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Reliability and validity of the Brachial Plexus Outcome Measure in children with obstetric brachial plexus palsy

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ABSTRACT

Study Design: Clinical measurement and cross-sectional study.
Introduction: Numerous scales have been developed to examine activities of daily living and function in children with brachial plexus palsy. The Brachial Plexus Outcome Measure (BPOM) scale was developed in 2012 by Emily S. Ho and contains 14 items that measure activity and self-evaluation.
Purpose of the Study: The aim of the study was to cross-culturally translate the BPOM scale into Turkish and test its measurement properties in children with brachial plexus palsy.
Methods: The scale was translated into Turkish using standard cross-cultural translation procedures. Forty-eight children with obstetric brachial plexus palsy (OBPP) were included in psychometric evaluations. Internal structure consistency and test-retest reliability were measured for reliability analyses. For each item on the scale, Cronbach alpha coefficient and item-total score correlations for all subscales were calculated. The scale was administered at baseline and 1 week later by 2 different physiotherapists to evaluate test-retest reliability. Concurrent construct validity was assessed using Pearson correlations between the OBPP and the Mallet classification system.
Results: Eighteen (37.5%) girls and 30 (62%) boys, in total 48 children, whose mean age was 8.7 ± 2.4 (minimum-maximum = 5-14) years were included in the study; 9 (18.9%) have a history of both early microsurgery and tendon transfers and 39 (81.3%) have a history of only tendon transfer. Cronbach alpha ranged from 0.89 to 0.96, and for the whole scale, it was calculated as 0.938.
Discussion: Test-retest reliability was high. Moderate correlations were observed between the measures.
Conclusion: The Turkish BPOM scale is a valid and reliable measurement for assessing function in children with OBPP in the Turkish population.

Introduction

Obstetric brachial plexus palsy (OBPP) is a unilateral or bilateral clinical condition and occurs secondarily to problems that develop due to injury at birth on the C5, C6, C7, C8 roots and T1 trunks, divisions, cords, and branches, and varying degrees of paralysis at various levels of the upper limb.[1] The incidence of OBPP ranges between 0.38 and 3 per 1000 live births in different countries.[2]

Structural problems such as muscle imbalance, contracture, and joint deformities are seen in the upper limbs with OBPP, which limit performance of activities of daily living. The aim of either conservative (physiotherapy, occupational therapy, orthotics, and botulinum toxin A injections) or surgical treatments (primary microsurgical reconstruction and secondary tendon transfers) is to develop optimal function in the children.[3] The assessment and planning of treatment are very important in children with OBPP. Muscle strength, range of motion, and upper limb functionality are the main components of assessment. The activities are assessed in eligible age within the evaluation of upper limb strength, active upper limb movement, and the ability to perform age-appropriate activities.[4]

Different methods of evaluation have been used in studies of children with OBPP.[5,6] The need for new evaluation scales that take into account the International Classification of Functioning, Disability and Health (ICF) and include spontaneous use in daily life of the upper limb in children with OBPP has been suggested.[7]

The Brachial Plexus Outcome Measure (BPOM) scale developed by Ho et al[8] is well aligned with the theoretical framework of the ICF of the World Health Organization. It emphasizes assessment of functionality in activities of daily living of children with brachial plexus.[8] Scales, such as the Active Movement Scale, the Mallet classification system, and others, have less focus on activity and

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participation. The BPOM scale can be clinically relevant for assessing physical measurement and participation in children with brachial plexus injuries.

The purpose of this study was to develop and evaluate cultural adaptation of a Turkish version of the BPOM scale and investigate its validity and reliability in children with brachial plexus injury.

Methods

This research is a validity-reliability study.

Participants

This study included 48 children with OBPP in the Division of Hand Surgery, Department of Plastic Reconstructive and Aesthetics Surgery, Medicine Faculty, Istanbul University, Istanbul, Turkey.

The inclusion criteria include children who

- are aged between 4 and 18 years;
- had early microsurgery to repair brachial plexus or who had a secondary surgery at a late term;
- are able to use their upper limb in activities of daily living;
- are able to be tested 6 months after operation; and
- have permission from their families in the form of voluntary consent.

