School-Age Outcomes in Children Who Were Extremely Low Birth Weight From Four International Population-Based Cohorts
Saroj Saigal, Lya den Ouden, Dieter Wolke, Lorraine Hoult, Nigel Paneth, David L. Streiner, Agnes Whitaker and Jennifer Pinto-Martin

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http://www.pediatrics.org/cgi/content/full/112/4/943
ABSTRACT. **Objective.** The aim of this study was to determine whether learning and school problems in extremely low birth weight (ELBW) and reference children differ between cohorts in different countries. 

**Methods.** Participants were 4 international population-based cohorts of ELBW survivors who were 500 to 1000 g birth weight from New Jersey, central-west Ontario, Bavaria, and Holland (n = 532) and were followed longitudinally from birth. Psychometric data were collected independently and prospectively and included at least 1 measure of cognitive status and 1 measure of achievement administered to the children between the ages of 8 and 11 years. Adjustments were made for comparison of all measures based on reference norms within each country. Information on special educational assistance and grade repetition was obtained from the parents.

**Results.** The overall follow-up rate was 84% (range: 74%–90%; n = 436). The proportion of children who performed within the normal range (≥85) were as follows: IQ between 44% and 62%; reading between 46% and 81%; arithmetic between 31% and 76%; and spelling between 39% and 65%. Children from New Jersey had the lowest rates of cognitive and achievement deficits, and Bavarian children did less well in achievement scores relative to their peers and other cohorts. Despite these differences, more than half of all cohorts required special educational assistance and/or repeated a grade.

**Conclusions.** School difficulties were found to be a serious sequela of ELBW in all 4 countries, an observation that has social and economic implications. PEDIATRICS 2003;112:943–950; extremely low birth weight, school-age outcomes, international cohorts, population-based study.

ABBREVIATIONS. ELBW, extremely low birth weight; SD, standard deviation; WISC-R, Wechsler Intelligence Scale for Children-Revised; ANOVA, analysis of variance.

Advances in neonatal care have resulted in improved survival of extremely low birth weight (ELBW) infants. However, concerns have been expressed that these improvements may produce an increase in neurodevelopmental morbidity among survivors. A number of studies now document the prevalence of a broad range of neurologic, behavioral, and intellectual impairments at school-age in children who were born in the early era of neonatal intensive care. Without exception, these studies suggest that children who were ELBW are more likely to have lower IQ and academic achievement scores, experience greater difficulties at school in mid-childhood, and require significantly more educational assistance than children who were born at term.

Few of these studies are population-based, and therefore generalizability of the published data originating from single centers with high expertise may be limited. Moreover, few studies extend beyond the early school years, and it is difficult to assess accurately intellectual abilities until later in childhood. Also, differences in the inception cohorts and lack of a reference group preclude precise comparisons between studies. Differences in the philosophy of resuscitation and in the aggressiveness of neonatal interventions, for example, are not often addressed, and these practice differences may affect survival and long-term outcome. In addition, socioeconomic factors, racial and ethnic differences, the nature of funding of health care, and variability in the methodologic rigor at follow-up may further contribute to differences in the reported outcomes.

Differences between studies may be even more pronounced in international comparisons. The risk of mortality and early neurodevelopmental morbidity for infants <26 weeks’ gestation in relation to approaches to clinical management of obstetric and neonatal care have been investigated by Lorenz et al in 2 settings in Holland and New Jersey. They have shown that the lower mortality but higher risk of disabling cerebral palsy in New Jersey with near universal initiation of neonatal intensive care was accompanied by increased utilization of health care resources. It is plausible that these variations in management styles may have significant impact even at school age. In this study, we describe and compare the outcomes at mid-childhood from 4 carefully conducted international population-based cohorts of...
ELBW children in terms of cognitive and achievement measures and school difficulties. The aim of this study was to determine whether learning and school problems in ELBW and reference children differ between cohorts in the different countries and to explore the reasons for the differences, if any.

