

Influence of the home environment on the motor development of infants with Down syndrome

Influência do ambiente domiciliar no desenvolvimento motor de lactentes com síndrome de Down

Influencia del ambiente domiciliar en el desarrollo motor de bebés con síndrome de Down

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ABSTRACT | Children with Down syndrome present impairments in neuro-psychomotor development, which are related to muscle tone, postural control and balance. Motor development is influenced by biological, psychological, social and environmental factors. Thus, the environment in which the infant is in can facilitate the neuro-psychomotor development. The objective of this study was to evaluate the influence of the home environment on the motor development of infants with Down syndrome. Sixteen infants with Down syndrome were divided into Group I (3 to 11 months of age) and Group II (12 to 18 months of age), evaluated by the Alberta Infant Motor Scale (AIMS) and the Affordances in the Home Environment for Motor Development Infant-Scale (AHEMD-IS) questionnaire. Data analysis was performed using the Kruskal-Wallis test, Spearman's correlation coefficient and the likelihood ratio test. The results showed a significant positive relationship between the gross AIMS score and the variety of stimuli ($p=0.01$, $r=0.78$) and with the AHEMD-IS questionnaire score ($p=0.02$, $r=0.74$) in Group 2. Family income and affordances with motor function toys ($p=0.05$, $r=0.49$) were also correlated, but the correlation was weak. The home environment plays an important role in the motor development of children with Down syndrome aged between 12 and 18 months, as it provides opportunities for experiencing and experimenting. Better suited environments provide better motor performance.

Keywords | Motor Development; Infant; Environment; Physical Therapy.

RESUMO | Crianças com síndrome de Down apresentam atrasos no desenvolvimento neuropsicomotor relacionados a tônus muscular, controle postural e equilíbrio. O desenvolvimento motor sofre interferência multifatorial, que envolve características biológicas, psicológicas, sociais e ambientais. Assim, o ambiente em que o lactente está incluído pode atuar como facilitador do desenvolvimento neuropsicomotor. O objetivo deste estudo foi avaliar a influência do ambiente domiciliar no desenvolvimento motor de lactentes com síndrome de Down. Participaram do estudo 16 lactentes com a síndrome, divididos em grupo I (3 a 11 meses) e grupo II (12 a 18 meses), avaliados pela *Alberta Infant Motor Scale (AIMS)* e pelo questionário *Affordances in the Home Environment for Motor Development - Infant Scale (AHEMD-IS)*. A análise de dados foi feita por meio do teste de Kruskal-Wallis, coeficiente de correlação de Spearman e teste de razão de verossimilhança. Os resultados evidenciaram uma correlação positiva significativa entre o escore bruto da AIMS e a variedade de estímulos ($p=0,01$, $r=0,78$) e com o escore total do questionário AHEMD-IS ($p=0,02$, $r=0,74$) no grupo II. Verificou-se, ainda, correlação entre a renda familiar e as oportunidades com brinquedos de função motora grossa ($p=0,05$, $r=0,49$), porém com correlação fraca. Conclui-se que o ambiente domiciliar

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tem importante papel no desenvolvimento motor de crianças com síndrome de Down entre 12 e 18 meses, por proporcionar oportunidades de vivências e experimentações. Assim, pode-se afirmar que ambientes mais adequados proporcionam melhor desempenho motor.

Descritores | Desenvolvimento Motor; Lactente; Domicílio; Fisioterapia.

