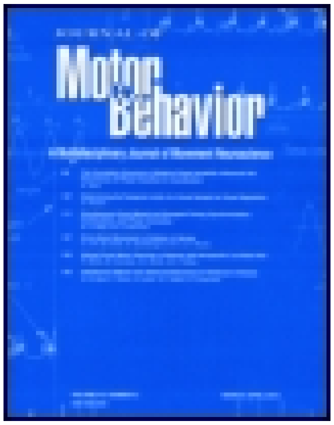

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RESEARCH ARTICLE

Motor Performance in the Third, Not the Second Month, Predicts Further Motor Development

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ABSTRACT. The aim was to verify if motor performance at second or third month of life better predicts further development. The global motor development was assessed by a neurologist and by a physiotherapist in 111 children at 2, 3, 6, and 9 months. At 2 and 3 months a physiotherapist also performed the assessment of qualitative elements. The physiotherapeutic assessment in the third month showed higher compatibility with the neurological assessment. Proper motor performance at third month could ensure the level of at least 7 months in the ninth month of life. Qualitative score above 7 of 15 points in the third month ensured proper development in ninth month. Third month of life is a better predictor of further motor development.

Keywords: motor development, qualitative assessment, infants

Early diagnosis is necessary in order to determine neurological integrity and the potential risk of improper development (Spittle, Orton, Doyle, & Boyd, 2007), and also to undertake possible early intervention. Neurological integrity is expressed as proper functional development, which defines a child's ability to acquire new psychomotor capabilities day by day, adequate to the child's age.

The analysis of the utility of the assessment tools of a child's development indicates that the best diagnostic tests are those that allow the assessment of not only the occurrence of spontaneous movements, and mainly their quality. Such tools due to their high sensitivity detect, apart from major motor disorders (e.g., cerebral palsy [CP]), also minor developmental problems (Heineman, & Hadders-Algra, 2008). Performing a comprehensive neurological examination exclusively offers good predictive value in case of major motor disorders, while an examination based on assessment according to standardized scoring (Infant Motor Evaluation–Time, Toddler Scale; Miller & Roid, 1994) provides a detailed description of motor functions, but it is poor at predicting future disorders, except for those tools which are time consuming and are made up of many elements (Bayley Scales; Bayley, 1993; PDMS-II; Folio & Fewell, 2000; Heineman, & Hadders-Algra, 2008).

Qualitative tests include the General Movements Assessment (GMsA; Einspieler, Prechtl, Ferrari, Cioni, & Bos, 1997). The noninvasive character of the GMsA makes it an important tool in diagnosing newborns and infants. Observations of the quality of general movements are performed to determine the integrity of the CNS in infants (Einspieler, Prechtl, Bos, Ferrari, & Cioni, 2004). The study shows that repeatedly performed GMsA until the age of 3–4 months is a better method to identify children with neurological deficiencies than the traditional neurological examination (Prechtl et al., 1997). Abnormal movements observed in the GM assessment are related to high risk of the occurrence of CP, subsequent minor neurological dysfunction, attention deficit, hyperactivity, or aggressive behavior at school age (Palisano, Snider, & Orlin, 2004). However, GMsA is difficult to perform under outpatient clinic conditions and it cannot be used in order to plan therapy.

The assessment of development should be performed as soon as possible, according to some authors the best moment is the second month of life when an individual can observe first symmetrical positioning of the head related to the extension of the cervical spine, the tendency to reach the center line with hands, and uniform load of both sides of the body (Vojta & Peters, 2007). Others claim that the third month of life is the best moment, due to the fact that movements become more purposeful and isolated, and therefore developmental disorders are more visible (Vojta & Peters, 2007). We definitely have to agree with the statement that the assessment of motor development should not be restricted to checking the general movements only, which will further be referred to as quantitative assessment, but it has to include qualitative observations. What is important is that the assessment should be noninvasive (i.e., it should be based on observations of the spontaneous behavior of a child), but at the same time it has to be transparent, easy, and quick to perform under outpatient clinic conditions and useful for the purpose of the determination of the therapeutic program, if required in case of the observed child.

The aim of this study was therefore to check which elements of motor performance, and at what month of life, predict a better prognosis for further development.

Motor Performance in the Second and Third Months of Life (Quantitative and Qualitative Elements)

The second month of life is characterized by gradual straightening of the spine (the next stage of the craniocaudal development). Its clear manifestation is the symmetrical positioning of the head (quantitative pattern) related to the full extension of the cervical section of the spine. In the

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prone position in the second month of life there is support on forearms positioned distally from the line of the spine (quantitative pattern), palms are half open, while lower extremities still remain slightly flexed due to the anteversion of the pelvis (Prechtl, 1984; Touwen, 1976; Vojta & Peters, 2007).

