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PHYSICAL DEVELOPMENT OF CHILDREN WITH CEREBRAL PALSY

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SAMARKAND STATE MEDICAL UNIVERSITY

UNIVERSITY OF PADOVA

ANDIJAN MEDICAL STATE INSTITUTE

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Monograph

SAMARQAND
2024

UO'K 616.831-053.2
KBK 56.12
M 41

Z.F. Mavlyanova.
Physical development of children with cerebral palsy [Text] / Z.F. Mavlyanova., S.A. Bondarev., M.T. Butabaev.- Samarqand: Samarkand, 2024.-116 p.

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The monograph contains information on the importance of systematic clinical and neurological monitoring of patients with cerebral palsy, including, along with standardized methods of medical examination, assessment of physical development. The data presented in the monograph will make it possible to carry out timely prevention of secondary complications, as well as to give parents of a sick child recommendations for development of the child, taking into account the identified symptoms. Timely and adequate monitoring of nutritional status and physical development in children with cerebral palsy will contribute to the improvement of the child's somatic status and rehabilitation results.

The monograph is aimed at neurologists, pediatricians, rehabilitation therapists, as well as doctoral students, residents and students of medical universities.

The monograph was reviewed by the Academic Council of Samarkand State Medical University. Protocol No. 7 dated February 28, 2024

ISBN 978-9910-771-42-2

CONTENTS

LIST OF ABBREVIATIONS

LYM - absolute number of lymphocytes
AEDs - Antiepileptic Drugs
PED - Protein-energy deficiency
WHO - World Health Organization
TL - Tibia Length
DS - Diagnostic Specificity
BL - Body Length
CP - Cerebral Palsy
GT - Gastrointestinal Tract
BMI - Body Mass Index
SFF - Skin - Fat Fold
SFFaT - The skin-fat fold above the triceps
SFFuB - Skin-fat fold under the shoulder blade
ICF - International Classification of Child and Adolescent Functioning, Disability and Health
BW - Body Weight
CC - Chest Circumference
SMC - Shoulder Muscle Circumference
UAC - Upper Arm Circumference
CP - Cerebral Palsy
CFCS - Communication Function Classification System
DIS - The Drooling Impact Scale
GMFCS - Global Motor Function Classification System
GMFM-88 - Gross Motor Function Measure
MACS - Manual Ability Classification System

INTRODUCTION

Today, cerebral palsy (CP) is a serious medical and social problem that has a significant impact not only on reducing the quality of life, but also on increasing the level of disability among children. According to the World Health Organization (WHO), "... Cerebral palsy is the leading cause of childhood neurological disability in the world, its incidence in the world ranges from 2-3.6 to 8 per 1000 newborns. Recently, the number of children with cerebral palsy has increased by 14% in the world, its prevalence is 17 million". Psychomotor disorders in cerebral palsy are primarily associated with delayed growth and development, the correction of which begins late, when the child is diagnosed with serious irreversible changes.

Large-scale studies are being conducted around the world to assess physical development in cerebral palsy, for example, the overall prevalence of physical development disorders in patients with cerebral palsy has been determined by measuring height and weight, followed by assessment according to international WHO criteria using z-score indicators; anthropometry and body composition assessment have been identified as clinically useful nutritional screening methods for the detection of overweight; The anthropometric parameters of patients were compared with the normal values of healthy children, as well as with the degree of motor disorders, oral-motor dysfunction, assistance in feeding, duration of meals and daily feeding time, etc.

Many researchers agree that children with cerebral palsy are quite capable of living a life comparable to healthy people in terms of life expectancy, but about 10% of them die in early childhood [Gafurov B.G., 2018; Novak I. et al., 2014; Westbom L. et al., 2011; Brooks J. et al., 2014]. An adequate assessment of their condition consists of the results of a general clinical examination of a child with cerebral palsy and the identification of his eating habits, assessment of the development and composition of his body - anthropometry, bioimpedancemetry and osteodensitometry, as well as the study of his energy production by direct and indirect calorimetry, biochemistry of the patient's nutritional status [Novikova V.P., 2014; Gordeeva N.V. et al., 2015; Dobrynina E.A., 2018; Dzhurabekova A.T. et al., 2020].

The study of the physical development of children with cerebral palsy is a rather complex event due to the peculiarities of the pathology -

skeletal deformities, joint contractures, muscle spasms, intellectual and behavioral deviations, which makes all standard medical scales inapplicable [Deineko V.V., 2016; Madzhidova Y.N. et al., 2018; Abduvakhidova D.N. et al., 2020]. Patients with cerebral palsy undergo anthropometric measurements followed by the calculation of the body mass index (BMI), which with a margin of error assess their physical condition and energy metabolism, and the basal metabolism of such children is more reliably determined by the ratio of fat and muscle mass [Sullivan P. et al., 2015]. Oeffinger D.J. et al. (2014) proved in his study the adequacy and accuracy of bioimpedancemetry, measurement of skin folds using the Gurka method in cerebral palsy with moderate motor disorders [Oeffinger D. J., 2014].

Chapter I. Features of Physical Development of Children with Cerebral Palsy as One of the Problems of Pediatric Neurology

Worldwide, cerebral palsy (CP) is not only the most common [1,69,86] and complex disease among all neuromotor disorders in children [40,80], but also the most common cause of physical disability in childhood [81,82,83,84,88,99,106], diagnosed in one in 500 children in developed countries [13,78] and resulting in more than 1 million chronic patients aged 21 years [16,25,77].

According to many authors, the incidence of cerebral palsy varies and averages 2.0-2.5 per 1000 live births [18,71,84,96,100,109]: according to Bjorgaas H. M. et al. (2013) - 2-3 cases per 1000 children [74], according to Westbom L. the prevalence of cerebral palsy (CP) is 2.4–2.6 per 1000 children [110], according to McPhee P. G. et al. (2019) - 1.5-3.0 per 1000 live births [97], 2.0-3.5 per 1000 live births according to Herrera-Anaya E. et al. Redon E. et al. The prevalence of cerebral palsy in Mexico is reported to be between 3.0 and 4.0 per 10,000 live births, in Colombia it is 1.19 per 1000 children under 10 years of age, and 16.2% in children with an average age of 4 years [88]. And in Australia, according to the Queensland Registry, 80-120 children with cerebral palsy are born annually [92].

Katharina Delhusen Carnahan et al. (2007) cite a frequency of children with cerebral palsy in Sweden of 2.4 per 1000 children, explaining this by a thorough analysis of all children with cerebral palsy living in the region to identify and enroll them in the CPUP health and registration program. In the same study, the proportion of children with minor functional limitations (GMFCS I and MACS I) was higher than in some earlier studies, which is also explained by the widespread participation of children in the CPUP program [91].

The range of developmental levels and comorbidities in children with cerebral palsy varies, affecting the quality of life of children and their families, as well as functional outcomes [6,7,82]. The basis of the health and physical well-being of any child is generally considered to be their physical development, the disorders of which can be due to many reasons and in most cases speak of pathology or malnutrition [19,27,46]. The study of physical development, as one of the main signs of children's health, is widely used in practical pediatrics, as it non-invasively reflects the endocrine and somatic status of the child and his nutrition [5,93].

The development and nutritional status of children and adolescents with cerebral palsy has been the subject of numerous studies over the past 50 years [76,103]. In children with severe neurological disorders, both malnutrition and overeating are major health problems. This prompts studies to assess the nutritional status of this category of children, including the study of body composition parameters [104] and anthropometric indicators, especially for the diagnosis of malnutrition syndrome [69].

Non-nutritional factors influencing food intake and physical development in children with neurological diseases include cognitive impairment and long-term use of antiepileptic drugs. Children with neurological disorders often suffer from epilepsy and usually need long-term treatment with antiepileptic drugs (AEDs). Valproic acid is the most commonly prescribed antiepileptic drug in childhood, but it often leads to side effects. Among the dose-dependent side effects of valproic acid, gastrointestinal disorders such as anorexia, food withdrawal, nausea, vomiting, and dyspepsia have been described, and cases of valproate-induced gastritis have been reported. Diarrhea, weight loss, abdominal cramps, and constipation are less common. The gastrointestinal (GT) side effects described above may contribute to poor nutritional status in children with cerebral palsy [58].

The neurological disease itself can have an impact on growth. For example, in patients with unilateral spastic cerebral palsy, the growth and thickness of the skin-fat folds are normal, but there is a much smaller length and circumference of the affected side compared to the unaffected side. In addition, there is delayed skeletal maturation and reduced bone density on the affected side, and muscle atrophy independent of malnutrition interferes with growth on the affected side [21,95].

