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Diagnostic tools used to assess the functional development of 2-year-old children born prematurely

Aneta Suder[1], Julia Nawrot[2], Małgorzata Kulesa-Mrowiecka[1], Joanna Zyznawska[1], Agnieszka Gniadek[2]

[1] Institute of Physiotherapy, Faculty of Health Sciences, Jagiellonian University Medical College, Kraków, Poland
[2] Institute of Nursing and Midwifery, Faculty of Health Sciences, Jagiellonian University Medical College, Kraków, Poland

Corresponding author: Aneta Suder, M.D., D.Sc.
Institute of Physiotherapy, Faculty of Health Sciences
Jagiellonian University Medical College
ul. Michałowskiego 12, 31-126 Kraków, Poland
Phone: +48 12 634 33 97 Int. 24; E-mail: aneta.suder@uj.edu.pl

Abstract: In Poland, preterm infants account for 6–7% of all births. Preterm deliveries are associated with a number of short- and long-term health conditions and therefore pose a major public health challenge. Monitoring the psychomotor development of children born prematurely is a significant challenge for pediatricians and neonatologists. Early diagnosis of delayed functional development enables timely therapeutic intervention by developmental specialists, such as physiotherapists, educators, psychologists, and speech therapists. Currently, monitoring the development of preterm infants during the first year of life is common practice. However, due to the significant percentage of late preterm infants in the population of prematurely born newborn population, there is a justified need to focus on the periodic assessment of their functional development also beyond the first year of life. Regular and multidimensional developmental monitoring in this group of patients is crucial due to the increased risk of subtle but clinically significant developmental delays that may manifest at later stages of life.

Keywords: preterm infant, psychomotor development, diagnostic tools.

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Introduction

In Poland, preterm infants account for approximately 6–7% of all births. Preterm delivery is associated with a wide range of short- and long-term complications and therefore poses a major public health challenge. The most serious early consequences of prematurity include respiratory distress syndrome (RDS), bronchopulmonary dysplasia (BPD), intraventricular hemorrhage (IVH), necrotizing enterocolitis (NEC), retinopathy of prematurity (ROP), hearing impairments, congenital heart defects, and significantly low birth weight [1]. In terms of long-term neurological outcomes, prematurity is most commonly associated with cerebral palsy (CP), intellectual disability, autism spectrum disorder (ASD), attention deficit hyperactivity disorder (ADHD), aphasia, sensory integration disorders, developmental coordination disorders, epilepsy, and various emotional and behavioral difficulties. Hearing and vision impairments are also frequently observed, potentially further hindering the child's ability to function within educational and social environments [2].

Regardless of gestational age at birth and the type or severity of early perinatal complications, every preterm infant requires systematic and long-term monitoring of psychomotor development. According to the standards of the Polish Society of Neonatology and the Polish Pediatric Society, the developmental follow-up process should be comprehensive. It must include not only the assessment of the child's current functional status but also the identification of risk factors that may adversely affect future development (Table 1) [2].

Table. 1. Perinatal Risk Factors for Neurodevelopmental Impairment.

• **Gestational age:** <28 weeks of gestation — *very high risk,* <32 weeks of gestation — *high risk*	
• **Birth weight:**	
	<1000 g — *very high risk*
	<1500 g — *high risk*
	Birth weight below the 3rd percentile
• **Major clinical conditions associated with increased risk:**	
	Retinopathy of prematurity requiring treatment
	Moderate to severe bronchopulmonary dysplasia
	Neonatal encephalopathy
	Intraventricular hemorrhage
	Periventricular leukomalacia
	Neonatal seizures
	Resuscitation at birth
	Term infants requiring mechanical ventilation for more than 24 hours
	Congenital anomalies of the heart and central nervous system, inborn errors of metabolism, and genetically determined syndromes
	Neonatal neuroinfections
	Infants post-neurosurgical or cardiac surgical procedures
	Hyperbilirubinemia
	Neurobehavioral abnormalities
	Abnormal results on newborn hearing screening
	Neonatal abstinence syndrome

A detailed family history is also of key importance, particularly regarding the parents' socio-economic status. The next step involves assigning the child to an appropriate observation group: ill child, healthy child, or child requiring further observation [2].

The ill child group includes patients presenting with significant central nervous system (CNS) symptoms, who should remain under continuous care of a pediatric neurology clinic. Healthy children, who do not exhibit significant risk factors, should undergo regular neurodevelopmental assessments in a pediatric clinic according to the recommendations of the American Academy of Pediatrics (AAP) — at 9, 18, 24, 30, and, if necessary, 36 months of age.