In the third month of life, along with the raising of the head in the prone position above the base of support, the upper extremities are used as support organs for the first time in life; owing to the fully extended spine it is also possible to observe isolated movements of the head. The pelvis is in an intermediate position and the straightening movement in hip joints begins.

The support plane at the medial epicondyle of the humerus (quantitative pattern) is a necessary condition for the raising of the chest with the simultaneous overcoming of the force of gravity. At this time the elbows are outside the line of shoulder joints (Cioni & Mercuri, 2007; Hadders-Algra, & Brogren Carlberg, 2008; Vojta & Peters, 2007).

In the supine position in the second month of life a symmetrical positioning of the head (quantitative pattern) can be observed; a child still needs a large base of support to maintain a stable position on the back, therefore the movement of the upper extremities is performed by the tendency to reach the center line—bringing fingers together (quantitative pattern), the shoulders lie on the base surface, while the lower extremities are raised above the base surface for the first time in life. In the next month of life the longitudinal axis of the body (spine) is extended in all planes (qualitative assessment) and support-extension mechanisms emerge (Guzzetta et al., 2005; Hadders-Algra, 2004; Heineman, Bos, & Hadders-Algra, 2008).

In the third month of life a child is able to raise both lower extremities above the base surface symmetrically (Touwen, 1976), with the hip and knee joints flexed at the right angle, while the movement performed with the upper extremities involves bringing hands together at the center line. Due to such motor activity the support plane at quadrilateral is being formed—the nuchal line, spines of scapulae and Th 12 (quantitative pattern). The upper and lower extremities are in an intermediate position between external and internal rotation, the palms are open with the thumb pointing externally from the hand (Vojta & Peters, 2007).

Due to the fact that in a number of publications, including our own (Gajewska, Sobieska, Kaczmarek, Suwalska, & Steinborn, 2013) it was shown that motor development, at least with respect to purposeful movements of the upper extremities, is affected by the proper functioning of the senses and the proper intellectual development, a group of children with no deficiencies or with motor deficiencies were investigated for the purposes of this study exclusively.

The selected target group comprised of children referred to a neurologist for observation on the basis of the positive medical history, parents' anxiety, or concerns expressed by a general practitioner (GP). The study was deliberately not conducted among the entire healthy population as previous studies (Gajewska et al., 2013) have shown that children developing properly achieve maximum scores on the suggested scale.

Aim of the Study

After the analysis of the available literature a quantitative and qualitative assessment sheet was developed for children aged 2 and 3 months for the following purposes:

1. To demonstrate the reliability, sensitivity, and the predictive value of the motor development assessment sheet developed by the authors.
2. To check which quantitative and qualitative elements of motor performance in the second and third months of life are essential for the assessment and determine further development of a child in the sixth and ninth months of life.
3. To demonstrate whether a better predictor of future motor development is the assessment performed in the second or the third month of a child's life.

Method

Participation

The prospective investigation of motor development involved a group of 132 children.

Rejection reasons were incomplete data or lacking follow-up examination. Eventually, 111 children (42 girls, 69 boys) with no genetic or metabolic disorders or severe birth defects qualified for the participation in the study. There were 72 children born at term and 39 born prematurely. In case of prematurely born infants their corrected age was taken into consideration (Blauw-Hospers & Hadders-Algra, 2005). The investigated children were not divided into groups according to whether they were born at term or prematurely; studies conducted previously demonstrated no impact of this factor on the motor performance in the group with corrected age (Gajewska et al., 2013).

On average children in the investigated group were born at week 37 $\pm$ 3, the mean body weight was 2850 $\pm$ 898 g, the mean head circumference was 33 $\pm$ 2 cm, the mean body length was 53 $\pm$ 4 cm, and the mean chest circumference was 32 $\pm$ 3 cm. The Apgar scale scoring was as follows: at 1 min, median 10 (lower quartile [Q25] = 8, upper quartile [Q75] = 10); at minutes 3, 5, and 10, the score was 10 points (Q25 = 9, Q75 = 10). Risk factors were defined as potentially affecting motor development, such as intraventricular hemorrhage (IVH) were analyzed (in all children brain sonography was performed in the second month), Apgar score at 5 min, the presence of respiratory distress syndrome, intrauterine hypotrophy, or hyperbilirubinemia based on medical records, after consulting a neurologist.