Table 1
Demographic characteristics

$N = 48$	Minimum-maximum	X ± SD
Age	5-14	8.68 ± 2.432
Birth weight	2840-5350	4054.86 ± 538.504
		n (%)
Gender		
Female		18 (37.5)
Male		30 (62.5)
Involvement type		
C5-C6		3 (6.3)
C5-C7		19 (39.6)
C5-T1		9 (18.8)
C5-T1 + Horner syndrome		4 (8.3)
Injury side		
Right		29 (60.4)
Left		13 (27.1)
Methods of delivery		
Normal		37 (77.1)
Vacuum		2 (4.2)
Mode of delivery		
Head		38 (79.2)
Birth place		
Hospital		39 (81.3)
House		1 (2.1)
Delivery		
Doctor		29 (60.4)
Midwife		9 (18.8)
Mobile diaphragm		
Yes		15 (31.3)
No		11 (22.9)
Reanimation		
Yes		7 (14.6)
No		20 (41.7)
Maternal disease		
Yes		7 (14.6)
No		30 (62.5)
Accompanying injury		
Horner syndrome		2 (4.2)
Torticollis		1 (2.1)
No		27 (56.3)

SD = standard deviation; X = mean.

The exclusion criterion include children with muscle strength of shoulder and finger flexors less than 3 (Oxford Scale).

Some adjustments were made based on a pretest study with this scale to allow for cultural adaptation. The test-retest studies were completed with a total of 48 children (18 girls [37.5%] and 30 boys [62.5%]). The children were between 5 and 14 years, and the average age was found to be 8.7 ± 2.4 years. Children's demographic information, functionality level, and health conditions affected by the disease were evaluated. The evaluations were repeated after 1 week. Demographic characteristics of the children are shown in Table 1. The children's parents were informed about the scale and the purpose of the study, and a written consent form that showed voluntary participation in the study was completed by a parent. The children were evaluated with the BPOM scale and the modified Mallet classification system by 2 PhD-level physiotherapists who had experience in the field of OBPP and hand rehabilitation. Forty-eight children were tested using both scales, and the tests were repeated after 1 week (test-retest reliability). The physical/neurologic and clinical case conditions were reviewed. There were no changes in the children, and none of them had received any treatment within that period.

Measures

Each child's mother was asked regarding the demographic characteristics. Physical examination was performed by the physiotherapists and the data were recorded for children with OBPP.

Instruments

The modified Mallet classification system

The modified Mallet classification system assesses general function of the shoulder. It has been used in numerous studies of both conservative and surgical treatments of OBPP. Patients were evaluated for active performance of 5 different shoulder movement patterns of the modified Mallet classification system: abduction, external rotation, hand to head, hand to back, and hand to mouth. Each movement is scored between 1 and 5 (1 = no function, 5 = normal movement pattern).[9,10]

The BPOM

The BPOM scale was developed to investigate the level of functional and ICF activity of children with brachial plexus. It has 2

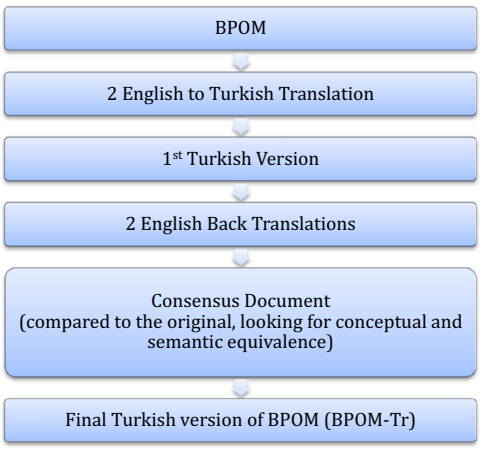

Fig. 1. The flowchart of the Brachial Plexus Outcome Measure (BPOM) translation steps to Turkish language.

Table 2
Results of range of motion and muscle strength

$N = 48$	Range of motion				Muscle strength	
	Active		Passive		Minimum-maximum	X ± SD
	Minimum-maximum	X ± SD	Minimum-maximum	X ± SD		
Shoulder abduction	20-180	124.07 ± 37.706	100-180	159.62 ± 23.491	2-5	4.16 ± 0.850
Shoulder flexion	20-180	137.09 ± 34.334	110-180	166.79 ± 19.718	2-5	4.37 ± 0.792
Elbow flexion	50-145	122.33 ± 21.988	75-150	138.95 ± 12.812	3-5	4.41 ± 0.572
Elbow extension	−55 to 60	−9.53 ± 19.018	−30 to 30	−2.63 ± 9.777	0-5	3.93 ± 1.274
Forearm pronation	−70 to 90	43.05 ± 33.039	45-90	79.38 ± 13.067	1-5	3.17 ± 1.465
Forearm supination	−20 to 90	46.05 ± 30.090	20-90	78.63 ± 18.912	0-5	3.35 ± 1.496
Wrist extension	0-90	43.52 ± 19.959	40-90	72.75 ± 11.489	1-5	3.93 ± 1.328

