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Early childhood development and nutritional status in urban Ethiopia

Tefera Darge Delbiso[1] | Yakob Desalegn Nigatu[1] | Natan Tilahun[2]

[1]Department of Nutrition and Dietetics, School of Public Health, Addis Ababa University, Addis Ababa, Ethiopia

[2]ChildFund Ethiopia, Addis Ababa, Ethiopia

Correspondence
Tefera Darge Delbiso, Department of Nutrition and Dietetics, School of Public Health, Addis Ababa University, Addis Ababa, Ethiopia.
Email: teferadarge@gmail.com

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Abstract

Early childhood development (ECD) is crucial for better health and well-being throughout life, but few studies have examined how ECD relates to child malnutrition. This is mainly due to lack of reliable and disaggregated data on ECD. We estimated the prevalence of ECD delays (communication, fine motor, gross motor, problem-solving and personal–social) and examined how different ECD domains were associated with child nutritional status in urban Ethiopia. Using a community-based cross-sectional survey design, 627 mother–child (12–36 months old) pairs were included in the study. The ECD was assessed using the Age and Stage Questionnaire (ASQ-3), and the nutritional status was assessed using anthropometric measurements. The association between the ECD domains and nutritional status was analysed using ordinal logistic regression, adjusting for confounding variables. Delays in ECD domains were common, especially in fine motor domain (41.9%); and more than half of the children were stunted (52.8%). Stunting and underweight were associated with ECD delays, while wasting was not. Accordingly, stunted children were more likely to have worst ECD delays in fine motor (odds ratios [OR] = 1.54; 95% confidence interval [CI]: 1.11; 2.15), gross motor (OR = 1.47; 95% CI: 1.05; 2.04) and problem-solving (OR = 1.41; 95% CI: 1.02; 1.96) domains compared to non-stunted children. Similarly, underweight children were more likely to have worse ECD delays in gross motor (OR = 1.91; 95% CI: 1.20; 3.04) and fine motor (OR = 1.90; 95% CI: 1.15; 3.15) domains compared to normal children. Coordinated and targeted ECD interventions, such as nurturing care, should be promoted and implemented widely to improve ECD outcomes and child nutrition.

KEYWORDS
Age and Stage Questionnaire (ASQ-3), early childhood development, nutrition

1 | INTRODUCTION

Early childhood development (ECD) in the first 3 years of age is crucial for improved health, human capital and well-being across the life-course through generations. It is influenced by various factors, such as biological factors (prenatal and postnatal growth, nutrient deficiencies and infectious diseases), psychosocial factors (parenting factors, maternal depression and exposure to violence), socioeconomic and cultural factors (gender inequality, low maternal education, poor access and quality of early childhood care and education and poverty), and lack of early

stimulation. These factors interact with each other to shape the physical, sensory motor, social-emotional and cognitive development of children (Alderman & Fernald, 2017; Ali, 2013; Walker et al., 2007, 2011). In 2010, about 250 million under-5 children (43% of all the children) were at risk of poor development in low- and middle-income countries (LMICs), which was a decrease from 279 million children (51% of all the children) in 2004 (Lu et al., 2016). At the same time, in Ethiopia, over 60% of the children were at risk of poor development (Lu et al., 2016).

To ensure every child reach their full potential, it is crucial to promote and protect ECD through provision of nurturing care, including responsive care, opportunity for early learning, safety and security, and proper nutrition and health (Alderman & Fernald, 2017; Black et al., 2020; Richter et al., 2017). Despite the high return on investment, the implementation of ECD programs in developing countries is fragmented and lacks coordination, particularly for children under 3 years of age. This fragmentation and lack of coordination pose a significant challenge to ensuring quality ECD in developing countries, including Ethiopia (Black et al., 2017; Ministry of Health, 2019).