METHODS

The design of the study was longitudinal follow-up of all 4 cohorts of ELBW survivors from birth to mid-childhood (age 8–11 years). Selection of psychometric measures and data collection were independent and specific to each center and collected prospectively as described below. Comparisons between centers and sharing of the collective data were made possible through a collaborative grant to establish the nature and frequency of both short- and long-term neurodevelopmental sequelae (principal investigator, Nigel Paneth). Details of each of the 4 inception cohorts are provided below.

Study Populations

Central New Jersey Cohort

During the period August 1984 through June 1987, 231 liveborn infants between 500 and 1000 g birth weight were born or transferred to 3 tertiary care hospitals in 3 counties in central New Jersey (Table 1). These infants are a subset of 1105 infants enrolled in the Neonatal Brain Hemorrhage study, representing 85% of regional births ≤2000 g birth weight; 89% of these were inborn.13 The survival rate to hospital discharge of the ≤1000 g cohort was 49% (n = 113); 36% of the subjects were black; 8% were Latino; 55% were non-Latino white; 1% were other; and 25% were multiple births. All infants were followed prospectively from birth to school age. One infant died between discharge and the 9-year assessment. Neurologic assessments were performed at 9 years of age by trained clinicians on 79% of the eligible subjects. Psychometric assessments took place predominantly in the homes of the subjects at the same age.14 When home visits could not be arranged, telephone or mailed questionnaires were completed by the mother or guardian. The proportions of eligible survivors assessed by psychometric assessments was 60% at 9 years of age; however, the follow-up figure was higher (74%) when maternal assessment of school performance was also included (Table 2). A reference group was not recruited.

Central-West Ontario Cohort

During the period 1977 to 1982, 397 live births of 500 to 1000 g birth weight were born in the region of central-west Ontario (Table 1).15 The majority of infants (69%) were inborn at the tertiary care center; 16.4% were transferred from community hospitals, and a small proportion (14.3%) died at the local hospitals before they could be transferred and are included in the denominator of live births. Intensive care was not initiated and/or was withdrawn in 16.8% of births. The survival rate to hospital discharge was 45% (n = 179); 94% of the subjects were white. All survivors were followed prospectively from birth to 8 years of chronologic age; 6 ELBW children died postdischarge. At 8 years of age, 135 (90%) of 173 ELBW survivors and 145 sociodemographically and age-matched term control children, recruited from a random list of children provided by the local school boards, were assessed at the hospital clinic by research psychometrists who were blind to the group status (Table 2). Neurologic examination was performed on all subjects at the same visit by 2 pediatricians and an experienced nurse clinician.

Bavarian Cohort

During the period February 1985 to January 1986, 203 infants who were of 500 to 1000 g birth weight were enrolled in the study (Table 1); of these, 95 infants survived (survival rate: 47%). These subjects were part of a larger cohort of 682 infants <32 completed weeks' gestation, or <1500 g birth weight, delivered in South Bavaria from a catchment area of 16 children’s hospitals.16 Comparison with state perinatal survey records indicated that >99% of all births were recorded during the study period. Three ELBW children died postdischarge; the follow-up rate was 87% (n = 80) at 8.5 years of age (Table 2). In addition, a full-term control group (n = 320), as well as a normative population sample representative of the region (n = 291), was matched for age, sex, maternal educational status, and urban versus rural place of residence and studied prospectively at the same ages. The children were seen in the hospital clinic with face-to-face assessments using a battery of standardized tests, observations, and interviews from birth to 8.5 years.

TABLE 1. Neonatal Demographics of Live Births and Survivors, 501–1000 g Birth Weight, in Four International Cohorts

