomes of stunting, underweight or thinness. Detailed results from adjusted models for stunting, underweight and thinness are provided in Table S1. There was no evidence of effect modification for the relationship between HFI and growth outcomes by child sex or randomization to the LEAPS intervention (p values for interaction > 0.05).

3.2 | Developmental Outcomes

The relationships between HFI categories and child IDELA scores are shown in Table 3. In multivariable models, increasing HFI categories were associated with lower total IDELA scores (p-trend, 0.04) and lower emergent literacy scores (p-trend, 0.02). Severe food insecurity experienced was associated with −0.11 SD (95% CI, −0.21, 0.00) lower total IDELA scores and

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TABLE 2 | Adjusted associations of household food insecurity levels with child growth outcomes ($n = 2782$).

	Height-for-age *z* scores		Weight-for-age *z* scores		BMI-for-age *z* scores	
	Mean ± SD	Adjusted SMD (95% CI)	Mean ± SD	Adjusted SMD (95% CI)	Mean ± SD	Adjusted SMD (95% CI)
Reference: Food secure	−1.51 ± 1.05	Reference	−1.44 ± 0.85	Reference	−0.71 ± 0.91	Reference
Mild food insecurity	−1.58 ± 1.04	−0.11 (−0.23, 0.01)	−1.53 ± 0.85	−0.09 (−0.18, 0.01)	−0.74 ± 0.91	−0.01 (−0.11, 0.09)
Moderate food insecurity	−1.51 ± 1.05	−0.03 (−0.14, 0.07)	−1.48 ± 0.87	−0.04 (−0.12, 0.05)	−0.76 ± 0.91	−0.01 (−0.10, 0.07)
Severe food insecurity	−1.61 ± 1.08	−0.15 (−0.28, −0.02)	−1.59 ± 0.83	−0.14 (−0.25, −0.04)	−0.81 ± 1.01	−0.06 (−0.18, 0.05)
p value for trend		0.09		0.03		0.35

Note: Adjusted for child age, sex, birth order, number of children in household, mother education level, father education level, family structure (joint/extended and nuclear), household wealth index, randomization to LEAPS intervention and survey round.
Abbreviations: CI, confidence interval; SMD, standardized mean difference.

TABLE 3 | Adjusted association of household food insecurity levels with IDELA scores ($n = 2790$).

	IDELA total score Adjusted SMD (95% CI)	IDELA emergent numeracy score Adjusted SMD (95% CI)	IDELA emergent literacy score Adjusted SMD (95% CI)	IDELA socioemotional score Adjusted SMD (95% CI)	IDELA motor score Adjusted SMD (95% CI)
Reference: Food secure	Reference	Reference	Reference	Reference	Reference
Mild food insecurity	0.07 (−0.03, 0.16)	0.02 (−0.07, 0.11)	0.04 (−0.05, 0.13)	0.11 (0.03, 0.20)	0.10 (0.02, 0.18)
Moderate food insecurity	−0.04 (−0.12, 0.05)	−0.03 (−0.11, 0.05)	−0.05 (−0.13, 0.03)	0.03 (−0.05, 0.11)	0.01 (−0.06, 0.08)
Severe food insecurity	−0.11 (−0.21, 0.00)	−0.04 (−0.14, 0.06)	−0.11 (−0.21, −0.01)	−0.06 (−0.16, −0.04)	−0.07 (−0.16, 0.02)
p value for trend	0.04	0.35	0.02	0.48	0.24

Note: Adjusted for child age, sex, birth order, number of children in household, mother education level, father education level, family structure (joint/extended and nuclear), household wealth index, randomization to LEAPS intervention and survey round.
Abbreviations: CI, confidence interval; IDELA, International Development and Early Learning Assessment; SMD, standardized mean differences.

