

Cognitive profile, motor deficits and influence of facilitators for rehabilitation of children with neurological dysfunction

Perfil cognitivo, déficits motores e influência dos facilitadores para reabilitação de crianças com disfunções neurológicas

Perfil cognitivo, déficits motores e influencia de los facilitadores para rehabilitación de niños con disfunciones neurológicas

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ABSTRACT

Objective: To investigate whether healthy children and adolescents suffering from neurological diseases can be grouped into distinct and homogeneous groups using criteria such as cognitive performance, motor functioning and parents' perceptions about the rehabilitation facilitators.

Methods: Sample was comprised by 15 healthy children and 43 patients (28 with cerebral palsy and 15 with stroke (n=15), aged from five to 18 years old. The Environment Factors Assessment related to the Children Neurologic Rehabilitation (EFACN) was used to assess parents' perception about the rehabilitation facilitators. Cognitive impairment was assessed using the Mini Mental Status Examination (MMSE), adapted for this age, and the motor impairment was clinically evaluated. Cluster analysis and one way ANOVA were conducted to compare the results.

Results: Cluster analysis identified four groups with distinct clinical and socio-demographic patterns, confirmed by ANOVA ($p < 0.001$). Dissociation between cognitive and motor functions was found. Parents of children with severe impairment evaluated more positively rehabilitation facilitators.

Conclusions: The qualification of rehabilitation facilitators by EFACN and cognitive assessment by MMSE can help to identify the needs of children with neurological disabilities who present cognitive and motor impairment.

Key-words: stroke; cerebral palsy; International Classification of Functioning, Disability and Health; cognition; rehabilitation.

RESUMO

Objetivo: Investigar se crianças e adolescentes saudáveis e com doenças neurológicas podem ser reunidas em grupos distintos e homogêneos, usando como critérios o desempenho cognitivo, o funcionamento motor e as percepções dos pais quanto aos facilitadores para a reabilitação.

Métodos: Participaram deste estudo 15 crianças saudáveis (C) e 43 pacientes (28 com paralisia cerebral e 15 com acidente vascular cerebral), entre cinco e 18 anos. Foi aplicado aos pais o instrumento denominado Avaliação dos Fatores Ambientais relacionados à Reabilitação Neurológica Infantil (AFARNI). O comprometimento cognitivo foi avaliado por meio do Mini-Exame do Estado Mental, adaptado para essa

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faixa etária, e o comprometimento motor foi investigado por avaliação clínica. Para comparar os resultados, foi realizada uma análise de conglomerados e ANOVA.

Resultados: A análise de conglomerados identificou quatro grupos de pacientes com características clínicas e sociodemográficas distintas, confirmados pela ANOVA ($p < 0,001$). Houve dissociação entre os grupos com relação ao comprometimento cognitivo e motor. Os pais de crianças com maior comprometimento avaliaram de forma mais positiva os facilitadores para a reabilitação.

Conclusões: A qualificação dos facilitadores para a reabilitação por meio da AFARNI e a avaliação cognitiva com auxílio do Mini-Exame do Estado Mental podem contribuir para identificar as necessidades de suporte para crianças com deficiências neurológicas que apresentam comprometimento cognitivo e motor.

Palavras-chave: acidente vascular cerebral; paralisia cerebral; Classificação Internacional de Funcionalidade, Incapacidade e Saúde; cognição; reabilitação.

RESUMEN

Objetivo: Investigar si niños y adolescentes sanos y con enfermedades neurológicas pueden ser reunidos en grupos distintos y homogéneos, usando como criterios el desempeño cognitivo, el funcionamiento motor y las percepciones de los padres respecto a los facilitadores para la rehabilitación.

Métodos: Participaron de ese estudio 15 niños sanos (C) y 43 pacientes (Parálisis Cerebral - PC, $n=28$; Accidente Cerebrovascular - ACV, $n=15$), con edad entre 5 y 18 años. Se aplicó a los padres instrumento nombrado Evaluación de los Factores Ambientales relacionados a la Rehabilitación Neurológica Infantil- AFARNI. El comprometimiento cognitivo fue evaluado mediante el Mini-Examen del Estado Mental, adaptado para esa franja de edad, y el comprometimiento motor fue investigado por evaluación clínica. Para comparar los resultados, se realizó un análisis de conglomerados y ANOVA.

