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Cognition, Academic Progress, Behavior and Self-Concept at 14 Years of Very Low Birth Weight Children

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ABSTRACT. The aim of this study was to compare cognition, academic progress, behavior, and self-concept children of very low birth weight (VLBW, birth weight < 1501 g) born in the period 1980 to 1982 with randomly selected children of normal birth weight (NBW, birth weight > 2499 g). At 14 years of age, 130 (84.4%) of 154 VLBW and 42 (70.0%) of 60 NBW children were assessed. Ten VLBW children and one NBW child who had cerebral palsy were excluded. VLBW children scored at a significantly lower level on all three composite scales of the Wechsler Intelligence Scale for Children, 3rd Edition. VLBW children were also significantly disadvantaged on more specific cognitive processes, including tests of visual processing and visual memory and on subtests reflecting learning and problem solving. Only in arithmetic was a difference between the groups discerned on tests of achievement. Significantly more VLBW children were rated by teachers as socially rejected and by their parents as having learning problems at school. VLBW children had significantly reduced self-esteem. VLBW children had more cognitive, academic, and behavioral problems and lower self-esteem at 14 years of age than NBW control subjects. *J Dev Behav Pediatr 22:11–18, 2001.* Index terms: *low birth weight, adolescence, cognition, academic, behavior.*

Over the past few decades a number of studies have shown that advances in neonatal intensive care have dramatically improved the survival rate for very low birth weight (VLBW, birth weight < 1501 g) children.[1–3] When VLBW survivors have been followed to primary school age, most studies report a slight, but statistically significant, lag in overall cognitive functioning compared with children of normal birth weight (NBW, birth weight > 2499 g).[4–6] Of greater concern is the clinically significant increase in the numbers of VLBW children experiencing learning problems requiring remedial education or special school services.[7,8] In addition, the frequently reported behavior problems[5,9] raise questions about the emotional well-being of VLBW children and, in particular, how they feel about themselves. Despite the consistent findings of more problems in VLBW children compared with controls, the likely inner stress that they may experience, and their greater need for special services, few studies have followed VLBW children beyond the primary school years.[7,10–12]

The aim of this study was to compare the progress in cognition, academic progress, behavior, and self-concept at 14 years of age of VLBW children without physical or major sensorineural impairment with a group of NBW children.

METHODS

The children of very low birth weight (VLBW) comprised 154 long-term survivors out of 227 consecutive live births of birth weight < 1501 g, a survival rate of 68%. The VLBW children were born between October 1, 1980, and March 31, 1982, at the Royal Women's Hospital, Melbourne, a large tertiary care center. The 60 children of normal birth weight (NBW) were randomly selected from children born in the same hospital at the same time. Details of the perinatal care for this cohort have been described.[13,14] Both groups of children were enrolled in a longitudinal follow-up program throughout childhood. Sociodemographic data collected included social class assigned

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according to the occupation of the main income earner in the family and was rated on the Daniel scale,[15] which ranges from 1 (high social class) to 7 (low social class). Families whose income was derived from social security benefits were assigned a score of 7 for social class. Other sociodemographic data obtained included country of birth of the mother (English the main language or not) and years of mother's schooling. The study was approved by the Research and Ethics Committees of the Royal Women's Hospital, Melbourne.

As part of the prospective follow-up program, children were assessed at intervals up to 14 years of age, corrected for prematurity, where appropriate. Details of the cognitive, academic, and behavioral performance of these children at 8 years of age have been reported.[5] When the children were assessed at age 14 years, their newborn status and results of earlier assessments were unknown to the assessors. Of the original cohorts, 130 (84.4%) of the VLBW and 42 (70.0%) of the NBW children were seen by the research team. Of the 24 VLBW children not fully assessed by the research team, 6 were lost, 16 refused, and 3 were inaccessible. Of the 18 NBW children not fully assessed by the research team, 4 were lost, 12 refused, and 2 were inaccessible. Ten VLBW children and one NBW child who had cerebral palsy were excluded. No children were legally blind or required hearing aids.