Malnutrition is cited as one of the main drivers of suboptimal child development across different studies (Alderman & Fernald, 2017; Ali, 2013; Cavagnari et al., 2023; Lu et al., 2016; Walker et al., 2007). In Ethiopia, malnutrition is a serious public health concern—39% of under-5 children were stunted, 11% were wasted, and 22% were underweight (Ministry of Health et al., 2023). Malnutrition contributes to a quarter of child deaths, costs about 17% of the GDP and increases the risk of primary school grade repetitions by 5% (African Union Commission et al., 2013). Several studies have documented factors contributing to child malnutrition based on the UNICEF conceptual framework (Black et al., 2008). Child characteristics (age, sex, birth order and birth weight), maternal characteristics (nutritional status and education), household characteristics (socioeconomic status, family size, access to improved sanitation), breastfeeding and caring practices, and humanitarian crisis, such as droughts and conflicts, were identified as the most consistent factors associated with child malnutrition (Delbiso et al., 2017; Katoch, 2022). On the other hand, an estimated 60% of under-5 children in Ethiopia are at risk of suboptimal development due to poor health, undernutrition, lack of sensitive and responsive childcare, feeding, stimulation, safety and poor care during pregnancy (Lu et al., 2016; Ministry of Health, 2019, 2020; Oumer et al., 2022). However, studies assessing the association between ECD and child malnutrition are scarce. This is mainly due to the complexity of measuring the ECD domains and lack of reliable and disaggregated ECD data (Lu et al., 2016; Richter et al., 2017).

We found two published studies conducted in Ethiopia using the recommended direct measurement of ECD—the Age and Stage Questionnaire (ASQ-3) (Oumer et al., 2022; Workie et al., 2020). This questionnaire has a high sensitivity and better responsiveness to interventions (Black et al., 2017). Other population-based studies use either proxy indicators, such as stunting and extreme poverty (Grantham-McGregor et al., 2007; Lu et al., 2016), or the UNICEF early childhood development index (ECDI) widely used in the multiple indicator cluster surveys (MICS) (Bliznashka et al., 2021; Ewerling et al., 2020; Kang et al., 2018; Loizillon et al., 2017; Shrestha et al., 2022). However, the ECDI has limitations, such as ceiling effects, inadequate measurement of socioemotional development, unreliable at the individual level for capturing physical and socioemotional indicators (Bliznashka et al., 2021; Ewerling et al., 2020), and only used for children 36–59 months (Loizillon et al., 2017).

Key messages

- Studies examining early childhood development (ECD) and child nutrition are scarce in Ethiopia, mainly due to lack of reliable and disaggregated ECD data.
- We estimated the prevalence of ECD delays and examined how different ECD domains were associated with child nutrition in urban Ethiopia using a direct ECD measure.
- Our study revealed that stunted and underweight children had a higher likelihood of ECD delays. To address these issues, we recommend coordinated efforts across key sectors, such as health, education, women's affairs and social protection, to promote and implement ECD interventions, such as nurturing care.

Accurate and sensitive ECD measures from conception to age three, which is critical for child development, are essential for effective and targeted interventions (Daelmans et al., 2017). Our study is therefore aimed at estimating the prevalence of ECD delays and assessing the association between ECD and child nutritional status to fill the dearth of evidence in the area using a more refined and recommended ECD tool—the ASQ-3.

2 | METHODS

2.1 | Study design and settings

We used baseline data collected as part of the Growth and Economic Opportunities for Women (GrOW)—East Africa project, a quasi-experimental design aimed to assess whether subsidized and enhanced quality community-based childcare services can improve women's wellbeing and empowerment while promoting ECD in Ethiopia (Study ID: RIDIE-STUDY-ID-63bf977db6192). The project is implemented in the urban settings of Addis Ababa (the capital city of Ethiopia), Adama (a city in the central Oromia region and located about 100 km southeast of Addis Ababa) and Debre Birhan (a city in Amhara region and located about 120 km northeast of Addis Ababa) by ChildFund Ethiopia, Children Believe, and Tesfa Berhan Child and Family Development. The study area selection was therefore dictated by the presence of these implementing partners. The baseline survey was conducted using a community-based cross-sectional survey design between July and September 2022.

2.2 | Study population, sample size and sampling procedure

The study population consists of all women who were unemployed or had irregular jobs at the time of data collection and their children (age 12–36 months old) in the study sites (Addis Ababa, Adama and Debre Birhan cities).

