Predictive Value of the Global School Adaptation Questionnaire at 5 Years of Age and Educational Support at 7 Years of Age in Very Preterm Children

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Objective To assess the Global School Adaptation (GSA) questionnaire of children's abilities and classroom behavior administered to teachers of very preterm children at 5 years of age as a predictor of the need for educational support (grade retention, special class, learning support) at age 7.

Study design We assessed 858 very preterm children (<33 weeks of gestation) at 5 years of age using the GSA and again at 7 years to determine the use of educational support. We examined the association between the GSA score and educational support at 7 years and performed a receiver operating characteristic curve analysis.

Results At 7 years of age, 130 children had educational support (15.2%). Children with a nonoptimal GSA score (<45) at 5 years required educational support more often (57.7%) than children with a GSA score of 45 or greater (15.4%) (OR, 7.5; 95% CI, 5.02-11.21). The need for educational support was associated with male sex; a low parent socioeconomic level; lower birth weight, birth head circumference, or gestational age (28-30 weeks of gestation); severe neurologic complications; patent ductus arteriosus ligation; and the use of therapy services at 5 years of age. After adjustment, only the GSA score was associated with educational support at 7 years of age (OR, 0.86; 95% CI, 0.84-0.88). A receiver operating characteristic curve analysis of the GSA performance revealed an optimal cut-off at 48, with a sensitivity of 70.8%, a specificity of 73.5%, and an area under the curve of 0.79.

Conclusions Using a cut-off score of 48, the GSA at 5 years of age may be a useful tool to identify children born preterm at risk of school-based learning difficulties. *(J Pediatr 2020;226:129-34)*.

The long-term consequences of prematurity include behavioral and cognitive impairments that may manifest at school age as learning disabilities.[1,2] Compared with children born at term, late and moderate preterm children (32-36 weeks of gestational age) are at increased risk for requiring special education and have a higher frequency of grade retention before 10 years of age.[3] All learning domains are affected, namely reading, spelling, and especially mathematics, even in the absence of cognitive impairments.[4-7] Furthermore, behavioral impairments in children born preterm may impact school-aged social adaptation.[8]

Whereas cognitive ability and language delay are well-established predictors of academic achievement, a more comprehensive evaluation is necessary to identify children who are at high risk for difficulties at school age.[7,9,10] Disorders such as attentional hyperactivity, executive dysfunction, and behavioral regulation are frequent and impact school performance.[11-13] The effects of these problems optimally need to be assessed in a classroom environment.

Little is known about which preschool cognitive assessments predict the need for educational support at school age. However, teachers' assessments from kindergarten to third grade have been reported to predict subsequent school achievement.[14] That study was not specific to preterm children and there are few teacher-based behavioral questionnaires that have been used in preterm children at early school age. The Global School Adaptation (GSA) questionnaire was devised to explore the behavioral abilities of children in the classroom and it was specifically designed to be used by teachers.[15] A previous study found that assessments with the GSA correlated with intelligence quotients in a cohort of very preterm children.[16]

The objective of the present study was to investigate to what extent evaluations by teachers of 5-year-old children using the GSA questionnaire can predict educational support at 7 years in children born very preterm who were included in the Loire Infant Follow-up Team (LIFT) cohort.

Methods

This study included all surviving infants born between September 2006 and December 2011 at a gestational age of less than 33 weeks who were enrolled in

AUC	Area under the curve
GSA	Global School Adaptation
LIFT	Loire Infant Follow-Up Team

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LIFT cohort.[17] The LIFT network includes 24 maternity clinics and 3 neonatal intensive care units. The goal of the LIFT network is to screen for early clinical problems and to provide patient-specific care. A standard assessment takes place at 3, 9, 12, 18, and 24 months and 3, 4, 5, and 7 years of age. The LIFT cohort is registered with the French data protection authority in clinical research (Commission Nationale de l'Informatique et des Libertés or CNIL, No. 851117). The study received a favorable assessment from the relevant ethics committee (GNEDS, Groupe Nantais d'Ethique dans le Domaine de la Santé). Written consent was obtained from the parents of each child before inclusion.

