

## Nine-year Follow-up of Infants Weighing 1 500 g or Less at Birth

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**ABSTRACT.** Michelsson, K., Lindahl, E., Parre, M. and Helenius, M. (II Department of Paediatrics, Children's Hospital, University of Helsinki, Finland). Nine-year follow-up of infants weighing 1 500 g or less at birth. *Acta Paediatr Scand* 73:835, 1984.

A nine-year follow-up of 116 children born consecutively in 1971-74 with a birthweight of 1 500 g or less showed that 59 had died. Of those who were alive, four had severe motor and/or mental handicaps and three were blind because of retrolental fibroplasia. The low birthweight children without severe handicaps were found to have impaired motor function, speech defects and impaired school achievement more often than the controls. There was a significant correlation between the test results at the age of five and nine years, which indicates that children with school failure can be recognized and early remedial treatment started before school or on starting school. *Key words:* Low birthweight, follow-up study, neurodevelopmental dysfunction.

The mortality rate of infants weighing  $\leq 1\,500$  g at birth has decreased during the last three decades from 80% to about 30% (1, 2). With the lowered mortality the incidence of severe handicaps has diminished and ranges now from 8% to 20% for infants with a birthweight of  $\leq 1\,500$  g (2-4).

Less is known about the incidence of minor neurodevelopmental handicaps which often cannot be verified before school age. The importance of longitudinal studies has therefore gained emphasis in determining the true risk status of low birthweight (LBW) infants.

Minor neurodevelopmental handicaps, such as minimal brain dysfunction (MBD), slight visual and hearing impairment, and school problems have been found to occur in 13-21% of surviving prematures (3, 5). Hertzog (6) followed 66 children with a birthweight of 1 000-1 750 g up to the age of eight years. She found 13 children with localizing neurological findings and 20 with two or more 'soft' signs. Drillien (7) reported that 53% of the children with a birthweight below 1 500 g had one or more physical defects and 78% were reported to have behavioural problems. The late prognosis has much improved since then. In several studies, no detectable handicaps have been found in 56-90% of surviving children born with a birthweight below 1 500 g (4, 8-10).

There are also reports, however, which are not so optimistic about the late prognosis. The school achievement has been impaired in up to 37% of preterm infants (11). Fitzhardinge & Ramsay (12) found among 32 children with a birthweight below 1 250 g 9 with MBD and 10 with perceptual motor difficulties, of which 7 were doing poorly at school.

The present study reports a nine-year follow-up of children who were born consecutively during a four-year period with a birthweight  $\leq 1\,500$  g. One of the goals of the longitudinal study was to develop methods for identifying the mildly handicapped at the age of five years, thus enabling early intervention for identifiable problems. The test results from the five- and nine-year examinations are therefore compared in order to evaluate if at the age of five it had been possible to foresee school failure at age nine.

### MATERIAL

The series consisted of 116 infants with a birthweight of 1 500 g or less. The infants were born in 1971-74 at the Institute of Midwifery, Helsinki, and were prospectively followed-up to the age of nine years.



(g.w.) or earlier, 26% at 31–33 g.w., 21% at 34–36 g.w. and 7% at  $\geq 37$  g.w. Sixteen (28%) were born small for gestational age and ten (18%) were twin partners. The social class was according to the father's occupation (or mother's if she was unmarried or divorced) in 47% group I–II and in 53% group III–IV. Seventeen percent were not married at the time of delivery. Toxaemia was noted in five mothers. Two children were born together with an intrauterine conception device.

The Apgar scores for 31 children (54%) were  $\leq 6$  at 1 and/or 5 minutes of age. Intubation and ventilation were performed immediately after birth on six children, the rest had received additional oxygen through funnel or mask ventilation. Five children were treated with a respirator for 3–7 days. Repetitive apnoeic spells were noted in eight children. Caesarean section had been performed in ten cases. Eight children were born by breech delivery and one by forceps delivery.

Nine children had had hyperbilirubinaemia  $>200$  mmol/l; four of these above 300 mmol/l. Blood exchange transfusions were given to five children. One child had had convulsions in the neonatal period, and one had been treated for *E. coli* septic infection.

*Severe handicaps.* Children with known severe handicaps were not invited to the nine-year examination. These were three blind children with retrolental fibroplasia, one of which also had spastic tetraplegia. Three children had both severe mental retardation and cerebral palsy; two spastic tetraplegia and one diplegia. One child had hemiplegia.