In children with cerebral palsy, in comparison with their healthy peers, a feature of physical development is a weakening of their physical health, a significant deviation in comparison with normal indicators of growth and development [11,75]. In connection with the increase in children diagnosed with cerebral palsy, the study of morphofunctional status in the process of their social adaptation and comprehensive rehabilitation is an urgent problem [13,101]. It is known that the main problem in children with cerebral palsy is musculoskeletal pathology, but many of them often have other comorbidities [4,54,67,105].

WHO recommends the use of anthropometry at different ages to assess health, nutrition and social well-being. Anthropometry is relevant throughout the life cycle, not only for individual assessments, but also for health and socio-economic conditions [12,44,108]. Anthropometry is the single most portable, universally applicable, inexpensive and non-invasive method available for assessing the proportions, sizes, and composition of the human body [30,32]. The most commonly used anthropometric parameters to assess a child's physical development are weight/height, height/age, weight/age, and mid-shoulder circumference [10,62].

The main purpose of anthropometry is to assess and monitor growth. Height and body weight are often used as markers of health and to assess nutritional status [34,42]. Additional anthropometric measurements, such as length, width, circumference, thickness of the skin and fat fold, provide more information about the child's developmental process. The growth pattern is the result of the interaction between the child's genes and the environment. This includes the socio-economic environment of the family and school, as well as the ecological environment in the district and the country [29]. Changes in one or more of these factors are reflected in the change in the growth pattern. It is difficult to assess which variables, such as genetics, growth hormones, timing of maturation, nutrition, and physical activity, influence the anthropometric development of children. All variables are important in the development of body composition changes [3,20,89].

The percentile weight-to-age ratio of children with cerebral palsy is lower than in the general population, especially in children with severe motor dysfunction [14,107]. Brooks et al. (2011) conducted 102163 weight measurements in 25,545 children with cerebral palsy from 1988 to 2002, followed by an assessment of the effect of low weight on mortality. The authors showed that the weight-to-age ratio of children with cerebral palsy varies depending on gender and GMFCS levels. Among those who had a weight below the 20th percentile and a GMFCS level I to V, comorbidities were more common. For children with GMFCS levels I and II, weighing less than the 5th percentile, the hazard factor was 2.2; At GMFCS levels III through Y, weighing below the 20th percentile, the mortality rate reached 1.5 [76]. Mortality in cerebral palsy is fifty times higher than from other causes in the pediatric population, depending on the severity and concomitant diseases, the survival rate reaches 60% [51].

A child's growth is often a reflection of his or her health and physical development, and growth abnormalities are indicative of an endocrine or nutritional imbalance in the child [9,48,73]. Children with cerebral palsy have lower weight and height than their healthy peers [57,73].

Growth charts are a standard tool for monitoring children's growth, development, and overall health. Existing charts are descriptive references rather than prescriptive standards, showing how a particular group of children has grown up, not how a particular child should grow. WHO has constructed growth charts based on selected samples of "healthy children" living in favourable conditions that can help them reach their full genetic growth potential, who are breastfed and whose mothers do not smoke. It is even more difficult to talk about growth charts for the so-called "healthy" population of children with cerebral palsy [47].

Stunting in children with cerebral palsy is often considered a "normal", incurable side effect of cerebral palsy, however, the impact of poor growth on children's health, participation, and quality of life are areas that require further study [60].

The largest study to date of the growth parameters of children and adolescents with cerebral palsy was based on retrospective data obtained from the medical records of 24,920 children and adolescents aged 2 to 20 years. 10th, 50th and 90th percentile curves have been developed for body weight, height and BMI for more than 141,900 height and weight measurements. Poor growth in children with cerebral palsy may be due to nutritional factors, physical factors, and factors related to damage to the brain itself. Nutritional factors include inadequate food intake, secondary to impaired oral motility and swallowing abilities, poor nutritional status can directly affect growth. Physical factors lead to a decrease in the mechanical load on the bones due to immobility. Studies of bone growth have shown that immobilization reduces bone formation and longitudinal bone growth and increases bone resorption, which suppresses certain growth-promoting hormones. Factors associated with damage to the brain itself can influence growth either directly (through a negative neurotrophic effect on linear growth) or indirectly (through the endocrine system). Differences in height between impaired limbs in children with hemiplegia support the hypothesis that non-nutritional factors play a significant role in reduced height in children with cerebral palsy [85].

In recent decades, there has been a growing interest in assessing body composition in children. Tracking changes in body composition during childhood requires accurate assessment of body composition in laboratory, clinical, and routine settings. Assessment methods range from simple routine and inexpensive to complex, expensive laboratory tests [38]. The human body can be divided into two chemically based components: fat and fat-free masses. Fat-free mass can be measured by many indirect methods, such as hydrodensitometry, spectrometry, and the deuterium oxide dissolution method. These measurement methods are based on two assumptions about the composition of fat and fat-free mass: 1) the composition and density of lean mass are relatively stable, with little individual variability in water, protein and mineral content; 2) the composition and density of fat mass varies from person to person. The more lean mass components can be estimated, the more accurate the fat content estimate will be [37,39]. The use of assessment methods for the adult population in children significantly overestimates the fat content of hydrodensitometry, the predicted density, the determination of total potassium in the body, the impedance prediction equations, as a rule, underestimate the body fat content of prepubertal children [56]. Systematic errors of this kind decrease with increasing age. Using an approach to constants that depend on age and sex eliminates the systematic errors of pediatric methods for assessing body composition. One of the main limitations in comparing methods for assessing body composition in children is the lack of a reference standard method [70].

The method of measuring skin folds and anthropometry involve the development of prediction models in which anthropometric measurements are related to body fat mass. The skin folding method allows you to indirectly measure the thickness of subcutaneous fat. The value of subcutaneous fat, assessed by measuring the skin fold at 12 sites, is similar to the value obtained by MRI. The thickness of the skin fold in several areas of the human body indicates the overall fat factor of the human body. In addition, it is estimated that approximately one-third of all body fat is found subcutaneously. There are significant biological variations in subcutaneous, intramuscular, intermuscular, and internal fat deposits, and lipids in the bone marrow and central nervous system should not be forgotten. This biological change in the distribution of body fat is influenced by age, gender, and the amount of fat. Measurements of skin folds are relatively simple, and their reliability and reproducibility are high when performed correctly [52].

The physical development of a child with cerebral palsy is related to health, social participation, and life expectancy. Due to differences in body composition, simple anthropometric measures used in other population groups (weight/height, BMI, shoulder circumference, single measurement of skin and fat fold - FGC) do not predict the nutritional status of children with cerebral palsy. In this regard, based on the measurement of the thickness of the QFS, equations have been developed to predict the percentage of body fat. Dimension Thickness QLS is a rapid and non-invasive method that allows you to assess the nutritional status from infancy. This parameter shows a good correlation with body fat mass, including in newborns. The reliability for LCA is 95%. The following indicators are calculated: sum of four skin folds (mm) = thickness of the FCL on the triceps + thickness of the CLF on the biceps + thickness of the CLF under the shoulder blade + thickness of the QLF above the iliac crest; centralized total cutaneous fold coefficient = ((thickness of QLF under the scapula + thickness of QLF above iliac crest) / sum of four QLFs)×100; weight/height (kg/m); BMI (weight/height^2; kg/m^2); Ponderal index (weight/height^3×10-1; kg/m^3×10-1). According to the authors, the thickness of the QLS can provide information about perinatal nutritional status and neonatal outcome. Total and subcutaneous fat mass are lower in low-gestational neonates, but there is no difference in intra-abdominal fat mass. The subcutaneous and intra-abdominal constituents of adipose tissue are under different regulatory controls during fetal life, with female infants having a higher percentage of body fat. Reduction of subcutaneous adipose tissue at birth is associated with intrauterine growth restriction. The best independent predictor of body composition in preterm and full-term infants is weight, which accounts for 84% of the change in fat mass [65].

Oral motor dysfunction and swallowing disorders, nutritional deficiencies, and poor growth are often found in children with cerebral palsy and negatively affect physical and cognitive development, as well as quality of life. Karagiozoglou-Lampoudi T. et al. (2012) assessed the nutritional status of 42 children with cerebral palsy (mean age 8±4.0 years). Using WHO growth charts, we identified risk factors for eating disorders and assessed their impact on children's growth. Children with cerebral palsy have been found to have a significant incidence of nutritional deficiencies. According to the authors, the WHO z-score provides accurate parameters for assessing nutritional deficiencies in patients with cerebral palsy. Along with anthropometry and the Nutritional Ability Assessment (PFA), the use of the International Nutritional Quality Index (DQI) will add predictive value, both in the initial height assessment and in the monitoring of patient growth [90].

