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# Early childhood education attendance and school readiness in low- and middle-income countries: The moderating role of family socioeconomic status



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#### ABSTRACT

This study examined associations between attendance at early childhood education (ECE) programs and school readiness, and the extent to which the ECE–school readiness association is moderated by family socioeconomic status (SES). Data were from 58 low- and middle-income countries (N = 165,875,  $M_{age} = 47.52$  months). Multilevel analysis showed that ECE attendance was positively associated with total and domain-specific school readiness, in addition to the role of family SES. The association was of medium effect size for literacy–numeracy readiness and small effect size for learning and socioemotional readiness. The ECE–school readiness association was moderated by family SES, although this varied by school readiness domains. While the ECE–literacy–numeracy association was stronger for high SES children (i.e., leveraging effect), the ECE–learning readiness association are stronger for lower SES peers (i.e., compensatory effect). No SES differences were observed for socioemotional competency (i.e., additive effect). Our findings suggest that although ECE attendance plays a significant role in developing school readiness and subsequent learning outcomes, policy makers must pay attention to increasing both the quantity and quality ECE of provision for children from low SES backgrounds.

#### Introduction

Early childhood education attendance and school readiness in low- and middleincome countries: The moderating role of family socioeconomic status

Readiness to learn on entry to formal schooling is a significant predictor of children's educational achievement and life course outcomes (Boivin, Desrosiers, Lemelin, & Forget-Dubois, 2014; Blair & Raver, 2015; Duncan et al., 2007; Quirk et al., 2016). For instance, children with higher school readiness scores achieve higher grades in reading and mathematics during early primary school (Micalizzi et al., 2019), and those who enter school with low readiness competencies fall behind their peers (Chaudry et al., 2017; Shanahan & Lonigan, 2010). According to the human capital model, learning is easier for children who have underpinning skills required by schools (Heckman, 2000). School readiness enables them to engage in positive classroom interactions as well as behaviors that drive achievement (Cunha et al., 2006; Entwisle et al., 2005; La Paro & Pianta, 2000; Romano et al., 2010). High levels of school readiness competencies may also invoke positive peer and teacher feedback, enable children to be selected to benefit from academic stretch activities reserved for high achieving students, or be placed in high ability groups associated with greater teacher support (Francis et al., 2017; Majzub & Rashid, 2012; McIntyre et al., 2007).

Research from low- and middle-income country  $(LMIC)^1$  contexts indicates that most children, especially those from low socioeconomic backgrounds, start primary school with poor readiness competencies

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<sup>&</sup>lt;sup>1</sup> Low- and middle-income countries (LMIC) are a diverse group of countries defined by the World Bank using country's gross national income (GNI) per capita. The most recent constitution of LMICs consist of three categories (low, lower middle, and upper middle income countries) and excludes high income countries https://datahelpdesk.worldbank.org/knowledgebase/articles/ 378834-how-does-the-world-bank-classify-countries. While there is a high degree of stability in countries that belong to the LMIC group, countries can be reclassified across the three main groupings (https://datahelpdesk.worldbank.org/knowledgebase/articles/906519). We address the diversity between LMIC contexts in our analysis using multilevel modelling and accounting for country level wealth.

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(e.g., Bornstein et al., 2012; Britto et al., 2011; Tran et al., 2016; UNESCO, 2017; Walker et al., 2011; Wolf & McCoy, 2019). To improve school readiness and address inequalities in readiness competencies, the United Nations, development partners, and governments expanded access to early childhood education (ECE) in LMIC contexts (Spier et al., 2019; United Nations, 2015). This policy was largely informed by evidence from high income contexts that ECE attendance is associated with cognitive, socioemotional, and behavioral school readiness competencies (Britto et al., 2011; United Nations, 2015).

However, within LMIC contexts, very little research attention has been devoted to understanding the nature of the association between ECE attendance and school readiness. In fact, given that school readiness competencies are multidimensional (Boivin & Bierman, 2014), we know little about the specific readiness competencies that are developed through ECE attendance. Additionally, questions have been raised about the quality of ECE provision in LMIC contexts and, therefore, its ability to significantly influence school readiness competencies (Britto et al., 2011; Spier et al., 2019). Access to quality provision is also associated with family socioeconomic status (SES) (Hlasny, 2017; McCoy et al., 2018b), with children from higher SES backgrounds accessing higher quality ECE (Hlasny, 2017; McCoy et al., 2018b). This suggests that SES may moderate the association between ECE and school readiness. Knowledge of this possible moderating effect of family SES on the ECEschool readiness association in LMIC contexts remains unclear. This is important for understanding the extent to which ECE can bridge the SES gap in children's school readiness competencies.

The current study addresses the aforementioned research gaps by examining the association between ECE attendance and school readiness, and the extent to which the ECE–school readiness association is moderated by family SES in LMIC contexts.

#### School readiness and early childhood education (ECE)

According to Britto (2012) school readiness consists of three fundamental questions: whether (1) children are ready for school, (2) schools are ready for children, and (3) families and communities are ready to help children transition into schools. However, readiness is widely conceptualized within Britto's (2012) first domain, that is, "are children ready for school?" For instance, Boivin & Bierman, 2014 defined school readiness as the "basic skills that children need to possess at school entry in order to adapt successfully to the school environment and to learn and achieve at a satisfying level" (p. 5). Domains of school readiness usually include cognitive abilities such as pre-mathematics and language competencies, and social, emotional, and behavioral competencies (Boivin & Bierman, 2014; Snow, 2006). In this study, we conceptualize school readiness as the literacy and numeracy, learning, and behavioral competencies of preschool children, as these are often associated with children's academic progress when they transition to school (e.g., Barnett et al., 2020; Micalizzi et al., 2019).

Attendance at ECE is one of the key determinants of school readiness competencies (e.g., Britto et al., 2011; Tran et al., 2016). According to developmental theories (e.g., Bronfenbrenner & Morris, 2006), children's immediate environments (i.e., microsystem) are critical for the development of key competencies. This is because children engage in sustained and reciprocal interaction with caregivers within their immediate environment and these proximal processes drive development of key competencies. ECE is an important microsystem specifically geared towards facilitating interactions that develop school readiness competencies. It can also serve as a catalyst for parents to engage in their child's learning, an important determinant of children's school readiness (Barnett et al., 2020). Research indicates that children enrolled in ECE programs demonstrate higher cognitive abilities such as competencies in language production and comprehension (La Paro et al., 2009; Willoughby et al., 2019) and positive social, emotional, and behavioral dispositions than their peers who do not attend ECE (Bornstein & Hendricks, 2012; Britto et al., 2011; Fox, Levitt, & Nelson III, 2010; Magnuson & Waldfogel, 2005). Attendance at ECE is also associated with later school outcomes (Chaudry et al., 2017; Micalizzi et al., 2019; Shanahan & Lonigan, 2010), although other post-ECE factors such as parental socioeconomic status, teacher and school factors remain crucial for achievement during the period of formal schooling (e.g., Lehrl et al., 2016). While some studies, mostly from a US context, have indicated "fade out" effects of ECE on subsequent educational achievement (e.g., Bailey et al., 2017; Lipsey et al., 2018), others have found evidence of positive longer term ECE effects on achievement (Atteberry et al., 2019; Bai et al., 2020; Gormley, Phillips, & Anderson, 2018). Burger (2010), based on a systematic review of the evidence, concluded that ECE attendance has larger positive short-term but smaller longer-term effects on cognitive development.

The impact of ECE on learning competencies and desire to improve children's readiness to learn on entry to primary school has led governments in LMIC contexts to develop policies aimed at expanding access to ECE for all children (McCoy et al., 2018a; Nonoyama-Tarumia et al., 2009; Tran et al., 2016; UNESCO, 2015). Further, the United Nations, as part of its Sustainable Development Goals, Target 4.2, called for all children to "have access to quality early childhood development, care and pre-primary education so that they are ready for primary education" (United Nations, 2015). However, questions have been raised about the quality of ECE provision in most LMIC contexts (Britto et al., 2011; Spier et al., 2019) and the extent to which they impact children's school readiness competencies. Additionally, although there are multiple competencies of school readiness, ECE in LMIC contexts tend to prioritize development of academic competencies (e.g., Agbenyega, 2018; Wolf, 2020) due to parental preferences for academically focused education (e.g., Wolf, 2020). Knowledge about the extent to which ECE attendance is associated with a wider range of school readiness competencies (e.g., socioemotional, behavioral) in LMIC contexts is rare. In this study, we examined the extent to which ECE is associated with both overall and domain-specific school readiness competencies in LMIC contexts.

#### SES, school readiness, and ECE

Both school readiness and access to ECE are socioeconomically stratified. Research from high and LMIC contexts indicate that children from higher SES backgrounds demonstrate higher readiness competencies compared to low SES peers in cognitive, socioemotional, and behavioral domains prior to starting school (Barnett et al., 2020; Bradley & Corwyn, 2002; Fernand et al., 2011; McCoy et al., 2018a; Micalizzi et al., 2019; Nonoyama-Tarumia et al., 2009; Wolf & McCoy, 2019). This is because familial context is an important determinant of children's development (Bronfenbrenner & Morris, 2006), and SES shapes the household context in which children develop (e.g., Shaw & Shelleby, 2014; Wolf & McCoy, 2019). For instance, parents from higher SES households are able to invest in resources (such as ECE) that help their children develop school readiness competencies (Miller et al., 2015; Shaw & Shelleby, 2014; Wolf & McCoy, 2019). Additionally, high SES parents tend to be more involved with home learning activities (e.g., reading books) and have the knowledge to effectively support their children's learning at home (e.g., Barnett et al., 2020; Wolf & McCoy, 2019). This SES difference in school readiness is important because it is the genesis of inequalities in educational and life course outcomes (e.g., Bornstein et al., 2012, Frongillo et al., 2017; Kim et al., 2019).

