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Does pre-school improve cognitive abilities among children with early-life stunting? A longitudinal study for Peru

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ABSTRACT

Several studies in developing countries have found that children who experience growth faltering in the first years of life show lower cognitive abilities than their peers. In this study, we use the Young Lives longitudinal dataset in Peru to analyze if attending pre-school affects cognitive abilities at age five years, and if there is an interaction with HAZ at age one year. Using instrumental variables we found, for receptive vocabulary, a positive effect of attending *Jardines* (formal) pre-schools; the effect of attending *PRONOEI* (community-based) pre-schools was not significant. More years attending *Jardines* was more beneficial for children who were better nourished. We suggest working to improve the quality of *PRONOEIs*, and with teachers on targeting children of lower nutritional status.

1. Introduction

Many empirical studies have shown negative associations between early growth faltering in children, subsequent low height-for-age *z*-scores (HAZ) over time relative to the medians for the WHO (2006) reference for well-nourished populations, and school achievement and learning. For example, Grantham-McGregor et al. (2007) reviewed the literature in developing countries and found that early stunting (HAZ < -2 SD from median) and poverty in the first five years of life were associated with lower subsequent cognitive abilities, school achievement, and productivity in adult life. Their estimates suggest that worldwide 200 million children under five years of age in developing countries are not fulfilling their developmental potential. Theoretical models and empirical findings suggest that schooling (or other formal educational programs) and nutrition may have independent but also possibly interactive effects in promoting children's development. For example, Pollitt (1990, 2002) reviewed empirical studies that showed that different health and nutrition deficiencies have impacts on school achievement. Brown and Pollitt (1996) provided a theoretical model on how undernutrition could affect intellectual development, including schooling attainment as a mediating mechanism.

Starting interventions early would seem an important consideration, in order to avoid what could be irreversible damage due to early-life growth faltering and other developmental deficiencies. This would seem to point to the possible value of pre-school interventions. Indeed, among educators and many policymakers, early childhood care and education have

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become a priority, and were included as the first goal of Education for All [EFA] (UNESCO, 2006). EFA reports show that pre-school enrolment rates are increasing in most countries. Internationally, there is evidence of the positive effects of early childhood care and education on later achievement (Ruhm & Waldfogel, 2011); however, the impacts of programs vary, suggesting that there are issues of quality in how programs are conceived and implemented (see Barnett, 2008, for the USA; Goodman & Sianesi, 2005 for the UK; and Díaz, 2006, for Peru). Montie, Xiang, and Schweinhart (2006) examined the impact of pre-school attendance on cognitive and verbal abilities by age seven years in a 10-country study. Even though their study included only children enrolled in pre-school, they found that abilities by four years of age predicted abilities three years later, thus emphasizing the importance of early interventions. Schady et al. (2015) also report that differences in cognitive skills by household wealth quartiles begin prior to 30–36 months of age and persist into the early schooling years in five Latin American countries, including Peru. Engle et al. (2011) estimate high benefit-cost ratios (6.4–17.6, depending on baseline enrollment and discount rates) for reducing pre-school enrollment gaps by wealth quintiles in 73 developing countries. In spite of the potential benefits pre-school may have on the development of cognitive abilities of children in developing countries, to our knowledge there are only a handful of studies that examine the benefits of pre-school on children who experience early-life growth faltering. The present study explores if the type of pre-school and the number of years attended is related to children's skills by age five years, and also if there is an interaction between HAZ at age one year and attending either type of pre-school on children's cognitive skills.

1.1. Stunting, development of cognitive abilities and schooling

Early-life stunting is widely considered a non-specific indicator of chronic undernutrition. Though reductions in stunting prevalence are occurring globally, chronic undernutrition continues to be a major public health issue, especially for developing countries. De Onis, Blossner, and Borghi (2012) have estimated that worldwide, 171 million children are stunted (data for 2010). Most stunted children live in developing countries, with particularly high and stagnant rates in Africa and downward trends in Asia and Latin America, though still relatively high in much of Asia and a few countries in Latin America. Causes of early undernutrition are varied and depend upon manifestation. Infants and young children who fail to thrive (i.e., whose weight, height, head circumference, and psychosocial development are markedly below age-related norms) may fail because of organic and non-organic reasons including illnesses and genetic conditions on the one hand and inadequate parenting and environmental factors on the other (Iwaniec, 2004). McDougall, Drewett, Hungin, and Wright (2009) found eating difficulties to be associated with early weight faltering. However, Wright, Parkinson, and Drewett (2006) found that social and maternal characteristics had little influence. With respect to wasting, Martorell and Young (2012) found that high levels of undernutrition were associated with the poor status of women, the "thin-fat" infant phenotype, chronic dietary insufficiency, poor dietary quality, seasonality, and poor levels of sanitation. Martorell and Young (2012) and Schott, Crookston, Lundeen, Stein, and Behrman (2013) have identified a range of factors associated with stunting, including wealth, short stature of the mother, being a thin mother, mother's and father's level of schooling, and early age at first delivery. Victora, de Onis, Hallal, Blossner, and Shrimpton (2010) have found that growth faltering begins quickly after birth, thus suggesting that interventions should start during pregnancy or before children reach two years of age. In Peru, stunting prevalence has gone down (about 18% of children under 5 years of age are stunted; data for 2009; UNICEF, 2011). The prevalence of chronic undernutrition in Peru places the country above the mean for Latin America and the Caribbean, with reductions observed in most countries (UNICEF, 2006).

Several longitudinal studies provide ample evidence regarding the association between early growth faltering and later cognitive abilities and school achievement. For example, in Zimbabwe, Alderman, Hoddinott, and Kinsey (2006) found that undernutrition in early childhood had an effect on the number of school grades completed by young adulthood. For Guatemala, Behrman et al. (2014) found an impact of HAZ by age 72 months (plus or minus six months) on adult reading and cognitive abilities. The literature review mentioned above by Grantham-McGregor et al. (2007) also concludes that early stunting predicts later cognitive ability and school achievement.