The examination was performed at the clinic of the Greater Poland Center for Child and Adolescent Neurology in Poznań (Poland) and the child clinic in Bydgoszcz in the years 2011–2013.

Informed consent was obtained from all parents or caregivers of the subjects and the study was approved by the Research Ethics Committee of Poznan University of Medical Sciences and registered under number 22/10 (07-01-2010). It conformed to all ethical issues included in the Helsinki declaration.

Procedures

All children were subject to a global assessment of the functional development at 2, 3, 6, and 9 months of life performed by a neurologist and by a physiotherapist. At the age of 9 months the neurologist pointed at children with evolving CP or delay in motor development (referred to later as max at nine months). The final diagnosis was made later, at the age of 18 months and the maximum achieved motor performance was assessed.

The examination was performed independently, both the neurologist and the physiotherapist had information only about whether an infant was born prematurely or at term to calculate the corrected age, but they were not aware of the infant's clinical history details nor the parallel opinion.

The physiotherapist carried out the assessment of individual quantitative elements included in the analysis at 2, 3, 6, and 9 months (based on the literature; Gajewska et al., 2013; Hadders-Algra, 2004; Vojta & Peters, 2007) observed in supine and prone positions at 2, 3, and 6 months, and in prone position only at 9 months. The assessment included the left and the right side of the body.

In the prone position in the second month the assessment involved the upright symmetrical positioning of the head, first purposeful eye movements, and support on forearms with upper extremities moved distally; and in the third month: the support triangle—symmetrical support on the medial epicondyli of the humerus and the pubic symphysis, the head raised above the base surface.

In the second month in the supine position the assessment involved the tendency to reach the center line of the upper extremities (bringing fingers together) and the motor patter of contact with the mother, and in the third month the assessment focused on the symmetrical positioning of the head as a function, the tendency to reach the center line with hands (bringing hands together), and lifting of the lower extremities above the base surface, and this position is delimited by the fulcrum quadrilateral—the nuchal line, spines of scapulae, and Th 12.

In the sixth month the assessment in the prone position involved support on both hands and extended upper extremities and thighs—the support rectangle, in supine position: rotation from the back to the abdomen. In the ninth month the object of the assessment was standing by furniture and walking sideways, using the split step.

Possible assessment score was 0 if the test performed only partially or completely incorrectly and 1 if the test performed completely correctly.

In the second and third month the physiotherapist also performed an examination that involved the assessment of qualitative elements (according to a motor development assessment sheet developed by us).

In the second month in prone position eight, and in supine position seven elements were checked, while in third month the assessment involved 15 elements in prone position and 15 elements in supine position. Each element was assessed as 0 if the test was performed only partially or completely incorrectly, 1 if the test was performed completely correctly. The duration of the examination performed by the physiotherapist was between 10 and 15 min. Each assessed element had to be observed at least three to four times during the test.

The presence of all of the aforementioned elements both in the prone and supine positions was considered as the norm. The global physiotherapeutic assessment (1) is equivalent to the maximum qualitative and quantitative assessment. According to global assessment children were classified into the following groups: developing properly (correct) or requiring rehabilitation (incorrect). Each time the assessment performed by the physiotherapist was compared with the diagnosis made by the neurologist (concurrent validity).

The physician making the assessment carried out a comprehensive neurological examination, which is a commonly used technique, and its predictive validity for minor motor disorders is moderate at best (Heineman & Hadders-Algra, 2008). The selection of the research method usually depends on the time allocated to the performance of a given procedure, the availability of other sources of screening tests and personal preferences of a neurologist (American Academy of Pediatrics, 2001), therefore the neurological examination was based on the Denver Development Screening Test II (DDST II; Ślenzak, & Michałowicz, 1973) and the evaluation of reflexes, muscle tone (hypotony and hypertony), and symmetry (Gajewska et al., 2013). Previously, this type of an examination was used in the assessment of children aged 3 months (Gajewska et al., 2013). The DDTS II was used to check all areas, but in the examination two of them were used for the assessment of: fine motor skills, locomotion and postural coordination/gross motor skills (American Academy of Pediatrics, 2001; Drachler, Marshall, & de Carvalho Leite, 2007; Hsu et al., 2013).

