Perceptual-motor abilities in pre-school preterm children

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ABSTRACT

Background: Several studies report a high percentage of premature infants presenting perceptual motor difficulties at school age. The new version of the Movement Assessment Battery for Children allows the assessment of perceptual-motor abilities in children from the age of 3 years.
Aims: To evaluate early perceptual-motor abilities in prematurely born children below the age of 4 years.
Study design: The Movement Assessment Battery for Children 2nd edition was administered to 105 low-risk prematurely born children (<32 weeks gestation) and in a control group of 105 term-born children matched for age and sex. All children were assessed between the age of 3 years and 3 years–11 months.
Results: 63 children (60%) had total scores above the 15th percentile, 15 (14.3%) had scores between the 5th and the 15th percentile, and 13 (12.4%) below the 5th percentile. The remaining 14 children (13.3%) refused to perform or to complete the test. The difference between preterm and control group was significant for total scores, Manual Dexterity and Aiming and Catching scores. In the preterm group there was a correlation between age at testing, total scores and Aiming and Catching subscores. The Movement ABC-2 subscores were significantly lower in children born below 29 weeks.
Conclusion: Perceptual-motor difficulties can already be detected on the assessment performed before the age of 4 years. Prematurely born children assessed between 3 years and 3 years–3 months appeared to have more difficulties in performing the test than the older ones or their age matched term-born peers. These findings support the possibility of a delayed maturation in the younger age group.

1. Introduction

Several follow up studies of prematurely born children have previously reported perceptual-motor difficulties at school age [1–6]. The majority of these studies using the Movement Assessment Battery for Children, a test assessing manual dexterity, ball games and static and dynamic balance [1–6], showed that up to 60% of children born below the gestational age of 35 weeks had difficulties at school age.

No systematic study has so far been performed to identify earlier signs of perceptual-motor difficulties. While several papers have reported early neurodevelopmental findings using general scales or have explored specific aspects of neurodevelopment, such as visual motor, sustained attention, memory and language production below the age of 4 years [7–10], less has been reported on early perceptual-motor abilities. One of the reasons is that the original version of the Movement ABC [11], or its previous version, the Test of Motor Impairment, were developed for children above the age of 4 years [1–4]. The Movement ABC 2nd edition can be used in children as young as 3 years [12] and can therefore allow detection of earlier perceptual-motor difficulties. The test has recently been shown to be a reliable measure in a group of 3 year old children [13] and in 6 to 12 year old Taiwanese children with Developmental Coordination Disorder [14].

The aim of this study was to evaluate possible signs of perceptual-motor difficulties in a cohort of low-risk children born prematurely assessed before the age of 4 years.

2. Methods

Study cohort: prematurely born children followed at the neonatal intensive care unit at Gemelli Hospital, Rome, Mangiagalli Hospital, Milan, and Stella Maris Institute, Pisa were assessed between February 2009 to May 2011.

Children were consecutively enrolled if:

a) they were born between 25 and 32 weeks gestational age (GA) determined from first trimester ultrasound scans;
b) cranial ultrasound scans were normal or only showed transient flares or germinal layer haemorrhages during the first 2 postnatal weeks and, at term equivalent age, showed no parenchymal abnormality and no evidence of atrophy i.e. no dilated ventricles (>14 mm Ventricular Index (VI)), irregular ventricular margins, widened inter-hemispheric fissure or enlarged extracerebral space [15];
c) they were clinically stable by 35 weeks.

We excluded children with major congenital malformations, genetic chromosomal abnormalities, metabolic disorders, congenital infection or any sign of encephalopathy or seizures during their neonatal course, severe jaundice requiring phototherapy, and retinopathy of prematurity greater than stage 2.

In all, developmental quotient (DQ) at 2 years was evaluated with the Griffiths Mental Development Scales and neurological examination had been reported as normal at the age of 2 years.

All prematurely born children were assessed using chronological age and not corrected age as in our routine we use corrected age up to the age of two years.

