Longitudinal motor development of “apparently normal” high-risk infants at 18 months, 3 and 5 years

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Abstract

Background: Motor development appears to be more affected by premature birth than other developmental domains, however few studies have specifically investigated the development of gross and fine motor skills in this population. Aim: To examine longitudinal motor development in a group of “apparently normal” high-risk infants. Setting: Developmental follow-up clinic in a perinatal centre. Study design: Longitudinal observational cohort study. Subjects: Fifty-eight infants born less than 29 weeks gestation and/or 1000 g and without disabilities detected at 12 months. Outcome measures: Longitudinal gross and fine motor skills at 18 months, 3 and 5 years using the Peabody Developmental Motor Scales. The HOME scale provided information of the home environment as a stimulus for development. Results: A large proportion (54% at 18 months, 47% at 3 years and 64% at 5 years) of children continued to have fine motor deficits from 18 months to 5 years. The proportion of infants with gross motor deficits significantly increased over this period (14%, 33% and 81%, \( p < 0.001 \)), particularly for the ‘micropreemies’ (born < 750 g). In multivariate analyses, gross motor development was positively influenced by the quality of the home environment. Conclusions: A large proportion of high-risk infants continued to have fine motor deficits, reflecting an underlying problem with fine motor skills. The proportion of infants with gross motor deficits significantly increased, as test demands became more challenging. In addition, the development of gross and fine motor skills appears to be influenced differently by the home environment.

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1. Introduction

With rapid advances in neonatal medicine, increasing numbers of infants born extremely early are surviving [1–3], and attention has recently been directed at examining the quality of survival in this high-risk group, born at <29 weeks gestation and weighing <1000 g. Studies investigating the outcome of these infants have focused on examining the incidence of major disability, which is significantly higher for this population, reported to be 10–30% [4–9]. The majority of studies have found that, whilst there is an increased incidence of major disability in this population, the majority have average intelligence and attend mainstream schools [4,6,10]. Even amongst infants with no major disability, a higher prevalence of minor morbidities, including motor deficits, has been found [11–14].

Research has largely concentrated on cognitive aspects and has given limited attention to the significance of motor difficulties, which are frequently reported [15–19]. Motor development during these formative years provides a foundation for subsequent development and optimises occupational performance in the areas of self-care, learning, leisure and play. Minor problems, which are likely to interfere with learning and success at school, may not be detected until school age. Motor difficulties then, can impact on a child’s ability to learn and successfully participate in everyday life at school and home.

We have previously investigated fine motor skills in apparently ‘normal’ preterm children, finding the majority (71%) had fine motor deficits at 5 years [20]. Although Churcher et al.’s [21] study examined the development of fine motor skills over the first 2 years of life, no study has specifically investigated the development of both gross and fine motor skills to school-age.

The aim of this study was to prospectively examine the gross and fine motor development of a group of high-risk infants who did not have a major disability at 18 months, 3 and 5 years. The motor development of “micropreemies” (born <750 g) and the influence of the home environment and gender on motor development over this period were also examined.

2. Methods

High-risk infants (<29 weeks gestation or <1000 g) born between 1992 and 1993 at Westmead Hospital, Sydney were enrolled in the Growth and Development Clinic for long-term follow-up with our multidisciplinary team, which included a paediatrician, occupational therapist, psychologist and physiotherapist. At each assessment, infants were seen by a paediatrician for clinical and neurological examinations. A psychologist assessed general development at 12 months and 3 years of age using the Griffiths Mental Development Scales [22]. The Locomotor and Eye–Hand Coordination Scales of the Griffiths was also administered at the 5-year assessments. Other routine screening included a hearing assessment by an audiologist using visual reinforced audiometry at 6 months corrected age, and periodic follow-up by an ophthalmologist and orthoptist in early infancy, at 12 months corrected age and then yearly reviews.
At 12 months, infants who were assessed as not having a neurodevelopmental deficit were eligible for this longitudinal study. Of the 121 infants initially discharged home, 2 who were deceased and 22 (18%) identified with a neurological or intellectual disability were excluded from the study. These included children identified with cerebral palsy, those who had a DQ < 70 on the Griffiths, a visual or hearing impairment. In addition, there were 12 (10%) children who were lost to follow up, leaving 85 eligible for this study.

