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# Motor behavior of low birth weight and very low birth weight premature infants

*Comportamento motor de lactentes prematuros de baixo peso e muito baixo peso ao nascer*

*Comportamiento motor de bebés prematuros de bajo peso y muy bajo peso al nacer*

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**ABSTRACT** | The objectives of this study were to verify the difference between the motor behaviors of low birth weight (LBW) premature infants and very low birth weight (VLBW) premature infants in the first 8 months of life and assess motor behavior of these infants in different age groups. We evaluated 41 LBW infants (2499g to 1500g) and 22 VLBW infants (1499g to 1000g). Groups were divided according to age into NB-1 month, 2-4 months, and 5-8 months, and their motor behavior was analyzed by the Alberta Infant Motor Scale (AIMS) score and percentile. Kruskal-Wallis test was utilized to verify the difference of motor behavior between age groups (NB to 1 month, 2-4 months, and 5-8 months) in each group independently. To detect differences between groups (LBW and VLBW) in each age group, we used the Mann-Whitney test ( $p \leq 0.05$ ). A significant difference was observed between the LBW group and the VLBW group, both for score ( $p=0.011$ ) and percentiles ( $p=0.010$ ), in age groups 2-4 months and 5-8 months ( $p=0.017$ ;  $p=0.013$ , respectively). In the comparison between age groups 0-1 month and 2-4 months, we observed higher scores for the LBW ( $p=0.000$ ) and VLBW ( $p=0.001$ ) groups and lower percentiles ( $p=0.003$ ) for the VLBW group at 2-4 months. Between age groups 0-1 month and 5-8 months, we observed higher scores ( $p=0.000$ ;  $p=0.000$ ) and lower percentiles ( $p=0.005$ ;  $p=0.000$ ) at 5-8 months. Between age groups 2-4 months and 5-8 months, we observed higher score ( $p=0.000$ ;  $p=0.000$ ) and lower percentile ( $p=0.006$ ;  $p=0.004$ ) at 5-8 months. Birth weight had a significant impact on motor development

of premature infants, and developmental delays can be more evident at older ages.

**Keywords** | Infant, Premature; Infant, Very Low Birth Weight; Child Development.

**RESUMO** | Os objetivos deste estudo foram verificar a diferença do comportamento motor entre lactentes prematuros de baixo peso (BP) e muito baixo peso (MBP) nos primeiros 8 meses de vida e avaliar o comportamento motor em diferentes faixas etárias desses lactentes. Avaliou-se 41 lactentes nascidos com BP (2.499 a 1.500g) e 22 com MBP (1.499 a 1.000g). Dividiu-se os grupos nas faixas de RN-1 mês, 2-4 meses e 5-8 meses, e seu comportamento motor foi analisado pelo escore e percentil da Alberta Infant Motor Scale (AIMS). Foi utilizado o teste Kruskal-Wallis para verificar a diferença do comportamento motor entre as faixas etárias (RN a 1 mês, 2-4 meses e 5-8 meses) em cada grupo independentemente. Para verificar a diferença entre os grupos (BP e MBP) em cada faixa etária utilizou-se o teste Mann-Whitney ( $p \leq 0,05$ ). Observou-se diferença significativa entre os grupos BP e MBP, tanto no escore ( $p=0,011$ ) quanto nos percentis ( $p=0,010$ ), nas faixas etárias de 2-4 e 5-8 meses ( $p=0,017$ ;  $p=0,013$ , respectivamente). Na comparação entre 0-1 mês e 2-4 meses foram observados maiores escores nos grupos BP ( $p=0,000$ ) e MBP ( $p=0,001$ ) e menores percentis ( $p=0,003$ ) no grupo MBP aos 2-4 meses. Entre 0-1 mês e 5-8 meses, observamos maiores escores ( $p=0,000$ ;  $p=0,000$ ) e menores percentis ( $p=0,005$ ;  $p=0,000$ ) aos 5-8 meses, bem como, entre 2-4 e 5-8 meses apresentaram maior escore ( $p=0,000$ ;  $p=0,000$ ) e menor

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percentil ( $p=0,006$ ;  $p=0,004$ ) aos 5-8 meses. O peso ao nascer demonstrou ter repercussão importante no desenvolvimento motor de lactentes prematuros, sendo que atrasos podem ser mais nítidos em idades mais avançadas.