Some limited literature has focused on the potential role pre-school and primary school attendance may have in helping children who experienced early-life growth faltering. For example, Grantham-McGregor, Powell, Walker, Chang, and Fletcher (1994) found that for severely undernourished, hospitalized, Jamaican children (initial ages 6–24 months), an intervention that started at the hospital but continued at home (i.e., two visits per week for three years) had an effect on cognitive development up to 14 years after treatment. This intervention included efforts to help mothers increase their verbal interactions and improve their play with children. Also, Walker, Chang, Powell, and Grantham-McGregor (2005) report on a study on nutrition and psychosocial stimulation of Jamaican children. The psychosocial intervention consisted of visiting children at home once a week for one hour for two years. The purpose of visits was to improve mother–child interactions. The intervention occurred when children were 9–24 months. While both the nutrition and psychosocial interventions had positive impacts in the short term, only the psychosocial intervention showed an impact on measures of cognitive development and achievement when children were 17–18 years of age. In a longitudinal study in the Philippines, Mendez and Adair (1999) found that stunting between zero and two years of age predicted cognitive abilities when children were 8–11 years old. More importantly, they found that stunted children were more likely than non-stunted children to enroll late in primary school, were absent more, and repeated more grades. In a longitudinal study in Guatemala, Hoddinott et al. (2013), using instrumental variable techniques, found that a one-SD increase in HAZ at age 24 months was associated with more

Table 1
Sample size by round, panel and analytical sample.

	Round 1	Round 2	Panel	Analytical sample (R1 and R2)
Girls	1.026	973	973	715
Boys	1.026	990	990	708
Total	2.052	1.963	1.963	1.423

schooling (0.78 grades) and higher test scores for reading and nonverbal cognitive skills (0.28 and 0.25 SDs, respectively), about 35 years later.

Recently there has been a discussion regarding height gain after the first year of life and later cognitive development and achievement. For example, Gandhi et al. (2011) found that for rural Malawian children, height gains between 18 and 60 months (controlling for length at one and six months of age) predicted mathematics achievement and grade repetition by the age of 12 years. Crookston et al. (2013) examined associations between recovery from early stunting and cognitive abilities using longitudinal data from Ethiopia, India, Peru and Vietnam. They used HAZ at one year and HAZ gains from ages one to eight years as predictors of achievement and cognitive development by eight years of age. They found that persistently stunted children had lower test scores, and those who were never stunted had higher results. However, children who recovered from early stunting had higher scores than those persistently stunted on several of the cognitive tests investigated across countries. Therefore, good nutrition early in the child's life seems important though there appears to be potential to reverse at least some of the negative effects of early stunting. These studies suggest a potential beneficial effect of recovery in HAZ, and while this does not deny the importance of policies and programs aimed at pregnancy and the first two year years of life, a better understanding of influences after the second year of life would be beneficial in improving understanding of both nutrition and cognitive development as children age beyond the first two years. While the interventions used in the two Jamaican studies occurred at home starting at an early age, it is more common in developing countries to implement large pre-school programs in the period immediately before primary school (i.e., for children ages three to five), thus making the analysis of the impact of these programs on children who experience growth faltering an important policy issue. In the next section we turn briefly to describing pre-school programs in Peru.

1.2. Types of pre-school in Peru

Over the past few decades, early childhood education has become an important issue in many developing countries, including Peru. For example, the General Education Law of 2003 states that pre-school education is mandatory for ages three to five. According to this law, the main objectives of pre-school are to help children develop cognitive and socio-emotional skills and encourage family involvement as part of the socialization process. While there are a variety of early childhood education programs, including those that are institutional and home-based (i.e., targeting parents) for children from birth to two years, coverage for this age group is low. Here, we describe programs for children ages three to five years. For these ages, there are two types of pre-school: *Programas no Escolarizados de Educación Inicial* (*PRONOEI*) and *Jardines*.

The *PRONOEI* are public programs created in the late 1960s in an effort to provide an alternative for children who did not have access to pre-schools, especially in marginal urban and rural areas. Up to the present, the program has focused on this population as its main target. *PRONOEI's* teachers are mothers from the community who receive training in child development and teaching techniques from a certified teacher hired by the Ministry of Education. The Ministry also provides materials, such as toys, but the community usually provides the building where *PRONOEI* works. *PRONOEI* pre-schools are expected to meet for four hours a day, usually four days a week (the remaining day is expected to be devoted to training and preparation). According to statistics from the Ministry of Education[1] in 2006, there were 259,314 children attending 18,610 *PRONOEI* pre-schools.

Jardines are set up in more populated areas and in buildings provided by the state or a private provider. Teachers are usually certified, and they are expected to offer classes for four or five hours a day, five days a week.[2] In 2006, there were 829,526 children enrolled in *Jardines* and the number of *Jardines* was 17,986.[3] Two studies suggest that after controlling for several covariates, *Jardines* have a higher impact than *PRONOEI* on primary school achievement (language and mathematics; Cueto & Díaz, 1999; Díaz, 2006).

2. Objectives

The present study seeks to explore if the type of pre-school (i.e., *PRONOEI* or *Jardin*) and number of years attended is associated with children's skills, in vocabulary and early numeracy, by age five years. A second and equally important

[1] Ministry of Education (2007). *Plan Estratégico Institucional 2007–2011.*
[2] The information about pre-schools in Peru is based on the *Decreto Supremo N° 013-2004-ED*.
[3] Numbers calculated using the datasets from the National School Census 2006 retrieved from escale.minedu.gob.pe.

objective is to determine whether there is an interaction between HAZ at age one year and attending either type of pre-school from ages three to five years on the above-mentioned skills at age five years.