Table 1. Results for the Test of Motor Impairment, ITPA and WISC

Test of Motor Impairment and ITPA were administered to 41 LBW children and 39 controls, WISC to 30 LBW children and all controls

Test item	LBW children	Controls	p-value <sup>a</sup>
Test of Motor Impairment	8.6 $\pm$ 7.1	5.0 $\pm$ 3.9	<0.01
WISC			
Verbal	105.7 $\pm$ 12.4	118.0 $\pm$ 10.2	<0.001
Performance	110.0 $\pm$ 12.0	118.5 $\pm$ 12.9	<0.01
Total score	108.7 $\pm$ 10.4	120.1 $\pm$ 10.4	<0.001
ITPA			
Visual reception	33.8 $\pm$ 7.2	37.1 $\pm$ 7.3	<0.05
Visual sequential memory	31.2 $\pm$ 6.7	35.6 $\pm$ 4.4	<0.01
Auditory sequential memory	36.3 $\pm$ 7.0	35.6 $\pm$ 5.3	NS
Auditory association	35.4 $\pm$ 6.8	39.7 $\pm$ 5.8	<0.01
Auditory closure	32.1 $\pm$ 6.9	36.6 $\pm$ 6.7	<0.01
Manual expression	34.8 $\pm$ 6.5	35.7 $\pm$ 6.4	NS
Sound blending	36.9 $\pm$ 6.2	39.2 $\pm$ 5.4	NS
Total score	34.6 $\pm$ 3.3	37.1 $\pm$ 3.0	<0.001

<sup>a</sup> Determined by *t*-test.

Table 2. Correlation between test results at five and nine years

Five years	Nine years	r	p
Neurodevelopmental screening examination	Test of Motor Impairment	0.613	<0.001
Neurodevelopmental screening examination	School achievement	0.490	<0.01
ITPA	School achievement	0.449	<0.01
ITPA	IQ	0.652	<0.001
Total impairment score	Total impairment score	0.612	<0.001
Total impairment score	School achievement	0.747	<0.001

Children with less severe forms of disabilities were asked to the follow-up. These were one child with slight hemiplegia, one with a convulsive disorder and one with vision impairment due to retrolental fibroplasia.

*Minor handicaps.* Nine children did not attend the follow-up examinations; one was not traced and the rest were not brought by the parents mainly because of travelling difficulties. The results are thus based on the data of 41 children, 15 boys and 26 girls.

The mean length of the LBW children was at the age of nine years  $132.9 \pm 6.6$  cm and the mean weight was  $29.0 \pm 4.9$  kg. The mean head circumference was  $52.2 \pm 1.9$  cm. There were no significant differences compared with the control series. The social class distribution at the age of nine was I-II in 49%, III-IV in 47% and V (retired, unemployed) in 4%. The corresponding figures for the control series were 47%, 51% and 2%.

Four children had a squint and three marked myopia. The child with retrolental fibroplasia had also hearing impairment and used a hearing aid. Three other children had mild unilateral sensorineural hearing impairment.

Table 1 shows the test results of the Test of Motor Impairment, the WISC and the ITPA. The LBW children did significantly worse than the controls in the Test of Motor Impairment. Taking 13 points as the lower limit, for unequivocally pathological performance, 20.0% of the LBW children fell in this category compared with 2.6% of the controls. The LBW children were significantly worse than the controls also in both the verbal and performance part of the WISC intelligence test, and in four of the seven ITPA subtests.

According to the teachers' statements, the LBW children had inferior school marks compared with controls; the difference was, however, not statistically significant. The teachers stated that 67% of the LBW children were in need of extra supervision compared with 38% of the controls. In the writing test the LBW children had significantly more misspellings than the controls ( $p < 0.001$ ). There were no significant differences in the ability to pronounce words when reading, but the LBW children read significantly slower than the controls ( $p < 0.01$ ). Of the LBW children 28% were receiving speech therapy, compared with 4% of the controls.

There was no significant correlation between school marks and social class distribution. The scores of the Test of Motor Impairment correlated significantly with school marks ( $r = 0.454$ ,  $p < 0.001$ ) and intelligence test ( $r = 0.525$ ,  $p < 0.001$ ).

*Comparison of the results at five and nine years.* The mean neurodevelopmental score for the LBW children was at the age of five years  $22.6 \pm 18.6$ , the mean ITPA including all 12 subtests was  $34.1 \pm 4.2$ . The correlation between the test results for the LBW children at the age of five and nine years are presented in Table 2 and shows a significant correlation between the results.