Overall, SES is a multidimensional construct that refers to the relative economic position of individuals or families based on access to wealth, power, social recognition, or privileges (Bradley & Corwyn, 2002; McLoyd, 1998; Mueller & Parcel, 1981). It is typically measured using different indicators such as income, education, and job status (Bradley & Corwyn, 2002; Kim et al., 2019). Within LMIC contexts, rural-urban location is an important measure of SES due to its association with access to valued resources and services (UN, 2020), with evidence indicating location to be a predictor of key developmental outcomes (e.g., McCoy et al., 2016; Nyatsikor et al., 2020). Emerging evidence from developmental research suggests that these different dimensions of SES, although associated with each other, are likely to have unique influences on children's developmental outcomes (Bukodi & Goldthorpe, 2013; Schenck-Fontaine & Panico, 2019; Tamis-LeMonda et al., 2009). So far, only limited research attention (e.g., McCoy et al., 2016) has been devoted to examining the extent to which different dimensions of SES independently influence school readiness within LMIC contexts. Such findings can have significant implications for policy decisions, such as identifying low SES groups for intervention to reduce educational inequality.

One key objective for expanding access to ECE in LMIC contexts was to address socioeconomic inequalities in children's school readiness (Spier et al., 2019; UNESCO, 2015). However, studies from high income contexts have found different types of outcomes when examining the impact of ECE on child outcomes by low socioeconomic groups (Lehrl et al., 2016; Miller et al., 2014). The first is a *compensatory effect* whereby children from lower SES households derive greater benefit from ECE attendance than high SES peers (Bai et al., 2020; Burger, 2010; Gormley, Phillips, & Anderson, 2018). For instance, Bai et al., (2020) found that the effect of ECE on cognitive achievement was stronger for children from low SES groups compared to high SES backgrounds. Children from low SES backgrounds are expected to receive the greatest benefits because they have limited preacademic stimulation at home (Miller et al., 2014) and ECE is viewed as an equalizing mechanism.

The second is a leveraging or accumulated advantages effect in which benefits of ECE attendance are greater for higher compared to lower SES peers. For instance, Belsky et al. (2006) in their study of the Sure Start program in the UK found that children from less socially deprived backgrounds derived the greatest benefit (i.e., decreased behavior problems), while the program appeared to have an adverse effect on the behavior of children from low SES backgrounds. It is argued that leveraging effects occur because children from higher SES backgrounds are better prepared to capitalize on learning experiences provided by ECE programs (Miller et al., 2014). Leveraging can also be explained by the quantity as well as quality of ECE accessible to all children (Britto et al., 2011; Buyse et al., 2011; O'Connor & McCartney, 2006; Tran et al., 2016; Votruba-Drzal et al., 2004). Access to quality ECE is highly correlated with children's socioeconomic conditions (Hlasny, 2017; McCoy et al., 2018b). Research from high and LMIC contexts indicate that parents from high SES backgrounds are able to afford and enroll their children in higher quality ECE programs (Bainbridge et al., 2005; La Paro et al., 2009; McCoy et al., 2018b; Nonoyama-Tarumia et al., 2009), thereby resulting in greater benefits.

The third is *an additive effect* whereby benefits of ECE attendance are similar for all children irrespective of their family SES (i.e., no interaction effect: Lehr et al., 2016). Burger's (2010) review found that most studies showed no consistent advantage from ECE attendance for lower compared to higher SES children. While ECE programs improved readiness outcomes, they did not compensate for social disadvantage.

Within LMIC contexts, very little attention has so far been devoted to understanding inequalities in children's school readiness (for exceptions, see Wolf & McCoy, 2019) and studies have rarely examined the moderating role of SES on the association between ECE attendance and children's school readiness outcomes. Additionally, both school readiness and SES are multidimensional (Boivin & Bierman, 2014; Bukodi & Goldthorpe, 2013), and our literature review has not revealed any studies that have examined whether these associations vary by dimensions of school readiness and SES. These are gaps we address in the current study. Understanding both the nature of SES inequalities as well as the moderating role of SES is important. This is because reducing inequality depends on the extent to which ECE has a similar impact on the readiness competencies of children from high and low SES backgrounds.

#### The present study

In the present study, we drew on data from UNICEF's Multiple Indicator Cluster Survey (MICS) to examine the association between ECE attendance, family SES, and domains of school readiness in 58 LMICs. Additionally, we examined whether the association between ECE and school readiness is moderated by family level SES. Fig. 1 shows the proposed multilevel model of the association among ECE, SES, and school readiness.

To test this model, we were guided by the following research questions and hypotheses.

- Is ECE attendance associated with domains of school readiness (total, literacy–numeracy, learning, and socioemotional school readiness)? We hypothesize that children who attend ECE will have higher scores on all school readiness domains.
- 2 To what extent is family level SES (i.e., wealth, education, and location) associated with each domain of school readiness? We hypothe-size that SES at the family level will be positively associated with all domains of school readiness. In other words, children from high SES backgrounds will have higher scores in domains of school readiness.
- 3 To what extent is the association between ECE attendance and school readiness moderated by family level SES? Specifically, does ECE attendance have similar associations with school readiness for children from different SES backgrounds? Based on the current literature we anticipate three possible outcomes: a) *a leveraging effect* whereby the association between ECE and school readiness will be stronger for children from higher compared to lower SES backgrounds, b) *a compensatory effect* in which ECE attendance will be more strongly associated with school readiness for children from lower compared to higher SES backgrounds, and c) *an additive effect* where associations between ECE attendance and school readiness will not vary by family SES.

#### Method

#### Sample and study design

The current study is based on data from the Multiple Indicator Cluster Survey (MICS). The MICS is a global and internationally comparable, multistage probability household sample survey designed to be representative of a national or subnational level of each participating country (Khan & Hancioglu, 2019; Loizillon et al., 2017). Data was collected through face-to-face interviews with participants, with the majority of data on child development provided by mothers (Loizillon et al., 2017). To ensure reliability and consistency, indicators are measured using internationally agreed-upon approaches, and data collection in each country follows a structured approach. For the current study, we selected data from MICS rounds 4 or 5, as these were the most comprehensive rounds of data available at the time the study was conceptualized. Countries were included and excluded on the basis of availability of child developmental data (i.e., completed under-5 questionnaire). We restricted our sample to children between 36 and 59 months of age and selected information for only the focus child in cases where multiple children were present in the household. The data cleaning process is described in Appendix A. Our final data came from 58 countries with a sample size of N = 165,875 children. This total sample consists of participants with at least one response to any of the items measuring our dependent variable (i.e., school readiness). The mean age was 47.52 months (SD = 6.81), and 49.1% were girls. Detailed information about the MICS data collection procedures as well as survey development can be found elsewhere (Khan & Hancioglu, 2019; Loizillon et al., 2017).

#### Study measures

*School readiness.* School readiness was measured using the Early Child Development Index (ECDI) in the MICS dataset. The ECDI is a 10-



Fig. 1. Proposed multilevel model of the association ECE, SES, and school readiness.

*Note.* ECE = Early childhood education; SES = Socio-economic status; LitNum = Literacy–Numeracy readiness; Learn = Learning readiness; SocEmo = Socioemotional readiness; HDI = Human Development Index.

item binary response measure (no = 0; yes = 1) which asks parents to indicate whether the focus child engages in a series of activities associated with key developmental milestones. It captures developmental status of children within four domains—literacy–numeracy, physical, learning, and socioemotional—and items are summed up to compute total or domain-specific scores (Loizillon et al., 2017).

For the current study, we used eight items capturing three domains (literacy-numeracy, learning, and socioemotional). We excluded items from the physical domain because our main research question was to examine the association between ECE attendance and school readiness. Domain-specific school readiness are as follows: Literacy-numeracy readiness was measured with three items: "Can (named child) identify or name at least 10 letters of the alphabet?", "Can (named child) read at least four simple, popular words?", and "Does (named child) know the name and recognize the symbol of all numbers from 1 to 10?". Learning readiness consists of two items: "Does (named child) follow simple directions on how to do something correctly?", and "When given something to do, is (named child) able to do it independently?". Finally, socioemotional readiness was measured using three items: "Does (named child) get along well with other children?", "Does (named child) kick, bite, or hit other children?", and "Does (named child) get distracted easily?". The last two items were reverse-scored, with higher scores indicating higher socioemotional readiness. Total school readiness was measured using all items from the three domains. To ensure comparability of estimates across the domains, both total and domain-specific scores were transformed into a standardized Z-score.

Loizillon et al. (2017) provides detailed information on the development and psychometric validation of the ECDI. This consisted of multicountry field tests, validity, and reliability studies, as well as expert deliberations. Studies using the ECDI and its domains across several countries have found it to be associated with known sociodemographic predictors such as home learning environment, wealth, and nutritional status (Bornstein et al., 2012; Jeong et al., 2016; McCoy et al. 2016).