To estimate the total sample size, we used different variables (proportion of employed women, proportion of children at risk of poor development, proportion of women participated in decisions about major household purchase based on employment status) and different sample size estimation formulas (single population proportion and power calculation formulas). Finally, the sample size was estimated using power calculation (Lwanga & Lemeshow, 1991) with the following parameters: a power of 80%, 5% margin of error, and findings from the Ethiopian Demographic and Health Survey (EDHS) reported that 84% of employed women participated in decisions about major household purchase, compared to 74% of non-employed women (Central Statistical Agency CSA Ethiopia, & ICF, 2016), the largest sample size of 526 was obtained. Considering the possible dropouts over the project period, we added 20% nonresponse and the final sample size becomes 632 mother–child pairs.

The baseline survey covered 14 woredas/kebeles, the smallest administrative level in Ethiopia, from seven sub-cities where the implementing partners are operating. Specifically, two woredas from Lemi-kura sub-city of Addis Ababa, five woredas from Bole and Abba Geda sub-cities of Adama, and seven kebeles from Atse Zera Yacob, Etege Taytu, Atse Menelik and Tebase sub-cities of Debre Birhan were included in the survey. All women who satisfied the inclusion criteria and consented to participate in the project were listed in the selected woredas/kebeles. Once the list was compiled, a random sample of 632 mother–child pairs (154 each from Addis Ababa and Adama; and 324 from Debre Birhan) were selected for the study.

2.3 | Variables and measurements

2.3.1 | Outcome variable

The outcome variable, ECD domains, was assessed using the third edition of ASQ-3. The ASQ-3 is a widely used screening tool for development delays in children 3 to 61 months of age. The ASQ-3 covers five broad developmental domains: communication (vocalizing, listening, understanding), fine motor (hand, finger movements), gross motor (arm, leg, body movements), problem-solving (learning, playing with toys) and personal–social (solitary social play, play with toys and other children) skills. Each of the domains contains six questions; the questions are responded as "yes", "sometimes" and "not yet" with scores 10, 5 and 0, respectively, and administered to the child's mother/caregiver. Each domain is scored from 0 to 60 points, with 60 being a perfect score (Squires & Bricker, 2009). The ASQ-3 questionnaire has a sensitivity of 82.5%–85.9%, and specificity of 85.7%–92.1% (Rothstein et al., 2017). We measured child development at their dwellings. Scores obtained from each domain is compared with established cutoff points at one and two standard deviations (SD) to identify children at risk of developmental delay for each age groups. We calculated the average cutoff scores for each domain for the age group from 12 to 36 months based on the ASQ-3 technical report recommendations (Squires et al., 2009). If the average cutoff scores is ≤2.0 SD below the mean, then the child is categorized as having "possible developmental delay", if the score is ≤1.0 SD but >2.0 SD below the mean then the child is categorized as "needs monitoring", and if the score is >1.0 SD below the mean then the child is categorized as "on track" (Squires et al., 2009).

2.3.2 | Exposure variables

The exposure variable—nutritional status—was assessed using anthropometric measurements. We measured the height of the children using a portable measuring board to the nearest 0.1 cm and weight using digital scale to the nearest 0.01 kg. The measurements were taken twice and the difference between replicate results was checked. For values above the allowable difference (i.e., 0.5 kg for weight and 1.0 cm for height), the measurements were repeated. Finally, the average of the two measurements was taken. Then, the anthropometric index (height-for-age *z*-score [HAZ], weight-for-length/height *z*-score [WHZ] and weight-for-age *z*-scores [WAZ]) are derived based on the WHO 2009 Child Growth Standard using WHO Anthro software 3.2.2. Children with HAZ < −2 SD of the median on the WHO child growth standard are categorized as stunted (HAZ < −3 SD severely stunted and HAZ ≤ −2 SD and ≥−3 SD moderately stunted); children with WHZ < −2 SD of the median are categorized as wasted (WHZ < −3 SD severely wasted and WHZ ≤ −2 SD and ≥−3 SD moderately wasted); and children with WAZ < −2 SD of the median are categorized as underweight (WAZ < −3 SD severely underweight and WAZ ≤ −2 SD and ≥−3 SD moderately underweight). Otherwise, children are considered normal (WHO, 2006).

