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Risk Factors Affecting School Readiness in Premature Infants With Respiratory Distress Syndrome

Athena I. Patrianakos-Hoobler, MD[a], **Michael E. Msall, MD**[a], **Jeremy D. Marks, MD, PhD**[a], **Dezheng Huo, PhD**[b], and **Michael D. Schreiber, MD**[a]

[a] Department of Pediatrics, University of Chicago, Chicago, Illinois

[b] Department of Health Studies, University of Chicago, Chicago, Illinois

Abstract

OBJECTIVE—Advances in neonatal care have resulted in children born pre-maturely with respiratory distress syndrome (RDS) successfully reaching school age. It is unknown how many will be ready for school and what factors affect school readiness in these children at high risk. Our objective was to assess readiness of children born prematurely with RDS in the last decade for entry into public school, and determine risk factors associated with lack of school readiness in this population.

METHODS—This was a single-center prospective cohort study. Follow-up data were collected for 135 of 167 (81%) surviving premature infants with RDS requiring surfactant-replacement therapy and mechanical ventilation. The children were seen between July 2005 and September 2006 (average age: 5.7 ± 1.0 years) and underwent standardized neurodevelopmental and health assessments and socioeconomic status classification. A 4-level school-readiness score was constructed by using each child's standardized scores on assessments of basic concepts (Bracken School-Readiness Assessment), perceptual skills (Visual-Motor Integration Test), receptive vocabulary (Peabody Picture Vocabulary Test, Third Edition), daily living functional skills (Pediatric Functional Independence Measure), and presence of sensory impairments or autism. Proportional odds models were used to identify risk factors predicting lower school-readiness levels.

RESULTS—Of the children examined, the mean birth weight was 1016 ± 391 g, and the mean gestational age was 27.5 ± 2.6 weeks. Ninety-one (67%) children were school-ready. Using multivariate analysis, male gender, chronic lung disease, and severe intraventricular hemorrhage or periventricular leukomalacia were associated with lower school-readiness levels. However, the most powerful factor determining school-readiness level was low socioeconomic status.

CONCLUSION—Interventions targeting neonatal morbidities may be much less effective at improving overall performance at school age compared with the effect of the impoverished social environment.

Keywords

chronic lung disease; developmental outcome; intraventricular hemorrhage; kindergarten readiness; neurodevelopmental outcome; periventricular leukomalacia; prematurity; respiratory distress; school-age follow-up; social disadvantage; socioeconomic status; very low birth weight

Address correspondence to Michael D. Schreiber, MD, University of Chicago, 5721 S Maryland Ave, MC 8000, Chicago, IL 60637. mschreiber@peds.bsd.uchicago.edu.

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WHAT'S KNOWN ON THIS SUBJECT

Premature infants are at increased risk for abnormal neurodevelopmental outcomes at 2 years' postconceptional age. It is not known what factors increase the risk that these infants will be unready to enter school at an appropriate age.

WHAT THIS STUDY ADDS

Using a multidimensional assessment in a school-aged cohort of premature infants, we identify risk factors for lack of school readiness. Low socioeconomic status increases the risk of lower school-readiness levels far more than bronchopulmonary dysplasia or severe IVH/PVL.

In comparison with term children, infants having birth weights of <2000 g have increased risks of adverse neurodevelopmental outcomes, including cerebral palsy (CP), impaired cognition, blindness, and deafness.[1–6] Assessments of neurodevelopmental outcomes have been routinely performed at corrected ages of 1 to 2 years. The developmentally limited repertoire of behaviors in these infants necessarily restricts assessments of higher-level cognition, communication, and motor coordination employed during later development.[7] Thus, results of neurodevelopmental assessments performed at 2 years of age may not reliably predict performance in later childhood.[8–10] Impairments of motor function and cognition, detected at 2 years of age, may be transient, such that some children are able to catch-up by early school age.[11–13] In contrast, children in which CP is not found at age 2 may subsequently exhibit CP.[11,12] Finally, subtle cognitive problems may not be detectable until school age, when the complexity of cognitive and adaptive demands increase markedly in academic and social spheres.[14,15]

The goal of the present study was to assess school readiness at 5 to 6 years of age in a cohort of infants having birth weights of <2000 g with moderate respiratory distress syndrome (RDS),[16] and to identify the risk factors associated with lack of school readiness. We defined school readiness as preparedness to learn to read, write, follow directions, interact socially, and function independently in activities of daily living. Disorders in these domains have been associated with increased risk for grade repetition, need for special education, and academic underachievement.[17,18]

PATIENTS AND METHODS

Study Population

The study population consisted of school-aged survivors from a cohort of 207 patients with RDS requiring surfactant-replacement therapy and mechanical ventilation. Data for this study were obtained between July 2005 and September 2006. The protocol was approved by the institutional review board of the University of Chicago. Informed consent was obtained from all parents.

