Validation of the PDMS-2 scale in the Spanish population. Evaluation of physiotherapy intervention and parental involvement in the treatment of children with neurodevelopmental disorders

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Aim. Cross-culturally adapt the PDMS-2 scale from Spanish-Mexican to Spanish-Spanish and evaluate its validity. To determine the efficacy of physiotherapy treatment (number of physiotherapy sessions and activities proposed by the physiotherapist and performed by the parents) in children with neurodevelopmental disorders between the ages of 0 and 3 years.

Subjects and methods. A first prospective descriptive study of validation of the PDMS-2 scale including 74 subjects with neurodevelopmental disorder with aged from 0 and 3 years old. A second randomized clinical trial to evaluate the physiotherapy (Bobath concept) intervention in the experimental group (EG) ($n = 37$) who received unique 30-minute weekly sessions for 8 weeks against the control group (CG) ($n = 37$) that did not receive physiotherapy using the PDMS-2 scale for evaluation.

Results. An adequate inter-rater reliablity was found (ICC = 0.76). The scale showed also a very good internal consistency (alpha = 0,99). Significant differences between both groups at 8 weeks. EG obtained better scores in the postest after administrating the physiotherapy treatment ($p < 0.001$) Moderate and significant correlation coefficients were found between the number of physiotherapy sessions and Total Motor Quotient (TMQ) ($r = 0.38$; $p < 0.05$) and the home actitvities with TMQ ($r = 0.46$; $p = 0.005$).

Conclusions. The Peabody PDMS-2 scale is a valid and reliable instrument to measure gross and fine motor development in children with neurodevelopmental disorder aged from 0 and 3 years old. Physiotherapy is useful for helping children with delayed neurodevelopment improve. The number of physiotherapy sessions and the activities proposed by the physiotherapist and performed at home by the parents show a direct and positive relationship with the results obtained in motor development.

Key words. Bobath concept. Neurodevelopmental delay. Neurological rehabilitation. PDMS-2. Physiotherapy. Validation.

Introduction

Because of the complexity of the paediatric patient and the importance of early-life intervention (between 0 and 3 years), assessment in neurological physiotherapy for small children requires greater adjustment and precision in clinical practice. Assessment is the first stage of the method of intervention in physical therapy [1], 'a process of collecting information about disordered movement patterns, underlying impairments, activity restrictions, and societal participation of people with neurological pathology for the purpose of intervention planning' [2] with the main purpose of helping the therapist to determine the best intervention [3].

The physiotherapy assessment process comprises an adequate anamnesis (based on medical history and family interview) and qualitative and quantitative evaluation tools [4]. The process must be broken down into different examinations that guide the evaluation according to the individual's chronological age and the motor skills appropriate to each phase of neurodevelopment [5].

In order to obtain optimal results and to be able to make clinical decisions, it is necessary to achieve, first of all, a common language and assessment tools agreed upon by the different specialists working on the same objectives [6]. Validated measurement tools are essential in physiotherapy assessment, for ascertaining the child's initial state, building a physiotherapy diagnosis based on the evidence [7] and determining the objectives and the plan of care [8]. With objective measurements and a physiotherapy diagnosis in hand [9], we can establish objectives and evaluate their achievement, to ascertain the effectiveness of physiotherapy treatment [10] and assess

the motor stages of the population with neurodevelopmental disorders compared with the healthy population. The Peabody developmental motor scale [11] is an instrument that includes these aspects [12]. To know its validity in the Spanish population is a valuable tool for assessment in clinical practice. Of all the scales available for the assessment of motor development in children from 0 to 3 years of age, the PDMS-2 is one suited to the work of the physiotherapist. It enables different areas of development to be analysed and evaluated separately, by breaking down those items and areas that present greater difficulty [13]. Through evaluation of motor item achievement, the PDMS-2 can be used to quantify the exact point of a child's development; this is one of its biggest advantages over other scales.