Chapter II: Features of the Neurological Status and Assessment of the Physical Development of Children with Cerebral Palsy

§2.1. General characteristics of the examined children

In order to assess the physical development of children with cerebral palsy and the impact of the severity of neurological disorders on the characteristics of their physique, material was collected on the basis of the departments of pediatric neurology of Clinic No. 1 of the Samarkand State Medical Institute and the Samarkand Regional Multidisciplinary Children's Medical Center. The diagnosis of a specific form of cerebral palsy was established on the basis of the study of risk factors, medical history, clinical and neurological picture, and standardized assessment of motor functions.

The criteria for inclusion in the study were: a referral diagnosis of cerebral palsy (ICD-10 code G 80) of any clinical form; age of children from 2 years to 16 years. The study excluded children with signs of cerebral palsy, whose medical history, including details of pregnancy, childbirth, the postpartum period and the period of early development, did not find risk factors. Such children required an in-depth examination to exclude genetic diseases, congenital metabolic disorders, and congenital progressive pathologies of the central nervous system. The study also did not includechildren with a family history (cases of children born with cerebral palsy in the family, unspecified neurological diseases, unexplained deaths in childhood); Taking medications that may have altered body composition (steroids, thyroxine, antiretrovirals) cases of cerebral palsy of postnatal origin (injuries, tumors, accidents, etc.).

The clinical groups of the examined were: a research group of 214 patients diagnosed with cerebral palsy. The control group included 40 somatically healthy children observed in family polyclinics in Samarkand.

The methods and scope of the studies are shown in Table 1. Of the 254 children who took part in the dynamics of clinical observation, 214 children with cerebral palsy made up the research group, and the control group consisted of 40 practically healthy children. In the examined children with cerebral palsy, the degree of spasticity was assessed according to the modified Ashworth scale among 188 patients, in the remaining 26 cases, the children were diagnosed with atactic cerebral palsy (G 80.4).

Table 1

Scope of research conducted

INVESTIGATIONS	Number	
	Children examined	Studies conducted
Functional Characteristics of Observed Using Scales		
Clinical Observations	254	254
Gross Motor Function Measure (GMFM-88)	214	214
Global Motor Function Classification System (GMFCS)	214	214
Ashworth Scale for Grading Spasticity (modified Bohannon and Smith, 1964)	214	188
Classification of upper limb function in children with cerebral palsy aged 4 to 18 years (Manual Ability Classification System, MACS)	214	158
Anthropometry		
Growth	254	254
Mass	254	254
Body Mass Index (BMI)	254	254
Lower leg length	214	214
Determination of the thickness of the skin-fat fold above the triceps (QWST)	254	254
Determination of the thickness of the skin-fat fold under the shoulder blade (SLC)	254	254
Measurement of Upper Arm Circumference (UAC)	254	254
Calculation of Shoulder Muscle Circumference (BMP)	254	254
Chest circumference	254	254
Rorera Index	254	254
Verbek Index	254	254
Brugsch Index	254	254
Piñé Index	254	254
% Body Fat	254	254

The level of upper limb functioning according to the MACS scale was studied among 158 children with cerebral palsy aged 4 to 16 years, in the remaining 56 cases the assessment was not carried out, since the age of the children was younger than 4 years.

On the basis of an in-depth clinical and neurological examination, carried out according to a single scheme using traditional methods of examination, patients in accordance with the International Classification of Diseases of the 10th revision (ICD-10) were divided into 6 groups depending on the topographic form of cerebral palsy (Fig. 1):

Group 1 - spastic cerebral palsy, quadriplegia – G 80.0 - 20.1% (n=43)
Group 2 – spastic diplegia – G 80.1 – 18.2% (n=39)
Group 3 – infantile hemiplegia (hemiparesis) – G 80.2 – 18.7% (n=40)
Group 4 - dyskinetic cerebral palsy (athetosis, choreoathetosis) – G 80.3 – 14.5% (n=31)
Group 5 - atactic cerebral palsy (atony) – G 80.4 – 12.1% (n=26)
Group 6 - another type of cerebral palsy - G 80.8 - 16.4% (n=35).

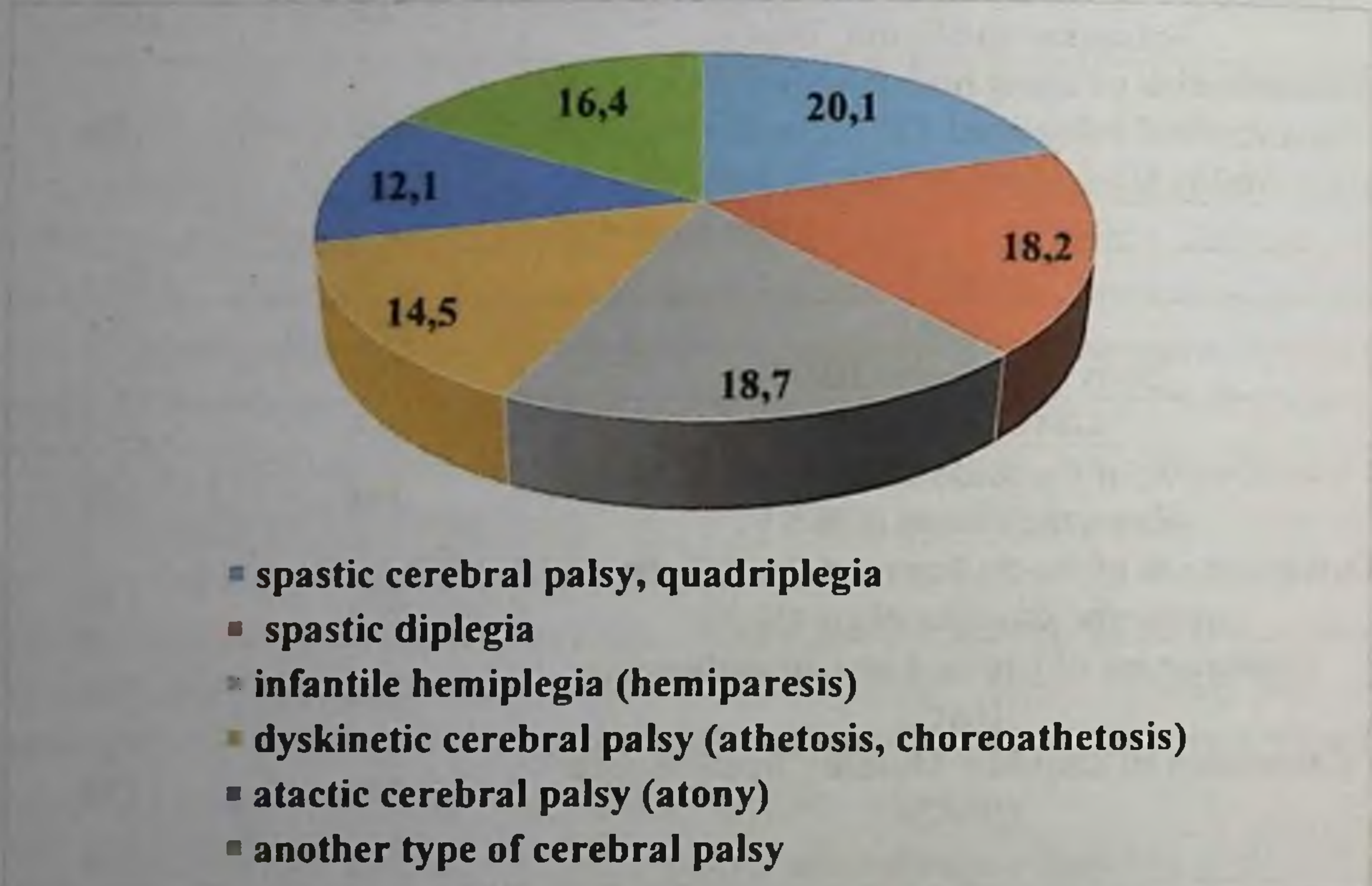


Figure 1*. Distribution of patients depending on the topographic form of cerebral palsy according to ICD-10*

The group of children with cerebral palsy was divided by age and gender. The age of the children included in the study was 2-16 years, the mean age was 6.7±0.27 years. The age gradation of children was carried out according to the recommendations of the WHO (2021) and is presented in Table 2.

Table 2

Distribution of examined children with cerebral palsy depending on the age gradation WHO (2021)

Age Periods	Number of children examined, n=214	
	Abs.	%
Early age – 1-4 years	84	39,3
Older children – 5-9 years old	78	36,4
Younger Teens - 10-14 years old	39	18,2
Older teenagers – 15-16 years old	13	6,1

The analysis of the socio-economic characteristics of families with a child with cerebral palsy included the level of income, the social status of the parents and their education, the place of residence of the parents/guardians, the assessment of housing and living conditions, the marital status of the mother, as well as the completeness of the family. Of the parents of children with cerebral palsy, 194 (49.1%) males and 201 females (50.9%) took part in the study.