After conducting the examination neurologists classified a child into one of three groups: normal (no neurological abnormalities), suspected (not requiring rehabilitation—for observation), and abnormal. A child was classified as abnormal if he or she exhibited clear neurological disorders, such as increased (hypertony) or decreased (hypotony) muscle tone accompanied by abnormal reflexes and failure to perform tasks in the area of motor skills for a given age group in the DDST II test. A child was classified into the suspected group—not requiring rehabilitation—for observation if it exhibited mild symptoms of neurological disorders, such as mild muscle tone regulation disorders, slight reflex dysfunction, minor developmental asymmetry, and a delay in the area of motor skills in the DDTS II test. Assessing children at the age of 9 months the neurologist pointed out at those evolving CP. According to the opinion of neurologists the diagnosis of CP was made as follows: hypertony or hypotony, spontaneous motor behavior, reflexes, brain sonography, and magnetic resonance imaging if brain sonography result was suspected, follow-up observation, checking the motor development and alterations of motor behavior with age (Surveillance of Cerebral Palsy in Europe, 2000). The final diagnosis was made at the age of 18 months (Table 1).

The interobserver examination was carried out independently by two physiotherapists on the same day in children age 2 and 3 months old for the assessment of the qualitative development and the results were kept blinded until the final statistical analysis. The examination included 28 children age 2 months, 40 children were assessed that way at 3 months of age. The intraobserver part was conducted by comparing direct observations with the outcome of the video footage analysis, in 30 children in the second and 44 children in the third month, with two weeks time distance. The observer was blind with respect to the clinical status of the infants. Inter- and intraobserver data in the second and third month showed strong reliability (Tables 2 and 3).

Statistics

A statistical analysis of the results was performed by means of the following tests:

1. Mann-Whitney U test with correction for tied ranks (for comparisons between two groups of measurements made on the ordinal scale of the free data scheme).
2. Kruskal-Wallis test followed by multiple comparisons post hoc test by Dunn (for comparisons between a larger number than two measurement groups, carried out on the ordinal scale of the free data scheme).
3. Pearson's Chi-square test (for comparisons of two or more groups of measurements made on the nominal scale).

The StatSoft, Inc. (2011) software package was used for the calculations. STATISTICA (data analysis software system), version 10 (StatSoft Polska, Kraków, Poland).

In case of the chi-square test, when Cochran's conditions regarding the expected cell count were not satisfied, the exact (and not the asymptotic) statistical value was determined using permutation algorithms included in the STATXACT package, version 10.0.0, by Cytel Software Corporation (Cytel Software Corporation, Cambridge, MA).

Results

The neurological assessment carried out in the ninth month allowed for the classification of children according to the maximum development attained. A total of 66 children were assessed as developing properly in the ninth month (max = 9), 10 children as manifesting symptoms of CP (max = 0). Of 10 children evolving CP, eight were finally diagnosed with quadriplegia and two with diplegia.

In the group of children in the ninth month no children were assessed as demonstrating development typical for the fourth to fifth month, some of them (35) exhibited slight delay in motor development (max = 6–8 months).

An attempt was made to make a comparison of the assessment made by the neurologist and the global assessment carried out by the physiotherapist in the second and third months depending on the final assessment in the ninth month. It shows that the assessment of motor development in the third month of life demonstrated slightly better compatibility with the neurological assessment in comparison with the assessment in the second month of life (Table 1). In the second month the compatibility of the physician's assessment with the physiotherapeutic assessment was $z = -4.63328$, $p < .001$, while in the third month the compatibility of the physician's assessment with the physiotherapeutic assessment was $z = -4.39621$, $p < .001$.

The assessment made by the neurologist and the physiotherapist was also checked in the sixth ($z = -5.72483$, $p < .001$) and ninth month ($z = -8.67709$, $p < .001$).

Next, a comparison of the global physiotherapeutic assessment in the investigated group of children at the second–sixth–ninth months in relation to the assessment at third–sixth–ninth months with a subdivision according to the development level attained in ninth month was made. High compatibility of the assessment was reported, as it reached 100% in children assessed incorrectly, and in case of proper development the value was 93%.

Proper development at second/third month in 34 of 36 cases guaranteed proper development in the ninth month: for the second–sixth–ninth months scheme, $\chi^2(14, N = 112) = 108.9$, $p < .001$; for the third–sixth–ninth months scheme, $\chi^2(14, N = 112) = 109.6$ for $p < .001$ (Table 2).

None of the children who were assessed as developing properly in the third month of life (global physiotherapeutic assessment = correct) were assessed as manifesting development below the age of 7 months in the ninth month of life. Children assessed in the third month as incorrect (requiring rehabilitation), but assessed as correct (developing properly) in the sixth month in the final assessment attained development corresponding to eighth or ninth month.

