Early Childhood Research Quarterly 68 (2024) 24–34

Contents lists available at ScienceDirect

Early Childhood Research Quarterly

journal homepage: www.elsevier.com/locate/ecresq

Research Paper

Quality and inequality in pre-primary and home environment inputs to early childhood development in Egypt

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ARTICLE INFO

Keywords:
Pre-primary
Early childhood development
Education quality
Home environment
Egypt

ABSTRACT

By the time children start primary school, large socioeconomic disparities are evident in their learning and development. Both pre-primary and home environments can play important roles in influencing school readiness and can contribute to disparities in early childhood development, but there is limited evidence on their relative roles in the Middle East and North Africa. This paper examines how pre-primary quality, stimulation at home, and early childhood development vary by socioeconomic status for pre-primary students in Egypt. The results demonstrate substantial socioeconomic inequality in stimulation at home, more so than in pre-primary quality and inputs, although there is variation in the degree of inequality across different dimensions of pre-primary quality. "Double inequality" is observed, where students with less stimulating home environments experience slightly lower quality pre-primary inputs. There are particularly large pre-primary inequities in structural quality (physical environment) and less inequity in process quality (pedagogy). These results suggest that targeted investments in pre-primary education in Egypt are necessary to reduce inequality in school readiness but are likely insufficient to close the socioeconomic status gap in children's development. Investing in interventions to improve vulnerable children's home learning environments, as well as investing in quality pre-primary, is critical to address disparities in children's development.

1. Introduction

Globally, millions of children are at risk for low-quality care in the early childhood years, and consequently poor development (McCoy et al., 2022). Both home learning environments and pre-primary environments influence early child development (ECD) (Black et al., 2017; Britto et al., 2017), yet few studies have addressed the joint impacts of home and pre-primary on children's development in many parts of the world. As countries increase investments in early childhood, it is increasingly important to understand the extent to which pre-primary can either compensate for lower-quality home learning environments, or whether children from higher-quality home learning environments benefit more from pre-primary, referred to as the Matthew Effect (Bakermans-Kranenburg et al., 2005).

An estimated 4.5 million children aged 3-4 in the Middle East and North Africa (MENA) experience challenges in achieving healthy ECD (McCoy et al., 2016). Low-quality home environments and insufficient access to pre-primary both contribute to faltering ECD in MENA. The region has pre-primary enrollment rates and rates of high stimulation at home that are the second-lowest of any region, and close to those in sub-Saharan Africa (El-Kogali & Krafft, 2015; McCoy, Salhi, et al., 2018).

For the children who do enroll, the global literature demonstrates that the quality of pre-primary is critically important to its impacts on development (Blimpo et al., 2022; Bouguen et al., 2018; Holla et al., 2021). However, there is limited research on pre-primary quality in MENA. The existing literature in MENA is largely non-representative case studies, for example, focusing on private pre-primary centers in one emirate of the UAE (Verma & Cook, 2019), or ten kindergartens of varying types across urban and rural locations in Egypt (Solayman, 2017). The existing case studies do demonstrate that quality is highly variable across centers and kindergartens (Solayman, 2017; Verma & Cook, 2019), underscoring the need for nationally representative research on pre-primary quality.

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https://doi.org/10.1016/j.ecresq.2024.03.001
Received 28 April 2023; Received in revised form 10 January 2024; Accepted 1 March 2024

Substantial socioeconomic disparities in stimulating home environments and access to pre-primary globally, in MENA, and in Egypt have been documented (Flood et al., 2022; Krafft & El-Kogali, 2021; McCoy, Salhi, et al., 2018). MENA is the region of the world with the largest disparities in home stimulation by wealth (McCoy, Salhi, et al., 2018). In Egypt, 16 % of children from the poorest fifth of households attend pre-primary, while 77 % of those from the richest fifth of households do so (Krafft, 2015). While research exists globally on unequal pre-primary quality (Flood et al., 2022), less is known about inequities in access to quality pre-primary learning environments in MENA.

This study uses data from kindergartens (KGs) and KG students in Egypt to investigate and compare socioeconomic inequality in both pre-primary quality and home environments. The relative degree of inequality in home and pre-primary environments has important implications for the potential of pre-primary to reduce, maintain, or exacerbate school readiness gaps for disadvantaged children.

1.1. Theoretical framework: Nurturing care

An emerging scientific consensus emphasizes nurturing care as essential to children's development (Black et al., 2017; Britto et al., 2017). Nurturing care is an environment sensitive to children's health, that promotes early learning, and provides stimulating interactions. Attitudes and knowledge of caregivers, responsiveness of interactions, and safety are central dimensions of nurturing care. Parental socioeconomic status is an important part of the enabling environment for nurturing care. Both the home and care settings (such as pre-primary) are key sites for nurturing care (Black et al., 2017; Britto et al., 2017). This theoretical framework thus informs our focus on the home environment and pre-primary, as key determinants of ECD, examining the influence of socioeconomic status on the home environment, pre-primary, and ultimately ECD.

1.2. Evidence on inequality in early childhood development in the Middle East and North Africa

Past research has established large socioeconomic disparities across multiple dimensions of ECD in MENA and Egypt specifically (El-Kogali & Krafft, 2015; Ersado & Aran, 2014; Hlasny, 2017; Krafft & El-Kogali, 2021). Inequality in MENA is particularly high at the early childhood stage compared to other ages (Krafft & El-Kogali, 2021). Disparities by wealth and mother's education tend to be largest, with father's education playing a smaller role (Hlasny, 2017). Disparities by wealth and mother's education can be substantial; for instance, in Turkey, comparing children of mothers who did not complete primary to those whose mothers completed above primary, or comparing those with low to high socioeconomic well-being, there was almost a full standard deviation difference in vocabulary at age three (Baydar & Akcinar, 2015).

1.3. Evidence on home environment inequality in the Middle East and North Africa

Children in MENA do not have equal access to stimulating home environments. Home environment wealth inequality in MENA is higher than for other regions of the world (McCoy, Salhi, et al., 2018). In a review of ECD in MENA, in all but one country there were statistically significant disparities in home stimulation by socioeconomic and demographic background (Krafft & El-Kogali, 2021). Research in Turkey found that a stimulating home environment mediates socioeconomic disparities in age-three vocabulary (Baydar & Akcinar, 2015).

1.4. Evidence on pre-primary inequality in MENA

Inequality in pre-primary education starts with whether children are able to attend pre-primary at all. Inequality in pre-primary enrollment in MENA is higher than for other stages of education (Krafft & El-Kogali, 2021), and access has been worsening over time (Hlasny, 2017). There are large disparities in pre-primary access by socioeconomic background. For instance, in Algeria, enrollment in 2012 was 5 % for children of mothers with no education and 36 % for children of mothers with higher education (Lassassi, 2021). Higher-income and more educated parents are more likely to ensure their children attend high-quality early childhood settings, which in turn leads to compounding disparities as children with more home stimulation are also more likely to enroll in pre-primary, as was demonstrated in Algeria (Lassassi, 2021).

The literature in MENA has established sizeable disparities in pre-primary access, but the literature on pre-primary quality is limited (Solayman, 2017; Verma & Cook, 2019). Likewise, there is very little evidence on inequality in pre-primary quality. There is, for example, a case study of 10 kindergartens in Egypt showing modest urban-rural disparities in meeting national accreditation criteria (Solayman, 2017). This paper, examining child development outcomes, pre-primary quality, home environments, and inequality with nationally representative data on KG students from Egypt, is thus substantially advancing the literature on a number of fronts. Two particularly unique contributions are measuring inequality in pre-primary quality in a MENA context and comparing the relative inequality of home environments and pre-primary quality.