The psychologist assessed the children with tests including the Wechsler Intelligence Scale for Children, 3rd Edition (WISC-III)[16] to assess overall language and nonverbal abilities. The 11 subtests (including the supplementary digit span test) measure different aspects of language, numerical ability, and performance abilities. In addition, other tests included the Bead Memory Test from the Stanford-Binet Intelligence Scale,[17] which estimates visual memory, and the Complex Figure of Rey Test (CFRT),[18] which assesses visual-motor, planning, memory, and organizational skills. The children were asked to copy the CFRT, a complex geometric design, using a series of colored pencils that could be used to document the order in which parts of the design were copied. Both the accuracy and the organization of the task were scored according to Lezak.[17] The same scoring criteria were used when the children were asked to recall the CFRT from memory after a 3-minute delay. Tests of academic progress included the Wide Range Achievement Test, 3rd Edition, (WRAT3),[19] with subscales of reading, spelling, and arithmetic. The reading subscale is a short screening test of the ability to read single words of increasing difficulty; in a similar manner it tests spelling and also includes a paper and pencil test of arithmetic.

Teachers rated the children's progress on a number of academic subjects (English, mathematics, science, language other than English, and physical education) on a 5-point scale that was dichotomized into failing or below average compared with the remainder. Teachers completed the Adelaide Teacher Rating Scale.[20] This scale is based on the Conners'[21] behavior questionnaire and has been validated on a large representative sample of Australian children. This scale was chosen not only because it had been validated on Australian children, but also because we had used it when the children were 8 years of age and because it is briefer than the Achenbach Teacher's Rating Scale. The 39-item teachers' scale has seven factors: (1) conduct problems, (2) hyperactive-inattentive, (3) unforthcoming-unassertive, (4) depressed mood, (5) socially rejected, (6) antisocial, and (7) anxious to please. On this scale teachers rated items contributing to each factor as 0, no problem; 1, occasional problem; 2, moderate problem; and 3, severe problem. The factor score is determined by adding the score on each item contributing to the factor. If the child's score is greater than 2 SD above the mean for the normative population, it is defined as a significant problem. Parents completed the Achenbach Child Behavior Checklist,[22] which identifies problems similar to those on the Adelaide Teachers' Rating

Table 1. Demographic Data

	VLBW (n = 120)		NBW (n = 41)		
	Mean	SD	Mean	SD	Statistical significance
Birthweight (g)	1167	215	3417	432	t = 43.6; $p < 0.0001$
Gestational age (w)	29.3	2.0	39.9	1.0	t = 32.4; $p < 0.0001$
Birthweight SD score	−0.72	1.04	−0.14	0.80	t = 3.2; $p = 0.002$
	n	%	n	%	
Male	65	54.2	25	61.0	$\chi^2 = 0.3$; NS
Multiple birth	27	22.5	0	0	$\chi^2 = 9.5$; $p < 0.01$
Mother born in country with English the major language	92	76.7	26	63.4	$\chi^2 = 2.1$; NS
Social class, median IQR[a]	4.6	3.7, 5.9	4.5	2.6, 6.0	NS[b]
Social class					
Upper (score,[a] 1–3)	35	29.2	16	39.0	NS[b]
Middle (score,[a] 4–5)	56	46.7	15	36.6	
Lower (score,[a] 6–7)	29	24.2	10	24.4	
Mother's schooling > 10 years	46	38.3	21	51.2	$\chi^2 = 1.6$, NS

VLBW, very low birth weight; NBW, normal birth weight; SD, standard deviation; NS, not significant; IQR, interquartile range.
[a]Social class on the Daniel scale.
[b]Mann-Whitney U test.

Table 2. Psychological Test Scores - WISC-III

	VLBW (n = 120)		NBW (n = 41)		
	Mean	SD	Mean	SD	Mean difference
Composite scales					
Full Scale	96.2	15.5	105.0	13.3	8.9 (3.5, 14.2)[a]
Verbal Scale	94.5	16.1	103.2	13.7	8.7 (3.1, 14.2)[a]
Performance Scale	99.2	15.1	106.7	12.6	7.6 (2.4, 12.7)[a]
Other subscales					
Picture Completion	10.1	3.0	10.2	3.0	0.1 (−1.5, 1.6)[b], NS
Information	8.6	3.1	10.6	2.9	2.0 (0.4, 3.5)[b]
Coding	9.3	3.6	10.7	3.0	1.4 (−0.4, 3.2)[b], NS
Similarities	9.3	3.6	10.8	3.0	1.5 (−0.3, 3.4)[b], NS
Picture Arrangement	9.3	3.3	10.8	2.5	1.5 (−0.1, 3.1)[b], NS
Arithmetic	8.8	3.3	10.8	3.2	2.0 (0.3, 3.7)[b]
Block Design	10.4	4.0	12.0	3.6	1.5 (−0.5, 3.5)[b], NS
Vocabulary	9.0	3.3	10.0	2.4	1.0 (−0.6, 2.6)[b], NS
Object Assembly	9.6	3.2	11.1	3.1	1.5 (−0.1, 3.1)[b], NS
Comprehension	9.2	3.3	10.4	3.2	1.2 (−0.5, 2.9)[b], NS
Digit Span	9.9	3.6	9.8	3.6	−0.1 (−2.0, 1.8)[b], NS