Neonatal Course

Each child's birth weight, gestational age, Apgar scores, and neonatal clinical course were obtained from a research database populated during the infant's initial hospitalization, as was the presence of chronic lung disease (CLD) (oxygen requirement at 36 weeks' postconceptional age), severe intraventricular hemorrhage (IVH) (grade III and IV), periventricular leukomalacia (PVL), necrotizing enterocolitis, sepsis, and multiple gestation.

Follow-up Assessments

Children and families were assessed in a single visit. Caretakers completed questionnaires regarding race, their child's need for special education services, and ongoing morbidities. We classified ongoing morbidities as none/mild (eg, allergies, eczema), chronic (eg, failure to thrive, asthma on controller medication), or multiple chronic morbidities/technology dependence (eg, ventriculo-peritoneal shunt, gastrostomy tube).

Information on socioeconomic status and the child's functioning and behavior was collected using standardized instruments. Socioeconomic status was determined by using the Hollings head Index of Social Position (ISP),[19] a 2-factor index based on the head of household's highest educational attainment and current occupation. Independent functioning was determined by using the Pediatric Functional Independence Measure (WeeFIM),[20] an 18-item instrument measuring performance in essential daily functional skills across the domains of self-care, mobility, and cognition. Behavior was assessed using the National Initiative for Children's Healthcare Quality Vanderbilt Parent Assessment Scale,[21] a screen for common pediatric behavioral disorders including inattentiveness and hyperactivity related to attention-deficit/hyperactivity disorder, oppositional-defiant disorder, conduct disorder, anxiety, and depression. Children were classified as having any of the above disorders according to the scoring instructions of the Vanderbilt Scale.

Children were evaluated by a pediatrician and/or a developmental and behavioral specialist unaware of the children's perinatal history at the University of Chicago Hospitals, La Rabida Children's Hospital (Chicago, IL), or by home visit. Children underwent a detailed physical and neurologic examination. Children with abnormalities of tone and posture were classified as having a CP syndrome, and the Gross Motor Function Classification System (GMFCS)[22] level was assigned (level 1: mild; levels 2–3: moderate; levels 4–5: severe-profound).

All children underwent a battery of developmental assessments: the Bracken School-Readiness Assessment[23] evaluated understanding of foundational concepts in the categories of colors, letters, numbers, sizing, comparisons, and shapes. The Peabody Picture Vocabulary Test, Third Edition (PPVT-III)[24] assessed receptive vocabulary. The Beery Test of visual-motor integration (VMI)[25] assessed the ability to copy geometric forms. Raw scores were converted to standard scores (mean: 100; SD: 15). To identify autism, children with developmental delay in communication, concepts, and/or behavior were administered the Childhood Autism Rating Scale.[26]

Use of a hearing aid constituted the criterion for hearing loss. Children with hearing aids who were unable to communicate were presumed deaf. Visual acuity was assessed with Lea symbols.[27] Children with corrected visual acuity between 20/60 and 20/200 were considered visually impaired, and children with acuity worse than 20/200 were considered blind.

School-Readiness Assessment

School-readiness levels were derived from scores on the WeeFIM, Bracken School-Readiness Assessment, PPVT-III, and Beery Test of VMI. Using these scores and the presence of sensory or motor impairment, children were assigned to 1 of 4 levels of school readiness (Table 1).