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−0.11 lower (95% CI, −0.21, −0.01) emergent literacy scores as compared with food-secure children. There was no relationship between HFI and EF scores in multivariable models. Full model results for EF outcomes across all HFI categories are shown in Table S2. There was also no evidence of effect modification of the relationship of HFI with child development scores by child sex or by randomization to the LEAPS intervention (p values for interaction > 0.05). Stratified models by child sex and by randomization to the LEAPS ECCE intervention are presented in Tables S3 and S4, respectively.

4 | Discussion

This study investigated the associations between HFI and growth and development outcomes among preschool-aged children 4.5–5.5 years of age in rural Pakistan. We found that increasing levels of HFI were associated with lower WAZ scores among preschool-aged children, and that experiences of severe food insecurity were associated with lower HAZ and WAZ scores as compared with food security. We also found that increasing HFI was associated with lower total IDELA scores and lower emergent literacy scores during the preschool years. We did not observe any significant associations between HFI and EF scores. There was also no evidence that child sex or the LEAPS ECCE intervention modified the association of HFI categories with either growth or development outcomes.

Acute and chronic undernutrition remain public health challenges in Pakistan. In our study, in rural Sindh, the prevalence of stunting, underweight and thinness among children in our sample was 34%, 27% and 8%, respectively. These findings are generally consistent with other studies and national surveys examining child malnutrition in rural Pakistan (Chaudhry et al. 2021; Ersado et al. 2023; UNICEF 2021), which further emphasizes the need for programmes that address child nutrition efforts in rural areas in the country. We also found that severe HFI was associated with poorer HAZ scores as compared with food-secure children, an indicator of chronic undernutrition, and that increasing levels of HFI were associated with poorer WAZ score outcomes, which could indicate either acute or chronic malnutrition. We did not find any association of HFI with BMIZ z scores generally considered an indicator of acute undernutrition. Our findings are consistent with existing literature from Ethiopia (Humphries et al. 2015), Nepal (Singh et al. 2014), Bangladesh (Saha et al. 2009) and Malaysia (Ali Naser et al. 2014), which indicate that HFI is associated with shorter stature and linear growth faltering among children below the age of 5 years. Similar to our study, these studies have primarily found associations between child HAZ and WAZ, but not BMIZ among young children, which suggests that HFI is more closely tied to linear growth as compared with ponderal growth (Ali Naser et al. 2014; Humphries et al. 2015; Singh et al. 2014).

A growing body of literature has pointed to pathways in which HFI leads to suboptimal growth among young children. Several studies have found that HFI leads to inadequate dietary diversity and compromised immune system function, which can further result in an infection–malnutrition cycle (Olodu et al. 2022; Psaki et al. 2012). A study conducted in India found that there was a dose–response relationship between HFI and severity of growth faltering in children less than 5 years old (Mitra et al. 2019). We did not find an association with stunting, wasting or underweight using standard cut-offs, but we likely had limited statistical power for these binomial outcomes. A comparison of child growth patterns in 54 countries with WHO standards found that linear growth faltering (stunting) is particularly pronounced during the first 2 years of life, while the 2–5-year age group is characterized by some catch-up growth, and therefore potentially less susceptible to the impact of deficiencies in essential food intake (Victora et al. 2010). Therefore, future research should examine the pathways through which HFI impacts growth outcomes in preschool children, particularly by exploring the mechanistic links between dietary diversity, immune system functioning and the infection–malnutrition cycle, to provide clearer insights into age-specific interventions.

We did not find that gender was an effect modifier in the relationship between HFI and growth outcomes. This finding differs from findings in the literature from both Pakistan and globally that has found that the relationship between HFI and height-based indicators in particular differ between female and male children (Khan et al. 2016; Saha et al. 2009; Yang et al. 2019). These differences may be attributed to variability in categorizing thresholds of food insecurity across studies (e.g., no food insecurity and any food insecurity as compared with our quartile split) (Gallegos et al. 2021), and the fact that the impacts of food insecurity can differ significantly across different age groups (Victora et al. 2010), which may cause gender differences to not emerge distinctly.