2.3.3 | Covariates

The covariates are identified based on the conceptual model of the underlying and immediate causes of undernutrition and its consequences (Black et al., 2008). This includes child characteristics (age, sex and morbidity 2 weeks preceding the survey); mothers characteristics (age, level of education, marital status, engagement in income generating activities and overall health status); and household characteristics (household headship, family size, household food insecurity and wealth index).

The household food insecurity was estimated using the Household Food Insecurity Access Scale (HFIAS)—a set of questions used to distinguish food-secure from food-insecure households. HFIAS has nine occurrence questions (yes or no) followed by a frequency-of-occurrence question to determine whether the condition happened rarely, sometimes, or often in the past 4 weeks. The HFIAS questions relate to three different domains of food insecurity:

anxiety and uncertainty of food supply, insufficient food quality, and insufficient food intake and its physical consequences. The HFIAS score is categorized into four levels of household food insecurity (access) prevalence: food security, and mildly, moderately and severely food insecurity (Coates et al., 2007).

The wealth index, a composite measure of household living standard, is constructed using the Principal Components Analysis (PCA) (Vyas & Kumaranayake, 2006) by incorporating several variables including household's ownership of selected assets, such as chair or table, television and electricity; materials used for the house construction—wall, floor and roof materials; types of drinking water sources and toilet facilities (improved or not); and household income. The wealth index places individual households on a continuous scale of relative wealth. We then categorized the wealth index into three—poor, middle and rich.

2.4 | Data collection and quality assurance

Standard and validated questionnaires were used to collect the baseline data. The questionnaire is developed in English and translated into Amharic language (widely used local language in the study areas) for ease of understanding by the data collectors and the respondents. The questionnaire was pretested before the actual data collection; ambiguous and inconsistent questions were identified and revised accordingly. The final questionnaire was designed into a digital data collection platform, KoboCollect with the aim to improve data quality, speed and timeliness.

Data collectors and supervisors are recruited based on their educational qualifications, previous experience in conducting similar surveys and language skills—fluency in both English and Amharic. The survey team was given a 3-day training on the objective of the study, research ethics, survey questionnaire and use of digital data collection devices. They practiced the survey instruments by conducting mock interviews among themselves and then did a pilot survey in Addis Ababa before the actual data collection. During field data collection, the supervisors check each questionnaire for completeness and consistency before it is submitted to the server. The questionnaires submitted to the server were monitored by the research team throughout the survey implementation period.

2.5 | Data processing and analysis

Before analysis, we screened the data for missing values, outliers and values out of range; and the necessary revisions have been made. We described the characteristics of the study participants, the prevalence of nutritional status and ECD domains using number (percent) and median (interquartile range—IQR). The ECD domains and nutritional status indicators were reported disaggregated by age (12–24 months and 25–36 months age), and their association was tested using χ^2 test. The outcome variable, ECD domains, are ordered variables with three categories: on track, needs monitoring and possible delay. Thus, we performed a multivariable ordinal logistic regression model to examine the independent associations between ECD domains and nutritional status indicators after adjusting for confounders, which includes child, mother and household characteristics.

The proportional odds assumption was tested using the Brant method and the result is nonsignificant as desired. The model goodness-of-fit was assessed using the ordinal version of Hosmer-Lemeshow (HL) tests using a "ologitgof" STATA command and found to be a good-fit ($p > 0.1$) (Fagerland & Hosmer, 2017). We reported the odds ratios (OR) and the 95% confidence intervals (CI) for the final multivariable models, adjusted for the covariates. The statistical significance was judged based on the noninclusion of 1.0 in the 95% CI. STATA software package version 14 was used for data analysis.

2.6 | Ethical considerations

Ethical clearance was obtained from the Addis Ababa University College of Health Sciences Institutional Review Board (IRB; 053/22/SPH). All the study participants were informed about their voluntary participation, and their liberty to withdraw from the research at any time without explanation and/or prejudice. Then voluntary verbal informed consent was obtained from the mothers and parental/guardian assent was obtained for the children.