Gross and fine motor skills were assessed by an occupational therapist with the Peabody Developmental Motor Scales [23] at 18 months corrected age, 3 and 5 years chronological age. This test has been used in a number of follow-up studies investigating motor skills in the preterm population [9,21,35]. It is a standardised and norm-referenced test of gross and fine motor skills from birth to 8 years of age. It consists of a Gross Motor and Fine Motor Scale, each of which is divided into skill categories. Test items reflect typical motor tasks for each age, including ball skills, balance items, drawing and manual dexterity tasks. Performance on this test was summarised and analysed using the developmental motor quotient (DMQ), which has a mean of 100 and a standard deviation of 15.

One occupational therapist (T.G.) conducted the motor tests at all three assessment points. Testing commenced in 1993 and finished in 1999 when the 5-year assessments were completed. Assessments were performed in the clinic rooms and children were examined individually.

At the initial 18 month assessment, the occupational therapist conducted an interview with the family for completion of the Home Observation of the Maternal Environment (HOME) Scale [24]. This is an instrument designed to provide specific and sensitive information about the adequacy of the home environment as a stimulus for infant cognitive, social, and physical development. The HOME scale uses a combination of observer/interview technique, usually involving the mother or primary caretaker. The scale contains 45 items organised into six subscales: emotional and verbal responsivity of the mother; avoidance of restriction and punishment; organization of physical and temporal environment; provision of appropriate play materials; maternal involvement; and opportunity for variety in daily stimulation. The scale provides a Total Score that reflects the social, emotional and cognitive supports available in the home. Infants were considered to be from a lower HOME group (i.e. homes with fewer social, emotional and cognitive supports) if total scores were placed within categories 1–3 (total score < 35), and from a higher HOME group if placed within categories 4–5 (total score >35).

2.1. Data analysis

Perinatal variables, socio-economic status and motor scores collected at the clinic were analysed using the Statistical Package for the Social Sciences on a personal computer. The probability value for all tests was set at \( p < 0.05 \). Student’s \( t \)-test and Mann–Whitney Test were used for continuous data and Fisher exact test for categorical data. Friedman Test of Repeated Measurements and Cochran’s Test were used where appropriate. Spearman’s rho correlation was used to examine the relationship between the Peabody and Griffiths scores. Regression analyses were used to examine the influence of home environment and being “micropreemies” on gross and fine motor skills at age 5.
3. Results

Amongst the 85 children enrolled for this study, 13 (15%) were lost to follow up during the next 4 years. Fourteen however, had missed one of the three assessments over this period. Therefore, for the purpose of this longitudinal study, results were only analysed for the remaining 58 eligible infants who had completed all assessments at all 3 specified ages. Perinatal details of the 3 groups are summarised in Table 1. Comparison between these groups indicated no difference, with the exception that those lost tended to be of shorter gestation.

The study group comprised 31 males and 27 females born at 28 weeks gestation (median gestational age) and weighing 942.5 g (median birth weight). Their mean GQ at the age of 12 months was 105.5 (SD 8.7, range 81.9–129.2).

3.1. Motor development over time

3.1.1. Gross motor development

At 18 months corrected age, the mean Gross Motor DMQ for the group was 90.0, with 13.8% scoring below 1 standard deviation. The mean score was similar at 3 years of age (DMQ = 91.0), although a greater proportion of the group (32.8%) scored within the deficit range. By 5 years, the group mean had dropped to 79.0 and the