We also found that increasing levels of HFI were associated with lower IDELA total scores and lower emergent literacy scores. One potential explanation for the relationship between HFI and development outcomes is that exposure to malnutrition and subsequent infection during early childhood can cause deficits in neuronal growth, pruning and connectivity in specific brain regions involved in memory, learning and advanced cognitive abilities (Prado and Dewey 2014). In addition, living in food-insecure households can be a major source of stress and anxiety for families and children, which can further interfere with the development of child cognition, learning and memory (Shankar et al. 2017). Few studies have examined the association between HFI and developmental outcomes, particularly for preschool-aged children in LMICs. A systematic review and meta-analysis of 19 studies (15 from HICs and four from LMICs) found that HFI was associated with increased developmental risk and poorer math and vocabulary scores only in HICs and, there was only evidence on a negative impact on vocabulary in LMICs (de Oliveira et al. 2020). A recent longitudinal study from Ghana found that persistent HFI was associated with lower literacy scores among preschool-aged children, and there were no gender differences in the relationship between HFI and development outcomes (Aurino et al. 2020) both of which are consistent with our findings. However, we did not find an association between HFI and EF outcomes. One possible explanation is that our study assessed HFI cross-sectionally over a 30-day recall period. Aurino et al. (2020), using a longitudinal study design, found that transitory food insecurity over 3 years predicted lower short-term memory

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and self-regulation scores, while Grineski et al. (2018) similarly reported that persistent or deepening food insecurity was associated with lower working memory in US children. These findings suggest that cumulative exposure to food insecurity may be more consequential for EF outcomes than point-in-time exposure. By contrast with literature in the United States on preschool-aged children (Jackson et al. 2021; Johnson and Markowitz 2018), we did not find any association between HFI and socioemotional or motor development outcomes in our sample. Future studies should explore whether these differences might be associated with informal support networks and developmental opportunities within the child's immediate caregiving environments in Pakistan. In addition, it is also important to note that more research is generally needed to determine the consistency of these differences and to understand the underlying reasons for their occurrence.

4.1 | Limitations

Our study had a few limitations. We conducted a cross-sectional analysis to examine the occurrence and intensity of HFI at a single-time point, but not the persistence, using a scale that assessed experiences of food insecurity in the 30 days before data collection. We, therefore, were unable to differentiate between participants who experienced short-term, recent food insecurity, from those who experienced longer-term, chronic food insecurity. Employing a longitudinal study design would have been able to capture the persistence of food insecurity (i.e., prolonged hunger or food deprivation), which may have given us an indication of how HFI impacts outcomes that take longer to emerge, such as children's developmental outcomes. In addition, we measured food security at the household level rather than at the individual child level, which may not be reflective of an individual child's dietary intake and may have led to the omission of intrahousehold impacts and feeding prioritization, such as those related to gender and age. Finally, we conducted our research in a rural area of Pakistan, which may limit the generalizability of our findings to other contexts, such as urban areas of Pakistan as well as other LMICs in South Asia and globally.

5 | Conclusions

Our findings highlight the disproportionately high rates of HFI experienced by children and families in rural Pakistan and contribute to the growing body of evidence that food insecurity is a risk factor for both suboptimal growth and poor development outcomes in preschool children. Global evidence from the recent Lancet Series on the Next 1000 Days suggests that beyond infancy, children remain susceptible to malnutrition and growth faltering, yet also retain the capacity for catch-up growth if supported by integrated interventions (Draper et al. 2024; Nores et al. 2024). Our results emphasize the urgency for integrated, multisectoral approaches to address food insecurity among preschool-aged children. Future research should consider children's history of growth deficiencies and their previous exposure to food-insecure environments when designing interventions. In addition, robust policy support to improve access to and maintenance of health records—especially in rural settings—would help researchers identify the underlying pathways and relationships that link early malnutrition to later health and developmental outcomes. These interventions should involve coordination among health screening centres, nutrition supplementation programmes, and educational institutions to create sustainable and effective solutions to improve the health and well-being of children and families in rural Pakistan and other LMICs.