Based on the results obtained using a validated assessment scale, the physiotherapist can establish a treatment programme based on the results obtained. With treatment the physiotherapist performs the appropriate intervention to reach the objectives, using techniques and procedures designed to develop motor skills and preventing or reducing motor deficiencies to obtain optimal levels of mobility and participation [14]. However, no specific treatment technique exists at present for early intervention in children between 0 and 3 years of age with neurodevelopmental disorders [15], the Bobath concept enables interaction between the physiotherapist and the child by tailoring each treatment session to the patient's special needs; it affords adaptation to the environment and normalization of movement in each particular case and at each point of neurodevelopment. Developed by Berta and Karel Bobath in the middle of the 20th century, the Bobath concept is suitable for the treatment of movement and tone disorders caused by a central lesion of the nervous system [16] by providing postural control and neuromotor actions, the approach seeks to empower the child with the highest level of independence possible for his/her age and ability limitations [17].

The evolution and prognosis of children with neurodevelopmental disorders depend largely on the date of detection through appropriate assessment and the date when early care is begun. If these times are reduced, the period of stimulation deprivation is shorter, and the subject can use the plastic capacity inherent in the first months and years of life to recover from their injuries and attain normal development [18].

Our objective was to cross-culturally adapt the PDMS-2 scale from Spanish-Mexican to Spanish-Spanish and evaluate its validity to determine the efficacy of physiotherapy treatment (number of physiotherapy sessions and activities proposed by the physiotherapist and performed by the parents) in children with neurodevelopmental disorders between the ages of 0 and 3 years.

Subjects and methods

Study design and participants

First, a descriptive validation study of the PDMS-2 was carried out (*n* = 74). In phase two a randomized clinical trial was performed, where the physiotherapy intervention in the subjects belonging to the experimental group (EG) (*n* = 37) was evaluated in comparison with the physiotherapy intervention in the subjects in the control group (CG) (*n* = 37). The sample comprised 74 children aged between 0 and 3 years with neurodevelopmental disorders who attended the Physiotherapy Unit of La Paz Children's Hospital on referral from the hospital's Physical Medicine and Rehabilitation Service.

The inclusion criteria were: a) the subjects had to present pre-, peri- or postnatal neurodevelopmental disorder (assumed because the Rehabilitation Service had referred them for physiotherapy treatment); and b) the subjects' age had to fall in the range between 0 and 3 years.

All subjects who did not meet the two requirements were excluded, as were those who were given the opportunity to begin physiotherapy treatment earlier than the eight-week waiting list. No subject who satisfied the inclusion requirements refused to participate in the study.

To study the effectiveness of the physiotherapy intervention, the sample of 74 subjects was divided into two groups, the experimental group and the control group. The subjects were assigned to the groups randomly according to their arrival under referral from the Physical Medicine and Rehabilitation Service.

Prior to participation in the study, written informed consent was obtained from each individual's parent/guardian. The La Paz Hospital ethics committee gave ethics approval, code PI: 3282. The study project was filed in the hospital's research area along with the parents' informed consent forms.

Measures

Peabody developmental motor scale
The Peabody Developmental Motor Scale (PDMS-2) measures the development of gross and fine motor skills in children between birth and 83 months

of development [19]. It comprises six subtests. The items evaluated in the PDMS-2 are classified into two groups: the gross motor quotient (containing four items: reflexes or motor responses, stationary, locomotion and object manipulation) and the fine motor quotient (the two remaining items: grasping and visual-motor integration). The sum of the two groups is the total motor quotient [20].

The administration time ranges roughly from 45 minutes to 60 minutes, and the examiner assigns a score ranging from 0 to 2, where 2 is performance according to the established criteria, 1 is performance that is similar but not exact and 0 is impossibility of performance or failure to demonstrate ability to perform the item [21]. The raw scores can be used to establish percentiles, standard scores and overall ratios. Thus, the PDMS-2 is a useful tool for comparing percentiles and quotients with the results of other measurement scales [22].