3. Methods

3.1. Data

We analyzed data from the Young Lives (YL) longitudinal study. This is an international study that tracks the development of 12,000 children in four countries (Ethiopia, India, Vietnam and Peru) since 2002. YL has information on two cohorts of children that were born around 1994 (older cohort) and 2001 (younger cohort). The present study uses data from the younger Peruvian cohort only (early-life nutritional status is not available for the older cohort) and includes two rounds of household surveys gathered in Peru and administered at home to children and their caretakers in 2002 and 2006.

3.2. Sample

The original sample was selected randomly from 20 sites across the country. However, since the focus of the study is childhood poverty, the richest 5% of districts were excluded from the sampling framework (Escobal & Flores, 2008) in order to oversample poor areas in Peru. Originally, the younger cohort had 2052 children (Round 1) and 1963 in Round 2 (Cueto et al., 2011). From the sample of 1963 children, we only included the 72.5% of the children who attended either a *Jardin* or a *PRONOEI* pre-school or no pre-school. Mixed cases[4] (i.e., children who attended both in successive years) as well as children who attended other types of childcare programs from ages three to five years were excluded from the analysis (Table 1).

3.3. Statistical model

To address our research questions, we first considered OLS regression models. This model permitted the estimation of the main effects of pre-school attendance and child nutritional status on performance on tests of cognition by age 5, controlling for child and family characteristics:

$$Y_i = \beta_0 + \beta_1 S_i + \beta_2 Jardin_i + \beta_3 PRONOEI_i + \sum_{m=4}^{p} \beta_m X_i + \varepsilon_i$$

where
Y_i : abilities by age five (PPVT or CDA, see below),
S_i : nutritional status at age one (HAZ),
$Jardin_i$: number of years attended a *Jardin*pre-school,
$PRONOEI_i$: number of years attended a *PRONOEI*pre-school,
X_i : individual and family variables,
β_i : regression coefficients,
ε_i : error term,
p : number of control variables included in the model.

In this model, β_2, and β_3 are the main effects of attending a *Jardin* or *PRONOEI* pre-school on cognitive abilities, respectively, and β_1 is the main effect of nutritional status, holding constant child and family characteristics (X_i).

However, one problem with using OLS regressions is the possible endogeneity of nutritional status, number of years the child attended a *Jardin* and number of years the child attended a *PRONOEI*. For example, there may be unobserved variables (e.g., parenting skills) that affect positively early-life nutrition and pre-school enrollment as well as cognitive skills at age five. In our model the unobserved variables for the cognitive skills equation will be included in the error term and, given the assumptions specified in the previous sentence, the error term will be positively correlated with the nutritional status and pre-school variables in our model. As a result the estimated parameters are likely upward biased, because they are including the effects of these unobserved variables in the disturbances in addition to the observed nutrition and pre-school variables. Our literature review indicates that the regression coefficients using OLS in models such as this one are claimed to be biased in other contexts (Glewwe, Jacoby, & King, 2001; Alderman, Hoogeven, & Rossi, 2009). To test the robustness of the OLS we used a Two Stage least squares (2SLS) regression model or instrumental variables. To run this type of model it is necessary to find a variable(s) called an instrument(s). Good instruments predict well the endogenous variables (nutritional status, number of years the child attended a *Jardin* and number of years the child attended a *PRONOEI* pre-school) in the model and have no direct impact on the main dependent variable (cognitive abilities). Thus, the first step effectively is to run OLS regression(s) where the outcome(s) is the right-side endogenous variable(s) (nutritional status, number of years the child attended a *Jardin* and number of years the child attended a *PRONOEI* pre-school) and the independent variable(s) include all

[4] The total mixed cases were 67, distributed in three groups: one year in Jardin and one year in PRONOEI (21 cases), two years in Jardin and one year in PRONOEI (17 cases) and, two years in PRONOEI and one year in Jardin (29 cases).

instrument(s), and estimate the predicted values for the outcome(s). The second step (and second stage) is to run the original model but instead of using the endogenous variable(s), use the predicted variable(s) estimated in the first step that are not correlated with the second-stage disturbance term if the instrument(s) is (are) good in the sense defined above. Finally, to test for possible interaction effects, given the potential high correlation of interaction terms of our endogenous variables, we divided the analytic sample in two: children at risk (HAZ below -1 SD) and normal (HAZ above or equal to -1 SD) and we run the 2SLS model in both samples, in order to explore a possible shift in the slope for *Jardin* or *PRONOEI* that indicates an interaction effect. We used -1 SD as cut-off score since from this threshold a child is considered mildly malnourished while values above -1 indicate well-nourished children (Peiris & Wijesinghe, 2010).

3.4. Selection of instruments

For this study, we used three instruments, each motivated primarily by one of the three endogenous variables, though all three enter into the first-stage relation for each of the endogenous variables. For nutritional status, mother's height was used given that different studies with children under five years of age have found that maternal height is highly correlated with child stunting. Studies in different contexts like Hernandez-Diaz et al. (1999) in Mexico, Subramanian, Ackerson, Smith, and John (2009) in India, and Felisbino-Mendes, Villamor, and Velasquez-Melendez (2014) in Brazil show that shorter mothers are more likely to have stunted children, and this relationship remains after holding constant diverse environmental and socioeconomic factors. We are aware of literature that describes associations between maternal height and child cognitive abilities, but this relationship is often indirect. For *years the child attended a PRONOEI pre-school*,we used the ratio between the number of these pre-schools and the total number of all types of pre-schools in each district. We used this instrument given that those districts with higher ratios are more likely to enroll children in a *PRONOEI* pre-school, and this instrument should not be directly correlated with unobserved determinants (i.e., parenting skills) of children's cognitive abilities. Finally, the third instrument used for *years the child attended a Jardin* was the proportion of household heads in the district that had completed secondary education or more. Household heads with greater formal schooling usually invest more in early child development by enrolling their children in *Jardines*, given that they are more likely to identify the benefits of a pre-school that are often regarded as higher quality, given the target families mentioned above.