Author Contributions

A.A. conceptualized and conducted the analysis and drafted the manuscript. C.R.S., coinvestigator of the parent trial, oversaw the analysis, contributed to the interpretation of findings, and reviewed draft manuscripts. A.K.Y., PI of the parent trial, contributed to the conceptualization of the study, interpretation of findings and reviewed draft manuscripts. E.F. oversaw data collection procedures, prepared and cleaned the data for analysis, and reviewed the manuscript. S.S. oversaw field data training and collection activities and reviewed the manuscript. S.B., co-PI of the parent trial, reviewed the manuscript. All authors read and approved the final manuscript.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data the findings of this study are available from the corresponding author upon request.

References

Ali Naser, I., R. Jalil, W. M. Wan Muda, W. S. Wan Nik, Z. Mohd Shariff, and M. R. Abdullah. 2014. "Association Between Household Food Insecurity and Nutritional Outcomes Among Children in Northeastern of Peninsular Malaysia." *Nutrition Research and Practice* 8, no. 3: 304–311. https://doi.org/10.4162/nrp.2014.8.3.304.

Aurino, E., J. Fledderjohann, and S. Vellakkal. 2019. "Inequalities in Adolescent Learning: Does the Timing and Persistence of Food Insecurity at Home Matter?" *Economics of Education Review* 70: 94–108. https://doi.org/10.1016/j.econedurev.2019.03.003.

Aurino, E., S. Wolf, and E. Tsinigo. 2020. "Household Food Insecurity and Early Childhood Development: Longitudinal Evidence From Ghana." *PLoS ONE* 15, no. 4: e0230965. https://doi.org/10.1371/journal.pone.0230965.

Baig-Ansari, N., M. H. Rahbar, Z. A. Bhutta, and S. H. Badruddin. 2006. "Child's Gender and Household Food Insecurity Are Associated With Stunting Among Young Pakistani Children Residing in Urban Squatter Settlements." *Food and Nutrition Bulletin* 27, no. 2: 114–127. https://doi.org/10.1177/156482650602700203.

Berens, A. E., S. K. G. Jensen, and C. A. Nelson. 2017. "Biological Embedding of Childhood Adversity: From Physiological Mechanisms to Clinical Implications." *BMC Medicine* 15, no. 1: 135. https://doi.org/10.1186/s12916-017-0895-4.

Chaudhry, O., M. Ali Raza, G. Luis, et al. 2021. *Pakistan Child Poverty National and Subnational Trends*. Unicef. https://www.unicef.org/pakistan/media/4431/file/Technical%20Note%20-%20Pakistan%20Child%20Poverty.pdf.

17408709, 2025, 4, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/mcn.70062 by Cochrane Peru, Wiley Online Library on [10/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Coates, J., A. Swindale, and P. Bilinsky. 2007. "Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide (Version 3)." Food and Nutrition Technical Assistance Project (FANTA), FHI 360/Academy for Educational Development.

Cogill, B. 2001. *Anthropometric Indicators Measurement Guide*. Food and Nutrition Technical Assistance Project, Academy for Educational Development.

de Oliveira, K., G. M. de Almeida, M. B. Gubert, et al. 2020. "Household Food Insecurity and Early Childhood Development: Systematic Review and Meta-Analysis." *Maternal & Child Nutrition* 16, no. 3: e12967. https://doi.org/10.1111/mcn.12967.

de Onis, M. 2007. "Development of a WHO Growth Reference for School-Aged Children and Adolescents." *Bulletin of the World Health Organization* 85, no. 9: 660–667. https://doi.org/10.2471/BLT.07.043497.