We categorized children scoring >85 on all assessments, or scoring 70 to 85 on only 1 assessment, as level 4 (ie, school-ready). Children scoring 70 to 85 on no more than 2 assessments were level 3 (ie, also school-ready, but less ready than children in level 4). These children did not have either impairments in multiple domains or mental retardation that would render them unready for school. We categorized children scoring 70 to 85 on ≥3 assessments as level 2; these children had impairments in multiple domains, and therefore, were not school-ready. Children scoring <70 on any single assessment were also categorized as level 2; these

children had mental retardation or severe communicative, perceptual, or adaptive developmental disorders. We categorized children with deafness, blindness, or an inability to speak as level 1 (ie, also not school-ready). Children with severe autism (score of >36, and moderately severe abnormal ratings on 3 of the 5 subscales of the Childhood Autism Rating Scale) were also categorized as level 1.

Statistical Analysis

We assessed the roles played by demographics, socioeconomic status, and neonatal morbidities in predicting the level of school readiness using proportional odds models.[28] We examined each factor in a univariate analysis. Factors with a *P* value of < .15 in the univariate analysis were included in subsequent multivariate models. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated from the proportional odds model as the estimate of the strength of association. A *P* value of ≤ .05 was considered statistically significant.

RESULTS

Patient Population

Data were obtained for 135 of the 167 (81%)surviving children at a mean age of 5.7 years (SD: ±1 year). Thirty-two children were lost to follow-up. For the 5 children who could not be seen, we administered the parent questionnaire, the WeeFIM, and the Vanderbilt Scale by telephone. With this information, school-readiness levels were easily assigned. One child was reported to be blind (level 1). From recent medical charts, a second child had documented global developmental delay (level 1). Two children were reported to have CP, and, using directed questioning, were assigned GMFCS levels of 1 and 3. These children were classified as school-readiness level 2. The fifth child was in kindergarten without special services and, based on reports of parent and teacher, was classified as level 4.

Maternal demographic factors and infant birth data are presented in Table 2. The mean birth weight was 1016 g (SD: ±391 g), and the mean gestational age was 27.5 weeks (SD: ±2.6 weeks). There were no significant differences between the birth weights (1136 ± 380 g; *P* = .12) and gestational ages (27.9 ± 2.7 weeks; *P* = .44) of the infants who were lost to follow-up compared with those in the study. The majority of children (58%) came from families classified by the Hollingshead Index of Social Position as lowest socioeconomic status (levels 4 and 5). Only 12% of children came from families with highest social position (levels 1 and 2).

School-Readiness Outcomes

Children who were ready for school (level 3 and 4) constituted 67% of the cohort (Fig 1). Of the children who were scored as not ready for school, 37% were classified as having the lowest school-readiness level (level 1).

We next asked whether epidemiologic factors contributed to lack of school readiness. Gender,[15,29–35] maternal nonwhite race,[31,33,34] and birth weight[4,10,31,34,36,37] adversely affect neurodevelopmental outcome. In our study, boys had more than 2 times the odds of having a lower school-readiness level compared with girls (Table 3). Infants born to black mothers were at a similar disadvantage compared with infants born to nonblack mothers (Table 3). The differences in mean birth weights of children grouped by school-readiness levels were not statistically significant (*P* = .11).

We then asked to what extent an infant's neonatal course and ongoing morbidities at follow-up determined lack of school readiness. Prolonged postnatal steroid treatment has been associated with abnormal neurodevelopment.[35,38–40] In our study, dexamethasone was the only systemic cortico-steroid used. No significant difference in school-readiness levels was

observed between children exposed to prolonged postnatal dexamethasone (>7 days) and those not receiving prolonged dexamethasone (Table 4).

CLD[4,8,35,41,42] and the presence of severe IVH/PVL[4,8,29,34,35,37,42–44] adversely affect neurodevelopment. In this study, infants with CLD or severe IVH/PVL were >2½ times more likely to have lower school-readiness levels (Table 4). Because chronic illness may slow physical and intellectual development, we assessed the role played by ongoing morbidities. As the number of ongoing morbidities increased, the likelihood of lower school-readiness levels increased. The odds of having lower school-readiness levels increased approximately threefold in children classified as having 1 chronic morbidity, while increasing 11-fold in children with multiple chronic morbidities or technology dependence (Table 4).