TABLE 1. A Comparison of the Assessment Made by the Neurologist and the Global Assessment Carried Out by the Physiotherapist in the Second and Third Months Depending on the Final Diagnosis

	Neurological assessment at 2 months – normal $n = 37$		Neurological assessment at 2 months – suspected $n = 16$		Neurological assessment at 2 months – abnormal $n = 58$	
Final assessment	Physiotherapeutic assessment at 2 months – abnormal $n = 33$	Physiotherapeutic assessment at 2 months – incorrect $n = 4$	Physiotherapeutic assessment at 2 months – correct $n = 2$	Physiotherapeutic assessment at 2 months – incorrect $n = 14$	Physiotherapeutic assessment at 2 months – correct $n = 0$	Physiotherapeutic assessment at 2 months – incorrect $n = 58$
Month 2						
max = 9	31	2	1	11		21
max = 8						5
max = 7	2	1	1	2		17
max = 6		1		1		5
max = 0 cerebral palsy						10
	Neurological assessment at 3 months – normal $n = 39$		Neurological assessment at 3 months – suspected $n = 15$		Neurological assessment at 3 months – abnormal $n = 57$	
Final assessment	Physiotherapeutic assessment at 3 months – correct $n = 35$	Physiotherapeutic assessment at 3 months – incorrect $n = 4$	Physiotherapeutic assessment at 3 months – correct $n = 1$	Physiotherapeutic assessment at 3 months – incorrect $n = 14$	Physiotherapeutic assessment at 3 months – correct $n = 0$	Physiotherapeutic assessment at 3 months – incorrect $n = 57$
Month 3						
max = 9	32	4		10		20
max = 8	1					5
max = 7	2		1	1		18
max = 6				3		4
max = 0 cerebral palsy						10

TABLE 2. Final Motor Performance in Relation to Early Assessment

General assessment	2–6–9 months versus 3–6–9 months	Month 3 sum quality: Prone position median (Q25–Q75)	Month 3 sum quality: Supine position median (Q25–Q75)	Max = 0	Max = 6–8	Max = 9
incorrect-incorrect-incorrect	44 equal	0[a] (0–6)	1[a] (0–6)	9	29	6
incorrect-incorrect-correct	16 equal	6[a] (0–9)	6[a] (0–9)	1	0	15
incorrect-correct-incorrect	3 equal, 1 not (correct-correct-incorrect)			0	2	1
incorrect-correct-correct	8 equal, 2 not (correct-correct-correct)	13 (9–13)	12 (11–13)	0	0	10
correct-incorrect-incorrect	1 equal			0	1	0
correct-incorrect-correct	4 equal			0	0	4
correct-correct-incorrect	2 equal			0	2	0
correct-correct-correct	28 equal, 2 not (incorrect-incorrect-correct)	15 (15–15)	15 (15–15)	0	0	30

Note. Scheme beginning in the third month, if different from the second month, is provided in the parentheses.
[a]The difference in relation to the maximum assessment for the correct-correct-correct group (Kruskal-Wallis test $p < .001$ for the supine and prone positions).

Ultimately, 66 children were assessed as demonstrating development typical for the ninth month; in this group 34 children in the third month were given globally incorrect physiotherapeutic score, but those that improved in the sixth month (27) were eventually given the maximum score in the ninth month. Seven children, on the other hand, who in the sixth month still failed to achieve the maximum score, but showed improvement in the prone position assessment, were qualified as correct during the examination in the ninth month. Their assessment in the third month in prone and supine positions differs significantly from those children, who improved already at the age of 6 months (Mann-Whitney U test $p = .003$ and $p = .008$, respectively).

Children, who in the final assessment achieved motor performance typical for ninth month, but were given incorrect physiotherapeutic score in the second month failed to exhibit proper qualitative characteristics, whereas in the third month they manifested dysfunction regarding the proximal development characteristics, though the distal characteristics (e.g., open palms, thumb outside) could have been correct (Tables 3 and 4).

Analyzing the quantitative assessment in the second and third months, depending on the final diagnosis, it is possible to notice that the observation of children in both positions, the prone and supine positions, has the diagnostic (prognostic) value.

If a child, in the qualitative assessment observed in the second month, is given above 3/8 points (38%) in the prone position or 3 of 7 points (43%), then his/her development in the final assessment will be proper or slightly delayed. However, if a child in prone or supine position in the third month of life scores above 7 of 15 points (47%), it indicates that in the ninth month of life he or she will demonstrate proper development or his/her development may be slightly delayed (Figure 1).

The analysis of summary variables shows that for a child to achieve the development typical of month sixth-ninth he/she has to score at least six points in the third month in qualitative characteristics and these include characteristics significantly distinguishing the subgroups (Tables 2 and 3), while the quantitative analysis does not provide a distinguishing factor with regard to these children (Figure 2).