Dercon, S., and A. Singh. 2013. "From Nutrition to Aspirations and Self-Efficacy: Gender Bias Over Time Among Children in Four Countries." *World Development* 45: 31–50. https://doi.org/10.1016/j.worlddev.2012.12.001.

Draper, C. E., A. K. Yousafzai, D. C. McCoy, et al. 2024. "The Next 1000 Days: Building on Early Investments for the Health and Development of Young Children." *Lancet (London, England)* 404, no. 10467: 2094–2116. https://doi.org/10.1016/S0140-6736(24)01389-8.

Ersado, L., A. Hasan, K. M. Geven, et al. 2023. Pakistan—Human Capital Review: Building Capabilities Throughout Life. World Bank.

FAO, IFAD, UNICEF, WFP, and WHO. 2024. The State of Food Security and Nutrition in the World (SOFI) 2024: Financing to end Hunger, Food Insecurity and Malnutrition in all Its Forms. https://www.fao.org/publications/sofi/2024/en/.

Finch, J. E., A. K. Yousafzai, M. Rasheed, and J. Obradović. 2018. "Measuring and Understanding Social–Emotional Behaviors in Preschoolers From Rural Pakistan." *PLoS ONE* 13, no. 11: e0207807. https://doi.org/10.1371/journal.pone.0207807.

Gallegos, D., A. Eivers, P. Sondergeld, and C. Pattinson. 2021. "Food Insecurity and Child Development: A State-of-the-Art Review." *International Journal of Environmental Research and Public Health* 18, no. 17: 8990. https://www.mdpi.com/1660-4601/18/17/8990.

Grineski, S. E., D. X. Morales, T. W. Collins, and R. Rubio. 2018. "Transitional Dynamics of Household Food Insecurity Impact Children's Developmental Outcomes." *Journal of Developmental & Behavioral Pediatrics* 39, no. 9: 715–725. https://doi.org/10.1097/DBP.0000000000000598.

Gebreyesus, S. H., T. Lunde, D. H. Mariam, T. Woldehanna, and B. Lindtjørn. 2015. "Is the Adapted Household Food Insecurity Access Scale (HFIAS) Developed Internationally to Measure Food Insecurity Valid in Urban and Rural Households of Ethiopia?" *BMC Nutrition* 1, no. 1: 2. https://doi.org/10.1186/2055-0928-1-2.

Hannum, E., J. Liu, and E. A. Frongillo. 2014. "Poverty, Food Insecurity and Nutritional Deprivation in Rural China: Implications for Children's Literacy Achievement." *International Journal of Educational Development* 34: 90–97. https://doi.org/10.1016/j.ijedudev.2012.07.003.

Hentschel, E., H. Tomlinson, A. Hasan, et al. 2024. "Risks to Child Development and School Readiness Among Children Under Six in Pakistan: Findings From a Nationally Representative Phone Survey." *International Journal of Early Childhood* 56, no. 1: 129–167. https://doi.org/10.1007/s13158-023-00353-2.

Humphries, D. L., K. A. Dearden, B. T. Crookston, et al. 2015. "Cross-Sectional and Longitudinal Associations Between Household Food Security and Child Anthropometry at Ages 5 and 8 Years in Ethiopia, India, Peru, and Vietnam." *Journal of Nutrition* 145, no. 8: 1924–1933. https://doi.org/10.3945/jn.115.210229.

Jackson, D. B., A. Testa, and D. C. Semenza. 2021. "Household Food Insecurity and School Readiness Among Preschool-Aged Children in the USA." *Public Health Nutrition* 24, no. 6: 1469–1477. https://doi.org/10.1017/S1368980021000550.

Johnson, A. D., and A. J. Markowitz. 2018. "Associations Between Household Food Insecurity in Early Childhood and Children's Kindergarten Skills." *Child Development* 89, no. 2: e1–e17. https://doi.org/10.1111/cdev.12764.