WISC-III, Wechsler Intelligence Scale for Children, 3rd Edition; VLBW, very low birth-weight; NBW, normal birth weight; SD, standard deviation; NS, not significant.
[a]95% confidence interval (CI).
[b]99.5% CI.

Scale. Parents were asked about repetition of grades at school and additional educational resources consumed by their child. Parents also completed the Achenbach Social Competence Scale.

Children were assessed on how they felt about themselves by the Coopersmith Self Esteem Inventory,[23] and by the Achenbach Youth Self Report (social competence scale).[24]

Data were edited and analysed using SPSS for Windows (SSPS Inc., Chicago, IL).[25] Univariate analyses included χ^2 tests or Fisher's Exact test for dichotomous variables, *t*-tests for normally distributed continuous variables, and mean differences and 95% confidence intervals (CI) were calculated. For comparisons of the subscales of the WISC-III, the Bonferroni correction for multiple comparisons was applied and mean differences and 99.5% CI were calculated. Nonnormally distributed variables were analysed by the Mann-Whitney U-test. To adjust for confounding variables, psychological test scores were analysed by multiple linear regression, and adjusted mean differences and 95% CI were calculated from the regression coefficients and their standard errors. For all main comparisons between groups, p-values < 0.05 were considered statistically significant, whereas for the subscales of the WISC-III, p-values < 0.005 were considered statistically significant.

RESULTS

There were no significant differences between the 120 children of very low birth weight (VLBW) and the 41 children of normal birth weight (NBW) who remained in the study, either in gender or social variables (Table 1). The VLBW children were significantly lighter and more immature at birth, they had lower birth weight SD scores,

Table 3. Psychological Scores: Other Tests

	VLBW (n = 120)		NBW (n = 41)		
	Mean	SD	Mean	SD	Difference
Bead Memory Test	95.6	17.4	104.9	15.5	9.3 (3.1, 15.4)[a]
Wide Range Achievement Test					
Reading standard score	96.8	14.4	100.4	12.7	3.7 (−1.4, 8.7)[a], NS
Spelling standard score	93.7	16.2	98.6	13.8	4.8 (−0.9, 10.5)[a], NS
Arithmetic standard score	89.0	13.8	95.9	13.6	6.9 (1.9, 11.9)[a]
	Median	IQR	Median	IQR	
Figure of Rey					
Accuracy	34	31.2, 35	34	32, 35	Z = 0.46, NS[b]
Organization	2	2, 3	3	2, 3	Z = 1.97, $p = 0.048$[b]
Accuracy after 3 minutes	23	17, 26	23	16.5, 27.5	Z = 0.19, NS[b]
Organization	2	1, 3	2	2, 3	Z = 1.12, NS[b]

VLBW, very low birth weight; NBW, normal birthweight; SD, standard deviation; NS, not significant; IQR, interquartile range.
[a]Mean difference (95% confidence interval).
[b]Mann-Whitney U test.

Table 4. Academic Progress

	VLBW (n = 120)		NBW (n = 41)		
	n	%	n	%	Difference
Teacher's rating: below average or failing					
English	29/102	28.4	4/35	11.4	NS
Mathematics	34/101	33.7	6/34	17.6	NS
Science	27/94	28.7	4/33	12.1	NS
Language other than English	21/81	25.9	6/31	19.4	NS
Physical education	14/91	15.4	1/31	3.2	NS
Repeated grades	18/116	15.5	1/41	2.4	$p = 0.026$[a]
Help at school					
Integration aide	6	5.0	0	0	NS
Special class	2	1.7	1	2.4	NS
Remedial reading	8	6.7	0	0	NS
Remedial mathematics	4	3.3	0	0	NS