Discussion

The global physiotherapeutic assessment in the second and third months provides almost identical results, although in the examination carried out in the third month it is possible to observe clearer polarization: children are assessed as either completely correct, and then they develop properly, or as definitely incorrect, and then they have to be classified as being at risk of CP, or they manifest minor qualitative deficits and their development at month ninth will be slightly delayed. The assessment of qualitative elements in the second month shows much greater dispersion, and therefore it is of lesser prognostic significance. It seems that even those children who develop absolutely properly do not all achieve full performance in the second month, rated as maximum qualitative assessment. However, in the third month healthy children achieve a much more uniform

TABLE 3. Elements of Motor Performance Assessment in the Second Month

Element	Right (R) Left (L)	Interobserver validity	Intraobserver validity	Max = 0 Cerebral palsy n = 10	Max = 6–7–8 n = 35	Max = 9 n = 66	Chi square
Quantitative features, prone position: First symmetrical positioning of the head upward 0/1		1.00	1.00	10 / 0	31 / 4	28 / 38	25.98
First purposeful eye movements 0/1		1.00	1.00	9 / 1	18 / 17	11 / 55	0
Distal movement of the upper extremities, forearms support 0/1		1.00	1.00	10 / 0	32 / 3	30 / 36	25.85
Qualitative features, prone position:	R 0/1	1.00	1.00	10 / 0	31 / 4	25 / 41	30.32
Shoulder protraction absent	L 0/1	0.9	0.82	10 / 0	32 / 3	26 / 40	31.55
Forearms support (the motor activity of	R 0/1	1.00	1.00	10 / 0	32 / 3	28 / 38	28.61
the arms moves from the frontal plane to the sagittal plane), elbows at the height of the shoulders	L 0/1	0.9	0.82	10 / 0	32 / 3	29 / 37	27.21
Spine significantly extended 0/1		0.9	1.00	10 / 0	31 / 4	29 / 37	24.62
Slight pelvic anteversion 0/1		0.9	1.00	10 / 0	28 / 7	21 / 45	29.16
Lower extremities significantly	R 0/1	0.54	0.76	9 / 1	23 / 12	16 / 50	0
extended	L 0/1	0.54	0.76	9 / 1	23 / 12	16 / 50	0
Quantitative features, prone position: Tendency to reach the central upper extremities line, bringing fingers together 0/1		1.00	1.00	10 / 0	31 / 4	28 / 38	25.98
Pattern of motor contact with the mother 0/1		1.00	1.00	8 / 2	20 / 15	14 / 52	0
Qualitative features, supine position: First positioning of the head in line with the body axis 0/1		1.00	1.00	10 / 0	27 / 8	29 / 37	16.47
Bringing fingers together along the	R 0/1	1.00	1.00	10 / 0	32 / 3	29 / 37	27.21
central line, shoulders on the base surface	L 0/1	1.00	1.00	10 / 0	32 / 3	29 / 37	27.21
Symmetrical load on both sides of the	R 0/1	0.76	0.65	10 / 0	30 / 5	26 / 40	26.31
body	L 0/1	0.88	0.8	10 / 0	30 / 5	27 / 39	24.92
First lifting of the lower extremities	R 0/1	0.69	0.67	8/2	25 / 10	17 /49	0
above the base surface, slight flexion	L 0/1	0.60	0.67	8/2	24 / 11	17 /49	0

Note. The number of children who did or did not executed the assessed element is given.

level of development, therefore it may be suggested that the assessment of motor performance in the third month should be considered as of greater prognostic value. It seems that the improvement observed between months 3 and 6 guarantees further proper development, especially if the improvement was observed in the prone position, what could also be demonstrated in children aged 6 months (Gajewska, Sobieska, & Moczko, 2014)

All children who were given incorrect functional assessment in the second month were subject to an adequate therapy. It may not be ruled out that the therapy caused a change in the children's condition in third month and the following months, although Table 2 demonstrates that between months 2 and 3 such a difference (improvement from incorrect to correct) refers to only one child in the global functional assessment. Anyway, it should be stressed that improper motor behavior may already be noticed as early as in the second and third month, and thus both early diagnosis and early intervention is very important and should not be postponed to 18 months (American Academy of Pediatrics, 2001).

At the same time children who failed to improve by month 6 regardless of the fact whether they were subject to physiotherapy did not exhibit proper development at month 9. It was demonstrated that children who failed to improve between months 2 and 3 and 6 do not continue to develop. Improvement in month 6 in relation to the decreased assessment in months 2 and 3 guarantees further development, although it may still be delayed.