Among parents, the largest share was in the age group of 30-39 years (65.3% (258 persons), followed by ≤29 years - 26.6% (105 persons), 40-49 years - 7.1% (28 persons) and over 49 years - 1.0% (4 persons) (Table 3).

Table 3

Distribution of parents of children with cerebral palsy, according to age at the time of the examination

	Father		Mother		Altogether	
Age, years	Abs.	%	Abs.	%	Abs.	%
≤ 29 years old	43	22,2	62	30,8	105	26,6
30-39 years old	128	66,0	130	64,7	258	65,3
40-49 years old	20	10,3	8	4,0	28	7,1
> 49 years old	3	1,5	1	0,5	4	1,0
Altogether	194	49,1	201	50,9	395	100

A study of the educational level of parents showed that the majority of respondents had secondary education – 90.1% (n=356), a much smaller number of parents had specialized secondary education – 7.1% (n=28) and higher education – 2.8% (n=11) (Table 4), while the majority of mothers had the status of housewives, and fathers belonged to the category of workers.

Table 4

Distribution of Parents of Examined Children with Cerebral Palsy by Level of Education

Education	Father		Mother		Total	
	Abs.	%	Abs.	%	Abs.	%
No	0	0,0	0	0,0	0	0,0
Higher	8	4,1	3	1,5	11	2,8
Overall Average	160	82,5	196	97,5	356	90,1
Specialized Secondary	26	13,4	2	1,0	28	7,1
Altogether	194	49,1	201	50,9	395	100,0

Statistical data on the etiological cause of cerebral palsy were based on the analysis of risk factors suggesting the impact of a harmful agent on the occurrence of disorders in the development of the central nervous system in the patient. The main risk factors, as noted by a number of researchers, are prematurity, encephalopathy, neonatal seizures, neonatal or postnatal stroke, multiple pregnancies, postnatal infections, and postnatal surgery [1,50,72,79]. That is why the statistical data on the etiological cause of cerebral palsy in the study were based not on the cause of the disease, but on the analysis of risk factors suggesting the effect of a harmful agent on the occurrence of disorders in the development of the central nervous system in the patient.

Table 5 presents the prognostic significance of perinatal risk factors for central nervous system damage in the formation of various forms of cerebral palsy in children.As can be seen from the presented data, prenatal, intranatal and postnatal risk factors play an important role in the development of cerebral palsy. It should be noted that there is a significant difference in the influence of a number of factors in different topographic forms of this pathology. For example, the following risk factors were the most informative for quadriplegia: prenatal factors include low birth weight (RR=0.769; $\chi 2=17.2$; $P<0.01$), gestational age less than 36 weeks (RR=0.735; $\chi 2=16.9$; $P<0.01$) and infection with TORCH infections (RR=0.689; $\chi 2=15.6$; $P<0.01$); among intrapartum patients – fetal hypoxia during labour (RR=0.542; $\chi 2=12.4$; $P<0.05$) and birth trauma (RR=0.721; $\chi 2=18.2$; $P<0.01$); the proportion of postnatal factors was distributed as follows: neonatal seizures (RR=0.786; $\chi 2=17.2$; $P<0.01$), coagulopathy (RR=0.651; $\chi 2=15.4$; $P<0.01$), mechanical ventilation after birth (RR=0.801; $\chi 2=18.8$; $P<0.01$).

In spastic diplegia, the following data were obtained: prenatal factors included fetal prematurity (RR=0.541; $\chi2=10.9$; $P<0.05$), low birth weight (RR=0.641; $\chi2=12.6$; $P<0.05$), severe maternal toxicosis (RR=0.636; $\chi2=13.4$; $P<0.01$); among intrapartum, hemorrhage in placenta previa (RR=0.842; $\chi2=18.4$; $P<0.001$) and fetal hypoxia during labour (RR=0.578; $\chi2=14.3$; $P<0.05$); postnatal factors: mechanical ventilation after birth (RR=0.584; $\chi2=15.6$; $P<0.05$). The following risk factors are informative for hemiplegia: severe toxicosis (RR=0.559; $\chi2=14.9$; $P<0.05$); prolonged difficult labour (RR=0.742; $\chi2=16.4$; $P<0.01$).

The following risk factors were informative in dyskinetic cerebral palsy: maternal hyperthyroidism (RR=0.701; $\chi2=15.4$; $P<0.01$), bleeding during pregnancy (RR=0.497; $\chi2=11.4$; $P<0.05$), severe toxicosis (RR=0.565; $\chi2=12.6$; $P<0.05$), fetoplacental insufficiency (RR=0.665; $\chi2=13.6$; $P<0.01$); among intrapartum membranes – premature rupture of membranes (RR=0.642; $\chi2=13.4$; $P<0.05$), fetal hypoxia during labour (RR=0.741; $\chi2=17.8$; $P<0.01$) and prolonged difficult labor (RR=0.632; $\chi2=16.4$; $P<0.01$). Postnatal hyperbilirubinemia (RR=0.596; $\chi2=15.7$; $P<0.05$).

Informative risk factors for atactic cerebral palsy among prenatal factors were bleeding during pregnancy (RR=0.541; $\chi2=12.2$; $P<0.05$) and severe maternal toxicosis (RR=0.578; $\chi2=13.1$; $P<0.05$); and in the postnatal period, neonatal convulsions (RR=0.741; $\chi2=17.9$; $P<0.01$).

At the birth of a child with mixed cerebral palsy, the main prenatal risk factors were severe maternal toxicosis (RR=0.821; $\chi2=19.2$; $P<0.01$), low birth weight (RR=0.751; $\chi2=18.3$; $P<0.01$) and fetal prematurity (RR=0.585; $\chi2=15.4$; $P<0.05$). Prolonged difficult labor (RR=0.491; $\chi2=14.5$; $P<0.05$) and fetal hypoxia during labour (RR=0.431; $\chi2=13.6$; $P<0.05$) formed the main structure of intranatal risk factors. Among postnatal factors, the main postnatal problem in the development of this form of cerebral palsy was neonatal seizures (RR=0.767; $\chi2=18.6$; $P<0.01$) and hyperbilirubinemia (RR=0.821; $\chi2=18.8$; $P<0.01$).

According to the distribution by sex, there was an almost 2-fold predominance of boys (62.6%) over girls (37.4%), their ratio was 1.7:1; This coincides with the literature data, according to which the incidence among boys is 62.9%. This pattern is explained by the greater vulnerability of the premature male infant to white matter damage and intraventricular hemorrhage, as well as the neuroprotective effect of the female sex hormone estrogen. There are also statistics indicating the highest incidence of cerebral palsy among young children (2-4 years) – 60% of cases, which, according to the authors, is a consequence of the loss of follow-up care for children (88%) and increased mortality with increasing age. In the study, cerebral palsy was diagnosed more often among young (39.3%) and older children (36.4%), making up an average of 75.7% in children under the age of 9.

When studying the perinatal anamnesis, it can be concluded that, regardless of the form of cerebral palsy, prenatal, intranatal and postnatal risk factors have a large share in the development of this pathology. Often, several factors were identified, which resulted in the development of intrauterine hypoxia in the fetus. At the birth of a child with any of the observed topographic forms of cerebral palsy, mothers had prolonged difficult labor, and the child was born with birth trauma. Among postnatal risk factors, neonatal seizures and hyperbilirubinemia exacerbated neonatal severity. These factors are quite manageable and should be taken into account, first of all, as the main parameters in the protection of the health of women of reproductive age, as well as in the prevention of toxic hyperbilirubinemia. And improving the pregravid state of women's health, planning pregnancy, reducing the impact of adverse ante- and intranatal factors is the main direction in the prevention of cerebral palsy.