The following perinatal, neonatal, and social characteristics were collected during the neonatal period: antenatal corticosteroid therapy, multiple pregnancy, mode of delivery, the child's sex, gestational age (categorized as 24-27, 28-30, and 31-32 weeks gestational age), the birth weight Z-score computed according to the Olsen standards, intubation at birth, severe neurologic complications (grade 3-4 intraventricular hemorrhage or periventricular leukomalacia), ligation of the patent ductus arteriosus, and breastfeeding at discharge.[18] The socioeconomic data consisted of the socioeconomic level and eligibility for social security benefits for those with low incomes. The socioeconomic level was categorized using a scale based on the official classification developed by the French National Institute for Statistics and Economic Studies. At 5 years of age, the parents' marital status was rated as either living together or living separately. At 5 and 7 years of age, the parents were asked whether educational supports were needed in addition to therapy services. At each visit, the referring pediatricians performed a neurodevelopmental assessment that included a physical examination as well as an evaluation of learning reading, spelling, and numeracy achievements. Children who already received educational support at 5 years of age were excluded from the analysis.

The GSA score was originally defined as a tool for use by teachers to assess children's abilities and behavior in the classroom.[15,19] At 5 years of age, the questionnaire was given to parents of children followed through the LIFT network, who then forwarded it to the teachers. Six questions investigate linguistic competence (school conversation, participation, pertinence, vocabulary, syntax and pronunciation, and understanding), and 5 questions investigate nonverbal abilities (memory, arithmetic, the capacity for logic, manual ability, and gross motor coordination) (**Appendix**; available at www.jpeds.com). Eight questions pertain to behavior in the classroom (respect of classroom rules, attention, independence when faced with a task, speed of task execution, work organization, self-confidence, the ability to keep up with the pace of the classroom, and tiredness). The final question asks the teacher to provide their prognosis for the child's future adaptation to school life. The answer to each question was assigned a score between 1 and 3, with higher values representing better abilities. The total score was calculated by adding the points from the 20 questions (range of potential scores, 20-60). A higher score corresponds with better adaptation by the child to school life. The threshold value for a positive evaluation of a child's adaptation to school life was previously defined as a score of greater than 45.[16]

Educational support at 7 years of age was defined as participation in a mainstream class with grade retention, in a special school or class, or in a mainstream class with learning support (a learning support assistant), a school specialized support network for pupils in trouble (intervention by an additional teacher in or outside of the classroom), in troubled pupils monitoring teams (regular meetings of the professionals taking care of the pupil), or a meeting with the school psychologist or with the school doctor).

The need for therapy services at 5 and 7 years of age was defined as 1 or more appointments with a speech, physical, or occupational therapist or an orthoptist, or as support in a child development center.

Statistical Analyses

Quantitative variables are presented as medians (25th-75th percentiles) or mean ± SD, and the qualitative variables are presented as the number of subjects and percentages. The differences were analyzed with a χ^2 test or Fisher exact test for the discrete variables with expected values of less than 5. The Student *t* test and the nonparametric Mann-Whitney U test were used to compare continuous variables.

To study possible selection biases, for infants with a GSA evaluation at 5 years of age, the sample of children seen in consultation at age 7 years of age was compared with the sample of children not seen at 7 years of age.

Associations between socioeconomic conditions, perinatal characteristics, neonatal morbidities, and the need for educational support at 7 years of age were estimated in bivariate analysis. A logistic regression model including the GSA score as a continuous variable as a main factor was computed to define covariables that may have been associated with educational support.

A receiver operating characteristic curve analysis and the area under the curve (AUC) were used to estimate the discrimination of the model. An optimal cut-off point for the GSA score was selected to maximize sensitivity and specificity, to classify children into 2 categories, namely, those with and without educational support.

A missing data imputation was performed to verify that the results of the multivariate analysis of the sample of 858 children with a visit at 7 years of age were not biased compared with the sample of children with a GSA at 5 years of age.