Lower socioeconomic status has been linked to decreased cognition at 2 years of age and during kindergarten.[4,5,8,10,30,31,33,43,45] To assess the role of socioeconomic class and school-readiness levels, we classified families by Hollings head ISP scores and compared school-readiness levels of upper class families (levels 1 and 2) with each of the other ISP scores. Overall, worse ISP scores were significantly associated with increased odds of having lower school-readiness levels ($P = .003$). Most strikingly, children from ISP class 5, the lowest socioeconomic class, had a more than four fold increased likelihood of having lower school-readiness levels compared with children from ISP class 1–2 (Table 5).

Receiving early intervention (EI) services might be expected to improve functional outcomes. Furthermore, access to EI may depend on socioeconomic class. Accordingly, we asked whether receipt of EI depended on socioeconomic status. All infants were referred for EI, and 86% received it. Children who received EI and were more socially advantaged (ISP class 1–3) were more likely to be school-ready than children who received EI and were less socially advantaged (OR: 2.74 [95% CI: 1.30–5.74] $P = .008$). Only 19 children did not receive EI; whether a child received EI was not dependent on social position ($P = .94$).

To understand which of the risk factors identified by univariate analysis were independent, we performed serial multivariate analyses, whereby a multivariate model was sequentially pruned of variables found not to be significant. The presence of chronic morbidities was not employed in the multivariate model, because it was measured at the same time as school readiness. In the first model, we considered birth weight, race, gender, ISP level, CLD, and IVH/PVL. Subsequent iterations removed birth weight and race for lack of significance. The final model, therefore, included as significant factors gender, CLD, IVH/PVL, and Hollingshead ISP (Table 6). In this model, socioeconomic class played the most significant role, with children in ISP level 5 having a greater than sevenfold increased likelihood of having lower school-readiness levels compared with children in ISP level 1–2.

DISCUSSION

In this follow-up study of school-aged children who were premature infants with RDS and treated with surfactant-replacement therapy, we used historical, physical, and neurodevelopmental assessments to measure readiness for entry into public school and the risk factors determining lack of school readiness. Male gender, CLD, and severe IVH/PVL, factors well-known to predispose to abnormal neurodevelopment, constituted risks for lower school-readiness levels. However, decreased socioeconomic class constituted the strongest barrier to achieving school readiness.

Assessing intercenter differences in neurodevelopmental outcome of extremely low birth weight premature infants at 18 to 22 months of age, Vohr et al[46] found that the use of postnatal steroids and increased duration of mechanical ventilation increased rates of neurodevelopmental impairment. We also found that longer duration of ventilatory support

was associated with decreased school-readiness levels. However, after adjusting for CLD in a multivariate analysis, duration of ventilatory support was not an independent risk factor. In addition, having a prolonged postnatal dexamethasone course was not associated with lack of school readiness. However, the small number of children receiving prolonged postnatal steroids (15 of 135 infants) is likely too small to detect significant differences.

A child's readiness for school requires age-appropriate physical, behavioral, communicative, visual, motor, and conceptual skills. Accordingly, in designing our assessment of school readiness, we used a multidimensional battery of well-validated cognitive, language visual-motor, functional, and behavioral assessments, supplemented with diagnoses of CP and sensory impairment, to assign school-readiness levels. Children scoring between 1 and 2 SDs below the mean on ≤2 measures (level 3) have been considered to have minor impairments and may need special education services.[17] Accordingly, we considered these children ready for school but at an increased disadvantage compared with their peers. Children unable to perform better than 2 SDs below the mean in any of the measures employed (level 2), as well as those having significant sensory or motor impairment (level 1), clearly cannot participate in the regular classroom.

Neurodevelopmental follow-up studies of preterm infants at school age have used full-scale IQ scores or disability diagnoses (CP, blindness, deafness) as primary outcome variables.[15,47,48] However, preterm infants are at increased risk for learning disabilities,[45] which by current definition occur in the setting of normal IQ scores.[49,50] Children having learning disabilities require special education services,[51] and these needs will not be identified by standard IQ assessments alone. A school-readiness evaluation, such as ours, that assesses performance in these domains more completely describes a child's overall learning ability. Our assessment distinguishes important, subtle, functional delays leading to poor school performance. Future long-term neurodevelopmental follow-up studies may benefit from adding multidimensional school-readiness evaluations to standard assessments of IQ and disability.

