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# Prematurity and school readiness in a nationally representative sample of Australian children: Does typically occurring preschool moderate the relationship?

Jen-Hao Chen [a,*], Amy Claessens [b], Michael E. Msall [c,d]

[a] Department of Sociology, National Chengchi University, Taipei, Taiwan 64 Section 2, Zhinan Road, Taipei, Taiwan 11605
[b] Harris School of Public Policy Studies, University of Chicago, Chicago, IL, United States
[c] Section of Developmental and Behavioral Pediatrics University of Chicago Comer Children's Hospital, Chicago, IL, United States
[d] JP Kennedy Research Center on Intellectual and Developmental Disabilities, University of Chicago, Chicago, IL, United States

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ABSTRACT

*Objective:* This study aims to examine the relationship between indicators of prematurity and children's cognitive and behavioral school readiness in a nationally representative sample and to investigate whether typically occurring preschool enrollment moderates this relationship, particularly for children from disadvantaged families in Australia.
*Methods:* The Longitudinal Study of Australian Children is a nationally representative prospective sample of two cohorts of children with sequentially obtained indicators of child health and developmental outcomes. We analyzed information on 8060 children aged 4–5 years who had complete data on birth weight, gestational age, prenatal risks, social factors, and cognitive and behavioral outcomes of school readiness. Multivariate regressions were used to relate three indicators of prematurity (low birth weight, preterm birth, and small for gestational age) to cognitive and behavioral school readiness.
*Results:* Children born preterm, small for gestational age, or with low birth weight have significantly lower cognitive school readiness after controlling for social factors and prenatal risks. None of the premature indicators were associated with behavioral school readiness. All children benefited from attending preschool. Yet, preschool enrollment did not moderate the relationship between prematurity and school readiness. The only exception is for small for gestational age survivors with low educated mothers. Preschool enrollment was associated with an increase in cognitive school readiness skills.
*Conclusions:* Prematurity was associated with lower cognitive school readiness skills. Typical occurring preschool did not eliminate this association. Findings suggest that simply expanding the preschool enrollment is inadequate to address the developmental needs of premature children from disadvantaged backgrounds.


## 1. Introduction

Children born preterm (<38 weeks gestation), born with low birth weight (<2500 g), or born smaller in size than normal for gestational age (weight below 10th percentile for the gestational age) have increased risks for ongoing health and developmental problems. Across a wide range of degrees of prematurity, survivors have high rates of neurodevelopmental and behavioral disorders that impact on their physical and social–emotional health, learning and community participation [1–11]. From the developmental and life course perspective, cognitive and behavioral outcomes measured at school entry, often conceptualized as school readiness skills, are particularly important for success in learning in groups and maintaining positive relationships with peers [12,13]. These skills provide a foundation upon which children build and develop new skills that are important for children's learning and academic trajectories. Various empirical studies have demonstrated that children's cognitive skills and behaviors measured in early school years strongly predict educational attainment and labor market successes [14–16].

Early childhood education program plays an important role in improving children's school readiness skills. Evaluations of preschool programs in the United States demonstrate positive benefits on children's cognitive skills [17,18]. In particular, preschool improves cognitive school readiness skills for children from socially disadvantaged families as compared to their non-attendance peers with similar background [18,19]. While preschool may not completely compensate

*Abbreviations:* LBW, low birth weight; LSAC, Longitudinal Study of Australian Children; PPVT, Peabody Picture Vocabulary Test; SDQ, Strength and Difficulties Questionnaire; WAI, Who Am I?.

* Corresponding author at: Department of Sociology, National Chengchi University, Taipei, Taiwan 64 Section 2, Zhinan Road, Taipei, Taiwan 11605. Tel.: +886 29393091x50841.
*E-mail address:* jenhao78@gmail.com (J.-H. Chen).

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for all aspects of social disadvantages, it provides a cognitively stimulating learning environment and substantially reduces the socioeconomic gaps in school readiness. As such, many scholars and agencies call for increasing government investments in early childhood education programs.