*Early childhood education (ECE) Attendance.* ECE attendance was measured by asking parents to indicate whether the focus child "attends any organized learning or early childhood education program, such as private or government facility, including kindergarten or community child care" Responses were dummy coded (no = 0; yes = 1).

**Parent socioeconomic status (SES).** We used a multidimensional measure consisting of three different indicators (education, location, and wealth index) to measure parental SES. *Parental education* was measured using the education of head of household (none = 0; primary+ = 1). *Location* measured whether participants lived in rural (0) or urban (1) areas. Finally, *wealth* index, as measured in the MICS dataset, is constructed using information from context-specific assets, household characteristics, and water and sanitation facilities. It was measured on a 5-point scale (1 = poorest to 5 = richest). Previous studies have indicated these measures to be objective, valid and reliable indicators of family SES (e.g., Frongillo et al., 2017; McCoy et al., 2016; UN, 2020).

*Covariates.* Demographic indicators of *Gender* (male = 0; female = 1) and *age of focus child* in months were used as individual-level covariates in the model. Given the multilevel nature of the data, we also used *country-level SES* as covariates to enable us to separate the influence of country-level SES from family-level SES. We measured country-level SES using the Human Development Index (HDI) corresponding to the year of the MICS survey (e.g., UNDP, 2018). The HDI has been used in previous studies as a valid proxy of country-level wealth (e.g., McCoy et al., 2016; Tran et al., 2016).

#### Missing data

Overall, missing data was very small. For the independent variables, missing data ranged from 0% to .4% with four out of the seven independent variables (child age, wealth, sex and HDI) having no missing data. Missing data for attendance at ECE was tiny at .2%. Dependent variables were computed when participants had a response on all items measuring the specific domain. Missing data for the total school readiness subscales was tiny ranging from .9% to 2.7%. Analysis for total school readiness (outcome with the biggest level of missingness) indicates that those with missing data were more likely to be from lower wealth households, households with no education, and those who did not attend ECE. There were no differences by rural-urban location, child sex and age.

#### Statistical analysis

Analyses were undertaken using multilevel modeling. Specifically, we fitted a two-level linear regression model to account for the clustering of individuals within countries (n = 58). In Model 1, unconditional baseline models with no predictors were estimated for both total and domain-specific school readiness. The baseline models enabled us to obtain intra-class correlation coefficients (ICC) and test the assumption of within-country clusters. This was followed by the addition of covariates and individual-level predictors in Model 2. All predictors were grand mean centered and added to the model using a stepwise approach (Hox, Moerbeek, & van de Schoot, 2017). Additionally, we estimated random slopes for the individual-level predictors.

In Model 3, we estimated within-level interactions to examine whether the associations between ECE attendance and domains of school readiness are moderated by family SES (Fig. 1). This was followed by a sensitivity analysis of cross-level interaction to account for possible ECE–school readiness association being moderated by country level SES (HDI). We evaluated improvements in model fit using the Akaike information criterion (AIC) and the Bayesian information criterion (BIC). As a rule, models with smaller AIC and BIC values represent a better model fit regardless of the number of parameters. Analyses were undertaken using Mplus 8.7 with a maximum likelihood estimator (Muthén & Muthén, 1998–2012). Given the very small number of missing data overall, and the large dataset, we used complete cases for analysis. We also took into account sample weights included in the MICS dataset to compensate for over and under sampling and variations in nonresponse.

#### Results

#### Descriptive and correlational analyses

Table 1 provides descriptive information on key variables in our study including the proportion of children who attended ECE across countries. Correlational analysis (Table 2) across key variables indicated small to moderate positive associations between ECE attendance and school readiness domains (r = .06 to r = .45), as well as family SES and school readiness domains (r = .05 to r = .27). There were also small to moderate correlations between family SES and ECE attendance (r = .19 to r = .26).

#### Inferential analysis

#### Baseline models and model fit

The unconditional models (Model 1, Appendices B-E) indicated significant variations in total and domain-specific school readiness scores both within and between countries, thereby supporting the application of the multilevel approach. Respectively, the ICC indicated that 78%, 77%, 88%, and 93% of differences in the total, literacy–numeracy, learning, and socioemotional school readiness were within countries. AIC and BIC values from conditional models including predictors showed that successive models were an improvement over the previous models (Table 3).

#### Association between ECE attendance and school readiness

Findings indicated that ECE attendance was uniquely associated with higher school readiness scores (Table 4). Specifically, attending ECE was associated with increased scores in *total school readiness* (b = .431, p < .001), *literacy–numeracy* (b = .555, p < .001), *learning* (b = .122, p < .001), and *socioemotional readiness* (b = .030, p < .05). The effect size of the estimates from bivariate associations suggests that ECE attendance was more strongly associated with literacy–numeracy (medium effect size) followed by learning and socioemotional readiness (both small effect sizes). The strength of these associations varied across countries (see variance component in Table 4). Fig. 2 shows the average school readiness scores for children with and without ECE attendance.



Fig. 2. Average Total, Literacy–Numeracy, Learning, and Socioemotional Readiness by ECE Attendance.

#### Association between SES and school readiness

Findings indicated significant associations between family SES and *total school readiness*. At the family level, children whose parents have completed at least a primary education (b = .146, p < .001), who are from higher wealth households (b = .079, p < .001) and living in urban areas (b = .031, p < .05) obtained higher total school readiness scores than their peers whose parents have no education, are from lower wealth households, and that live in rural areas.

When looking at the specific domains of school readiness, we found similar socioeconomic inequalities in relation to *literacy-numeracy readiness*, with higher scores for children whose parents have completed primary education (b = .144, p < .001), those from higher wealth households (b = .085, p < .001), and children residing in urban areas (b = .061, p < .001). For *learning readiness*, there were significant associations with parental education (b = .102, p < .001) and wealth (b = .034, p < .001), but not location. However, findings with regard to *socioemotional readiness* were mixed. Consistent with other domains, children from higher wealth households (b = .025, p < .001). In contrast, rural children had higher socioemotional scores than their urban peers (b = -.032, p < .05). No differences were found for parental education. The strength of these associations also varied across countries (see variance component in Table 4).

#### Moderating role of family SES on the ECE-school readiness association

The results found that family SES significantly moderated the association between ECE attendance and school readiness, albeit in a complex way. The association between ECE attendance and *total school readiness* was larger for children from high compared to low wealth households (b = .035, p < .01), and for those whose parents completed at least a primary education compared to no education (b = .062, p < .05). There was no significant moderating effect for location, suggesting that the association between ECE attendance and total readiness was similar for children from rural and urban areas (Fig. 3a).

For *literacy–numeracy readiness* (Fig. 3b), the association with ECE attendance was larger for children from higher SES backgrounds, that is, higher wealth households (b = .050, p < .01), urban areas (b = .069, p < .01) and for those whose parents have completed at least a primary education (b = .097, p < .001) than peers from low SES households. For *so-cioemotional readiness*, there was no significant interaction between ECE attendance and SES, suggesting that the association between ECE attendance and this domain of readiness, however, suggests that the association between ECE attendance and learning readiness was greater for children from rural areas (b = -.037, p < .05) and whose parents had no formal education (b = -.040, p < .05). Although similar trends were found for family wealth, the results were not statistically significant (Table 4 and Fig. 3c).

#### Sensitivity analysis

Low- and middle-income contexts represent a diverse range of countries with varying economic conditions. The results showed significant

#### Table 1

Descriptive information of sample size, gender distribution (boys), area (urban), year of survey, HDI, and mean of total school readiness for each country, sorted by HDI (from lowest to highest)