Statistical significance was defined as a *P* value of less than .05 for the whole analysis. SAS software, version 9.4 (SAS Institute, Cary, North Carolina), was used for the data analysis.

Results

A total of 2324 children were enrolled in the LIFT cohort during the study period, of whom 1575 (67.8%) had a visit at

5 years of age, 1209 (52%) were assessed with the GSA questionnaire, and 858 had a visit at 7 years of age (**Figure 1**). The birth and infant characteristics, as well as the family demographics of the children with and without a visit at 7 years of age, are presented in **Table I**. The children who were not included more often had a GSA score of less than 45.

Table II presents the types of educational support provided at 7 years of age. There were 130 children (15.2%) who received support, especially school specialized support network for pupils in trouble (5.9%). The characteristics associated with educational support are reported in **Table III**. A GSA score of less than 45 at 5 years of age was significantly more frequent in children who required educational support at 7 years of age. For the children with educational support at 7 years of age, a GSA score of less than 45 at 5 years of age was a more frequent occurrence (57.7%) than the use of therapy services (33.1%) ($P < 10^{-4}$).

After adjustment in a logistic regression model, only the GSA score, as a continuous variable, was significantly associated with educational support at 7 years of age (aOR, 0.86; 0.84-0.88). Thus, educational support at 7 years of age decreased as the GSA score increased (for an increase of 1 point).

The ability of the GSA score at 5 years of age to predict educational support at 7 years of age was assessed using receiver operating characteristic curve analysis. The optimal cut-off value for the GSA was 48, with a sensitivity of 70.8% and a specificity of 73.5%, and an AUC of 0.79 (**Figure 2**; available at www.jpeds.com).

The AUC obtained after imputation analysis of the 1575 children with a visit at 5 years of age was not significantly different from the sample of 858 children with a visit at 7 years of age.