Table 5

Perinatal risk factors in the formation of various forms of cerebral palsy

Factor of risk	Spastic cerebral palsy, quadriplegia, G 80.0 (n=43)		Spastic diplegia, G 80.1 (n=39)		Childhood hemiplegia (hemiparesis), G 80.2 (n=40)		Dyskinetic cerebral palsy, G 80.3 (n=31)		Atactic cerebral palsy, G 80.4 (n=26)		Another type of cerebral palsy G 80.8 (n=35)	
Prenatal factors (intrauterine)												
	n	%	n	%	n	%	n	%	n	%	n	%
Fetal prematurity (gestational age less than 36 weeks)	15	34,9	23	58,9	8	20,0	6	19,4	3	11,5	12	34,3
Low birth weight (less than 2500 g)	18	41,9	22	56,4	10	25,0	6	19,4	3	11,5	15	42,9
Epilepsy in mother	0	0,0	2	5,1	2	5,0	0	0,0	0	0,0	1	2,9
Hyperthyroidism in mother	5	11,6	4	10,3	1	2,5	8	25,8	0	0	3	8,6
Infection with TORCH infections	10	23,3	4	10,3	3	7,5	6	19,4	2	7,7	2	5,7
Bleeding during pregnancy (usually in the third trimester)	4	9,3	10	25,6	7	17,5	10	32,3	8	30,8	2	5,7
Severe toxicosis	6	13,9	29	74,4	27	67,5	25	80,6	9	34,6	20	57,1
Taking medications during pregnancy	1	2,3	2	5,1	0	0,0	0	0,0	0	0,0	0	0,0
Fetoplacental insufficiency	9	20,9	5	12,8	0	0,0	7	22,6	2	7,7	5	14,3
Intrapartum factors (during childbirth)												
Prolonged difficult labor	8	18,6	5	12,8	16	40,0	12	38,7	3	11,5	11	31,4
Premature rupture of membranes	7	16,3	8	20,5	4	10,0	9	29,0	2	7,7	2	5,7
Incorrect insertion of the fetal head	0	0	2	5,1	0	0	3	9,7	1	3,8	0	0,0
Bleeding with placenta previa	0	0	11	28,2	2	5,0	2	6,5	1	3,8	2	5,7
Fetal hypoxia during labor	27	62,8	13	33,3	8	20,0	16	51,6	3	11,5	10	28,6
Birth injury	30	69,8	6	15,4	4	10,0	5	16,1	3	11,5	7	20,0
Postnatal factors (in the first two years of life)												
Neonatal seizures	30	69,8	2	5,1	0	0,0	0	0,0	7	26,9	12	34,3%
Performing mechanical ventilation after birth	11	25,6	4	10,3	0	0,0	0	0,0	0	0,0	4	11,4
Neonatal hyperbilirubinemia	8	18,6	2	5,1	0	0,0	21	67,7	0	0,0	9	25,7
Coagulopathies	19	44,2	0	0,0	0	0,0	0	0,0	0	0,0	7	20,0

§2.2. Methods for assessing the neurological status and physical development of children with cerebral palsy

All patients with cerebral palsy underwent comprehensive clinical and neurological monitoring, including clinical observation during hospitalization with an assessment of the impact of the neurological status of the patient with cerebral palsy on the severity of changes in physical development. Since the degree of severity of motor disorders was primarily taken into account in the observation process, the neurological status was studied in the scope of a rational examination plan for each patient according to the traditional scheme.

To quantify the motor activity of a child with cerebral palsy, a number of scales were used to assess motor activity. Since it is important to have certain measurable goals when assessing a patient's condition, and it is easier to track the dynamics of their development when assessing skills, the scales of functional assessment of the condition of patients with cerebral palsy used by us are the most accurate indicator of the severity of neurological disorders [64].

Functional Examination Methods

International Classification of Functioning, Disability and Health, Children and Youth Version (ICF-CY)

In order to systematize and dynamically monitor the results of the rehabilitation measures of the studied patients with cerebral palsy, the ICF was used, consisting of 25 categories (Annex 1), divided into sections - "Functioning" and "Contextual factors". The "Functioning" section includes "bodily functions", "body structure", "activity and participation", while the "Contextual Factors" section includes "environmental factors" and "personality factors".

The component of each section is subdivided into domains containing different categories, which makes it possible to describe and measure the degree of impairment in children, taking into account a unified individual profile of the child's functioning, including personal and environmental factors [33,68].

Scale of Quantitative Assessment of General Motor Function (Gross Motor Function Measure, GMFM-88)

GMFM-88 is essentially a standardized observation tool that allows you to objectively measure changes in major motor functions in patients with cerebral palsy over time. The scale consists of 88 actions of varying difficulty, grouped into five categories of major motor function according to the initial position for performing tasks: lying down and turning over (position A, 17 acts); sitting position (position B, 20 acts); crawling and kneeling (position C, 14 acts); standing position (position D, 13 acts); walking, running and jumping (position E, 24 acts).

The assessment of the child's performance of the act was carried out without taking into account how well it was performed. Each score of the studied positions had a special description, and the calculation of points for each act was based on a four-point scale from 0 points to 3 points. The appropriate number of points was marked with "V", if the position was not checked (NT) - the number in the right column was circled.If it was not possible to make a decision on the assignment of a point, the lower of two possible points was chosen. The descriptor evaluation for each action is described in detail in Annex 2.

At the end of the test, the marked points were summed up and divided by a certain denominator specified for each item and multiplied by 100%: the sum of position A was divided by 51, the sum of position B was divided by 60; the sum of position C – by 42; the amount of position D – by 39; the sum of position E is 72. For example, the calculation of the target area of Parameter A "Lying Position and Turning Over" was carried out as follows:

$$\frac{\text{the sum of position A»}}{51} = \times\ 100 = \% \frac{}{51}.$$

The result was evaluated as a percentage. The calculation of the total score coefficient was carried out according to the formula:

$$Total\ Points = \frac{\%A+\%B+\%C+\%D+\%E}{Total\ number\ of\ parametres\ \{equal\ to\ 5\ \}}$$

Classification System for Major Motor Functions
(Global Motor Function Classification System, GMFCS)

Established in 2007 GMFCS includes the age group of children and adolescents from 2 to 18 years old and is based on the concept of the WHO International Classification of Functioning, Disability and Health, which is undoubtedly important, since personal factors (energy and personal preferences of the patient) and environmental factors (distance from school, public places) certainly affect the assessment of motor functions in children with cerebral palsy.

It should be noted that the level of motor skills in GMFCS in a child with cerebral palsy does not change and remains the same from the age of two throughout life, but with age, the patient experiences the dynamics of motor development within the same level. In this regard, we did not use this scale to assess the dynamics of motor development, and the degree of impairment of the patient's motor functions according to the GMFCS scale was necessarily taken into account when formulating the diagnosis of cerebral palsy.

With this in mind, the current daily activity of the child in large motor functions was classified into 5 levels, without taking into account the quality of movements and the prognosis of their improvement. In Annex 3 There are separate descriptions for each level in four age groups: 2-4 years, 4-6 years, 6-12 years, and 12-18 years.

Modified Ashworth Scale
(Ashworth Scale for Grading Spasticity, modified Bohannon and Smith, 1964)

The most common method of diagnosing and assessing spasticity today is this scale, which is a generally accepted method in world practice for determining the degree of increase in muscle tone. In the process of measuring on a six-point scale (0, 1, 1+, 2, 3, 4 points), the resistance to rapid passive stretching of the tested muscle was evaluated: a slight increase in muscle tone, in the form of initial tension with rapid subsequent relief, corresponds to 1; an increase in muscle tone, in the form of its tension up to half the volume of passive movements – 1+; a moderate increase in muscle tone without difficulty in passive movements – 2; a significant increase in muscle tone and difficulty in passive movements movements – 3; the presence of flexion or extensor

Classification of upper limb functioning in children with cerebral palsy (Manual Ability Classification System, MACS)

The MACS scale allows you to quantify the level of hand functionality of children with cerebral palsy 4-18 years old. As a classifier of their functionality, it has 5 levels, each of which describes and evaluates the patient's daily actions with both hands at home and outside the home (Annex 5).

Communication Function Classification System (CFCS)

Used to assess the degree of perception of verbal and non-verbal communication with other people, it has 5 levels of communication impairment with an indication of the most acceptable method of communication (speech, sounds, eye movements, facial expressions, gesture system, etc.):

CFCS I – the patient communicates effectively with both family members and strangers;

CFCS II – the patient exchanges information efficiently but slowly, both with family members and with strangers;

CFCS III – involves the effective exchange of information only with family members;

CFCS IY – the child is periodically effective in exchanging information and only with family members;

CFCS Y – exchange of information with both family members and strangers is not possible (Annex 6).

Methods for Assessing Physical Development and Body Composition

For a comprehensive study of the morphological features of children, a set of anthropometric methods and techniques was used, consisting of the determination of the main (body weight, body length) and additional (shoulder circumference, chest circumference, thickness of skin and fat folds, length of the leg) anthropometric indicators, which are an objective quantitative method for assessing the nutrition of children. Anthropometric studies were carried out using a unified method using anthropometric instruments (height gauge, medical scales, steel centimeter tape with a millimeter scale, caliper) [22,23,41,43].

For patients with cerebral palsy, Brooks diagrams have been developed, presented in Annex 7, taking into account the correction for the disease and retardation in physical development, the patient's gender, the level of motor activity according to the GMFCS system and the type of nutrition - through the mouth (per os), through a nasogastric tube or gastrostomy ("tube fed"). But since the sample of children with severe and moderate forms of cerebral palsy severity, used to calculate specific growth and body weight curves, is heterogeneous, and there may be many children with varying degrees of malnutrition, there is a high risk that the malnutrition diagnosed during the study will be normalized in children with cerebral palsy.