1.5. Pre-primary and kindergartens in Egypt

At age four in Egypt, children are eligible for KG, which serves children aged 4-6. KG is not compulsory, and children can enter at either KG 1 or KG 2. The Ministry of Education and Technical Education (MoETE) oversees KGs and provides public KG classes in public primary schools. The majority of KG enrollment is in the public sector, with private provision at 26 %. Private KGs are primarily attended by children from wealthy households (El-Kogali & Krafft, 2015). There is substantial inequality in pre-primary enrollment in Egypt in general, with children from wealthier, more educated households more likely to attend pre-primary (El-Kogali & Krafft, 2015; Krafft, 2015; Krafft & El-Kogali, 2021). For instance, only 20 % of children with mothers who had no education attended pre-primary compared to 65 % of children with mothers with higher education (El-Kogali & Krafft, 2015).

Pre-primary enrollment in Egypt has historically been substantially below the world average but has recently been rising. Around 2000, the pre-primary gross enrollment rate hit 10 %, and reached 28 % as of 2010 but then plateaued (World Bank, 2022). Starting in 2018, MoETE began a series of system-wide educational reforms, referred to as education 2.0 (Moustafa et al., 2022). The new education 2.0 system was competency-based, multi-disciplinary, and aimed to foster a variety of 21st century skills. The new system also included a new approach to assessment and examination. Goals of the reform included expanding access to pre-primary education and improving the quality of education. Reforms were implemented grade by grade, starting with the pre-primary level (Moustafa et al., 2022).

1.6. Present study

This study uses data from KGs and KG students in Egypt to investigate quality and inequality in both pre-primary and home environments – the two central drivers of ECD for pre-primary students. It is particularly unusual to have data on both pre-primary quality and home environments, to be able to examine inequality as well as potential complementarities or substitutions between these important inputs. Egypt is a valuable setting to be able to assess this inequality; the country has relatively low pre-primary enrollments compared to other countries at similar levels of development (El-Kogali & Krafft, 2015). Pre-primary is also the phase of education in Egypt with the largest socioeconomic inequality (Krafft & El-Kogali, 2021).

Based on existing literature, we hypothesized that socioeconomic

status (SES) disparities in the quality of learning environments (at home and in pre-primary settings) and disparities in children's developmental outcomes would be evident in Egypt. We have four specific hypotheses about Egyptian pre-primary students:

1) Students have unequal ECD that reflects their SES, with higher SES children demonstrating more developed skills and competencies.
2) Students have experienced unequal home environments that reflect their SES, with higher SES children experiencing more stimulating and supportive home learning environments.
3) Students have unequal pre-primary environments that reflect their SES, with higher SES children experiencing higher quality pre-primary learning environments.
4) Students' home environments will be more unequal than their pre-primary learning environments.

We test these hypotheses for outcomes based on factor analyses using measures of ECD, various dimensions of pre-primary quality, and home stimulation. Data are from a sample of KGs designed to be nationally representative of KG students. We assess the magnitude and statistical significance of relationships between outcomes and SES using descriptive approaches and regression models.

2. Methods

2.1. Participants

The study sample was designed to be nationally representative of Egyptian KGs and their students. Note that this sample is representative of KG students but not representative of all KG-aged children. The St. Catherine University Institutional Review Board reviewed the study (#1296). All participants gave informed consent. Egypt's Education Management Information System (EMIS) database from 2018-19 was the sample frame. The sample was stratified by public versus private, region, and community poverty status. Within each stratum, a random sample totaling 46 districts was drawn, probability proportional to size. Five schools were randomly selected within each district. A total of 214 schools were sampled.

Data were collected for up to three KG1 and three KG2 classes per school (randomly selected if more than three). There were 638 classrooms with child and teacher data completed. A random sample of four children per classroom was selected. The sample of children whose data were successfully collected was 2,455 observations (child response rate of 96 %). The data collection firm tried up to three times to reach a parent, based on phone numbers provided by the school. For the parent data, there was substantial non-response (primarily that parents did not pick up calls from survey data collectors, but some refusal when reached) such that only 1,437 were reached and consented (response rate of 56 %). When a parent (usually the mother) was reached, they provided information on both parents' characteristics (e.g., both mother's and father's education). We focus on the sub-sample with parental data in order to be able to investigate home environments and inequality. Due to non-response and some missing data (primarily on asset items), our analysis sample for our multivariate models is 1,308 children (and correspondingly their parents), from 189 schools and 500 classrooms. There are therefore an average of 2.62 children from each classroom in the analytic sample.

2.2. Measures

The Measuring Early Learning Quality Outcomes (MELQO) tools (UNESCO, 2017) were the foundation of data collection, locally adapted to the Egyptian context. The MELQO tools have two main components, the Measure of Development and Early Learning (MODEL) for measuring the development of children aged 3-6, and the Measure of Early Learning Environments (MELE). The MODEL collects data through a child direct assessment, parent report of child development (including home and family background), and teacher report of child development. The MELE collects data via classroom observation, a teacher interview, parent interview, and school director interview. The tools were designed specifically to measure child development and quality of early childhood education in low- and middle-income countries (Raikes et al., 2019).

The MELQO tools were developed to create a core set of tools to measure ECD, building on and drawing from existing measurement tools. A small group of experts led the tool development, and engaged non-profits, governments, universities, and multi-lateral organizations in developing and reviewing the tools (Raikes et al., 2019; UNESCO, 2017). The goal of the project was to create tools that were feasible to use and adapt across low- and middle-income countries, at scale. The tools were piloted in 2015 in non-representative samples, and then the pilot-tested tools were used in national studies starting in 2016. The tools were finalized and publicized in 2017 (Raikes et al., 2019). The tools were validated in countries in sub-Saharan Africa, where their psychometric properties were generally consistent with concepts of school readiness, confirmatory factor analysis supported key domains of quality, expected associations with family background were observed, and teacher reports and child direct assessments were associated as expected (Raikes et al., 2020; Raikes et al., 2019).

The MELQO tools were translated into Arabic and adapted to the Egyptian context and curriculum in collaboration with the MoETE, kindergarten teachers, and kindergarten supervisors. An adaptation workshop occurred in May 2019 that included a careful review of items by a group of stakeholders along with addition or modification of items to align with Egypt's national standards for kindergarten. For example, the indicator for how high children can count was set to whether or not children can count to ten based on the national standard that kindergarten students should be able to count to ten. The tools were programmed into tablets using ODK-X software (Brunette et al., 2017). Pre-piloting of the instruments subsequently took place in Egypt in two governorates, ten schools, ten classrooms, with ten teachers and 30 children. Training of the master trainers, a mix of MoETE officials, supervisors, and Egyptian academic experts, by the international experts took place in January 2020. Training of enumerators took place over 10 days starting in late February 2020, including piloting in schools. Enumerators were required to reach scores of at least 80 % on activities and quizzes during training, to ensure adequate inter-rater reliability. Enumerators were graduates of faculties of kindergarten education or child psychology, or kindergarten teachers or supervisors. Data collection was initially scheduled to take place in mid-March 2020. On the date data collection was supposed to begin, schools were closed due to COVID-19.

In fall 2021, public schools reopened on October 9. After schools opened, a repeat of training was held for enumerators. Data collection in schools took place from November 6, 2021, to December 8, 2021. Parents were interviewed over the phone through December 15, 2021.

