Motor and functional development in infants born preterm and full term: influence of biological and environmental risk factors

Desenvolvimento motor e funcional em crianças nascidas pré-termo e a termo: influência de fatores de risco biológico e ambiental

Desarrollo motor y funcional en niños nacidos pretérmino y a término: influencia de factores de riesgo biológico y ambiental

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ABSTRACT

Objective: To compare motor development in preterm and full term infants from 12 to 18 months and to investigate the relationship between functional performance and quantity and quality of environmental stimulation.

Methods: Quantitative, exploratory and longitudinal study, which included 30 preterm (gestational age: 30.0±2.3 weeks and birth weight: 1178±193g) and 30 full term infants (39±1.3 weeks and 3270±400g). Motor development was evaluated by the Alberta Infant Motor Scale and the Peabody Developmental Motor Scales. Home environment was assessed by the Home Observation Measurement of the Environment. The Pediatric Evaluation of Disability Inventory was used to examine functional abilities.

Results: The preterm group presented slower gait acquisition (p=0.005), although no significant differences between groups were found in the Alberta Infant Motor Scale at 12 (p=0.187) and 15 months (p=0.80). At 18 months, significant differences were found in gross (p<0.001) and fine (p=0.001) motor development and in functional abilities, with a better performance of the full term group. There were differences between groups in the Home Observation Measurement of the Environment inventory (p=0.008).

Conclusions: Performance differences between groups increased from 12 to 18 months, and environmental factors might have enhanced the effects of biological risks. Developmental follow-up programs should focus on aspects of the environment where the child lives.

Key-words: prematurity; child development; risk factors; evaluation.

RESUMO

Objetivo: Comparar o desenvolvimento motor de crianças de 12 a 18 meses nascidas pré-termo e a termo e investigar sua relação com o desempenho funcional e com a quantidade e qualidade de estímulos ambientais.

Métodos: Estudo quantitativo e longitudinal com 30 crianças prematuras (idade gestacional de 30,0±2,3 semanas e peso ao nascimento de 1178±193g) e 30 nascidas a termo (idade gestacional de 39,0±1,3 semanas e peso ao nascimento de 3270±400g). O desenvolvimento motor foi avaliado pelos testes *Alberta Infant Motor Scale* e *Peabody Developmental Motor Scales*. O ambiente domiciliar foi avaliado com o *Home Observation Measurement of the Environment*. Com o intuito de examinar as habilidades funcionais, utilizou-se o *Pediatric Evaluation of Disability Inventory*.

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Fonte financiadora: a segunda autora tem bolsa de pesquisador nível 2 do Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq)
Conflito de interesse: nada a declarar

Recebido em: 8/2/2012
Aprovado em: 25/6/2012

Resultados: Houve maior lentidão para aquisição da marcha no grupo pré-termo (p=0,005), embora não tenha sido encontrada diferença significativa entre os grupos no *Alberta Infant Motor Scale* aos 12 (p=0,19) e aos 15 meses (p=0,80). Aos 18 meses foram encontradas diferenças significativas no desenvolvimento motor grosso (p<0,001) e fino (p=0,001) e nas habilidades funcionais, com vantagem para o grupo a termo. Houve diferença significativa entre os grupos quando avaliados pelo inventário *Home Observation Measurement of the Environment* (p=0,008).

Conclusões: Houve aumento da diferença entre os grupos no desempenho motor dos 12 aos 18 meses, sendo que fatores ambientais podem ter potencializado os efeitos do risco biológico. Programas de acompanhamento do desenvolvimento devem enfocar aspectos do ambiente onde a criança vive.

Palavras-chave: prematuridade; desenvolvimento infantil; fatores de risco; avaliação.

RESUMEN

Objetivo: Comparar el desarrollo motor de los 12 a los 18 meses de niños nacidos pretérmino y a término e investigar la relación entre desarrollo motor, desempeño funcional y la cantidad y calidad de estímulos ambientales.