VLBW, very low birth weight; NBW, normal birth weight; NS, not significant.
[a]Fisher's exact test.

and more were from multiple births (Table 1). The 34 VLBW children in the original cohort but not reported in this study had mostly similar perinatal data compared with the 120 VLBW children with outcome data in this study (gestational age, mean 29.5 weeks, SD 1.7; 47.1% male, 11.8% from multiple births; 79.4% of mothers born in an English-speaking country), with the exception that they were significantly heavier at birth (birth weight, 1260 g, SD 194; mean difference, 93 g, 95% CI, 12 g–174 g). There were no significant differences in these perinatal variables for the 19 NBW children in the original cohort but not reported in this study compared with the 41 NBW children with outcome data in this study (data not shown). Of the 120 VLBW children reported in this study, 8 (7%) had grade 3 or 4 cerebroventricular hemorrhage (CVH) and 10 (8%) had necrotizing enterocolitis (NEC) in the newborn period. The VLBW children were born in an era when cystic periventricular leukomalacia could not be diagnosed by ultrasound.

VLBW children scored at a significantly lower level on all three composite scales of the Wechsler Intelligence Scale for Children (WISC-III) (Table 2). Compared with the NBW children who all scored within the normal range on the WISC III Full Scale, 22 VLBW children scored lower than 1 SD below the mean ($7 < -2$ SD; 15 between < -1 and -2 SD). On multivariate analysis, all three composite scales of the WISC-III were significantly higher in children from a higher social class (increase with 1-point increase in social class [95% CI]: Full Scale, 5.1 [3.8, 6.4]; Verbal Scale, 5.0 [3.7, 6.4]; Performance Scale, 4.1 [2.8, 5.4]). Other potential confounding variables (mother's education, mother's country of origin, multiple birth, gender, birth weight SD score) were not statistically significant. After adjustment for social class, the differences between the

Table 5. Behavior

	VLBW (n = 120)		NBW (n = 41)		
	n	%	n	%	Difference
Teacher's behavior rating of child-Glow and Glow/Conners					
Conduct problems	11/103	10.7	1/33	3.0	$p = 0.29$, NS
Hyperactive/inattentive	8/103	7.8	1/33	3.0	$p = 0.69$, NS
Unforthcoming/unassertive	5/103	4.9	0/33	0	$p = 0.34$, NS
Socially rejected	12/101	11.9	0/33	0	$p = 0.038$[a]
Antisocial	1/103	1.0	0/33	0	$p = 1.0$, NS
Depressed mood	3/102	2.9	2/33	6.1	$p = 0.6$, NS
Parent's behavior rating of child-Achenbach					
Social competence	12/110	10.9	2.39	5.1	$p = 0.36$, NS
Activities scale	9/110	8.2	2/39	5.1	$p = 0.73$, NS
Social scale	10/110	9.1	2/39	5.1	$p = 0.73$, NS
School scale	38/110	34.5	3/39	7.7	$p = 0.001$[a]
Behavior problems	12/108	11.1	2/39	5.1	$p = 0.35$, NS
Internalizing problems	11/108	10.2	2/39	5.1	$p = 0.52$, NS
Externalizing problems	8/108	7.4	1/39	2.6	$p = 0.45$, NS

VLBW, very low birthweight; NBW, normal birthweight; NS, not significant.
[a]Fisher's exact test.

Table 6. Self Assessment

	VLBW (n = 120)		NBW (n = 41)		Difference
Achenbach Youth Self Report					
Activities, mean/SD	7.0	2.8	7.3	2.1	0.3 (−0.6, 1.3)[a]
Problems, n	10/113	8.8%	1/39	2.6%	NS
Social, mean/SD	6.7	2.0	6.8	1.8	0.1 (−0.6, 0.8)[a]
Problems, n	15/111	13.5%	2/40	5.0%	NS
Academic, mean/SD	1.8	0.9	2.0	0.5	0.2 (−0.2, 0.5)[a]
Problems, n	15/112	13.4%	3/39	7.7%	NS
Total raw score, mean/SD	14.6	9.8	13.7	2.8	−0.9 (−4.1, 2.2)[a]
Total T, mean/SD	46.1	13.0	46.0	10.9	−0.1 (−4.7, 4.5)[a]
Problems with total T, n	27/111	24.3%	6/39	15.4%	NS
Coopersmith Self Concept, median/IQR					
Percentile	62.5	40, 90	80	60, 90	Z = 2.18, $p = 0.03$[b]
Total long form	75	62, 86	82	73, 88	Z = 2.51, $p = 0.012$[b]
General Self	20	16, 23	22	20, 24	Z = 2.94, $p = 0.003$[b]
Social scale	7	5, 8	7	6, 8	Z = 1.45, NS[b]
Lie scale	2	1, 3	2	1, 4	Z = 0.96, NS[b]
School scale	5	4, 7	6	5, 7	Z = 1.02, NS[b]
Homeparents	7	6, 8	7	6, 8	Z = 0.10, NS[b]