SD = standard deviation; X = mean.

subscales: Activity and Self-evaluation. The BPOM Activity subscale has 11 items, and each item is scored between 1 and 5 on an ordinal scale. A score of 1 indicates that the task cannot be completed, and a score of 5 indicates that the task can be completed with normal movement pattern. The Activity subscale contains 3 parts: (1) shoulder, (2) elbow and forearm, and (3) wrist, finger, and thumb. The BPOM Self-evaluation subscale consists of 2 visual analog scales to evaluate the working of the arm and hand and 1 visual analog scale to evaluate the appearance of the arm and hand of the child. Several categories and items are evaluated simultaneously, and each score is calculated separately to define the function.[9]

Procedure for cross-cultural adaptation

Permission from Emily S. Ho (BSc, OT Reg[Ont], MEd) was obtained for use of the measure. She was consulted about the scale as needed. This study was approved by the Istanbul Faculty of Medicine Clinical Research Ethics Committee.

The BPOM was translated from the original English language to Turkish language by 2 physiotherapist professionals. The two new translations were assessed by the committee and converted into a single scale by consensus. To arrive at the final version of the scale, it was translated into Turkish and then translated back into English by a person whose native language is English and who is not a health professional. The new English scale was sent to the center that received permission from the producers for the question of the eligibility scale, and the adaptation study was approved. The necessary corrections were made, and the scale was retranslated into English from the original English version by the committee. The committee deliberated to achieve the final consensus measure (Fig. 1).

Statistical analysis

Adjustments to items were made after a pretest with 5 children to identify the need for cultural adaptation. Reliability was analyzed with internal consistency and test-retest reliability.

The test-retest reliability and correlation of the scale were assessed with intraclass correlation coefficient (ICC) and Pearson analysis. ICC values ranged from 0.00 to 1.00. ICC values between 0.60 and 0.80 were accepted as perfect.[11,12] Acceptable values include reliability under random measurement errors. Scales should be above 0.90 for application to individual patients,[11] but scales above 0.75 may be acceptable for group comparisons. Construct validity is supported when similar scales correlate with each other. In contrast, scales that measure different things are expected to be uncorrelated.[12] The relationship between the BPOM scale and the modified Mallet classification system levels was examined by Pearson correlation analysis for concurrent construct validity.

Results

Translation and cross-cultural adaptation

The difficulties of the scale were viewed in harmonizing the Turkish language and cultural differences. Turkish terms that are more easily understood and clearer were used where needed for clarity. Changes were made to item 7 (from “play” to “beat” [*çalmak*]) and item 9 unit of measure (from 5’’ [inch] to 12.7 cm [*santimetre*]).

Table 3
Results of first and second assessments of BPOM scale

BPOM scale	First assessment	Second assessment	*z*	*P*
	X ± SD	X ± SD		
Item 1	3.17 ± 1.522	3.15 ± 1.335	0.690	<.001
Item 2	3.93 ± 1.324	3.89 ± 1.415	0.830	<.001
Item 3	2.77 ± 1.344	2.99 ± 1.342	0.661	<.001
Item 4	1.83 ± 1.123	1.86 ± 1.195	0.834	<.001
Item 5	4.50 ± 0.861	4.42 ± 0.915	0.598	<.001
Item 6	4.16 ± 1.193	4.15 ± 1.159	0.808	<.001
Item 7	4.65 ± 0.756	4.56 ± 0.825	0.468	<.001
Item 8	2.91 ± 1.206	3.02 ± 1.076	0.517	<.001
Item 9	4.14 ± 1.262	4.19 ± 1.217	0.893	<.001
Item 10	4.42 ± 0.868	4.49 ± 0.937	0.777	<.001
Item 11	4.61 ± 0.798	4.62 ± 0.789	0.721	<.001
Item 12	5.91 ± 3.129	6.66 ± 2.64	0.493	<.001
Item 13	6.65 ± 3.145	7.33 ± 2.912	0.854	<.001
Item 14	7.52 ± 2.857	7.99 ± 2.472	0.670	<.001
Total	41.01 ± 8.075	41.40 ± 8.382	0.916	<.001

BPOM = Brachial Plexus Outcome Measure; X = mean; SD = standard deviation.