3.5. Sampling selection bias

We restricted the sample to those children who attended a *Jardin* or *PRONOEI* and those who did not attend pre-school. This could generate a selection bias in our sample. To control for this, we included the inverse Mills ratio in all regression models. To calculate this estimator, we followed the two-step procedures recommended by Heckman (1979). In the first step, with data from all respondents to the Panel sample of Young Lives (Rounds 1 and 2), we estimated a logistic regression model, where 1 means being part of the analytical sample, as a function of child and family socio-demographic characteristics.[5] Once this model was estimated, we included the predicted probability of the logistic regression in all models.

3.6. Variables[6]

3.6.1. Our dependent variables[7]

*Peabody Picture Vocabulary Test (PPVT), Spanish version*is a test designed to measure receptive vocabulary, where the task of the examiner is to show a set of four pictures and ask the child to select the picture that best represents the word spoken by the examiner (Dunn, Padilla, Lugo, & Dunn, 1986). The test is orally administered, un-timed and norm-referenced. It has 125 items and can be used with persons from 2.5 years to 19 years of age. We used the raw scores, since the standard scores are not adequate because the normalization sample is from the 1980s and did not include Peru.

Child Development Assessment (CDA) is a test originally developed by the International Evaluation Association to evaluate three dimensions of child development: early numeracy, early vocabulary and socio-emotional skills. The YL study only used the subtest that assesses early numeracy skills. This subtest requires children to pick an image from a selection of three or four that best reflects the quantitative concept read by the examiner, such as none, most, few, many, etc. This scale had 15 items; each correct answer was scored 1 point and 0 if it was wrong. We used the raw score (sum of all correct answers) as the dependent variable.

3.6.2. Our instrumentals variables

Maternal height, measured in centimeters. This variable comes from the Young Lives survey where the fieldworkers measured mother's height following international standards for anthropometric measures.

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[5] We included child's age, mother's age, child's sex, child's mother tongue, HAZ, maternal schooling attainment, place of residence, household wealth index, if child attended Jardin and if child attended PRONOEI.

[6] All variables come from the Young Lives data set unless indicated otherwise.

[7] For more information about the tests see Cueto et al. (2009).

Education of the household head[8], is the proportion of household heads that had completed at least secondary schooling in the district where the Young Lives child lived. This variable comes from the National Census of 2007.

Ratio of PRONOEI pre-schools over total pre-schools, is the ratio between number of *PRONOEI* pre-school and number of all type of pre-schools in the district. This variable comes from the School Census administered by the Ministry of Education (data from 2006).

3.6.3. Our main right-side endogenous variables

Height-for-age z-score (HAZ), is commonly used to represent child nutritional status based on the WHO (2006) growth reference curves. Given that HAZ in round 1 had a negative correlation with the age at which data were collected (i.e., children were between 6 and 18 months in Round 1 of Young Lives), we used HAZ adjusted by age to obtain estimates for 12 months.[9]

Years of pre-school attendance, this variable included pre-school attendance (yes/no), intensity of pre-school (years attended) and school type (*Jardin, PRONOEI*). Our first variable is *Attended a Jardin* which is an ordinal variable taking the value of 0 if a child did not attend or 1 if the child attended one year, 2 if child attended a *Jardin* for two years, and 3 if the child attended a *Jardin* three years between 2004 and 2006 (in Peru, the school year runs from March to December). We followed the same procedure for *Attended a PRONOEI pre-school*. The reference group is children who did not attend pre-school between 2004 and 2006.

Finally, we used the following control variables: sex (female), age of the child in months, mother tongue (indigenous), mother's schooling (completed secondary or more), place of residence (urban), mother's age, and household wealth index in 2002 (composite score made up of three indices: housing quality, housing services and durable assets).

4. Results

4.1. Sample characteristics

Table 2 shows the characteristics for our analytical sample by type of pre-school attended. In terms of individual and family characteristics, children who attended *Jardin* pre-schools have better HAZ scores, are a few months older, mainly Spanish speakers, have mothers with more schooling, live mainly in urban areas, have higher socioeconomic status, and higher PPVT and CDA test scores than their peers who attended a *PRONOEI* or did not attend a pre-school. The only statistically significant difference between children who did not attend pre-school and those who attended *PRONOEI* was that the latter were more likely to be rural. Overall, children who did not attend pre-school or who attended a *PRONOEI* tended to be poorer and indigenous, and showed lower test scores by age five years.

4.2. Interactions between child nutritional status and pre-school attendance on children's abilities

Table 3 shows that across most groups, non-stunted children have higher CDA and PPVT raw scores. However, the gap between non-stunted and stunted children is higher for those who attended a *Jardin*.

Table 4 shows that children who were not stunted at age one year in most cases had statistically higher cognitive scores than those who were stunted, and this difference increases with years of pre-school. Therefore, we use years attending pre-schools, *Jardin or PRONOEI*, as the main independent variables in our analysis. Finally, Figs. 1 and 2 show the relationships between nutritional status and the two tests by type of pre-school attended. For those who attended*Jardines*, there was a stronger relationship between nutritional status and abilities. On the other hand, there is no significant association between HAZ and CDA for those who attended *PRONOEI* pre-schools.

