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Perinatal and postnatal markers of cerebral palsy

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Abstract. ***Background.*** *The aim of this study is to identify adverse factors of the perinatal and postnatal periods that provoke the onset of cerebral palsy.* ***Materials and methods.*** *The experimental study used theoretical methods aimed at analysing the results of scientific research and drawing conclusions. Empirical methods included analysis, comparison, data processing, interviews, and a questionnaire for parents of children with cerebral palsy. The latter included questions that covered perinatal (information about parents, pregnancy), intrapartum (features of the course of childbirth) and postnatal (assessment of the child's general and neuromotor function) development. Indicators of the first manifestations of neurological symptoms and concomitant disorders were studied.* ***Results.*** *The results of the study materials give a clear idea that the perinatal period of development is an important stage of foetal functioning. Identification of pathological factors allows preventing negative consequences in advance. The studied children with cerebral palsy were at high risk at the stage of perinatal development. Their mothers experienced severe toxicosis/gestosis during pregnancy and were in hospital. Their health condition deteriorated due to chronic, infectious, viral diseases, and swelling of the extremities that affected the intrapartum period, including the course of labour, which often required medical or mechanical stimulation. Hypoxia, asphyxia and ischaemia were detected in newborns. They were found to be underweight, short, in need of artificial feeding, and in a prolonged painful condition. Children with cerebral palsy developed differently in the postnatal period, and most of them had delayed neuromotor development (holding the head, sitting, standing, walking) compared to normal peers. During medical examinations, the children were diagnosed with spastic diplegia, left-sided hyperkinesis, spastic tetraparesis, and spastic hemiparesis. They also had concomitant disorders, namely: speech hearing, vision disorders (strabismus), mental retardation.* ***Conclusions.*** *A comprehensive study of children with cerebral palsy in the perinatal, intrapartum and postnatal periods is extremely important. Early diagnosis will allow building the ways of perspective rehabilitation, outline the conditions of physical, emotional, cognitive and social development of a child with cerebral palsy, improve the quality of life and integration into society.*

Keywords: *children with cerebral palsy; perinatal period; intrapartum period; postnatal period; comprehensive study*

Introduction

Scientific research in the field of medicine, special education and psychology shows that the state of a child's physical [1] and neuromotor capabilities [2] significantly affects their psychophysical [3], speech [4] and intellectual [5] development, personality formation and the ability to successfully integrate into society in the future. However, according to statistics, the number of children with neuromotor disabilities is increasing every year, and this trend is particularly evident in Ukraine. One of the most difficult categories is children with cerebral palsy.

Cerebral palsy is a persistent non-progressive movement syndrome (hyperkinesis, ataxia, paresis, paralysis) provoked by damage to the central nervous system in the perinatal, intrauterine and postnatal periods [6]. The specificity of the disorders affects not only the motor functioning of the child, but also their intellectual [7, 8], mental [9] and speech development [10], and nutrition, which, according to re-

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search, is interdependent with neuromotor maturity [11]. Sometimes, it is combined with epileptic seizures, hearing and visual impairment, etc. This problem is still relevant in paediatric neurology worldwide.

Spontaneous motor activity is one of the first ways in which infants experience and interact with their environment. Disorders of these movements are the first indicator of a problem in psychophysical development [12]. Accordingly, early diagnosis (from 3 months of age [13]), while studying the structure of the brain, observing motor activity, allows identifying markers of cerebral palsy [14], determine the characteristics of mental sphere, timely implement physiotherapy [15], and develop a rehabilitation programme aimed at improving neurological status [16], motor and psycho-speech development in this group of children [17, 18].

When examining children with central palsy, a group of researchers believes it is advisable to consider the socioeconomic background of families, which affects the severity of the disease, especially in low-income settings [19].

An important step in determining the causes of cerebral palsy is to study the mother's pregnancy history. Perinatal damage to the central nervous system outlines pathological conditions that have arisen under the influence of negative factors. This subsequently affects the growth and development of the foetus [20]. It is worth noting that the perinatal period is divided into late antenatal (22–24 weeks of gestation), intrapartum — the process of childbirth and early neonatal — the first 7 days of a child's life.

