

NEUROPSYCHOLOGY TODAY

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Prematurely Born Children: Introduction

In the US, 8-10% of all pregnancies result in premature birth, which accounts for most cases of infant mortality and nearly half of the cases of congenital neurological disorders in the country. Males are more affected by early delivery and growth retardation, and are less likely to survive the neonatal period compared to females. In addition to male sex, the risk of premature birth is associated with lower parental education and socioeconomic status, maternal smoking, and multiples' birth. Also, mothers who previously had multiple deliveries or a preterm delivery are more likely to have a preterm baby.^{1,2,3}

Even though the advances in obstetric and neonatal care have resulted in increased rates of survival among the preterm infants, the rate of the associated health problems remains relatively high. Infants born prematurely are at a higher risk of certain medical, neurocognitive, neurobehavioral, and academic problems that may persist into adolescence and adulthood. The risk of these conditions increases with the increasing degree of prematurity, in addition to the contributing sociodemographic risk factors and neonatal complications. Early identification and treatment of such neurodevelopmental symptoms is associated with improved outcomes.^{1,2,4}

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Causes of Premature Birth

Preterm labor can occur for a variety of reasons. For instance, it may result from a spontaneous premature delivery with or without premature rupture of the membranes that support the fetus in the womb ("water breaking"), which can be caused by abnormal protein production by the womb and/or the fetus. Preterm labor has also been linked to certain maternal infections (i.e., bacterial vaginosis, trichomoniasis), shortened cervix, low progesterone levels, and possibly uterine contractions throughout pregnancy. To prevent preterm labor in high risk pregnancies, the obstetricians may recommend bed rest and medications that relax the uterus muscles. These methods, however, are not always effective.^{1,2,4}

In some cases, premature birth is a result of medical induction of labor or delivery by cesarean section. This typically occurs when pregnancy is complicated by a medical condition such as gestational hypertension or diabetes, or fetal growth restriction. Early delivery may be considered to be more safe for both the mother and the infant than continued fetal development in a compromised intrauterine environment.³



Medical and Neurological Problems Associated with Preterm Birth

Health care professionals consider labor that starts before 37 weeks of pregnancy to be preterm. In the research literature, children born prematurely are classified as late preterm (34-36 weeks' gestational age), moderately preterm (32-34 weeks), and very preterm (31 weeks or less). According to research, in addition to low birth weight, premature infants are more likely to have breathing problems and underdeveloped organs, which puts them at risk and often requires them to stay in the hospital until their condition is stable. In fact, Respiratory Distress Syndrome (RDS) is the most common medical complication of prematurity which may cause death or lead to broncho-pulmonary dysplasia (chronic lung disease).^{1,2,4,5,6}

Aside from lung disease, babies born prematurely are at a higher risk for necrotizing enterocolitis (a gastrointestinal complication), patent ductus arteriosus (a heart condition), late onset sepsis, shunt dependent hydrocephalus, pneumothorax, jaundice, as well as certain life-long health problems, including cerebral palsy, seizures, and vision and hearing disorders. Further, infants born early tend to have reduced musculature, which may contribute to delays in the motor skills acquisition. Preterm children have also been found to have diminished weight, height, and head circumference in school.^{1,5,6}

With regard to the effects of premature birth on the brain, such conditions as hypoxia, intraventricular hemorrhages,

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periventricular leucomalasia, and metabolic and nutritional insults may develop. In their turn, these complications are likely to cause cerebral abnormalities and impair normal neurochemical brain development. Moreover, long-term structural brain abnormalities can occur, as it has been found that children born prematurely are more likely to present with ventricular dilation, thinning or atrophy of the corpus colosum, reduced cerebellar volume, hippocampi, basal ganglia, and amygdala (controlling for overall brain volume), abnormal gyrification (cortical folding; see Image on p.3), delayed myelination, and white matter abnormalities.^{1,6,7}

Many of these atypical features have also been reported among adolescents born prematurely, pointing to persistent brain abnormalities associated with pre-term birth. Importantly, some of the aforementioned brain regions underlie many of the deficits found in specific cognitive functions found in children with a history of premature birth. It is not surprising, thus, that these children exhibit cognitive deficits alongside developmental delays, behavioral problems, and consequent academic underachievement.^{1,6,7}