Procedure
Adaptation and validation of the PDMS-2
The PDMS-2 was initially conceived, created and validated in English (Ed. ProEd), and it is validated and marketed in Spanish by Editorial ProEd Latinoamérica, Mexico. Authorization to adapt the scale for cross-cultural use in Spain was secured from ProEd Mexico, and the scale was adapted following the general recommendations for cultural adaptation and validation of measuring instruments [23]. With the cooperation of five Spanish-speaking physiotherapists (four from Spain and one from Mexico), a panel of experts was formed who adapted the ProEd Mexico questionnaire and prepared a reconciled version.

This adapted version was pilot tested on a sample of three subjects referred to the Physiotherapy Unit at La Paz Teaching Hospital (to which La Paz Children's Hospital belongs) to evaluate their understanding of the items and the scale's adaptation. The result was favourable.

For validation the study subjects were evaluated twice, with a one-week interval between test and retest.

Physiotherapy intervention evaluation study
A randomized clinical trial was carried out to evaluate physiotherapy intervention (Bobath concept) in the subjects of the EG versus the CG. The PDMS-2 was retested eight weeks after the start of treatment/intervention in both the experimental group and the control group.

The number of physiotherapy sessions and the activities proposed by physiotherapists and per-

formed by the parents of the experimental group were studied.

The experimental group, composed of 37 subjects between 0 and 3 years of age, was tested using the PDMS-2 at their first consultation, again at one week and once more at eight weeks. During this period the subjects attended weekly 30-minute physiotherapy treatment sessions based on the Bobath concept.

The control group, composed of 37 subjects, was tested using the PDMS-2 at their first consultation, one week later and eight weeks later. During this period the subjects did not receive physiotherapy treatment, but remained on the waiting list. Subjects able to start rehabilitation treatment earlier than eight weeks for service availability reasons did not participate in the study.

Data were collected by three physiotherapists with a minimum of four years' experience apiece in the evaluation and treatment of paediatric patients but no experience in the application and use of the PDMS-2 measuring instrument. Prior to data collection and study completion, they underwent a one-month training period during which they used both audio-visual and written materials, the assessment subjects were counted and a consensus was reached on how to administer the PDMS-2.

Subjects were assigned randomly to the evaluators. The physiotherapists for the experimental group were randomly assigned also, at the beginning of the rehabilitation treatment.

Each physiotherapist recorded three measurements on the Peabody scale for each subject at their first session, one week later and eight weeks later. The physiotherapists also administered a weekly 30-minute physiotherapy session to the subjects of the experimental group.

The PDMS-2 is divided into six subtests, which are described in 'Measures'. Subtest 1, 'Reflexes' is only administered when the child is less than 12 months old, and subtest 4, 'Object manipulation' is only administered to those over 12 months of age. Therefore, only five of the six subtests on the scale were administered to any subject.

Each participant's complete clinical history was analysed, and a complementary record sheet was kept to record the number of sessions they attended as well as the number of times they carried out the proposed activities at home. All data were recorded using a Microsoft Excel database.

Data analysis

Descriptive statistics were used for the sample demographics, including age, gender and birth weight.

Table I. Sociodemographic data of the control group and the experimental group.

	Control Group	Experimental Group
Sex (M/F) (%)	57/43	54/46
GA (weeks) [min-max]	24-37	27-37
Weight (g) [min-max]	751-4.499	1.000-3.999
Length (cm) [min-max]	30-51	30-51

F: female; GA: gestational age; M: male.

Validation study

Inter-rater reliability was evaluated using the intraclass correlation coefficient (ICC) assuming a 95% confidence interval. The criteria thresholds for reliability were: ICC less than 0.30 indicates poor or no correlation; ICC between 0.31 and 0.50 indicates medium correlation; ICC between 0.51 and 0.70 indicates moderate correlation; ICC between 0.71 and 0.90 indicates good correlation and ICC greater than 0.90 indicates very good or excellent correlation [24].