RESUMEN | Los niños con síndrome de Down presentan retraso en el desarrollo neuropsicomotor, relacionado con el bajo tono muscular, el control postural y el equilibrio. El desarrollo motor sufre interferencias multifactoriales, que involucra características biológicas, psicológicas, sociales y ambientales. Por lo tanto, el ambiente en el que se incluye el bebé puede actuar como un facilitador del desarrollo neurológico. El objetivo de este estudio fue evaluar la influencia del ambiente familiar en el desarrollo motor de los niños con síndrome de Down. El estudio incluyó 16 bebés con síndrome de Down, divididos en el grupo I (3-11 meses

de edad) y el grupo II (12-18 meses de edad), evaluada por *Alberta Infant Motor Scale* (AIMS) y por *Affordances in the Home Environment for Motor Development questionnaire Infant-Scale* (AHEMD-IS). El análisis de datos se realizó mediante la prueba de Kruskal-Wallis, coeficiente de correlación de Spearman y la prueba de razón de verosimilitud. Los resultados mostraron una relación positiva significativa entre la puntuación bruta de AIMS y la variedad de estímulos ($p=0,01$, $r=0,78$) y la puntuación total del cuestionario AHEMD-IS ($p=0,02$, $r=0,74$) en el grupo II. También se verificó relación entre la renta familiar y las oportunidades con juguetes de función motora gruesa ($p=0,05$, $r=0,49$), pero con pobre correlación. Se concluye que el ambiente familiar tiene un papel importante en el desarrollo motor de los niños con síndrome de Down, entre 12 y 18 meses, así que proporciona oportunidades para las vivencias y experiencias. Ambientes más adecuados proporcionan un mejor rendimiento del desarrollo motor.

Palabras clave | Desarrollo Motor; Niños; Domicilio; Fisioterapia.

INTRODUCTION

Down syndrome (DS) is the most common chromosomal abnormality in the population and is characterized by intellectual and motor deficits^{1,2}. Impaired neuro-psychomotor development of children with DS is related to low muscle tone and difficulties in postural control and balance³⁻⁵.

The child with DS has intrinsic limitations, such as muscle hypotonia and joint hypermobility, which collaborate for the motor impairment, slowness of movement and postural control changes⁶. In addition to known biomechanical and neurobiological changes that cause such impairments, factors like environmental context, experience and the practice of movements also exert important influence^{7,8}.

Motor development suffers a multifactorial interference involving biological, psychological, social and environmental characteristics⁹. Thus, the environment where the infant is in can be a facilitator of his/her development. In addition, there are stimuli affordances within the home environment that represent a potential for action and, consequently, for learning and developing skills¹⁰⁻¹². The characteristics of parents, such as socioeconomic status, education level and a stable partnership, reflect the care offered and are considered strong contributors to an adequate child development¹³.

Another relevant factor is the existing relationship between the parents and the child: helping he/she to move freely, to stand, to engage in conversations, to play games and interact with other children. This set of attitudes provides learning and brings benefits to child development¹².

The acquisition of motor skills in children with DS, although slower, occurs gradually and in the same sequence as that of typical infants¹⁴. Considering these information and the exploration of space as a favorable environment for motor development, the objective of this study was to verify the influence of the home environment on motor development of infants with DS.

METHODOLOGY

This is a descriptive, observational and cross-sectional study, performed at the *Hospital das Clínicas* of the Universidade Federal de Uberlândia (HC-UFU – University Hospital), from October 2016 to January 2017. The population was composed by patients from the Down Syndrome Outpatient Clinic of the HC-UFU. The sample included infants diagnosed with DS, aged between 3 and 18 months, living in the region of the Triângulo Mineiro, Minas Gerais, Brazil.

This study was approved by the Research Ethics Committee of the Universidade Federal de Uberlândia (opinion no. 1795167), the person responsible for the patient signed the Informed Consent Form.

The exclusion criteria were defined as infants with associated congenital anomalies (infants with corrected asymptomatic or symptomatic cardiac changes were included), neurological diseases and/or orthopedic problems that limited the mobility. All patients being treated in the clinic and diagnosed with Down syndrome, within the age group, were invited to participate in the study. Given some refusal to participate, the final sample was composed by 16 infants, who were divided into Group I (3 to 11 months, n=7) and Group II (12 to 18 months, n=9).