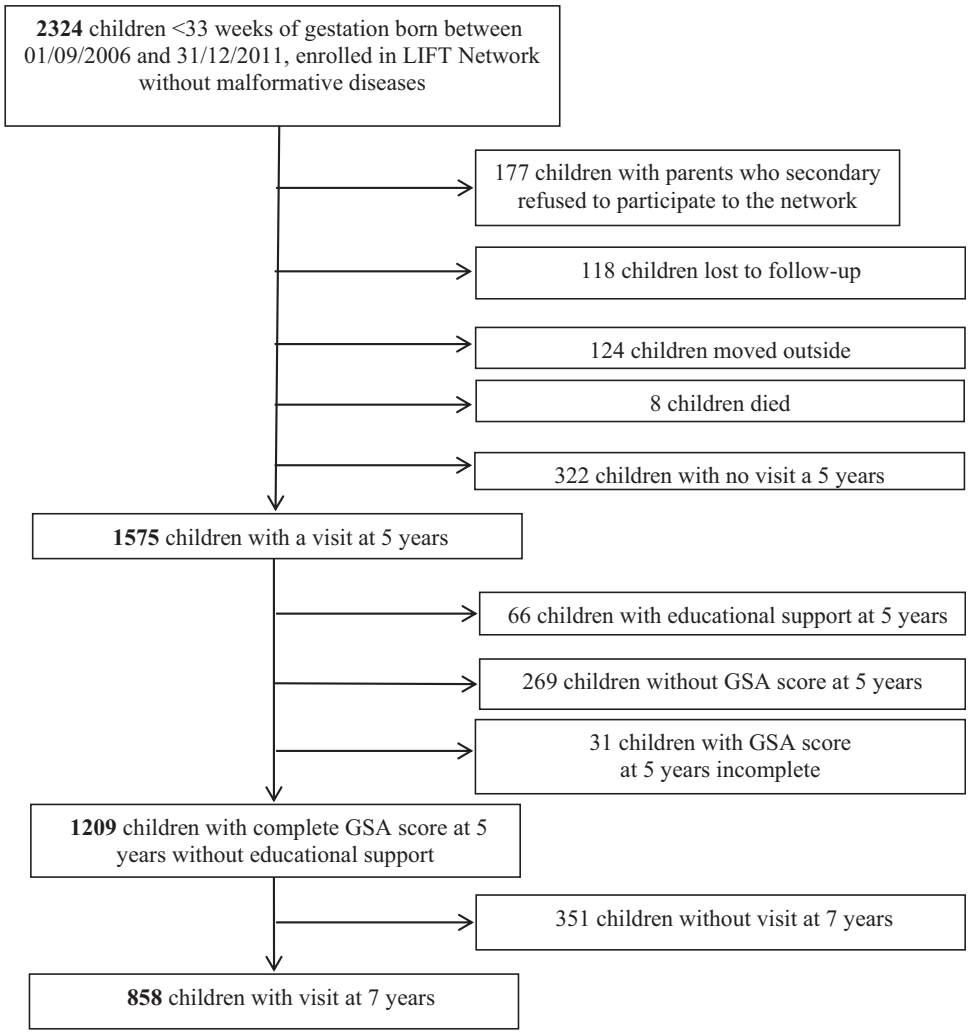

Figure 1. Study flowchart.

Table I. Birth characteristics and infant and family demographics of the included children compared with children not assessed at 7 years of age

Categories	Included (n = 858)	Not included (n = 351)	*P* value
Male sex	444 (51.8)	185 (52.7)	.76
Gestational age, wk	29.9 ± 2.1	30.16 ± 2.00	.19
24-27	140 (16.3)	47 (13.4)	.25
28-30	302 (35.2)	121 (34.5)	
31-32	416 (48.5)	183 (52.1)	
Antenatal corticosteroid therapy	563 (65.6)	224 (63.8)	.55
Multiple pregnancy	306 (35.7)	149 (45.9)	.043
Birth weight Z-score*	−0.216 [−0.949 to 0.468]	−0.23 [−0.91 to −0.47]	.51
≤−1	204 (23.8)	78 (22.2)	.55
≥−1	653 (76.1)	273 (77.8)	
Birth head circumference Z-score*	−0.101 [−0.828 to 0.427]	−0.16 [−0.89 to 0.43]	.55
<−1	134 (15.6)	64 (19.5)	.25
≥−1	673 (78.4)	265 (80.6)	
Intubation at birth	286 (33.3)	110 (31.3)	.5
Ligation of the patent ductus arteriosus	28 (3.3)	7 (2.0)	.23
Severe neurologic complications	27 (3.2)	16 (4.6)	.23
Breastfeeding at discharge	192 (22.4)	68 (19.4)	.25
Parent's socioeconomic level at 5 years of age, high	145 (16.9)	54 (15.4)	.52
Eligibility for social security benefits for low income	28 (4.3)	23 (8.8)	.007
Mother in a relationship at 5 years of age	786 (91.6)	280 (90.0)	.40
GSA score at 5 years	50.1 ± 7.8	49 ± 7.8	.028
<45	187 (21.8)	98 (27.9)	.023

Values are mean ± SD, number (%), or median [IQR].
*The Z-scores were computed according to Olsen standards.

Discussion

In our cohort of 858 very preterm children, 15.2% received educational support at 7 years of age. Educational support was associated with gestational age, birth measurements, neonatal complications, and parent socioeconomic level, and it was strongly associated with the teacher's GSA evaluation at 5 years of age. For children receiving educational support at 7 years of age, 33.1% used therapy services and 57.7% had a GSA score of less than 45 at 5 years of age. This suggests that the domains of the skills assessed by the GSA (linguistic competence, nonverbal abilities, and behavior in the classroom) are particularly pertinent for assessing readiness to learn, and these skills may be more important indicators of later school difficulties than the need for therapy services at 5 years of age.