Khan, G. N., A. Turab, M. I. Khan, et al. 2016. "Prevalence and Associated Factors of Malnutrition Among Children Under-Five Years in Sindh, Pakistan: A Cross-Sectional Study." *BMC Nutrition* 2, no. 1: 69. https://doi.org/10.1186/s40795-016-0112-4.

Knueppel, D., M. Demment, and L. Kaiser. 2010. "Validation of the Household Food Insecurity Access Scale in Rural Tanzania." *Public Health Nutrition* 13, no. 3: 360–367. https://doi.org/10.1017/S1368980009991121.

Lanier, P., K. Maguire-Jack, B. Lombardi, J. Frey, and R. A. Rose. 2018. "Adverse Childhood Experiences and Child Health Outcomes: Comparing Cumulative Risk and Latent Class Approaches." *Maternal and Child Health Journal* 22, no. 3: 288–297. https://doi.org/10.1007/s10995-017-2365-1.

Lye, C. W., S. Sivasampu, T. Mahmudiono, and H. A. Majid. 2023. "A Systematic Review of the Relationship Between Household Food Insecurity and Childhood Undernutrition." *Journal of Public Health* 45: e677–e691. https://doi.org/10.1093/pubmed/fdad070.

Marcoux, A. 2002. "Sex Differentials in Undernutrition: A Look at Survey Evidence." *Population and Development Review* 28, no. 2: 275–284. https://doi.org/10.1111/j.1728-4457.2002.00275.x.

Milner, E. M., K. J. Fiorella, B. J. Mattah, E. Bukusi, and L. Fernald. 2018. "Timing, Intensity, and Duration of Household Food Insecurity Are Associated With Early Childhood Development in Kenya." *Maternal & Child Nutrition* 14, no. 2: e12543. https://doi.org/10.1111/mcn.12543.

Mitra, S., D. Mukhopadhyay, A. Sarkar, and I. Saha. 2019. "Are Household Food Security, Nutrient Adequacy, and Childhood Nutrition Clustered Together? A Cross-Sectional Study in Bankura, West Bengal." *Indian Journal of Public Health* 63, no. 3: 203–208. https://doi.org/10.4103/ijph.IJPH_357_18.

Mohammadi, F., N. Omidvar, A. Houshiar-Rad, M.-R. Khoshfetrat, M. Abdollahi, and Y. Mehrabi. 2012. "Validity of an Adapted Household Food Insecurity Access Scale in Urban Households in Iran." *Public Health Nutrition* 15, no. 1: 149–157. https://doi.org/10.1017/S1368980011001376.

Mutisya, M., N. Kandala, M. W. Ngware, and C. W. Kabiru. 2015. "Household Food (In)Security and Nutritional Status of Urban Poor Children Aged 6 to 23 Months in Kenya." *BMC Public Health* 15, no. 1: 1052. https://doi.org/10.1186/s12889-015-2403-0.

Nores, M., C. Vazquez, E. Gustafsson-Wright, et al. 2024. "The Cost of Not Investing in the Next 1000 Days: Implications for Policy and Practice." *Lancet (London, England)* 404, no. 10467: 2117–2130. https://doi.org/10.1016/S0140-6736(24)01390-4.

Obradović, J., J. E. Finch, X. A. Portilla, M. A. Rasheed, N. Tirado-Strayer, and A. K. Yousafzai. 2019. "Early Executive Functioning in a Global Context: Developmental Continuity and Family Protective Factors." *Developmental Science* 22, no. 5: e12795. https://doi.org/10.1111/desc.12795.

Obradović, J., A. K. Yousafzai, J. E. Finch, and M. A. Rasheed. 2016. "Maternal Scaffolding and Home Stimulation: Key Mediators of Early Intervention Effects on Children's Cognitive Development." *Developmental Psychology* 52: 1409–1421. https://doi.org/10.1037/dev0000182.