<table>
<thead>
<tr>
<th>Variable</th>
<th>Studied(^a) (n = 58)</th>
<th>Incomplete(^b) (n = 14)</th>
<th>Lost(^c) (n = 13)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestational (weeks)</td>
<td>28.0</td>
<td>27.0</td>
<td>27.0**</td>
</tr>
<tr>
<td>Median (quartiles)</td>
<td>(27.0, 29.0)</td>
<td>(25.8, 28.0)</td>
<td>(26, 27.5)</td>
</tr>
<tr>
<td>Birthweight (g)</td>
<td>942</td>
<td>952.5</td>
<td>895</td>
</tr>
<tr>
<td>Median (quartiles)</td>
<td>(794, 1090)</td>
<td>(841.3, 1122.5)</td>
<td>(837.5, 1137.5)</td>
</tr>
<tr>
<td>Males (%)</td>
<td>31 (53%)</td>
<td>7 (50%)</td>
<td>6 (46%)</td>
</tr>
<tr>
<td>5-min Apgar &lt; 5 (%)</td>
<td>9 (16%)</td>
<td>1 (7%)</td>
<td>5 (38%)</td>
</tr>
<tr>
<td>Days mech. ventilated</td>
<td>6.5</td>
<td>9.5</td>
<td>6</td>
</tr>
<tr>
<td>Median (quartiles)</td>
<td>(1.0, 19.5)</td>
<td>(1.75, 21.3)</td>
<td>(2, 26.5)</td>
</tr>
<tr>
<td>CLD (%)</td>
<td>10 (17%)</td>
<td>6 (43%)</td>
<td>1 (8%)</td>
</tr>
<tr>
<td>NEC (%)</td>
<td>10 (17%)</td>
<td>1 (7%)</td>
<td>3 (23%)</td>
</tr>
<tr>
<td>NEC with surgery (%)</td>
<td>9 (16%)</td>
<td>0 (0%)</td>
<td>1 (8%)</td>
</tr>
<tr>
<td>Grade III–IV I.V.H. (%)</td>
<td>3 (5%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Hydrocephalus (%)</td>
<td>1 (1.7%)</td>
<td>0 (0%)</td>
<td>1 (8%)</td>
</tr>
<tr>
<td>P.V.L. (%)</td>
<td>2 (3%)</td>
<td>0 (0%)</td>
<td>1 (8%)</td>
</tr>
<tr>
<td>Stage 3 R.O.P. (%)</td>
<td>7 (12%)</td>
<td>2 (14%)</td>
<td>1 (8%)</td>
</tr>
<tr>
<td>GQ median (quartiles)</td>
<td>104.6 (100.7, 111.4)</td>
<td>107.7 (103.9, 118.7)</td>
<td>104.9 (100.5, 109.6)</td>
</tr>
</tbody>
</table>

NEC = necrotising enterocolitis; I.V.H. = intraventricular haemorrhage; CLD = chronic lung disease, oxygen dependency > 36 weeks gestation. P.V.L. = periventricular leukomalacia; R.O.P. = retinopathy of prematurity.

\(^a\) Completed all assessments.
\(^b\) Missed one assessment.
\(^c\) Lost to follow up.
** Significantly different to group studied, \(p < 0.05\); Wilcoxon Signed Ranks Test and Chi-square Tests used.
majority (81.1%) scored below the ‘normal’ range on the test. The gross motor quotient significantly decreased over time (see Table 2). Fig. 1 illustrates the change in percentage of children with gross motor deficits over this period.

### 3.1.2. Fine motor development

At initial assessment, the mean fine motor DMQ was 84.0, which is just below the ‘normal’ range on the test. Over half (53.5%) of the group’s score indicated a deficit in fine motor skills. The mean DMQ remained fairly consistent at the 3- and 5-year
assessments (89.0 and 84.0, respectively), with a slight increase in the percentage scoring below 1 standard deviation (46.5% and 63.8%, respectively). A significant proportion of children (63.8%) continued to have fine motor deficits at 5 years of age. There was no change in the fine motor scores over this period (refer to Table 2) nor the percentage of children identified with fine motor deficits (refer to Fig. 1).

3.2. Influence of gender

The group comprised 31 males and 27 females. There was no difference between motor scores for males and females at any of the assessments (refer to Table 3).