While some studies have linked birth weight and prematurity to school readiness using clinical or regional samples, relatively few have examined nationally representative samples [4,8,9,11]. Furthermore, despite many studies examining the benefits of preschool attendance of socially and economically disadvantaged children, fewer studies have examined the role of typically occurring preschool in moderating the relationship between prematurity and school readiness skills in the general population of children. Using nationally representative cohorts at birth and at school entry from the Longitudinal Study of Australian Children (LSAC), we examined the impact of low birth weight status, preterm delivery and small for gestational age on cognitive and behavioral school readiness skills. In addition, we also investigated to what extent premature children benefit from enrolling in typically occurring preschool as compared to their non-enrolled peers.

Australia offers a unique context to study these research questions. The preschool education in Australia is similar to that in the United States in many aspects. Like in the U.S., preschool is the main source of early childhood education program for children before formal schooling (i.e., kindergarten). Children normally start preschool at 4 years old. In addition, as in the United States, there is no fixed preschool curriculum in Australia. While all Australian states have curriculum frameworks for preschool, none of them are mandatory [20]. As such, preschool curriculums may vary from school to school within the same state. Furthermore, states also differ in terms of their provision of early childhood education programs. Some state governments directly fund and provide preschool education. Others prefer to subsidize existing non-government organizations that provide preschool services [20].

However, Australia preschool education is distinct on several aspects. First, the Commonwealth Government of Australia aims to promote preschool education by moving towards a universally available preschool system. Importantly, the current government funding for early childhood education has more than doubled since 2005 [21]. This may reflect the relatively high preschool enrollment rate in Australia as compared to the United States. Estimates suggest that over half of the 4-year-old Australian children enroll in preschool; and by the time the children are 5-years-old, more than 90% enroll in preschool [22]. Second, among enrolled children, many of them receive a substantial amount of preschool education. Estimates from the survey suggest that 4-year-old children on average spend approximately 12–13 hours per week in preschool program [23]. Statistics from administrative data also show that about 80% of children were enrolled in programs for more than 15 hours per week [24]. In addition, estimates from the Longitudinal Study of Australian children showed that most of the 4-year-old children had enrolled in the program for approximately 7–11 months by the time of interview [23]. As such, many of the recent cohorts of Australian children are exposed to substantial amounts of preschool education for a long period of time.

Additionally, Australia has a universal health insurance such that all citizens have access to healthcare. As such, Australia looks better in some early childhood health indicators. For example, estimates show that approximately 6% of liveborn Australian children were of low birth weight [25], comparing to 8% of U.S. children [26]. Because children in Australia have more equitable access to healthcare resources compared to those in the United States, prematurity may be less harmful for Australian children's developmental outcomes than their U.S. peers. Taken together, the expansion of early childhood education in Australia and the more equitable Australian healthcare system provide a unique social context to examine the association between prematurity and school readiness and whether typically occurring preschool programs moderate the relationships between the two. Results from this study also have significant implications for health and education policies in Australia.

## 2. Methods

### 2.1. Data

The Longitudinal Study of Australian Children (LSAC) is a nationally representative sample of Australian children [27]. LSAC was designed to focus on family and social issues and to capture information about child health and development. LSAC currently follows two cohorts of Australian children, a birth cohort of children recruited during their first year of life in 2004 and a kindergarten cohort recruited in 2004 who were between 4 and 5 years. In case of multiple births, the survey team randomly selected one child from the family. The present study relied on three waves of data for the LSAC birth cohort – age 9 months (wave 1), age 2.5 years (wave 2), and age 4–5 years (wave 3) – and the first wave of the LSAC kindergarten cohort (age 4–5 years). The birth cohort started with 4386 children in 2004. In the third wave of the survey, 3831 children (87%) had follow-up assessments as well as in-home behavioral questionnaires on children's social–emotional skills. The kindergarten cohort began with 4983 children in the first wave of the survey. Among them, 4229 children (84%) had school readiness assessments and had completed in-home behavioral questionnaires. The children who did not complete the in-home behavioral survey were more likely to be from rural areas and where slightly more economically disadvantaged. Multiple imputation (MI) was used to account for potential biases resulting from missing data in all missing variables. MI involves replacing missing values with predictions based on other observed variables using the Monte Carlo technique. This led to a final analytic sample of 8060 children, and when weighted is representative of two cohorts of children in Australia.