4.3. Effects of stunting and pre-school, and their interaction, on children's abilities

Table 5 shows correlations between nutritional status (HAZ adjusted scores) and the CDA and PPVT scores, which are positive and significant. Mixed results were found for years of pre-school attendance. For *Jardin*, we found a positive and statistically significant relationship with CDA and PPVT scores, while the opposite relationship was found between *PRONOEI* and abilities, although the correlations were low. In Table 6, we present the main effects of HAZ and pre-school for the two dependent variables using an OLS model where Model 1 (M1) does not include any control variables and Model 2 does. For the CDA, *HAZ* and *PRONOEI* had significant main effects when no controls are included, but they become non-significant once control variables are included. For the PPVT, the main effects for the two types of pre-school and HAZ were significant even after controlling for child and family characteristics (although the effect of PRONOEI is marginal). Thus, from the OLS analysis, the main effect of *Jardin* seems to be stronger than those of the other two variables. However, as mentioned above, the OLS analysis does not solve endogeneity issues that are likely to bias the results. Table 7 gives 2SLS estimates for

[8] Person within the dwelling identified by household members as the head of the family.

[9] For more information about the adjustment, see Crookston et al. (2013).

comparison.[10] The results show that the main effect for *HAZ* was positive and statistically significant, while no significant effect of years attending pre-school was found for the CDA. The results for the PPVT indicate that the main effects for *JARDIN* and HAZ were positive and statistically significant, while those for *PRONOEI* were not significant. Thus, at least for the effect of *Jardin* and PRONOEI we found consistent results in the OLS and 2SLS for the PPVT. These statistically significant results using HAZ in the 2SLS are consistent with many studies summarized above.

Finally, to test the adequacy of the instruments, we used the Stock–Yogo test (2005), which indicates the percent of bias in the OLS estimates. We rejected the null hypothesis that the instrument is weak when the *F*-statistic of the first stage (OLS regression) is higher than the critical value on tables for 10% of bias tolerance. Table 8 shows that for the three instruments, the null hypothesis is rejected, which confirms the adequacy of the instruments used for each endogenous variable in our models in Table 7.

In order to explore our second objective, we run the 2SLS of Table 7 to simulate the PPVT raw score in children at risk of being stunted (HAZ < −1 SD from mean) as well as not at risk of being stunted (HAZ> = −1 SD). Fig. 3 shows that attending *JARDIN* three years increases vocabulary skills, compared to those who do not attend pre-school (zero years); however, the effect is higher for those children above −1 SD in HAZ. In contrast, Fig. 4 suggests that attending *PRONOEI* does not increase PPVT scores regardless of nutritional status, which is aligned to the results of Table 7.

5. Discussion

Mitigating cognitive deficits observed for children with early stunting is a matter of considerable policy and academic interest. While it is known that early stunting is negatively associated with later cognitive development and school achievement, and that pre-school education might have a beneficial effect for all children, there are only a handful of studies that explore the interaction between these two. In this study we focused on whether or not pre-schools might have not only a main effect on cognitive abilities that increases with number of years attended, but also if it helps reduce the gaps between children with differing degrees of stunting at age one. Based on previous studies, we explored if the quality of the pre-school, approximated here through a differentiation between *Jardines* and *PRONOEI*, made a difference. There are two studies in Peru

Table 2
Child and family characteristics for YL children by type of pre-school attended.

	Did not attend pre-school (n = 308)	*JARDIN* (n = 922)	*PRONOEI* (n = 193)	Total (n = 1423)
HAZ adjusted by age one	−1.70[a] (1.25)	−1.18[b] (1.14)	−1.50[a] (1.10)	−1.34 (1.18)
Stunted by age one	0.41[a] (0.49)	0.22[b] (0.41)	0.32[a] (0.47)	0.27 (0.45)
Age in months	61.71[a] (4.87)	64.05[b] (5.36)	62.05[a] (5.25)	63.27 (5.35)
Female	0.54[a] (0.50)	0.49[a] (0.50)	0.46[a] (0.50)	0.50 (0.50)
Indigenous mother tongue	0.21[a] (0.41)	0.09[b] (0.29)	0.21[a] (0.41)	0.13 (0.34)
Mother has complete secondary	0.14[a] (0.35)	0.44[b] (0.50)	0.18[a] (0.39)	0.34 (0.47)
Urban	0.53[a] (0.50)	0.78[b] (0.42)	0.37[c] (0.48)	0.67 (0.47)
Wealth index at age one	0.36[a] (0.21)	0.50[b] (0.22)	0.34[a] (0.19)	0.44 (0.23)
PPVT score by age five	18.68[a] (13.35)	31.53[b] (17.66)	22.00[a] (15.03)	27.46 (17.39)
CDA score by age five	7.66[a] (1.92)	8.65[b] (2.03)	7.70[a] (2.17)	8.30 (2.07)

Note: Means with the same superscript (i.e., a, b or c) indicate no significant differences at 5% (Bonferroni and Scheffe tests). Standard deviation reported in parenthesis.
Own elaboration.Source: Young Lives Data, Rounds 2 and 3.

[10] Results from the first stage are shown in Appendix A.

Table 3
CDA and PPVT mean scores by nutritional status and pre-school attendance.

	CDA			PPVT		
	Not-stunted	Stunted	Difference	Not-stunted	Stunted	Difference
Did not attend pre-school	7.79 (183)	7.48 (125)	0.31	21.13 (183)	15.09 (125)	6.04[a]
Attended *PRONOEI*	7.92 (131)	7.23 (62)	0.69[a]	23.79 (131)	18.23 (62)	5.56[a]
Attended *JARDIN*	8.82 (720)	8.00 (202)	0.82[a]	33.74 (720)	23.67 (202)	10.07[a]

Note: Number of children reported in parenthesis.
Own elaboration.
[a] Differences are statistically significant at 5% according to the *t*-test for independent samples.Source: Young Lives Study, Rounds 1 and 2.