**Descritores** | Prematuro; Recém-Nascido de muito Baixo Peso; Desenvolvimento Infantil.

**RESUMEN** | Este estudio tiene el propósito de comprobar la diferencia de comportamiento motor entre bebés prematuros de bajo peso (BP) y muy bajo peso (MBP) en sus primeros 8 meses de vida y de evaluar sus comportamientos motores en las distintas franjas etarias. Participaron del estudio 41 bebés BP (2499 a 1500g) y 22 bebés MBP (1499 a 1000g). Los grupos fueron divididos según las franjas etarias de RN-1 mes, 2-4 meses y 5-8 meses de edad, y su comportamiento motor fue evaluado según la puntuación y el percentil de Alberta Infant Motor Scale (AIMS). Para comprobar la diferencia de comportamiento motor entre las franjas etarias (RN a 1 mes, 2-4 meses y 5-8 meses) en cada grupo independientemente se utilizó el test Kruskal-Wallis,

y para comprobar la diferencia entre los grupos (BP y MBP) en cada franja etaria se utilizó el test Mann-Whitney ( $p\leq 0,05$ ). Se mostró una diferencia significativa entre estos grupos tanto en la puntuación ( $p=0,011$ ) cuanto en los percentiles ( $p=0,010$ ), en las franjas etarias de 2-4 y de 5-8 meses ( $p=0,017$ ;  $p=0,013$ , respectivamente). Al comparar los bebés de 0-1 mes y los de 2-4 meses se concluyó que las mayores puntuaciones entre los grupos BP ( $p=0,000$ ) y MBP ( $p=0,001$ ) y los menores percentiles ( $p=0,003$ ) en el grupo MBP que tiene 2-4 meses. Ya entre los de 0-1 mes y de 5-8 meses obtuvieron las mayores puntuaciones ( $p=0,000$ ;  $p=0,000$ ) y con los de 5-8 meses los menores percentiles ( $p=0,005$ ;  $p=0,000$ ), así como entre los de 2-4 y de 5-8 meses obtuvieron mayor puntuación ( $p=0,000$ ;  $p=0,000$ ) y los de 5-8 meses menor percentil ( $p=0,006$ ;  $p=0,004$ ). Se concluyó que el peso al nacer muestra una importante resonancia para el desarrollo motor de bebés prematuros y que retrasos pueden ser más visibles en edades más avanzadas.

**Palabras clave** | Prematuro; Recién Nacido de muy Bajo Peso; Desarrollo Infantil.

## INTRODUCTION

Premature birth is defined by the World Health Organization (WHO) as all births occurring before 37 weeks of gestation, and low birth weight (LBW) as all live births with birth weight of less than 2500g<sup>1</sup>.

Prematurity and LBW are determinants of neonatal morbidity and mortality, infections, higher hospitalization rates, alterations in gross motor development and personal and social behavior, postnatal neuropsychological deficit, and poor school performance<sup>2-5</sup>.

The lower the birth weight, the greater the likelihood that children at older ages will develop problems concerning difficult to reverse sequelae<sup>6</sup>, since the direct and indirect repercussions can leave damage that will compromise future development<sup>7</sup>.

The infant born prematurely, because functional and structural maturity of organs and tissues was not reached, as intrauterine development was not completed, can have deviations in the pattern of motor development, which may be associated with biological risk factors such as LBW<sup>8-11</sup>. The risk of motor development impairment for these infants increases as birth weight and gestational age (GA) decrease<sup>9</sup>.

Motor disorder, when present, will interfere with the overall maturity of the child, due to the reduction in quality of environmental exploration and of the interactive possibilities that guide the development of socialization, self-care, cognition, and language processes<sup>12,13</sup>. In their study, Luoma et al.<sup>14</sup> observed alterations in the motor coordination and fine motor control areas of the hand for LBW children at the age of 5 years. Other studies<sup>15,16</sup> also showed delays in the motor area in this population.

Motor development delays have been object of study in many areas of health, emphasizing the importance of early evaluation and identification of behavioral alterations and their possible influencing factors. However, few studies have been found to verify how early motor development occurs during the first eight months of life of LBW and very low birth weight (VLBW) infants. This knowledge will assist health professionals in the adequate stimulation for each age group of the infant. In addition, Brazilian studies on psychomotor development of at-risk newborns, especially VLBW premature infants<sup>17,18</sup>, are scarce.

Thus, the objectives of this study were to assess motor behavior among LBW and VLBW premature infants in the first 8 months of life and assess motor behavior of these infants in different age groups.