Métodos: Estudio cuantitativo, direccional y longitudinal, que incluyó a 30 niños prematuros (edad gestacional: 30,0±2,3 semanas y peso al nacer: 1178±193 gramas) y 30 nacidos a término (edad gestacional: 39,0±1,3 semanas y peso al nacer: 3270±400 gramas). El desarrollo motor fue evaluado con el uso de las pruebas Alberta Infant Motor Scale (AIMS) y Peabody Developmental Motor Scales (PDMS-2). El ambiente domiciliar fue evaluado con el Home Observation Measurement of the Enviroment (HOME). Para examinar las habilidades funcionales se utilizó el Pediatric Evaluation of Disability Inventory (PEDI).

Resultados: Hubo mayor lentitud para adquisición de la marcha en el grupo pretérmino (p=0,005), aunque no se haya encontrado diferencia significativa entre los grupos en la AIMS a los 12 (p=0,187) y a los 15 meses (p=0,80). A los 18 meses se encontraron diferencias significativas en el desarrollo motor grueso (p<0,001) y fino (p=0,001) y en las habilidades funcionales, con ventaja para el grupo a término. Hubo diferencia significativa entre los grupos, evaluada por el inventario HOME (p=0,008).

Conclusiones: Hubo aumento de la diferencia entre los grupos en el desempeño motor de los 12 a los 18 meses, siendo posible que factores ambientales hayan potencializado los efectos del riesgo biológico. Programas de seguimiento del desarrollo deben enfocar aspectos del ambiente donde vive el niño.

Palabras clave: prematuridad; desarrollo infantil; factores de riesgo; evaluación.

Introduction

Seventy-five percent of newborn infants (NB) who need perinatal intensive care are at risk of neurodevelopmental problems and the percentage increase as birth weight and gestational age reduce[1]. In 2007, 19,457 of the 259,505 live births recorded in the Brazilian state of Minas Gerais were preterm and 3,637 infants had birth weights of less than 1,500g[2]. It is necessary to document the consequences of prematurity among Brazilian children in order to provide information on which public policies can be based.

Motor function merits special attention since it is generally the first observable marker of developmental abnormalities[3]. In addition to biological factors such as prematurity, environmental variables such as the physical space in which children live, their parents' educational level and their families' dynamics, spending power and social network also have effects on child development[4]. Few studies have investigated the relationship between prematurity, motor development and environmental factors and when motor development is studied it is generally dealt with from the perspective of biological risk[5-8].

Another important aspect of child development is a child's functional performance in their home environment[9-11]. There are few studies of the impact of risk factors on children's performance in daily activities[12-14], which is relevant information since it reveals the way that motor and cognitive components are manifest in the day-to-day lives of children and their families.

Aiming at improving the understanding of the impact of prematurity on child development, in this study preterm children from low-income families and full term children from low-income families were compared in terms of functional and motor performance at 12, 15 and 18 months of age. An additional goal was to investigate the relationship between biological and environmental factors and child motor development.

Methods

This was a longitudinal observational study of a sample comprising (a) a group of preterm (PT) children born with gestational ages (GA) ≤34 weeks and weight ≤1,500g and (b) a control group (FT) of children born full term with GA ≥37 weeks and weight ≥2,500 grams and paired to the PT for sex and corrected age. Both groups were recruited from the children born at the maternity unit in the Hospital das Clínicas da Universidade Federal de Minas Gerais (HC-UFMG). The PT were enrolled from the institution's follow-up program for high-risk children (ACRIAR).