3 | RESULTS

3.1 | Children, mothers and household characteristics

Data were collected from 627 mother–child pairs, resulting in a response rate of 99.2%. Slightly over half of the children were boys (52.3%), the median age was 26 months (IQR: 20–32; 47.1% were 12–24 months old) and 40.5% had reported illnesses. The median age of the mothers was 28 years (IQR: 25–33), 18.2% had no education, 68.9% married or cohabiting, 49.3% engaged in income-generating activities, 69.4% were in a good health, over half (52.2%) participate in decision-making from a medium to a high extent, 96.5% were biological mothers to the child and 27.8% were household head. The median household size was four (IQR: 3–5), 95% suffered from mild to severe food insecurity, and wealth index was reported as tertiles (Table 1).

3.2 | ECD domains

Fine motor domain accounted for the largest possible delay (41.9%), followed by personal-social (30.7%), problem-solving (30.3%), gross motor (29.1%) and communication (14.2%). Except the personal social domain, all the ECD domains were significantly associated with child age ($p < 0.001$). Possible delays were more likely among the younger children, 12–24 months old, compared to the older ones,

TABLE 1 Percent distribution of the child, mothers and household characteristics of the study participants in urban Ethiopia, July–September 2022.

Characteristics	*N*	*n* (%)
Child characteristics		
Sex (boys)	627	328 (52.3)
Age in months, median (IQR)	627	26 (20–32)
Age group	627	
12–24 months		295 (47.1)
25–36 months		332 (52.9)
Child was ill 2 weeks preceding the survey	627	254 (40.5)
Maternal characteristics		
Age in years, median (IQR)	627	28 (25–33)
Education	627	
No education		114 (18.2)
Primary		278 (44.3)
Secondary or higher		235 (37.5)
Married/co-habiting	627	432 (68.9)
Engaged in income-generating activities	627	309 (49.3)
Health status 12 months preceding the survey	627	
Good		435 (69.4)
Average		132 (21.1)
Poor		60 (9.6)
Extent of participation in decision-making	623	
Smaller extent		298 (47.8)
Medium extent		135 (21.7)
Higher extent		190 (30.5)
Biological mother to the child	627	605 (96.5)
Household head	627	174 (27.8)
Household characteristics		
Household size, median (IQR)	627	4 (3–5)
Household food insecurity	627	
Food secure		31 (4.9)
Mildly food insecure		42 (6.7)
Moderately food insecure		316 (50.4)
Severely food insecure		238 (38.0)
Wealth index	627	
Rich		209 (33.3)
Middle		209 (33.3)
Poor		209 (33.3)

25–36 months old, except for the personal social domain. For example, fine motor delay was 68.8% among the younger children compared to 19.6% among the older ones ($p < 0.001$) (Table 2).

3.3 | Nutritional status of the children

The nutritional status of children 12–36 months was estimated and found that 52.8% were stunted (27.4% severe and 25.4% moderate), 3.3% were wasted (0.7% severe and 2.6% moderate) and 14.2% were underweight (3.8% severe and 10.4% moderate). Stunting was significantly associated with child age ($p < 0.001$). Accordingly, the prevalence of stunting was significantly higher among the younger age (12–24 months) compared to older ones (25–36 months) (59.6% vs. 46.8%) (Table 3).

3.4 | Association between ECD and nutritional status

The ECD domains (gross motor, fine motor and problem-solving) were significantly associated with stunting and underweight, after adjusting for covariates. Stunted children were 1.47 times (OR = 1.47; 95% CI: 1.05; 2.04) and underweight children were 1.91 times (OR = 1.91; 95% CI: 1.20; 3.04) more likely to have the worst gross motor development delay compared to normal children. Similarly, stunted children were 1.54 times (OR = 1.54; 95% CI: 1.11; 2.15) and underweight children were 1.9 times (OR = 1.90; 95% CI: 1.15; 3.15) more likely to have the worst fine motor development delay compared to normal children. The risk of experiencing the worst delay in problem-solving was 1.41 times (OR = 1.41; 95% CI: 1.02; 1.96) more likely among stunted children compared to normal children. However, wasting was not associated with ECD domains (Table 4).