Careful observation of "risk group" infants is necessary to determine neurological status and to develop a positive trajectory for their treatment and development. Early diagnosis is becoming a tool for clinical assessment in combination with history taking, assessment of motor functions, neuroimaging, and observation [21]. It is important for preventing secondary complications and improving the quality of life of the child and immediate family. In infants, symptoms of cerebral palsy occur and develop before the age of 2 years, so it is advisable to use a combination of standardised instruments together with clinical history to predict the risk of its occurrence [22].

The analysis of scientific sources allows us to clearly predict the importance of perinatal, intrauterine and postnatal (early age) study of the causes of cerebral palsy, determine research methods and identify potential dangers.

The purpose was to study the adverse factors of the perinatal and postnatal periods that provoke the onset of cerebral palsy.

Materials and methods

Design. The study examines the main pathological markers of the perinatal (intrapartum) and postnatal periods indicating cerebral palsy. In particular, the history of the mother's pregnancy, childbirth, the first manifestations of central nervous system damage, and concomitant disorders. Indicators of general and motor development of young children (from 1 to 3 years) are taken into account.

Participants. The study included 86 young children, namely of the first (16.3 %, n = 14), second (46.5 %, n = 40) and third (37.2 %, n = 32) years of life. The results of the study materials were compared with the parameters of normotypic development indicated in the Munich Functional Developmental Diagnosis [23], the Bayley Scales of Infant and Toddler Development-III [24], the Peabody Developmental Motor Scale — second edition [25, 26], and the data of early neuromotor development of the child [27, 28].

Instruments and procedure. To study the pathogenic influence on the development of a child with cerebral palsy in the perinatal (intrapartum) period, the mother's anamnestic data were collected, in particular:

— age during pregnancy;

— pregnancy: toxicosis (first trimester), gestosis (second, third trimester), chronic diseases, infectious diseases, cytomegalovirus infection, acute respiratory viral infection (ARVI), leg oedema;

— features of childbirth: early labour, dehydration, rapid labour, caesarean section, chemical stimulation, mechanical stimulation.

To study the postnatal period of children's development (1 week, 1 month, 6 months), we analysed the indicators of the first manifestations of neurological symptoms and investigated concomitant disorders (speech, hearing, vision, mental retardation).

Additional attention was paid to general physical (weight, height at birth) and neuromotor development (head holding, sitting, standing, walking). The parameters were assessed using a point system, in particular: 3 points corresponded to normotypical indicators, 2 points revealed minor deviations, 1 point characterised the need for assistance from an adult, 0 points — no necessary skills.

Results

Markers of abnormalities in the perinatal period

The study data show that most children with cerebral palsy were born to women aged 26 to 35 years (46.5 %, n = 40). According to researchers, childbirth after 30–35 years is more often accompanied by any pathology, which is quite logical [29]. A slightly smaller percentage (34.9 %, n = 30) were aged 21–25 years. And only 18.6 % of participants were under the age of 20 at the time of their children's birth (n = 16). It is worth noting that the age of the fathers of children with cerebral palsy is also predominantly in the range of 26 to 35 (44.2 %, n = 38) and 21 to 25 years (37.2 %, n = 32). Significantly lower number of men were aged 36 to 45 (15.1 %, n = 13) and over 45 years (3.5 %, n = 3) (Table 1).

All interviewed parents claimed that they had not any developmental disabilities in their lives. Also, there were no cases of children with psychophysical disorders in their families.

Table 1. Age of parents at the birth of a child with cerebral palsy

Age, years	Mother		Father	
	%	n	%	n
< 20	18.6	16	–	–
21–25	34.9	30	37.2	32
26–35	46.5	40	44.2	38
36–45	–	–	15.1	13
> 45	–	–	3.5	3

A study of maternal health during the perinatal period of child development showed that 73.3 % (n = 63) experienced severe toxicosis in the first trimester of pregnancy. In 26.7 % (n = 23), gestosis of the second and third trimesters was observed. In addition, pregnancy was accompanied by chronic diseases (10.5 %, n = 9), infectious diseases (27.9 %, n = 24), cytomegalovirus (17.4 %, n = 15), ARVI (24.4 %, n = 21), and leg oedema (19.7 %, n = 17) (Fig. 1).