Exclusion criteria were clinical signs identified by the ACRIAR team as suggestive of: neurological damage (e.g. abnormal tonus, involuntary movements, hyperreflexia, retention of primitive reflexes), mental retardation (e.g. evident delays in global development) or sensory deficiency (sight or hearing), orthopedic problems and congenital malformations; need for neuromotor intervention during the data collection period; full term delivery with a history of acute and/or chronic prenatal or perinatal hypoxia. The children enrolled on the study had apparently normal development, despite the issues associated with prematurity. It should be pointed out that all of the children treated at the ACRIAR are assessed by a multidisciplinary team comprising a pediatrician, a neuropediatrician, a physiotherapist, an occupational therapist, a speech and hearing specialist and a psychologist. The first consultation takes place soon after discharge from the nursing ward and thereafter routine tests are conducted (e.g. hearing tests, neurological examination) in order to identify clinical signs of neurological damage, sensory deficit or significant developmental delays that merit referral for treatment.

All preterm children who attended the ACRIAR during the 2-year recruitment period (2008/2009) and met the study's inclusion criteria were enrolled. Children were enrolled at 8 months of age and for each preterm child a full term child was chosen at random from the HC/UFMG live births register and paired for corrected age and sex. The baby's family was then contacted and invited to take part in the study. Initially records were searched for babies born on the same day (±3 days) and meeting the recruitment criteria and in cases where there was more than one infant, lots were drawn. Babies whose parents could not be located or refused to take part were replaced with another, chosen in the same way. Dropouts were replaced with children of the same sex identified at random from the live births register. The recruitment process was conducted by an undergraduate bursary winner and the second author, so that the examiner did not know which group the children she assessed belonged to. Both groups predominantly contained children from low-income families seen on the Brazilian National Health Service (*Sistema Único de Saúde*). Socioeconomic status was estimated using the social work department's socioeconomic from Universidade de São Paulo (USP)[15], which is based on the number of family members, income, educational level and nature of parents' employment. The study was approved by COEP/UFMG (ETIC-429/07) and the study objectives were explained to parents before they signed free and informed consent forms.

During the recruitment interview conducted at 8 months, an appointment was made for the next assessment at 12 months and an estimate was made of predicted age of walking attainment. Parents were told that the lead researcher (ESS) would contact them around the estimated walking attainment age. Parents were contacted by telephone every two weeks from 10 months onwards in order to determine the exact date on which the child first managed five independent steps[16]. All children were assessed at 12, 15 and 18 months of age (corrected age for preterms).

At 12 and 15 months, the Alberta Infant Motor Scale – AIMS was administered[17]. The AIMS is a test of gross motor development for children from zero to 18 months and offers good validity and reliability[3,5]. Scores equating to percentiles below 5% are indicative of delayed motor development from 8 months of age onwards[17].

At 15 months, the Home Observation for Measurement of the Environment – HOME, Infant-Toddler (IT) version[18] was administered. This is an observation protocol containing 45 binary items that assess the quality and quantity of stimuli and support available to children from zero to 3 years within their natural surroundings. The median total Home score is 32 points and scores more than five points below the median are considered as suspicious. The HOME inventory was administered during a home visit which was arranged with the child's mother to fit in with her schedule at a time that was convenient for the family and when the child would be at home.

At 18 months, the Peabody Developmental Motor Scales (second edition, PDMS-2) (PDMS-2)[19] and the Pediatric Evaluation of Disability Inventory (PEDI)[20] were administered. The PDMS-2[19] comprises two different scales that are scored separately, one for fine motor abilities and the other for gross motor functions, and is applicable to children from zero to 72 months. The PDMS-2 is widely used internationally, has good test-retest and interexaminer reliability[19] and also offers good validity[21]. Raw scores are converted into quotients for fine motor, gross motor and overall motor abilities, which are the most reliable PDMS-2 standardized scores[19]. The quotients have a mean of 100 and a standard deviation of 15 and scores below 85 are suggestive of delayed motor development.