Table 4
Results of internal consistency analysis of BPOM

BPOM scale	Cronbach α	ICC
Item 1	0.79	0.65
Item 2	0.84	0.83
Item 3	0.78	0.64
Item 4	0.91	0.88
Item 5	0.75	0.49
Item 6	0.88	0.86
Item 7	0.92	0.39
Item 8	0.80	0.55
Item 9	0.91	0.93
Item 10	0.72	0.79
Item 11	0.88	0.71
Item 12	0.98	0.47
Item 13	0.88	0.88
Item 14	0.84	0.68
Total	0.77	0.90

BPOM = Brachial Plexus Outcome Measure; ICC = intraclass correlation coefficient.

Table 5
Results of part/material analysis of BPOM

BPOM scale	First assessment														Second assessment													
	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12	Item 13	Item 14	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12	Item 13	Item 14
First assessment																												
Item 1	1																											
Item 2	0.591	1																										
Item 3	0.256	0.388	1																									
Item 4	−0.078	0.231	0.331	1																								
Item 5	0.262	0.472	0.457	0.205	1																							
Item 6	0.444	0.471	0.643	0.225	0.498	1																						
Item 7	0.039	0.311	0.358	0.144	0.377	0.375	1																					
Item 8	0.039	0.002	0.375	0.262	0.244	0.322	0.353	1																				
Item 9	0.509	0.530	0.669	0.258	0.547	0.769	0.420	0.344	1																			
Item 10	0.337	0.523	0.261	−0.146	0.497	0.296	0.215	0.011	0.328	1																		
Item 11	0.314	0.281	0.453	0.188	0.508	0.549	0.299	0.315	0.374	0.369	1																	
Item 12	−0.123	−0.106	0.046	0.041	−0.158	−0.001	0.178	−0.048	0.041	−0.187	0.040	1																
Item 13	−0.022	0.099	0.132	0.160	0.086	0.098	0.212	0.275	0.279	−0.092	0.041	0.243	1															
Item 14	−0.066	0.032	0.008	0.072	−0.098	−0.011	−0.050	−0.106	−0.017	−0.009	0.019	0.434	0.306	1														
Second assessment																												
Item 1	0.718	0.627	0.277	−0.131	0.421	0.430	0.294	−0.072	0.426	0.367	0.256	−0.185	0.102	0.030	1													
Item 2	0.579	0.772	0.436	0.168	0.528	0.496	0.226	0.074	0.631	0.451	0.358	−0.172	0.082	0.004	0.626	1												
Item 3	0.334	0.529	0.755	0.424	0.592	0.655	0.498	0.496	0.789	0.323	0.463	0.101	0.225	0.155	0.346	0.596	1											
Item 4	0.030	0.229	0.236	0.672	0.053	0.222	0.244	0.371	0.228	−0.173	0.127	0.066	−0.071	0.073	−0.028	0.238	0.408	1										
Item 5	0.417	0.386	0.562	0.265	0.664	0.641	0.403	0.377	0.753	0.405	0.489	0.090	0.288	0.055	0.340	0.525	0.689	0.248	1									
Item 6	0.387	0.421	0.631	0.297	0.406	0.868	0.489	0.350	0.820	0.238	0.556	0.070	0.287	−0.017	0.379	0.459	0.722	0.287	0.697	1								
Item 7	0.339	0.497	0.483	0.147	0.533	0.594	0.373	0.170	0.566	0.607	0.421	−0.109	0.098	−0.085	0.318	0.418	0.522	0.166	0.723	0.595	1							
Item 8	0.000	−0.070	0.320	0.104	0.212	0.202	0.257	0.755	0.233	−0.026	0.202	0.031	0.185	−0.135	−0.014	0.046	0.404	0.365	0.341	0.215	0.183	1						
Item 9	0.353	0.435	0.499	0.229	0.525	0.557	0.326	0.373	0.781	0.325	0.423	0.022	0.303	0.050	0.297	0.507	0.639	0.639	0.220	0.764	0.671	0.333	1					
Item 10	0.275	0.581	0.471	0.168	0.611	0.511	0.460	0.114	0.501	0.679	0.494	0.015	0.237	0.101	0.434	0.494	0.553	0.553	0.068	0.647	0.863	0.154	0.652	1				
Item 11	0.300	0.568	0.463	0.225	0.564	0.593	0.449	0.364	0.597	0.555	0.556	0.011	0.179	0.059	0.321	0.468	0.613	0.613	0.201	0.603	0.684	0.266	0.750	0.801	1			
Item 12	0.003	−0.136	−0.120	0.020	0.015	−0.102	0.042	0.000	0.054	−0.342	−0.130	0.523	0.450	0.224	−0.058	−0.145	0.015	0.015	−0.054	0.075	−0.242	0.022	−0.045	−0.144	−0.147	1		
Item 13	0.205	0.177	0.159	0.049	0.281	0.158	0.145	0.409	0.294	0.086	0.080	0.037	0.403	0.160	0.160	0.154	0.311	0.311	0.103	0.262	0.077	0.237	0.229	0.100	0.277	0.414	1	
Item 14	0.024	−0.017	−0.151	0.007	0.119	−0.101	−0.223	−0.111	−0.062	−0.014	−0.043	0.024	0.213	0.545	0.044	0.005	−0.008	−0.008	0.026	0.059	−0.167	−0.196	−0.014	−0.049	0.092	0.409	0.557	1