VLBW, very low birth weight; NBW, normal birth weight; NS, not significant; IQR, interquartile range.
[a]Mean difference (95% confidence interval [CI]).
[b]Mann-Whitney U test.

VLBW and NBW children remained statistically significant (mean difference [95% CI]; Full Scale, 7.7 [3.1, 12.2]; Verbal Scale, 7.4 [2.6, 12.2]; Performance Scale, 6.6 [1.9, 11.2]). Within the VLBW cohort, there were no significant differences on the three composite scales of the WISC-III between children with or without either NEC or grade 3 or 4 CVH (data not shown).

More specific cognitive processes that showed significant differences between the groups included WISC-III subtest measures reflecting educational achievement (Information and Arithmetic, Table 2), and measures of visual processing and visual memory (the Binet Bead Memory Test and the Organization Scale for the direct copy of the Complex Figure of Rey Test [CFRT], Table 3). There were no differences in the accuracy of the copy of the CFRT, either directly or after a delay of 3 minutes. On tests of Reading, Spelling, and Arithmetic, only Arithmetic showed differences between the groups at a statistically significant level (Table 3).

Significantly more VLBW children had repeated at least one grade of school by age 14 years (Table 4). Although teachers rated more VLBW children as performing below average or failing in all areas and VLBW children required more educational resources, no differences were statistically significant (Table 4).

On teacher ratings of behavior, significantly more VLBW children were rated in the clinical range on Social Rejection (Table 5). No other teacher ratings of behavior showed significant differences between the groups. Significantly more VLBW parents than NBW parents rated their children as performing below average or failing at school. There were no other significant differences in behavior rated by parents. There were no significant gender differences in any of the behavior measures

There were no significant differences between the groups on the Achenbach Youth Self Report (Table 6). On the Coopersmith Self Esteem Inventory both groups had a median Self Esteem percentile higher than the median of the American normative sample. However, the VLBW children scored at a significantly lower level than did the NBW children. Examination of the subscales of the Self Esteem Inventory revealed there was no difference between how children in the VLBW and children in the NBW groups perceived themselves as relating to their families, their peers, or their school, but they scored at a significantly lower level on the General Self subscale, which measures how they feel about themselves. The only significant gender difference on the Coopersmith Self Esteem Inventory was that boys scored higher on the General Self subscale (mean difference, 1.4, 95% CI 0.1, 2.7), but this did not alter the significant difference between VLBW children and controls. There was no significant relationship between growth at 14 years of age and any measure of self-esteem.

When the major analyses for cognition, academic progress, behavior, and self-concept were repeated including children with cerebral palsy, some differences between the VLBW and NBW children were slightly larger, but no major statistical conclusions were altered (data not shown). If the major analyses were compared between the 25 children of birth weight less than 1000 g and the 95 children of birth weight from 1000 to 1500 g, there were no statistically significant differences between the groups (data not shown).

DISCUSSION

A strength of our study is that we were able to follow 84% of VLBW children to 14 years. Although only 70% of controls were reviewed at this age, we consider this a reasonable return considering the difficulty of obtaining the cooperation of adolescents when they had little to gain from the repeated assessments. Other advantages include the

prospective follow-up of both groups and that the study focused on a broad range of functional outcome measures, including data from the children themselves, as well as parent and teacher informants. The measures replicated many of those used when the children were assessed at 8 years of age,[5] thus permitting identification of any change in their functioning in the early teenage years. Changes in functioning over time will be the subject of a separate report. We corrected age for prematurity, because we reported previously that there is a small difference in psychological test scores, even at age 14 years,[26] and to be consistent with earlier reports on this cohort.