Resultados: El análisis de conglomerados identificó a cuatro grupos de pacientes con características clínicas y sociodemográficas distintas, confirmadas por ANOVA ($p < 0.001$). Hubo disociación entre los grupos respecto al comprometimiento cognitivo y motor. Los padres de niños con más comprometimiento evaluaron de modo más positivo a los facilitadores para la rehabilitación.

Conclusiones: La cualificación de los facilitadores para la rehabilitación mediante AFARNI y la evaluación cognitiva con ayuda del Mini-Examen del Estado Mental puede contribuir para identificar las necesidades de auxilio para niños con deficiencias neurológicas que presentan comprometimiento cognitivo y motor, lo que permitirá la implementación de la perspectiva biopsicosocial de OMS en la práctica clínica.

Palabras clave: accidente cerebrovascular; parálisis cerebral; Clasificación Internacional de Funcionalidad; Incapacidad y Salud (CIF); cognición; análisis por conglomerados; rehabilitación.

Introduction

The key to successful treatment and prevention of chronic conditions is understanding the relationship between impairment in body structures and functions and psychosocial factors in order to select problems to be targeted by the healthcare team⁽¹⁾. Therefore, when the rehabilitation team is planning an intervention, the team members should list those factors that have a potential for improvement and the environmental resources needed for their rehabilitation. The lack of facilitators can represent a barrier to the functioning or development in childhood. In addition, can be interpreted as a neglect of public health, family or professionals. On the other hand, overly interventionist, paternalistic or protective actions can also limit children's development of autonomy, meaning that they can also be considered barriers. In this context, the extent to which a given factor will be considered a barrier or a facilitator will depend on the true needs of each case⁽²⁾. This is why assessment of environmental factors necessarily involves achieving an overview of the context in which the child or adolescent is living.

The World Health Organization's International Classification of Functioning, Disability and Health (ICF)⁽³⁾ considers that environmental factors can function as facilitators or barriers to a person's adaptation to different health conditions. Aids to rehabilitation are defined as those environmental factors that are of use for promoting functioning and preventing disability. Let us consider, for example, stroke in childhood. After such events have compromised patients independence in terms of communication, mobility and self-care, they may find themselves in an environmental context that assists them to recover their lost abilities or in a situation that throws up barriers against expression of neuroplastic processes⁽²⁾. Therefore, it falls to the rehabilitation

team to identify patients' capacities and limitations on the personal and environmental levels and to intervene to alter their environments as far as possible.

The principal focus of the published literature describing functional assessment of stroke in childhood and cerebral palsy (CP) is on analysis of etiology⁽⁴⁻⁷⁾ or of the impairments and limitations related to these neurological conditions⁽⁸⁻¹³⁾. It is therefore necessary to conduct studies to develop assessment instruments that are capable of registering children's needs in order to achieve integrated environmental intervention that will assist them to optimize their functional performance (medications, physiotherapy, occupational therapy, psychology, speech therapy, family therapy, specific educational programs, equipment to aid mobility, etc). There is very little published literature on the subject of using the ICF to categorize environmental factors that assist rehabilitation in cases of neurological dysfunction. It is against this background that the present study was designed to identify clinical criteria (cognitive performance and parents' perceptions about which rehabilitation facilitators) that can be used to classify patients into distinct and homogenous groups. The relevance of classification into groups for rehabilitation is that different groups may have distinct care requirements.

The objective of the present study was therefore to investigate whether children and adolescents with neurological diseases (CP and stroke in childhood) and healthy children can be assigned to distinct and homogenous groups on the basis of cognitive performance, motor function and their parents' perceptions of rehabilitation facilitators.

Methods

This study was approved by the UFMG and *Fundação Hospitalar do Estado de Minas Gerais* (FHEMIG) Research Ethics Committees.

