Articles

Behavioural problems in children who weigh 1000 g or less at birth in four countries

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Summary

Background The increased survival chances of extremely low-birthweight (ELBW) infants (weighing ⩽1000 g at birth) has led to concern about their behavioural outcome in childhood. In reports from several countries with different assessments at various ages, investigators have noted a higher frequency of behavioural problems in such infants, but cross-cultural comparisons are lacking. Our aim was to compare behavioural problems in ELBW children of similar ages from four countries.

Methods We prospectively studied 408 ELBW children aged 8–10 years, whose parents completed the child behaviour checklist. The children came from the Netherlands, Germany, Canada, and USA. The checklist provides a total problem score consisting of eight narrow-band scales. Of these, two (aggressive and delinquent behaviour) give a broad-band externalising score, three (anxious, somatic, and withdrawn behaviour) give a broad-band internalising score, and three (social, thought, and attention problems) indicate difficulties fitting neither broad-band dimension. For each cohort we analysed scores in ELBW children and those in normal-birthweight controls (two cohorts) or national normative controls (two cohorts). Across countries, we assessed deviations of the ELBW children from normative or control groups.

Findings ELBW children had higher total problem scores than normative or control children, but this increase was only significant in European countries. Narrow-band scores were raised only for the social, thought, and attention difficulty scales, which were 0·5–1·2 SD higher in ELBW children than in others. Except for the increase in internalising scores recorded for one cohort, ELBW children did not differ from normative or control children on internalising or externalising scales.

Interpretation Despite cultural differences, types of behavioural problems seen in ELBW children were very similar in the four countries. This finding suggests that biological mechanisms contribute to behavioural problems of ELBW children.

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Introduction

Follow-up studies of extremely low-birthweight (ELBW) children (⩽1000 g) have identified major disabilities such as cerebral palsy, mental retardation, blindness, and deafness. High rates of behavioural problems have also been noted in ELBW children of school age, with attention problems being the most frequently cited.[1–11] Since behavioural problems adversely affect school performance and development of social relations, these are important long-term effects of preterm birth. Investigators from several countries have noted a higher frequency of behavioural problems in ELBW children than in other infants. However, cross-cultural studies are lacking.

Is the development of behavioural problems related to low-birthweight and its associated medical risk factors or do cultural aspects play a part? Our aim was to answer this question by studying the types and rates of behavioural problems recorded in ELBW children in four population-based cohorts from North America and Europe.

Methods

Study population

We obtained behavioural data for all survivors from four large prospective cohorts of preterm infants in four countries. These cohorts were: the neonatal brain-hemorrhage cohort (NBH) from the USA (1105 births ⩽2000 g, born 1984–87);[12] the McMaster ELBW cohort (McM) from Canada (397 births ⩽1000 g, born 1977–82);[13] the Bavarian longitudinal study of children at biological risk (BLS) from Germany (682 births <1500 g, <32 weeks, or both; born 1985–86);[14] and the project on preterm and small for gestational age infants (POPS) from Netherlands (1338 births <1500 g, <32 weeks, or both; born 1983).[15] We describe only the findings for ELBW children.

We obtained reference data from normative population samples for two of the participating countries (USA and Netherlands). These samples included healthy children from the same country as the study population. Thus, we included 1200 4–11-year-old children in USA[16] as normative controls and 1172 4–11-year-olds in Netherlands.[17] In Canada[13] and Germany[14] we used 145 and 335 same-aged full-term control children.

Study protocol

We assessed behaviour with the child behaviour checklist, which was completed by parents, at age 8–10 years. The list contains 118 items for difficult behaviour, all scored zero (not true), one (somewhat or sometimes true), or two (very true or often true),[16] and allows the calculation of a total problem score. Principal components analyses revealed eight categories: withdrawn (rather be alone, shy), somatic complaints (dizzy, headaches), anxious or depressed (cries, nervous), social difficulties (acts young, not liked), thought difficulties (hears or sees things, repeats acts), attention difficulties (cannot concentrate, impulsive), delinquent behaviour (steals, swears), and aggressive behaviour (mean, threatening). Principal factor analysis of the eight categories produced two broad-band groupings: internalising, derived

Characteristic	Cohort				
	USA	Canada	Germany	Netherlands	Total
Total births	231	397	203	310	1141
Survived until assessment	113 (49%)	179 (45%)	91 (45%)	140 (45%)	523 (46%)
Assessed CBCL at age 8–19	80 (71%)	150 (84%)	78 (86%)	100 (71%)	408 (78%)
Mean (SD) gestational age (weeks)	27 (2·3)	27 (2·3)	29 (2·0)	29 (2·3)	28 (2·5)
Mean (SD) birthweight (g)	853 (114)	834 (126)	888 (101)	882 (105)	860 (116)
Male	32 (40%)	67 (45%)	35 (45%)	42 (42%)	176 (43%)

CBCL=child behaviour checklist.