Therefore, it is believed that low birth weight infants have higher scores and percentiles for motor behavior than those with very low birth weight. Regarding the analysis according to age group, it is assumed that older infants, after the 4<sup>th</sup> month of life, may have better motor behavior than younger infants due to the time of environmental experience and adaptation to the extra-uterine environment.

## METHODOLOGY

The study included 63 infants divided into two groups: 41 LBW infants (2499g to 1500g) and 22 VLBW infants (1499g to 1000g). It was a convenience sample, and cross-sectional assessments were carried out for the age groups: newborn (NB) to 1 month (27 participants), 2–4 months (20 participants), and 5–8 months (16 participants) of corrected age (CA). Noteworthy, infants were included only once in one of the age groups analyzed. Sample characterization is presented in Table 1. There was sample loss of 53 infants of the number of infants eligible for the study. Exclusion criteria for these were information missing from medical records, no contact information found for parents or guardians, and crying at the time of evaluation.

The study included premature infants with birth weight ranging from 1000g to 2500g; born at the hospital where the study was conducted; whose parents authorized the participation in the study. Infants with evidence of neurological disorders/damage, genetic syndromes, congenital malformations, with severe respiratory complications that evolved to neurological damage due to lack of cerebral oxygen were excluded.

This study was approved by the Research Ethics Committee. Premature infants who met the inclusion criteria of this study were selected, after the free and informed consent form was signed by parents or guardians, for the analyses that composed the sample of this research.

The infants participated in a motor development monitoring program of the Hospital, in which parents were advised to stimulate their children at home; however, they did not participate in any early intervention program.

The counselling for parents occurred monthly and was based on the age of each infant. Parents were encouraged to put their children on anti-gravity positions, such as

prone, sitting and crawling, depending on the age of the infant, and to stimulate them with flashy toys (visually and sonorously) in an attempt to promote movements that require muscle activations of specific muscle groups, aimed at exploration and selection of new motor skills. Parents were advised to stimulate their children every day, for at least 30 minutes. Upon returning to the next evaluation of the monitoring program, parents were asked about the conduct of stimulation at home and infants were re-evaluated by the researchers.

The Alberta Infant Motor Scale (AIMS), developed by Piper and Darrah<sup>19</sup>, was used to evaluate the motor behavior of the infants, which was applied by a single evaluator, trained to use the Scale. The purpose of the scale is to assess and monitor the gross motor development of infants through observation of spontaneous motor activity, from birth to 18 months of life or until independent walking is attained. The scale consists of 58 items: 21 observed in prone position, 9 in supine position, 12 sitting, and 16 standing (postures illustrations can be seen in Figure 1). Motor behavior is classified according to the percentile graph presented in the scale (percentiles <5, 5, 10, 25, 50, 75, 90, or >90). The test's total score (0–58 points) is the sum of the subtotals obtained in each subscale, which is converted into percentiles of motor performance, considering the child's CA on the evaluation date. Higher values indicate that the infant's motor repertoire is more varied and improved<sup>19</sup>. Infants were evaluated on their birth day with a tolerance of up to 10 days after this date. To apply the scale, the infant was positioned initially in the position in which he/she felt more comfortable, according to the parent or guardian. Evaluation time ranged from 15 to 30 minutes, depending on the infant's collaboration.

Motor behavior was analyzed both through AIMS percentiles and total scores in each age group under study. With data resulting from the evaluations, comparisons were carried out between the values, of score and percentile, observed between the LBW group and the VLBW group, and the difference between the different age groups in each group under study was verified.

Data were analyzed using the SPSS version 22.0 program. Normality of the data was analyzed using the Kolmogorov-Smirnov test. Since normality was not found, we used nonparametric tests to perform the comparisons of the study. In order to verify the difference of motor behavior between age groups

(NB–1 month, 2–4 months, and 5–8 months) in each group independently, the Kruskal-Wallis test was used, with a significance level of 5%. When differences were found in the age groups, multiple comparisons were applied using the Mann-Whitney test, dividing the significance of 5% by the number

of comparisons (3) thus adopting a significance of 1.7% ( $p < 0.017$ ). To verify differences between the groups (LBW and VLBW) in relation to the AIMS percentiles and scores, the nonparametric Mann-Whitney test was used, with a significance level of 5% ( $p < 0.05$ ).