2.3. Outcome measures

We examine three main categories of outcomes: early childhood development (collected through direct assessments and teacher reports), pre-primary quality (collected through observations), and stimulation at home (collected through parent reports). We summarize a large number of variables into factors using confirmatory factor analysis. All factors are normalized to have a mean of zero and standard deviation of one; the units are thus standard deviations. Appendix B (all appendices are provided in the online supplementary materials) details the factor analysis and lists each item included in each factor; for full questions and responses see questionnaires, available at https://carolinekrafft.com/wp-content/uploads/2022/10/Diagnostic-KG-Instruments-ENGLISH-upload-2022.10.14-CGK.pdf. The only selection criteria was that the first factor has an eigenvalue of at least one. We kept even items with low loadings in making the index, but since the loadings were small,

they have a small role in determining the value of the factor. In Appendix A, we present results that first factor sub-tasks and then factor those sub-tasks together as a sensitivity analysis for ECD outcomes (In Appendix, Table 3). We also present results using an additive index for home stimulation (In Appendix, Table 4). Results are similar.

Early child development. To measure ECD, we create factors for: (1) literacy skills, (2) math skills, (3) executive function, and (4) socio-emotional skills, as well as (5) an overall "school readiness" factor including all these items. In what follows, we describe the items that enter into each of these factors (see Appendix B for items).

Literacy skills. Multiple domains of literacy were measured using the direct assessment of children, including literacy interest, expressive language, expressive vocabulary, letter identification, letter sound identification, initial sound discrimination, listening comprehension, name writing, shape copying, and receptive spatial vocabulary. Teacher reports of letter skills, name and word writing, text directionality, letter names, and picture drawing were also included. Almost all items were binary variables, and a few count or ordinal.

Math skills. Math skills were measured in the direct assessment via verbal counting, producing a set, number identification, number comparison, and simple addition. In the teacher report, math skills were measured by shape identification, color identification, counting, size comparison, time comparison, and number comparison. All but counting were binary variables.

Executive function. Executive function was measured from the direct assessment through a series of head, toes, knees, and shoulders tasks (ordinal), forward digit span items, and pencil tap activities (the latter two categories were binary variables).

Socio-emotional skills. Socio-emotional skills were measured on the direct assessment in terms of perspective taking and understanding feelings (binary variables). Teacher report responses (all but one ordinal) on the child being on task, following instructions, planning, stopping, interrupting, being hardworking, curious, responsible, considerate, collaborative, helping others, taking turns, sharing, adjusting to transitions, settling, using self-control, kicking/pushing/poking, being upset when left, sadness, describing feelings, and playing pretend were also inputs to socio-emotional skills.

Pre-primary quality. To measure pre-primary quality, we created factors for: (1) teaching practices, (2) the environment, (3) materials, (4) adherence to the curriculum, and (5) teacher attitudes. Both the nurturing care framework and global efforts to measure pre-primary quality emphasize a number of dimensions of quality, spanning interactions (process quality) and the environment, including materials (structural quality) (Black et al., 2017; Burchinal, 2018). The environment and materials factors capture structural quality, while teaching practices, adherence to the curriculum, and teacher attitudes capture process quality. These different factors may also have unique relationships with SES, with important policy implications for addressing inequality. For instance, the physical environment is shaped by school management and centralized resource allocations (e.g., building new classes and buildings), while materials (e.g., writing implements) are often bought by families and thus may be more closely related to SES. In what follows, we describe the items that enter into each factor (see Appendix B for items).

Teacher practices. Teacher practice items were all from the classroom observation, measuring math, reading and writing, expressive language, books or stories, telling stories, fine motor skills activities, singing/music, major motor skills activities, modifying bad behavior, oral praise, participation, wait time, supervision, individualization, and tracking children's development. Most items were on a four-point scale, but some were binary variables.

Environment. For the environment, the factor was based on classroom observation items for class size, space inside the class, seats/writing surface, yard space, games/equipment for major motor activities, soap/water, handwashing, clean/appropriate toilets, and safety hazards. All items were binary variables, except class size (integer) and handwashing (ordinal).

Materials. The materials factor was based on classroom observation items for portfolios, textbooks, writing utensils, art, fantasy play, blocks, education toys or math materials, storybooks, activities hall essentials, and the number of storybooks. All items were ordinal except two were binary variables.

Adherence. The adherence to the curriculum factor relied on items from the classroom observation: whether the education 2.0 curriculum was used, if the preparation record matches the lesson, and if the schedule was followed. All items were binary variables.

Teacher attitudes. Teacher attitudes were measured by items from the teacher interview, specifically job satisfaction, whether the teacher feels valued, job importance, professional support, training, understands education 2.0, and feeling overwhelmed. All items were on a five-point Likert scale, from strongly disagree to strongly agree.

Stimulation at home. Stimulation at home is based on the parent reports. The stimulation at home items are derived from the Family Care Indicators (FCI). The items used are (ordinal) children's books at home, and days (0-7) in the past 7 days engaging in the following activities: reading at home, singing songs, playing, and telling stories.

2.4. Covariates

We control for child sex and the child's age in months in our models. Age in months was calculated based on the date of birth reported by the parents and the date of the interview. In terms of family background, we include a number of items we refer to as SES. An asset index based on a factor analysis of owning various durable goods and housing conditions is included in the SES domain. Data on mother (or female caregiver) and father (or male caregiver) education level, along with mother and father occupation categories was also included in the domain of SES. Given the literature emphasizing mother's education as particularly important (McCoy et al., 2018; Sun et al., 2016), and the evidence from Egypt that mothers undertake disproportionate care work (12:1 hours compared to men (Economic Research Forum & UN Women, 2020)), we expect mothers and fathers to potentially have different impacts on children's development and home stimulation. It is unknown – but a question we test – whether there are differential relationships between mothers' and fathers' SES and pre-primary quality. We describe the characteristics of our sample in terms of mother and father characteristics in Appendix A.

2.5. Analytic procedure

We undertake single-factor confirmatory principal factor analysis using a regression scoring method to generate our key outcomes. We provide details on the factor analyses including uniquenesses, loadings, scoring coefficients, and Eigenvalues in Appendix B, and illustrative examples in the body of the paper. The appendix also presents Cronbach's alpha for the underlying items; note that Cronbach's alpha is based on the average inter-item correlation of the underlying items and does not reflect the validity of the factor analysis, unlike the Eigenvalue. All of our factors had Eigenvalues above one; they ranged from 1.092 (home stimulation) to 30.713 (overall readiness). We present descriptive statistics on inequality in KG students' development, pre-primary quality, and home stimulation by SES. We use visualizations of mean outcomes by mother's and father's characteristics and local polynomials (using a triangle kernel) of outcomes relative to the continuous asset index. In additional descriptives we show how stimulation at home and different aspects of pre-primary quality are related (also using local polynomials), highlighting how the different inputs to ECD can potentially offset or compound inequality in ECD, creating "double inequality."

We estimate a series of ordinary least squares (OLS) models for these different outcomes (each of the outcome measures described above, separately) including SES. Denote the outcome for child i as Y_i. Denote the covariates as $ME_{i,j}$ for mother's education, $FE_{i,j}$ for father's

education, $MO_{i,j}$ for mother's occupation, $FO_{i,j}$ for father's occupation, A_i for the asset index, S_i for child sex, and C_i for child's age in months. We thus estimate:

$$Y_i = \alpha + \beta_j ME_{i,j} + \delta_j FE_{i,j} + \gamma_j MO_{i,j} + \eta_j FO_{i,j} + \kappa A_i + \lambda S_i + \theta C_i + \varepsilon_i$$

These predictors are entered simultaneously, although in Table 5 and Table 6 (in Appendix A), mothers' and fathers' characteristics are entered separately (the results are generally similar to when mothers' and fathers' characteristics enter into the model simultaneously). Table 7 (in Appendix A) presents the correlations between all the study variables, and while aspects of SES are correlated, correlations are modest.

