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Gross motor performance and its association with neonatal and familial factors and day care exposure among children up to three years old

Desempenho motor grosso e sua associação com fatores neonatais, familiares e de exposição à creche em crianças até três anos de idade

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Abstract

Objective: To analyze gross motor performance and its association with neonatal and familial factors and day care exposure among children up to three years of age attending public day care centers. **Methods:** This was a cross-sectional study that evaluated 145 children (58 aged 6-11 months, 54 aged 12-23 months and 33 aged 24-38 months) attending six public day care centers in Piracicaba, State of São Paulo. The Peabody Developmental Motor Scale-2 test was used to assess overall gross motor performance and the motor subtests that make up the scale (reflexes, stationary skills, locomotion skills and object manipulation). Neonatal, familial and daycare center exposure data were also collected and their association with suspected delays in gross motor performance was investigated. **Results:** The prevalence of suspected delays in gross motor performance was 17%, with disadvantages among children under 24 months of age and with regard to locomotion skills. There were associations of risk between suspected delays in gross motor performance and family income, and between suspected delays in locomotion skills and parental educational level. Children whose families had a monthly income of up to 700 reais were 2.81 times more likely to present delays in gross motor performance. Children whose parents had up to eight years of education were 4.63 times more likely to present delays in locomotion skills. There was no association of risk with the other variables. **Conclusion:** The results indicate the need for greater attention to motor development during the first 24 months of children who attend day care centers, especially those with low-income and less-educated parents.

Key words: day care centers; child; child development; environment; risk factors.

Resumo

Objetivo: Analisar o desempenho motor grosso e sua associação com fatores neonatais, familiares e de exposição à creche em crianças com até três anos de idade, frequentadoras de creches públicas. **Métodos:** Estudo transversal no qual foram avaliadas 145 crianças (58 com idade entre 6-11 meses, 54 entre 12-23 meses e 33 entre 24-38 meses) frequentadoras de seis creches públicas de Piracicaba (SP). O teste *Peabody Developmental Motor Scale-2* foi utilizado para avaliação do desempenho motor grosso global e subtestes motores que compõem a escala (Reflexos, Habilidades Estacionárias, Habilidades de Locomoção e Manipulação de Objetos). Foram coletados dados neonatais, familiares e de exposição à creche e pesquisada a associação desses ao desempenho motor suspeito de atraso. **Resultados:** A prevalência de suspeita de atraso no desempenho motor grosso foi de 17%, com desvantagens em crianças menores de 24 meses e em Habilidades de Locomoção; encontrada associação de risco de desempenho motor grosso suspeito de atraso e renda familiar, e suspeita de atraso em Habilidades de Locomoção e escolaridade paterna. Crianças cujas famílias tinham renda mensal até R$700,00 estavam 2,81 vezes mais expostas a apresentar desempenho motor grosso suspeito de atraso. Crianças cujos pais tinham até oito anos de escolaridade apresentaram risco 4,63 vezes maior de atraso em Habilidades de Locomoção. Não foi encontrada associação de risco com as demais variáveis. **Conclusão:** Os resultados apontam maior atenção ao desenvolvimento motor durante os primeiros 24 meses de crianças que frequentam creches, especialmente as inseridas em famílias com menor renda mensal e cujos pais têm menos escolaridade.

Palavras-chave: creches; criança; desenvolvimento infantil; meio ambiente; fatores de risco.

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Introduction

Child development consists in various interdependent domains (sensory-motor, cognitive and socioemotional) influenced by biological factors (i.e. gestational age, birth weight, etc.), socioenvironmental factors (e.g. socioeconomic status, parental education, etc) and hereditary factors; all of these factors can be affected by adverse or favorable situations[1]. The first years of life are particularly important as that is when vital development occurs in all domains due to intense events in the development of the nervous system (NS), modulated by the quality of the environment[1]. In the general context of child development, motor development is regarded as an essential component with implications to other developmental aspects[2]. During the first years, it provides the foundation for subsequent development and optimizes functional performance in areas such as learning, self-care, leisure, and games[3]. It is also an important indicator of NS maturity and integrity and of general well-being[4].