Control group: we also assessed a control group of term born children (GA ≥ 37 weeks), matched for age and sex. All had a negative clinical history for neurological diseases. The control group was recruited from three primary schools in Rome and Pisa.

This study was approved by the Ethical Committee in each of the three Centers involved in the research. Parents of children in the preterm and in the control group gave informed consent to the work.

2.1. Perceptual motor abilities

These were evaluated by using the Test component of the Movement ABC-2. The test includes three items assessing manual dexterity, two assessing aiming and catching and three balance.

Individual results can be compared and scored according to normative data available for each year and, within each year, for the first and the second semester (i.e. 3 years to 3 years–5 months and 3 years–6 months to 3 years–11 months). The test is designed to give a global score but the subscores for the three subscales can also be compared to age specific normative data.

All assessments were administrated by pediatric neurologists.

The results were scored in two ways:

First, we compared the scores of the prematurely born children with the normative data available from the manual. The results were scored as *normal* (when falling above the 15th centile), *borderline* (when falling below the 15th centile but above the 5th) and *abnormal* (when falling below the 5th centile). We also noted if the child refused to perform the test or part of it.

As the Movement ABC-2 has not yet been validated in Italy, the results were also compared with a control group of preschool children matched for age and sex.

ANOVA model was used to compare differences in the Movement ABC-2 results between prematurely born children and the control group. In prematurely born children the correlation between the

Table 1
Movement ABC-2 percentile scores in prematurely born children and in control group.

MABC-2 Percentile Score	Prematurely born children		Control group		
	Median	Range	Median	Range	p value
Total	32.76	0.5–99	52.17	2–100	p < 0.00001
Manual dexterity	30.16	0.5–98	58.65	5–100	p = 0.00002
Aiming and catching	32.95	1– 99	45.17	0–100	p = 0.0276
Balance	41.30	0.5–99	48.56	0–100	p = 0.343323
Refusal	14		1		p < 0.00001

Movement ABC-2, age at testing time, gestational age and birth weight were also investigated using the Pearson correlation analysis.

Differences between groups were considered significant after correction for multiple comparisons (P corrected < 0.05).

Post-hoc analyses was conducted to qualify the nature of interaction (Tukey's Honest Significance Test), between subgroups of sampled populations.

3. Results

One hundred and five prematurely born children (43 males, 62 females) fulfilled the inclusion criteria and all agreed to participate to the study. Median gestational age at birth was 29.2 weeks, range 26–31 weeks. Median birth-weight was 1177 grams, range 480–2200 grams. Median chronological age at the assessment was 40.33 months, range 36–47 months.

All had normal DQ at 2 years and none had signs of cerebral palsy on neurological examination.

3.1. Movement ABC-2

When compared to the available normative data, 63 of the 105 prematurely born children (60%) had total scores at or above the 15th percentile. Fifteen of the remaining 42 had scores below the 15th but above the 5th centile (14.3%) and 27 (25.8%) had scores below the 5th percentile. While 13 of these 27 (12.4%) completed the test with abnormal scores (below the 5th) the other 14 (13.3%) refused to perform or to complete the test. The results of these children, according to the manual, had also to be considered below the 5th centile, but were kept separately.

Nineteen of the 63 children with total scores above the 15th percentile had a score below the 15th percentile on one of the sub-sections. Details of standard scores and centiles are provided in Tables 1 and 2.

3.1.1. Control group

When compared to the normative data, available from the manual, 99 of the 105 children (94.2%) had total scores at or above the 15th percentile. Six children (5.7%) had total scores below the 15th percentile, of which 1 (0.9%) fell below the 5th percentile. Twenty children had total scores above the 15th percentile but had a score at or below the 15th

Table 2
Movement ABC-2 standard scores in prematurely born children and in control group.