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Study Cohorts</th>
<th>All Cohorts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live births 500–1000 g (n)</td>
<td>231</td>
<td>397</td>
</tr>
<tr>
<td>Proportion &lt;750 g (n [%])</td>
<td>82 (36)</td>
<td>185 (47)</td>
</tr>
<tr>
<td>Birth weight (g; mean [SD])</td>
<td>788 (138)</td>
<td>763 (146)</td>
</tr>
<tr>
<td>Gestation (wk; mean [SD])</td>
<td>26.5 (2.5)</td>
<td>25.9 (2.5)</td>
</tr>
<tr>
<td>Survival rates* (%)</td>
<td>49</td>
<td>45</td>
</tr>
<tr>
<td>Survivors 500–1000 g (n)</td>
<td>113</td>
<td>179</td>
</tr>
<tr>
<td>Proportion &lt;750 g (n [%])</td>
<td>20 (18)</td>
<td>47 (26)</td>
</tr>
<tr>
<td>Birth weight (g; mean [SD])</td>
<td>851 (119)</td>
<td>837 (123)</td>
</tr>
<tr>
<td>Gestation (wk; mean [SD])</td>
<td>27.3 (2.5)</td>
<td>27.0 (2.3)</td>
</tr>
<tr>
<td>Ventilated (%)</td>
<td>93</td>
<td>82</td>
</tr>
<tr>
<td>Vent days (median [IQR]†)</td>
<td>16 (7, 43)</td>
<td>32 (12, 56)</td>
</tr>
<tr>
<td>Hospital days (mean [SD]‡)</td>
<td>90 (34)</td>
<td>100 (32)</td>
</tr>
</tbody>
</table>

IQR indicates interquartile range (25th, 75th percentile).

* To hospital discharge.
† Ventilator days for proportion ventilated only.
‡ Total hospitalization days, including convalescent care.
§ ANOVA P < .001.
¶ ANOVA P < .05.
# x2 P < .001.
** Maternal education for Holland presented in years of education: <12 years = 71%; 12 + years = 13%; 15 + years = 14%; university = 1%.
years of chronological age. Neurologic examinations were performed by trained clinicians using a structured format.

Dutch Cohort
In 1983, 1338 infants (94% of all live births) were delivered before 32 completed weeks of gestation and/or a birth weight of <1500 g. Of these, 310 infants weighed 500 to 1000 g at birth (Table 1), and 145 infants survived (survival rate 47%). All children were followed prospectively from birth to between 9 and 11 years of chronological age. Five children died postdischarge; the follow-up rate was 84% (118 of 140) at school age (Table 2). At 5 years of age, neurologic assessments were performed on 96% of the subjects in their homes by a trained pediatrician. Although information on school difficulties was obtained by questionnaires on 84% of the cohort, psychometric tests were administered to only 30 randomly selected children. Term controls were not recruited, and the results were compared with the Dutch psychometric norms published in 1986.

Psychometric Tests
Each center had at least 1 measure of cognitive status and 1 measure of achievement administered to the children (Table 3).

Adjustments for Reference Standards
In view of the discrepancies related to the years of standardization of the psychometric measures, adjustments were made for comparisons for both cognitive and achievement measures based on the reference norms and standard deviations (SD) within each country. Because New Jersey did not have any term controls, the means and SD of the most recent standardization sample for Wechsler Intelligence Scale for Children-Revised (WISC-R)23 and Wide Range Achievement Test Revised22 were used. As the Wechsler Intelligence Scale for Children, Third Edition (mean: 100; SD: 15)27 and the Woodcock Johnson (mean: 100; SD: 15)28 were used. For the purposes of this study, children with school difficulties were defined as children who received special educational assistance, and children were rarely sent to special schools. Grade retention was enforced for children with significant delay in most school boards.

Parents of children in all cohorts completed questionnaires about grade repetition and special educational assistance. Criteria for providing special education in New Jersey and Ontario varied among schools. In general, children received part- or full-time special assistance in their own class and sometimes outside the class but generally within the same school. Referral for special educational assistance was at the discretion of classroom teachers, and children were rarely sent to special schools. In Bavaria, all children received a school entry assessment, and decisions for placement in a special school or delayed entry were made jointly among the school educational and medical services, support agencies, parents, and the head of the school. Special schools are provided for children with physical, neurosensory (blind, deaf), and mental handicaps and for children with learning disabilities and language disorders. Children who attended special schools were considered to have full-time special educational assistance. Nearly all children attended public schools, as private schooling is rare in Germany. The school system in Holland is somewhat similar to Bavaria. The teacher/consultant determines school placement and grade failure (either grade repetition or delayed school entry is accepted), and extra help within the classroom for mild problems is provided; children with physical or significant developmental problems are sent to special schools. For the purposes of this study, children with school difficulties were defined as children who received special educational assistance and/or had repeated a grade. However, in view of the differences between countries in the provision of remedial ser-