We cluster standard errors on the school level. ICCs for child-level outcomes are 0.204 (home stimulation), 0.275 (language), 0.283 (math), 0.220 (executive functioning), 0.242 (socio-emotional), and 0.277 (overall readiness). ICCs for classroom level outcomes are 0.923 (environment), 0.375 (attitudes), 0.449 (teaching practices), 0.759 (materials), and 0.697 (adherence). Since different aspects of SES are multicollinear, and since we are testing a number of individual covariates, we undertake and discuss results based on tests for the joint significance of the categorial SES variables (mother's education; father's education; mother's occupation; father's occupation).

Weights are used in all our analyses. The weights account for the original random stratified sampling design, including on the school level (school weights were the number of schools in the strata nationally divided by the number of schools in the strata in the sample), random sampling of classes (weighted by the school weight times the number of classes in the grade divided by the number sampled), and random sampling of students (four students were randomly sampled per class, and weighted by the classroom weight times the number of students enrolled in the class divided by the number who completed the survey). Weights thus also account for non-response. Non-response accounts for the number of observations that should have been included (for example, the number of children or parents per class or per school). The parent-level weight was therefore based on the classroom weight times the number of students enrolled in that class and divided by the number of parents in that class that successfully responded. We use this parent weight in our analyses.

3. Results

3.1. Examples of outcomes and inputs

In Figure 6, in Appendix A, we provide examples of ECD outcomes, home stimulation, and pre-primary inputs, as context. ECD outcomes and pre-primary inputs are presented as the percentage of children achieving tool items (for example, the percentage of children who had accurate forward digit span). While only 46 % of children reported being happy while reading, 55 % are always or often considerate per the teacher report, 62 % of the time children correctly recognize letters, 71 % of the time they had accurate forward digit span, and 87 % of the time they could count to ten.

In terms of home stimulation, parents were asked how many days in the last 7 (from 0-7) someone in the household engaged in various activities with the child. Reading was rarest (1.3 days on average), followed by telling stories (1.7 days), singing (1.8 days) and then most frequently playing (5.8 days). Data from pre-primary observations revealed that 46 % of children attended a pre-primary with at least one physical hazard and 67 % attended a pre-primary where the teacher agreed or strongly agreed they were overwhelmed by their work. Although only 56 % had a portfolio to track their development, 81 % of children were in classes where children received individual instruction during the observation, and in 83 % of cases the preparation record matched the schedule in the teacher's guide. The results demonstrate that while some children are meeting the ECD outcome indicators (such

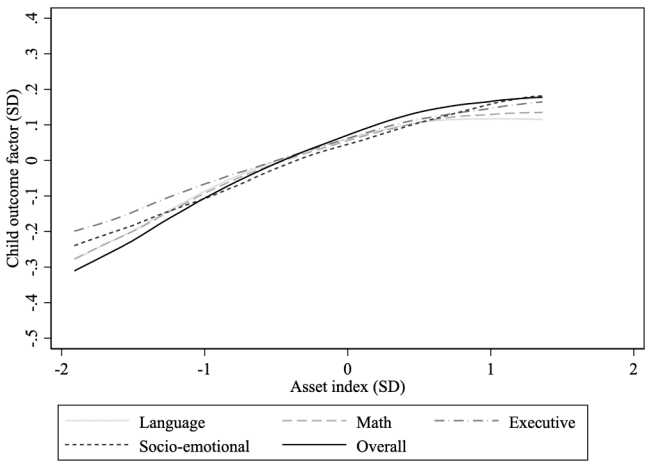

Fig. 1. Child outcome factors (in standard deviations [SD]) by asset index (in SD) *Source:* Authors' calculations.
Notes: Local polynomial with triangle kernel, bandwidth two. Visualizing from 1st-99th percentile.

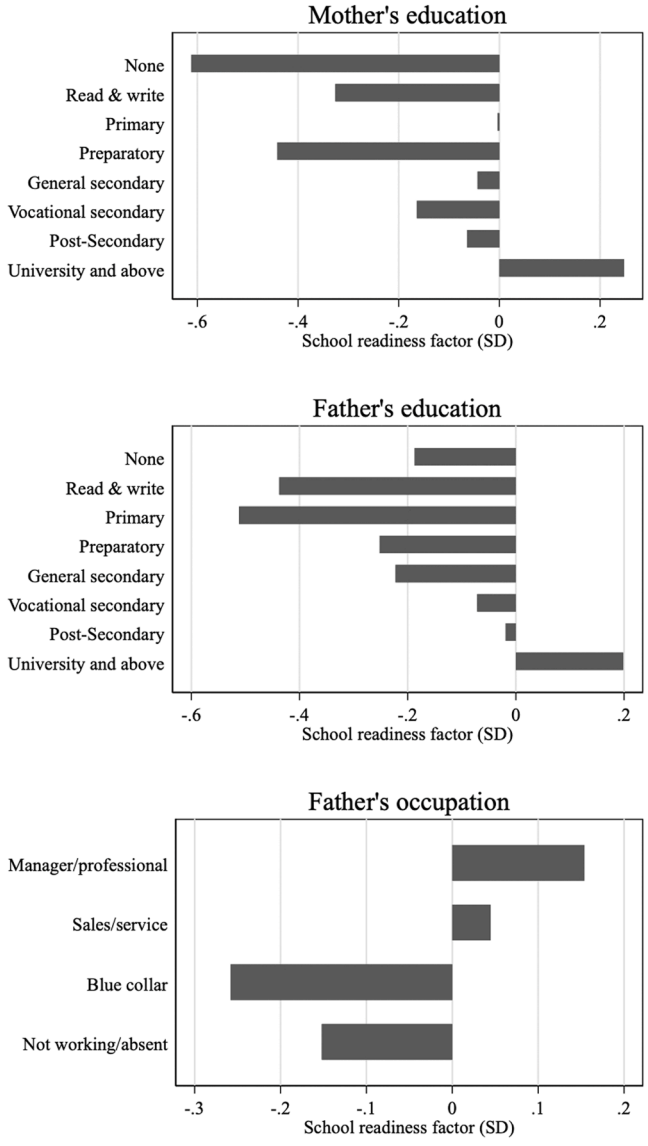

Fig. 2. Mean school readiness factor (in standard deviations [SD]) by parental education, father's occupation *Source:* Authors' calculations.

Table 1
OLS models of socioeconomic inequality in early childhood development outcomes.