Table 3
Motor development of micropreemies and influence of gender and the home environment at 18 months, 3 and 5 years

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>18 months</th>
<th>3 years</th>
<th>5 years</th>
<th>p-valuea</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gross motor</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Micropreemies</td>
<td>10</td>
<td>89.5 (87, 95)</td>
<td>85.0 (75, 96)</td>
<td>74.0 (74, 78)</td>
<td>0.03*</td>
</tr>
<tr>
<td>Others</td>
<td>48</td>
<td>94.0 (87, 106)</td>
<td>93.0 (83, 98)</td>
<td>81.0 (75, 84)</td>
<td>&lt;0.01*</td>
</tr>
<tr>
<td>p-valueb</td>
<td></td>
<td>0.19</td>
<td>0.14</td>
<td>0.002*</td>
<td></td>
</tr>
<tr>
<td><strong>Fine motor</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Micropreemies</td>
<td>10</td>
<td>84.0 (80, 89)</td>
<td>83.0 (83, 89)</td>
<td>75.0 (65, 84)</td>
<td>0.12</td>
</tr>
<tr>
<td>Others</td>
<td>48</td>
<td>84.0 (84, 89)</td>
<td>89.0 (77, 98)</td>
<td>84.0 (79, 97)</td>
<td>0.59</td>
</tr>
<tr>
<td>p-valueb</td>
<td></td>
<td>0.42</td>
<td>0.21</td>
<td>0.006*</td>
<td></td>
</tr>
<tr>
<td><strong>Gross motor</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>31</td>
<td>90.0 (87, 100)</td>
<td>91.5 (80, 98)</td>
<td>79.0 (79, 87)</td>
<td>&lt;0.01*</td>
</tr>
<tr>
<td>Female</td>
<td>27</td>
<td>94.0 (87.5, 106)</td>
<td>91.0 (83, 98)</td>
<td>79.0 (75, 82)</td>
<td>&lt;0.01*</td>
</tr>
<tr>
<td>p-valueb</td>
<td></td>
<td>0.20</td>
<td>0.99</td>
<td>0.82</td>
<td></td>
</tr>
<tr>
<td><strong>Fine motor</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>31</td>
<td>84.0 (80, 89)</td>
<td>83.0 (72, 93)</td>
<td>82.0 (77, 90)</td>
<td>0.43</td>
</tr>
<tr>
<td>Female</td>
<td>27</td>
<td>84.0 (84, 89)</td>
<td>89.0 (78, 100)</td>
<td>84.0 (79, 97)</td>
<td>0.20</td>
</tr>
<tr>
<td>p-valueb</td>
<td></td>
<td>0.73</td>
<td>0.16</td>
<td>0.11</td>
<td></td>
</tr>
<tr>
<td><strong>Gross motor</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher HOME</td>
<td>35</td>
<td>94.0 (89, 106)*</td>
<td>93.0 (85, 98)</td>
<td>82.0 (77, 87)*</td>
<td>&lt;0.01*</td>
</tr>
<tr>
<td>Lower HOME</td>
<td>23</td>
<td>88.5 (87, 98)</td>
<td>85.0 (79, 95)</td>
<td>75.0 (65, 82)</td>
<td>&lt;0.01*</td>
</tr>
<tr>
<td>p-valueb</td>
<td></td>
<td>0.04*</td>
<td>0.09</td>
<td>0.03*</td>
<td></td>
</tr>
<tr>
<td><strong>Fine motor</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher HOME</td>
<td>35</td>
<td>86.0 (84, 85)</td>
<td>89.0 (81, 99)</td>
<td>84.0 (79, 97)</td>
<td>0.34</td>
</tr>
<tr>
<td>Lower HOME</td>
<td>23</td>
<td>84.0 (73, 89)</td>
<td>78.0 (70, 90)</td>
<td>82.0 (71, 85)</td>
<td>0.86</td>
</tr>
<tr>
<td>p-valueb</td>
<td></td>
<td>0.12</td>
<td>0.05</td>
<td>0.08</td>
<td></td>
</tr>
</tbody>
</table>

Median DMQ (interquartile range) shown.

a Friedman test of repeated measurements.

b Mann–Whitney Test.

* Significant difference between groups.
3.3. Performance of “micropreemies”

Micropreemies ($n = 10$) consistently performed lower on tests of gross and fine motor skills compared with the rest of the group (refer to Table 3). Quotients were significantly lower at 5 years (gross motor $p = 0.002$; fine motor $p = 0.006$).

3.4. Influence of home environment

There were 23 infants whose HOME score placed them in the Lower HOME group (total scores 1–3) and 35 who scored in the Higher HOME group (total scores 4–5). The Lower HOME group consistently had poorer scores on tests of gross and fine motor skills at all ages, however this only reached significance for the 18 months and 5 year gross motor assessments ($p = 0.04$ and $p = 0.03$, respectively). There was no difference between the two groups at any age on the fine motor scale, although this approached significance at the 3-year assessment (refer to Table 3).