Inclusion criteria for all study groups were age between 5 and 19 years and consent to and signature of a free and informed consent form. Inclusion criteria for the control group were to be free from neurological problems and be enrolled at a normal school. The clinical sample included patients with a

diagnosis of stroke in childhood or CP made by a neurologist. Diagnoses were taken from the patient medical records held by the institutions from which cases were recruited.

Sample size was calculated using the results of a pilot study of 10 children (5 controls and 5 cases) to achieve statistical power of 90%. Since the effect size⁽¹⁴⁾ identified by comparison of the pilot study groups was elevated (greater than 1.4), the sample size needed to provide a statistical power of 90% was 10 participants in each group⁽¹⁴⁾.

A total of 58 5-to-18-year-old children were enrolled on the study. The sample was made up of a control group of 15 pupils from public schools in Belo Horizonte, Brazil, and a clinical group of 43 children with diagnosis of neurological disease, including 28 patients with CP and 15 children with stroke in childhood. The CP cases were identified by the local APAE (*Associação dos Pais e Amigos dos Excepcionais*, which roughly translates as the association of the parents and friends with special needs). The stroke cases were identified by the Hematology Department at the Hospital *Borges da Costa* and in the FHEMIG General Pediatrics Center's database. Stroke in childhood cases were identified by searching all medical records for 2001 to 2007 and attempts were then made to locate patients.

Data collection took place from February 2007 to March 2008. Table 1 lists data on sociodemographic characteristics and degree of motor impairment.

The following data collection instruments were used:

- Socioeconomic status questionnaire: The Brazilian Economic Classification Criteria, produced by the Brazilian Association of Market Research Companies (ABEP - *Associação Brasileira de Empresas de Pesquisa*) were used to classify socioeconomic status⁽¹⁵⁾.
- Mini-Mental State Examination (MMSE): Jain and Passi⁽¹⁶⁾. adapted and validated the MMSE for children from 3 to 14 years on the basis of a system of scores for cognitive impairments. This instrument assesses the mental functions of language, spatial and temporal orientation, attention, memory and constructive praxis⁽¹⁷⁾. Jain and Passi⁽¹⁶⁾ defined a cutoff point for cognitive deficit of two standard deviations below the mean.

Table 1 - Sociodemographic characteristics and degree of motor impairment of the sample, broken down by study group

Groups	n	Sex (%)	Age (years)	Socioeconomic status ⁽¹⁵⁾	Class ⁽¹⁵⁾
Controls	15	60	7.9±1.2	14.1±4.7	C
Cases – CP	28	50	11.1±4.0	10.4±3.7	D
Cases – stroke in childhood	15	40	9.5±3.1	14.6±5.8	C

Socioeconomic status: ABEP scores.

- Assessment of environmental factors related to neurological rehabilitation in childhood - AFARNI): This instrument was developed by Andrade & Haase⁽¹⁸⁾ and is based on the ICF model, in which parents classify environmental factors as facilitators or barriers to the development and/or rehabilitation of their children. The inventory contains 26 items which parents score as barriers or aids on an ordinal scale. Each environmental factor is therefore considered to be a facilitator (mild, moderate, considerable, complete) or a barrier (mild, moderate, severe, complete). Alternatively, an environmental factor can also be defined as neutral, i.e. it is not considered as either a facilitator or a barrier to the child or adolescent's adaptation to their daily activities⁽³⁾. High scores indicate that factors are perceived as facilitators. In order to help parents and children to understand the items, some of the third-level ICF categories were included in the AFARNI (medication, diet, health services, education services, public sector services) and other third-level categories were chosen by the researchers; for the item on health professionals (e355) the objective was to define the professionals more precisely (occupational therapist, psychologist, physiotherapist, physician, speech therapist, nurse). The ICF category immediate family (e310) was distinct in the subcategories (father, mother, carer and siblings)⁽¹⁸⁾.