The PEDI[20] is a questionnaire designed to be administered to parents that has been translated and culturally adapted for Brazil. It is used to assess children from 6 months to 7 and a half years for their degree of independence performing daily activities. The PEDI comprises three scales assessing (I) capability, (II) degree of caregiver assistance and (III) environmental adaptations needed for self-care, mobility and social function. For the purposes of this study only scales I and II for self-care abilities and mobility were used. The range of normality is 30 to 70, indicating adequate functional performance.

Motor tests were administered by a single examiner (ESS) who was blind to the children's birth weights and gestational ages. Prior to data collection, the examiner for this study was trained and tested for inter-examiner reliability against an external examiner. The two examiners evaluated 10 children together for each of the tests used in the study and then scored them independently. Intraclass Correlation Coefficients indicated adequate reliability (AIMS 0.99, HOME 0.99, PDMS-2 2 gross motor 0.82 and fine motor 0.83). The PEDI was administered by final-year physiotherapy or occupational therapy undergraduates from UFMG who had been trained previously and achieved good reliability scores applying the inventory. With the exception of the HOME assessment, all tests were administered at the ACRIAR center in a room appropriate for child motor assessment. Only data from children for whom all results from all assessments were complete were included in the final analysis.

The sample size was estimated on the basis of the annual turnover of children meeting the sample criteria seen at ACRIAR. Analysis of the center's database indicated that it would be possible to enroll at least 25 children per year. It was estimated that a sample of 25 children would offer 70% power to identify a moderate effect as being statistically significant. In view of the difficulties involved in selecting and following children, efforts were made to recruit at least 30 participants per group.

SPSS for Windows version 15.0 was used for data analysis. Since the test of normality (Shapiro-Wilk) did not confirm normal distribution for some of the variables, nonparametric analysis was used. The chi-square test was used to assess the association between two qualitative variables (e.g.: group and socioeconomic status) and quantitative variables were compared with the Mann-Whitney test, followed by calculation of the effect size for the most relevant outcomes. Relationships between quantitative variables were tested using the Spearman correlation coefficient. The significance level was set at $p<0.05$. for all analyses.

Results

A total of 69 children were recruited, 9 (13.2%) of whom were excluded: one preterm child exhibited signs of brain damage (tonus alterations, hyperreflexia and retention of primitive reflexes); two children, one preterm and one full term, failed to return for data collection; six children (four preterms) dropped out of the study because they moved house and did not maintain contact with the researchers.

The PT group had 29 children classified as adequate for gestational age (AGA) and one as small for gestational age (SGA). One boy with a birth weight greater than 1,500g (1,564g), but a gestational age of 31 weeks, was added to the PT group to bring the sample up to 60 members, 30 per group, 15 girls and 15 boys. The time these children spent in neonatal hospital care ranged from 20 to 86 days (mean±SD: 46±19), and 13 children (43.3%) suffered intraventricular hemorrhage, four with grade I hemorrhages, four with grade II hemorrhages and four with grade III hemorrhages; 20 (69%) were put on mechanical ventilation; 11 (37%) suffered retinopathy; and two (6.9%) had convulsions.

The FT group had 27 AGA infants, three were large for gestational age (LGA) and there were no reports of neonatal intercurrent conditions, although one child spent 7 days in hospital because of maternal complications. The three LGA

Table 1 - Demographic data

	Mean		Median		Minimum–Maximum	
	Preterm Group	Full term group	Preterm Group	Full term group	Preterm Group	Full term group
Gestational age at birth (weeks)	29.9±2.9	39.1±1.3	30.0	39.0	25.0–33.0	37.0–41.0
Birth weight (grams)	1179 ± 190	3269±399	1210	3265	700–1565	2510–4405
Age of mother (years)	28.1±7.8	28.5±6.3	29.0	27.0	15.0–43.0	17.0–41.0
Age of father (years)	32.3±9.7	31.3±8.0	32.0	30.0	18.0–53.0	17.0–59.0
Monthly income (in multiples of the minimum wage)	2.5±1.6	3.3±1.2	2.0	3.0	1.0–8.5	1.5–5.0
Number of children	2.2±1.5	2.1±1.0	1.5	2.0	1.0–6.0	2.0–4.0

Mean: mean±standard deviation; n=30 in each group children in the FT group were not excluded from the sample because they exhibited a similar motor performance profile to the other FT children.