### 2.2. Measures

#### 2.2.1. Prematurity

This study focused on three measures of prematurity: low birth weight, preterm birth, and small for gestational age. In the first wave of the survey (for both cohorts), the LSAC collected information about birth outcomes – birth weight (in grams) and gestation period (in weeks) – directly from the child's Health Record Book (i.e., the "baby" book). If the book was not readily available, the mother was asked to provide detailed information on child's birth and birth outcomes. Continuous measures of birth weight and gestation period were transformed to three categorical variables. The first was an indicator of birth weight status which was coded as normal birth weight, moderately low birth weight (defined as less than 2500 g but more than 1500 g), and very low birth weight (defined as less than 1500 g). The second was an indicator of preterm status which was coded into a three-category variable: term birth, moderate preterm birth (defined as less than 37 completed weeks but more than 32 weeks gestation), and very preterm birth (defined as less than 32 weeks gestation). Finally, we combined information of birth weight and gestational age to create a binary indicator of small for gestational age using the Australian birth weight percentile by gestational age chart developed by Roberts and Lancaster [28].

#### 2.2.2. School readiness outcomes

Building on previous psychological and educational literature, we adopted a multi-dimensional approach of school readiness including both verbal and nonverbal cognitive skills and socioemotional skills [6,12,29,30]. When the children were between 4 and 5 years old (i.e., the third wave of the survey for the birth cohort and the first wave of the survey for kindergarten cohort), the LSAC administered two engaging tests which directly assessed children's cognitive skills. The first test is the "Peabody Picture Vocabulary Test" (PPVT) which measures children's knowledge of spoken words and receptive vocabularies. The second test is the "*Who Am I?*" (WAI) which measures children's nonverbal cognitive abilities using drawings and general

concepts needed for beginning school [27,31]. Based on children's performance, two raw scores for verbal and nonverbal cognitive skills underlying school readiness were created using Rasch Modeling techniques.

While the child was evaluated, mothers were also asked to assessed children's socioemotional and behavioral functioning using the Strengths and Difficulties Questionnaire (SDQ) [32]. As recommended in the LSAC technical report [33], we combined the original five SDQ domains into two broad scales of children's socioemotional well-being: (1) pro-social skills, and (2) externalizing problem behaviors. The reliabilities of these two scales are 0.58 and 0.72 respectively [33]. To facilitate interpretation and comparison across different cognitive and social–emotional outcomes, we standardized these raw scores based on our final analytical sample.

#### 2.2.3. Preschool attendance

The LSAC questionnaire asked mothers whether their children currently attended preschool when the children were between 4 and 5 years old. If the answer was yes, mothers were asked how many hours their children were in preschool each week and how long (months) their children were in preschool. Based on this information, we created a binary indicator of preschool attendance, a continuous variable of hours of preschool attendance each week, and a continuous variable for the duration of preschool attendance.

#### 2.2.4. Covariates

Because many characteristics of children and families are associated with birth outcomes and school readiness outcomes, several potential confounding variables are included in the analyses. Full control variables included child age, gender, multiple births, maternal age, maternal education, household income, family structure, not speaking English as the primary language at home, immigration status, and Aboriginal/Torres Strait Islander status, receiving the Child Care Benefit, and state of residence. In addition, we also controlled for maternal drinking and smoking during pregnancy, as well as maternal diabetes, and high blood pressure while pregnant.

### 2.3. Analytical plan

Multivariate regressions were used to estimate the relationship between indicators of prematurity (i.e. low birth weight status, degree of prematurity and small for gestational age status) and school readiness outcomes. First (model 1), each school readiness outcome was regressed on indicators of prematurity, adjusted for prenatal risks, social and demographic characteristics. Second (model 2), we built on our first statistical model and tested for potential interaction effects of preschool enrollment on school readiness. Because prior studies showed that the benefits of early interventions for children from socially and economically disadvantaged background, we also tested whether the aforementioned interaction effects are moderated by children's family background of maternal education, income, minority status (i.e., three-way interactions between indicator of prematurity, preschool attendance, and family socioeconomic background). All models controlled for potential confounding variables previously described and were properly weighted using the population weights provided by the survey. However, even with these controls and weights, we emphasized that this analysis was correlational and not causal; and caution should be used in interpreting the results. The following equations showed our model specifications:

$$School\ Readiness = \alpha + \beta Prematurity\ Indicator + \gamma coverivates + \varepsilon \quad (1)$$

$$School\ Readiness = \alpha + \beta Prematurity\ Indicator + \gamma coverivates + \delta interactions + \varepsilon. \quad (2)$$