Table 1. Low weight and very low weight premature infants sample characterization

	N	GA (weeks) mean±SD	BW (g) mean±SD	BW/GA	Time of hospitalization (days) mean±SD
LBWPT	41	33.9	1877.14	PIG=11	13.53
		±1.81	±252.55	AIG=28	±12.58
				GIG=2	
VLBWPT	22	31.22	1305.9	PIG=7	24.93
		±2.79	±125.94	AIG=15	±19.33
				GIG=0	

LBWPT=low birth weight premature infant; VLBWPT=very low birth weight premature infant; N=number of infants; SD=standard deviation; GA=gestational age; BW=birth weight; SGA=small for gestational age; AGA=appropriate for gestational age; LGA=large for gestational age

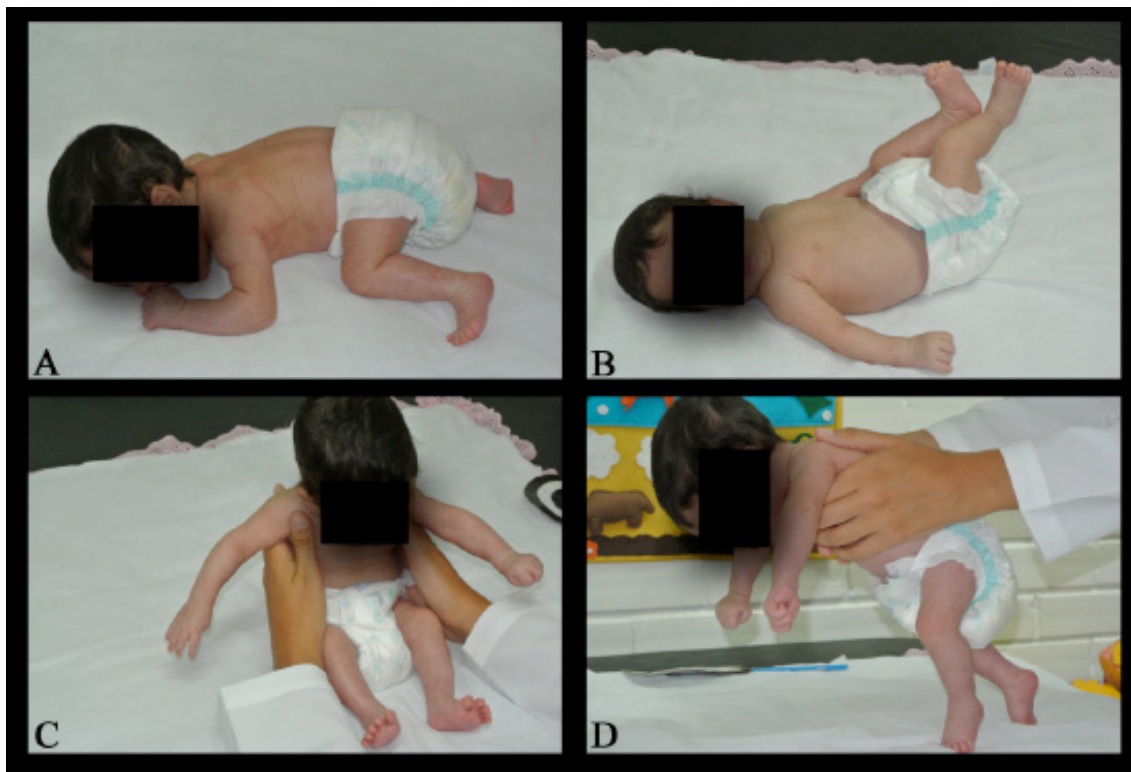


Figure 1. Positions evaluated with the Alberta Infant Motor Scale. (A) Prone. (B) Supine. (C) Sitting. (D) Standing

## RESULTS

### Intergroup analysis in each age group

In the intergroup analysis, we presented the results for the difference between the LBW group and the VLBW group in each age group analyzed (NB–1 month, 2–4 months, and 5–8 months).

In the NB to 1 month age group, there was no significant difference between the LBW group and the VLBW group both for AIMS score and percentile (Table 2). For the 2–4 months age group, there were higher score ( $p = 0.011$ ) and percentile ( $p = 0.010$ ) for the LBW group compared to the VLBW group; as well as for the 5–8 months age group both for score ( $p = 0.017$ ) and percentiles ( $p = 0.013$ ) (Table 2).