In recent decades, the growing number of children enrolled in day care centers[5] in the first few months of life[5] has introduced a new, permeating factor into their development, namely the daily experience of a collective environment. According to the United Nations Children's Fund (UNICEF)[6], in 2001, 10.7% of the Brazilian children up to three years old attended day care centers; in 2006, this proportion had risen to 15.5%; it is estimated that by 2011 this proportion will reach 50%. Although access to childhood education is a fundamental right[6,7] and its purpose is the child's integral development, the increase in the proportion of children who experience this collective environment raises some concerns. Belsky[8] warns that there are risks and benefits associated with the daily care dispensed in early childhood; thus, it is important to know its effect on child development, without losing sight of the various factors that could potentially influence this development. In Brazil, studies on children in day care centers are scarce and indicate problems concerning employee qualifications; infrastructure; the adoption of routines with emphasis on nourishment and hygiene; increased exposure to infections and possible repercussions for motor development[9-13].

It is estimated that around 200 million children up to the age of five who live in developing countries fail to reach their cognitive, motor, and socioemotional development potential, considering that this is the result of the interrelation of genetic, biological, and socioenvironmental factors[1]. A better knowledge of the impact of these factors on child development in their first years of life is fundamental to establishing strategies to promote progress and prevent delays. In this context, the aim of the present study was to analyze gross motor performance and its association with neonatal and familial factors, as well as day care exposure of children up to three years old who attend public day care centers.

Methods

This was an exploratory cross-sectional study in which 145 children aged 0-3 attending six public day care centers in Piracicaba (SP) were evaluated as to motor performance, neonatal and familial characteristics, and day care exposure. The study was approved by the Research Ethics Committee (Protocol 80/05) of Universidade Metodista de Piracicaba (UNIMEP). For the sample calculation, the following parameters were taken into account: a finite population, 1456 children enrolled in the 1st, 2nd, and 3rd stages of preschool (year of 2006 – Municipal Education Department); estimated 20% probability of finding changes; 7% sampling error with a confidence interval of 95%; estimated minimal sample of 115 children. A convenience sample from the public day care centers of Piracicaba (SP) was used considering the following criteria: no intervention of any kind (e.g. physical education); interest on the part of the principals; and proximity to the university where the study was based. Three day care centers were located in the east part, two in the south part, and one in the north part of town. The collection was carried out on location from March 2006 to November 2007. The study included 0-3 year olds who attended day care centers on a full-time basis and whose guardians signed a consent form. Exclusion criteria were malformations, neurological problems, genetic syndromes and severe illnesses. From an initial sample of 162 children, 17 were excluded for absence due to illness or for leaving the school. Thus, 145 children (73 boys and 72 girls) composed the final sample of this study, of which 58 were 6-11 months old, 54 were 12-23 months old, and 33 were 24-38 months old.

The Peabody Developmental Motor Scale-2 (PDMS-2) test[14] was used to obtain the results of the overall gross motor performance and the motor subtests of this scale: Reflexes (up to 11 months) – evaluates the ability to automatically react to environmental stimulus (e.g. walking reflex, protective reactions); Stationary Skills (1-71 months) – measures the ability to adjust the body to the center of gravity and maintain balance (e.g. control of the head, trunk, and orthostatic position); Locomotion Skills (1-71 months) – evaluates the ability to move (e.g., to roll over, walk, crawl, etc.); Object Manipulation (12-71 months) – tests the ability to throw, catch and kick a ball). The performance in the gross motor scale is expressed by means of the Gross Motor Quotient (GMQ), with a mean of 100 and standard deviation (SD) of 15. In each subtest, it is expressed by the Standard Score (SS), with a mean of 10 and SD of 03; the performance can be rated as: very high, high,

above average, average, below average, poor, very poor. In the present study, the motor performance variable was treated as a dichotomous variable; adequate gross motor performance when GMQ≥90 and suspected delay when GMQ<90; adequate performance in each subtest when EP≥8 and suspected delay when EP<8; in other words, there was suspected delay when the performance was below average, poor, or very poor.

The PDMS-2 was chosen for being a standardized instrument that evaluates gross motricity in detail and for being a diagnosis scale. It is also suitable to the age group studied and can be applied to day care centers. Each child was evaluated, according to chronological age or age corrected for prematurity, by two examiners (a graduate student and an undergraduate research fellow). One was responsible for conducting the test, and the other for recording the results. The examiners attended PDMS-2 training sessions and took part in an inter-examiner agreement study that included 14 infants evaluated separately by each examiner (Intraclass Correlation Coefficient =0.83; p<0.001). The resources used for the tests included a mat, a table and chair, PDMS-2 original material, and toys. The child had to be alert and wear clothes that did not restrict movements. The test was scheduled according to the daily routine of the day care centers, respecting the allotted times for meals, bathing, and napping. If interrupted, the tests were completed within five days, as established by the scale[14].