## 3. Results

Table 1 provides weighted descriptive statistics for the 8060 children. Overall, of the 8060 children, 93% were term, 6% were moderate preterm, 1% were very preterm. With respect to birth weight, 94% were normal birth weight, 5% were moderately low birth weight, and 1% were very low birth weight. About 10% of the children were considered small for gestational age. The mean (sd) age of the child at the time of assessment was 57 (2.7) months old. About 70% had attended preschool. On average, children in the sample received 18 h of preschool education per week and have attended the program for approximately 10 months by the time of interview. The mean maternal age was 30.7 (5.4) years with 32% of children born to an immigrant mother and 3% to mothers with aboriginal or Torres Strait Islander status. Nearly one third of the mothers consumed alcohol, 20% smoked, 6% reported having diabetes, and 8% had high blood pressure. Social risks included 46% of mothers without a high school diploma, 13% in single-parent families, and 16% not speaking English at home.

Table 1 also includes school readiness scores of cognitive and behavioral skills. The average PPVT score was 64.45 and the average WAI score

**Table 1**
Descriptive statistics of maternal and child characteristics and school readiness.

| | Mean (SD) |
|---|---|
| Child characteristics | |
| Child age at the time of assessments (in months) | 57.30 (2.75) |
| Female | 0.49 |
| Multiple birth | 0.03 |
| Ever attended preschool | 0.70 |
| Hours of preschool attended | 18.27 (10.77) |
| Months of preschool attended | 10.94 (8.56) |
| Received child care benefit | 0.49 |
| Birth weight status | |
| Normal birth weight (>2.5 kg) | 0.94 |
| Moderately low birth weight (1.5–2.49 kg) | 0.05 |
| Very low birth weight (<1.5 kg) | 0.01 |
| Preterm birth | |
| Term (>37 wks) | 0.93 |
| Moderate prematurity (32–37 wks) | 0.06 |
| Very preterm (<32 wks) | 0.01 |
| Small for gestational age | 0.10 |
| Maternal and household characteristics | |
| Maternal age at birth (in years) | 30.66 (5.36) |
| Mother immigrant | 0.32 |
| Mother aboriginal status or Torres strait islander | 0.03 |
| Prenatal drinking | 0.32 |
| Prenatal smoking | 0.20 |
| Diabetes during pregnancy | 0.06 |
| High blood pressure during pregnancy | 0.08 |
| Average weekly household income | 1528 (1130) |
| Mother no high school | 0.46 |
| Single-parent family | 0.13 |
| Not speaking English at home | 0.16 |
| School readiness | |
| PPVT score[a] | 64.45 (6.22) |
| WAI score[b] | 64.69 (8.27) |
| SDQ: Pro-social scale[c] | 7.70 (1.79) |
| SDQ: Externalizing behaviors scale[c] | 2.38 (1.94) |

[a] PPVT = Peabody Picture Vocabulary Test.
[b] WAI = *Who Am I?*
[c] SDQ = Strength and Difficulties Questionnaire.

was 64.69. The mean pro-social scale was 7.70 and the mean externalizing behaviors scale was 2.38.