### Table 2. Prevalence of Neurosensory Impairments Among Survivors in Four International Cohorts

<table>
<thead>
<tr>
<th>Country</th>
<th>New Jersey</th>
<th>Ontario</th>
<th>Bavaria</th>
<th>Holland</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Follow-up rate (%)</td>
<td>74</td>
<td>90</td>
<td>87</td>
<td>84</td>
<td>84</td>
</tr>
<tr>
<td>Age (mo, mean [SD])</td>
<td>114 (6)</td>
<td>93 (5)</td>
<td>102 (4)</td>
<td>124 (3)</td>
<td>118/140</td>
</tr>
<tr>
<td>Controls available</td>
<td>N/A</td>
<td>Yes</td>
<td>Yes</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Neurosensory impairments*</td>
<td>22</td>
<td>27</td>
<td>25</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>All impairments (%)</td>
<td>19</td>
<td>13</td>
<td>16</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Cerebral palsy</td>
<td>22</td>
<td>27</td>
<td>25</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>

*D Neurosensory impairments include cerebral palsy, mental retardation (IQ >3 SD below mean), blindness, and deafness.

### Table 3. Description of Psychometric Tests and Reference Standards

<table>
<thead>
<tr>
<th>Country</th>
<th>Tests (Standardization Year)</th>
<th>Tests of Achievement (Standardization Year)</th>
<th>Reference Group for Adjustments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holland</td>
<td>WISC-R (1984)27</td>
<td>Mathematical Ability Test (1993)25, 26</td>
<td>Dutch standardized tests reference norms (mean 100, SD 15)</td>
</tr>
</tbody>
</table>

K-ABC indicates Kaufman Assessment Battery for Children; WRAT-R, Wide Range Achievement Test–Revised.
services, we also report the proportion who received both special education and repeated a grade.

Informed Consent
Informed consent was obtained from the parents of all subjects at the time of the assessments within each country and per the guidelines of the local Ethics Review Board.

Statistical Analysis
Analysis of variance (ANOVA) was used to compare mean birth weight, number of days of mechanical ventilation, gestational age, and total number of neonatal hospitalization days among survivors of the 4 cohorts. The days of ventilation are reported as median and interquartile range (25th and 75th percentiles). However, because of the positively skewed distribution, we also used a natural log transformation before we ran the ANOVA. Bonferroni correction was used to adjust for multiple testing. Significant findings were followed by Bonferroni post hoc tests to determine which groups were significantly different. Independent t tests were used to compare the mean psychometric scores for sex (male vs female) and birth weight groups (<750 g vs 750-1000 g) within each individual cohort. χ² tests for categorical data were used to determine whether significant differences were found between countries in the proportion of children who needed special education, had repeated a grade, and had school problems. Regressions were run independently for each cohort to evaluate the contribution to the variance in IQ scores made by the 3 birth variables: birth weight, number of days of mechanical ventilation, and sex. Holland was not included in the regression analysis or in the independent t tests as the number of children on whom IQ scores were available was small.

RESULTS

Demographic Data and Neonatal Illness
Table 1 shows the combined data for 1141 live births ≤1000 g birth weight for the 4 cohorts. The live births in the North American cohorts were more immature in gestational age and had lower mean birth weights compared with the European cohorts. The proportion of infants <750 g birth weight was also higher for the North American cohorts, yet a similar proportion, between 45% and 49%, survived. Although approximately 23% of the survivors in the North American cohorts were <750 g, only 12% of the European cohorts were this small. Three variables of neonatal morbidity collected prospectively were selected—proportion ventilated, days of ventilation, and days of neonatal hospitalization—to measure the severity of neonatal illness among survivors. The ANOVAs showed significant mean differences (P < .001) between cohorts in birth weight, gestational age, number of days ventilated, and days of neonatal hospitalization—among survivors. Mean birth weight and especially mean gestational age of the survivors were also significantly lower in the North American cohorts compared with the European cohorts (P < .001). The proportion of survivors ventilated was lowest in Holland (53%) and highest in Bavaria (95%). Even more striking is the median number of days of ventilation, which was only 6 days for Holland, compared with 16 days for New Jersey, 32 days for Ontario, and 38 days for Bavaria. The mean number of days of neonatal hospitalization, including convalescent care, was highest for Bavaria at 120 days, followed by 100 days for Ontario. The differences in mean number of days to discharge between New Jersey and Bavaria, Holland and Bavaria, and Bavaria and Ontario all were significant at P < .001. From these variables, it seems that neonatal intensive care was most aggressive in Bavaria, followed by Ontario and New Jersey, and considerably more selective in Holland, which offered treatment preferentially to the more mature infants.