In Table 3 the total impairment score at five and nine years are compared. The children were divided into groups with scores 0-2 and  $\geq 3$ . Of the 25 children with scores 0-2 at age five only one child had at the age of nine scores  $\geq 3$ . The child managed badly in school and

Table 3. The correspondence between the total impairment score at five and nine years

	Scores	Age nine	
		0-2	$\geq 3$
Age five	0-2	24	1
	$\geq 3$	6	10

Sensitivity (10/11) 100=91%. Specificity (24/30) 100=80%.

had repeated one class. ( had scores  $\geq 3$  at age nine children and three had r children with motor han children, and there were |

## DISCUSSION

The present study was a certain high risk factors : comprised 5.4% of the | children belonging to the

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The occurrence of min and learning difficulties h; Francis-Williams & Davie 105 children with a birth considerable degree of mi below 1 500 g. No control of 23 LBW children did. follow-up study of preme results of prematurely bo

The scores of Test of | children and 3% of the c; with both school achieve; lesion which causes the learning and behaviour. S studying preterm childre; motor abilities that the se of outcome. Fuller et al. ( neonatal period pathologi; later learning dysfunction

Fitzhardinge & Ramsa expressive ability in the p LBW children were receiv in the control series. The only include motor handi influence school achieve children (18) that the ex severity of the neonatal di years more neurologically such as asphyxia, respira

The significant correlati



had repeated one class. Of the 16 children with scores  $\geq 3$  at five years the majority also had scores  $\geq 3$  at age nine. The school start had been postponed for two of the high score children and three had repeated one class. One child was attending a special class for children with motor handicaps, one was in a special class for emotionally disturbed children, and there were plans to move one child to a special class for mentally retarded.

### DISCUSSION

The present study was a part of a prospective research project in which infants born with certain high risk factors were followed-up to the age of nine years. The high risk group comprised 5.4% of the live born during the four-year period (20). About 10% of the children belonging to the high risk group had a birthweight  $\leq 1500$  g.

The 51% mortality in our study is comparable with rates reported from the early 1970s (1, 4, 9). The lack of facilities for intensive care and the fact that the children had to be in good enough condition to tolerate transportation to the Children's Hospital might have increased the mortality rate slightly.

The rate of severe motor and mental handicaps was 6% in the present study which is similar to previous reports (1, 21). According to Stewart et al. (1) the rate of severe handicaps has despite intensive care remained stable at 6–8%, although the proportion of apparently normal survivors has increased as a result of the decreasing mortality.

The occurrence of minor handicaps has varied more. Neurological 'soft signs', MBD, and learning difficulties have been present in 13–29% in previous studies (3, 5, 10, 12, 22). Francis-Williams & Davies (22) found that learning difficulties were present in one fifth of 105 children with a birthweight of 1500 g or less. Noble-Jamieson et al. (23) found a considerable degree of minor neurological dysfunction in children born with a birthweight below 1500 g. No control child in their series received neurological scores  $\geq 5$ , while eight of 23 LBW children did. Drillien et al. (24) used the Test of Motor Impairment in their follow-up study of prematurely born and noted significant differences between the test results of prematurely born and controls.

The scores of Test of Motor Impairment in our study were  $\geq 13$  in 20% of the LBW children and 3% of the controls. As the Test of Motor Impairment correlated significantly with both school achievement and intelligence quotient, it can be assumed that an organic lesion which causes the motor disturbances is also responsible for the dysfunction in learning and behaviour. Similar results have been reported previously. Siegel (25) noted in studying preterm children who at school age were delayed in perceptual memory and motor abilities that the severity of illness during the perinatal period was the best indicator of outcome. Fuller et al. (26) found in the autopsies of 16 premature infants who died in the neonatal period pathological cerebral findings which were postulated to be precursors of later learning dysfunction and MBD in children who survive.

Fitzhardinge & Ramsay (12) associated speech defects including both receptive and expressive ability in the prematurely born with brain dysfunction. In our series 17% of the LBW children were receiving speech therapy at the age of nine years compared with none in the control series. The minor neurological dysfunction associated with LBW thus not only include motor handicaps but also dysfunction of perceptual and language skills, and influence school achievement. We have previously noted in examining five-year-old children (18) that the extent of the neurodevelopmental dysfunction depended on the severity of the neonatal disease. Children weighing  $\leq 2000$  g at birth were at the age of five years more neurologically impaired if they subsequently had other perinatal risk factors such as asphyxia, respirator treatment or hypoglycaemia (18, 19).

The significant correlation between the test results of the neurodevelopmental screening

examination at age five and the school achievement at age nine indicates that there is a possibility of identifying children at risk of school failure at the age of five years and thus starting remedial treatment early. However, a diagnosis of neurodevelopmental dysfunction should not be assessed only on our test results; more thorough examinations are needed for those who do not manage.

#### ACKNOWLEDGEMENTS

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