The following independent neonatal variables were considered: gestational age (< or ≥ 37 weeks of gestation) and birth weight (< or ≥ 2500 g.; World Health Organization – CID10[15]) and the Apgar score (< or ≥ seven in the 1st and 5th minute of life). To collect the neonatal data, the family was asked to provide the researchers with a photocopy of the child's Health Record Book; the missing information was completed by consulting the maternity records. Family data were collected by means of a closed questionnaire, adapted from the items on familial characteristics of the Affordances in the Home Environment for Motor Development - Self-Report[16], taking into account: parental age (< or ≥ 20 years); parental education level (≤ or > eight years); parental cohabitation (yes or no); number of adults (> or ≤ two) and children (< or ≥ two) in the same household; monthly family income (median income ≤ or > R$700.00, i.e. approximately twice the minimum wage). For risk analysis, we also considered the child's median time attending day care centers (< or ≥ 6 months) and the child's mean age at the time of enrollment (≤ or > 7 months).

Statistical analysis

The continuous variables were expressed by central tendency and dispersion measures, and the categorical variables by frequencies. To test the differences in motor performance between the groups (defined by age), the ANOVA test for independent groups was used (the assumptions of normal distribution [Kolmogorov-Smirnov test] and homogeneity of variance [Levene's test] were confirmed); as a post hoc, Bonferroni's test was applied. The chi-square test was used to analyze the association between the proportion of participants in the categories of the variable motor performance and the age groups and motor subtests. For the association and risk analysis of categorical data, we used the Prevalence Ratio Index or Odds Ratio (OR), with the respective Confidence Interval (CI). The risk association was considered significant when the lower limit of the CI was greater than one. The level of significance was set at 5%.

Results

Overall, the mean performance of the group was compatible with the reference sample for the GMQ (100±11.02). However, considering the mean of performances according to the age groups (6-11 months = 97.15±9.03; 12-23 months = 99.42±11.63; 24-38 months = 105±11.18) there was a difference in the monthly mean score (F=7.46; p=0.01). The post hoc test indicated that children older than 24 months had a better performance, when compared to those aged between 6-11 and 12-23 months.

The prevalence of suspected delay in motor performance is displayed in Table 1. There was suspected delay in the overall gross motor performance in 17% of the children. Considering each age group, there is a tendency to a higher prevalence of suspected delay among children up to 11 months old (17.2%) and between 12-23 months (22%), compared with those older than 24 months (6%), although there was no statistical significance (x^2=3.91; p=0.141). Subtest analysis shows a higher prevalence of suspected delay in locomotion skills, followed by reflexes, object manipulation and stationary skills, with a significant difference between the motor subtests (x^2=13.30; p=0.004).

Because the prevalence of suspected delay in locomotion skills (16%) was similar to that of overall gross motor performance (17%), we also investigated the risk association for this subtest (Table 2). Children from families with an income of up to R$700.00 were 2.81 times more likely to have suspected delay in gross motor performance. Children whose parents had up to eight years of education were 4.63 times more likely to have suspected delay in locomotion skills. No risk association was found between the delay in motor performance and the other variables studied.

Table 1. Prevalence of children with suspected delay in gross motor performance according to subtest and age.

Gross motor performance	n	Suspected Delay (GMQ<90) *f* (%)	Adequate (GMQ≥90) *f* (%)	p-value
	145	24 (17%)	121 (83%)	-
Performance according to age	145			
6-11 months	58	10 (17.2%)	48 (82.8%)	
12-23 months	54	12 (22.2%)	42 (77.8%)	
24-38 months	33	2 (6%)	31 (94%)	0.141[(a)]
Performance according to subtest	145	Suspected Delay (SS<8) *f* (%)	Adequate (SS≥8) *f* (%)	
Reflexes	58	8 (13.8%)	50 (86.2%)	
Stationary Skills	145	5 (3.4%)	140 (96.6%)	
Locomotion Skills	145	23 (16%)	122 (84%)	
Object Manipulation	87	8 (9%)	79 (91%)	0.004[(b)]

GMQ= Gross Motor Quotient; SS=Standard Score; *f*=absolute frequency; %=relative frequency; [(a)]x^2=3.91 (comparison by ages); [(b)]x^2=13.30 (comparison by subtests).

Table 2. Independent variables associated with Gross Motor Performance and Locomotion Skills subtest.