Table 4
CDA and PPVT mean scores by nutritional status and years of pre-school attendance.

	CDA			PPVT		
	Not-stunted	Stunted	Difference	Not-stunted	Stunted	Difference
0 years	7.79 (183)	7.48 (125)	0.31	21.13 (183)	15.09 (125)	6.04[a]
1 year	8.39 (349)	7.82 (130)	0.57[a]	28.44 (349)	21.45 (130)	6.99[a]
2 years	8.74 (367)	7.62 (105)	1.12[a]	33.01 (367)	21.39 (105)	11.62[a]
3 years	9.32 (135)	8.59 (29)	0.73	39.74 (135)	30.24 (29)	9.50[a]

Note: Number of children reported in parentheses.
Own elaboration.
[a] Differences are statistically significant at 5% according to the *t*-test for independent samples.Source: Young Lives Study, Rounds 1 and 2.

suggesting that the *Jardines* could be of higher quality, a result that is confirmed with the rigorous analysis performed here. Controlling for endogeneity is particularly important in this case, as *PRONOEI* are focused on children who are poorer and more likely to live in rural areas and be indigenous, while *Jardines* are set up in urban areas, where Spanish is predominant and children and their families tend to have access to more resources.

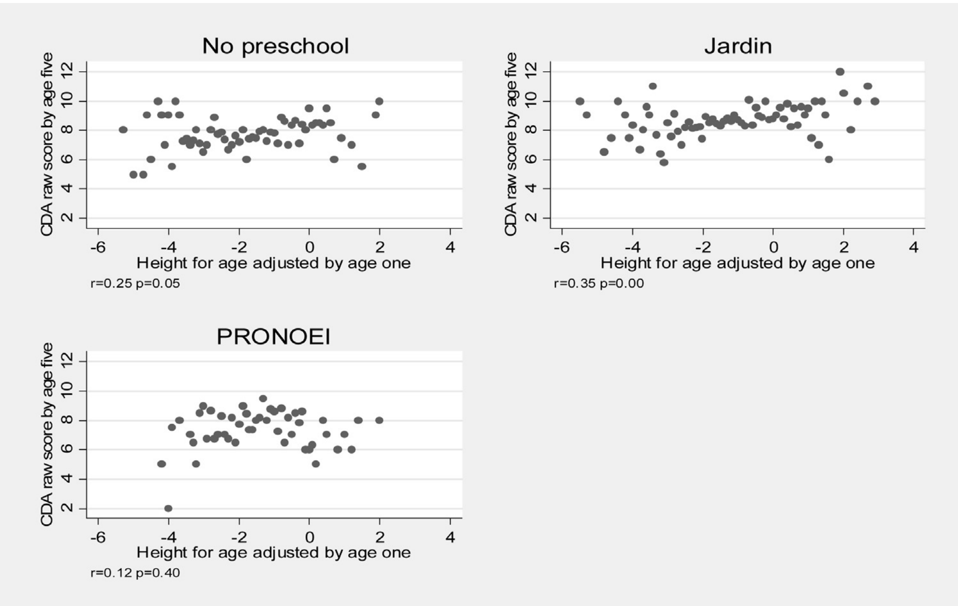

Fig. 1. Scatterplot between HAZ and raw numeracy (CDA) by type of pre-school attended.

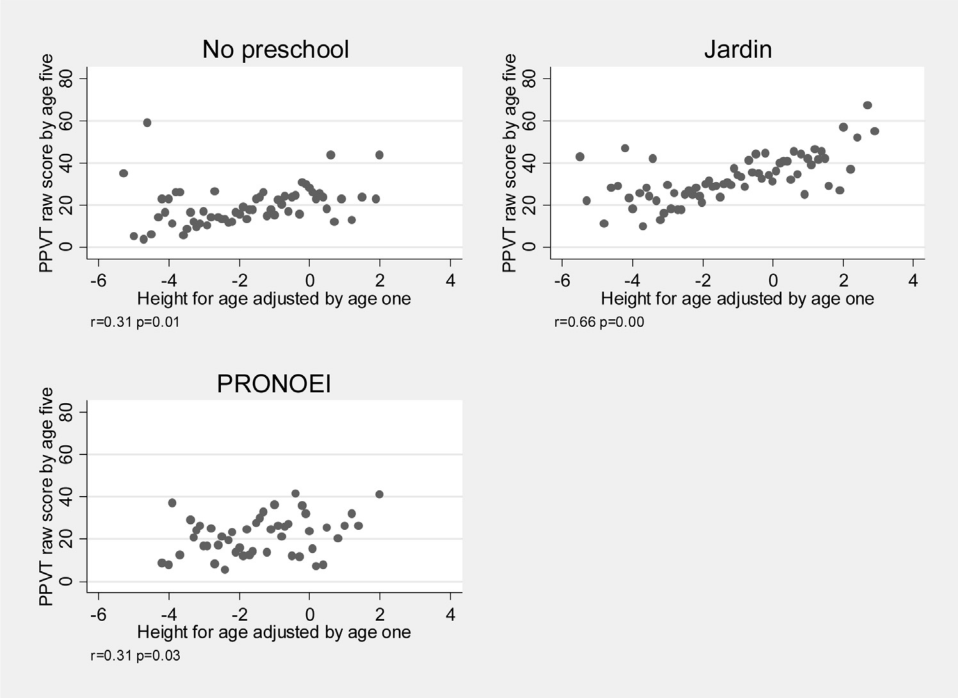

Fig. 2. Scatterplot between HAZ and PPVT by type of pre-school attended.