Country	Ν	Boys (%)	Urban (%)	Mean wealth ( <i>SD</i> )	Primary parental education (%)	MICS round	HDI	Total school readiness (8 items)	ECE Attendance (%)
Central Africa Republic	3.385	48.2	33.4	2.71 (1.29)	78.9	MICS4	.351	3.32	3.5
Chad	6,253	49.4	36.4	3.11 (1.38)	34.4	MICS4	.371	2.97	5.1
Sierra Leone	3,347	50.4	27.7	2.77 (1.41)	29.0	MICS4	.385	3.39	13.9
Mali	1,502	51.7	20.6	2.73 (1.42)	23.2	MICS5	.418	3.58	4.9
Gambia	3,002	51.8	29.4	2.56 (1.40)	17.8	MICS4	.441	4.04	16.4
Guinea Bissau	2,255	50.1	27.7	2.45 (1.29)	50.1	MICS5	.445	3.85	10.3
Guinea	2,549	52.2	29.2	2.73 (1.36)	29.7	MICS5	.449	3.37	8.6
Togo	1,637	51.3	24.9	2.59 (1.35)	59.3	MICS4	.456	3.64	26.3
Malawi	6,928	50.1	10.9	2.84 (1.37)	87.2	MICS5	.461	4.03	38.6
Cote d'Ivoire	3,038	51.5	26.1	2.44 (1.28)	36.8	MICS5	.486	3.77	10.9
Benin	4,013	49.3	51.3	3.13 (1.47)	50.9	MICS5	.505	3.81	16.9
Madagascar	1,109	51.0	4.1	2.74 (1.36)	44.7	MICS4	.507	3.92	7.6
Mauritania	3,690	49.3	41.6	2.83 (1.38)	66.2	MICS5	.514	4.31	13.2
Zimbabwe	3,640	49.8	26.8	2.89 (1.40)	94.1	MICS5	.525	3.85	23.2
Nigeria	9,411	51.0	27.6	2.90 (1.42)	80.8	MICS5	.530	4.50	40.9
Cameroon	2,308	50.0	46.4	2.95 (1.34)	78.2	MICS5	.543	4.04	33.3
Pakistan	14,965	50.9	35.5	2.63 (1.37)	60.4	MICS5	.548	4.13	22.5
Laos	4,195	51.7	18.0	2.47 (1.38)	76.2	MICS4	.558	4.89	21.4
Nepal	2,035	52.1	17.6	2.41 (1.42)	57.9	MICS5	.560	4.19	52.1
Ghana	2,812	50.9	29.0	2.15 (1.34)	50.1	MICS4	.563	4.27	57.5
Kenya	957	49.0	39.5	2.71 (1.39)	66.3	MICS5	.566	4.26	37.7
Bangladesh	8,501	52.1	15.6	2.57 (1.41)	57.3	MICS5	.567	4.21	14.1
Sao Tome e Principe	761	51.0	58.7	2.63 (1.34)	94.3	MICS5	.567	3.97	37.3
Swaziland	954	51.2	15.4	2.61 (1.37)	77.0	MICS5	.580	4.26	30.2
Congo	3,099	51.3	30.4	2.07 (1.26)	90.0	MICS5	.595	3.73	23.6
Guyana	1,171	51.9	19.9	2.50 (1.47)	98.0	MICS5	.648	5.76	61.4
Iraq	12,098	50.4	54.0	2.38 (1.32)	80.9	MICS4	.656	4.36	3.4
Kyrgyzstan	1,568	51.3	31.4	2.70 (1.38)	98.4	MICS5	.663	4.50	24.9
El Salvador	2,700	51.3	55.9	2.86 (1.42)	86.1	MICS5	.670	4.73	26.6
Viet Nam	1,111	49.0	38.3	2.88 (1.45)	89.8	MICS5	.675	5.23	73.5
Palestine	2,851	52.3	81.6	2.89 (1.40)	98.6	MICS5	.6/9	4.54	29.0
Moldova Turlen en isten	/06	54.1	50./	3.40 (1.43)	100.0	MICS4	.684	5.14	/4.6
furkinenistan	1,274	32.3	43.4	3.13 (1.40)	99.9	MICSS	.701	4.99	49.0
Polizo	1,190	40.9 E1 2	30.0	2.00(1.33)	74.0	MICS4	.700	4.42 E 49	27.0
Jamaica	1,028	51.5	42.2	2.79 (1.38)	94.0 100.0	MICS5	.709	5.48	00.1
Dominican Popublic	7.074	50.7	64.4	2.09 (1.33)	02.0	MICS5	719	5.90	36.3
Tunicia	1.092	52.5	58.2	2.59(1.59)	93.0	MICSA	718	J.11 4 91	30.3
Bosnia and Herzegovina	1,002	49.8	29.6	2.00(1.40) 2 99(1.44)	92.0	MICS4	721	5.40	93
Mongolia	2 178	50.5	56.0	2.55 (1.44)	88.0	MICS5	729	4 45	69.3
St Lucia	119	48.7	36.1	2.63 (1.13)	95.7	MICS4	730	6.11	84.9
Macedonia	715	51.3	66.0	3.03(1.40)	94.3	MICS4	738	5.50	19.4
Algeria	5.255	52.6	65.9	2.87 (1.40)	74.6	MICS4	.740	4.49	15.0
Thailand	5.233	51.5	45.1	2.81 (1.38)	93.0	MICS5	.741	6.03	86.0
Ukraine	1.848	51.1	63.8	2.94 (1.43)	99.6	MICS4	.743	5.30	53.8
Costa Rica	868	48.0	48.0	2.45 (1.38)	95.8	MICS4	.760	4.82	13.8
Lebanon	665	53.2	62.3	3.08 (1.42)	96.7	MICS4	.760	5.42	57.6
Mexico	2,987	51.3	63.9	2.52 (1.31)	94.2	MICS5	.767	4.85	60.6
Trinidad & Tobago	496	48.4	41.9	2.65 (1.37)	98.4	MICS4	.773	6.43	85.4
Serbia	1,668	51.0	65.5	3.11(1.46)	93.9	MICS5	.775	5.59	35.5
Panama	2,157	54.5	34.0	2.04 (1.31)	86.5	MICS5	.776	4.52	35.5
Kosovo	821	52.7	41.9	2.83 (1.44)	91.3	MICS5	.786	4.85	15.0
Uruguay	709	52.8	88.0	2.87 (1.54)	100.0	MICS4	.790	5.75	82.1
Barbados	192	55.2	56.3	3.04 (1.42)	100.0	MICS4	.795	6.57	90.6
Kazakhstan	2,135	50.4	54.9	3.00 (1.43)	100.0	MICS5	.797	5.04	59.8
Belarus	1,388	49.6	70.9	3.24 (1.42)	100.0	MICS4	.803	5.50	87.2
Montenegro	800	54.6	68.9	3.12 (1.42)	85.1	MICS5	.803	5.30	31.0
Argentina	3,448	51.4	100.0	2.86 (1.43)	98.8	MICS4	.819	5.39	57.8

between-country variations in school readiness scores (see ICCs), and between-country variations in the association between ECE attendance and school readiness (level 1 within variance components, Table 4). Additionally, country level economic conditions (HDI) were positively associated with school readiness scores (Table 4). We therefore undertook a sensitivity analysis to examine if the strength or direction of association between ECE attendance and school readiness outcomes was moderated by country level wealth (HDI). Results (Table 4) showed that associations between ECE attendance and *total readiness* (b = -.93, p <.001), *literacy and numeracy* (b = -1.33, p < .001), and *learning readiness*  (b = -.74, p < .001) were larger in lower compared to middle-income countries. The only difference was for *socioemotional readiness* where the association between ECE attendance and socioemotional readiness was larger for children from middle compared to lower income countries (b = .41, p < .001).

# Discussion

This study provides novel evidence from 58 low- and middle-income countries on the association between ECE attendance, dimensions of

# Table 2

Correlations table										
	1	2	3	4	5	6	7	8	9	10
1. Total school readiness	-									
2. ECE	.39**	-								
3. LitNum	.75**	.45**	-							
4. Learn	.59**	.17**	.20**	-						
5. SocEmo	.58**	.06**	.07**	.10**	-					
6. Location	.19**	.19**	.20**	.11**	.05**	-				
7. Wealth	.22**	.26**	.27**	.07**	.04**	.46**	-			
8. Parental education	.24**	.23**	.22**	.15**	.08**	.21**	.22**	-		
9. HDI	.35**	.26**	.24**	.30**	.15**	.27**	01**	.36**	-	
10. Sex	05**	01**	23**	01**	06**	.82	001	003	.01**	-
11. Age	.18**	.19**	.21**	.10**	.03**	.02**	.004	.02**	.04**	.01

\*\* p < .01Note. ECE = Early childhood education; LitNum = Literacy-Numeracy readiness; Learn = Learning readiness; SocEmo = Socioemotional readiness; HDI = Human Development Index.

Table 3	
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Baseline models and model fits

		M1	M2	M3
Total school	BIC	422706.10	390713.11	390589.75
readiness	AIC	422676.18	390573.59	390409.13
	N	158,679	157,231	157,231
LitNum	BIC	444503.62	396589.49	396254.69
	AIC	444473.60	396449.53	396074.74
	N	163,826	162,302	162,302
Learn	BIC	441170.24	432583.30	432567.51
	AIC	441140.21	432443.29	432387.50
	Ν	164,375	162,829	162,829
SocEmo	BIC	448322.81	442301.97	442308.67
	AIC	448292.83	442162.22	442128.99
	Ν	161,335	159,832	159,832

*Note.* LitNum = Literacy-Numeracy readiness; Learn = Learning readiness; SocEmo = Socioemotional readiness; AIC = Akaike information criterion; BIC = Bayesian information criterion; N = sample size.

family SES and school readiness, and the extent to which the ECEschool readiness association is moderated by family SES. The results revealed strong associations between attendance at ECE and both total and domain-specific school readiness competencies. The associations were of moderate effect for literacy-numeracy, and small effect for learning and socioemotional readiness. Additionally, we found an overall strong association between the dimensions of family SES and school readiness competencies, supporting our assumption of socioeconomic inequalities in school readiness across LMICs. However, there were exceptions, with children from rural areas demonstrating higher socioemotional readiness competencies than their peers from urban areas. Family SES moderated the association between attending ECE and school readiness, albeit in complex ways. While the association between ECE attendance and literacy-numeracy readiness were strongest for children from high SES backgrounds, the trend of association between ECE attendance and learning readiness were stronger for children from low SES backgrounds.