		Gross Motor Performance				Locomotion Skills			
Independent variables (n)	n (%)	S	A	OR	CI 95%	S	A	OR	CI 95%
Mother's age (n=135)									
<20 years age	7 (5%)	3	4	4.05	0.54-25.61	2	5	2.16	0.19-14.27
≥20 years age	128 (95%)	20	108	1		20	108	1	
Father's age (n=129)									
<20 years age	3 (2%)	1	3	1.77	0.03-23.19	2	1	11.26	0.54-670.37
≥20 years age	126 (98%)	20	106	1		19	107	1	
Mother's education (n=133)									
≤8 years	45 (34%)	7	38	0.97	0.32-2.86	7	38	1.06	0.35-3.17
>8 years	88 (66%)	14	74	1		13	75	1	
Father's education (n=91)[(a)]									
≤8 years	37 (41%)	8	29	2.21	0.61-8.12	10	27	4.63	1.17-21.79[(*)]
>8 years	54 (59%)	6	48	1		4	50	1	
Parent cohabitation (n=136)									
no	45 (33%)	9	36	1.38	0.49-3.79	8	37	1.19	0.41-3.37
yes	91 (67%)	14	77	1		14	77	1	
Adults at home (n=136)									
>2	56 (41%)	10	46	1.12	0.41-3.02	9	47	0.99	0.35-2.73
≤2	80 (59%)	13	67	1		13	67	1	
Children at home (n=134)									
≥2	104 (78%)	16	88	0.73	0.24-2.53	16	88	0.73	0.24-2.53
<2	30 (22%)	6	24	1		6	24	1	
Monthly family income (n=137)									
≤R$700[(b)]	63 (46%)	16	47	2.81	1.02-7.88[(*)]	13	50	1.88	0.68-5.23
>R$700[(b)]	74 (54%)	8	66	1		9	65	1	
Gestational age (n=133)									
<37 weeks	14 (10.5%)	5	9	3.12	0.73-11.75	4	10	2.24	0.46-8.85
≥37 weeks	119 (89.5%)	18	101	1		18	101	1	
Birth weight (n=133)									
<2500 grams	8 (6%)	3	5	3.35	0.47-18.69	2	6	1.98	0.18-12.19
≥2500 grams	125 (94%)	19	106	1		18	107	1	
Apgar 1' (n=92)[(c)]									
<7	6 (6.5%)	0	6	0.0	0.00-7.54	1	5	1.71	0.03-17.95
≥7	86 (93.5%)	11	75	1		9	77	1	
Age at the time of enrollment (n=145)									
≤7 months	78 (54%)	13	65	1.02	0.39-2.67	10	68	0.61	0.23-1.63
>7 months	67 (46%)	11	56	1		13	54	1	
Time of day care exposure (n=145)									
≥6 months	75 (52%)	12	63	0.92	0.35-2.40	12	63	1.02	0.38-2.72
<6 months	70 (48%)	12	58	1		11	59	1	

f=relative frequency; S=Suspected Delay; A=Adequate; OR=Odds Ratio; CI 95%=Confidence Interval (significant association when limit >1); [(*)]=significant risk association; [(a)]=the association was calculated only for the 91 families with cohabiting parents and which gave information regarding paternal education level; [(b)]=approximately twice the minimum wage in Brazil; [(c)]=less than 1% of the children had an Apgar score <7 in the 5th minute.

Discussion

Considering the group as a whole, 17% of the children had suspected delay in gross motor performance. The motor performance analysis showed disadvantages in children under 24 months old and in locomotion skills, as well as a risk association between suspected delay in gross motor performance and family income and between suspected delay in locomotion skills and parental education level.

Several studies on children who attend day care centers and preschools report suspected developmental delays, including motor development. However, the studies are still inconclusive, and the prevalence of delay or suspected delay ranges from 10% to 43% in the different studies[11-13,17,18]. The suspected delays found in the present study are also variable if one takes into account the values for different ages (analysis of variance) and for the different motor domains (Table 1). Among the studies identified in the literature, the present study is the only one to use a scale of diagnosis to assess the motor development of children who attend day care centers, therefore we believe the results may contribute to understanding the heterogeneity of the findings.

The disadvantage in locomotion skills evidenced by the present study suggests this is the most affected motor domain in the group examined, especially in the first two years of life, a period considered fundamental for the acquisition of independent erect locomotion[2]. There is evidence that, in many institutions, infants spend most of the day in their cribs, which limits the opportunities to explore the environment and interact with other children, with potential repercussions for locomotion skills[5]. According to Campos et al.[19], early locomotion experiences are essential to developmental changes, with a significant impact on social and emotional development, communication through motor actions, spatial perception and cognition.