Table II. Types of educational support and therapy services (n = 858)

Populations	Number (%)
Any educational support	130 (15.2)
Schooled in special class	4 (0.5)
Grade retention	30 (3.5)
Learning support assistant	22 (2.6)
School specialized support network for pupils in troubled	50 (5.9)
Meeting with school psychologist	29 (3.4)
Meeting with school doctor	9 (1.1)
In troubled pupils monitoring teams	19 (2.3)
Therapy services at 7 years of age	263 (30.7)
Therapy services at 5 years of age	155 (18.1)

Our results are consistent with a previous French study (EPIPAGE 1) of children born very preterm in 1997.[20] In this study, 15% of the children needed educational support and the use of therapy services increased between 5 and 7 years of age by as much as 30%. The same characteristics predictive of cognitive impairment in our study at 5 years of age were found to be risk factors for educational support and the use of therapy services in the EPIPAGE 1 study, namely, male sex, lower gestational age, birth weight and intrauterine growth restriction and social disadvantage.[21,22] The correlation between educational support and social disadvantage points out the special vulnerability of this subgroup and highlights the role of follow-up of preterm children by the LIFT network team in assisting this vulnerable population to access school services.[23]

A number of authors have assessed preschool neurodevelopmental functioning. Pritchard et al assessed children at a corrected age of 4 years using a school readiness framework that comprised cognitive ability, with intelligence quotient assessment, language ability, executive function, and a pediatric examination.[24] This evaluation at 4 years of age was found to exhibit an AUC of greater than 0.77 for predicting academic difficulty at 6 years of age. Similarly, Taylor et al found that the parent K-SEALS questionnaire, which assesses preschool language and number skills at 5 years of age, was associated with academic underachievement at 7 years of age in a cohort of 194 preterm infants.[25] However, general behavior in the classroom is not assessed in this parent questionnaire.

The GSA also has been shown to correlate with intelligence quotients in a cohort of children born very preterm.[16] This real-life functioning questionnaire is hence at least as relevant

Table III. Association between educational support and birth characteristics, infant, and family demographics

	Educational support (n = 130 [15.2%])		No educational support (n = 728 [84.8%])		
Variables	**Number**	**%**	**Number**	**%**	**Crude HR [95%CI]**
Sex					
Female	45	34.6	369	50.7	ref
Male	85	65.4	359	49.3	1.94 (1.32-2.87)
Gestational age, wk					
31-32	50	21.5	366	50.3	ref
28-30	52	40.0	250	34.3	1.52 (1.00-2.32)
24-27	28	38.5	112	15.4	1.83 (1.10-3.04)
Antenatal corticotherapy					
Yes	79	60.8	484	66.5	ref
No	51	39.2	244	33.5	0.78 (0.53-1.15)
Multiple pregnancy					
No	75	64.1	398	60.1	ref
Yes	42	35.9	264	39.9	0.84 (0.56-1.27)
Birth weight Z-score*					
≥−1	89	68.5	564	77.6	ref
<−1	41	31.5	163	22.4	1.59 (1.06-2.40)
Birth head circumference Z-score					
≥−1	90	75.0	583	84.9	ref
<−1	30	25.0	104	15.1	1.87 (1.18-2.97)
Intubation at birth					
No	73	56.2	499	68.5	ref
Yes	57	43.9	229	31.5	1.70 (1.16-2.49)
Ligation of the patent ductus arteriosus					
No	122	93.8	708	97.3	ref
Yes	8	6.2	20	2.7	2.32 (1.00-5.39)
Severe neurologic complications					
No	122	93.8	709	97.4	ref
Yes	8	6.2	19	2.6	2.45 (1.05-5.71)
Breastfeeding at discharge					
Yes	26	20.0	166	22.8	ref
No	104	80.0	562	77.2	1.18 (0.74-1.88)
Parents' socioeconomic level					
Higher level	12	9.2	133	18.3	ref
Intermediate level	118	90.8	595	81.7	2.2 (1.18-4.10)
Eligible for social security benefits for low income					
No	87	93.5	540	96.1	ref
Yes	6	6.5	22	3.9	1.69 (0.67-4.29)
Mother in relationship at 5 years					
Yes	117	90.0	669	91.9	ref
No	13	10.0	59	8.1	0.79 (0.42-1.49)
GSA score at 5, mean ± SD		42.4 ± 8.8		51.5 ± 6.4	0.86 (0.84-0.88)
≥45	55	42.3	616	84.6	ref
<45	75	57.7	112	15.4	7.5 (5.02-11.21)
Therapy services at 5					
No	87	66.9	616	84.6	ref
Yes	43	33.1	112	15.4	9.15 (4.14-20.21)
No therapy services at 5 and at 7	28	21.5	504	69.2	ref
No therapy services at 5 but therapy services at 7	59	45.4	112	15.4	9.5 (5.8-15.5)
Therapy services at 5 and at 7	36	27.7	56	7.7	11,6 (6.6-20.4)
Therapy services at 5 but no therapy services at 7	7	5.4	56	7.7	2.2 (0.9-5.4)