The ability to perform MRI in premature children has allowed for a better understanding of brain development and the potential contribution to long-term adverse outcome in this vulnerable population. By using MRI, Peterson[52] measured regional brain volumes in 8-year-old children who were preterm and term infants who had their IQ measured. In the brain regions of preterm infants where the greatest abnormalities in regional brain volumes were observed, the degree of abnormality correlated with IQ,[52] suggesting a contribution of morphologic abnormality to functional outcome. It is conceivable that school-readiness levels correlate similarly with regional brain volume abnormalities.

By using functional MRI, Ment et al[53] demonstrated that, at 8 years of age, preterm boys who received indomethacin in the NICU may demonstrate improved phonologic processing compared with saline-treated boys, and comparable with boys born at term. In our study, all infants with birth weights <1250 g received prophylactic indomethacin. To the extent that this subtle improvement in linguistic processing may improve performance on the school-readiness tests we employed, school-readiness levels of those males in our study who received prophylactic indomethacin may have been improved. However, the profound effects we observed of low socioeconomic status on school readiness are likely to dwarf any possibly beneficial effect of indomethacin.

A school-readiness measure has, to our knowledge, been employed in only 1 previous study, in which risk factors associated with need for special education services in kindergarten were assessed in premature infants (23–28 weeks' gestation).[17] This retrospective cohort study defined kindergarten-readiness as having no major impairments or no more than 1 minor impairment. In this population, only 35% of children were considered kindergarten-ready,

consistent with the study being performed before the routine use of surfactant and antenatal steroids. Interestingly, neither IVH nor CLD was found to be a significant risk factor for lack of kindergarten readiness. Nonetheless, socioeconomic class was found to be as powerful a predictor of lack of kindergarten-readiness as in the present population.

We found that the strongest risk for decreased school-readiness levels was low socioeconomic status. Although where a child received early intervention was independent of socioeconomic status, it is unclear whether the detrimental effect of socioeconomic status is related to the quality of early intervention received or the social milieu of impoverished families. Impoverished families are at higher risk for parents with decreased education,[31,54–59] having a single parent household,[58,60] having decreased access to resources,[60–62] poor nutrition,[59,63–65] and increased psychological distress.[66,67] These factors likely contribute to impoverished environments for child development, including a low stimulation environment,[68,69] impoverished oral language exposure,[57,60,68] and decreased exposure to cognitively stimulating materials,[62,67,70] factors potentially affecting neurodevelopmental outcome. To the extent that families in our study in the lowest socioeconomic stratum are similarly at risk, our data demonstrate that this social environment conspires to retard cognitive and functional development to a far greater extent than physical morbidities acquired as a result of prematurity or its complications.

We found that 33% of school-aged children born prematurely with RDS were, in fact, not ready for school and 15%, although ready, were at risk for needing special education. How do these statistics compare to the general population? To our knowledge, no information is systematically compiled by public school districts on school readiness of children entering kindergarten. Therefore, a direct comparison of our cohort with the general population is not possible. Similarly, without a term control group matched for socioeconomic status, we are unable to assess whether decreased socioeconomic status plays as significant a role in determining school readiness in term infants.

CONCLUSIONS

In the current era of neonatology, an adverse socioeconomic environment increases the risk that a child born prematurely will not be prepared to enter school on time. This risk is disproportionately high among children who live in poverty. Our findings demonstrate the risk of neonatal morbidities in determining school readiness. However, decreased socioeconomic status plays a far greater role in determining school readiness than these biomedical risks. Consequently, interventions targeting neonatal morbidities are likely to be less effective at improving school readiness in the setting of an impoverished socioeconomic environment.