Consistent with our first hypothesis and previous studies (Bornstein & Hendricks, 2012; Britto et al., 2011; Willoughby et al., 2019), we found strong associations between ECE attendance and all domains of school readiness in LMIC contexts. Overall, the association between ECE and school readiness was significant to the extent that children from low

#### Table 4

inal model for Total, Literacy–Numeracy	, Learning, and	d Socioemotional	school readiness
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	Total school readiness	LitNum	Learn	SocEmo
Intercept	.083 (.028)**	.062 (.037)	.080 (.025)**	.027 (.025)
Within				
ECE (yes)	.431 (.024)***	.555 (.039)***	.122 (.018)***	.030 (.013)*
SES				
Location (Urban)	.031 (.014)*	.061 (.015)***	.018 (.009)	032 (.016)*
Wealth	.079 (.006)***	.085 (.007)***	.034 (.004)***	.025 (.006)***
P. education	.146 (.025)***	.144 (.021)***	.102 (.022)***	.016 (.021)
Controls				
Age (months)	.020 (.001)***	.022 (.001)***	.011 (.001)***	.003 (.001)***
Gender (Male)	108 (.011)***	046 (.008)***	033 (.005)***	132 (.016)***
Between				
HDI	2.391 (.195)***	1.593 (.281)***	1.870 (.223)***	1.242 (.163)***
Interactions				
Location*ECE	.039 (.023)	.069 (.023)**	037 (.018)*	.029 (.022)
Wealth*ECE	.035 (.012)**	.050 (.016)**	010 (.005)	.014 (.010)
P.Edu*ECE	.062 (.025)*	.097 (.026)***	040 (.018)*	.028 (.025)
HDI*ECE	928 (.166)***	-1.33 (.215)***	740 (.125)***	.408 (.114)***
Variance Component				
Level 1 (within)	.698 (.022)***	.668 (.032)***	.830 (.070)***	.927 (.029)***
Level 2 (between)	.046 (.009)***	.088 (.021)***	.030 (.008)***	.038 (.009)***
ECE	.030 (.007)***	.083 (.013)***	.017 (.005)***	.008 (.003)**
Location (Urban)	.008 (.004)*	.010 (.003)**	.002 (.001)*	.009 (.004)*
Wealth	.002 (.000)***	.003 (.001)***	.001 (.000)***	.002 (.000)***
P. education	.017 (.010)	.010 (.007)	.017 (.010)	.011 (.010)

\* p < .05

\*\* *p* < .01

\*\*\* p < .001*Note.* ECE = Early childhood education; SES = Socio-economic Status; Lit-Num = Literacy–Numeracy readiness; Learn = Learning readiness; SocEmo = Socioemotional readiness; HDI = Human Development Index.

# A. Total school readiness



# B. Literacy-Numeracy readiness





# C. Learning readiness



Fig. 3. Simple slopes for the effect of interaction term (ECE\*SES) and school readiness (i.e., total, literacy-numeracy, and learning readiness).

SES households who attend ECE have higher school readiness scores than high SES peers who do not attend ECE. ECE is therefore a key contextual factor that enables all children to develop school readiness competencies (e.g., Barnett et al., 2020; Bronfenbrenner & Morris, 2006). Our findings extend knowledge about the role of ECE by showing that attending ECE is more strongly associated with literacy–numeracy readiness, followed by learning and socioemotional readiness. In other words, ECE in LMIC contexts has a stronger association with cognitive outcomes compared to other domains such as learning and socioemotional competencies. This is likely due to the greater priority placed by ECE on the development of academic competencies (e.g., Agbenyega, 2018; Wolf, 2020) due to parental preferences for academically focused education (e.g., Wolf, 2020).

Apart from ECE attendance, we found that familial socioeconomic context was an important determinant of children's school readiness competencies. In line with our second hypothesis and previous studies on socioeconomic inequalities in school readiness (e.g., Fernand et al., 2011; Micalizzi et al., 2019; Tran et al. 2016; Wolf & McCoy, 2019), children from high SES households demonstrated higher levels of overall school readiness.

However, by using a multidimensional conceptualization of family SES and school readiness, we provide a nuanced understanding of this association. First, despite the interrelatedness between the different dimensions of family SES used in our study (household wealth, parental education, and location), we found that each dimension of SES was uniquely associated with overall school readiness. When comparing all dimensions of SES, we found that parental wealth was the most consistent SES dimension associated with all domains of school readiness, followed by parental education and location. Second, we demonstrate that the nature of association between family SES and school readiness depends on the dimension of SES and domain of school readiness being examined. Whereas higher levels of all SES dimensions (high wealth, parents with at least primary education, and those in urban areas) were associated with higher levels of literacy-numeracy and learning readiness, this was not the case for location and socioemotional readiness. Specifically, children in rural areas demonstrated higher socioemotional readiness than their urban peers, contrary to our expectations. While the reasons for this need to be examined in future studies, this latter finding questions a predominantly deficit view of children from low SES backgrounds and suggests the need to draw on the key strengths they possess at the start of formal schooling. Our findings on the association between SES and school readiness strengthens recent arguments proposing that, although dimensions of SES are interrelated, they are likely to have unique influences on children's developmental outcomes (Bukodi & Goldthorpe, 2013; Schenck-Fontaine & Panico, 2019; Tamis-LeMonda et al., 2009). Research exploring socioeconomic inequalities should therefore use multidimensional measures of SES where possible to enable a more nuanced understanding of its complex association with child development.

One of the key questions in this study (i.e., our third hypothesis) was the extent to which the association between ECE and school readiness is moderated by family SES. The findings for total school readiness scores suggest that ECE attendance has a stronger association with school readiness outcomes for children from high compared to low SES backgrounds. In other words, where both high and low SES groups attend ECE, the benefits for total school readiness appear to be higher for high SES children compared to low SES peers. This suggests a predominantly leveraging effect (Belsky et al., 2006; Miller et al., 2014) and the argument that differences in the quantity or quality of ECE accessed by children from high and low SES backgrounds (Bainbridge et al., 2005; La Paro et al., 2009; McCoy et al., 2018b; Nonoyama-Tarumia et al., 2009) will lead to a stronger association between ECE and readiness for children from high rather than low SES backgrounds.

However, our findings relating to the moderating role of SES vary by specific domain of school readiness. The association between ECE and literacy-numeracy readiness was stronger for children from higher rather than lower SES backgrounds, a conclusion consistent with a leveraging effect. On the other hand, in line with a compensatory effect (Bai et al., 2020; Lehrl et al., 2016), the association between ECE attendance and learning readiness was stronger for children from lower SES backgrounds (i.e., those from rural areas and whose parents have no formal education). Put another way, the benefits of ECE for learning readiness appear to be higher for children from rural areas and households with low parental education. For socioemotional readiness, we found an additive effect (Burger, 2010; Lehrl et al., 2016) with no variations in the strength of associations between ECE attendance and readiness across socioeconomic groups. Our finding suggests that while ECE attendance may close the socioeconomic gap in some domains of school readiness, it may widen inequality in other domains. Future studies should examine the conditions under which ECE might exacerbate socioeconomic inequalities or serve as an equalizer for children's school readiness.

Finally, our findings showed that the strength of associations among ECE, SES and school readiness vary across countries. Similarly, our sensitivity analysis suggests that country level income may moderate the association between ECE attendance and school readiness outcomes. Specifically, there was a stronger association between ECE attendance and school readiness outcomes (i.e., literacy–numeracy and learning readiness) for children in lower compared to middle income countries; while the association between ECE attendance and socioemotional readiness outcomes were stronger for children in middle compared to lower income countries. Future research should examine these between country differences especially in the effect of ECE attendance on school readiness and the rationale for these differences.

#### Strengths and limitations

There are a number of strengths and limitations of the present study. The use of data from 58 LMIC contexts enabled us to examine associations between ECE, SES, and school readiness across a wider range of contexts. The consistency of findings across these contexts, albeit with variability, indicates the usefulness of the findings in guiding policy and practice for improving school readiness outcomes for millions of children around the world. In other words, the present study provides evidence that might help to achieve key UN global goals of equitable access to quality education. Another strength of the current study is the use of multidimensional conceptualization of SES and school readiness to illuminate nuances in the association between ECE attendance, SES, and school readiness. Awareness of such nuances is crucial for formulating policy and interventions that take these complexities into account, as well as providing a nuanced theoretical understanding of the association between ECE, SES, and school readiness.

Despite the unique contributions of the present study, our findings should be interpreted considering the following limitations. First, the study uses cross-sectional data and examines associations. We also did not account for any readiness competencies prior to children accessing ECE. As a result, findings cannot be interpreted as causal. Future studies using experimental design and longitudinal data are needed to establish a causal relationship between attending ECE, family SES, and children's school readiness competencies. Given existing evidence for a potential fadeout effect of ECE (Atteberry et al., 2019; Burger, 2010; Lipsey et al., 2018), it will also be important to examine the short- and long-term impact of ECE attendance on outcomes in LMIC contexts. Second, the measures of school readiness and ECE attendance used in the current study are based on parent reports rather than an independent objective measure of children's competencies. Whether these measures are invariant across countries is also not known. Therefore, we cannot eliminate the possibility of measurement error between parents and across countries. Closely linked to the above is the degree to which the school readiness measures reflect the complexity of domains measured.

While these measures have an advantage of simplicity and consistency across several countries, the number of items used to measure each domain may not be comprehensive given the complexity of the constructs being assessed. The extent to which the measure predicts longer term future outcomes should be the focus of future studies. Third, the data on ECE attendance do not enable us to differentiate between ECE settings (e.g., formal, private, community, etc.) or quality of the ECE accessed. We are also unable to account for aspects such as timing and duration of attendance. These are important aspects of ECE likely to impact children's school readiness that should be considered by future studies. These studies should also consider using administrative data to capture important aspects of access, attendance, timing, and duration of ECE. Finally, our study mainly focuses on whether children are ready for school. Britto (2012) argues that readiness should be seen from a multidimensional perspective, and future studies should consider the other two dimensions of whether schools and communities are ready for children. This will entail a focus on quality of educational provision and the ability of schools to support children to overcome any difficulties.