Internal consistency was rated by correlating the measures of total motor scores, gross motor scores and fine motor scores with Cronbach's alpha. The magnitude of each value for Cronbach's alpha was interpreted to characterize the strength of the internal consistency: α > 0.9 excellent; α > 0.8 good; α > 0.7 acceptable; α > 0.6 questionable; α > 0.5 poor; α < 0.5 unacceptable [25].

Physiotherapy intervention evaluation study

The scores in each of the PDMS-2 assessments, at baseline and at eight weeks, were described. The raw scores, age equivalents, percentiles, standard scores and ratios were collected at three points in time using the Peabody scale for each subject. The assumptions of normality were tested by the Kolmogorov-Smirnov test, and the equality of variances was tested using Levene's test. An unpaired t test was used to compare the EG to the CG. The number of sessions and the performance of activities by the parents were evaluated using the Pearson correlation analysis. Data were analysed using the statistical package for the social sciences (SPSS), version 24.0.

Results

Participant characteristics

A total of 74 participants were assessed at their eight-week follow-up visit. The characteristics of the participants were as follows: CG (21 males, 16 females, median gestational age 30.5 weeks, median birth weight 3,000.5 grams, median birth length 40.5 centimetres) and EG (20 males, 17 females, median gestational age 32 weeks, median birth weight 2,499.5 grams, median birth length 40.5 centimetres). The clinical characteristics are described in table I.

Inter-rater reliability

The instrument's inter-rater reliability was satisfactory. The ICC values for the different subsections of the PDMS-2 are shown in Table II. Good correlation was observed for reflex (ICC = 0.76), while very good results were found in terms of inter-rater reliability for the rest of the PDMS-2 subsections.

Internal consistency

Cronbach's alpha coefficients for internal consistency are shown in table II. The coefficients ranged from 0.991 to 0.999, strong in all the PDMS-2 subsections.

Analysis and study of physiotherapy intervention

As described in table III, significant differences were found in motor scores after physiotherapy intervention. At post-treatment, children in the EG had higher mean scores than children in the CG. Comparison between EG and CG in post-treatment scores reached significance levels ($p < 0.001$) in the post-test.

Analysis and study of the number of physiotherapy sessions

Twenty-nine of the EG subjects received a total of eight physiotherapy sessions, four received six sessions and four received four sessions. Correlation analysis to examine the relationship between the number of physiotherapy sessions the EG received and the EG's TMQ scores showed a significant direct correlation ($r = 0.384$, $p = 0.019$).

Analysis and study of the number and performance of proposed activities

Analysis and study of the correlation between the number of activities proposed by the physiotherapist and performed by the parents and the TMQ motor scores showed a significant direct association ($r = 0.46$, $p = 0.005$). Eleven of the EG subjects

Table II. Inter-rater reliability and internal consistency of cohort (*n* = 74).

	ICC	α
Reflex	0.758	0.999
Stationary	0.999	0.999
Locomotion	0.999	0.999
Manipulation	0.999	0.991
Grasping	0.991	0.999
Visual-motor integration	0.999	0.999

ICC: intraclass correlation coefficient.

Table III. Post-test results after physiotherapy intervention.

	Group	n	Mean	Standard deviation	p
GMQ	Experimental	37	24.65	8.554	<0.001
	Control	37	17.65	7.342	
FMQ	Experimental	37	17.22	7.048	<0.001
	Control	37	11.86	4.814	
TMQ	Experimental	37	42.32	14.162	<0.001
	Control	37	29.57	11.498	

GMQ: gross motor quotient; FMQ: fine motor quotient; TMQ: total motor.

performed the activities proposed by the physiotherapist four to five days a week, 21 subjects performed the activities two to three days a week, four performed them one day a week, and one did not perform any of the proposed activities weekly.