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ABBREVIATIONS

CI
: confidence interval

CLD
: chronic lung disease

CP
cerebral palsy

EI
early intervention

GMFCS
Gross Motor Function Classification System

IVH
intraventricular hemorrhage

ISP
Index of Social Position

OR
odds ratio

PPVT-III
Peabody Picture Vocabulary Test Third Edition

PVL
periventricular leukomalacia

RDS
respiratory distress syndrome

VMI
visual-motor integration

WeeFIM
Pediatric Functional Independence Measure

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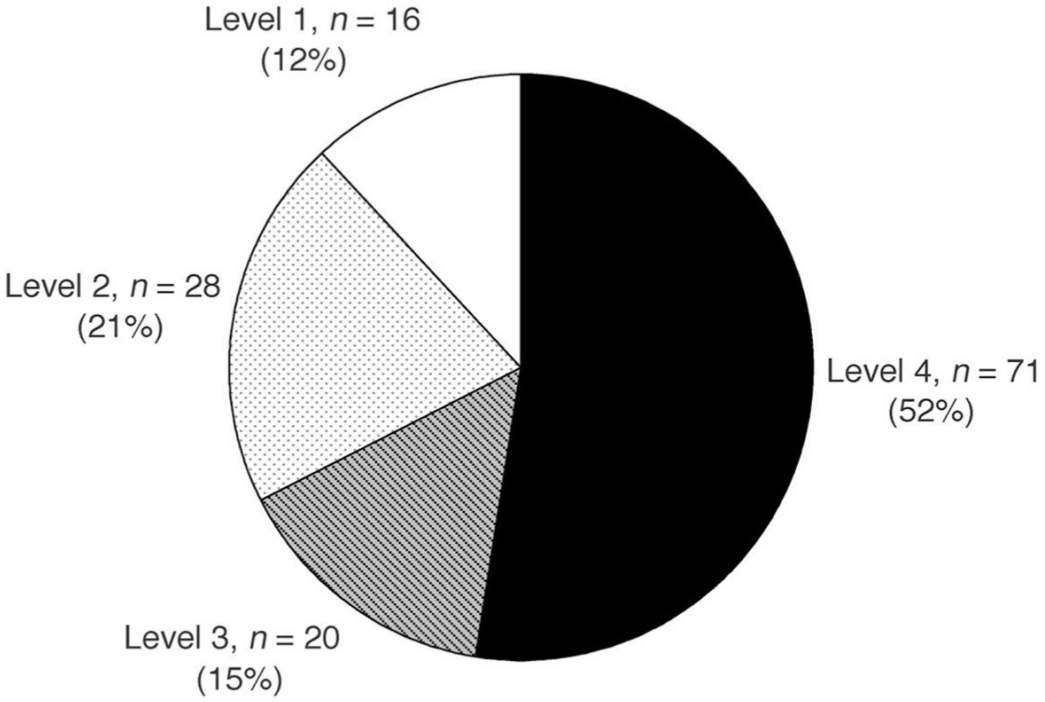

FIGURE 1.
Distribution of school-readiness levels.

TABLE 1
Classification of School Readiness (Highest to Lowest)

School-ready	
Level 4	No more than 1 developmental assessment score between 70 and 85
Level 3	No more than 2 developmental assessment scores between 70 and 85
Not school-ready	
Level 2 (1 of the following)	3 developmental assessment scores between 70 and 85
	1 test developmental assessment score 370
	Visual impairment
	Hearing impairment
	CP: GMFCS level 1–3 (mild-moderate)
Level 1 (1 of the following)	Bracken score 350
	Blindness
	Deafness
	CP: GMFCS level 4–5 (severe-profound)
	Autism

Developmental assessments: WeeFIM, Bracken School-Readiness Assessment, PPVT-III, and Beery Test of VMI.

TABLE 2

Demographics and Clinical Characteristics

Mean birth weight, g (±1 SD)	1016 ± 391
Gestational age, wk	27.5 ± 2.6
Male, *n* (%)	67 (50)
Race (identified by maternal report), *n* (%)	
Black	95 (70)
White	23 (17)
Hispanic	16 (12)
Other	1 (1)
Hollingshead ISP, *n* (%)	
Levels 1–2	16 (12)
Level 3	41 (30)
Level 4	37 (27)
Level 5	41 (31)
1-min Apgar score, median (interquartile range)	5 (4–6)
5-min Apgar score, median (interquartile range)	7 (6–8)
Ventilator type, *n* (%)	
Conventional	69 (51)
High-frequency oscillatory ventilation	66 (49)
Corticosteroids, *n* (%)	
Antenatal	78 (59)
Postnatal (>7 d)	15 (11)
CLD, *n* (%)	63 (47)
Severe IVH/PVL, *n* (%)	23 (17)