The conducted examinations show that quantitative assessment alone performed at month second and third does not determine further disorders. Only the qualitative analysis, particularly of proximal elements, allows the catching of these irregularities and a physiotherapist can,

TABLE 4. Elements of Motor Development Assessment in the Third Month

Element	Right (R) Left (L)	Interobserver validity	Intraobserver validity	Max = 0 Cerebral palsy $n = 10$	Max = 6–7–8 $n = 35$	Max = 9 $n = 66$	Chi square
Quantitative characteristics in prone position: Symmetrical support points on the medial epicondyles of humeral bone and on the pubic symphysis max = 15		1.00	0.87	0	0	32	24.62
Qualitative characteristics: Isolated head rotation 0/1		0.89	0.87	10 / 0	27 / 8	24 / 42	22.63
Arm in front, forearm in intermediate position, elbow outside of the line of the shoulder	R 0/1	1.00	1.00	10 / 0	29 / 6	27 / 39	22.67
	L 0/1	1.00	1.00	10 / 0	31 / 4	25 / 41	30.32
Palm loosely open	R 0/1	0.81	1.00	8 / 2	18 / 17	12 / 54	0
	L 0/1	0.81	0.82	8 / 2	19 / 16	11 / 55	0
Thumb outside	R 0/1	0.77	0.82	8 / 2	18 / 17	11 / 55	0
	L 0/1	0.77	1.00	8 / 2	19 / 16	10 / 56	0
Spinal cord segmentally in extension 0/1		0.89	0.87	10 / 0	31 / 4	30 / 36	23.31
Scapula situated in medial position	R 0/1	0.89	0.87	10 / 0	31 / 4	26 / 40	28.82
	L 0/1	0.89	0.87	10 / 0	31 / 4	23 / 43	33.46
Pelvis in intermediate position 0/1		0.93	0.87	10 / 0	30 / 5	20 / 46	35.80
Lower limbs situated loosely on the substrate	R 0/1	0.87	0.87	10 / 0	26 / 9	12 / 54	0
	L 0/1	0.87	0.87	10 / 0	26 / 9	13 / 53	0
Foot in intermediate position	R 0/1	0.84	0.87	7 / 3	17 / 18	10 / 56	0
	L 0/1	0.84	0.87	7 / 3	18 / 17	9 / 57	0
Quantitative characteristics in supine position: Quad support: nuchal line, scapula crest, T12. Functions: head within axis of the body, upper limbs tend toward the body's center line, lower limbs bent at a right angle at the hip and knee joint, foot in intermediate position 0/1		0.93	0.87	10 / 0	28 / 7	27 / 39	20.63
Qualitative characteristics: Head symmetry 0/1		0.89	0.87	10 / 0	25 / 10	22 / 44	21.75
Spinal cord in extension 0/1		0.88	0.87	10 / 0	31 / 4	29 / 37	24.62
Shoulder in balance between external and internal rotation	R 0/1	0.90	1.00	10 / 0	27 / 8	25 / 41	21.30
	L 0/1	0.90	1.00	10 / 0	29 / 6	23 / 43	28.35
Wrist in intermediate position	R 0/1	0.87	1.00	9 / 1	17 / 18	9 / 57	0
	L 0/1	0.87	1.00	9 / 1	18 / 17	9 / 57	0
Thumb outside	R 0/1	0.87	0.93	9 / 1	16 / 19	10 / 56	0
	L 0/1	0.87	0.93	9 / 1	16 / 19	13 / 53	0
Palm in intermediate position	R 0/1	1.00	0.87	9 / 1	16 / 19	10 / 56	0
	L 0/1	1.00	0.87	9 / 1	16 / 19	10 / 56	0
Pelvis extended (no anteversion and retroversion) 0/1		1.00	0.84	10 / 0	28 / 7	22 / 44	27.60
Lower limb situated in moderate external rotation	R 0/1	0.87	1.00	9 / 1	23 / 12	16 / 50	0
	L 0/1	0.87	1.00	9 / 1	23 / 12	18 / 48	0
Lower limb bent at a right angle at hip and knee joints, foot in intermediate position—lifting above the substrate	R 0/1	0.90	1.00	9 / 1	25 / 10	17 / 49	0
	L 0/1	0.90	1.00	9 / 1	25 / 10	17 / 49	0

Note. The number of children who did or did not executed the assessed element is given.