The AFARNI was administered during individual structured interviews with children's parents or guardians in order to collect data on their perceptions of rehabilitation facilitators⁽¹⁸⁾. Motor impairment was assessed clinically. Cognitive performance was analyzed using the children's MMSE results.

The Statistical Package for the Social Sciences, version 15.0, was used for data analysis. Initially, descriptive statistical analyses were conducted in order to define the socio-demographic profile of the sample. Univariate analysis of

variance was then used to test whether there were differences between the groups delineated by diagnosis of neurological dysfunction. Receiver operating curve analysis was used to perform a preliminary test of the accuracy of the MMSE for this sample of children. The AFARNI were then collapsed into two variables, using the means for the scores given by the instrument, defined as Basic Environmental Factors (BEF) and Specific Environmental Factors (SEF). The BEF variable is calculated as the mean score for items that are essential for the development and function of all of the children, irrespective of clinical status, such as nutrition, parents, siblings, extended family, friends, toys and games, educational services, teachers, transport and social attitudes. The SEF variable was calculated from the means of items related to specific types of healthcare, such as health professionals, special education, orthoses and prostheses, etc.

Preparatory to classifying study participants into homogeneous groups, an exploratory cluster analysis was conducted using the Ward method^(19,20), with criterion variables being standardized scores for the degree of motor impairment, for perceived environmental factors and for MMSE. Standardized scores (Z score) were used in order to avoid bias in the cluster analysis, since the variables are expressed along different scales. Analysis of variance (univariate ANOVA) with Bonferroni corrections for multiple comparisons was used to confirm the results of the cluster analysis.

Results

The MMSE adapted for children proved capable of assessing general cognitive function, since the area under the ROC curve indicated 94% accuracy for discriminating cognitive deficits in children with brain damage (CP and stroke in childhood) from controls (area under the curve=0.94; 95%CI 0.87-0.99; $p < 0,001$). The MMSE was therefore both accurate and sensitive for detecting cognitive deficits in children in a

Table 2 - Descriptive and comparative analysis of responses to a checklist based on the ICF and of MMSE scores for the three groups (controls, CP and stroke in childhood)

		Clinical status			p
		Controls	CP	Stroke in childhood	
MMSE	mean±SD	33.5±3.9	8,3±10.9	24.1±9.7	<0.001
BEF	mean±SD	21.0±7.2	22.5±9.8	21.3±13.2	0.88
SEF	mean±SD	6.6±6.9	23.3±7.4	10.9±7.3	0.001
Motor impairment		N=100% H=0 Q=0	N=0 H=25.9% Q=74.1%	N=20% H=80% Q=0	<0.001

BEF: basic environmental factors; SEF: specific environmental factors; N: no impairment; H: hemiplegia; Q: quadriplegia

rapid and simple manner and therefore appropriate for use in routine pediatric practice.

Table 2 shows the results of the descriptive analysis and the comparison between patients and controls. The sample was subdivided on the basis of clinical diagnosis in order to test for significant differences between the three groups in terms of the variables being studied. Differences were detected between the groups' mean MMSE scores for degree of motor impairment and for perceived SEF ($p < 0.001$). However, the BEF did not reveal significant differences between groups. When effect size was analyzed⁽¹⁴⁾ for the final MMSE and SEF results, the effect sizes were large (d values⁽¹⁴⁾ from 1.59 to 2.42), which shows that the differences between groups in terms of cognitive function and perception of environmental aids were large and clinically

significant and that the study achieved statistical power of more than 96%⁽¹⁴⁾.

The Spearman coefficients for the correlations between MMSE scores, motor impairment assessment and perceived SEF, were moderate (around 0.70). The correlations between variables and BEF were not significant. Furthermore, no significant differences were detected between groups for BEF ($p = 0.88$), since these factors are relevant to the functioning of all three study groups. Since the BEF provide no information on characteristics that differentiate the three groups, it was not included in the cluster analysis.