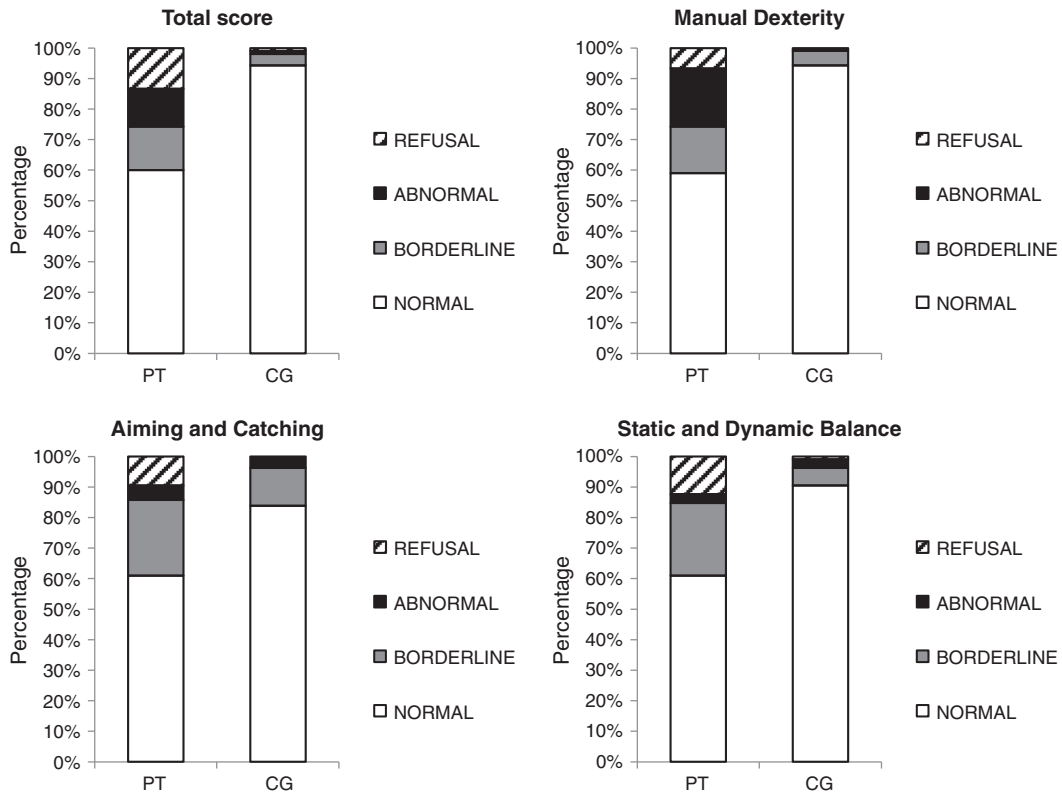| MABC-2 Standard Score	Prematurely born children		Control group	
	Median	SD	Median	SD
Total	7.11	3.74	10	3.14
Manual dexterity	7.24	3.42	10.99	2.97
Aiming and catching	7.58	3.52	9.57	3.11
Balance	8.17	4.4	9.97	3.35