TABLE 3

Intrinsic Factors and School Readiness

Risk Factor	School-Readiness Levels				OR (95% CI)	*P*
	4 (*N* = 71)	**3 (*N* = 20)**	**2 (*N* = 28)**	**1 (*N* = 16)**		
Birth weight, mean ± SD, g	1046 ± 426	1135 ± 298	937 ± 387	871 ± 282	—	
Per 100-g increment	—	—	—	—	0.92 (0.86–1.02)	.11
Gender, *n* (%)						
Male	28 (42)	14 (21)	13 (19)	12 (18)	2.19 (1.15–4.21)	.02
Female	43 (63)	6 (9)	15 (22)	4 (6)	—	
Maternal race, *n* (%)						
Black	44 (46)	15 (16)	24 (25)	12 (13)	2.29 (1.08–4.87)	.03
Nonblack	27 (68)	5 (13)	4 (10)	4 (10)	—	

TABLE 4

Neonatal Morbidities, Chronic Disease Burden, and School Readiness

Risk Factor	School-Readiness Levels				OR (95% CI)	*P*
	4 (*N* = 71)	**3 (*N* = 20)**	**2 (*N* = 28)**	**1 (*N* = 16)**		
Severe IVH/PVL, *n* (%)						
Yes	7 (30)	6 (26)	4 (17)	6 (26)	2.61 (1.15–5.94)	.02
No	64 (57)	14 (13)	24 (21)	10 (9)	—	
CLD, *n* (%)						
Yes	26 (41)	10 (16)	15 (24)	12 (19)	2.53 (1.32–4.85)	.005
No	45 (63)	10 (14)	13 (18)	4 (6)	—	
Postnatal steroids (>7 d), *n* (%)						
Yes	6 (40)	1 (7)	4 (27)	4 (27)	2.34 (0.84–6.51)	.10
No	63 (53)	19 (16)	24 (20)	12 (10)	—	
Ongoing morbidities, *n* (%)						
None/mild	55 (63)	14 (16)	14 (16)	4 (5)	1.0	<.001
Chronic	14 (39)	5 (14)	11 (31)	6 (17)	3.04 (1.44–6.40)	
Multiple chronic/technological dependence	0 (0)	1 (9)	3 (27)	5 (45)	11.7 (3.32–41.0)	

TABLE 5

Socioeconomic Status and School Readiness

Risk Factor	School-Readiness Levels				OR (95% CI)	*P*
	4 (*N* = 71)	**3 (*N* = 20)**	**2 (*N* = 28)**	**1 (*N* = 16)**		
Hollingshead ISP						
Level 1–2	12 (75)	1 (6)	2 (13)	1 (6)	1.0 (reference)	.003
Level 3	27 (66)	5 (12)	4 (10)	5 (12)	1.56 (0.43–5.68)	
Level 4	14 (38)	11 (30)	10 (27)	2 (5)	3.30 (0.94–11.6)	
Level 5	18 (44)	3 (7)	12 (29)	8 (20)	4.42 (1.24–15.8)	

TABLE 6

Risk Factors for Lack of School Readiness: Multivariate Analyses

Risk Factor	All Variables		Without Birth Weight		Without Race and Birth Weight	
	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Birth weight, per 100 g	0.95 (0.86–1.06)	.36	—		—	
Maternal race						
Black vs nonblack	2.11 (0.88–5.02)	.093	2.18 (0.91–5.19)	.079	—	
Male gender	2.30 (1.10–4.78)	.026	2.09 (1.03–4.24)	.04	2.09 (1.04–4.20)	.04
Hollingshead ISP						
Level 1–2	1.00 (reference)	.008	1.00 (reference)	.007	1.00 (reference)	.001
Level 3	1.90 (0.47–7.70)		1.93 (0.47–7.94)		2.32 (0.58–9.36)	
Level 4	3.37 (0.85–13.4)		3.31 (0.82–13.3)		4.50 (1.16–17.4)	
Level 5	5.10 (1.24–21.0)		5.25 (1.25–21.9)		7.63 (1.92–30.4)	
CLD	2.23 (1.02–4.89)	.045	2.62 (1.29–5.32)	.007	2.39 (1.19–4.79)	.01
Severe IVH/PVL	2.61 (1.03–6.61)	.044	2.71 (1.07–6.86)	.035	2.54 (1.01–6.36)	.05