Long-Term Neurodevelopmental and Neuropsychological Symptoms

As stated earlier, a number of studies have demonstrated that prematurely born children are at an increased risk of structural brain abnormalities, which can result in neurodevelopmental, behavioral, and cognitive deficits. The risk of health complications and developmental issues increases with earlier preterm delivery, and until recently, most researchers and health professionals believed that late preterm infants born healthy do not experience any short-term or long-term symptoms.^{1,3,6}

However, a 2002 NIH study revealed that neurodevelopmental dysfunction may occur even in healthy children born only a few weeks early. Specifically, the results of the study showed that children born only 1-4 weeks prematurely were likely to exhibit a

delay in one or two developmental milestones such as crawling, picking up small objects, and talking.³

In terms of neuropsychological functioning, it has been demonstrated that even after controlling for socioeconomic status, preterm children without major neurological or intellectual deficits score approximately 10-15 points lower on IQ tests compared to the average scores of full-term children. This difference in IQ scores, however, is accounted for by the preterm children's deficits in specific cognitive skills, rather than by global intellectual impairment. Specific functions that tend to be impaired in preterm children include attention, verbal ability, executive functioning, spatial reasoning, perceptual motor ability, and particularly, memory and processing speed. Language and reading abilities are less likely to be impaired in these children. Neuropsychological exam can determine which cognitive skills have developed well and which cognitive skills are below the age norm.^{4,7}

Further, researchers have found that cognitive deficits among the preterm toddlers and schoolchildren, in fact, stem from neuropsychological weaknesses that surface as early as infancy. For instance, infants born prematurely have weaker elemental information processing abilities (look duration, shift rate, recognition, etc.), which progress into later deficits in more complex functions and fully account for lower cognitive performance at ages 2-3 years.⁷

In other words, weaknesses in simple infant cognitive processes, which constitute the building blocks of more complex abilities, are responsible for the cognitive deficits frequently found in preterm children. Thus, early identification and treatment of neuropsychological deficits may alleviate their detrimental effects on children's cognitive development and functioning at later ages.⁷

Comprehensive neuropsychological evaluation involves a thorough assessment of the children's cognitive skills and can be utilized for children as young as 2 years of age. Neuropsychological exam is used to

objectively measure the extent of cognitive and sensory motor deficits that may later cause learning problems. It can also be useful in detailing the child's profile of strengths and weaknesses and determining the appropriate special interventions, as discussed on page 3.

Neuropsychological exam is necessary to detect the subtle developmental consequences of preterm birth, referred to as "hidden handicaps," that typically do not surface during routine visits to a pediatrician.⁴

A comprehensive neuropsychological exam involves numerous objective measures that assess the level of the child's functioning on each of the specific cognitive skills, as compared to his or her peers. The neuropsychologist diagnoses the child and offers recommendations to rehabilitate cognitive deficits, which may be used for attaining special accommodations and IEP at the school.^{4,7}

About Dr. Rimma Danov

Dr. Rimma Danov received her PhD in clinical psychology from Adelphi University in NY. She completed her internship in clinical psychology and neuropsychology at Harvard Medical School and postdoctoral fellowship in pediatric and adult neuropsychology in a private clinic affiliated with NJ Medical School and the Robert Wood Johnson Medical Center. She is an assistant clinical professor at Penn State University, Dept. of Kinesiology, and has served as an assistant clinical professor at NYU School of Medicine, Dept. of Neurology, and Adelphi University, Derner Institute. In the past, she worked as a neuropsychologist for the NJ Devils Hockey Team and was engaged as a co-investigator of TBI in boxers at the NYS Athletic Commission.

Presently, Dr. Danov maintains a full-time private neuropsychology practice where she examines neurocognitive and neurobehavioral functioning of patients 2-90 years of age with various neurological and neuropsychiatric disorders, such as MS, TBI, CVA, Parkinson's, Alzheimer's, dementia, ADHD, PDD, Autism, learning disabilities, seizures, and many others, using state-of-the-art neuropsychological techniques. Dr. Danov also conducts and publishes research in these areas. She is available for medico-legal consultations and testimony.

