



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



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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.

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## 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?.

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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

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