Discussion

The overall aim of this study was to cross-culturally adapt the Peabody developmental scale second edition (PDMS-2) for the Spanish population and evaluate its validity. The findings support that The Peabody PDMS-2 scale is a valid and reliable instrument to measure gross and fine motor development in children with neurodevelopmental disorder aged from 0 and 3 years old.

Standardized validated scales are an indispensable tool in the practice of physiotherapy, for measuring the patient's condition and thus providing grounds on which treatment can be proposed [26]. We know the PDMS-2 is a valid, reliable instrument for evaluating neurodevelopment [27]. Validated and adapted to different languages and countries [28], it is a useful element in physiotherapy assessment as well.

Our data indicate that the Spanish version of the PDMS-2 has adequate inter-rater reliability for motor quotients and good internal consistency. The original version of the scale also has good inter-rater reliability for the motor quotients and a high consistency for each subtest [20]. Despite this evidence, reports of cross-cultural studies [21] reveal some differences in assessment between children from different cultural backgrounds. For instance, Tripathi et al [28] reported that Indian children

scored higher on the gross motor scale than on the fine motor scale and showed significant differences from the normative sample. Motor skills have a great impact on adaptation and personal interaction with the environment [8]. The evidence presented by anthropological research shows considerable cross-cultural variation in motor development. The results of applying the same scale in different countries or regions may vary according to environment and practices, so cultural contextualization of the scale is necessary [29].

The second aim was to determine the efficacy of physiotherapy treatment (number of physiotherapy sessions and activities proposed by the physiotherapist and performed by the parents) in children with neurodevelopmental disorders between the ages of 0 and 3 years. The results show the usefulness of assessment based on the PDMS-2, the importance of early-age physiotherapy intervention and a positive correlation between the number of treatment sessions and activities done at home and the child's overall motor and developmental scores.

When motor performance is evaluated through the administration of a developmental scale, motor delays can be detected, and therapeutic services can be justified [30]. Although the literature contains studies of the effects of physiotherapy, the present study finds a relationship between the number of therapy sessions and the importance of parents' involvement in the treatment. Physiotherapy is a powerful and effective tool in early life, stimulating plasticity [31] and motor development [32]. Physiotherapy intervention at an early age facilitates adaptation to preschool stages later [33].

The experimental group scored better in the post-test after physiotherapy treatment. We also

found a direct significant relationship, in terms of linear correlation, between the number of sessions and TMQ, and between the number of activities proposed by the physiotherapist/performed by parents and TMQ motor scores. Our results show a direct relationship between the number of sessions and motor improvement and also between the number of activities performed by parents and total motor scores. This is the first step toward identifying the importance of physiotherapy and treatment dosage and parental involvement in the whole treatment approach. These results concur with previous studies [34].

We know that physiotherapy is fundamental in diagnosis, treatment and prognosis in development [35] [36], but we do not know exactly how many sessions are indicated for each patient [37]. Further research into physiotherapy's benefits and dosage is necessary. The evidence shows that physiotherapy is beneficial for children with developmental disorders [38]. Chen et al (2004) analysed the development of hospitalized children and adolescents who were included in rehabilitation programs during their stay. The episodes were varied, as well as the ages, and the scores differed for each pathology and length of stay. The greatest functional change was observed in the 'brain-trauma' group, which was also the group that presented the greatest number of hours in contact with rehabilitation professionals. Ferrante et al (2019) recently analysed 75 children with brain paralysis between the ages of 6 and 24 months, establishing three groups depending on the dose of treatment: Level 1 with one hour of therapy daily for 20 weeks, level 2 with two hours of therapy three days a week for 6.6 weeks and level 3 with one two-hour session per week for 20 weeks. Studies on pre-term infants [39] show that a single early intervention does not have an acute effect on the spontaneous movements of preterm infants and that more sessions are needed to obtain benefits. The findings support the necessity of physiotherapy and show that physiotherapy improves patients' developmental results [40], yet we have no clear data about the best frequency for optimizing development [41]. However, all studies indicate that, the greater the number of physiotherapy sessions, the greater the patient's improvement.