Neurosensorv Impairments
Table 2 shows that the total number of survivors assessed in all cohorts was 436. The mean age at assessments ranged between 93 months and 124 months. Control subjects were available only for Ontario and Bavaria. Overall, the prevalence of total neurosensory impairments (defined as cerebral palsy, deafness and blindness, and mental retardation IQ >3 SD below mean) was similar for New Jersey, Ontario, and Bavaria (22%, 27%, and 25%, respectively) and lowest for Holland (11%). The rates of cerebral palsy in the 4 cohorts were 19% for New Jersey, 13% for Ontario, 16% for Bavaria, and 8% for Holland.

Psychometric Scores
Table 4 shows the proportions of children in the 4 cohorts with mean psychometric scores within and below the normal range for the appropriate reference norms. The proportion within the normal range (≥85) were as follows: for IQ, between 44% and 62%; for reading, between 46% and 81%; for math, between 31% and 76%; and for spelling, between 39% and 65%. A higher proportion of children in the New Jersey cohort scored in the normal range in both IQ and achievement measures (spelling was not obtained) relative to the other cohorts. Although the distribution of IQ scores was similar in the Ontario and European cohorts, Bavarian children did less well on all achievement measures compared with...
their peers in their own country, as well as in comparison with the other 3 cohorts.

Also shown in this table are the proportion of children who performed 1 SD (<85) or 2 SD below the mean (<70), based on the age-appropriate norms within each country. Between 15% and 27% of ELBW children in all cohorts performed in the abnormal range for IQ. For achievement measures, in New Jersey, 11% scored >1 SD and 8% scored >2 SD below the mean for reading, whereas 9% scored >1 SD and 15% scored >2 SD below the mean for math. In Ontario, 11%, 25%, and 15% scored below 2 SD in reading, math, and spelling, respectively. However, in Bavaria, a much higher proportion, 47% and 40%, performed in the abnormal range (>2 SD below the mean) in math and spelling, respectively, whereas no children scored <70 on the reading test (30% of the children scored exactly at 70). The proportion of Dutch children who performed >2 SD below the mean for reading, arithmetic, and spelling was 4%, 30%, and 21%, respectively.

In Ontario, no significant differences were found in the scores between the smaller (<750 g) and the larger (750–1000 g) birth weight groups (not shown); however, in New Jersey, the <750 g birth weight group had significantly lower mean scores in reading (87 [SD: 26] vs 102 [SD: 26]; P < .05) and math (79 [SD: 35] vs 102 [SD: 26]; P < .05); and in Bavaria, the smaller birth weight group had lower mean IQ (57 [SD: 14] vs 80 [SD: 20]; P < .005) and math scores (49 [SD: 24] vs 70 [SD: 24]; P < .05) than the larger infants. Only 2 children <750 g birth weight were tested in Holland and are therefore not reported. Sex differences were seen only in the Ontario cohort, in which girls had higher IQs than boys (92 [SD: 19] vs 85 [SD: 20]; P < .05).

Parent Reports on School Performance

Table 5 provides data on school performance as reported by parents with respect to special educational assistance and grade repetition. A fairly high proportion of ELBW children from all cohorts (between 39% and 62%) were receiving either part- or full-time special educational assistance; there were no significant differences between countries (χ² = 4.55, df = 3, P = .2).