Our dependent variables included a general measure of receptive vocabulary (PPVT) and a measure of early numeracy skills (CDA). We performed OLS and 2SLS analysis, which yielded similar results. However, since the former does not control for endogeneity, while the latter does (see Table 7), we concentrate on the 2SLS estimates. Holding constant individual and family variables, the effect of attending *Jardines*on the PPVT was positive (0.08 SD, $p < 0.05$), while the effect of attending *PRONOEI* was not significant for both measures of cognitive skills, which is consistent with previous studies showing a positive impact for *Jardines* (Cueto & Díaz, 1999; Díaz, 2006). We also found that HAZ had a positive and significant effect on PPVT and CDA test scores. In regards to the interaction between HAZ and attending pre-school for more years from three to five years of age, we found that attending *Jardines* is more beneficial for better nourished children, thus increasing the gap in the PPVT.

We note that we did not find the same results for the CDA and PPVT, which could be because of the nature of each test used. As mentioned in a previous section, the CDA evaluates raw numeracy abilities for children aged 3–5 years old and most of our sample is aged 5 years old; therefore, the score variation is small (CV: 0.25) and the CDA scores are negatively skew

Table 5
Correlation among cognitive measures and main independent variables (N = 1.423).

	PPVT score	CDA score	HAZ adjusted to age one
CDA score	0.56 (0.00)	–	–
HAZ adjusted to age one	0.32 (0.00)	0.19 (0.00)	–
Years attending a *JARDIN*	0.37 (0.00)	0.25 (0.00)	0.22 (0.00)
Years attending a *PRONOEI*	−0.11 (0.00)	−0.10 (0.00)	−0.06 (0.02)

Note: *P*-values in parenthesis.
Own elaboration.Source: Young Lives Study, Rounds 2 and 3.

[10] Results from the first stage are shown in Appendix A.

Table 6
Effect of attending pre-school and nutritional status on cognitive abilities using OLS, standardized coefficients (*N* = 1.423).

	CDA		PPVT	
	M1	M2	M1	M2
Main effects				
HAZ adjusted to age one	0.12**	0.03	0.22**	0.05*
Years attended *JARDIN*	0.27**	0.08*	0.42**	0.09**
Years attended *PRONOEI*	0.05*	0.00	0.15**	0.05+
Control variables included	No	Yes	No	Yes
R-squared	0.09	0.20	0.22	0.51

Note: $^{**}p < 0.01$, $^{*}p < 0.05$, $+p < 0.10$. Standard errors are adjusted for possible covariance among children living in the same district. Model 2 includes as control variables: child's age, child's mother tongue, child's sex, maternal schooling attainment, mother's age, place of residence, and household wealth index. Standard errors were calculated using bootstrapping with 100 replications.

Table 7
Effect of attending pre-school and nutritional status on cognitive abilities using 2SLS, standardized coefficients (*N* = 1.423).

	CDA		PPVT	
	M1	M2	M1	M2
Main effects				
HAZ adjusted by age one	0.17**	0.19**	0.36**	0.39**
Years attended *JARDIN*	0.22**	0.06	0.30**	0.08*
Years attended *PRONOEI*	−0.07**	−0.04	−0.04	0.01
Control variables included	No	Yes	No	Yes
R-squared	0.13	0.18	0.35	0.44

Note: $^{**}p < 0.01$, $^{*}p < 0.05$, $+p < 0.10$. Standard errors are adjusted for possible covariance among children living in the same district. All models include as control variables: child's age, child's mother tongue, child's sex, maternal education, mother's age, place of residence, and wealth index. Standard errors were calculated using bootstrapping with 100 replications.

Table 8
Adequacy of the instruments.

	Maternal height	Education of the household head	Ratio of *PRONOEI*pre-schools
F-statistic first step	52.10	52.59	34.68
Stock–Yogo critical values $\alpha = 5\%$			
Bias 10%, 3 instruments	22.30	22.30	22.30
Bias 15%, 3 instruments	12.83	12.83	12.83

distributed (Cueto, Leon, Guerrero & Muñoz, 2009). While, the PPVT evaluates receptive vocabulary from children aged 2–17 years old; therefore, it is possible to capture the full range of children abilities and avoid possible ceiling effects.

While the positive effects of pre-school in general have been amply demonstrated by the literature, consistent with some of our findings, our results also suggest that not all types of pre-schools are equally effective, at least as measured by tests used in this study. It would seem that there are minimum levels of quality and intensity in the provision of pre-school education that are not being observed. However, one limitation of this study is that we cannot provide information on how these preschools worked.

Additionally, our results suggest that preschools in general are not places where inequalities linked with low height-for-age are overcome. In*Jardines*, children with higher HAZ had better results; while in *PRONOEI*, HAZ made no difference. In Peru and elsewhere, it is hoped that education will reduce inequalities but this seems to not be the case for the preschools studied here, although we have no specific information on how children of different nutritional status are treated by their teachers, peers and families.

In terms of policy, it would seem critical to increase the quality of *PRONOEI*s, especially since they are designed for children of lower socioeconomic status. Second, for both *PRONOEI* and *Jardines*, it would be good to work with teachers on how to target children of lower nutritional status. Improving their skills however might require comprehensive interventions (i.e., health, nutrition, and poverty reduction, plus work with their parents) aimed at reducing inequalities in abilities from an early age. Perhaps one way to do this would be to help teachers identify children who are likely to underperform (including those with low HAZ), so that they provide special attention to them. As mentioned above, there are studies suggesting that starting interventions early in life may have a large impact on development, and particularly it would seem that targeting parents at home may result in effects that are detectable many years later (e.g., Walker et al., 2005).