Nineteen of the mothers of PT infants (65.9%) had spent up to 8 years in formal education and 10 (34.5%) had spent more than 8 years in education. Eleven of the mothers of FT infants (36.7%) had spent up to 8 years and 19 (63.3%) had spent more than 8 years in formal education and the difference between groups was significant according to the chi-square test ($p<0.001$).

Twenty-one PT families (70.0%) and 8 (26.7%) FT families had incomes of less than three times the minimum wage, with a significant difference between groups ($p=0.005$). Notwithstanding, there was no difference between the groups ($p=0.211$) on the socioeconomic classification[19]. Table 1 lists the general characteristics of the sample.

The PT infants walked at 13.8±2.0 months corrected GA and the FT at 12.3±2.0 months. These data are shown converted into days in Table 2, together with the statistical test results and effect sizes. The AIMS only detected differences between the groups at 18 months, and only one PT child had an AIMS score below the fifth percentile at 12 months, which indicates risk of motor delay. None of the FT children had at-risk scores. The prerequisite for

Table 2 - Comparison of motor test results

	Mean±SD		Minimum–Maximum		Median		Mann-Whitney	Effect
	Preterm	Full term	Preterm	Full term	Preterm	Full term	*p*-value	Size
Age at acquisition of walking (days)	415±59	368± 62	351-572	231-518	399	364	0.005	0.78
AIMS Percentile - 12 months	52.8±4.5	54.1±3.9	4.0-9.0	5.0-9.0	36.0	50.0	0.187	0.56
AIMS Percentile - 15 months	55.7±2.7	57.2±2.2	51.0-5.0	51.0-5.0	25.0	90.0	0.080	1.00
PDMS-2 Gross	27.40±3.0	30.1±2.3	21.0-34.0	25.0-36.0	28.0	30.5	>0.001	1.18
PDMS-2 Fine motor	17.4±1.6	19.0±1.7	14.0-20.0	15.0-22.0	18.0	19.0	0.001	2.00
PDMS-2 Total	44.8±4.4	49.1±3.2	35.0-54.0	40.0-57.0	45.5	49.0	>0.001	1.41
PEDI Functional Capability, Self-care	50.2±9.6	57.0 ± 9.3	30.4-76.4	42.1-76.4	50.7	56.7	0.015	0.78
PEDI Functional Capability, Mobility	38.6±9.8	42.4±8.2	21.5-66.6	28.7-63.4	37.9	40.5	0.065	0.47
PEDI Carer Assistance, Self-care	41.0±12.5	47.0±13.4	10.0-71.7	25.5-76.9	40.9	44.9	0.111	0.48
PEDI Carer Assistance, Mobility	40.9±8.5	42.2±8.2	22.3-58.2	10.0-76.9	41.3	40.5	0.553	0.25

AIMS: Alberta Infant Motor Scale, PDMS-2: Peabody Developmental Motor Scales, 2nd edition; PEDI: Pediatric Evaluation of Disability Inventory; Mean: mean±standard deviation; n=30 in each group

Table 3 - Comparison of Home Observation Measurement of the Environment inventory results for preterm and full term groups

	Reference Median	Median Observed		Minimum–Maximum		Mann-Whitney
	(United States)	Preterm Group	Full term Group	Preterm Group	Full term Group	*p*-value
Responsiveness	9.0	9.5	10.5	2.0–1.01	5.0–11.0	0.06
Acceptance	6.0	5.5	6.0	1.0–7.0	2.0–8.0	0.27
Organization	5.0	4.0	4.0	1.0–6.0	2.0–6.0	0.18
Learning materials	7.0	4.0	4.0	0.0–9.0	0.0–6.0	0.02
Involvement	4.0	2.0	3.0	0.0–4.0	0.0–6.0	0.01
Variety	3.0	2.0	2.0	1.0–0.3	0.0–5.0	0.97
Total	34.0	27.0	29.5	12.0–36.0	17.0–39.0	0.01