3.5. Multivariate analyses for gross and fine motor skills at age 5

Regression analyses were performed to examine if fine and gross motor development were independently influenced by the home environment or being a “micropreemie”. Gross motor and fine motor scores at age 5 were used as dependent variables. For fine motor skills, being a micropreemie was associated with lower scores ($p = 0.001$), while a low HOME score was not ($p = 0.139$, NS). For gross motor skills, both being a micropreemie ($p = 0.029$) and low HOME scores ($p = 0.038$) were associated with low gross motor scores.

3.6. Relationship between Peabody Developmental Motor Scales and Griffiths Mental Development Scales

At age 3, there was a good correlation between the Peabody Gross Motor Scale and Griffiths Locomotor Subscale (median Locomotor quotient = 92, quartiles 81, 100, median difference = 2, quartiles $-4.8, 8.2$, $p = 0.183$ Wilcoxon; Spearman’s rho = 0.72) and between the Peabody Fine Motor Scale and Griffiths Eye–Hand Coordination Subscale (median Eye–Hand Coordination quotient = 90, quartiles 77, 96, median difference = 2, quartiles $-3.4, 7$, $p = 0.209$; Spearman’s rho = 0.72). However at age 5, the Griffiths subscale quotients were higher despite a good correlation with that of the Peabody scales (median Locomotor quotient = 90.6, quartiles 83, 99, median difference = 11, quartiles $-7, 8.5$, $p < 0.001$; Spearman’s rho = 0.80; and mean Eye–Hand coordination = 94, quartiles 86, 107, median difference = 11, quartiles 5, 20, $p < 0.001$; Spearman’s rho = 0.81). Those who ranked high on one scale tended to rank well on the other scale and visa versa.

In contrast to Peabody assessments, at age 5 there was no apparent deterioration of Griffiths Locomotor quotients from the age 3 assessments (median difference = 1, quartiles $-8, 8$, Wilcoxon $p = 0.937$, NS). The age 5 Eye–Hand Coordination subscale quotients were significantly higher compared with the age 3 assessments (median difference 6.5, quartiles $-1.3, 15$; $p = 0.001$).
4. Discussion

Motor skills are frequently reported to be problematic in groups of preterm and extremely low birth weight infants [25–33]. Despite this, relatively few studies have been conducted to specifically investigate the development of motor skills in this population. We [20] have previously studied the fine motor and visual-motor skills of ‘apparently normal’ very low birth weight children at 5 years and found that the majority continued to have fine motor deficits at this age. The purpose of this study was to investigate longitudinally the development of gross and fine motor skills over time in a group of ‘apparently normal’ high-risk children who were less than 29 weeks gestation or less than 1000 g. There were 58 infants who completed all longitudinal assessments of motor skills at 18 months, 3 and 5 years of age. The study group was comparable to those who were not assessed longitudinally. Although the children not assessed were of slightly lower gestation at birth, there was no difference in their general development (GQ) at 12 months corrected age compared to the children included. Our main finding is that a considerable proportion of children had fine motor deficits that persisted from infancy, but more strikingly was the increasing proportion of children found to have gross motor deficits.

4.1. Motor development over time

At 5 years of age, the group mean of gross motor skills had dropped below the ‘normal’ range on the test and the majority (81%) had deficits. These results indicate a higher prevalence of gross motor deficits in comparison to other studies, however we found a good correlation between the Peabody and Griffiths scores at the 3- and 5-year assessments. Some previous developmental follow-up studies have suggested that motor skills improve over time [2,5,12,34]. Many studies use assessments that are not designated tests of motor abilities, rather include a few motor items as part of a general developmental assessment and including children with a major disability. It is not possible to differentiate these results as gross or fine motor skills. Furthermore, most are follow up studies of children for the first 3 years of life or used different assessment instruments over time. None have used the Peabody Developmental Gross Motor Scale at school age. In fact, no study has specifically and consistently examined the development of both gross and fine motor skills in ‘apparently normal’ high-risk children to school age.