In this regard, to assess the physical development and adaptive capabilities of the children's body, graphs and curves developed as a result of multicenter studies based on the guidelines recommended by the WHO were used [49].

BMI was calculated according to a generally accepted formula:

$$BMI = \frac{weight\ (kg)}{length\ (m2)}$$

and assessed using percentile tables [49] (WHO, 2006; ASPEN 2008). The WHO tables are BMI parameters for children of the same age and sex in the form of graphs with boundaries of 3, 10, 25, 50, 75, 90 and 97 percentile intervals, and the mean values are located between the 25th and 75th percentiles.

The graphs have 5 curves: "median – 0, curves -2 and +2 standard deviations (SD), BMI between -2CO and -3CO, between +2CO and +3CO – low and high values on the verge of wasting and obesity, and results below -3CO and above +3CO – abnormal results" [49].

If it was not possible to verticalize the patient due to the state of health (pronounced spasticity, contractures of the knee and ankle joints, spinal deformities such as scoliosis, kyphosis, gross motor deficit, etc.), the estimated body length was determined using segmental measurement of the length of the tibia.

The length of the tibia was measured lying down with a flexible steel measuring tape along the medial surface of the tibia from the medial malleolus to the contact of the tibia and femur. In children with hemiparetic cerebral palsy, the measurement was carried out on the healthy contralateral side. The results were compared with percentile tables for tibia length obtained by University of Virginia researchers for girls and boys with cerebral palsy aged 2-18 years with GMFCS III-Y motor levels (Annex 8). The feasibility of using equations for predicting linear height by segmental lengths for children with moderate to severe cerebral palsy rather than the standard height measurement has been confirmed by a number of studies [93,98].

For children aged 2-12 years, the Stevenson (1995) equation was used to calculate the estimated height from the length of the tibia (Table 6):

height (cm) = (3.26×DD) + 30.8, where TL is the length of the tibia, cm.

In children over 12 years of age, the Gauld et al., 2004 equation was used to predict growth by segmental tibia length [4,61,84].

Table 6

Equations for estimating height from segmental tibia length in children and adolescents (Gauld et al., 2004)

Segmental Measure	Equation (cm)
Boys	
Tibia length (TL), cm	length (sm) =(2,423× TL) + (1,327×A) +21,818
Girls	
Tibia length (TL), cm	length (sm) =(2,473× TL) + (1,187×A) +21,151

Note: A – age, TL – tibia length, cm

Along with the classical methods of assessing the nutritional status and physical development, additional anthropometric methods for diagnosing the nutritional status were used, such as measuring the circumference of the upper arm, the thickness of the QLS and the circumference of the shoulder muscles. The masses of the shoulder muscles and FAs are significantly correlated with the total protein and fat stores [87].

A steel flexible measuring tape was used to measure the circumference of the upper arm. The midpoint of the distance from the acromial process of the scapula to the ulnar process of each arm, i.e. in the triceps area perpendicular to the length of the humerus, was determined and marked. After that, the shoulder was tightly wrapped with a measuring tape without compression of soft tissues, the circumference of the shoulder was measured along the midpoint three times with an accuracy of 1 mm. In children diagnosed with cerebral palsy, children's hemiplegia G80.2, the indicators obtained by measuring the upper limb of the healthy side were taken as a basis.

Since the UAC indicator, along with muscle mass, implies the thickness of bones, neurovascular bundle and fat mass, this parameter is not significant in isolation and affects the interpretation of the results obtained during measurement. In this regard, we calculated such a parameter as shoulder muscle circumference (BMP) - the main indicator of muscle mass and somatic protein pool:

WMD (cm) = UAC (cm) – 0.314×SFFT (mm) [63].

An important, non-invasive, and accurate anthropometric parameter for assessing regional and total fat content is the thickness of the skin-fat fold (SCL), which, according to ESGHAN (European Society of Gastroenterology, Hepatology and Nutrition), should become a routine component of assessing the nutritional status of children with cerebral palsy.

Plyometry of TCJS was carried out with an electronic caliper according to the Durnin-Womersly method in two standard places: "at the level of the middle third of the upper arm above the triceps and at the level of the lower angle of the scapula" [60]. The thickness of the SChT (skin-fat fold above the triceps) was measured 1 cm above the midpoint of the distance from the acromial process of the scapula and ulnar process, pulling the skin with the PFA perpendicular to the thumb and index finger, the measurement was carried out 1 cm distal to the fingers in the middle of the base and apex of the formed fold. During the measurement, the skin and fat fold was not released. After 2-3 seconds, the thickness of the crease was measured. In children with topographic cerebral palsy G80.2, the measurement was carried out on the healthy side.

The SFFuSB (skin fat fold under the shoulder blade) was measured 2 cm below the angle of the scapula, assuming that the skin fold is parallel to the line between the cervical vertebrae and the flanks. The pressure of the caliper legs on the fold was no more than 10 g per 1 mm^2 of the skin surface, the area of the skin captured by the fingers was at least 2-4 cm^2. Measurements were taken three times on both sides on dry and clean skin at intervals of 1 minute, so that the results differ by no more than 1.0 mm, after which the average value of the indicator is determined, integrating with the state of the body's fat depot. The results were compared with centile tables depending on age and sex. The norm of SFF was considered to be the range of 25-75 percentiles, below 25 percentiles – malnutrition [52,53,98]. Figure 2 shows the methodology for measuring SFFaT and SFFuSB.

a **b**

Figure 2. *Method of measuring the thickness of the skin-fat fold above the triceps (a) and under the shoulder blade (b)*

In accordance with Recommendation 5b of the ESPGHAN consensus document, the effectiveness of nutritional support is monitored based on the dynamics of body weight and fat mass, and the assessment of body composition in children with cerebral palsy is necessary for a clinically adequate assessment of the patient's nutritional status and optimization of nutritional recommendations.

In order to assess body composition, the percentage (%) of body fat was calculated using equations developed separately for boys and girls, Slaughter et al. (1988), %:

Boys = $1.21 \times (SFFaT + SFFuSB) - 0.008\ (SFFaT + SFFuSB)^2 - 1.7$;

Girls = $1.33 \times (SFFaT + SFFuSB) - 0.013\ (SFFaT + SFFuSB)^2 - 2.5$.

For the purpose of in-depth assessment of the physical development of children, the method of indices was used, which are ratios of individual anthropometric features expressed in mathematical formulas. We used a combination of mass-height (BMI or Quetelet index, Rohrer index) and chest-height (Pinier index, Verveck index, Brugsch index) indices [24].

The Rohrer Mass-Growth Index (INr) interpreted by N.A. Belyakova and A.N. Maslov [17], which makes it possible to increase the accuracy of the assessment of children's physical development, was calculated using the formula:

INr (kg/m^3) = W/H^3, where W is body weight (kg) and H is body height (m).

The obtained values of INr were interpreted as follows: 10.7-13.7 kg/m^3 – harmonious, average or normal physical development of children; <10.7 kg/m^3 – low physical development; > 13.7 kg/m^3 – excessive or high physical development. IN does not depend on the sex, age and height of children and can be widely used in screening and preventive examinations of children.

To assess the body type of children, the Piñé index was calculated, which is the difference between body length (BL, cm) and body weight (BW, kg), and expiratory chest circumference (CC, cm) [17]:

I (ed.) = BL – (BW + CC).

With the values of the Piñé index less than 10 units, they spoke of a strong physique and a high level of physical development; 10-20 units – physique and physical development above average; 21-25 units – medium and normal; 26-35 units – weak and below average; 36 units and more - very weak physique and low level of physical development.

To calculate the proportionality between height and chest circumference, the Brugsch index was calculated using the formula [17]:

I = CC × 100/BL, where CC is the chest circumference (cm); BL – body length (cm).

The obtained values of the Brugsch index were expressed in %. Its normal values were 64-60% in children aged 2-3 years; children under 7 years of age – 63-52%; over 7 years old – 55-50%. A decrease in the indicator below the standard values indicated narrow-chestedness, while an increase indicated wide-chestedness of the examined children.

To determine the constitutional body type, the Verweck index was calculated: I (unit) = BL/(2BW+OGK), where BL is body length (cm); BW – body weight (kg); CC – chest circumference (cm).

Next, the interpretation of the data obtained and the distribution of children by body type depending on the data obtained were carried out:

mesomorphic type (middle variant) – harmonious development – 0.85-1.25 units;

brachymorphic type (broad body and short limbs with a predominance of transverse over longitudinal dimensions) – moderate stunting or moderate brachymorphia – 0.75-0.85 units, pronounced brachymorphia or pronounced stunting – below 0.75 units;

Dolichomorphic type (narrow body and long limbs with a predominance of longitudinal dimensions over transverse ones) – from pronounced dolichomorphy, tall stature (>1.35 units) to moderate dolichomorphy, predominance of height in length (1.25-1.35 units).