Olack, B., H. Burke, L. Cosmas, et al. 2011. "Nutritional Status of Under-Five Children Living in an Informal Urban Settlement in Nairobi, Kenya." *Journal of Health, Population, and Nutrition* 29, no. 4: 357–363. https://doi.org/10.3329/jhpn.v29i4.8451.

17408709, 2025, 4, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/mcn.70062 by Cochrane Peru, Wiley Online Library on [10/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Olodu, M., A. Adeomi, O. Fagbulu, A. Teniola, and B. Afolabi. 2022. "Household Food Security, Dietary Patterns and Nutritional Status of Young Children in a Nigerian Community: Situation of Post-COVID-19 Lockdown." *African Journal of Food, Agriculture, Nutrition, and Development: AJFAND* 22, no. 10: 21919–21937. https://doi.org/10.18697/ajfand.115.21730.

Pervaiz, B., M. Q. Manzoor, and R. Pervaiz. 2022. "Estimation and Validation of Adapted Household Food Insecurity Access Scale in Lahore — Pakistan." *Sustainable Business and Society in Emerging Economies* 4, no. 2: 581–590. https://doi.org/10.26710/sbsee.v4i2.2411.

Prado, E. L., and K. G. Dewey. 2014. "Nutrition and Brain Development in Early Life." *Nutrition Reviews* 72, no. 4: 267–284. https://doi.org/10.1111/nure.12102.

Psaki, S., Z. A. Bhutta, T. Ahmed, et al. 2012. "Household Food Access and Child Malnutrition: Results From the Eight-Country MAL-ED Study." *Population Health Metrics* 10, no. 1: 24. https://doi.org/10.1186/1478-7954-10-24.

Rakotomanana, H., G. E. Gates, D. Hildebrand, and B. J. Stoecker. 2017. "Determinants of Stunting in Children Under 5 Years in Madagascar." *Maternal & Child Nutrition* 13, no. 4: e12409. https://doi.org/10.1111/mcn.12409.

Saha, K. K., E. A. Frongillo, D. S. Alam, S. E. Arifeen, L. Å. Persson, and K. M. Rasmussen. 2009. "Household Food Security Is Associated With Growth of Infants and Young Children in Rural Bangladesh." *Public Health Nutrition* 12, no. 9: 1556–1562. https://doi.org/10.1017/S1368980009004765.

Saha, K. K., F. Tofail, E. A. Frongillo, et al. 2010. "Household Food Security Is Associated With Early Childhood Language Development: Results From a Longitudinal Study in Rural Bangladesh." *Child: Care, Health and Development* 36, no. 3: 309–316. https://doi.org/10.1111/j.1365-2214.2009.01049.x.

Samuel, A., S. J. M. Osendarp, E. J. M. Feskens, et al. 2022. "Gender Differences in Nutritional Status and Determinants Among Infants (6–11 m): A Cross-Sectional Study in Two Regions in Ethiopia." *BMC Public Health* 22, no. 1: 401. https://doi.org/10.1186/s12889-022-12772-2.

Schmeer, K. K., and B. A. Piperata. 2017. "Household Food Insecurity and Child Health." *Maternal & Child Nutrition* 13, no. 2: e12301. https://doi.org/10.1111/mcn.12301.

Shah, N., and M. Hussain. 2019. "Household Food Insecurity and Its Association With Behavioral Problems in Children Living in Urban Slums: Findings From Karachi, Pakistan (P04-081-19)." *Current Developments in Nutrition* 3, no. S1: nzz051.P04–081–19. https://doi.org/10.1093/cdn/nzz051.P04-081-19.

Shankar, P., R. Chung, and D. A. Frank. 2017. "Association of Food Insecurity With Children's Behavioral, Emotional, and Academic Outcomes: A Systematic Review." *Journal of Developmental & Behavioral Pediatrics* 38, no. 2: 135–150. https://doi.org/10.1097/dbp.0000000000000383.