	Language	Math	Exec. function	Socio-emo.	Overall readiness
Asset factor	0.121*	0.113*	0.111	0.171***	0.151**
	(0.053)	(0.052)	(0.057)	(0.048)	(0.052)
Mother's ed. (none omit.)					
Read & write	0.379	0.545	0.411	0.088	0.490
	(0.255)	(0.291)	(0.251)	(0.328)	(0.254)
Primary	0.462*	0.555*	0.636**	0.149	0.635**
	(0.225)	(0.242)	(0.218)	(0.170)	(0.224)
Preparatory	0.304	0.073	0.118	-0.137	0.179
	(0.169)	(0.209)	(0.153)	(0.153)	(0.163)
General sec.	0.305	0.451*	0.297	0.143	0.382
	(0.214)	(0.211)	(0.215)	(0.210)	(0.194)
Vocational sec.	0.308	0.321	0.178	-0.085	0.277
	(0.166)	(0.178)	(0.141)	(0.137)	(0.152)
Post-Secondary	0.303	0.508**	0.083	0.083	0.296
	(0.194)	(0.177)	(0.183)	(0.175)	(0.170)
University+	0.548**	0.540**	0.427*	0.028	0.555**
	(0.184)	(0.188)	(0.179)	(0.158)	(0.177)
Father's ed. (none omit.)					
Read & write	-0.617**	-0.657*	-0.438	-0.356	-0.655**
	(0.235)	(0.257)	(0.259)	(0.205)	(0.247)
Primary	-0.446	-0.541	-0.542*	-0.012	-0.566*
	(0.238)	(0.277)	(0.233)	(0.206)	(0.258)
Preparatory	-0.027	-0.090	-0.231	-0.071	-0.151
	(0.165)	(0.191)	(0.202)	(0.186)	(0.172)
General sec.	-0.156	-0.353	-0.262	-0.101	-0.284
	(0.211)	(0.279)	(0.215)	(0.294)	(0.211)
Vocational sec.	-0.246	-0.186	-0.210	0.138	-0.223
	(0.172)	(0.187)	(0.153)	(0.152)	(0.161)
Post-Secondary	-0.127	-0.193	-0.496*	-0.087	-0.336
	(0.201)	(0.223)	(0.216)	(0.233)	(0.184)
University+	-0.371	-0.250	-0.185	0.018	-0.289
	(0.201)	(0.203)	(0.183)	(0.169)	(0.188)
Mother's occupation (manager/prof. omit.)					
Sales/service	-0.137	-0.015	-0.231	-0.103	-0.167
	(0.198)	(0.261)	(0.216)	(0.147)	(0.192)
Blue collar	-0.410	-0.393	-0.201	-0.482	-0.429
	(0.270)	(0.370)	(0.266)	(0.375)	(0.306)
No work/abs.	-0.049	-0.005	-0.095	-0.033	-0.065
	(0.107)	(0.074)	(0.100)	(0.092)	(0.071)
Father's occupation (manager/prof. omit.)					
Sales/service	-0.022	0.140	0.098	0.087	0.086
	(0.128)	(0.085)	(0.119)	(0.133)	(0.109)
Blue collar	-0.102	-0.047	0.018	-0.112	-0.059
	(0.105)	(0.095)	(0.107)	(0.121)	(0.104)
No work/abse.	-0.086	0.006	-0.046	-0.101	-0.068
	(0.110)	(0.113)	(0.118)	(0.122)	(0.108)
Child sex (female omit.)					
Male	-0.103	-0.072	-0.072	-0.306***	-0.125*
	(0.054)	(0.059)	(0.071)	(0.054)	(0.057)
Child age (in months)	0.058***	0.056***	0.040***	0.017**	0.059***
	(0.004)	(0.004)	(0.005)	(0.005)	(0.004)
Constant	-3.847***	-3.833***	-2.553***	-0.915*	-3.898***
	(0.352)	(0.394)	(0.384)	(0.390)	(0.361)
N (obs.)	1308	1308	1308	1308	1308
R-sq.	0.327	0.318	0.194	0.127	0.359
P-val. model	0.000	0.000	0.000	0.000	0.000
P-val. Moth. ed.	0.153	0.016	0.030	0.597	0.023
P-val. Fath. ed	0.118	0.160	0.210	0.087	0.296
P-val. Moth. oc.	0.442	0.757	0.611	0.569	0.418
P-val. Fath. oc.	0.781	0.347	0.769	0.448	0.670

Source: Authors' calculations.
Notes: *p<0.05; **p<0.01; ***p<0.001. Standard errors clustered on the school level.

as counting to ten) and experiencing high-quality inputs, others are not. There is thus important variation in ECD outcome indicators, and in the next section we investigate inequality by SES in ECD outcomes.

3.2. Inequality in early childhood development outcomes

In this section, to test H1, we substantiate inequality in ECD by SES. We examine the language, math, executive function, socio-emotional, and overall school readiness ECD outcomes (factors) and how they vary by SES. Fig. 1 presents the patterns of the various ECD development outcomes by the asset index, based on a local polynomial (triangle kernel). Fig. 2 shows the school readiness outcome by mother's and father's education and father's occupation (few mothers work). Patterns are similar for other outcomes. Table 1 shows multivariate models of how ECD outcomes depend on SES, controlling for child sex and age.

Within specific domains of child development and across all domains there is a clear socioeconomic gradient in ECD (consistent with H1). In the multivariate models, the magnitude of the relationship is relatively

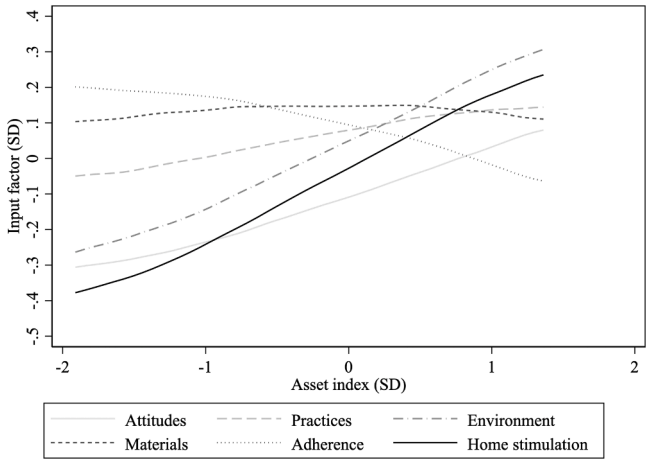

Fig. 3. Input factors (in standard deviations [SD]) by asset index (in SD) *Source:* Authors' calculations *Notes:* Local polynomial with triangle kernel, bandwidth two. Visualizing from 1st-99th percentile.

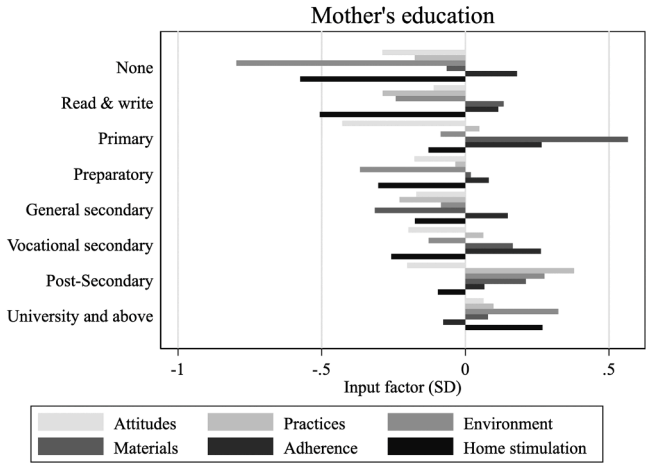

Fig. 4. Mean input factors (in standard deviations [SD]) by mother's education *Source:* Authors' calculations.

similar; a one SD increase in the asset index predicts between a 0.111 and 0.171 SD increase in the ECD outcome, depending on the outcome (consistent with H1). All are statistically significant at the 5 % level except for executive functioning (0.111).

There are particularly large differences in child outcomes by mother's education (consistent with H1). Descriptively (Fig. 2), children of mothers reporting no formal education have scores on the school readiness factor of -0.61 (factors are normalized, so factors are measured in standard deviations), compared to -0.16 for mothers with vocational secondary. Only at the university level is readiness above average (0.25).