The Brazilian version of the questionnaire "Affordances in the home environment for motor development – Infant Scale" (AHEMD-IS) was used to assess the affordances in the home environment¹¹, this instrument is composed by four dimensions: physical space, variety of stimulation, toys that stimulate gross motor skills and toys that stimulate fine motor skills, with a total of 35 items. The Brazilian version has been validated. The score is given for each dimension and the total score is calculated through the sum of the values obtained in all dimensions. The score was divided based on indexes found in the sample and classified as: "less than adequate", i.e., the affordances offered by the environment for the infant's motor development are few or need improvement; "moderately adequate", when the environment offers some affordances for motor development, although they could be improved; "adequate", for an environment that presents enough affordances in both quantity and quality; and "excellent", when the home environment provides several affordances¹¹.

The total AHEMD-IS score was calculated for both groups, given that the motor skills and affordances for motor development existing at home are very heterogeneous in these age groups. The following criteria were used for the score, for the 3 to 11 months age group this classification was considered: "less than adequate" when the score was ≤ 18 , "moderately adequate" between 19 and 23 points, "adequate" between 24 and 27 and "excellent" ≥ 28 points. For the 12 to 18 months age group: "less than adequate" when the score was ≤ 27 , "moderately adequate" between 28 and 33 points, "adequate" between 34 and 40 and "excellent" ≥ 41 points¹¹.

The assessment of motor performance was done after the interview using the AHEMD-IS questionnaire was conducted with the parents. The Alberta Infant Motor Scale (AIMS)¹⁵ was used, this scale was also validated for the Brazilian population¹⁶. The scale is observational, requires minimal handling and considers aspects of motor performance, such as weight bearing, posture and antigravity movements. On the occasion, the infants were left freely in the physical therapy room of the special patients sector of the HC-UFU, moving spontaneously. If the infants showed signs of crying, sleepiness or hunger, the evaluation was interrupted and rescheduled to occur in up to seven days.

The AIMS consists of 58 items that illustrate the development sequence of postural control in four positions. Each item observed in the child's repertoire of motor skills receives a score of one (1) and the items that are not observed receives a score zero (0). The infants are evaluated in the following positions: prone (21 items), supine (9 items), sitting (12 items) and standing (16 items). The total score ranges from 0 to 58 points. The total score and the age of the infant are located on the development curve that varies between the 5 percentile (greater chance of impaired motor development) and 90 (smaller chance of impaired motor development)¹⁶. For this study, the gross score was used for the analysis each infant¹⁷, given that all infants evaluated were at the curve or below the 5 percentile and were classified under risk of impaired motor development. The groups were divided to approximate the ages and their motor marks, Group I (3 to 11 months) and Group II (12 to 18 months).

After the evaluation, the parents received orientation on stimuli that could be offered to their children at home and had their questions answered according to what they asked.

All the data were collected by a single researcher and had an average duration of 40 minutes. The following clinical and epidemiological data were collected from the infants' records: gestational age, birth weight, birth length, cephalic perimeter at birth, Apgar score at the fifth minute of life, time of mechanical ventilation, oxygen therapy time and duration of the hospitalization.

The quantitative variables were described by median and maximum and minimum values. The qualitative variables were described by frequency and percentage. Given the sample size, the association

between numerical or ordinal categorical variables and the nominal categorical were evaluated using the Kruskal-Wallis test or Spearman's correlation coefficient¹⁸.

All tests were applied using a 5% significance level ($p < 0.05$). The procedures were performed using the software SPSS, version 20.0.

RESULTS

The evaluation comprised 16 infants, who were divided into Group I (GI) and Group II (GII), composed by 7 and 8 infants, respectively. Only one infant from each group was born preterm, these infants were evaluated considering their corrected age. The main characteristics of the infants are listed in Table 1.