*The Z-scores were computed according to Olsen standards.

as the more commonly used medical-parent combined assessment. Indeed, interest in school activities, class participation, and paying attention in the classroom are essential to academic achievement.[26] We noted that the GSA frequently pointed out concerns for inattention, which often become apparent at school.[27] This may be an early indication for performance-based cognitive assessment, particularly assessment of executive function.[28]

In terms of performance as a screening test, using the receiver operating characteristic curve, with an optimal cut-off of 48, the GSA questionnaire at 5 years of age exhibited a specificity of 73.5% and a sensitivity of 70.8% for detection of a need for educational support at 7 years of age. Using the previously published cut-off of 45, the sensitivity was low (57.7%), but the better specificity (84.6%) could allow for a decrease in the number of false-positive screening tests, which can lead to potential harm from educational support for children. A cut-off of 48, however, allowed for an acceptable level of specificity without missing children in need of educational support.

Our large, prospective, longitudinal study has several limitations. One of these is the rate of loss to follow-up among high-risk children (ie, children from low-income families that receive social security benefits due to their

low income, children with a GSA score of <45). Despite the correlation between the GSA and IQ, the predictive value of the GSA has yet to be compared with a well-known predictive value of a thorough standardized neuropsychological evaluation.[10,16]

The GSA at 5 years of age was a useful tool and may help clinicians to identify preterm infants at later risk of school difficulty at 7 years of age. This finding is important because early identification of difficulties at 5 years of age can allow implementation of early appropriate interventions, although we suspect that it will be more informative in conjunction with formal cognitive assessments owing to the low sensitivity. ■

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Data Statement

Data sharing statement available at www.jpeds.com.

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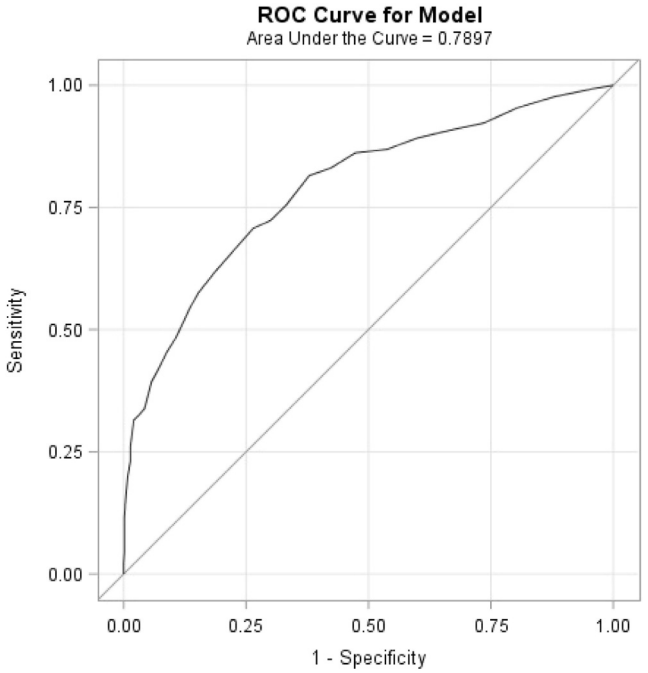

Figure 2. Receiver operating characteristic curve for GSA score at 5 years to predict educational support at 7 years.