§2.3. Statistical processing of research results

Statistical processing of the results of this study was carried out by the methods of variational statistics using Microsoft Office Excel-2019 programs with the determination of the mean value and arithmetic mean error by the method of moments (M±m), standard deviation (SD) of quantitative features with the correct distribution and median (Me) of quantitative traits in case of incorrect distribution. Qualitative indicators were processed by methods of nonparametric statistics, the relationship of features was determined using Pearson's $\chi 2$ criterion and Spearman's r criterion.With the correct distribution, the Student's criteria for the significance of the differences (t) and the degree of confidence (P) were used to determine the statistical significance of the measurements obtained, the differences were accepted as significant at the 95% confidence interval (P□□□□□□□

Chapter III. Clinical and neurological characteristics of children with cerebral palsy depending on the form of the disease

§3.1. Assessment of motor activity according to the Gross Motor Function Measure scale. GMFM-88 in children with cerebral palsy

Taking into account that this scale provides for the performance of all 88 acts by five-year-old children without motor impairment, children with cerebral palsy were divided into two groups during the study: 2-5 years old (n=84) and 5-16 years old (n=130). When analyzing the assessment of motor activity according to the GMFM-88 scale, we found that the highest degree of performance of motor acts provided for by the GMFM-88 scale is observed in children with atactic cerebral palsy – 68.8±3.8% (67.4±3.2% and 70.2±4.5% in the group of children aged 2-5 years and 5-16 years, respectively). Whereas the most A low level of motor skills performance was observed in quadriplegia, amounting to 35.3±3.6% in the group of children aged 2-5 years and 34.9±3.2% in children aged 5-16 years, the average for the group was 35.3±3.4%, which was significant (P<0.01) (Table 7).

Children aged 2-5 years in 100% of cases performed positions A (lying position and turning over) and B (sitting position), while position C (crawling and kneeling position) was not performed by 13 children out of 84 examined, which was 15.5% (Fig. 3). In most cases, the C position was not fulfilled by children with quardiplegia (9 out of 23 children), which is 39.1%, as well as 4 children with G 80.8 – 26.7%. At the age of 5-16 years, in 100% of cases, positions A and B were performed. Position C in this age group was not performed by 4 children with G 80.0 - 20% of 20 children aged 5-16 years, in other forms this position was performed by all children. Position D (standing) was not performed by 32 children aged 2-5 years (38.1%), including 19 children with G 80.0 out of 23 examined and 12 children with G 80.8 out of 15 examined (82.6% and 80.0%, respectively).

Table 7

Average values of the GMFM-88 scale depending on the form of cerebral palsy

Form	Age,old	Position					Total score
		A:	B:	C:	D:	E:	
G 80.0 (n=43)	2-5 лет, (n=23)	70,1±4,1	40,1±4,9	28,5±5,1	3,9±1,9		35,6±3,6
	5-16 лет, (n=20)	74,5±3,8	51,1±4,7	35,2±4,6	12,3±4,4	1,7±1,2	34,9±3,2
G 80.1 (n=39)	2-5 лет, (n=12)	89,2±1,2*	65,4±2,9*	49,4±4,9*	38,7±4,4*		60,7±2,9*
	5-16 лет, (n=27)	89,5±1,2*	78,9±2,7*	54,1±2,3*,^	50,5±2,3*	47,6±3,2*	64,2±2,0*
G 80.2 (n=40)	2-5 лет, (n=9)	74,3±1,6*,^	80,4±1,9*,^	60,3±1,6*,^	52,1±1,9*,^		66,8±1,1*,^
	5-16 лет, (n=31)	78,6±0,9*, ^	86,3±0,9*,^	66,3±1,2*,^	58,6±1,4*,^	56,6±1,4*,^	69,3±0,9*,^
G 80.3 (n=31)	2-5 лет, (n=11)	60,4±5,3*, ^	40,9±6,1, ^	33,8±5,2*,^	28,2±4,1*,^		39,6±4,7^
	5-16 лет, (n=20)	76,9±2,9*,^	62,4±5,1*,^	63,5±4,7*,^	47,6±5,1*	35,3±6,9*,^	54,5±4,7*,^
G 80.4 (n=26)	2-5 лет, (n=14)	88,9±1,1*	75,0±3,6*,^	61,1±3,5*,^	44,5±5,7*,^		67,4±3,2*,^
	5-16 лет, (n=12)	91,0±1,3*	86,5±3,9*,^	69,4±2,9*,^	54,1±7,3*,^	49,9±7,4*	70,2±4,5*,^
G 80.8 (n=35)	2-5 лет, (n=15)	72,4±3,3^	52,3±6,9*,^	39,4±7,0*,	9,1±5,5*,^		43,3±5,1*
	5-16 лет, (n=20)	80,3±1,5*,^	80,7±3,0*	60,2±2,7*,^	37,7±5,6*	26,0±5,4*,^	56,9±3,2*

***Note:** A - lying position and turning over; B - sitting position; C - crawling and kneeling position; D - standing position; E - walking, running and jumping; * - reliability of data G 80.0 to indicators G 80.1, G 80.2, G 80.3, G 80.4, G 80.8 (P<0.05-0.01); ^ - reliability of G 80.1 data to G 80.2, G 80.3, G 80.4, G 80.8 (P<0.05-0.01)*

Out of 130 children aged 5-16 years, 18 children with cerebral palsy, which was 13.8%, of which 12 children with G 80.0 (60% of 20 children examined), 1 child with G 80.3 (5% of 20 examined children), 1 patient with G 80.4 (8.3% of 12 examined children) and 4 children with G 80.8 (20% of 20 examined children) did not fully perform position D.

Skills in position E (walking, running, and jumping) were absent in 32 patients aged 5-16 years, which accounted for 24.6% of the 130 children examined. It should be noted that 90% of children in G 80.0 were not able to perform E skills, and the rest of the cases were in G 80.8 and G80.3 (40% and 25%, respectively, of the total number of children with this form).

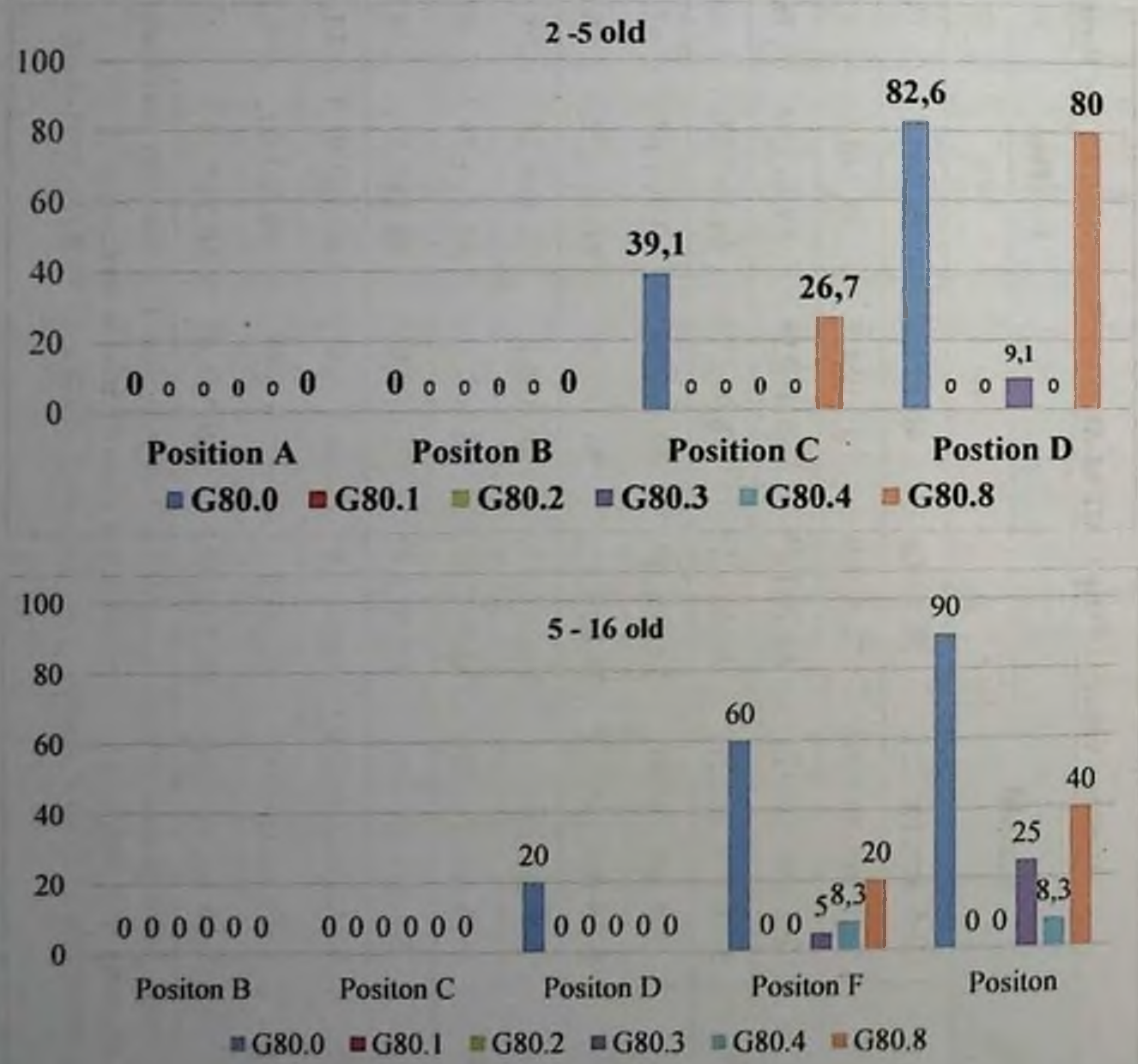


Figure 3. *Percentage of children with cerebral palsy who do not perform tasks on the GMFM-88 scale, depending on the form of the disease*