Cluster analysis identified an ideal solution with four groups, which are detailed in Table 3. It will be observed from these data that the clusters are clearly differentiated by mean scores for the MMSE, for the motor impairment

Table 3 - Profiles of the clusters formed on the basis of MMSE scores, specific environmental factors (SEF) and motor impairment

	Cluster 1		Cluster 2		Cluster 3		Cluster 4	
	n=18		n=17		n=7		n= 15	
	mean	SD	mean	SD	mean	SD	mean	SD
MMSE	31.9	6.0	23.8	7.4	11.9	10.3	0	0
SEF	6.3	6.7	14.4	8.1	23.1	2.7	25.5	7.2
Motor impairment	N=94.4% H=5.6% Q=0		N=0 H=70.6% Q=29.4%		N=14.3% H=85.7% Q=0		N=0 H=0 Q=100%	

* N: no impairment; H: hemiplegia; Q: quadriplegia

Table 4 - Clinical and sociodemographic characteristics of the clusters

Cluster	n	Female sex (%)	Age	Diagnosis	Motor impairment*
Group 1	18	55.6%	m=7.83 (SD=1.54)	C=83.3% CP=0% stroke=16.7%	N=94.4% LH=5.6% RH=0% Q=0%
Group 2	17	64.7%	m=11.24 (SD=3.90)	C=0% CP=41.2% stroke=58.8%	N=0% LH=17.6% RH=52.9% Q=29.4%
Group 3	7	57.10%	m=11.57 (SD=3.91)	C=0% CP=71.4% stroke=28.6%	N=14.3% LH=42.9% RH=42.9% Q=0%
Group 4	15	26,70%	m=9.67 (SD=3.44)	C=0% CP=100% stroke=0%	N=0% LH=0% RH=0% Q=100%

* N: no impairment; LH: left Hemiplegia; RH: right Hemiplegia; Q: quadriplegia

assessment and for the SEF. Table 4 lists the sociodemographic profiles and clinical features of the four clusters.

The first cluster contains the study participants with the best MMSE performance, a low degree of motor impairment and the lowest scores on the SEF evaluation. All of the healthy children in the sample were allocated to this group. Just three children with neurological problems (stroke in childhood) were included in cluster 1. Cluster 1 was characterized by a younger mean age and a homogeneous distribution of boys and girls.

Clusters 2 and 3 only contained cases, with differing proportions of patients with CP and stroke in childhood. These two groups were similar in terms of mean age and a predominance of girls, but there were important differences between them. Cluster 2 comprised children with moderate MMSE and SEF scores, indicating better overall results than cluster 3. However, cluster 2 had a greater degree of motor impairment than cluster 3, indicating that motor performance and cognitive functions are not associated dimensions in this sample.

The fourth cluster only contained the children with a diagnosis of CP. This cluster had an average age and a lower proportion of females. Cluster 4 children had greater cognitive and motor impairment and higher scores on the SEF evaluation.

The results of the cluster analysis were then investigated using univariate ANOVA. There were significant differences between the groups for MMSE scores ($p < 0.001$), degree of motor impairment ($p < 0.001$) and perceived SEF scores ($p < 0.001$). In order to break this finding down and identify the nature of the differences, multiple comparisons between the groups were made and adjusted by the Bonferroni method. The results indicated significant differences between the four groups for the three variables analyzed (MMSE, motor impairment and SEF; $p < 0.001$), which confirms the results of the cluster analysis. Nevertheless, there was no difference between groups 3 and 4 with relation to SEF, despite the fact that were statistically different in the cognitive and motor assessments, which could indicate that once cognitive and motor impairment passes a certain level, the SEF are equally important to people with moderate impairment as to people with severe impairment.

Discussion

In order to improve the functioning of children with neurological dysfunction, and in view of the heterogenous

clinical presentation that takes in a range of impairments and limitations, environmental factors must provide assistance rather than barriers⁽¹⁸⁾. The best way of minimizing the challenges involved in classifying the functional status of a child with neurological problems is to apply a multiaxial classification system based on different domains⁽²¹⁾. The ICF can serve as a reference for assessing the functional and psychosocial impact of different clinical conditions and so there is a need for instruments based on this classification to be developed with the final objective of making them available for use in clinical practice^(1,2,18). This study has contributed to addressing that need by providing evidence on the accuracy of instruments adapted for Brazilian children, which can be used by health professionals in an interdisciplinary fashion, namely the MMSE for children and the AFARNI.