4 | DISCUSSION

We estimated the prevalence of ECD delays among children 12–36 months old and assessed the association between ECD and nutritional status in urban Ethiopia. The fine motor domain was the most delayed aspect of ECD (41.9%). Stunting affected 52.8% of the children. Younger children were more likely to have ECD delays and stunted compared to the older ones. Stunting and underweight were significantly associated with gross motor and fine motor ECD domains. Stunting was also associated with problem solving domain. Whereas communication and personal-social ECD domains were not associated with the nutritional status indicators.

The prevalence of ECD delays in our study ranges from 41.9% for fine motors to 14.2% for communication. This finding is consistent with a study conducted in Guatemala, where the prevalence of ECD delays (using the ASQ-3 tool) ranged from 8%

TABLE 2 Early childhood development (ECD) domains, stratified by age group (12–24 and 25–36 months of age) in urban Ethiopia, July–September 2022.

ECD domains	Survey total N	n (%)	12–24 months n (%)	25–36 months n (%)	p Value
Communication	618				<0.001
Possible delay		88 (14.2)	62 (21.7)	26 (7.8)	
Needs monitoring		171 (27.7)	99 (34.6)	72 (21.7)	
On track		359 (58.1)	125 (43.7)	234 (70.5)	
Gross motor	605				<0.001
Possible delay		176 (29.1)	109 (39.6)	67 (20.3)	
Needs monitoring		97 (16.0)	43 (15.6)	54 (16.4)	
On track		332 (54.9)	123 (44.8)	209 (63.3)	
Fine motor	587				<0.001
Possible delay		246 (41.9)	183 (68.8)	63 (19.6)	
Needs monitoring		163 (27.8)	44 (16.5)	119 (37.1)	
On track		178 (30.3)	39 (14.7)	139 (43.3)	
Problem-solving	594				<0.001
Possible delay		180 (30.3)	122 (46.4)	58 (17.5)	
Needs monitoring		140 (23.6)	63 (23.9)	77 (23.3)	
On track		274 (46.1)	78 (29.7)	196 (59.2)	
Personal social	610				0.148
Possible delay		187 (30.7)	91 (32.7)	96 (28.9)	
Needs monitoring		138 (22.6)	53 (19.1)	85 (25.6)	
On track		185 (46.7)	134 (48.2)	151 (45.5)	

Note: *p* value based on χ^2 test of association.

TABLE 3 Nutritional status of the children, stratified by age group (12–24 and 25–36 months of age) in urban Ethiopia, July–September 2022.

Nutritional status	Survey total N	n (%)	12–24 months n (%)	25–36 months n (%)	p Value
Stunting	617	326 (52.8)	173 (59.6)	153 (46.8)	<0.001
Severe		169 (27.4)	108 (37.2)	61 (18.7)	
Moderate		157 (25.4)	65 (22.4)	92 (28.1)	
Normal		291 (47.2)	117 (40.4)	174 (53.2)	
Wasting	615	20 (3.3)	12 (4.1)	8 (2.3)	0.248
Severe		4 (0.7)	3 (1.0)	1 (0.3)	
Moderate		16 (2.6)	9 (3.1)	7 (2.2)	
Normal		595 (96.7)	279 (95.9)	316 (97.5)	
Underweight	625	89 (14.2)	51 (17.3)	38 (11.5)	0.112
Severe		24 (3.8)	13 (4.4)	11 (3.3)	
Moderate		65 (10.4)	38 (12.9)	27 (8.2)	
Normal		536 (85.8)	244 (82.7)	292 (88.5)	

Note: *p* values are based on χ^2 test of association.

TABLE 4 Multivariable-adjusted association (ordinal logistic regression) between early childhood development (ECD) domains and nutritional status in urban Ethiopia.