Table 1: **Baseline characteristics**

from the sum of items on the first three groups (anxious, somatic, withdrawn behaviour), and externalising, from those of the last two (aggressive and delinquent behaviour). The remaining three categories (social, thought, and attention problems) indicate trouble fitting either broad-band dimension.[16]

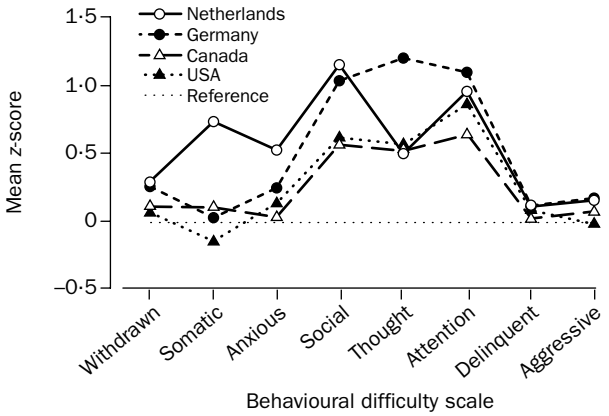
Statistical analysis

We established mean gestational age (in completed weeks), mean birthweight, and proportion of boys for each cohort, and tested differences in mean gestational age and mean birthweight by use of one-way ANOVA. Means and mean *z*-scores for total problem scores, internalising, and externalising behaviour, and for the eight category scales were recorded for each cohort. *Z*-score was defined as each patient score minus the mean of the reference group (country and sex specific) divided by the SD of that reference group. The result of this calculation, by definition, is that the *z*-scores of all country-specific reference groups become zero (SD 1). Mean *z*-scores of ELBW groups can, therefore, be compared with each other. In every cohort, differences in mean scores between index and reference group were tested with Student's *t* test. Additionally, between cohorts, differences in *z*-scores between ELBW groups were tested with one-way ANOVA with Bonferroni correction. A p value of ≤0·01 was judged significant.

Results

We assessed 78–150 ELBW children in each of the four cohorts (table 1). The overall rate of follow-up was 78%. Mean birthweight was 860 g, and mean gestational age was 28 weeks. Although birthweight differed only slightly among cohorts (f=5·437, p=0·001), gestational age was 2 weeks lower in North American than in European cohorts (f=26·551, p<0·001).

The differences in total problem score between ELBW boys and controls ranged from 3·3 points in USA to 9·8 in Netherlands, and in girls from 3·7 to 5·9 (table 2). In Germany and Netherlands the total problem score was only



Mean *z*-scores for eight problem scales in ELBW children
The null-line is the *z*-score for the country-specific reference group.

significantly raised in the ELBW group by comparison with the reference group. However, when comparing z-scores for ELBW groups between cohorts, differences in this score between European (*z*-score 0·54 SD) and North American (*z*-score 0·24 SD) ELBW groups were not significant. Internalising scores of ELBW children were only significantly increased in Netherlands. Externalising scores were similar in test children and controls in all countries. In the four cohorts, *z*-scores of the ELBW children for social, thought, and attention difficulty scales were 0·48–1·20 SD higher than those of the country-specific reference group (p<0·001; figure). When analysing these scores between ELBW groups, the size of the effect did not differ significantly. However, difference in social difficulties between European (*z*-score 1·10 SD) and North American (*z*-score 0·58 SD) ELBW groups was significant (p=0·001). In the Netherlands, somatic complaints and anxious or depressed behaviour were also significantly raised in ELBW children.

Discussion

We identified very similar types of behavioural problems in all four countries, despite cultural differences in mean scores. Crijnen and colleagues[18,19] have also shown that the child behavioural checklist can identify difficulties for which children might need help, even when they are from diverse cultural backgrounds. The mean total problem score in Canadian ELBW and control children was high relative to that of the other three countries, but the difference between ELBW and controls was in the same range. Our finding suggests that difficulties with the three dimensions of attention, social, and thought problems are not a function of cultural differences, but an indication of experiences specific to children who were born with an ELBW. Our findings are also consistent with types of behavioural problems