The dynamism of the developmental process and the greater vulnerability associated with young age may explain the differences found in the various age groups. The difference in motor performance between children under 24 months of age and children above that age suggests that the potential for full development is optimized with locomotion independence, i.e. the characteristics that influence the way a child moves change over time according to experience and learning, but also according to context and task[20]. One of the most common models used to explain the changes in child development is the transactional model which states that there is a degree of plasticity inherent to the child and to the environment[21]. The basic assumption of this model is that development is facilitated by a bidirectional and reciprocal interaction between the child and their environment, which are actively engaged with one another, changing and being changed by this interaction. Development is considered unique and peculiar, resulting in the balance between the risk factors and the protection factors of the child and the context[21].

Bradley and Vandell[22] point out that day care experiences interact with experiences at home and their own characteristics to produce the results in development. The risk associations that were found suggest the preponderant influence of the family on the motor development of the group studied. According to Belsky et al.[23], the family is the strongest and most consistent predictor of child development, but the quality of the care given in the first few years is very important.

Although the influence of neonatal risk factors is well described in the literature, the present study had a low occurrence of preterm births with low weight and Apgar score below seven (Table 2). In addition, no neonatal clinic complications were found, and preterm children were evaluated based on the corrected age. There is evidence that, in the absence of other disturbances and with age correction of preterm children, the motor development may be similar to that of children born at term[24].

There was also a low occurrence of potentially unfavorable family situations (e.g. teenage parents, low maternal education level). This may at least partially explain the absence of risk association of suspected delay for these variables[25]. As for the risk associations that were identified, they suggest greater risk of overall delay among children from low income families and a risk of delay in locomotion skills associated with low paternal education level. The relationship between low socioeconomic status/low income and developmental disadvantage is well known[1,26-28]. Poverty amplifies children's biological vulnerability, leading to unfavorable results in development[27]. The underprivileged segment of society combines social, economic and biological factors that determine a greater chance of developmental delay[28]. Poverty and its associated problems (i.e. malnutrition, unsanitary living conditions; parental education and inadequate stimulation at home) are regarded as the main risk factors in child development[1] and may have contributed to the findings.

The present study showed that, even in a group of children/families who use the public education system, there is a greater disadvantage (higher risk of motor development delay) associated with lower income (46% with an income under R$700.00; Table 2). Regarding parental education level, this result comes at a time of debate about the pertinence of including the father and his possible influence on child development. The education level of the head of the household substantially affects child well-being due to the vulnerability of children in early childhood[29]. It also has indirect repercussions on proper child rearing because it influences the access to and comprehension of the information disseminated by health and

education services and by the media[30]. The father's role in neurological and psychomotor development was evidenced in two studies. While studying the cognitive and motor development of 788 Chilean infants, researchers found that the best combination of risk categories for child development were temperament, maternal intelligence, paternal role and stimulation at home[27]. The study by Barros et al.[11] showed that biologically healthy children may suffer negative influences from environmental risk factors, including the absence of a father[11].

The present study did not find any risk associations between age at enrollment in day care or time of day care exposure and motor development, however the quality of the care received by the child may at least partially explain the findings in the literature[11-13,17,18]. Surveys on the quality of education in Brazilian preschools (1996-2003) showed that educators had difficulty overcoming poor eating and hygiene habits to promote practices that lead to full development[9]. Although preschools aim to foster development, the quality of the day care center environment as a place for child development has been questioned[30,31]. The findings of the present study and the reports in the literature suggest that, even if day care centers do not impair child development, they may not be acting satisfactorily to support and promote it, as recommended by the National Education Guidelines[7] and the National Curriculum Reference Guide[5].

The limitations of the present study were its cross-sectional design; the lack of investigations into the quality of the service provided at each day care center and at home, and the use of an assessment instrument still not validated in Brazil, which is also a limitation of this field of knowledge. There is a lack of instruments developed and/or validated in Brazil to evaluate early motor development. As a consequence, the use of foreign instruments has been frequent in Brazilian research[4,24,26].

In general, the results of the present study emphasize the need for more attention to motor development during the first 24 months of life of preschool children, particularly those from lower income and less educated families. Given the multicausal nature of development, which is influenced by child/environment interaction, and the importance of the object of study, i.e. child development, further investigation is needed into the associations found in the present study and into the use of study models (e.g. longitudinal studies) to explore the cause-and-effect relationships.

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