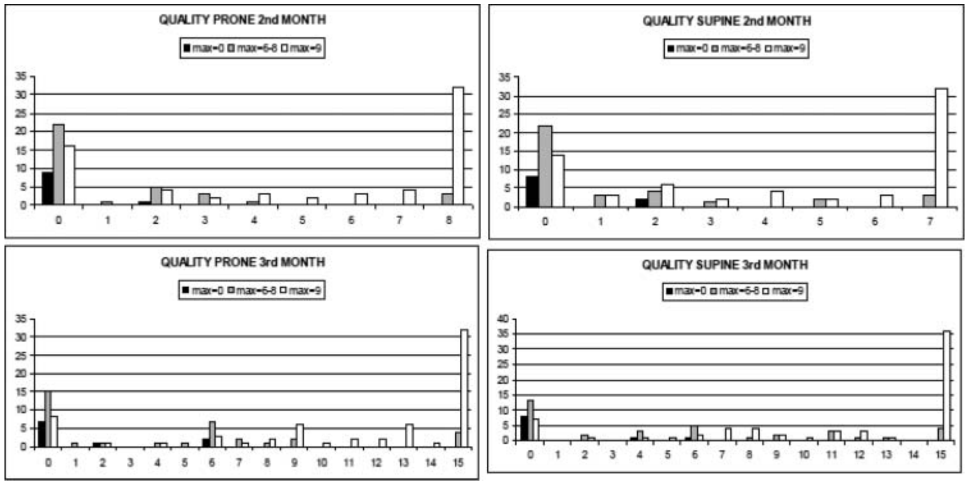

FIGURE 1. Number of children with a given sum of quality features of the second and third months, divided according to maximum achieved motor performance, in prone and supine positions, respectively.

on its basis, precisely define the main problem and thus develop a rehabilitation program.

Of 76 children, who were not initially assessed as correct, 67 attained a good level of development and only 10 of them were diagnosed with CP. Physiotherapy in case of these children is not capable of reversing the damage to the central nervous system that occurred, but it can possibly minimize its effects. It is debatable whether the improvement in motor development is spontaneous or it is the result of rehabilitation; however, conducting such a study for ethical reasons is not possible.

Motor development in relation to the Apgar scoring was not analyzed, as all children improved by the 10th min, and previous studies (Gajewska et al., 2013) demonstrated that incorrect results in the first minutes did not affect motor development.

As far as the other risk factors are concerned, only the occurrence of IVH exacerbated the prognosis for the attainment of the maximum motor development (in 16 of 111 children, $p = .01$) and the respiratory distress syndrome (in 13 of 111 children, $p = .02$. It is in agreement with the literature (Ballabh, 2010).

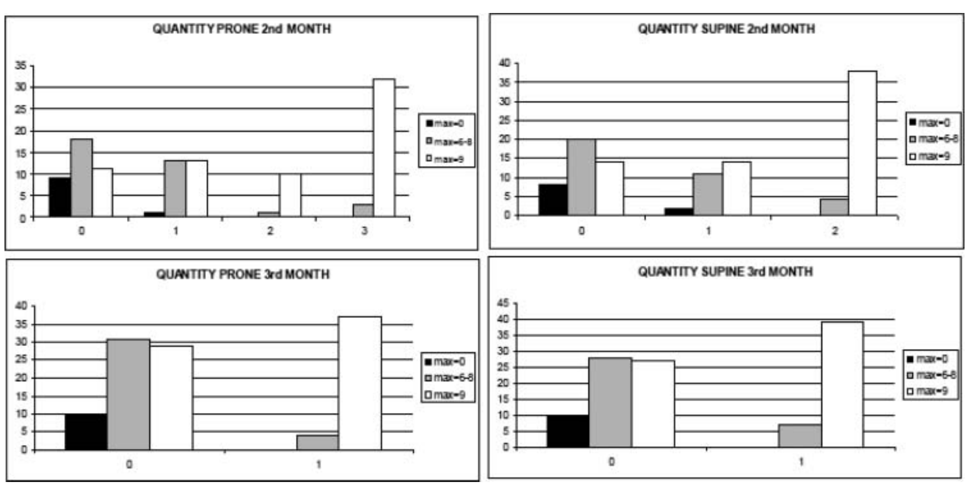

FIGURE 2. Number of children with a given sum of quantity features of the second and third months, divided according to maximum achieved motor performance, in prone and supine positions, respectively.

Conclusions

1. The quantitative and qualitative motor development assessment sheet seems to be a reliable research tool.
2. The assessment of motor performance in the third month is a better predictor of further motor development than the assessment in the second month.
3. The improvement of motor development between months 3 and 6 guarantees further proper development.
4. It seems that the qualitative assessment of the proximal elements of motor performance in the third month of life is the main predictor of further motor development.

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