In the multivariate models (Table 1), we primarily discuss the significant results of the joint tests (denoted p-val. mother's ed., etc., in the tables). Mother's education is jointly significant in predicting math, executive functioning, and overall school readiness skills (consistent with H1). There are, additionally, some significant individual coefficients for mother's education for language, but the joint test is not significant. Compared to a mother with no education, a mother with university education predicts an 0.555 SD higher overall readiness factor. There are similar but somewhat smaller disparities descriptively (Fig. 2) by fathers' education, father's occupation, and mother's occupation (which are all highly correlated with mother's education and other aspects of SES). None of these categories is jointly significant in any of the models (Table 1), although in some cases, after accounting for other characteristics, some individual fathers' education coefficients have a negative association with child outcomes. Overall, there are clear socioeconomic disparities (consistent with H1), most closely related to mother's education, but also tied to household wealth and income (proxied by the asset index).

3.3. Inequality in inputs

We now turn to examining inequality in home and pre-primary inputs by SES. In Fig. 3, we explore the patterns of pre-primary quality and home inputs by the families' asset index, based on a local polynomial (triangle kernel). Fig. 4 shows the variation in stimulation by mother's education. Table 2 shows OLS models for SES and the various home and pre-primary inputs (testing H2 and H3). There is substantial variation in the relationship between inputs and assets. Strong relationships were observed between home stimulation or pre-primary environments and the family asset index. A one SD increase in the asset index predicts a statistically significant 0.197 SD increase in home stimulation (consistent with H2). There are similar (and likewise significant) relationships of around 0.19 SD increases in the pre-primary environment or teacher attitudes for each SD increase in assets (consistent with H3). Other results for teaching practices (coefficient of 0.117), materials (-0.006) and adherence to the curriculum (-0.069) were not significantly associated with family assets.

Although there are descriptive differences in a number of inputs by parent's characteristics such as mother's education (Fig. 4), only a few are statistically significant. For instance, children of mothers with no education experience an average of a -0.57 stimulation factor, compared to 0.27 for those with university-educated mothers. Mother's education is jointly significant for home stimulation (consistent with H2) and teaching practices (consistent with H3, but only for this outcome, although individual coefficients for mother's education are significant for materials and the environment) (Table 2). There are not significant differences for any of the inputs by father's education, using the joint tests (although there are individual significant coefficients for teaching practices and adherence). Mother's occupation is jointly significant for teaching practices and curriculum adherence (and there are significant differences for individual coefficients for the environment and materials as well), but primarily with children of mothers engaged in sales and service jobs having better outcomes than children whose mothers are in managerial/professional jobs. However, few mothers work at all. Father's occupation is only jointly statistically significant for home stimulation (although there are individual coefficients significant in the environment and teaching practices models), with all other statuses having significantly lower home stimulation (by -0.185 to -0.322 SDs) compared to managerial/professional fathers. The centrality of mother's education and the asset index to input and outcome inequality were also visible in models without weights (not shown).

Although we have only one measure of home environment quality (stimulation at home), it is notable that we see stronger inequities in home environments than in pre-primary environments (consistent with H4). While different types of pre-primary inputs vary substantially in terms of their inequality, they are less unequal than home stimulation, particularly for materials and adherence to the curriculum, and to some extent teaching practices. These relative inequality results persist (not shown) in unweighted models as well.

In Fig. 5 we specifically explore the relationship between home inputs (home stimulation) and pre-primary inputs, based on a local polynomial (triangle kernel). This figure descriptively illustrates whether children experience "double inequality," that is, both worse home environments and worse pre-primary environments. The correlations between home stimulation and pre-primary inputs show double inequality, but are modest, with home stimulation not strongly correlated with quality of pre-primary environments. The strongest correlation (0.17) is with the environment, followed by teacher attitudes (0.13), materials (0.10) and teaching practices (0.08). Adherence to the

Table 2
OLS models of socioeconomic inequality in home and pre-primary inputs.

	Home stimulation	Environment	Attitudes	Teaching practices	Materials	Adherence
Asset factor	0.197***	0.188**	0.189***	0.117	-0.006	-0.069
	(0.034)	(0.065)	(0.051)	(0.075)	(0.072)	(0.058)
Mother's ed. (none omit.)						
Read & write	-0.082	0.385	0.083	-0.179	0.230	-0.048
	(0.156)	(0.329)	(0.237)	(0.266)	(0.238)	(0.183)
Primary	0.308	0.613	-0.192	0.224	0.550*	0.030
	(0.232)	(0.313)	(0.256)	(0.202)	(0.219)	(0.106)
Preparatory	0.136	0.268	0.016	0.082	0.123	-0.020
	(0.176)	(0.227)	(0.218)	(0.213)	(0.174)	(0.149)
General secondary	0.198	0.498	-0.044	-0.219	-0.172	0.096
	(0.178)	(0.350)	(0.207)	(0.242)	(0.246)	(0.154)
Vocational secondary	0.098	0.432	-0.031	0.111	0.221	0.141
	(0.134)	(0.275)	(0.206)	(0.195)	(0.179)	(0.100)
Post-Secondary	0.184	0.709*	-0.097	0.354	0.261	0.011
	(0.164)	(0.284)	(0.232)	(0.218)	(0.209)	(0.167)
University and above	0.278	0.596*	0.047	0.056	0.211	-0.064
	(0.145)	(0.289)	(0.224)	(0.228)	(0.226)	(0.153)
Father's ed. (none omit.)						
Read & write	0.071	0.378	0.020	-0.013	0.223	0.223
	(0.175)	(0.299)	(0.289)	(0.203)	(0.185)	(0.122)
Primary	0.043	0.337	0.031	0.316	0.336	0.263*
	(0.190)	(0.273)	(0.207)	(0.182)	(0.171)	(0.129)
Preparatory	0.012	-0.043	-0.113	0.124	0.164	0.114
	(0.146)	(0.225)	(0.164)	(0.220)	(0.213)	(0.129)
General secondary	-0.019	0.317	-0.080	0.606*	0.020	0.073
	(0.155)	(0.325)	(0.247)	(0.292)	(0.261)	(0.268)
Vocational secondary	0.045	0.263	-0.051	0.238	0.187	0.130
	(0.105)	(0.217)	(0.132)	(0.159)	(0.137)	(0.114)
Post-Secondary	-0.099	0.287	-0.096	0.216	0.209	0.097
	(0.126)	(0.265)	(0.151)	(0.211)	(0.171)	(0.130)
University and above	0.219	0.338	0.061	0.242	-0.044	0.043
	(0.131)	(0.269)	(0.158)	(0.201)	(0.170)	(0.150)
Mother's occupation (manager/prof. omit.)						
Sales/service	0.139	0.140	0.357	0.487**	0.567*	0.479**
	(0.193)	(0.155)	(0.226)	(0.175)	(0.228)	(0.171)
Blue collar	0.035	0.493*	0.123	0.509	-0.006	0.297
	(0.121)	(0.201)	(0.374)	(0.362)	(0.213)	(0.194)
Not working/absent	0.082	0.114	0.176	0.096	0.027	0.053
	(0.068)	(0.095)	(0.108)	(0.124)	(0.131)	(0.138)
Father's occupation (manager/prof. omit.)						
Sales/service	-0.264**	-0.132	0.007	-0.108	-0.172	-0.151
	(0.098)	(0.103)	(0.110)	(0.104)	(0.112)	(0.125)
Blue collar	-0.185*	-0.246*	-0.015	-0.015	-0.184	0.021
	(0.090)	(0.110)	(0.095)	(0.087)	(0.104)	(0.072)
Not working/absent	-0.322**	0.011	0.014	0.209*	-0.077	-0.199
	(0.106)	(0.121)	(0.131)	(0.101)	(0.106)	(0.137)
Child sex (female omit.)						
Male	0.035	0.020	0.030	0.033	0.047	0.012
	(0.047)	(0.056)	(0.053)	(0.058)	(0.060)	(0.061)
Child age (in months)	0.000	0.004	-0.008	0.016**	0.021***	0.013*
	(0.003)	(0.006)	(0.007)	(0.006)	(0.006)	(0.006)
Constant	-0.310	-1.026*	0.274	-1.410*	-1.520**	-0.933
	(0.270)	(0.516)	(0.543)	(0.543)	(0.497)	(0.553)
N (obs.)	1308	1302	1308	1302	1302	1302
R-sq.	0.233	0.181	0.086	0.078	0.090	0.081
P-val. model	0.000	0.000	0.000	0.000	0.000	0.101
P-val. Moth. ed.	0.014	0.175	0.556	0.028	0.110	0.282
P-val. Fath. ed	0.064	0.785	0.633	0.272	0.407	0.417
P-val. Moth. oc.	0.617	0.108	0.328	0.018	0.072	0.003
P-val. Fath. oc.	0.005	0.085	0.996	0.085	0.291	0.359