Table 2. AIMS score and percentile for the groups and ages analyzed

	AIMS Score – LBW					AIMS Score – VLBW				
	Min	25%	Med	75%	Max	Min	25%	Med	75%	Max
NB 1 month	3	4.25	5	6	11	4	4.5	6	6.5	11
2–4 months	8	11	15	17	25	5	7.5	9	13.8	17
5–8 months	13	20	25	32	36	14	17	20	22	28
	AIMS Percentile – LBW					AIMS Percentile – VLBW				
	Min	25%	Med	75%	Max	Min	25%	Med	75%	Max
NB 1 month	25	25	50	75	90	25	50	75	75	90
2–4 months	10	50	50	75	100	0	25	25	50	50
5–8 months	5	25	25	50	50	0	8.75	10	25	25

LBW=low birth weight infant; VLBW=very low birth weight infant; NB=newborn; Min=AIMS score and percentile minimum value; 25%=AIMS score and percentile value presented at Percentile 25; Med=AIMS score and percentile median value; 75%=AIMS score and percentile value presented at Percentile 75; Max=AIMS score and percentile maximum value

### Intragroup analysis between age groups

In the intragroup analysis, results of the difference between age groups in each group analyzed (LBW and VLBW) will be presented. In the LBW group, illustrated in Table 2, it can be observed that there were differences both for score ( $p=0.000$ ) and percentiles ( $p=0.009$ ) between the age groups analyzed. Comparative analysis between the age groups newborn 1 month and 2–4 months showed higher AIMS scores for 2–4 months ( $p=0.000$ ); however, there was no difference in percentiles between these age groups. Analysis between the age groups newborn 1 month and 5–8 months showed higher scores ( $p=0.000$ ) and lower percentiles ( $p=0.005$ ) for 5–8 months. In the comparative analysis between the age groups 2–4 months and 5–8 months, we observed higher score ( $p=0.000$ ) and lower percentile ( $p=0.006$ ) for 5–8 months.

In the VLBW group, we also found difference both for score ( $p=0.000$ ) and percentile ( $p=0.000$ ) between the age groups analyzed. In the comparative analysis between the age groups newborn 1 month and 2–4 months, we observed higher scores ( $p=0.001$ ) and lower percentiles ( $p=0.003$ ) for 2–4 months. In the analysis between the age groups newborn 1 month and 5–8 months, we observed higher scores ( $p=0.000$ ) and lower percentiles ( $p=0.000$ ) for 5–8 months. The comparative analysis between the age groups 2–4 months and 5–8 months showed a higher score ( $p=0.000$ ) and a lower percentile ( $p=0.004$ ) for 5–8 months. These results are presented in Table 2.

### DISCUSSION

This study aimed to verify the motor behavior among low birth weight and very low birth weight infants in the first 8 months of life, as well as evaluating the motor behavior of LBW and VLBW infants in different age groups. According to the results, the first hypothesis of the study was demonstrated partially, while the second hypothesis was refuted.

Regarding the comparison between the groups, we observed no difference between them in the age group newborn 1 month. However, infants in the VLBW group, in age groups 2–4 months and 5–8 months, had lower AIMS median score and percentile compared to the LBW group, thus showing that birth weight appears to influence motor development from 2 months of age on, agreeing partially with the hypothesis initially raised in the study.

Similar results were observed by Formiga<sup>20</sup>, who found that VLBW infants showed greater delay in relation to LBW infants aged 2–6 months of CA. According to Oliveira et al.<sup>21</sup> and Aylward<sup>22</sup>, children born with lower weight and lower gestational age showed worse motor performance, demonstrating that the variable birth weight has an important impact on the future prognosis of infants and should be a major eligibility criteria to classify babies as of high risk and low risk for developmental problems.

Other studies also observed influence of birth weight on motor development at older ages. The meta-analysis of Kieviet et al.<sup>23</sup> highlighted the substantial motor impairment in very premature and VLBW children

from birth to 15 years of age when analyzing studies that used other motor tests such as Bayley Scales of Infant Development II (BSID-II), Movement Assessment Battery for Children (MABC), Bruininks-Oseretsky Test of Motor Proficiency (BOTMP). Jeng et al.<sup>24</sup> also observed that VLBW premature infants have a higher risk of delayed development of the ability of walking, reaching it at about 14 months, while children born at term with appropriate weight begin to walk at 12 months. Another study<sup>21</sup> evaluated VLBW premature children aged 5–6 and found that 8.7% of children in the VLBW group had signs of definitive problem of motor coordination and 21.7% had suspected motor performance.