	ECD domains, OR (95% CI)				
Nutritional status	**Communication**	**Gross motor**	**Fine motor**	**Problem solving**	**Personal-social**
Stunting					
Stunted	1.27 (0.91; 1.77)	1.47 (1.05; 2.04)	1.54 (1.11; 2.15)	1.41 (1.02; 1.96)	1.18 (0.86; 1.61)
Normal (Ref.)	1.0	1.0	1.0	1.0	1.0
p Value	0.160	0.023	0.011	0.037	0.310
Wasting					
Wasted	0.93 (0.39; 2.24)	1.57 (0.58; 4.21)	1.74 (0.63; 4.82)	2.00 (0.80; 5.02)	0.69 (0.28; 1.73)
Normal (Ref.)	1.0	1.0	1.0	1.0	1.0
p Value	0.876	0.369	0.283	0.137	0.436
Underweight					
Underweight	1.36 (0.87; 2.13)	1.91 (1.20; 3.04)	1.90 (1.15; 3.15)	1.54 (0.97; 2.45)	1.24 (0.79; 1.94)
Normal (Ref.)	1.0	1.0	1.0	1.0	1.0
p Value	0.177	0.006	0.013	0.067	0.350

Note: Estimations are adjusted for child age, sex and morbidity; mothers age, education, marital status, engagement in income generating activities and overall health; and household head, family size, food insecurity and wealth index. Ref. is reference category.

Abbreviations: CI, confidence interval; OR, odds ratios.

to 40% (Mehner et al., 2019). A study conducted in the southern Ethiopia using the same screening tool—ASQ3, however, documented lower prevalence of ECD delays, ranging from 4.0% for fine motors to 8.8% for problem solving (Workie et al., 2020). On the other hand, multicounty studies conducted in Africa using the ECDI tool reported elevated prevalence of ECD delays (ranging from 8% for physical development to 90% for literacy–numeracy development) (Bliznashka et al., 2021; Ewerling et al., 2020). Our study revealed a high prevalence of stunting (52.8%), compared to the national (39%) and urban (29%) average reported in the most recent national survey of Ethiopia (Ministry of Health et al., 2023). This might be due to the characteristics of our study population who mostly lacked a stable or regular income, had low participation in decision-making, and were often single mothers. These factors could predispose children to poor nutrition (Alderman & Fernald, 2017; Black et al., 2008; Katoch, 2022).

Strengthening holistic and collaborated efforts through targeted interventions, such as ensuring nurturing care (Alderman & Fernald, 2017; Black et al., 2017; Daelmans et al., 2017; McDonald et al., 2018), is recommended to improve ECD. Despite the substantial progress made in improving the enabling environments for ECD in Ethiopia, ensuring ECD is still a challenge. For example, Ethiopia has introduced its first ECD policy and strategic plan in 2010. However, most of the interventions recommended in the plan were survival-focused and address mainly the health and nutrition aspect of young children, overlooking the other nurturing care components, such as responsive caregiving, early stimulation, opportunity for early learning (e.g., communication and play), and protection (Federal Democratic Republic of Ethiopia, 2022; Ministry of Health, 2020). Additionally, the health care providers knowledge and awareness on ECD and nurturing care was very limited (Ministry of Health, 2020). As a result, the plan was revised in 2020 to include the missing nurturing care components with the aim of supporting the attainment of the 2030 target for child health and well-being (Ministry of Health, 2020). Coordinated implementation of the revised ECD strategy across key sectors (such as health, education, women's affairs and social protection) and enhancing the knowledge and awareness of health care providers and concerned professionals on ECD would ensure better ECD.

We found a significant association between ECD domains and nutritional indicators, both stunting and underweight. Stunted children were 1.54 times, 1.47 times and 1.41 times more likely to have the worst fine motor, gross motor and problem solving development delays, respectively, compared to normal children. Similarly, children who were underweight had 1.91 times and 1.90 times higher likelihood of having the worst gross motor and fine motor development delays, respectively. Developmental delays can result from inadequate dietary intake and diseases caused by poor nutrition (Alderman & Fernald, 2017; Grantham-McGregor et al., 2007; McDonald et al., 2018). A poor diet can lead to inadequate intake of several nutrients, including iodine, iron, vitamin B and zinc. These nutrients are essential to specific physiological processes that affect early cognitive development (Alderman & Fernald, 2017; Black, 2003). Additionally, stunted children are more likely to miss out on supplementations, and their mothers may have failed to receive the essential supplementations in the first trimester of their pregnancy, such as iron and folic acid. This could lead to developmental delays (Ip et al., 2017; Walker et al., 2005).