We previously reported the outcome at 14 years of age of a consecutive cohort of VLBW children born in the same hospital during the years 1966 to 1970, a time predating modern neonatal intensive care.[7] As a group they were delayed in their educational achievements, particularly in reading, with 24% delayed in reading accuracy, and 48% delayed in reading comprehension. Teachers reported problems in English and mathematics. We were also concerned at the spasmodic nature and often short duration of help received by many of the children.

We assessed the current cohort of VLBW children born in the period 1980 to 1982 at 8 years of age,[5] as well as at 2[27] and 5[28] years of age. Compared with the cohort born in the years 1966 to 1970, there appeared an overall improvement in outcome at 8 years of age because these children were reading and performing in most academic areas as well as their NBW peers. However, we were concerned about the long-term progress of some of the children, because the VLBW group was inferior to the NBW children on tests of cognition and on teachers' reports of motor skills and inattention. Significantly more of the VLBW parents reported that their children were not coping at school.

The findings at 14 years of age for the current cohort were consistent with those obtained at earlier stages of the study. The VLBW children at 14 years of age continued to lag behind their NBW peers in cognitive development just as they did at 2,[27] 5,[28] and 8[5] years of age. The areas where they exhibited specific cognitive deficits were similar to those observed at 8 years, namely in visual processing, visual memory, and visual perceptual organization. The Binet Bead Memory Test and the organization of the copy of the CFRT are complex tasks requiring adequate visual processing and organization skills. Children displaying such deficits in cognitive functioning may need guidance in organizing their schoolwork and activities at home. Material could be presented to them simply, thus reducing the amount of information to be processed. Moreover, because some of the WISC-III subtests that showed significant differences between the groups are timed, children with problems in these areas may need more time to process information, and hence to complete tasks at school or home.

Compared with the NBW children, the VLBW children scored significantly lower on the Arithmetic and Information subtests of the WISC-III. The Information subtest reflects the children's ability to learn generally from the environment through the language medium whereas, at the 14-year level, the Arithmetic subtest measures mathematical problem-solving skills. Interestingly, of the academic tasks surveyed by the Wide Range Achievement Test, 3rd Edition (WRAT3), only arithmetic showed significant differences between the groups. The precursor of the weakness in arithmetic was observed by teachers of the children at 8 years of age when they tended to rate the VLBW children at a lower level on a number item of a school progress scale. This item aimed to measure the children's ability to grasp new number concepts and processes and to think flexibly.

In our earlier report of outcome at 14 years of VLBW children born in years 1966 to 1970,[7] a considerable number were delayed in both reading accuracy and comprehension (24% and 48%, respectively), a delay on both measures defined as a reading age more than 2 years behind the chronological age. Although the VLBW children in the present study achieved lower scores than the NBW children on both the reading and spelling tests of the WRAT3, these differences were not statistically significant. The difference between the current cohort and the previous cohort born in the 1966 to 1970 period may reflect the different social composition of the present cohort. The earlier group was derived from a predominantly low socioeconomic population. Furthermore, at that stage, we were unable to trace enough of the NBW controls born in the 1960s to compare with their same-aged peers.

It is notable that neither the present VLBW children nor those born in the 1960s differed from controls in their reading age at 8 years of age. The percentage of VLBW children aged 14 years rated as failing in mathematics and English in both studies was similar, and although more VLBW than NBW children were rated as below average or failing in a range of school subjects by their teachers, in the present study these differences were not statistically significant. The two facts that significantly more VLBW children than NBW children had repeated a grade at school and more required extra educational resources suggest that learning has been more difficult at least for a minority of the VLBW children compared with controls. This accords with the recent finding by Stewart et al[29] that 20% of VLBW children born in University College Hospital, London, required extra educational resources before age 14 to 15 years. Not surprisingly, compared with controls significantly more parents were concerned about their children's progress at school. Moreover the percentage of concerned parents increased since the children were seen at 8 years, from 20.5% then to 34.5% at 14 years. This suggests that as schoolwork becomes more abstract, parents perceive that more of their VLBW children struggle to keep up with their NBW peers. The Australian education system is reasonably uniform in its approach to repeating grades. Those who are not coping in the early years are advised to repeat a grade. To qualify for additional help at school, however, children have to have an IQ less than 70. This does not preclude parents seeking additional help outside the schoolroom. However, as with the VLBW cohort born in period 1966 to 1970, the low rate of receiving help at school suggests that parents are unsuccessful in their efforts and this remains a concern.