Despite the evidences that birth weight affects infant and child motor behavior, Manacero and Nunes<sup>25</sup> showed that premature infants, divided into groups below 1750g and above 1750g, had a progressive sequence of appearance of motor skills and verified that there was no influence of birth weight on the acquisition of motor patterns when percentiles were evaluated by AIMS. However, a limitation of the aforementioned study was that groups were stratified having birth weight of less than 1750g as cutoff, and not 1500g as in this and other studies.

Although most studies found in the literature agree with the results found in this study, an issue that remains is the fact that no difference was found between the groups considering the age group newborn 1 month. Importantly, in the studies found in the literature, no comparison was made between LBW and VLBW groups in specific age groups such as those presented in this study and, therefore, this result shows to be unique. It is believed that this result may be related to the fact that few motor skills are acquired in this age group. Thus, it is suggested that, regardless of birth weight, such behaviors do not differ between the LBW and VLBW groups. This difference becomes clear from the moment the motor skills of infants become more varied and complex such as those occurring from the second month of life on, for example, the acquisition of head control, the ability to sit independently, and the beginning of crawling<sup>26</sup>.

In the intragroup analysis, we observed an increase in the AIMS score value with increasing age in both groups analyzed. As new skills are acquired, there are increases in scores, which are sensitive indicators of changes<sup>19</sup>.

However, despite the increase in the score, there was a decrease in the percentile value in the age groups from

2 months, thus refuting the second hypothesis of the study. Similar results were found in the study of Metgud et al.<sup>27</sup>, who developed a study with 40 VLBW children, evaluated at 4–8 months of CA and later at 12 months. Of these, 20% had a significant motor delay and 5% had a slight delay in neuromotor performance by the age of 1 year. A marked increase of atypical neuromotor behavior was observed from 4 to 8 months, suggesting that at 8 months of CA many VLBW children showed more atypical neuromotor signals than in the previous age. Kieviat et al.<sup>23</sup> also argue that while young children are able to achieve important motor levels, more subtle motor problems tend to increase as greater demands are required from these children in school age or not.

In addition to these issues, it is important to note that premature infants have functional and structural immaturity of organs and systems and can have a different motor development pattern in relation to children born at term. Moreover, overall decrease in tonus can be observed, which is due to the reduction of time in the uterine environment and to the action of gravity on the weak muscles of these infants after birth<sup>8</sup>. Although flexor muscle tone increases as the premature infant develops, the full degree of muscle tone such as that of a term baby is not achieved, impacting the balance between flexor and extensor muscle groups, which can interfere with the acquisition of important motor skills<sup>8</sup>. Other authors also point out that prematurity, especially when associated with low birth weight, can interfere with the stability and pace of acquiring motor patterns during the first year of life of children, suggesting that the lower the weight and gestational age at birth, the greater the chance of delay<sup>9,28,29</sup>.

Thus, it is suggested that although LBW and VLBW infants presented improvements in motor behavior with the aging process, such improvements do not correspond to those expected for the age, as the percentile values achieved were low when analyzed in the curve of the percentile established by AIMS, collaborating similar results found in the literature<sup>9,30</sup>. The improvement in motor behavior with the process of aging may have occurred both due to maturational processes inherent in the development of the infant and as a result of the advice to provide stimulation that parents received. However, these aspects were not sufficient to achieve the motor behavior expected in the later ages evaluated.

The results found in this study contribute to a better understanding of how the global motor development of low birth weight and very low birth weight infants

in young age groups occurs. The fact that the infants present a lower percentile in the older age groups analyzed implies the importance of early intervention in this population as soon as possible, as even at early ages (as in the age group newborn 1 month) infants may present a percentile above 50%, as observed in this study.

The results of this study are limited to infants with birth weight below 2500 grams, having no full-term infants in the comparisons; and they differ in a cross-sectional study design. New studies could be carried out, with a longitudinal design, for the monitoring of such motor delays during development. However, this research is one of the few that studied the difference in motor behavior for specific and early age groups for low birth weight and very low birth weight infants.

## CONCLUSION

This study found that the motor behavior of very low birth weight premature infants was worse than that of low birth weight premature infants, and, in the age groups evaluated, the motor behavior of infants in the age group newborn 1 month in both groups showed better percentiles than in the older analyzed age groups.

The main findings suggest that the variable birth weight has a significant impact on the motor development of premature infants, and that delays may be more evident at older ages.

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