Undernutrition can alter brain's structure and function, affecting cognitive abilities and causing various cognitive deficits in malnourished children (Dutta Chowdhury & Ghosh, 2011). Along with environmental factors, such as poor stimulation, undernutrition can also affect children's brain development and cognitive function, leading to educational deficits, lower level of play, less positive effect, poor behaviours, poor attention and social relationships (Walker et al., 2007). Furthermore, stunting during early childhood is associated with cognitive deficits and poor development during later childhood (Alderman & Fernald, 2017; Bogale et al., 2013).

Our findings are consistent with previous studies that evaluated the association between ECD and child nutritional status. Community-based studies conducted in central and southern Ethiopia revealed that stunting and underweight negatively affect ECD outcomes. Children with these conditions had the lowest test scores, short-term memory, poor visual processing and poor ECD domains (Bogale et al., 2013; Oumer et al., 2022; Workie et al., 2020). Studies in Tanzania and Burkina Faso also found that stunting negatively affects ECD domains, including cognitive, communication, motor and language developments (Olsen et al., 2020; Sudfeld et al., 2015). A study conducted in Nepal found a similar finding where stunting and underweight, but not wasting, were significantly associated with ECD delays (Shrestha et al., 2022). Similarly, chronically undernourished infants are less likely to achieve three gross motor milestones (sitting without-support, crawling and walking without-support), according to a study conducted in Ecuador (Cavagnari et al., 2023). A meta-analysis conducted in South Asia found that stunting and underweight were negatively associated with cognitive development (Kang et al., 2018). An Indian study also found poor cognitive functions among stunted children, which is attributed to their poor nutritional and socioeconomic statuses (Dutta Chowdhury & Ghosh, 2011). Nutrition interventions, including essential supplements during pregnancy and early life of the child, contribute to improved ECD outcomes and thus need to be addressed in an efficient and coordinated manner. Our study found no significant association between wasting and ECD indicators, which is consistent with other studies (Kang et al., 2018; Oumer et al., 2022; Shrestha et al., 2022).

Our study has some limitations worth considering while interpreting the findings. First, the study population are women who were unemployed or had irregular jobs. Thus, we should be cautious while extrapolating the findings to the general population. Second, the sample size was estimated for impact evaluation using power calculation and thus the prevalence estimates may not be accurate. However, we believe that it gives a reasonable estimate of the ECD prevalence using a more refined tool—ASQ3. Third, the ECD tool we used was not validated in Ethiopia. However, we adapted the questions to the context and did a pretest to make sure that the caretakers could understand them. We suggest conducting a validation study of the ECD tool in the Ethiopian context. Fourth, we could not establish causality between ECD domains and nutritional indicators from the cross-sectional study. We thus recommend further studies using longitudinal data to establish the cause-effect relationship between ECD domains and nutrition indicators. Given that we only assessed protein-energy malnutrition, it would also be beneficial to explore how specific micronutrient deficiencies affect ECD domains.

5 | CONCLUSIONS

The prevalence of ECD delays was high, with fine motor delays being the lead. Stunting and underweight were significantly associated with ECD delays, particularly with the gross motor, fine motor and problem solving domains. To improve ECD outcomes and child nutrition, it is essential to promote and implement coordinated and targeted ECD interventions, such as nurturing care, across key sectors including health, education, women's affairs and social protection.

AUTHOR CONTRIBUTIONS

Tefera Darge Delbiso conceived the study and developed the protocols with contributions from Natan Tilahun. Tefera Darge Delbiso and Yakob Desalegn Nigatu led data collection, conducted analysis, and drafted the manuscript. Tefera Darge Delbiso and Natan Tilahun revised the final manuscript. All authors have read and approved the final manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data used to support the findings of this study is included in this article.

ETHICS STATEMENT

Ethical clearance was obtained from the Addis Ababa University (AAU), College of Health Sciences Institutional Review Board (IRB; 053/22/SPH).

ORCID

Tefera Darge Delbiso http://orcid.org/0000-0002-7681-1649

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