Table 2 presents the results from multivariate regression models relating three indicators of early childhood health to children's school readiness outcomes. Panel A shows results of birth weight status. Low birth weight status was negatively associated with cognitive outcomes in children. Very low birth weight children were rated 0.40 of a standard deviation lower ($B = -.40$, $p < .01$) on verbal (PPVT) cognitive school readiness skills even after accounting for a wide range of child and family background characteristics. Similarly, moderately low birth weight children were rated 0.23 of a standard deviation lower ($B = -.23$, $p < .001$), and very low birth weight children were rated 0.55 of a standard deviation lower ($B = -.55$, $p < .001$) on the nonverbal (WAI) cognitive school readiness skills. Panel B presents the results for gestational age. Among moderately preterm children, they scored 0.16 standard deviations lower ($B = -.16$, $p < .01$) in WAI scores. Among children surviving very preterm (<32 weeks gestation) births, their performance on nonverbal cognitive (WAI) skills of school readiness were 0.46 of a standard deviation lower ($B = -.46$ $p < .001$) than term peers. Among children who were small for gestational age (Panel C), they scored 0.1 standard deviations lower ($B = -.10$, $p < .05$) on verbal cognitive school readiness skills and were 0.09 standard deviations lower ($B = -.09$, $p < .05$) on nonverbal cognitive school readiness skills than appropriate-for-gestational-age peers. None of the estimates of behavioral outcomes measured by the SDQ were statistically significant for children in low birth weight, preterm, or small for gestational age groups.

Table 3 shows the impact of preschool participation on school readiness across the three indicators of prematurity and whether the relationship is moderated by family socioeconomic background such as low maternal education and poverty. Most of these interaction terms were not statistically significant. However, Panel C indicated that if small-for-gestational-age children from low-income family had participated in preschool, then they performed statistically significant higher ($p < .05$) on verbal cognitive school readiness skills than peers with similar socioeconomic background but not attending preschool.

Our results also showed that if low birth weight (either moderately low or very low) children with lower educated mothers participated in preschool, then they had higher rates of externalizing behaviors than their low birth weight peers who had low educated mothers but did not attend preschool. However, both coefficients were only marginally significant ($p < 0.1$). We also analyzed the impact of preschool participation on school readiness for children with moderate and very preterm gestation by maternal education and household income as well. As Panel B suggested, we found no statistically significant differences in cognitive and behavioral skills for children with moderate and very preterm status by family socioeconomic characteristics. These results suggest that though typically occurring preschool enrollment for disadvantaged premature children lessens their risk for not being ready, they do not fully catch up with their more advantaged peers by simply attending preschool.

## 4. Discussion

This study used newly available population-based prospective data of Australian children to examine the relationship between indicators of prematurity and school readiness outcomes. We found that on a population level low birth weight, preterm birth, and small for gestational age infants were more likely to have significantly lower performance on cognitive skills underlying school readiness. This finding is consistent with prior studies with clinical samples [6,12,30,34]. As these later skills involve both fine motor coordination and visual perceptual skills they are consistent with previous literature on very low birth weight and very preterm cohorts [35].

**Table 2**
Associations between indicators of prematurity and school readiness outcomes.

| | PPVT score[a] | WAI score[b] | SDQ[c]: Pro-social scale | SDQ[c]: Externalizing behaviors scale |
|---|---|---|---|---|
| *A: Birth weight* | | | | |
| (Ref: Normal birth weight) | −0.11 | −0.23*** | −0.03 | −0.02 |
| Moderately low birth weight (1.5–2.49 kg) | (0.06) | (0.05) | (0.06) | (0.06) |
| Very low birth weight (<1.5 kg) | −0.40** | −0.55*** | −0.12 | 0.15 |
| | (0.15) | (0.13) | (0.13) | (0.16) |
| Preschool attendance | 0.13*** | 0.24*** | −0.07 | 0.01 |
| | (0.03) | (0.03) | (0.04) | (0.03) |
| *B: Gestational age* | | | | |
| (Ref: Term) | −0.03 | −0.16** | −0.02 | −0.05 |
| Moderately preterm (32–37 wks) | (0.05) | (0.05) | (0.06) | (0.06) |
| Very preterm (<32 wks) | −0.16 | −0.46*** | −0.18 | 0.07 |
| | (0.09) | (0.09) | (0.10) | (0.10) |
| Preschool attendance | 0.13*** | 0.24*** | −0.07 | 0.01 |
| | (0.03) | (0.03) | (0.04) | (0.04) |
| *C: Small for gestational age* | | | | |
| (Ref: Appropriate for gestational age) | −0.10* | −0.09* | 0.06 | 0.07 |
| small for gestational age | (0.05) | (0.04) | (0.04) | (0.04) |
| Preschool attendance | 0.13*** | 0.24*** | −0.07 | 0.10 |
| | (0.03) | (0.03) | (0.04) | (0.03) |

*Note*: All regression analyses controlled for hours of preschool attendance each week, duration of preschool attendance, receiving child care benefit, child age at the time of assessments, gender, multiple birth, maternal age at child birth, maternal immigration status, aboriginal status or Torres Strait islander, prenatal drinking, prenatal smoking, diabetes during pregnancy, high blood pressure during pregnancy, average weekly household income, maternal education, family structure, not speaking English at home, and states.