Markers of abnormalities in the intrapartum period

These health problems also affected the course of labour. In particular, 48.8 % (n = 42) of women had prolonged labour, 25.6 % (n = 22) were dehydrated, 18.6 % (n = 16) had rapid labour, 30.2 % (n = 26) had a caesarean section. Stimulation of labour was used in 74.4 % (n = 64) of the participants: in 54.7 % (n = 47) — with medication and in 19.7 % (n = 17) — mechanically. In 25.6 % (n = 22) of women, there was no stimulation. According to the parents, 44.2 % (n = 38) of the newborns had hypoxia, 41.9 % (n = 36) had asphyxia, and 14 % (n = 12) had ischaemia.

At the time of birth, 48.8 % (n = 42) of babies screamed immediately, 41.9 % (n = 36) — after mechanical stimulation, and 9.3 % (n = 8) — within 5 seconds, scream was weak or resembled moans. In 18.6 % (n = 16) of cases, white asphyxia was recorded, and in 34.9 % (n = 30) — blue asphyxia. It was also noted that 72 % (n = 62) of children had a compatible Rh factor.

The newborns did not immediately take the breast and had weak sucking movements. Most of the children were artificially fed and had impaired unconditioned reflexes (sucking, snout and swallowing) responsible for the act of swallowing. A significant percentage of babies (60.5 %, n = 52) had deteriorating health conditions and were in intensive care, 39.5 % (n = 34) were discharged on time.

Markers of abnormalities in the postnatal period

The study found that there were significantly more boys (65.1 %, n = 56) with central palsy than girls (34.9 %, n = 30). Most children born with cerebral palsy (37.2 %, n = 32) weighed less than 2 kg, 30.2 % (n = 26) — less than 2.5 kg, 14 % (n = 12) — less than 3 kg, only 18.6 % (n = 16) had a normal weight of 3 to 4 kg. Height ranged from 40 to 50 cm in 62.8 % (n = 54) of babies, was less than 40 cm in 25.6 % (n = 22), more than 50 cm — in 11.6 % (n = 10).

Most parents reported that the first neurological symptoms were noticed in the first week of life in 23.3 % (n = 20) of children, in the first months of life — in 48.8 % (n = 42), and by 6 months — in 27.9 % (n = 24). After visiting medical institutions, 30.2 % (n = 26) of children were diagnosed with cerebral palsy by the age of 6 months, 25.6 % by the age of one year (n = 22), and 44.2 % by the age of 2 years (n = 38). It is worth noting that 27.9 % (n = 24) of children were suspected of having a developmental disorder by their parents, 20.9 % (n = 18) by their close environment, and 48.8 % (n = 42) by medical professionals.

During the examination, a significant percentage of children with cerebral palsy (spastic diplegia, left-sided hyperkinesis, spastic tetraparesis, spastic hemiparesis) had concomitant disorders, namely: speech (100 %, n = 86), mental retardation (71.0 %, n = 61), hearing (40.7 %, n = 35), vision (37.2 %, n = 32) (strabismus).

Children with cerebral palsy, in contrast to their peers with normal development, acquire neuromotor skills more slowly (Table 2).

At the end of the first month of life, the main indicator of a child's normal development is the ability to lift their head immediately while lying on the stomach. Only 14 % (n = 12) of babies make their first attempts to hold their heads. Most babies (30.2 %, n = 26) master this skill at 3 months, 14 % (n = 12) — at 6 months, 16.3 % (n = 14) — by 1 year, 14 % (n = 12) — by 2 years 6 months, 11.6 % (n = 10) of participants had not developed this skill at the time of the survey.