Source: Authors' calculations.
Notes: *p<0.05; **p<0.01; ***p<0.001. Standard errors clustered on the school level.

curriculum is not correlated with stimulation at home (-0.02). We test the statistical significance of these relations without and with controls in Appendix A, Table 8. In the models without controls, the relationships with the environment and attitudes are statistically significant, denoting double inequality. In the model with controls, the relationships with materials and adherence are positive and significant, denoting double inequality. The change in which aspects of pre-primary environments are correlated with home environments with and without controls may be due to inequality being in part mediated by SES. Generally, students with more stimulating home environments are experiencing slightly higher quality pre-primary inputs.

4. Discussion

This study provides documentation of early disparities in children's development and the quality of home and pre-primary learning environments in Egypt. Our analyses demonstrate that early disparities documented globally (McCoy et al., 2016; Sun et al., 2016) and

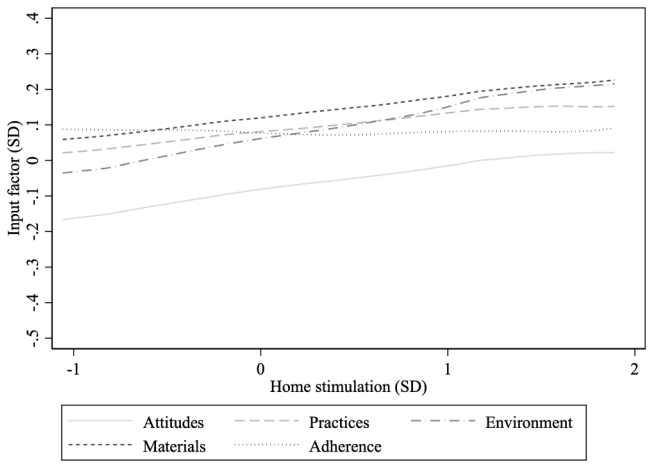

Fig. 5. Pre-primary input factors (in standard deviations [SD]) by home stimulation factor (in SD) *Source*: Authors' calculations.
Notes: Local polynomial with triangle kernel, bandwidth two. Visualizing from 1st-99th percentile.

elsewhere in MENA (Hlasny, 2017; Krafft & El-Kogali, 2021) are also evident in Egypt. We document disparities in children's learning outcomes in pre-primary. There are differences in children's language, math, executive function, socio-emotional, and overall school readiness outcomes by SES, particularly assets (wealth) and mother's education (consistent with H1).

The role of mother's education may reflect substantial gender inequality in care work in Egypt, as the ratio of women's to men's unpaid care work is 12:1 (Economic Research Forum & UN Women, 2020). The disproportionate time mothers spend, and the limited time fathers spend, may make mother's education particularly important in this context. Not all categories of mother's education are, however, equally important. Education has expanded substantially over time, and nearly half of the mothers of kindergarten students in our sample have a university education. It may be that only a university education provides a socioeconomic advantage; it may also be that we are underpowered to detect the benefits of less common categories. Although father's education is not jointly significant in predicting any of the ECD outcomes, the read and write or primary categories sometimes have a significant and negative coefficient. It may be that fathers with no education entirely lacked access to school, while those with only read and write or primary levels attended but dropped out early and are thus particularly disadvantaged. Our findings for H1 are consistent with literature elsewhere in MENA (Baydar & Akcinar, 2015; Hlasny, 2017; Krafft & El-Kogali, 2021) and globally (McCoy et al., 2018; Rao et al., 2019), showing an important role for wealth and mother's education in ECD inequality.

We also observe socioeconomic disparities in home learning environments (consistent with H2). As well as significant wealth disparities, the joint tests indicate significant differences by mother's education and father's occupation. Wealth and maternal education disparities in home stimulation are well-documented in the global literature (McCoy et al., 2016; Sun et al., 2016). Other research in MENA has shown an important role for father's education, although often secondary to mother's, in home stimulation (Hlasny, 2017; Krafft & El-Kogali, 2021). However, none of these studies has considered father's occupation in their analyses, highlighting an important contribution of our paper; future research on socioeconomic disparities in ECD should include occupation as well as education.

There are, furthermore, SES disparities in pre-primary quality (consistent with H3, although exactly which aspect of SES predicts quality varies across dimensions of quality). While theoretical models of nurturing care (Black et al., 2017) highlight the roles of both family and school in development, the literature has disproportionately focused on the home environment. Pre-primary quality overall is under-researched in MENA and the literature on inequality in pre-primary is very limited (Solayman, 2017). We show inequities are largest for structural quality (the pre-primary physical environment), whereas there is less inequity in process quality (teacher practices, children's experience of quality materials, and adherence to the curriculum).

There is thus some support for H4, that students' home environments are relatively more unequal than their pre-primary environments, although this varies by dimension of pre-primary quality. These are novel findings, which merit investigation in other contexts as well, as they have important implications for the role of pre-primary in redressing school readiness disparities. Children who experience lower-quality home learning environments also experience lower-quality pre-primary education in some regards, but not all. There is thus some evidence of "double inequality." This novel finding merits research on whether inequality in pre-primary quality is compounding disparities in home environments in other contexts.

4.1. Limitations

Our results indicate important disparities in ECD, home stimulation, and some aspects of pre-primary quality and inputs that are critical to address. However, there are a number of limitations to our results that must be kept in mind and point to important areas for future work and research. First, we were only able to estimate correlations between SES, outcomes, and inputs. We provide evidence on the associations between inputs and ECD in Appendix A, Table 9, and they show important but heterogenous associations by dimension of development and input, but these estimates are not causal effects. The causal effects of inputs, particularly pre-primary inputs, in MENA are under-researched and an important area for future work. Second, we were comparing one measure of home stimulation to multiple dimensions of pre-primary quality. There may be other aspects of the home environment that we were not able to observe that are more or less unequal. Measuring quality of home stimulation or pre-primary learning environments is quite challenging, as is measuring the learning and development of young children (Burchinal, 2018). Ongoing efforts to improve measurement of ECD and early environments may reveal additional variation in inequality. Additionally, we do not know if one type of input (home or pre-primary, or a particular aspect of pre-primary quality) is more important than another in affecting ECD.

Our analyses are based on a sample of pre-primary students. Not all children in Egypt attend pre-primary; indeed, there is substantial inequality in access to pre-primary (El-Kogali & Krafft, 2015). In the general population of pre-primary aged children (including those not attending), there may be different patterns of inequality in home environments. The children not enrolled in pre-primary might particularly benefit from pre-primary or might particularly suffer from low-quality or inequitable pre-primary if they attended pre-primary; our research is not able to assess these dynamics, and they remain an important area for future research.