Infants requiring further observation include those with significant risk factors and/or mild neurological symptoms. In this group, the AAP recommends conducting neurodevelopmental assessments at 6–8 weeks of life, and subsequently at 4, 8, and 12 months of age. Further management should be based on whether the child's development proceeds appropriately. The recommended schedule for neurodevelopmental assessment is presented in Fig. 1 [2].

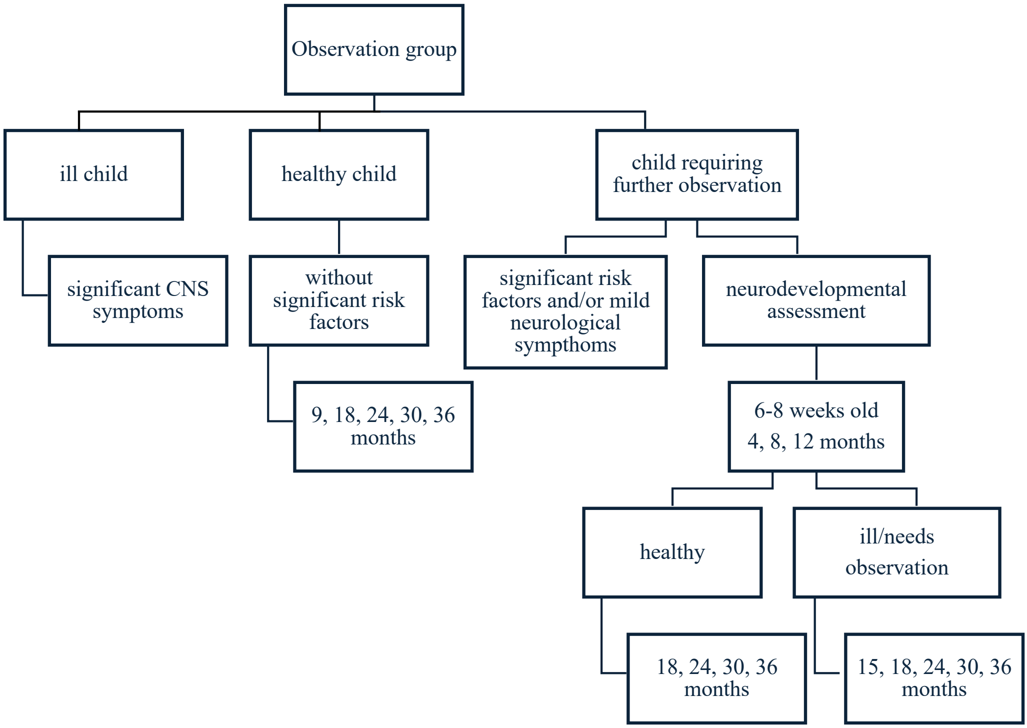

Fig. 1. Neurodevelopmental assesment scheme [2].

Psychomotor development is defined as the harmonious growth of a human being in the context of mental, intellectual, and cognitive processes integrated with motor development. Psychomotor delay is diagnosed when a child has not acquired the skills expected at a given stage of life. Brain immaturity caused by premature end of pregnancy is a common cause of psychomotor delay in preterm infants [3]. Typical psychomotor development is characterized by individual variability and variation of motor strategies. Variability refers to inter-individual differences in motor responses, while variation of motor strategies denotes a broad repertoire of movement strategies within a given child [4].

Scales used to diagnose the psychomotor development of 2-year-old preterm infants

To diagnose the functional development of at-risk children, developmental tests and scales are used to provide objective and numerical assessment in specific areas of development [5]. Developmental scales that can provide a tool for assessing 2-year-old children born prematurely are the Bayley III scale, the Denver II scale, The Peabody Developmental Motor scales-2, and the Munich Functional Developmental Diagnosis.

Bayley Scale III

The Bayley Scales of Infant and Toddler Development, Third Edition (Bayley-III), is the third iteration of a standardized tool designed to identify developmental problems in children aged 1 to 42 months. The original studies and measurement series aimed at detecting developmental delays were conducted by the American psychologist Nancy Bayley. The first and second editions of the Bayley Scales (BSID and BSID-II) provided only two broad indicators of development: the Mental Development Index, which assessed early cognitive and language development, and the Psychomotor Development Index, which assessed motor development. These general indices lacked the specificity to distinguish between delays in cognitive development, language skills, and fine or gross motor development—distinctions that are crucial for planning appropriate therapeutic interventions. Bayley-III was revised to enable separate composite scores for cognitive, motor, and language development [6, 7].