The foremost limitation of the study is the fact that it includes only seventy-four participants. Even so, it is a representative study sample for the study population. A greater number, as well as a longer follow-up, could expand on the results in subsequent studies. Other limitations include the inability to establish the appropriate number of physio-

therapy sessions for optimal performance and the precise amount of activities that parents should perform at home.

This study provides initial evidence to support the claim that physiotherapy is an effective treatment for subjects with developmental disorders. Physiotherapy is still developing, and work is still being done to create adapted protocols and interventions that cover three main components: the physiotherapist, the procedures and the therapeutic environment [42], including the work done by the family [43]. Parental involvement in therapy is markedly beneficial for the paediatric patient, and, although most parents show an interest in being involved in treatment, some of them experience feelings of frustration as well as the need to have a relationship of trust with their therapist [44]. Coordination of care for patients with special needs involves both patient and family satisfaction, health professionals, health systems and outcomes, with the role of the physiotherapist being that of a direct care manager and a member of the care team [45].

Conclusions

The Peabody PDMS-2 scale is a valid and reliable instrument for mesasuring gross and fine motor development in children with neurodevelopmental disorders between the ages of 0 and 3 years old. It was successfully adapted and validated for use with Spanish population. Physiotherapy is useful for helping children with delayed neurodevelopment improve. The number of physiotherapy sessions and the activities proposed by the physiotherapist and performed at home by the parents show a direct and positive relationship with the results obtained in motor development.

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Validación de la PDMS-2 en población española. Evaluación de la intervención de fisioterapia y la participación de los padres en el tratamiento de niños con trastornos del neurodesarrollo

Objetivo. Adaptar transculturalmente la escala del desarrollo motor de Peabody, segunda edición (PDMS-2), del español mexicano al español de España y evaluar su validez. Determinar la eficacia del tratamiento fisioterápico (número de sesiones de fisioterapia y actividades propuestas por el fisioterapeuta y realizadas por los padres) en niños con trastornos del neurodesarrollo de 0 a 3 años.

Sujetos y métodos. Un primer estudio descriptivo prospectivo de validación de la PDMS-2, que incluyó a 74 sujetos con trastorno del neurodesarrollo con edades comprendidas entre 0 y 3 años. Un segundo ensayo clínico aleatorio para evaluar la intervención de fisioterapia (concepto Bobath) en el grupo experimental ($n = 37$), que recibió sesiones únicas de 30 minutos semanales durante ocho semanas frente al grupo de control ($n = 37$), que no recibió fisioterapia y utilizó la PDMS-2 para su evaluación.

Resultados. Se encontró una adecuada confiabilidad interagente (coeficiente de correlación intraclase = 0,76). La escala mostró también una muy buena consistencia interna (alfa = 0,99). Hubo diferencias significativas entre ambos grupos a las ocho semanas. El grupo experimental obtuvo mejores puntuaciones en el postest después de administrar el tratamiento de fisioterapia ($p < 0,001$). Se encontraron coeficientes de correlación moderados y significativos entre el número de sesiones de fisioterapia y el cociente motor total ($r = 0,38$; $p < 0,05$) y las actividades realizadas en casa con el cociente motor total ($r = 0,46$; $p = 0,005$).

Conclusiones. La PDMS-2 es un instrumento válido y fiable para medir el desarrollo motor grueso y fino en niños con trastorno del neurodesarrollo de 0 a 3 años. La fisioterapia es útil en la mejoría en niños con retraso del neurodesarrollo. El número de sesiones de fisioterapia y las actividades propuestas por el fisioterapeuta y realizadas en casa por los padres muestran una relación directa y positiva con los resultados obtenidos en el desarrollo motor.

Palabras clave. Concepto Bobath. Fisioterapia. PDMS-2. Rehabilitación neurológica. Retraso del neurodesarrollo. Validación.