Singh, A., A. Singh, and F. Ram. 2014. "Household Food Insecurity and Nutritional Status of Children and Women in Nepal." *Food and Nutrition Bulletin* 35, no. 1: 3–11. https://doi.org/10.1177/156482651403500101.

Sudfeld, C. R., D. Charles McCoy, G. Danaei, et al. 2015. "Linear Growth and Child Development in Low- and Middle-Income Countries: A Meta-Analysis." *Pediatrics* 135, no. 5: e1266-1275. https://doi.org/10.1542/peds.2014-3111.

Thurstans, S., C. Opondo, A. Seal, et al. 2020. "Boys Are More Likely to be Undernourished Than Girls: A Systematic Review and Meta-Analysis of Sex Differences in Undernutrition." *BMJ Global Health* 5, no. 12: e004030. https://doi.org/10.1136/bmjgh-2020-004030.

Thurstans, S., C. Opondo, A. Seal, et al. 2022. "Understanding Sex Differences in Childhood Undernutrition: A Narrative Review." *Nutrients* 14, no. 5: 948. https://doi.org/10.3390/nu14050948.

United Nations. 2015. *Transforming Our World: The 2030 Agenda for Sustainable Development*. Division for Sustainable Development Goals: UN General Assembly. https://www.refworld.org/docid/57b6e3e44.html.

UNICEF. 2021. "*UNICEF Pakistan Annual Report 2020." United Nations Children's Fund (UNICEF) Pakistan*. https://www.unicef.org/pakistan/media/3631/file/Annual%20Report%202020.pdf.

Upadhyay, R. P., B. G. Pathak, S. V. Raut, et al. 2024. "Linear Growth Beyond 24 Months and Child Neurodevelopment in Low- and Middle-Income Countries: A Systematic Review and Meta-Analysis." *BMC Pediatrics* 24, no. 1: 101. https://doi.org/10.1186/s12887-023-04521-0.

Victora, C. G., M. de Onis, P. C. Hallal, M. Blössner, and R. Shrimpton. 2010. "Worldwide Timing of Growth Faltering: Revisiting Implications for Interventions." *Pediatrics* 125, no. 3: e473–e480. https://doi.org/10.1542/peds.2009-1519.

Yang, Q., T. Yuan, L. Yang, et al. 2019. "Household Food Insecurity, Dietary Diversity, Stunting, and Anaemia Among Left-Behind Children in Poor Rural Areas of China." *International Journal of Environmental Research and Public Health* 16, no. 23: 4778. https://doi.org/10.3390/ijerph16234778.

Yousafzai, A. K., M. A. Rasheed, A. Rizvi, F. Shaheen, L. A. Ponguta, and C. R. Reyes. 2018. "Effectiveness of a Youth-Led Early Childhood Care and Education Programme in Rural Pakistan: A Cluster-Randomised Controlled Trial." *PLoS ONE* 13, no. 12: e0208335. https://doi.org/10.1371/journal.pone.0208335.

Yousafzai, A. K., S. Siyal, E. E. Franchett, et al. 2025. "Effect of a Youth-Led Early Childhood Care and Education Programme on Children's Development and Learning in Rural Sindh, Pakistan (LEAPS): A Stepped-Wedge Cluster-Randomised Implementation Trial." *Lancet Child & Adolescent Health* 9, no. 1: 25–36. https://doi.org/10.1016/S2352-4642(24)00304-3.

Yousafzai, A. K., C. R. Sudfeld, E. E. Franchett, et al. 2021. "Evaluating Implementation of LEAPS, a Youth-Led Early Childhood Care and Education Intervention in Rural Pakistan: Protocol for a Stepped Wedge Cluster-Randomized Trial." *Trials* 22, no. 1: 542. https://doi.org/10.1186/s13063-021-05518-9.

Supporting Information

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