Reference median: median provided in Home Observation Measurement of the Environment inventory manual; n=30 per group administering AIMS at 15 and 18 months was absence of independent walking and the scale was administered to 17 PT and 10 FT children at 15 months and to just three PT children and one FT child at 18 months. Although there were no statistically significant difference in AIMS scores at 12 or 15 months, power was 0.95 at both ages and post hoc sample size calculations indicated that sample sizes of 87 and 29 participants per group, respectively, would have been needed.

The PT performed worse on the PDMS-2 (Table 2) and one (3.3%) PT child had an overall motor quotient indicative of delay, whereas none of the FT children showed signs of motor delay. None of the children in either group had a gross motor quotient indicative of delay. Two PT children (6.7%) and zero FT children had fine motor quotients indicative of delay.

Although PT infants scored lower on all of the PEDI subscales (Table 2), only the difference for the self-care scale was significant and all children had performance adequate for their ages on this scale. On the mobility scale, three (13.3%) PT children and one (3.3%) FT child had below-average scores for their ages, but the difference was not significant. In both groups, three (10%) children had below-average scores on the carer assistance scale, both for self-care and for mobility.

With regard to the HOME assessment, 17 (60%) PT children and six (20%) FT children's homes scored below 27 points, which is suggestive of environmental risk to development. Medians and statistical test results are shown in Table 3.

Significant, weak to moderate correlations were observed between GA and total HOME scores, between GA and PDMS-2 overall and subscale scores and between GA and performance on the PEDI self-care test (Table 4). Mothers' educational level was moderately correlated with family income, which, in turn, had a weak correlation with fine motor performance on the PDMS-2 only. Moderate to strong correlations were observed between this test's subscales.

Discussion

The results of this study provide further evidence that preterm children score lower on motor tests during their second year of life, which appears to have an impact on functional performance, especially walking and self-care abilities. The fact that the PT group had more limited environmental

Table 4 - Correlations between gestational age and study variables

	Age Gestational (weeks)	Mother's education (years)	Family income†	Acquisition of walking (days)	AIMS 12m	HOME Total	PDMS-2 GM	PDMS-2 FM	PDMS-2 Total	PEDI FC-SC	PEDI – FC-MO	PEDI CA-SC
Mother's education (years)	0.20											
Family income†	0.12	0.47**										
Acquisition of walking (days)	-0.37**	-0.00	-0.21									
AIMS percentile 12m	0.11	-0.17	0.07	-0.79**								
HOME Total	0.32*	0.15	0.23	-0.19	0.10							
PDMS-2 Gross Motor	0.44**	0.00	0.18	-0.32*	0.20	0.18						
PDMS-2 Fine Motor	0.37**	-0.01	0.28*	-0.20	0.05	0.35**	0.56**					
PDMS-2 Total	0.44**	0.061	0.18	-0.22	0.07	0.25	0.79**	0.74**				
PEDI Capability, Self-care	0.29*	-0.07	0.04	-0.21	0.19	0.23	0.39**	0.29*	0.31*			
PEDI Capability, Mobility	0.20	-0.12	0.05	-0.26*	0.33**	0.14	0.23	0.16	0.13	0.58**		
PEDI Assistance, Self-care	0.19	-0.07	0.23	-0.17	0.09	0.20	0.27*	0.16	0.14	0.60**	0.37**	
PEDI Assistance, Mobility	0.07	-0.15	0.13	-0.12	0.13	0.42**	0.09	0.23	0.09	0.44**	0.51**	0.58**

*$p<0.05$; **$p<0.001$; †in multiples of the minimum monthly wage; AIMS: Alberta Infant Motor Scale, PDMS-2: Peabody Developmental Motor Scales, second edition; PDMS-2 MG = Peabody Developmental Motor Scales – Gross Motor, PDMS-2 MF: Peabody Developmental Motor Scales – Fine Motor, PEDI: Pediatric Evaluation of Disability; FC-SC: Functional Capability, Self-care; FC:MO: Functional Capability, Mobility; CA-SC: Caregiver Assistance, Self-care

stimuli may have affected these results, potentiating the biological risk associated with prematurity.