Table 1. Sample characterization

	Group I (n=7)			Group II (n=9)			p^*
	Median	Minimum	Maximum	Median	Minimum	Maximum	
Gestational age (weeks)	38	33	39	38	33	39	0.210
Corrected age (months)	6	3	10	15	13	18	<0.001
Birth weight (g)	3085	2265	3850	2520	1545	3335	0.351
Birth length (cm)	46	41	50	47	34	49	0.606
Cephalic perimeter (cm)	32	29	36	32	28	34	0.918
Apgar index 5	9	8	10	9	8	9	0.210
Mechanical ventilation time (days)	0	0	0	0	0	45	0.470
Oxygen therapy time (days)	2	0	15	20	0	180	0.114
Hospitalization time (days)	2	0	32	45	0	195	0.055
Maternal age (years)	24	16	41	35	27	41	0.091
Maternal education level*	3	2	4	4	3	4	0.351
Paternal age (years)	32	19	41	37	30	49	0.071
Paternal education level*	4	2	4	4	3	4	0.758
Income (gross)	1760	880	3520	880	880	5280	0.837

p^* Kruskal-Wallis test

For GI, when the values obtained from the AHEMD-IS scale (total score and scores by categories) were correlated with the raw score from the AIMS, there was no statistically significant correlation. However, statistically significant correlations were observed for GII regarding the Variety of Stimulation and the total score from AHEMD-IS (Table 2).

Table 2. Correlation between the AHEMD-IS scores with the gross AIMS score

		PS	VS	GMT	FMT	Total AHEMD-IS	
Group I (n=7)	Gross AIMS	r	0.64	-0.23	0.24	0.08	-0.14
	Score	p^*	0.119	0.621	0.603	0.856	0.763
Group II (n=9)	Gross AIMS	r	0.52	0.78	0.57	0.34	0.74
	Score	p^*	0.151	0.012	0.110	0.373	0.022

* Spearman's correlation coefficient.

PS: physical space; VS: variety of stimulation; GMT: gross-motor toys; FMT: fine-motor toys

Family income also showed a poor correlation in relation to the affordance of gross-motor toys ($p=0.05$; $r=0.49$) (Table 3).

Table 3. Correlation between AHEMD-IS and maternal and paternal characteristics and household income

Variables		PS	VS	GMT	FMT	Total AHEMD-IS
Maternal age (years)	r	-0.30	-0.46	0.12	-0.15	-0.34
	p^*	0.252	0.068	0.646	0.557	0.192
Paternal age (years)	r	-0.24	-0.36	0.04	-0.19	-0.23
	p^*	0.365	0.161	0.872	0.486	0.386
Income (gross)	r	0.13	0.09	0.49	0.3	0.22
	p^*	0.622	0.731	0.056	0.259	0.404

(continuation)

Table 3. Continuation

Variables		PS	VS	GMT	FMT	Total AHEMD-IS
Maternal education level (years)	r	-0.17	-0.13	0.34	0.2	0.07
	ρ^*	0.519	0.617	0.196	0.451	0.811
Paternal education level (years)	r	-0.43	-0.03	0.33	0.32	0.25
	ρ^*	0.090	0.908	0.206	0.233	0.344

* Spearman's correlation coefficient.

PS: physical space; VS: variety of stimulation; GMT: gross-motor toys; FMT: fine-motor toys

DISCUSSION

This study investigated possible relationships between the influence of the home environment and the motor development of infants with DS. The motor development of infants with DS is expected to be impaired^{2,3}. However, when considering that the motor development is influenced by the home environment, our results showed that home affordances have a positive relationship with the motor performance of infants between 12 and 18 months. In other studies^{12,19}, environmental properties that provide individual action potentials (affordances), which are considered stimuli to develop skills, were also associated with motor development in typical infants, corroborating our results.

However, contrary to our findings, Bueno et al.⁹ evaluated 21 pre-term infants using the AIMS scale, the AHEMD-IS and the instrument of economic segmentation from ABEP (*Associação Brasileira de Empresas de Pesquisa* – Brazilian Association of Market Research) and found no significant correlation between motor performance and home affordances. This may have occurred due to a variety of factors related to child development, such as being an only child, attending daycare, family income, maternal education and occupation, as cited by authors themselves⁹.