Family, Behavioral, and Academic Outcomes of Premature Birth

As mentioned earlier, medical issues and brain abnormalities lead to developmental delays and cognitive deficits, which, in their turn, may translate into family, behavioral, and school-related difficulties among the children born prematurely. For instance, the whole family is affected by premature birth, since the parents of preterm children tend to report more psychological distress, burden, more marital stress, and more negative effects on siblings and overall family emotional health.⁴

As for the behavioral sequelae of premature birth, it is established that pre-term children have lower adaptive functioning, more externalizing and internalizing behaviors, lower social competence, more symptoms of anxiety and depression, and higher rates of Attention Deficit/Hyperactivity Disorder (ADHD). Studies suggest that these problems may exacerbate with age.⁴

While overall intelligence appears to be preserved among some of the prematurely born children, they are likely to exhibit specific cognitive deficits which may impair their school performance. Preterm schoolchildren score lower on most academic achievement tests, including measures of math and written and oral language. The link between cognitive deficits and academic underachievement is further supported by research demonstrating that among the prematurely born schoolchildren, perceptual planning scores mediate math performance, while verbal learning and working memory scores mediate reading ability.^{4,7}

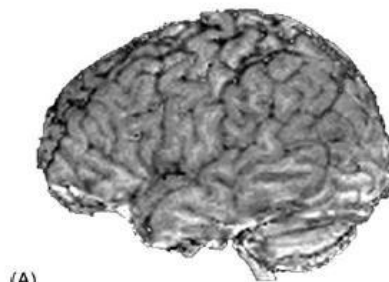
Research shows that about one-third of preterm infants with medical complications later have an Individualized Educational Plan (IEP) in school. However, even when the preterm infants are born without health complications, they are at a higher risk of school-related difficulties and behavioral problems compared to their full-term peers. For instance, these children are more likely to be diagnosed with learning disabilities, to require special services in preschool to early adolescence due to language delays, and to repeat a grade. In the light of

these findings, the researchers believe that all preterm children would benefit from early and continuous close monitoring in order to assess the risk of neurocognitive deficits and implement the appropriate interventions.^{4,7}

Interventions for Preterm Children

The treatment of cognitive and school-related problems among preterm children is based on the profile of their cognitive strengths and weaknesses, learning style, and parental reports, as assessed during the neuropsychological exam. In general, similar to other children with early neurodevelopmental issues, pre-term children with cognitive and behavioral deficits benefit from speech and occupational therapy, high degree of structure at home and school, emphasis on verbal rules and explications, assistance in developing study skills and organization strategies, repetition and mastery of materials before new content is introduced, and additional review of new materials.⁴

Also, due to executive functioning deficits, it is important to present abstract concepts in a semantically meaningful way, and help the child make inferences when learning math concepts and operations. Academic tutoring can be employed, since it provides the opportunity to pre-teach



(A)



(B)

The image above shows abnormal (increased) gyrification and the associated reduced gray matter volume in a preterm child (b) at age 8 years old vs. an 8 year-old born full-term (a). The most pronounced differences are seen in the temporal lobe, which is linked to language, learning, and memory functioning.

and re-teach various school-related skills and to assist children in developing effective organization strategies for their studies. In addition, tutors may help relieve some of the teacher and parent burden and child-parent conflict and allow parents play a more supportive role⁴ (visit www.55MyTutor.com for more information).

As for the school, instruction geared to the child's skill level is critical, in addition to such accommodations as extra time and modification of expectations and assignments, where appropriate. Overall, individualized approaches to instruction and tutorial assistance are likely to help improve the cognitive and academic outcomes associated with preterm birth.⁴

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1. Background image (pp.1,4): Jeff Johnson Biolog. & Medic. Visuals
2. Preterm baby (p.1): nursing.hmc.psu.edu
3. Gyrification (p.3). From Kesler et al. (2006). Increased temporal lobe... *Neuropsychologia* 44: 445-53.

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Each insurance carrier determines the medical necessity of every requested neuropsychological exam differently. Our billing staff determines whether the exam will be covered by the insurance before the exam begins and works very hard to obtain an authorization, if needed. If you have questions about a plan that is not listed here, contact our office to find out whether we can obtain an authorization or have recently joined that plan.

Languages

We are very much open to diverse cultures in this practice and value the quality of a bilingual neuropsychological exam performed in the patient's native language. Dr. Danov is a native Russian speaker. Her current clinical staff include native **Russian, Spanish** and **Hebrew** speakers.



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POSTAGE

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