The Bayley Scales of Infant and Toddler Development, Third Edition (Bayley-III), and its predecessor, the BSID-II, are widely used in both clinical practice and research for the early assessment of psychomotor development in preterm infants [8–12]. Recent studies have demonstrated that Bayley-III scores tend to be higher than BSID-II scores at 18–24 months of age, particularly in preterm populations. Therefore, Bayley-III results should be interpreted with caution across different age groups and diagnoses, as there is a risk of underestimating developmental delays [6, 13].

The Peabody Developmental Motor scales-2 (PDMS-2)

The Peabody Developmental Motor Scales–Second Edition (PDMS-2) is a standardized assessment tool used to evaluate developmental motor functions in both full-term and preterm infants and young children. It is widely applied to assess motor skills in children from birth to 72 months of age. The primary objective of the PDMS-2 is to estimate a child's motor competence relative to age-matched peers, enabling the identification of skill deficits, monitoring of developmental progress, and use in research contexts. The PDMS-2 incorporates both qualitative and quantitative criteria in its assessment approach [14, 15].

The scale consists of six subtests: Reflex, Stationary, Locomotion, Object Manipulation, Grasping, and Visual-Motor Integration. These subtests measure interrelated motor skills that are fundamental to early motor development. All subtests contribute to the Total Motor Quotient (TMQ), which reflects overall motor proficiency. Additionally, the Gross Motor Quotient (GMQ) is calculated by combining scores from the Stationary, Locomotion, and Object Manipulation subtests, thereby indicating the level of gross motor development. The Fine Motor Quotient (FMQ), on the other hand, is derived from the Grasping and Visual-Motor Integration subtests [16].

The PDMS-2 scoring system accounts for partially completed tasks, assigning scores on a 3-point scale (0 to 2 points). This allows for the allocation of 1 point when a child demonstrates emerging abilities toward task completion, even if the skill has not yet been fully mastered. In contrast, many developmental assessments only award points for full and successful task completion using a similar 0–2 point scale [17]. The PDMS-2 has also been successfully applied in studies assessing motor development in children born preterm [18, 19].

Denver Developmental Screening Test II (Denver II)

The *Denver Developmental Screening Test II* (Denver II) is a standardized screening tool designed to identify children whose development significantly deviates from age-appropriate norms. The tool was developed by condensing elements from 12 American standardized developmental assessments. It provides a brief evaluation—typically completed within 15 to 20 minutes—indicating whether a child's development is within the expected range or potentially delayed. The Denver II assesses four developmental domains: gross motor skills, fine motor-adaptive skills, language, and personal-social functioning [20]. In recent years, the Denver II has also been utilized in the assessment of developmental progress in preterm infants [21, 22].

Munich Functional Developmental Diagnosis (MFDD)

The Munich Functional Developmental Diagnosis (MFDD) is an assessment tool based on standardized developmental charts created by Hellbrügge and Pechstein, designed to identify developmental delays in infants and young children [23]. MFDD was developed through collaboration between pediatricians and psychologists at the Munich Children's Center, who studied thousands of healthy children, as well as those presenting with developmental delays or disorders [5].

This diagnostic approach enables the assessment of developmental progress in children from birth to six years of age. Because developmental rates vary by age, three versions of the MFDD are used: for children around 1 year of age, for those aged 2 to 3 years, and for those aged 3 to 6 years.

The MFDD for 1-year-olds assesses development across eight functional domains: sitting, walking, grasping, perception, speaking, understanding speech, and social behavior. For children aged 2 to 3 years, the MFDD evaluates seven domains: gross motor skills, manual dexterity, perception, expressive language, receptive language, social development, and level of independence.

A key practical advantage of the MFDD is its ability to evaluate multiple functional domains individually, rather than providing a single global developmental score. It employs a categorical scoring system, in which the examiner determines only whether a given task is successfully completed or not. The use of standardized testing materials is essential for the accurate administration of the MFDD [24].

An important advantage of the MFDD is its applicability to children born preterm, as it incorporates corrected postnatal age when evaluating psychomotor development [25–27]. Additionally, the MFDD is widely used to assess the functional status of children with various medical conditions or developmental disabilities [28–31].

Conclusion

All preterm infants should receive systematic follow-up care from a multidisciplinary team specializing in functional development until at least 3 years of age, with particular emphasis on the first 24 months of corrected age [32]. Monitoring the psychomotor development of preterm children should combine subjective clinical assessment with the objective application of standardized developmental scales.

In interdisciplinary developmental care, quantitative results obtained from standardized tests and scales play a crucial role in both team communication and the evaluation of therapeutic outcomes. Long-term monitoring of psychomotor development is essential, particularly in late preterm infants, in whom deficits in speech and cognitive development often become apparent around the age of 2 years.

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