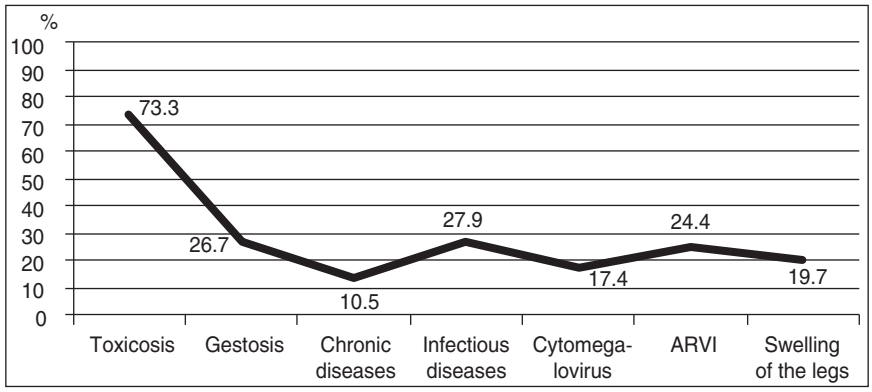

Figure 1. Maternal health during pregnancy

Table 2. Neuromotor development of a child with cerebral palsy

The first stage of neuromotor development	Children with cerebral palsy								Missing skill	Children with normotypic development			
	Age group									Age group			
	Months				Years					Months			
	1	3	6	9	1	2	3	> 3		1	6	8	11
Holding the head	14	30.2	14	–	16.3	14	–	–	11.6	+	–	–	–
Sitting	–	–	18.6	30.2	18.6	–	11.6	–	20.9	–	+	–	–
Standing	–	–	–	17.4	11.6	17.4	30.2	–	23.3	–	–	+	–
Walking	–	–	–	–	5.8	17.4	29.1	17.4	30.2	–	–	–	+

Based on normotypical development, most children make their first attempts at sitting by the 6th month of life. Only 18.6 % (n = 16) of children with cerebral palsy were close to normal. A significant percentage (30.2 %, n = 26) mastered the skill of sitting at 9 months, 18.6 % (n = 16) learned to sit by the age of 1 year, 11.6 % (n = 10) — by the age of 3 years, 20.9 % (n = 18) of participants are still unable to sit.

By the end of the eighth month, a child with normal development makes attempts to stand in one place, holding on to a stable object and even moving along it. Only 17.4 % (n = 15) of children with cerebral palsy could stand at 9 months of age. Other subjects mastered this skill later, in particular: 11.6 % (n = 10) — at 1 year, 17.4 % (n = 15) — by 2 years, 30.2 % (n = 26) — by 3 years. And many children (23.3 %, n = 20) could not stand on their own.

From the age of 11 months, babies with normal development can take their first steps by holding on to adults' hands or furniture. Children with cerebral palsy develop more slowly, namely: 5.8 % (n = 5) try to walk independently for the first time after the age of 1; 17.4 % (n = 15) — from the age of 2; 29.1 % (n = 25) — from the age of 3; 17.4 % (n = 15) — after the age of 3; 30.2 % (n = 26) do not have the ability to master this skill.

Discussion

The positions of many scientists confirm the relevance of our study. Early detection of cerebral palsy opens new psychomotor opportunities for this category of children. Considering the critical period and neuroplasticity of the brain will outline a promising trajectory for their lives [13].

In the early stages of development of children with cerebral palsy, it is important to take into account the systematic study of neuromotor capabilities and their close relationship with various aspects, namely: considering the dependence of motor maturity and food intake [11], assessing serious functional impairments affecting motor mechanisms [6], studying potential abnormalities in the structure of the brain of infants and monitoring their movements, which will allow identifying the first signs of cerebral palsy [14].

In our opinion, the diagnosis should be much more thorough than stated by the above authors. It should include the age and genetic potential of the parents, features of the perinatal, intrapartum and postnatal periods of a child's development, the first manifestations of neurological symptoms and concomitant disorders (hearing, vision, intelligence, speech, etc.).

Clinical assessment, history taking, study of motor functions, neuroimaging of children with motor disorders can provide timely detection of signs of neuromotor deficit and implementing effective physiotherapeutic, personalised intervention [6, 15], increasing the time organisation of spontaneous movements (for infants with postural asymmetry and/or tone regulation problems), improving neurological condition [16, 21], drawing up a long-term plan to stimulate psychophysical development [12].

A comprehensive study of young children with cerebral palsy is extremely important. This will help identify their individual needs, develop effective rehabilitation methods (improving motor, cognitive, and speech skills), prevent secondary complications, and improve the quality of life of the child and the immediate family [3, 4, 8, 22].