Fig. 1. Movement ABC-2 total and subscores in prematurely born children (PT) and control group (CG).
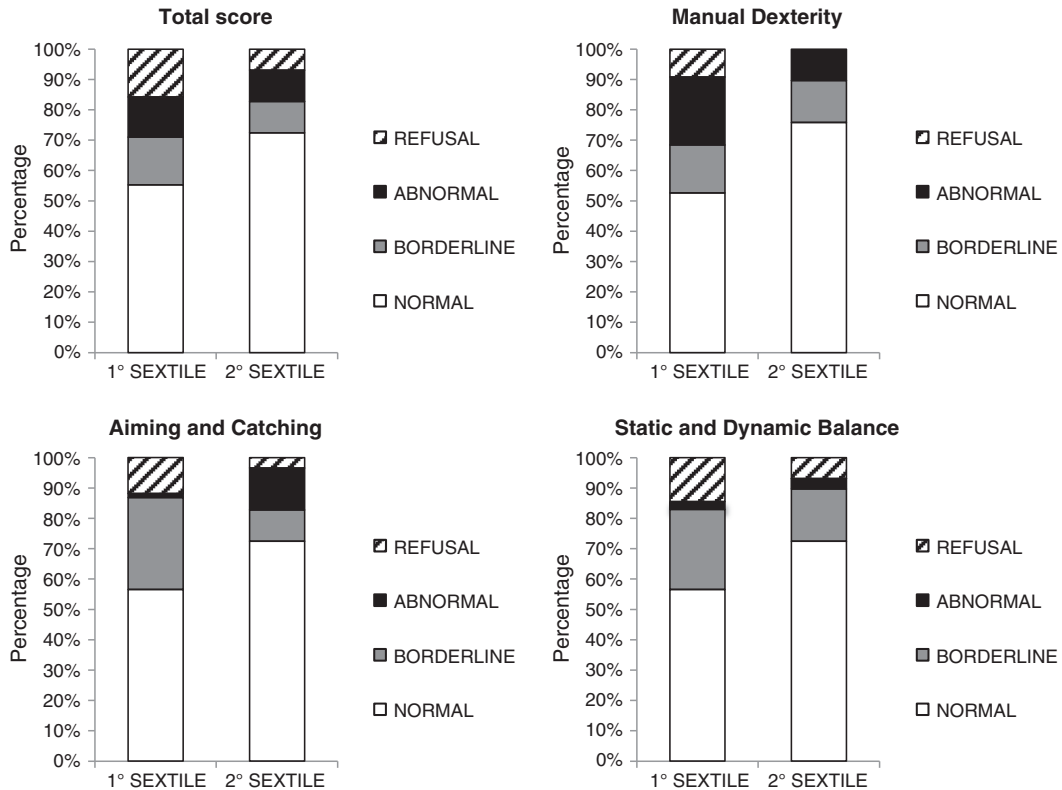

Fig. 2. Movement ABC-2 total and subscores according to the age at the test in prematurely born children.

percentile on one of the sub-sections. Details are provided in Table 1 and Fig. 1.

3.2. Comparison between study and control group

There was a difference in the Movement ABC-2 total scores between prematurely born children and control group ($F(1, 194) = 24.53$, $p < 0.001$) with prematurely born children having lower scores (mean (M) = 32.76, Standard Error (SE) = 2.85; control group: mean (M) = 52.17 SE = 2.69) with a group effect $F(1, 194) = 29.98$, $p < 0.001$ and a subscore effect $F(2, 388) = 10.77$ $p < 0.001$.

There was also a difference between prematurely born children and the control group in manual dexterity (prematurely born children: M = 30.16 vs control group: M = 58.65), $p < 0.001$ and in aiming and catching scores (prematurely born children: M = 32.95 vs control group: M = 45.17), $p = 0.02$, but not in balance scores ($p = 0.34$) (Tables 1–2).

3.2.1. Movement ABC-2 and age at testing

Fig. 2 shows the distribution of percentage of normal and abnormal results according to the age when the test was performed with a higher incidence of refusals and abnormal results in the children assessed before 3 years–6 months compared to the older ones. Eleven of the 14 children who refused to complete the test were between 3 years and 3 years–3 months.

A significant age effect on the Movement ABC-2 scores $F(4, 86) = 2.7$, $p = 0.03$ was found in the prematurely born group but not in the control group $F(3, 87) = 2.1520$, $p = 0.09$.

The prematurely born group assessed before 3 years–6 months showed lower scores than those assessed at an older age in the Movement ABC-2 total scores (M = 29.12 vs 38.46), $p = 0.04$ ($r = 0.21$) and in aiming and catching subscores (M = 36.63 vs 48.53), $p = 0.01$ ($r = 0.24$).

3.2.2. Movement ABC-2 and GA at birth

When the prematurely born group was subdivided according to GA, there were some differences in Movement ABC-2 subscores $F(8, 170) = 2.27$, $p = 0.02$ (Fig. 3). Children born at 26–28 weeks GA or below had significantly lower performances compared to those born at higher GA, in particular to those of 31–32 weeks in the Movement ABC-2 total scores (M = 12 vs 43.4), $p = 0.01$ and in manual dexterity subscores (M = 13.5 vs 43.4), $p = 0.01$. There were no differences in the children born at other gestational ages.