[a] PPVT = Peabody Picture Vocabulary Test.

[b] WAI = *Who Am I?*

[c] SDQ = Strength and Difficulties Questionnaire.

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

We found that preschool enrollment in Australia was positively associated with cognitive skills of children at kindergarten entry. However, we did not find that the positive effect was more pronounced for premature infants from socially disadvantaged families. As such, while premature children benefit from preschool attendance, typical occurring early education program cannot completely compensate for the social and neurological disadvantages. This finding is similar to U.S. Infant Health and Development Program (IHDP)'s results at 3 years for both moderate and very low birth weight and at age 5 years for moderate low birth weight survivors [36–38].

In addition, we also found suggestive evidence that low birth weight children with low-educated mothers demonstrated more externalizing problem behaviors that were associated with their enrollment in preschool. Perhaps these regulatory competencies require more systematic earlier supports (such as curricula that provide parents with information and social supports, helps parents manage self-identified problems, and promotes positive parenting skills) as was done in the IHDP and in home visiting programs for preterm children in Ireland and recently in Norway [39–44]. While several early intervention programs targeting premature infants have sometimes shown better socioemotional and behavioral outcomes for program participants [37], our results were consistent with studies on typical preschool programs in the U.S. which have been found to be associated with small to modest increases in behavior problems [45,46].

In short, experimental and observational studies of early childhood education and more typical preschool programs generally show a strong positive association between program participation and children's cognitive development [46–48]. Evidence also shows that children from socially and economically disadvantaged backgrounds benefit substantially from attending preschool even though preschool programs cannot totally compensate for all aspects of social adversities [17,19,49]. Thus, like previous studies, we found benefits of preschool attendance on cognitive school readiness skills but our results did not demonstrate positive impacts of typically occurring early childhood education programs on all aspects of behavior and development.

Several limitations to our findings exist. First, the data used are non-experimental. Even with the large set of potential confounding child and family characteristics included, the results maybe still subject to concerns about omitted variable bias and selection and thus the findings cannot be interpreted as causal relationships. Second, the characteristics and quality of preschool program might be an influential determinant of school readiness outcomes. Given the limitations of the available data, we are unable to examine which component or characteristics of the preschool programs are the most critical to the developmental outcomes of children at biological risk. Third, our sample (despite nationally representative) include only approximately 1% of children with a gestational age of <32 weeks and with very low birth weight status. The sizes of theses subgroups of children may make us unable to detect the impacts of preschool enrollment on these children, and also limit the generalizability of our results to very low birth weight and very preterm children in Australia. However, we still feel confident that our other results are generalizable to the two recent cohorts of