Grade repetition ranged between 19% and 34%, and, again, the proportions were not significantly different between the cohorts (χ² = 7.65, df = 3, P = .05). However, the proportion of children who had school difficulties (special education and/or grade repetition) was significantly different between countries and ranged from 51% in Holland to a high of 68% in Bavaria (χ² = 12.5, df = 3, P < .01). When the proportion of children who received special education and had also repeated a grade were considered (ie, the most learning compromised children), 14% to 17% of children in New Jersey, Ontario, and Dutch cohorts but no Bavarian children were in this category (χ² = 14.63, df = 3, P < .005). Clearly, Bavarian school policies provided one or the other form of remediation, which was mutually exclusive, in contrast to the other cohorts.

Perinatal Variables and Psychometric Scores

In New Jersey, birth weight, number of days on mechanical ventilation, and sex were not associated with mean IQ. In Ontario, the same variables accounted for 9% of the variance in IQ scores among the ELBW. The overall ANOVA was significant (P < .01), with the number of days on mechanical ventilation being the only significant variable in the regression model (P < .05). In Bavaria, 26% of the variance in IQ scores was accounted for by the same variables (P < .001), with the number of days on mechanical ventilation being the only significant variable in the model (P < .005). Thus, in the Ontario and the Bavarian cohorts, the number of ventilation days was significantly associated with IQ scores among ELBW.

DISCUSSION

This large, international, population-based study indicates that ELBW children at school age experience a substantial burden of childhood disability, school-related difficulties, and increased utilization of special educational resources. School difficulties thus are serious sequelae of ELBW in all 4 countries, an observation that has social and economic implications. These difficulties, which cannot be identified at younger ages, become steadily more apparent as the children face increasingly complex tasks in school. Remarkable similarities across all 4 cohorts are found both in survival rates and in the proportion of ELBW children requiring special educational assistance. More than half of ELBW children, wherever they are born in Western countries, experience serious educational problems. Thus, the impact on society, on families, and on the long-term future of the ELBW children is similar in Western countries providing neonatal intensive care to infants ≤1000 g.

In a separate report by this group, we found that
similar behavioral difficulties are also of major concern at school age in all 4 cohorts in children of this birth weight. Whether and to what extent these findings are applicable to the current survivors of neonatal intensive care remains to be investigated. It is likely that these children will also experience significant school difficulties because of the high disability rates as a result of the increased survival of the sicker and more immature infants.

There are also some significant differences between cohorts, and these include the less aggressive neonatal management and lower rates of neurosensory impairments in the Dutch cohort compared with the other cohorts. The New Jersey sample had the lowest rates of IQ deficits and reading problems compared with the Ontario and Bavarian cohorts. Nevertheless, despite better performance on standardized tests, the New Jersey cohort had the highest number of children in special education. There are several factors that are likely to explain this apparent paradox. Although 87% and 90% of the Bavarian and Ontario samples, respectively, were followed up with standardized tests, the ascertainment rate for administration of psychometric tests was substantially lower (60%) in New Jersey (although 74% of maternal respondents provided information on educational difficulties). Thus, a substantial number of children who were not assessed with the achievement tests were included in reporting educational difficulties and may represent a group who performed less well. It has been shown previously that nonparticipants have more intellectual and behavioral problems than participants.

Another issue is that of control subjects. The Ontario and Bavarian cohorts had same-aged control subjects, and thus concurrent norms were used, whereas the New Jersey cohort relied on test norms standardized several years earlier. Wolke et al showed that using outdated normative standards leads to significant overestimation of the mean intellectual performance of premature children compared with concurrent representative samples. Secular trends amounting to an average yearly increase of 0.2 to 1.2 IQ points have been reported for both adult and child populations. Finally, that the New Jersey children were assessed in their own homes rather than in a hospital setting, as in Bavaria and Ontario, may have led to less consistency in the assessments.