3.2.3. Movement ABC-2 and birth weight

The prematurely born children with a birth weight below 1000 g did not differ from those with a birth weight >1000 g on all the Movement ABC-2 subscores $F(12, 222) = 1.53$, $p = 0.11$ (Fig. 4).

3.2.4. Movement ABC-2 and cranial ultrasound

There was no difference in scores between children with normal and those who had minimal lesions on neonatal ultrasound.
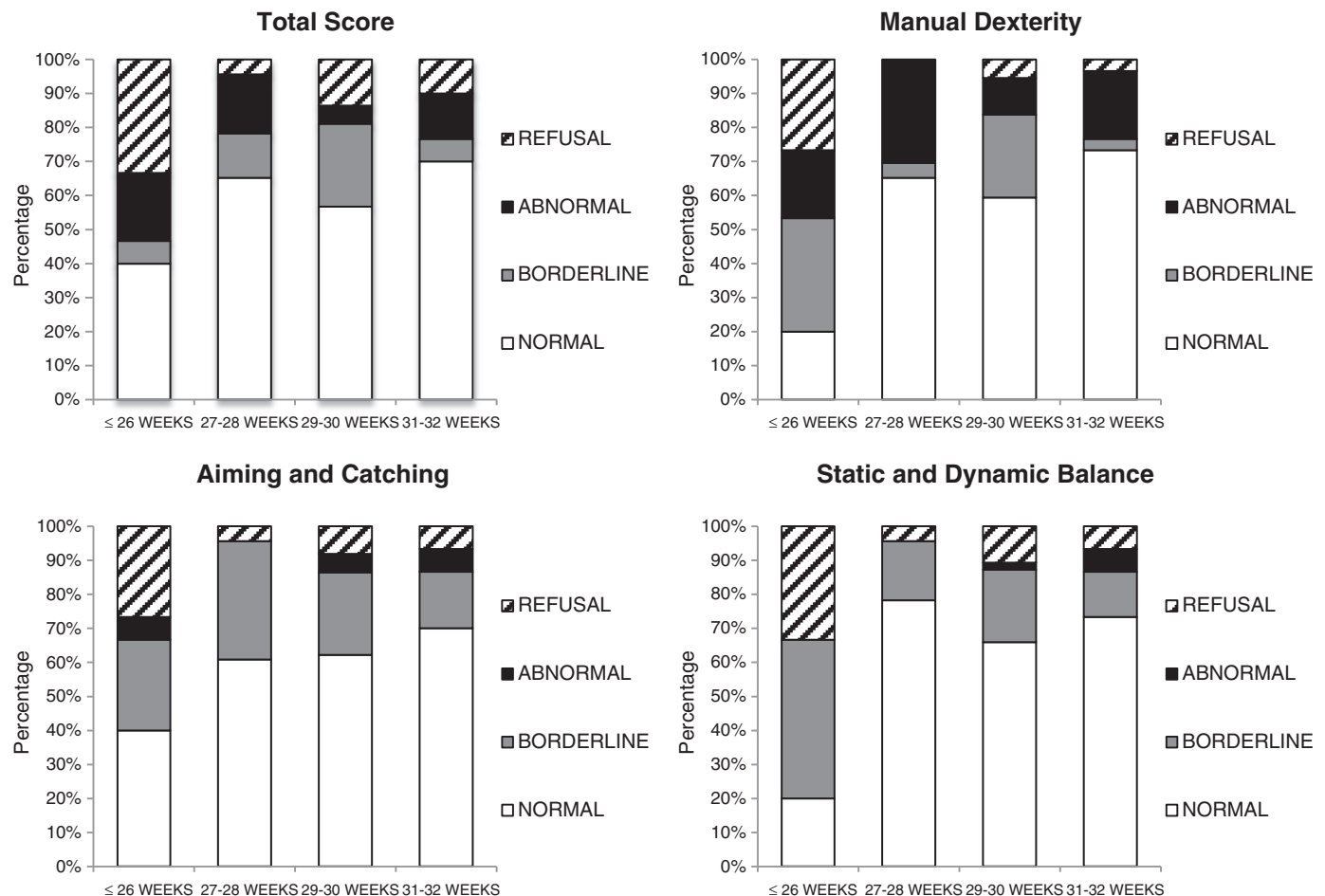