Conclusions

The analysis of the study materials suggests that perinatal and postnatal markers of cerebral palsy are of great importance in its diagnosis. In particular, the study of the perinatal period makes it possible to focus on critical stages of foetal development during the formation of organs and body systems. Identification of possible complications before birth allows specialist physicians to take into account pathological risks in time.

According to the study, children with cerebral palsy were constantly at risk during their perinatal development. Most of their mothers and fathers were middle-aged and older. A significant percentage of women were severely affected by toxicosis and gestosis of pregnancy, some of them were in hospital. Their health deteriorated due to chronic, infectious, viral and other diseases that significantly affected the intrapartum period and the course of labour, which required stimulation (medical and mechanical).

Hypoxia, asphyxia and ischaemia were detected in most newborns. Their postnatal development was characterised by certain complications: underweight, short stature, and artificial feeding. Most children with cerebral palsy had development delay of the main neuromotor components (holding the head, sitting, standing, walking).

It is worth noting that cerebral palsy is often accompanied by concomitant diseases (epilepsy, hearing, vision, speech, intellectual disabilities, etc.), and a comprehensive examination should include the participation of various specialists, such as neurologists, speech therapists, orthopaedists, paediatricians and psychologists. This will allow us to have a complete picture of the child's health status. It will also include physical therapy, speech therapy, sensory integration and social and psychological support in the rehabilitation process. The results of a comprehensive examination at this stage will help the family better understand the child's needs and adapt him or her to the educational and social environment for further psychophysical development.

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Перинатальні та постнатальні маркери дитячого церебрального паралічу

Резюме. Актуальність. Метою дослідження є виявлення несприятливих факторів перинатального та постнатального періодів, що провокують розвиток дитячого церебрального паралічу. **Матеріали та методи.** В експериментальному дослідженні використовували теоретичні методи, спрямовані на аналіз результатів наукових досліджень і формування висновків. Емпіричні методи включали аналіз, порівняння, обробку даних, опитування й анкетування батьків дітей із церебральним паралічем. Останнє включало запитання, що охоплювали перинатальний (відомості про батьків, вагітність), інтранатальний (особливості перебігу пологів) і постнатальний (оцінка загального та нейромоторного розвитку дитини) періоди. Вивчали показники перших проявів неврологічної симптоматики й супутніх розладів. **Результати.** Результати досліджень чітко вказують на те, що перинатальний період розвитку є важливим етапом функціонування плода. Виявлення патологічних факторів дозволяє завчасно запобігти негативним наслідкам. Досліджувані діти з церебральним паралічем перебували в групі високого ризику на перинатальному етапі. Їхні матері під час вагітності страждали на тяжкий токсикоз/гестоз і знаходились у стаціонарі. Стан їхнього здоров'я погіршився через хронічні, інфекційні, вірусні захворювання, набряки кінцівок, що вплинуло на інтранатальний період, зокрема перебіг пологів, які часто потребували медикаментозної або механічної стимуляції. У новонароджених виявлено гіпоксію, асфіксію та ішемію. Характерними для них були дефіцит маси тіла, низький зріст, потреба у штучному вигодовуванні, тривалий хворобливий стан. Діти з церебральним паралічем по-різному розвивалися в постнатальному періоді, у більшості з них спостерігалася затримка розвитку нейромоторних функцій (тримання голови, сидіння, стояння, ходьба) порівняно з нормотиповими однолітками. Під час медичного огляду діагностовано спастичну диплегію, лівосторонні гіперкінези, спастичний тетрапарез, спастичний геміпарез, а також супутні розлади, а саме порушення мовленнєвого слуху, зору (косоокість), розумову відсталість. **Висновки.** Комплексне обстеження дітей із церебральним паралічем у перинатальному, інтранатальному та постнатальному періодах є надзвичайно важливим. Рання діагностика дозволить побудувати шляхи перспективної реабілітації, окреслити умови фізичного, емоційного, когнітивного та соціального розвитку дитини, покращити якість життя та інтеграцію в суспільство.

Ключові слова: діти з церебральним паралічем; перинатальний період; інтранатальний період; післяпологовий період; комплексне дослідження