#### Implications for policy and practice

The findings from the current study point to the significant role that increasing ECE attendance can play in developing school readiness competencies for children in LMIC contexts. Although the findings are correlational in nature, the consistency of associations between attending ECE and school readiness outcomes across multiple countries provides further evidence that ECE is one of the important mechanisms for improving children's school readiness and, subsequently, future educational outcomes around the world. Further, our findings suggest that ECE in LMIC contexts may be strongly geared towards cognitive outcomes, thereby ignoring other important developmental domains necessary for future educational progress. Therefore, there is a need for policies, professional development, and education provision for early years staff to prioritize the development of other school readiness domains (e.g., socioemotional and behavioral) in addition to cognitive competencies. Given parental prioritization of academic domains in LMIC contexts (e.g., Wolf, 2020), parental engagement activities should emphasize the benefits of broader competencies for children's cognitive development to enable parental support.

Overall, access as well as ECE attendance remains low and unequal, with children from low SES backgrounds having lower access and attendance at ECE. An accelerated expansion of access targeting children from low SES backgrounds is needed to bridge inequality gaps prior to school entry. Apart from availability, parents might have a variety of reasons, including cost, for not sending their children to school, which may explain the ECE attendance gap. Making ECE affordable especially for children from low SES backgrounds is therefore important to closing the ECE attendance gap. In addition to attendance gaps, we found associations between attendance at ECE and school readiness to be on average stronger for children from higher rather than lower SES backgrounds, with one exception. A possible explanation for this differential association is that children from higher SES backgrounds may have greater access to higher quality ECE provision. This indicates a need for greater focus on quality ECE provision for all children to bridge the socioeconomic gap in readiness and, subsequently, future learning outcomes. Other sociodemographic characteristics such as ethno-linguistic inequalities may also influence the association between ECE attendance and school readiness. It is therefore important that ECE experiences are culturally relevant if they are to lead to positive outcomes.

Although attendance remains a crucial issue in LMIC contexts (UNESCO, 2015), access to high-quality programs remain a challenge (Magnuson & Waldfogel, 2005; Spier et al., 2019). A key policy consideration should be the development of adequate measures to benchmark the quality of ECE settings in LMIC contexts and the proportion of children from low SES backgrounds accessing different quality settings over time. This will enable a move beyond access to address quality, a key factor in narrowing the persistent educational inequality gap.

Finally, given the significant role of family SES on school readiness, it is evident that ECE alone cannot completely compensate for inequalities in children's school readiness outcomes due to unfavorable learning environments in low SES family circumstances (Burger, 2010). It is therefore important that policies equally address socioeconomic inequalities in children's living circumstances in efforts to close the gap in developmental outcomes.

#### Conclusion

The current study indicates that children's microsystem environments of family SES and ECE attendance are significantly associated with development of school readiness competencies. Early childhood education is an important microsystem specifically geared towards facilitating interactions that develop school readiness competencies. However, for ECE to contribute to improvements in quality education in LMIC contexts, greater emphasis must be placed on ensuring that it develops a wider range of children's school readiness competencies. The role of ECE in closing inequality gaps in children's school readiness and subsequent learning outcomes will require global efforts to accelerate access to quality ECE for all children, especially those from lower socioeconomic backgrounds.

#### Author contributions

Edward M. Sosu- Conceptualization; Methodology; Formal analysis; Resources; Data curation; Writing - original draft, review & editing; Visualization; Supervision; Project administration; Funding acquisition.

Sofia M. Pimenta - Data curation; Writing - original draft, review & editing

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#### Data Availability

Data will be made available on request.

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#### Appendix A. Data cleaning process



### Appendix B. Estimates and SE for Total School Readiness

	M1: Unconditional	M2: SES*ECE	M3: Interactions
Intercept	.175 (.064)**	.091 (.028)***	.083 (.028)**
Within			
ECE (yes)		.440 (.030)***	.431 (.024)***
SES			
Location (Urban)		.04 (.01)*	.031 (.014)*
Wealth		.08 (.01)***	.079 (.006)***
Parental education		.14 (.03)***	.146 (.025)***
Controls			
Age (months)		.020 (.001)***	.020 (.001)***
Gender (Male)		108 (.011)***	108 (.011)***
Between			
HDI		2.353 (.189)***	2.391 (.195)***
Interactions			
Location*ECE			.039 (.023)
Wealth*ECE			.035 (.012)**
P.Edu*ECE			.062 (.025)*
HDI*ECE			928 (.166)***
Variance component			
Level 1 (within)	.838 (.038)***	.699 (.022)***	.698 (.022)***
Level 2 (between)	.240 (.039)***	.044 (.009)***	.046 (.009)***
ECE		.044 (.008) ***	.030 (.007)***
Location (Urban)		.007 (.004)	.008 (.004)*
Wealth		.002 (.000) ***	.002 (.000)***
Parental education		.016 (.010)	.017 (.010)
Model fit parameters			
BIC	422706.10	390713.11	390596.74
AIC	422676.18	390573.59	390427.33
Ν	158,679	157,231	157,231
* <i>p</i> < .05; ** <i>p</i> < .01;*** <i>p</i>	< .001		

Appendix C. Estimates and SE for Each Subscale: Literacy-Numeracy Readiness

	M1: Unconditional	M2: SES*ECE	M3: Interactions
Intercept	.156 (.068)*	.081 (.037)*	.062 (.037)
Within			
ECE (yes)		.590 (.041)***	.555 (.039)***
SES			
Location (Urban)		.067 (.015)***	.061 (.015)***
Wealth		.089 (.007)***	.085 (.007)***
Parental education		.133 (.021)***	.144 (.021)***
Controls			
Age (months)		.022 (.001)***	.022 (.001)***
Gender (Male)		045 (.008)***	046 (.008)***
Between			
HDI		1.567 (.278)***	1.593 (.281)***
Interactions			
Location*ECE			.069 (.023)**
Wealth*ECE			.050 (.016)**
P.Edu*ECE			.097 (.026)***
HDI*ECE			-1.33 (.215)***
Variance component			
Level 1 (within)	.881 (.055)***	.670 (.032)***	.668 (.032)***
Level 2 (between)	.270 (.060)***	.087 (.020)***	.088 (.021)***
ECE		.080 (.013) ***	.083 (.013)***
Location (Urban)		.009 (.003)**	.010 (.003)**
Wealth		.003 (.001) ***	.003 (.001)***
Parental education		.009 (.007)	.010 (.007)
Model fit parameters			
BIC	444503.62	396589.49	396254.69
AIC	444473.60	396449.53	396074.74
Ν	163,826	162,302	162,302
*p < .05; **p < .01;***p	< .001		

# Appendix D. Estimates and SE for Each Subscale: Socioemotional Readiness

	M1: Unconditional	M2: SES*ECE	M3: Interaction
Intercept	.063 (.033)	.033 (.025)	.027 (.025)
Within			
ECE (yes)		.040 (.013)**	.030 (.013)*
SES			
Location (Urban)		030 (.016)	032 (.016)*
Wealth		.026 (.006)***	.025 (.006)***
Parental education		.012 (.021)	.016 (.021)
Controls			
Age (months)		.003 (.001)***	.003 (.001)***
Gender (Male)		132 (.016)***	132 (.016)***
Between			
HDI		1.232 (.162)***	1.242 (.163)***
Interactions			
Location*ECE			.029 (.022)
Wealth*ECE			.014 (.010)
P.Edu*ECE			.028 (.025)
HDI*ECE			.408 (.114)***
Variance component			
Level 1 (within)	.941 (.030)***	.927 (.029)***	.927 (.029)***
Level 2 (between)	.064 (.012)***	.038 (.009)***	.038 (.009)***
ECE		.007 (.003)**	.008 (.003)**
Location (Urban)		.009 (.004)*	.009 (.004)*
Wealth		.002 (.000)***	.002 (.000)***
Parental education		.011 (.010)	.011 (.010)
Model fit parameters			
BIC	448322.81	442301.97	442308.67
AIC	448292.83	442162.22	442128.99
Ν	161,335	159,832	159,832

# Appendix E. Estimates and SE for Each Subscale: Learning Readiness

	M1: Unconditional	M2: SES*ECE	M3: Interactions
Intercept	.111 (.044)*	.075 (.026)**	.080 (.025)**
Within			
ECE (yes)		.110 (.017)***	.122 (.018)***
SES			
Location (Urban)		.016 (.009)	.018 (.009)
Wealth		.033 (.004)***	.034 (.004)***
Parental education		.107 (.017)***	.102 (.022)***
Controls			
Age (months)		.011 (.001)***	.011 (.001)***
Gender (Male)		033 (.005)***	033 (.005)***
Between			
HDI		1.880 (.223)***	1.870 (.223)***
Interactions			
Location*ECE			037 (.018)*
Wealth*ECE			010 (.005)
P.Edu*ECE			040 (.018)*
HDI*ECE			740 (.125)***
Variance component			
Level 1 (within)	.855 (.073)***	.830 (.070)***	.830 (.070)***
Level 2 (between)	.114 (.030)***	.030 (.008)***	.030 (.008)***
ECE		.018 (.005)***	.017 (.005)***
Location (Urban)		.002 (.001)*	.002 (.001)*
Wealth		.001 (.000) ***	.001 (.000)***
Parental education		.016 (.010)	.017 (.010)
Model fit parameters			
BIC	441170.24	432583.30	432567.51
AIC	441140.21	432443.29	432387.50
Ν	164,375	162,829	162,829
* <i>p</i> < .05; ** <i>p</i> < .01;*** <i>p</i>	0 < .001		