Our findings with respect to cognitive and school outcome are consistent with studies which reported on the outcome of VLBW children born before modern neonatal intensive care.

Although few survived at that time, those who did had remarkably similar outcomes to our cohort. Douglas and Gear[10] followed to the age of 15 years 163 children of birth weight less than 2000 g who were born in 1946. There were small but significant differences in favor of controls on various tests of ability, but the greatest difference was on a nonverbal test. Wright et al[30] followed to the age of 10 years a group of children born in the period 1952 to 1956. Compared with their controls, VLBW children performed poorly on tests of vocabulary and spatial orientation.

One problem common to all follow-up studies is that the outcomes are determined well after the newborn period, by which time the results are less relevant to the children in newborn intensive care nurseries today. However, the outcomes reported are clearly relevant to all VLBW survivors born in the era of our cohort and, as outlined above, are similar to findings from cohorts born several decades earlier. The outcomes at age 14 years in our cohort provide the best estimate for what children in newborn nurseries today will be like at 14 years of age, until superseded by more contemporary data.

Comparing the behavior of VLBW with NBW adolescents in our study, we found no significant differences in ratings of internalizing or externalizing problem behaviors or of social competence. Perhaps the total group comparison was too general. We may need to look for more specific indicators of behavior difficulties. In Stewart et al's study,[29] behavior and adjustment problems in VLBW adolescents were significantly related to neurological abnormalities identified by brain MRI. Those children without neurological abnormalities were no different from control subjects. In our study, the only behavior that showed significant differences between the groups was social rejection, with 12 VLBW adolescents, but no controls, rated by teachers as having this problem. The items which contributed to social rejection included being isolated from and not being accepted by their social group. Teachers did not identify this problem when the children were 8 years old. Like academic learning, the social tasks of the adolescent years become more challenging and our results suggest that a small minority of these vulnerable VLBW children is not coping with these increased demands. Interestingly, the behavior dimension "unforthcoming-unassertive," which characterized a significant number of VLBW children at 8 years,[5] was no longer a problem as perceived by teachers. It could be that by 14 years of age they are able to present themselves as functioning better socially.

Potentially of greater importance is how adolescents feel about themselves. Although there was no difference between VLBW and NBW adolescents in how they felt in their relationships within the family and within the school, and they scored as well as American norms, the VLBW children did have lower self-esteem than their NBW peers. Some of the items which contributed to the General Self measure of the Coopersmith Inventory included responses to items such as "there are lots of things about myself that I would change if I could," as well as to items reflecting low self-opinion, such as "giving in easily" and "difficulty in decision-making." We speculate that a contributing factor to the lower self-esteem may be difficulty in keeping up both academically and socially with peers at an age when the peer group is so important.

Studying the long-term outcome of neonatal intensive care graduates born in the years 1978 to 1980 in Ontario, Canada, Speechley and Avison[31] found that the boys studied had more physical health problems than the control boys at 12 years of age. However, they found that girls at 12 years of age were significantly lower than control subjects on their self-ratings of social competence, social rapport, and, consistent with our findings for VLBW survivors, self-esteem. Their study involved a randomized controlled trial of low intensity social support in the first year of life. They found that the intervention made no difference to outcome in the short- or long-term. Clearly, more detailed study is required of the impact of birth vulnerability on the child and the family so that risk factors for less favorable outcome can be identified. Interventions could then target these specific risk factors.

Our results accord with those of Saigal et al[32] who compared the self-assessed health status and health-related quality of life at 12 to 16 years of age of 83% (141/169) of children of birth weight less than 1001 g born in the years 1977 to 1982 in the central-west region of Ontario, Canada, with 86% (124/145) of control children who had been born at term. The subjects included children with physical and sensorineural problems. A significant minority of the children of birth weight less than 1001 g reported their quality of life less favorably than the controls. But importantly, the majority of children of birth weight <1000 g experienced a quality of life no different from that of control children.

In conclusion, the findings of our study are consistent with both recent reports of overall functioning of other low birth weight groups in early adolescence and studies completed earlier in the 1900s when the survival rate was much lower. Considering their frail beginnings, as a group VLBW children do surprisingly well. However, as at 8 years of age, a significant minority has cognitive weaknesses, learning problems, and importantly, lower self-esteem than their NBW peers. Further research needs to identify precursors of these problems so that appropriate interventions can be developed.

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