**Table 3**
Moderating effects of preschool participation on prematurity-school readiness relationship.

| | PPVT score[a] | WAI score[b] | SDQ[c]: Pro-social scale | SDQ[c]: Externalizing behaviors scale |
|---|---|---|---|---|
| *A: Birth weight* | | | | |
| By maternal education | | | | |
| Moderately low birth weight × Preschool × Mother no high school | 0.30 | 0.07 | −0.03 | 0.40[†] |
| | (0.23) | (0.20) | (0.26) | (0.22) |
| Very low birth weight × preschool × Mother no high school | 0.23 | 0.62 | 0.20 | 0.93[†] |
| | (0.62) | (0.45) | (0.65) | (0.568) |
| By household income | | | | |
| Moderately low birth weight × Preschool × Bottom quintile income | −0.38 | −0.01 | 0.05 | 0.09 |
| | (0.26) | (0.25) | (0.25) | (0.29) |
| Very low birth weight × Preschool × Bottom quintile income | −1.34 | 0.99 | −0.66 | 0.25 |
| | (0.87) | (0.63) | (0.58) | (0.86) |
| *B: Gestational age* | | | | |
| By maternal education | | | | |
| Moderately preterm × Preschool × Mother no high school | −0.02 | 0.27 | 0.07 | 0.38 |
| | (0.23) | (0.21) | (0.27) | (0.24) |
| Very preterm × Preschool × Mother no high school | −0.26 | −0.21 | −0.33 | 0.48 |
| | (0.35) | (0.31) | (0.38) | (0.38) |
| By household income | | | | |
| Moderately preterm × Preschool × Bottom quintile income | −0.16 | −0.09 | 0.12 | 0.04 |
| | (0.32) | (0.26) | (0.43) | (0.33) |
| Very preterm × Preschool × Bottom quintile income | −0.35 | 0.09 | 0.20 | −0.43 |
| | (0.41) | (0.37) | (0.41) | (0.48) |
| *C: Small for gestational age* | | | | |
| By maternal education | | | | |
| Small for gestational age × Preschool × Mother no high school | 0.38[*] | 0.16 | 0.22 | 0.16 |
| | (0.19) | (0.15) | (0.18) | (0.15) |
| By household income | | | | |
| Small for gestational age × Preschool × Bottom quintile income | −0.28 | 0.08 | 0.33 | −0.25 |
| | (0.23) | (0.17) | (0.25) | (0.23) |

*Note*: All regression analyses controlled for hours of preschool attendance each week, duration of preschool attendance, receiving child care benefit, child age at the time of assessments, gender, multiple birth, maternal age at child birth, maternal immigration status, aboriginal status or Torres Strait islander, prenatal drinking, prenatal smoking, diabetes during pregnancy, high blood pressure during pregnancy, average weekly household income, maternal education, family structure, not speaking English at home, and states.

[a] PPVT = Peabody Picture Vocabulary Test.

[b] WAI = *Who Am I?*

[c] SDQ = Strength and Difficulties Questionnaire.

[†] $p < 0.10$.

[*] $p < 0.05$.

general population of Australian children. Future studies are definitely needed to investigate the relationship between preschool enrollment and school readiness for very premature and/or very low birth weight children.

Finally, school readiness measures, particularly the PPVT, may underestimate children's cognitive skills, particularly among children whose home language is not English since the PPVT is a language-based assessment instead of a general assessment of cognitive skills. Our coefficients of home language and cognitive school readiness skills (not shown) are consistent with this idea. We observed a strong negative association between not speaking English at home and PPVT but a small positive association between not speaking English at home and WAI. Thus, our measures of children's school readiness are not purely objective. Caution should be used in interpreting our results for children from non-English speaking households.

Currently, there are only a few nationally-representative data sets that capture information on early childhood health, child care experiences, and early education and include measures of school readiness around the world. However, data from several on-going birth cohort surveys will be available in the next few years [50–53]. Overall, these new nationally-representative data sets will further help inform policies and programs to address the developmental needs of children who are born prematurely in an era of scarce resources and from a comparative approach.

To conclude, this study makes several important contributions. First, we found that low birth weight status, preterm birth status, and small for gestational age status were strongly associated with cognitive school readiness. This association remained statistically significant with the inclusion of a wide range of prenatal and social risk factors. Second, in the Australian context, preschool enrollment did not guarantee success in all areas of development for low birth weight, preterm, and small for gestational age children from socially disadvantaged background. Children born prematurely improved in school readiness after preschool attendance but did not fully catch up with normal peers.

From a policy standpoint, this suggests that typically occurring preschool enrollment at aged 4–5 years may not be a substitute for intensive early childhood interventions that aim to promote communication, learning, behavioral regulation and social skills of preterm, low birth weight, and small for gestational age children. An important finding is that among small for gestational age children with low educated mothers, preschool enrollment substantially increased cognitive school readiness skills. More research is needed to identify which component and characteristics of preschool experiences are responsible for these outcomes across the diversity of premature children. In this way, our efforts at prevention and management can be analyzed so that access to prenatal, neonatal, and postnatal neuroprotection with respect to cognitive and social emotional competencies occurs across diverse social and cultural contexts.

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