Fig. 3. Movement ABC-2 total and subscores according to gestational age at birth in prematurely born children.
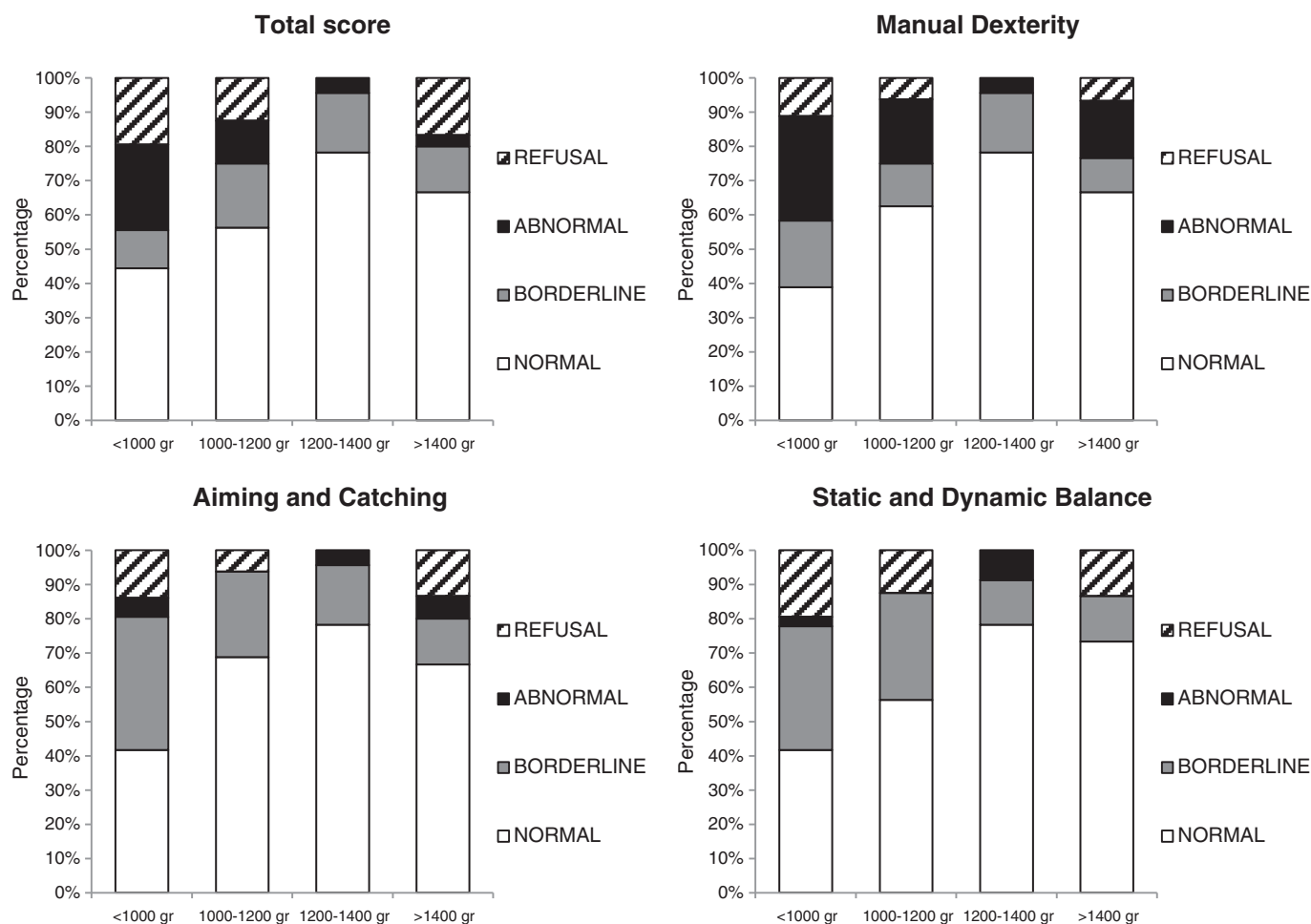
Fig. 4. Movement ABC-2 total and subscores according to the birth weight in prematurely born children.