A difference between the Ontario and Bavarian samples is that despite similar distribution of IQ scores, the Bavarian children did more poorly in arithmetic and spelling compared with the Canadian children, ie, they performed more poorly than might be expected on the basis of their intellectual level. One explanation may be that one quarter of the Bavarian ELBW children had delayed school entry by at least 1 year beyond the usual average age of school entry of 6.6 years. Thus, at the time of testing (8.5 years), they did more poorly than control subjects, who generally already had an extra year of schooling. It is not entirely clear why the proportion of children with achievement scores below 2 SD of norms is so much higher within the Bavarian cohort than in the North American cohorts. We can only speculate on some of the reasons, such as differences in teaching methods in school, different educational standards, cultural differences in the tests used, and differences in the policies of providing remedial education in the school systems. In the 2 European samples, there is a clear destreaming system, ie, it is geared toward average to above-average performance in regular schools; children with disabilities and below-average performance receive their education in special schools. Despite these differences, it seems that approximately half of the ELBW survivors within each cohort encountered school difficulties in mid-childhood. Of even greater concern is the finding in the Ontario cohort that these difficulties persist to adolescence.

The strengths of this study are the population-based nature of the data that were collected prospectively by experienced clinicians who followed methodologically rigorous standards. These include the considerable effort expended in reporting accurately the number of live births and deaths in all cohorts, the provision of details on subject losses, prevalence of neurosensory impairments, inclusion and exclusion criteria for psychometric tests, the availability of comparison or reference standards, and relevant information on standardization data for clinical and psychometric measures. The analysis of the grouped data was performed jointly by the principal investigators who had assembled the cohorts, an approach that has clear advantages over meta-analyses in which differences in the inception cohorts, modes of assessment, and analyses are not always known. At the same time, we recognize the problems that ensue from the independent assembly of these cohorts retrospectively, without previous consensus as to the study design or measures. We accept that some factors that may have an impact on the neonatal characteristics of the populations were difficult to control, such as varying criteria for reporting live births and deaths; differences in the philosophy of instituting resuscitation and/or withdrawal of intensive care; and aggressiveness of neonatal intervention and sociobiological factors such as social class, parental education, family configuration, source of health care funding, and available resources. For example, despite careful ascertainment, it is possible that some very immature live births were not registered in Holland as they were considered nonviable at the time. This fact and a selective policy of offering neonatal intensive care to the larger infants may have contributed to the more mature mean gestational age of the Dutch cohort relative to the other 3 cohorts. The mortality rate of the cohorts, however, did not differ, but the proportion ventilated and the mean days of ventilation in the Dutch cohort were remarkably lower, suggesting a less aggressive approach to the care of ELBW infants relative to other cohorts. These differences in management styles could have had an impact on subsequent morbidity and may explain the low prevalence of impairments in the Dutch children compared with the New Jersey cohort.
This is the first international collaboration to study and carefully compare the long-term outcomes of ELBW children. We have shown that comparison of national or international data on school outcomes is indeed a complex task. Although it is increasingly recognized that hospital-based studies are not generalizable and population-based studies are preferable, it is difficult for many centers to maintain their cohorts to school age without a high attrition rate. For conducting future comparative studies to determine whether management practices influence the long-term outcomes, it is necessary to develop a consensus nationally and internationally for the minimum data set necessary for reporting school problems. There needs to be consistency in the protocol for assessing neurodevelopment and in the inclusion and exclusion criteria used when reporting on children with impairments. It is also important for investigators to use current and within-country reference norms for tests of ability and achievement. The policies for special educational assistance, grade repetition, and programs for children with disabilities should be outlined clearly in the reports for meaningful interpretation and generalizability. Thus, we must define more clearly our own practices when reporting outcomes. The importance of methodologically rigorous population-based studies cannot be overemphasized. As we continue to save infants of borderline viability, it is imperative that the current survivors be followed to school age to provide a more complete picture of their overall outcome. Such information is necessary for parents, providers of health care and education, and the health care funding agencies.

ACKNOWLEDGMENTS
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A HERETICAL PROPOSAL

“It is time to refocus attention away from birth weight adjustment. As a measure of perinatal risk, birth weight is an inadequate proxy. Comparisons of hospital mortality rates would be more valid if adjustment were made for actual indicators of high risk, such as measures of preterm delivery, fetal distress, preexisting medical conditions, or currently unidentified biomarkers. Comparisons across communities would be more valid (and frequently more precise) without adjustment for birth weight.”


Submitted by Student
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