Campos et al.²⁰ compared infants with DS to typical infants and found that infants with DS performed fewer interaction activities with the environment. This can be explained by limitations in motor skills, such as deficits in postural and antigravity control^{2,3}. Therefore, we can consider that in addition to precarious home affordances, DS limitations interfere in motor performance²⁰. Our study showed no significant difference in the correlation between AHEMD-IS with the motor performance in GI. This finding can be justified by the ongoing relationship between home

affordances and motor development, i.e., as the infant ages, new stimuli are required for an adequate motor development¹⁷.

Infants with DS are already impaired when compared to typical infants during the first few months, however, antigravity skills in prone, sitting and standing positions require longer acquisition times²¹. Given this context and according to our findings, the variety of stimuli is critical to minimize the impairment, providing stimuli for the first few years is essential²². Infants must receive early stimulation from birth to optimize motor development, since the first years of life are the period of greatest neural plasticity²³.

In this study we observed a moderate correlation, although not statistically significant, between the physical space and motor development. This result resembles the findings from Parker et al. (2016)²⁴, in which the home physical space was associated to the motor percentile. According to the authors, the home environment and its mediations are the first scenarios experienced by the infant and are fundamental in this period, since the infants are learning to drag, crawl, climb and walk²⁴.

In this study, the household income showed a significant trend regarding a better affordance of gross-motor toys, similarly to the study of Nobre et al.²⁵. Having toys and play materials available influences the development of skills in infants, usually, families in a greater socioeconomic classification manage to achieve an adequate level for this variable on the AHEMD-IS scale²⁵. The socioeconomic status of a family may be associated with more information on the advantages of providing varied toys and their resources¹³. Thus, we believe in the importance of producing and offering educational and therapeutic resources to enhance the actions offered by the care services for the development of infants at risk, especially actions to guide the parents²⁶.

Sacani et al.¹², in a study conducted with 561 typical infants up to 18 months of age, that were evaluated by the AHEMD-IS and AIMS, showed that the actions of the parents towards their children have positive results for motor development. In our results, the maternal age showed significant trend with a variety of stimuli, i.e., the older the mother, fewer incentives were provided to the infants. Borba et al.²⁷ evaluated the motor performance of 40 infants from adolescent mothers and adult mothers. The authors used the instruments AIMS and Bayley Scale of Infant Development II to

evaluate motor and cognitive performance, respectively, and the AHEMD-IS questionnaire for the analysis of the environment. They found that, the higher the maternal age, the smaller the motor performance of the infant.

Conversely, other studies^{28,29} that assessed the motor development of infants from adolescent and adult mothers showed that a lower maternal age can be considered a risk factor for the motor impairment in children. We must highlight that different factors interact, such as task demands and environmental conditions. Thus, we can consider that the performance of the infants is influenced by various factors, and maternal age must be considered as one of them.

We find critical to note that providing guidance to the mothers may clarify to them the importance of performing stimuli at home. Oliveira et al.³⁰, when offering guidelines on stimuli tasks, noted that many mothers stated that they did not offer stimuli to their children due to the lack of knowledge or not deeming it necessary. Many of these children were restricted from engaging in social and cultural activities with other children, or were limited to their cradles, baby seats, the lap of an adult and baby walkers. Child development is better in quality when the parents receive guidance to correctly stimulate infants within the home environment³⁰.

Guidance actions on the benefits of affordances can be promoted in outpatient clinics and programs to stimulate infants with DS, as well as responding to parents' questions. Therefore, minimizing the expected impairments for this population is possible, in addition to reducing the time in stimulating programs and, consequently, the financial expenses from a possible prolonged stay.

As limitations of this study, we emphasize the smaller sample size and the lack of analysis of certain factors, like the occupation of the parents. However, this study advances in knowledge by comparing affordances and motor development in infants with DS.

CONCLUSION

The home environment has an important role in the motor development of children with Down syndrome, between 12 and 18 months, by providing affordances for experiences and experimentations. Better suited environments provide better motor performance.

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