In line with the literature[22,23], the preterm children walked later, at a mean age that was slightly higher than reported by other studies. In Taiwan, Luo *et al*[24] reported a median age of 12.8 months for independent walking, but their study included children born at up to 36 weeks' GA. In Spain, Gabriel *et al*[23] found a mean age of 13.5 months for a sample of 694 babies born with weight below 1,500g, which is similar to the data reported here. In Brazil, Volpi *et al*[22] employed enrollment criteria similar to those used for this study and observed independent walking at 12.8 months' corrected age. There is a certain variation in the means found in different studies, but all are within the range of 12 to 15 months that is expected for acquisition of walking[15,17]. Seventeen preterm children and 10 controls started walking after 15 months, which is suggestive of delayed walking development, especially among the PT infants. It should be pointed out that a majority of the families in both groups have low incomes and live in small homes which could restrict children's freedom to move about; a precondition for learning to walk independently.

Despite the strong correlation (-0.79) between age at walking and 12-month AIMS scores (Table 4), AIMS did not identify a difference between groups in terms of gross motor functions at 12 or 15 months. Considering that from 12 months on walking is the most relevant item in the AIMS, it was not expected that the test would fail to capture the difference between groups. It can be observed from Table 2 that the median PT scores are lower at 12 and 15 months, but the difference did not even approach significance. A similar result was reported by Lino[25], who failed to identify differences between performance on AIMS at 4, 6 or 8 months in a similar sample of preterm and full term babies. The failure to detect a statistical difference could be attributed to this study's small sample size, however, although the sample is limited, statistical power was high, which increases confidence in the results.

We should emphasize that the mean AIMS scores for both groups were within normal limits for age, which indicates that socially disadvantaged Brazilian children have gross motor performance consistent with international norms, irrespective of prematurity. Manacero and Nunes[26] administered the AIMS during the first 12 months of life of children born at GAs from 32 to 34 weeks and also observed motor performance within the range expected for age and found that scores were unrelated to birth weight (1,417±292g). The 34-week GA limit for the sample studied here was similar to the criterion used by Manacero and Nunes[26] and even though the sample of preterms under study included even smaller infants (1,179±190g), there was still no difference between the groups.

It was also observed that the correlation between GA and 12-month AIMS scores was not significant (Table 4) and few children in either group were identified as having delayed gross motor development. Thus, according to AIMS, healthy preterm very low birth weight infants and extremely low weight infants who are free from evident neurological sequelae have gross motor development that is compatible with their corrected age. This finding is not consistent with the difference between the groups in terms of acquisition of walking and these results lead us to question AMIS' discriminatory power for identifying gross motor delay in Brazilian children after 12 months.

Whereas the AIMS did not identify differences between the groups at 12 or 15 months, both the fine and gross motor scales of the PDMS-2 detected significant differences between groups at 18 months. According to Evensen *et al*[27], the PDMS is an important tool for early identification of motor problems in very low weight preterms. Furthermore, it tests a larger number of items than the AIMS does and can assess a wider range of behaviors, which may have contributed to identification of differences between the groups.