	USA		Canada		Germany		Netherlands	
	ELBW (n=80)	Norm (n=1200)	ELBW (n=150)	Control (n=145)	ELBW (n=78)	Control (n=335)	ELBW (n=100)	Norm (n=1172)
Total problem score								
Boys	27·6 (20·9)	24·3 (15·6)	38·8 (17·6)	34·6 (18·0)	30·5 (13·5)*	21·7 (13·1)	31·1 (20·7)*	21·3 (14·0)
Girls	26·8 (24·4)	23·1 (15·5)	35·9 (19·5)	31·8 (15·7)	24·3 (14·3)*	19·1 (10·9)	25·1 (20·0)*	19·2 (14·8)
Internalising score								
Boys	6·4 (7·0)	5·6 (4·7)	9·0 (4·7)	9·0 (6·4)	8·4 (5·5)	6·7 (4·9)	7·7 (6·7)*	4·5 (4·3)
Girls	6·1 (5·7)	6·3 (5·5)	10·4 (6·8)	9·4 (5·9)	7·6 (5·8)	6·9 (4·4)	7·9 (7·9)*	5·2 (5·0)
Externalising score								
Boys	9·4 (8·5)	9·8 (7·1)	13·4 (8·3)	12·9 (6·4)	11·1 (5·3)	9·1 (6·1)	10·2 (8·4)	8·3 (6·4)
Girls	8·4 (9·1)	8·2 (6·1)	10·7 (6·6)	10·4 (5·5)	7·2 (4·8)	7·1 (4·6)	6·2 (6·0)	6·0 (5·6)

*p<0·01, Student's *t* test contrast between ELBW and reference group per cohort.

Table 2: **Mean (SD) total problem score and scores on internalising and externalising broad-band categories in extremely low-birthweight (ELBW) group and reference group (norm or control) in four cohorts by sex**

described in a review of studies done by Chapieski and Evankovich[9] in prematurely born children.

Our cohorts did not share the same birth years. The largest temporal gap was between the McM cohort (born 1977–82) and the NBH cohort (born 1984–87). Moreover, the normative group for the US sample was obtained among 4–11 year olds in 1989, a time at which children in the NBH cohort were aged 2–5 years. We doubt that these modest temporal differences can explain our findings. Achenbach and Howell[20] assessed differences between their two normative samples of 1976 and 1989, and concluded that, unlike the case for cognitive outcome, in which temporal trends in scores have been described,[14] secular changes were small for behaviour.

Various mechanisms could be invoked to explain the association between ELBW and behavioural problems. Central nervous system insult due to prenatal or neonatal complications could lead to attention deficit and hyperactivity.[21,22] In the NBH cohort, a strong association (adjusted odds ratio 3·4) was identified between neonatal cranial ultrasound abnormalities indicative of white-matter injury and attention deficit disorder at age 6. Difficulties with making friends and maintaining social relations have been recorded more frequently in children who are hyperactive or have attention deficit disorders.[24] Poor processing of multiple cognitive stimuli (simultaneous information processing) could also cause difficulties in social situations, since these situations often need processing of multiple cues simultaneously.[25]

Another possible mechanism for the social difficulties that we report might be differences in parental behaviour. The immature behavioural organisation of the preterm infant could provide more challenges to parental behaviour and to parent-child interaction.[26] Life-threatening events in the perinatal period might induce overprotective parental behaviour, which leads to differences in parental perception of the child's behaviour, and to inadequate socioemotional behavioural adjustment in the child.[27]

Since the birth years of our study children in the 1980s, the survival rate for ELBW children has increased. Advances in medical technology and increased understanding of how to prevent cerebral damage in newborn babies might lead to a reduction in rates of behavioural difficulties.[28,29] However, because of these advances, ever increasing numbers of extremely immature and sick babies with a high risk for cerebral problems now have a chance to survive, and could add to the total number of children with behavioural difficulties in the community.[30] Children born with an ELBW, irrespective of culture, are at risk of attention, social, and thought difficulties. As such, prospective monitoring of these children for development of behavioural problems is advisable to prevent subsequent learning and social integration difficulties.

Contributors

ETM Hille and AL den Ouden developed the analytic plan for assessment of behaviour, did statistical analyses, and wrote the first draft of the report. All investigators participated in meetings to discuss findings, edit and revise the report, and review relevant literature. M Lambert, D Wolke, A Whitaker, and JF Feldman assisted in refining statistical analyses. Investigators responsible for orginal data collection and for preparation of behavioural data for analysis were: Netherlands, SP Verloove-Vanhorick and AL den Ouden; Germany, R Meyer and D Wolke; Canada, S Saigal and L Hoult; USA, N Paneth, JA Pinto-Martin, A Whitaker, and JF feldman. N Paneth led the effort to obtain funding for, and organise, collaborative analyses.

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