For the research agenda, this study includes an analysis of effects, but not of the differential quality and intensity of *Jardines* and *PRONOEIs*. It is surprising how little research conducted in developing countries addresses why some preschools

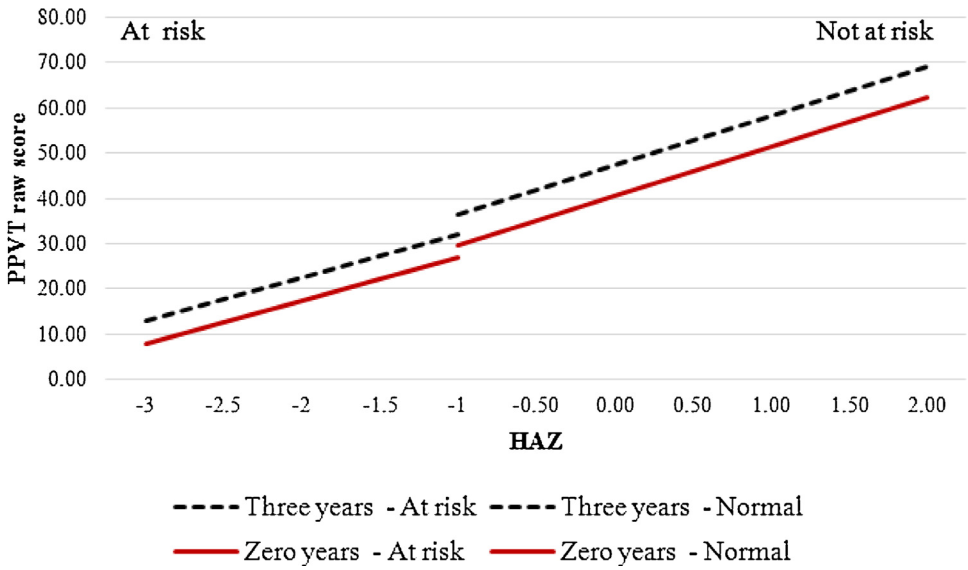

Fig. 3. PPVT score by nutritional status and years attending *JARDIN*.

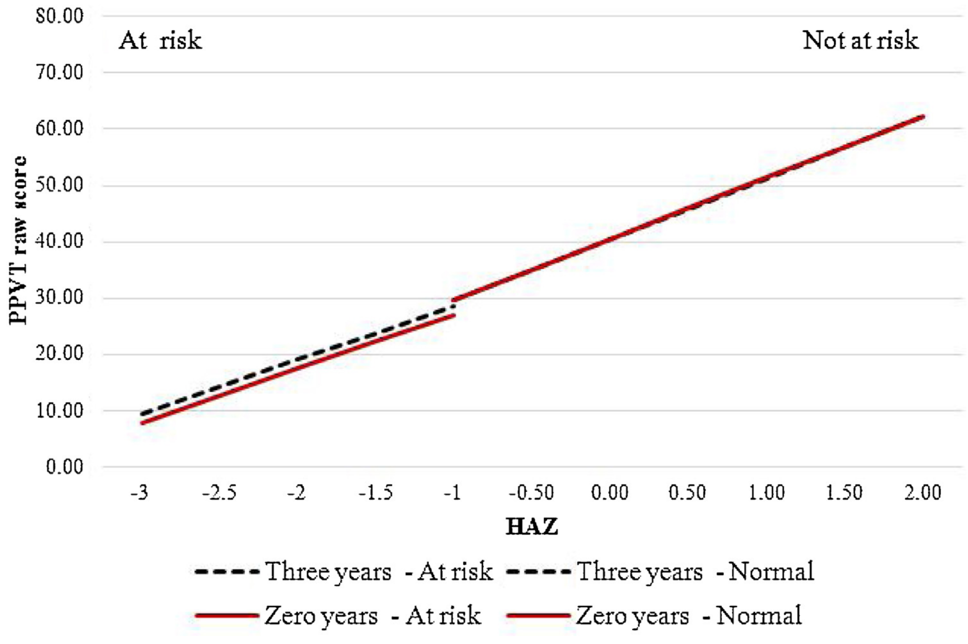

Fig. 4. PPVT score by nutritional status and years attending *PRONOEI*.

are more effective than others. Rigorous research in this area is critical to understanding how to increase the educational opportunities of all children.

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Appendix A.

See Tables A1–A3.

Table A1
First stage results of HAZ.

	HAZ
Instruments	
Maternal height	0.06**
Education of the household head	0.55
Ratio of PRONOEI pre-schools over total pre-schools	−0.24
Child and family characteristics	
Female	0.21**
Child's age	0.01
Mother tongue	−0.56**
Maternal education	0.24**
Mother's age	0.00
Wealth index	0.52*
Place of residence (urban)	0.14*
R-squared	0.26

**$p < 0.01$, *$p < 0.05$, +$p < 0.10$.

Table A2
First stage results of attending *Jardin*.

	Attending *Jardin*
Instruments	
Education of the household head	1.23*
Maternal height	0.43**
Ratio of *PRONOEI* pre-schools over total pre-schools	−1.08*
Child and family characteristics	
Female	0.21*
Child's age	0.07**
Mother tongue	−0.42
Maternal education	0.19**
Mother's age	0.06**
Wealth index	2.55**
Place of residence (urban)	0.55+
R-squared	0.15

**$p < 0.01$, *$p < 0.05$, +$p < 0.10$.

Table A3
First stage results of attending PRONOEI.

	Attending PRONOEI
Instruments	
Ratio of PRONOEI pre-schools over total pre-schools	2.45**
Education of the household head	1.86+
Maternal height	0.00
Child and family characteristics	
Female	−0.01
Child's age	0.04
Mother tongue	−7.68**
Maternal education	9.88**
Mother's age	0.57**
Wealth index	−0.90
Place of residence (urban)	−0.71+
R-squared	0.69

**$p < 0.01$, *$p < 0.05$, +$p < 0.10$.

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