For example, in a large, multicentre study, Vohr et al. [8] found 57% of the preterm group scored below the average range on the Psychomotor Index of the Bayley Scales of Infant Development at 18 months. In addition, there was a trend for the lighter birth weight categories to have lower test scores. This study however, included children with major disability and did not specifically examine motor skills. Ungerer and Sigman [34] found that deficits at 1 year, including motor deficits, were mostly overcome by 3 years. Similarly, Kitchen et al. [5] demonstrated that one third of their V.L.B.W. cohort had improved on all developmental domains by 5 years. Piper et al. [35] studied the motor development of high-risk infants over a brief period of time from 8 months to 12 months corrected age. Their results suggested that gross motor skills had improved by 12 months, but fine motor skills continued to be
delayed. The authors used two different measures of motor performance, namely the
Peabody Developmental Motor Scales at 8 months and the Griffiths Mental Develop-
ment Scales at 12 months.

However, some studies found similar results to our study. Jongmans et al. [11] found
44% of ‘apparently normal’ preterm children had borderline or abnormal motor skills at
school age. Indeed, a review of very low birth weight (V.L.B.W.) studies [36] indicated
the prevalence of motor impairment at school age could vary from 20% to 69%. In our
longitudinal assessment, the gross motor quotient was in the low average range until 5
years when it dropped significantly. This sudden decrease was difficult to explain. The
decrease may reflect the challenging nature of gross motor skills expected at this age on
the Peabody, thus unmasking deficits in foundation skills. General developmental
assessment tools, such as the Griffiths Scales, tend to measure the general ability in
completing a given task but are not as sensitive in detecting minor motor problems, as in
specifically designed motor scales, despite a correlation between them. It is noteworthy
that there was no “deterioration” in the Griffiths quotients. We found a significant
difference between the scales at age 5 years as the Peabody Scales becomes more
challenging and contain a greater number of items, including ball skills and balance,
which these children find particularly challenging.

In regards to fine motor development, Churcher et al. [21] conducted a longitudinal
study examining the fine motor skills of ‘high risk’ infants at 3, 6, 12 and 24 months.
The groups were assessed using the Peabody Developmental Fine Motor Scale and
found to be increasingly delayed as the infants reached 2 years. The proportion of
children scoring in the ‘at risk’ and ‘definite problem’ ranges also increased over this
time, with almost two thirds of the group (60%) scoring in these ranges. It is
important to note that the Churcher et al. [21] study however used a slightly different
definition of high-risk infants, including some born at full term with complications. In
their cohort of 66 children, there were only 13 (20%) who had a birthweight of
\( \leq 1000 \) g. This makes it difficult to directly compare results with the present study.
Nonetheless, findings of the present study showed the percentage of children who
were identified with fine motor deficit did not change significantly over time. There
were 53.5% of the study group who scored within the deficit range for fine motor
skills at the 18-month assessment, which is similar to Churcher et al.’s [21] results
(60% at 2 years). A significant proportion of children (64%) continued to have fine
motor deficits at 5 years of age. This is a similar finding to our previous study in
children who weighed less than 1500 g at birth and had no major disabilities, 71% of
this cohort had fine motor deficits at 5 years of age on the Peabody Developmental
Fine Motor Scale [20].

4.2. Performance of ‘micropreemies’

Recent studies have identified a subgroup of these high-risk infants, termed
‘micropreemies’, as the group of highest need and at most risk [4,8,37]. Hack et
al. [4] found infants with a birth weight < 750 g, performed significantly poorer on
tests of psychomotor skills, although this analysis included children with disabilities.
The researchers identified this group of infants as a ‘subgroup’ of VLBW children
who are at highest risk of neurobehavioural dysfunction and poor school performance. Jongmans et al. [11] also found that it was the “children with the lowest birth weight and the lowest gestational age who were the most affected at 6 years of age in their neurological and perceptual–motor development” (p. F13).

Our results found ‘micropreemies’ (birthweight < 750 g) consistently scored lower on tests of gross and fine motor skills in comparison to the rest of the group. Scores however were only significantly lower at the 5-year assessment. Similar to other studies, these results suggest that the subgroup of ‘micropreemies’ is indeed at highest risk (Hack et al. [4]; Lorenz et al. [37]; Vohr et al. [8]). However, the decrease in motor skills over time was not confined solely to the group of ‘micropreemies’.