BPOM = Brachial Plexus Outcome Measure.

Participants

Demographic characteristics of the study participants are shown in Table 1. Range of motion and the muscle strength of the children are shown in Table 2.

Reliability and validity

The mean scores of BPOM are shown in Table 3, and the reliability findings are shown in Table 4. The reliability of the total BPOM score was high (ICC, 0.93; 95% confidence interval, 0.89-0.96). The results of ICC and Pearson correlation analysis of BPOM subscales are shown in Table 4.

Concurrent validity was confirmed by the moderate and significant correlation found between the BPOM and the modified Mallet classification system ($r = 0.44$; $P < .01$). Internal consistency was confirmed by a Cronbach α of 0.72-0.98. The part/material analysis of the BPOM for each item of the first and second scores is shown in Table 5.

Discussion

This study successfully cross-culturally translated the Turkish version of the BPOM and confirmed its reliability and validity in children with OBPP. The estimation of upper limb functions in children with OBPP is important for evaluation of treatment.[13] In recent years, studies emphasized that functional evaluation should reflect the ICF by including aspects of body function as well as activity and participation.[14–16] The BPOM scale provides a tool that can be used to include these concepts in clinical evaluation.

Many different assessment scales are used to determine the effectiveness of conservative and surgery treatments in children with OBPP.[17,18] In our study, we compared the BPOM with the modified Mallet classification system because the BPOM items are similar to it. We have found that as expected, there was a moderate correlation between scores of these tests in that they are similar in their target population and focus on movement but dissimilar in how they assess functional movement. The BPOM Activity subscale is scored between 1 (cannot complete the task) and 5 (completes the task with a normal movement pattern). We found it a challenge to define the difference between minor and major compensatory movements that are observed between grades 3 (completes the task, does not show active movement in primary mover(s), and may use passive range of motion to complete the movement pattern) and 4 (completes the task, initiates all movement actively or the position of primary mover(s) is sufficient for function, and uses compensatory techniques to complete movement pattern). That is, there is potential for misclassification or disagreement between raters based on how these criteria are interpreted. We find that children with total involvement had lower results and children with C5-C6 involvement had higher scores, which suggests the ability to discriminate functional levels.

There is potential to improve the calibration of items as this can vary by task and functional level. For example, children exhibited difficulties with internal rotation when opening their pants, but it was easier than with their belt. Assessment of these subitems with the original belt specified for the BPOM scale is appropriate for standardization.

Currently, measurement instruments for OBPP focus primarily on physical ability, with limited information regarding the effect of the disablement on activities of daily living and the child's psychosocial well-being. The BPOM Self-evaluation scale improved awareness of their limbs and gave information on body-related self-image of the children.[19] This is important information because understanding the child's self-perception may help therapists and parents customize treatment to the child in a more patient-centered way.

Conclusions

The BPOM scale adapted for Turkish children with OBPP is valid and reliable.

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