The adapted MMSE proved an effective tool for rapidly screening the cognitive function of children and was sensitive enough to discriminate between children with brain damage and controls on the basis of cognitive function. Considering the utility of having a brief test for cognitive follow-up of children, it is possible that this instrument will come to be used routinely in pediatric care. In turn, the AFARNI proved itself sensitive enough to identify environmental facilitators and barriers related to neurological rehabilitation of children.

The lack of an association between cognitive and motor function was interesting to observe. This finding is particularly apparent in the comparison between clusters 2 and 3, which indicates that motor impairment is not associated with cognitive impairment. Considering that both CP and stroke in childhood are classified with relation to the degree of motor impairment, it is important to stress the need to complement the motor assessment with a cognitive evaluation. A wider-ranging examination avoids biased diagnoses that are entirely based on motor features, ignoring patients' cognitive capacity.

The cognitive and motor assessment conducted in this study showed that children with CP had worse performance than children who had suffered stroke in childhood. One environmental factor of note, and which can affect the rehabilitation process, is socioeconomic level. Analysis of the results showed that the children with CP had a lower socioeconomic level than the control group and than the children who had had stroke in childhood. It is therefore important to understand that family socioeconomic status can be either a barrier or a facilitator in the rehabilitation process and merits consideration in neuropsychiatric practice.

The perception of SEF as facilitator was greatest for Cluster 3, which had greater cognitive impairment and less motor impairment than Cluster 2. Analyzing the distribution of participants across the clusters, it was observed that as cognitive impairment increases, the children's parents' perception of SEF as aids increases. It could be inferred from these results that the parents of children with cognitive deficits feel a more significant need for support from specialist professionals and services. The scores assigned to different SEF may prove useful for identifying the support needs of children with neurological disabilities and cognitive impairment.

Assessments should be targeted in response to the differing priorities that result from the specific environmental or personal situation of a given child. This is why a standardized functional assessment must be sufficiently wide-ranging to take account of the differing contextual factors to which each child is exposed, since the need to participate in activities and for inclusion varies depending on the stage of child development.

The majority of studies about inclusion of children or adolescents with CP are related to linear questions related to treatment⁽²²⁻²⁵⁾ or education^(26,27). Palisano published the only study that has attempted to involve questions of family, school and rehabilitation, applying the ICF to CP cases⁽²⁸⁾. However, that study⁽²⁸⁾ did not offer a proposal for evaluating the barriers and facilitators at home, at school and in the community. In order to improve the functioning of children with a diagnosis of neurological dysfunction, and in view of the heterogenous clinical presentation that takes in a range

of impairments and limitations, environmental factors must be made to act as facilitators rather than barriers. If this can be achieved, family members, health professionals, friends, teachers and the community at large can contribute to these children's social participation. It is therefore necessary to identify the barriers that these children face at home, at school and in the community in order to obtain maximum results from rehabilitation supervised by health professionals and from recreational and leisure activities with family and friends.

Specific barriers to children with CP have not been systematically assessed, since research has concentrated on evaluating the structures and functions of the body and little is known about the effects of interventions on the levels of activity and inclusion of children with CP⁽²⁹⁾. For example, cardiorespiratory training and exercises to build muscle strength are often indicated for CP patients. However, the majority of children with impairments do not have access to facilities for physical activities, which constitutes a barrier to improving their cardiorespiratory function⁽²⁹⁾.

A multiaxial classification system should be constructed and must be validated in the future by means of a consensus on neuropediatric care⁽²¹⁾. Adopting the MMSE and the AFARNI in pediatric care could contribute to widening the scope of functional assessment of children with diagnoses of neurological disorders beyond the domain of motor function and to adopting a biopsychosocial perspective. Adopting the ICF's multidimensional model of functioning and disability in clinical practice could improve the process of assessment and intervention in neuropediatrics.

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