4.3. Influence of gender

The “male disadvantage” in regards to neonatal mortality and short-term morbidity in very low birth weight infants has previously been documented [37,38]. The prevalence of handicaps was found to be three times greater in boys in a study of long-term outcome of a national cohort of very preterm infants born in the Netherlands [39]. Hindmarsh et al. [40] specifically examined gender differences in the outcome of E.L.B.W. infants at 2 years. The results showed females had superior language abilities but no differences in motor skills at 2 years were apparent. Likewise, our results showed no differences in motor skills at 18 months, 3 or 5 years.

4.4. Influence of home environment

Social factors, notably maternal education level [14,18,32,41,42] are the most frequently reported predictors of poor neurodevelopmental outcome in high-risk infants [43–45]. Ornstein et al. [36] agree that widely different measures of socio-economic status and environmental influences are used in studies, but these are often the most important independent predictors of long-term outcome.

Whilst the home environment appears to play an important role in the cognitive and academic outcome of high-risk infants [14,32,42,44], findings are inconsistent in regards to their influence on motor skills. Seigel [46] and Dammann et al. [16] found no significant relation between visual-motor ability and social class. Our previous study [20] produced similar results, finding no relation between visual-motor, visual perceptual and fine motor skills and parental educational levels.

When we examined the influence of the home environment on the development of motor skills, results showed that infants from lower HOME groups consistently performed poorer on motor tests over time, however scores were only significantly different for gross motor skills. There was no difference for fine motor skills at any of the assessment ages. Our study, however, made no attempt to determine whether possible changes in the home environment following the initial assessment had any influence on later motor development.

Our results suggested environmental influences have a different impact on the development of fine motor skills in comparison to gross motor skills. The home
environment did have some influence on the development of gross motor skills. Likewise, the paper by Piper et al. [35] found that gross and fine motor skills develop differently in preterm infants and suggested that the extra-uterine environment impacts differently on gross and fine motor skills.

Bartlett and Piper [47] have offered an explanation for the environmental influence on gross motor development, “once the infant is at home, altered perceptions of the abilities of infants born early may cause parents to be hesitant to physically challenge their children to try difficult tasks and acquire new skills” (pp. 49–50). The development of fine motor skills, however may be largely influenced by other sensorimotor, cognitive and perinatal factors.

The development of motor skills is important for a child’s successful participation in everyday life, including learning tasks, self-care tasks and play skills. Authors have suggested that infants born prematurely develop motor skills differently than their full-term peers [46]. As Jongmans et al. [11] commented, many who are “identified as clumsy at school age find it difficult to make progress in school and often experience adjustment problems” (p. F14).

Both a strength and limitation of this study is the use of one assessor. Whilst a single observer may contribute to greater consistency overtime and prevent problems with inter-rater reliability, there is a possibility of observer bias as the observer was not blinded to perinatal variables or to scores from previous assessments. However, we believe that these results are not likely to be affected by this bias. We found fine motor results were stable over the years and the age 5 assessment results were similar to our previous study where two researchers conducted the assessments [20].

In light of these findings, it is then important that future research be conducted to determine the impact of these motor problems on later performance at school and activities of daily living. Studies should be specifically designed to determine whether these motor difficulties persist into later school years and the impact on functional tasks important for successful participation at school and home, such as dressing, use of cutlery, handwriting, ball skills, and other leisure/play activities that utilise motor skills. By examining specific deficits underlying motor dysfunction, results could provide valuable information into the nature of motor coordination problems in the high-risk population, which would be helpful when planning intervention programmes aimed at reducing the impact of motor difficulties for high-risk infants.

5. Conclusion

Our investigation into the long-term follow-up and development of motor skills in high-risk infants without a major disability found that a significant proportion continued to have fine motor deficits from 18 months to 5 years, reflecting an underlying problem with fine motor skills throughout this period. The proportion of infants with gross motor deficits significantly increased over this period, as test demands became more challenging, particularly for the ‘micropreemies’. In addition, the development of gross and fine motor skills appears to be influenced differently by the home environment.
References