#### References

- Agbenyega, J. S. (2018). Examining early childhood education system in Ghana: How can Bourdieuian theorisation support a transformational approach to pedagogy? In International handbook of early childhood education: Vol. 1 (pp. 673–690). Springer.
- Atteberry, A., Bassok, D., & Wong, V. C. (2019). The effects of full-day pre-kindergarten: experimental evidence of impacts on children's school readiness. *Educational evalua*tion and policy analysis, 41, 537–562. 10.3102/0162373719872197.
- Bai, Y., Ladd, H. F., Muschkin, C. G., & Dodge, K. A. (2020). Long-term effects of early childhood programs through eighth grade: Do the effects fade out or grow? *Children* and Youth Services Review, 112, Article 104890. 10.1016/j.childyouth.2020.104890.
- Bailey, D., Duncan, G. J., Odgers, C. L., & Yu, W. (2017). Persistence and fadeout in the impacts of child and adolescent interventions. *Journal of Research in Educational Effectiveness*, 10(1), 7–39. 10.1080/19345747.2016.1232459.
- Bainbridge, J., Meyers, M. K., Tanaka, S., & Waldfogel, J. (2005). Who gets an early education? Family income and the enrollment of three- to five-year-olds from 1968 to 2000. Social Science Quarterly, 86(3), 724–745. 10.1111/j.0038-4941.2005.00326.x.
- Barnett, M. A., Paschall, K. W., Mastergeorge, A. M., Cutshaw, C. A., & Warren, S. M. (2020). Influences of parent engagement in early childhood education centers and the home on kindergarten school readiness. *Early Childhood Research Quarterly*, 53, 260–273. 10.1016/j.ecresq.2020.05.005.
- Belsky, J., Melhuish, E., Barnes, J., Leyland, A. H., & Romaniuk, H. (2006). Effects of Sure Start local programmes on children and families: early findings from a quasi-experimental, cross sectional study. *BMJ*, 332(7556), 1476. 10.1136/bmj.38853.451748.2F.
- Blair, C., & Raver, C. C. (2015). School readiness and self-regulation: A developmental psychobiological approach. Annual Review of Psychology, 66, 711–731. 10.1146/annurev-psych-010814-015221.
- Boivin, M., & Bierman, K. L. (2014). School readiness: Introduction to a multifaceted and developmental construct. In Promoting school readiness and early learning: Implications of developmental research for practice (pp. 3–14). Guilford Press.
- Bornstein, M. H., & Hendricks, C. (2012). Basic language comprehension and production in >100,000 young children from sixteen developing nations. *Journal of Child Language*, 39(4), 899–918. 10.1017/S0305000911000407.
- Boivin, M., Desrosiers, H., Lemelin, J. P., & Forget-Dubois, N. (2014). Assessing the predictive validity and early determinants of school readiness using a population-based approach. In Promoting school readiness and early learning: Implications of developmental research for practice (pp. 46–72). The Guilford Press.
- Bornstein, M., Britto, P., Nonoyama-Tarumi, Y., Ota, Y., Petrovic, O., & Putnick, D. (2012). Child development in developing countries: Introduction and methods. *Child Development*, 83(1), 16–31. 10.1111/j.1467-8624.2011.01671.x.
- Bradley, R., & Corwyn, R. (2002). Socioeconomic status and child development. Annual Review in Psychology, 53, 371–399. 10.1146/annurev.psych.53.100901.135233.
- Britto, P. R. (2012). School readiness: A conceptual framework. United Nations Children's Fund.
- Britto, P., Yoshikawa, H., & Bolter, K. (2011). Quality of early childhood development programs in global contexts: Rationale for investment, conceptual framework and implications for equity. *Social Policy Report*, 25(2), 1–31. 10.1002/j.2379-3988.2011.tb00067.x.
- Bronfenbrenner, U., & Morris, P. A. (2006). The bioecological model of human development. In R. M. Lerner, & W. Damon (Eds.), Handbook of child psychology: Theoretical models of human development (pp. 793–828). John Wiley & Sons Inc.
- Bukodi, E., & Goldthorpe, J. H. (2013). Decomposing 'social origins': The effects of parents' class, status, and education on the educational attainment of their children. *European Sociological Review*, 29(5), 1024–1039. 10.1093/esr/jcs079.
- Burger, K. (2010). How does early childhood care and education affect cognitive development? An international review of the effects of early interventions for children from different social backgrounds. *Early Childhood Research Quarterly*, 25(2), 140– 165. 10.1016/j.ecresq.2009.11.001.
- Buyse, E., Verschueren, K., & Doumen, S. (2011). Preschoolers' attachment to mother and risk for adjustment problems in kindergarten: Can teachers make a difference? Social Development, 20(1), 33–50. 10.1111/j.1467-9507.2009.00555.x.
- Chaudry, A., Morrissey, T., Weiland, C., & Yoshikawa, H. (2017). Cradle to kindergarten: A new plan to combat inequality. Russell Sage Foundation.
- Cunha, F., Heckman, J. J., Lochner, L., & Masterov, D. (2006). Interpreting the evidence on life cycle skill formation. In E. Hanushek, & F. Welch (Eds.), *Handbook of the economics* of education (pp. 307–451). Elsevier.
- Duncan, G., Dowsett, C., Claessens, A., Magnuson, K., Huston, A., Klebanov, P., Pagani, L., Feinstein, L., Engel, M., Brooks-Gunn, J., Sexton, H., Duckworth, K., & Japel, C. (2007). School readiness and later achievement. *Developmental Psychology*, 43(6), 1428–1446. 10.1037/0012-1649.43.6.1428.
- Entwisle, D. R., Alexander, K. L., & Olson, L. S. (2005). First grade and educational attainment by the age 22: A new story. *American Journal of Sociology*, 110(5), 1458–1502. 10.1086/428444.
- Fernand, L. C. H., Weber, A., Galasso, E., & Ratsifandrihamanana, L. (2011). Socioeconomic gradients and child development in a very low income population: Evidence from Madagascar. *Developmental Science*, 14(4), 832–847. 10.1111/j.1467-7687.2010.01032.x.
- Fox, S. E., Levitt, P., & Nelson III, C. A. (2010). How the timing and quality of early experiences influence the development of brain architecture. *Child Development*, 81(1), 28–40. 10.1111/j.1467-8624.2009.01380.x.
- Francis, B., Archer, L., Hodgen, J., Pepper, D., Taylor, B., & Travers, M. (2017). Exploring the relative lack of impact of research on 'ability grouping' in England: A discourse analytic account. *Cambridge Journal of Education*, 47(1), 1–17. 10.1080/0305764X.2015.1093095.