4. Discussion

Using the Movement ABC-2 2nd edition we were able to assess a cohort of prematurely born children before the age of 4 years. Our results showed that 15 of the 105 prematurely born children (14.3%) had scores between the 5th and the 15th centile and another 13 below the 5th (12.4) with an additional 14 children (13.3 %) refusing to perform or to complete the test. According to manual instructions the results of these children should be scored as failed and therefore below the 5th centile. The percentage of abnormal results therefore rises to 40% when we also included the children who refused to perform or complete the battery.

These results are not easily comparable with previous studies in older children as in the other papers there are no details of children scored as abnormal because of a refusal to perform or to complete the test.

It is of interest that the refusal to complete the test mainly occurred in the youngest children, i.e. those assessed between 3 years and 3 years–3 months and this was more obvious on the items testing manual dexterity. There was an obvious age effect with children examined below the age of 3 years–6 months not only having the largest number of refusals to complete the assessment but also worse results in the overall score, in manual skills and in aiming and catching. Poorer performance was often related to a poor concept of timing and attention. A few children were able to perform the task, but required more time than controls to complete them, with a short attention span and tendency to get distracted during the task. This was not observed in the age matched control group. Our findings suggest that early in the third year of life prematurely born children may have a delay in the maturation of attention or in the control of hyperactive behaviour. As in our cohort attention difficulties and poor cooperation were less obvious in children assessed after the age of 3 years–3 months, it appears that these abilities may progressively improve during the third year of life. Not surprisingly, the refusals were more frequent in the children born below 28 weeks GA (6 out of 23, 26%) but could also be observed in those born after 28 weeks GA (8 out of 82, 9.7%). More generally, children born below 28 weeks GA had significantly lower performance compared to those born after 28 weeks. In contrast, although children born with a weight below 1000 g had lower performances compared to those with a weight above 1000 g, the difference was not significant.

Because the Movement ABC-2 has not been yet validated in the Italian population, in order to exclude possible cultural differences, we also assessed a control group matched for age and sex. Only one of the 105 controls refused to complete the assessment. Not surprisingly the control group had a significantly better performance compared to the study group.

The results in the control group showed that there are no large differences between our Italian control group and the UK norms [12]. Two children (1.9%) in the control group had results below the 5th centile and 4 (3.8%) had scores between the 5th and the 15th centile. Further normative data are being systematically collected to obtain more accurate information on the frequency distribution of the results for each item in a larger sample of the Italian population.

Our findings raise the question of whether corrected age should have been used instead of chronological age. There is currently no consensus regarding when to stop correcting age for prematurity. The majority of the studies on preterm children correct through age two years but other studies correct for the first three years [16,17]. In our study the youngest group, assessed below 3 years–3 months chronological age and therefore below the age of 3 years corrected age, appeared to have more difficulties in completing the tasks in the time frame allowed. These findings appear to suggest a possible delay in maturation of these aspects and the need to use corrected age but, as the numbers were relatively small, one cannot exclude that the refusal to complete the assessments observed in the younger children may be an early marker of attention difficulties that are frequently detected in prematurely born children at school age [18–20]. As all the children in this study will be reassessed after one year and again at school age, when more specific assessment of attention can be performed, this will help to establish the possible prognostic value of these early findings.

It is of interest that the incidence of perceptual-motor difficulties in our cohort was still slightly lower than that reported in previous studies assessing prematurely born children at school age [1,4,6]. Further follow up in our cohort will also help to establish whether the early assessment at 3 years fails to detect abnormalities that may become obvious at a later age.

Conflict of interest statement

Authors have nothing to disclose.

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