The sample we used from Egypt was designed to be nationally representative of KG students but is not representative of all KG-aged children, given substantial selection into KGs. Additionally, there was substantial non-response in the parental sample, which we use to measure SES. A model of parental response (Table 10, in Appendix A) based on school, child, and classroom characteristics showed no statistically significant differences between parents who did and did not respond. However, as Table 11 in Appendix A, shows, there are some differences between our parental sample and a nationally representative sample of parents of KG students. The respondents in our sample were of slightly higher SES. This bias in the sample will not bias our research questions on SES unless there is a differential relationship among the respondents.

Our data collection efforts were also in late 2021, during the ongoing COVID-19 pandemic. While children were again attending pre-primary

in person, the pandemic may have affected outcomes in complex ways that we are unable to unpack. These results do not necessarily generalize to other contexts, although future research should investigate the relative role of pre-primary and home environments in other countries in MENA and globally.

4.2. Policy implications

Our findings point to two avenues for improving ECD and equity in ECD that can be pursued in parallel: First, investments in upgrading the pre-primary inputs that are relatively equal can help close ECD gaps for children who do attend pre-primary. For instance, since adherence to the curriculum is relatively equitable, improvements in curriculum quality may in turn lead to equitable improvements in ECD among pre-primary students. Equitable improvements will likely not, however, be sufficient to address the inequities in ECD that pre-date pre-primary and inequality in other pre-primary inputs.

Thus, second, targeted efforts should address the socioeconomic inequality in both home and pre-primary environments. Efforts must target children from less advantaged socioeconomic backgrounds to ensure all children have equitable home environment, pre-primary, and ultimately ECD experiences. Although structural aspects of pre-primary quality may be easier for policy makers to standardize, they were more unequal than process components such as pedagogy. Addressing these structural inequities could help pre-primary better reduce gaps in school readiness for disadvantaged children. All these inputs should only be targets of policy inasmuch as they yield improvements in ECD. Although the literature suggests pre-primary quality and particularly the home environment matter for ECD, establishing which inputs have the highest causal impact on ECD within the Egyptian context would be valuable for policy.

Given the strong self- and cross-productivity of ECD skills (Helmers & Patnam, 2011), inequality is likely to compound over time. Approaches to addressing unequal learning should likely focus on compensatory models that provide high-quality pre-primary education to children most at risk for poor ECD (which is the opposite of what we typically see in Egypt). Redressing inequality in early learning can not only improve outcomes and close gaps for disadvantaged students, it can also benefit their peers, improving learning for all (Berlinski et al., 2022).

However, the effects of pre-primary and pre-primary quality on school readiness and potentially compensating for inequitable home environments can be complex. For instance, an experiment in Mauritius showed that high quality pre-primary benefited children with low educated fathers, but led to worse outcomes for children with poorly educated mothers (Morabito et al., 2018). Efforts to improve pre-primary quality and equity must assess their impacts to determine the mix of interventions that will be most effective in closing gaps in early learning.

An important question that our research sheds light on – but cannot fully answer – is whether pre-primary or high-quality pre-primary can close school readiness gaps for disadvantaged children. Children starting pre-primary already have unequal ECD due to unequal early home environments. If pre-primary is substantially higher quality than home environments, even if it is somewhat unequal in quality, it could still close gaps. Moreover, if pre-primary quality is similar to home environment quality on average, and less unequal (this latter condition we have confirmed in Egypt), it could also help close gaps.

While we cannot directly estimate, in our work, the impact of pre-primary and quality pre-primary on ECD or the impact of improving home environments (e.g., early stimulation interventions), we can draw on the literature to assess the potential of pre-primary to close school readiness gaps. Effect sizes of pre-primary quality on learning in high-income countries tend to be around 0.1 if not smaller (e.g. Brunsek et al., 2017; Perlman et al., 2016). However, one recent meta-analysis found effect sizes of 0.25 on children's skills for interventions designed to improve pre-primary quality in high-income countries and 0.16 for pre-primary quality in low- and middle-income countries (Holla et al., 2021). Quality improvements also had larger impacts than efforts to improve access (Holla et al., 2021). Interventions that improve home learning environments tend to have effect sizes in the 0.2-0.3 range if not larger (Dong et al., 2020; Knauer et al., 2019; Zuilkowski et al., 2019).

As a point of reference, in Egypt, having a mother with no education versus a university education was associated with a raw readiness gap of 0.86 standard deviations. Closing the readiness gap with targeted pre-primary quality interventions alone would require a 5.4 standard deviation increase in pre-primary quality (using an effect size of 0.16 (Holla et al., 2021)). Improvements via home stimulation would require 2.9-4.3 standard deviation increases in home environments. These back-of-the-envelope calculations suggest targeted efforts towards *both* home environment and pre-primary quality are needed to help close school readiness gaps.

4.3. Areas for future research

Our findings point to important areas for future research and data collection to inform policy. Nationally representative data on students at the pre-primary stage are rare in low- and middle-income countries (Raikes et al., 2021), including MENA. Data are important pre-requisites to evidence-based efforts to address inequality. Longitudinal data on ECD are needed in MENA to understand critical points for intervention. Further research on promoting pre-primary quality and the impact of quality interventions on ECD is needed. Most of the evidence on what works to promote teaching quality and learning in low- and middle-income countries comes from the primary level. For instance, only 8 % of studies on education in Africa focused on pre-primary (Evans & Mendez Acosta, 2021).

In addition, further research with causal identification strategies needs to assess whether, when, and how pre-primary may help close gaps in ECD, as well as which specific input improvements would be most effective for improving equity and learning. Efforts to examine the impact of quality pre-primary on ECD should therefore include estimates of the quality of children's home learning environments, given the large impact of home environments on children's learning and potential role of pre-primary and pre-primary quality in closing gaps.

CRediT authorship contribution statement

Caroline Krafft: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **Abbie Raikes:** Conceptualization, Investigation, Methodology, Writing – review & editing. **Samira Nikaein Towfighian:** Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Writing – review & editing. **Rebecca Sayre Mojgani:** Conceptualization, Investigation, Methodology, Writing – review & editing.

Declaration of competing interest

Caroline Krafft, Abbie Raikes, and Rebecca Sayre Mojgani served as World Bank consultants for the Bank's early childhood education engagement in Egypt. They provide consulting on measurement of early childhood development (ECD) outcomes. Samira Nikaein Towfighian served as the World Bank Lead on Egypt's ECD engagement. She provides technical assistance on ECD in other contexts as well.

Data availability

The authors do not have permission to share data.

Acknowledgments

This study is the result of a collaboration between the World Bank and the Ministry of Education and Technical Education of Egypt (MoETE). The authors thank Nelly El Zayat, Randa Shaheen, Linda Herrera, Kindergarten supervisors and all other MoETE colleagues who supported this work. Rana Yacoub provided excellent research assistance at all stages of the study. The authors are thankful to Amira Kazem, Alaka Holla, Amanda Devercelli, and Bridget Crumpton for their comments and feedback on earlier versions of the paper. We are also grateful to Andreas Bloom and Marina Wes as well as to the Egypt Country Management for their overall support. Data collection was conducted by Baseera, led by Hanan Girgis. This work was funded by the UK Strategic Partnership for Egypt's Inclusive Growth Trust Fund and the World Bank. All findings, interpretations, and conclusions in this paper are those of the authors and do not necessarily represent the views of the World Bank or the MoETE.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ecresq.2024.03.001.

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