- Frongillo, E., Kulkarni, S., Basnet, S., & Castro, F. (2017). Family care behaviors and early childhood development in low-and middle-income countries. *Journal of Child and Family Studies*, 26, 3036–3044. 10.1007/s10826-017-0816-3.
- Gormley, W. T., Jr., Phillips, D., & Anderson, S. (2018). The effects of Tulsa's pre-K program on middle school student performance. *Journal of Policy Analysis and Management*, 37(1), 63–87. 10.1002/pam.22023.
- Heckman, J. J. (2000). Policies to foster human capital. Research in Economics, 54(1), 3–56. 10.1006/reec.1999.0225.
- Hlasny, V. (2017). Evolution of opportunities for early childhood development in Arab countries. International Journal of Human Rights in Healthcare, 10(4), 256–276. 10.1108/IJHRH-11-2016-0022.
- Hox, J. J., Moerbeek, M., & van de Schoot, R. (2017). *Multilevel analysis techniques and applications* (Third Edition). Routledge.
- Jeong, J., McCoy, D. C., Yousafzai, A. K., Salhi, C., & Fink, G. (2016). Paternal stimulation and early child development in low- and middle-income countries. *Pediatrics*, 138(4), Article e20161357. 10.1542/peds.2016-1357.
- Khan, S., & Hancioglu, A. (2019). Multiple Indicator cluster surveys: Delivering robust data on children and women across the globe. *Studies in Family Planning*, 50(3), 279– 286. 10.1111/sifp.12103.
- Kim, S. W., Cho, H., & Kim, L. Y. (2019). Socioeconomic status and academic outcomes in developing countries: A meta-analysis. *Review of Educational Research*, 89(6), 875– 916. 10.3102/0034654319877155.
- La Paro, K. M., Hamre, B. K., Locasale-Crouch, J., Pianta, R. C., Bryant, D., Early, D., Clifford, R., Barbarin, O., Howes, C., & Burchinal, M (2009). Quality in kindergarten classrooms: Observational evidence for the need to increase children's learning opportunities in early education classrooms. *Early Education and Development*, 20(4), 657–692. 10.1080/10409280802541965.
- La Paro, K. M., & Pianta, R. C. (2000). Predicting children's competence in the early school years: A meta-analytic review. *Review of Educational Research*, 70(4), 443–484. 10.3102/00346543070004443.
- Lehrl, S., Kluczniok, K., & Rossbach, H. G. (2016). Longer-term associations of preschool education: The predictive role of preschool quality for the development of mathematical skills through elementary school. *Early Childhood Research Quarterly*, 36, 475–488. 10.1016/j.ecresq.2016.01.013.
- Lipsey, M. W., Farran, D. C., & Durkin, K. (2018). Effects of the Tennessee prekindergarten program on children's achievement and behavior through third grade. *Early Childhood Research Quarterly*, 45, 155–176. 10.1016/j.ecresq.2018.03.005.
- Loizillon, A., Petrowski, N., Britto, P., & Cappa, C. (2017). Development of the early childhood development index in MICS surveys. In *Proceedings of the MICS methodological* papers, no. 6, data and analytics section. Division of Data, Research and Policy, UNICEF.
- Magnuson, K. A., & Waldfogel, J. (2005). Early childhood care and education: Effects on ethnic and racial gaps in school readiness. *The Future of Children*, 15(1), 169–196. 10.1353/foc.2005.0005.
- Majzub, R. M., & Rashid, A. A. (2012). School readiness among preschool children. Proceedia Social and Behavioral Sciences, 46, 3524–3529. 10.1016/j.sbspro.2012.06.098.
- McCoy, D. C., Peet, E. D., Ezzati, M., Danaei, G., Black, M. M., Sudfeld, C. R., Fawzi, W., & Fink, G. (2016). Early childhood developmental status in low- and middle-income countries: national, regional, and global prevalence estimates using predictive modeling. *PLoS Med*, *13*(6), Article e1002034. 10.1371/journal.pmed.1002034.
- McCoy, D. C., Salhi, C., Yoshikawa, H., Black, M., Britto, P., & Fink, G. (2018b). Home- and center-based learning opportunities for preschoolers in low- and middle-income countries. *Children and Youth Services Review, 88*, 44–56. 10.1016/j.childyouth.2018.02.021.
- McCoy, D. C., Waldman, M., Field Team, CREDI, & Fink, G (2018a). Measuring early childhood development at a global scale: Evidence from the caregiver-reported early development instruments. *Early Childhood Research Quarterly*, 45, 58–68. 10.1016/j.ecresq.2018.05.002.
- McIntyre, L. L., Eckert, T. L., Fiese, B. H., DiGennaro, F. D., & Wildenger, L. K. (2007). Transition to kindergarten: Family experiences and involvement. *Early Childhood Education Journal*, 35(1), 83–88. 10.1007/s10643-007-0175-6.
- McLoyd, V. C. (1998). Socioeconomic disadvantage and child development. American Psychologist, 53(2), 185–204. 10.1037/0003-066X.53.2.185.
- Micalizzi, L., Brick, L. A., Flom, M., Ganiban, J. M., & Saudino, K. J. (2019). Effects of socioeconomic status and executive function on school readiness across levels of household chaos. *Early Childhood Research Quarterly*, 47, 331–340. 10.1016/j.ecresq.2019.01.007
- Miller, A. C., Murray, M. B., Thomson, D. R., & Arbour, M. C. (2015). How consistent are associations between stunting and child development? Evidence from a metaanalysis of associations between stunting and multidimensional child development in fifteen low- and middle-income countries. *Public Health Nutrition*, 19(8), 1339–1347. 10.1017/S136598001500227X.
- Miller, E. B., Farkas, G., Vandell, D. L., & Duncan, G. J. (2014). Do the effects of headstart vary by parental preacademic stimulation? *Child Development*, 85(4), 1385–1400. 10.1111/cdev.12233.

Mueller, C., & Parcel, T. (1981). Measures of socioeconomic status: alternatives and recommendations. *Child Development*, 52, 13–30.

- Nonoyama-Tarumia, Y., Loaizaa, E., & Engle, P. (2009). Inequalities in attendance in organized early learning programmes in developing societies: Findings from household surveys. *Compare*, 39(3), 385–409. 10.1080/03057920701712833.
- Nyatsikor , M. K., Sosu, E. M., Mtika, P., & Robson, D. (2020). Teacher characteristics and children's educational attainment in Ghana: do some teacher characteristics matter more for children attending disadvantaged schools? Frontiers in Education, 5, [162]. https://doi.org/10.3389/feduc.2020.00162

Muthén, L. K., & Muthén, B. O. (1998). Mplus user's guide - 2012 (7th ed.). Muthén & Muthén.

- O'Connor, E., & McCartney, K. (2006). Testing associations between young children's relationships with mothers and teachers. *Journal of Educational Psychology*, 98(1), 87–98. 10.1037/0022-0663.98.1.87.
- Quirk, M., Grimm, R., Furlong, M. J., Nylund-Gibson, K., & Swami, S. (2016). The association of Latino children's kindergarten school readiness profiles with grade 2–5 literacy achievement trajectories. *Journal of Educational Psychology*, 108(6), 814–829. 10.1037/edu0000087.
- Romano, E., Babchishin, L., Pagani, L. S., & Kohen, D. (2010). School readiness and later achievement: Replication and extension using a nationwide Canadian survey. *Developmental Psychology*, 46(5), 995–1007. 10.1037/a0018880.
- Schenck-Fontaine, A., & Panico, L. (2019). Many kinds of poverty: Three dimensions of economic hardship, their combinations, and children's behavior problems. *Demography*, 56(6), 2279–2305. 10.1007/s13524-019-00833-y.
- Shanahan, T., & Lonigan, C. J. (2010). The national early literacy panel: A summary of the process and the report. *Educational Researcher*, 39(4), 279–285. 10.3102/0013189x10369172.
- Shaw, D. S., & Shelleby, E. C. (2014). Early-starting conduct problems: Intersection of conduct problems and poverty. Annual Review of Clinical Psychology, 10, 503–528. 10.1146/annurev-clinpsy-032813-153650.
- Snow, K. L. (2006). Measuring school readiness: Conceptual and practical considerations. Early Education and Development, 17(1), 7–41. 10.1207/s15566935eed1701\_2.
- Spier, E., Leenknecht, F., Carson, K., Bichay, K., & Faria, A. (2019). Tipping the scales: Overcoming obstacles to support school readiness for all in low- and middle-income countries. *Early Years*, 39(3), 229–242. 10.1080/09575146.2019.1576031.
- Tamis-LeMonda, C., Briggs, R., McClowry, S., & Snow, D. (2009). Maternal control and sensitivity, child gender, and maternal education in relation to children's behavioral outcomes in African American families. *Journal of Applied Developmental Psychology*, 30, 321–331. 10.1016/j.appdev.2008.12.018.
- Tran, T., Luchters, S., & Fisher, J. (2016). Early childhood development: Impact of national human development, family poverty, parenting practices and access to early childhood education. *Child: Care, Health and Development, 43*(3), 415–426. 10.1111/cch.12395.

- UNESCO (2015). Education for All Global Monitoring Report. Paris. https://unesdoc. unesco.org/ark:/48223/pf0000232205
- UNESCO (2017). 2017/8 Education for All Global Monitoring Report. https://unesdoc. unesco.org/ark:/48223/pf0000259338
- United Nations (2015). Sustainable Development Goals: 17 Goals to transform our world. https://sdgs.un.org/goals
- United Nations (2020). World Social Report 2020: Inequality in a rapidly changing world. Department of Economic and Social Affairs: UN. https://www.un.org/ development/desa/dspd/wp-content/uploads/sites/22/2020/02/World-Social-Report2020-FullReport.odf
- United Nations Development Programme (UNDP). (2018). Human development indicators and indices: 2018 statistical update. United Nations Development Programme. https://hdr.undp.org/sites/default/files/2018\_human\_development\_statistical\_ update.pdf
- Votruba-Drzal, E., Coley, R. L., & Chase-Lansdale, P. L. (2004). Child care and low-income children's development: Direct and moderated effects. *Child Development*, 75(1), 296– 312. 10.1111/j.1467-8624.2004.00670.x.
- Walker, S., Wachs, T., Grantham-McGregor, S., Black, M., Nelson, C., Huffman, S., Baker-Henningham, H., Chang, S., Hamadani, J., Lozoff, B., Gardner, J., Powell, C., Rahman, A., & Richter, L. (2011). Inequality in early childhood: Risk and protective factors for early child development. *Lancet*, 378(9799), 1325–1338. 10.1016/S0140-6736(11)60555-2.
- Willoughby, M. T., Piper, B., Oyanga, A., & King, M. K. (2019). Measuring executive function skills in young children in Kenya: Associations with school readiness. *Developmental Science*, 22(5), e12818. 10.1111/desc.12818.
- Wolf, S. (2020). Me I don't really discuss anything with them": Parent and teacher perceptions of early childhood education and parent-teacher relationships in Ghana. *International Journal of Educational Research*, 99, Article 101525. 10.1016/j.iier.2019.101525.
- Wolf, S., & McCoy, D. C. (2019). Household socioeconomic status and parental investments: Direct and indirect relations with school readiness in Ghana. *Child Development*, 90(1), 260–278. 10.1111/cdev.12899.