Another relevant factor is that the HOME inventory results indicate that the PT were exposed to a significantly less stimulating environment (Table 3), which could have an effect on motor development. It is known that biological factors have a strong influence on development during the first year of life[5-7], but environmental factors become more and more relevant from the second year onwards[28]. The PT's homes scored lower on all areas of the inventory and the differences for overall score and for the subscales availability of learning materials and involvement with the child were significant. In line with this, 60% of the children in the PT group had scores suggestive of environmental risk, whereas just 20% of the FT group had scores below the median. Overall HOME scores had a weak but significant positive correlation with GA, indicating that the PT infants were living in less stimulating environments.

Although significant differences were identified between the groups in income and maternal educational level, and these are factors that have an impact on the way the home environment is organized[29,30], neither of these variables had a significant correlation with overall HOME scores (Table 4). Furthermore, the groups' socioeconomic classifications did not differ. The greater proportion of mothers with more than 8 years of formal education and the higher family incomes in the FT group may have contributed to increased availability of learning materials. Nevertheless, the fact that there was no significant correlation between income and mother's educational level and the fact that there was a significant correlation between overall HOME score and GA suggest that prematurity is somehow related to lower quality and reduced quantity of stimuli in the home environment.

It is of interest to note that, although the PT children exhibited conditions such as respiratory problems, anemia and retinopathy, requiring frequent medical attention, they scored lower on the HOME's involvement scale (Table 3), which indicates reduced physical interaction with their mothers. In this context the question arises whether the mothers of preterms who are faced with constant worries provoked by biological issues are not neglecting aspects such as playing with their children and building relationships with them. This should be investigated in future studies.

Returning to the issue of motor abilities, the difference identified between the groups at 18 months does appear to have a functional impact, since the PT performed worse at the self-care activities in the PEDI. Motor abilities contribute to functional performance, as is shown by the significant correlations between the PEDI capability scale for self-care results and PDMS-2 scores (Table 4). Mancini *et al*[14] also failed to detect a significant difference between 12-month old preterm and full term children in terms of PEDI-mobility scores, but in a later study of children aged 3 years or more, the preterm group learnt to walk later and scored lower for self-care capabilities. No difference was observed between the two groups in the present study in terms of carer assistance for mobility and self-care, possibly because 18-month old children are generally given help. Future studies should investigate the degree of assistance provided by the parents of older children, of whom a greater degree of independence is expected.

Goyen e Lui[29, examined "apparently normal" preterm children who had motor delays at 18 months, finding that motor problems were still present at 5 years of age and that children in less stimulating environments had worse outcomes. In the present study, the PT group did not only have worse motor performance, it also contained a higher number of children with scores indicative of environmental risk, which could potentiate the negative consequences of prematurity on motor development. Pediatric care is even more important for socially disadvantaged families and should extend beyond exclusively focusing on sensorimotor and cognitive aspects and encompass continuation of care and stimulation at home. While it is not always possible to intervene with biological characteristics, the quality and quantity of environmental stimuli can be improved by providing parents with guidance, which has a positive impact on children's performance[25].

The limitations of this study include its limited sample size, the fact that the samples were not paired for socioeconomic status, which meant that the groups differed in terms of family income, the use of imported tests, which restricts interpretation of each instrument's cutoff points, and the use of parents' reports to provide data on date of walking attainment. Future studies should study larger samples, stratified by degree of prematurity and social status, and should assess walking by direct observation. It should also be stressed that this study's exclusion criteria mean that the data analyzed are limited to preterms free from evident neurological sequelae. Studies with less restrictive criteria should be conducted to further investigate the relationship between prematurity and developmental disorders in Brazilian children.

It can be concluded from the results of this study that children born at gestational ages of less than 34 weeks and weighing less than 1,500g may exhibit motor and functional delays in their second year of life. As environmental factors may potentiate the impact of biological risk on development and it is necessary to investigate the relationship between prematurity and environmental risk factors in greater detail.

Acknowledgements

We are grateful to the children and their families who took part in this study and to the team at ACRIAR/UFMG for their support maintaining the follow-up program. The second author would also like to thank CNPq for financing her research activities.

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