Thus, it was found that a comprehensive approach to the quantitative assessment of the current state of the child using he GMFM-88 scale depending on the topographic distribution of cerebral palsy allows for a more accurate identification of problems at the moment, as well as to determine the immediate areas of development and, consequently, goals and objectives for the rehabilitation period, which is also confirmed by the research of other authors [94].

§3.2. Spasticity score according to the modified Ashworth scale

The strength of muscle resistance to passive movement in the joint was assessed using the Ashworth scale. As a result of the analysis, the dependence of the level of spasticity on the form of cerebral palsy was established (Table 8).

Table 8

The level of spasticity according to the modified Ashworth scale depending on the form of cerebral palsy in children

Degree	Form of cerebral palsy									
	G 80.0 (n=43)		G 80.1 (n=39)		G 80.2 (n=40)		G 80.3 (n=31)		G 80.8 (n=35)	
	n	%	n	%	n	%	n	%	n	%
	Upper extremity									
0	0	0,0	6	15,4	0	0,0	0	0,0	1	2,9^
1	1	2,3	12	30,8**	2	5,0	4	12,9**^	2	5,7*^^
1+	0	0,0	20	51,3	2	5,0	7	22,6^	2	5,7^^
2	4	9,3	1	2,5*	7	17,5	14	45,2**^^	9	25,7*^^
3	34	79,1	0	0,0	24	60	6	19,3**^^	20	57,1
4	4	9,3	0	0,0	5	12,5	0	0,0	1	2,9*
	Lower extremity									
0	0	0,0	0	0,0	0	0,0	0	0,0	1	2,9
1	0	0,0	0	0,0	1	2,5	4	12,9	0	0,0
1+	0	0,0	0	0,0	0	0,0	7	22,6	2	5,7
2	0	0,0	12	30,8	18	45	13	41,9	4	11,4^
3	30	69,8	27	69,2	19	47,5	7	22,6*^	24	68,6
4	13	30,2	0	0,0	2	5,0**	0	0,0	4	11,4*

*Note: * - reliability of G80.0 data to indicators G80.1, G80.2, G80.3, G80.4, G80.8 (P<0.05-0.01); ^ - reliability of G80.1 data to indicators G80.2, G80.3, G80.4, G80.8 (P<0.05-0.01)*

Normal muscle tone of the upper extremities was significantly more often recorded at G 80.1 (15.4%), 5.3 times less often at G 80.8 (2.9%; P<0.001). In other forms of cerebral palsy, normal muscle tone was not detected. A slight increase in skeletal muscle tone of the arms (1 or 1+ points) is often diagnosed in patients with G 80.1 – 82.1%. The minimum number of children with a score of 1 point was found at G 80.0 – 2.3%.

A significant increase in skeletal muscle tone of the arms (3 points) and rigid PEDt or unPEDt arms (contracture) (4 points) were found in 79.1% of children with G 80.0, while in other forms – in 9.3%. At G 80.1, a significant increase in skeletal muscle tone (3 points) and rigid PEDt or unPEDt arms (contracture) (4 points) were not recorded, at G 80.2 they were 60% and 12.5%, respectively and at G 80.8 – 57.1% and 2.9% (Fig. 4).

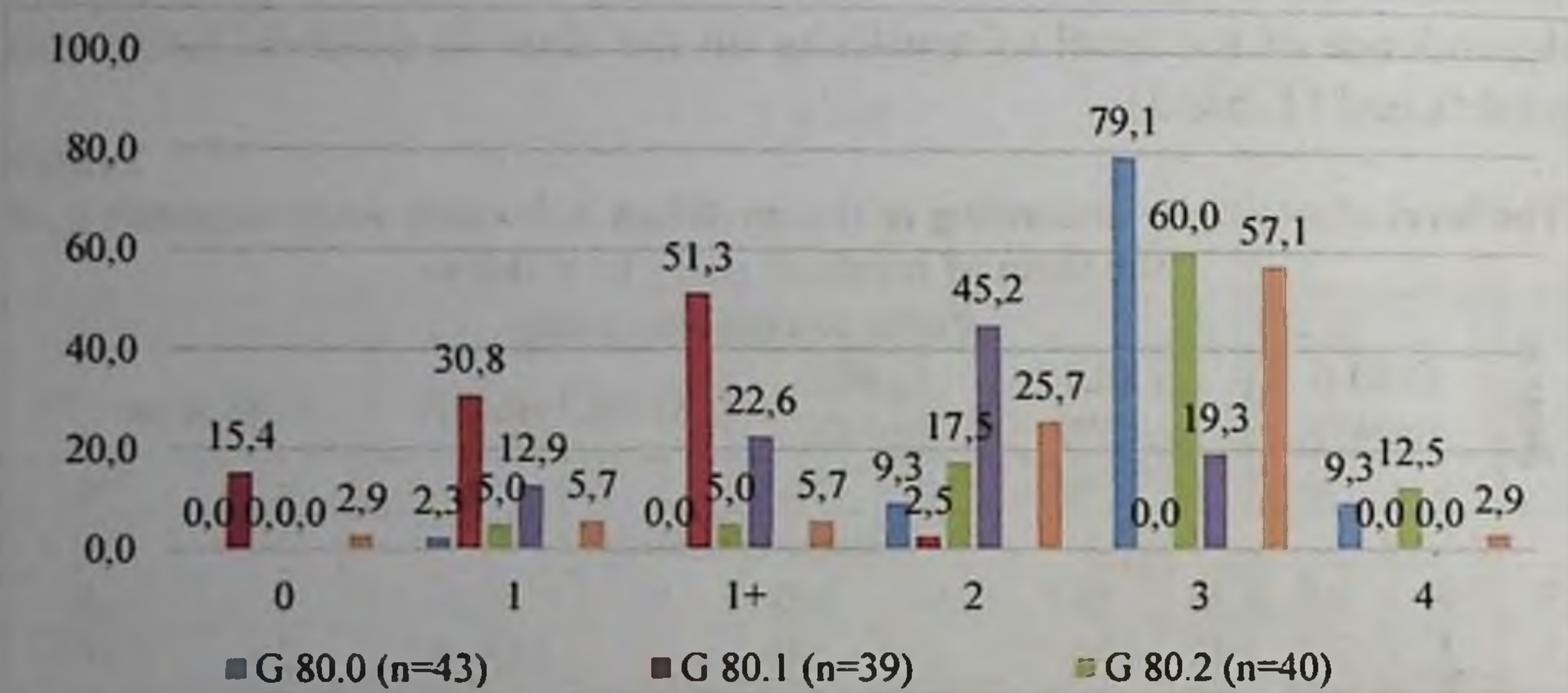


Figure 4. *The level of spasticity of the upper limbs according to the modified Ashworth scale depending on the form of cerebral palsy*

During the analysis, the dependence of the severity of spasticity indicators of the lower limbs on the form of cerebral palsy in children was established. Only 2.9% of patients had normal skeletal muscle tone at G 80.8. A slight increase in skeletal muscle tone of the lower extremities (1 or 1+ points) was often observed in patients with G 80.3 (12.9% and 22.6% of cases, respectively), with G 80.2 in 2.5% (P<0.01), and in 5.7% with G 80.8 (P<0.01).

A pronounced increase in skeletal muscle tone of the legs (Fig. 5) was registered more often in G 80.0 – in 69.8% of cases, in G 80.1 – in 69.2% of cases, in G 80.8 – in 68.6% of cases, the smallest number of children with a change in the muscle tone of the lower extremities, estimated at 3 points, occurred in G 80.2 – in 47.5% of cases, at G 80.3 – in 22.6% of cases (P<0.05).

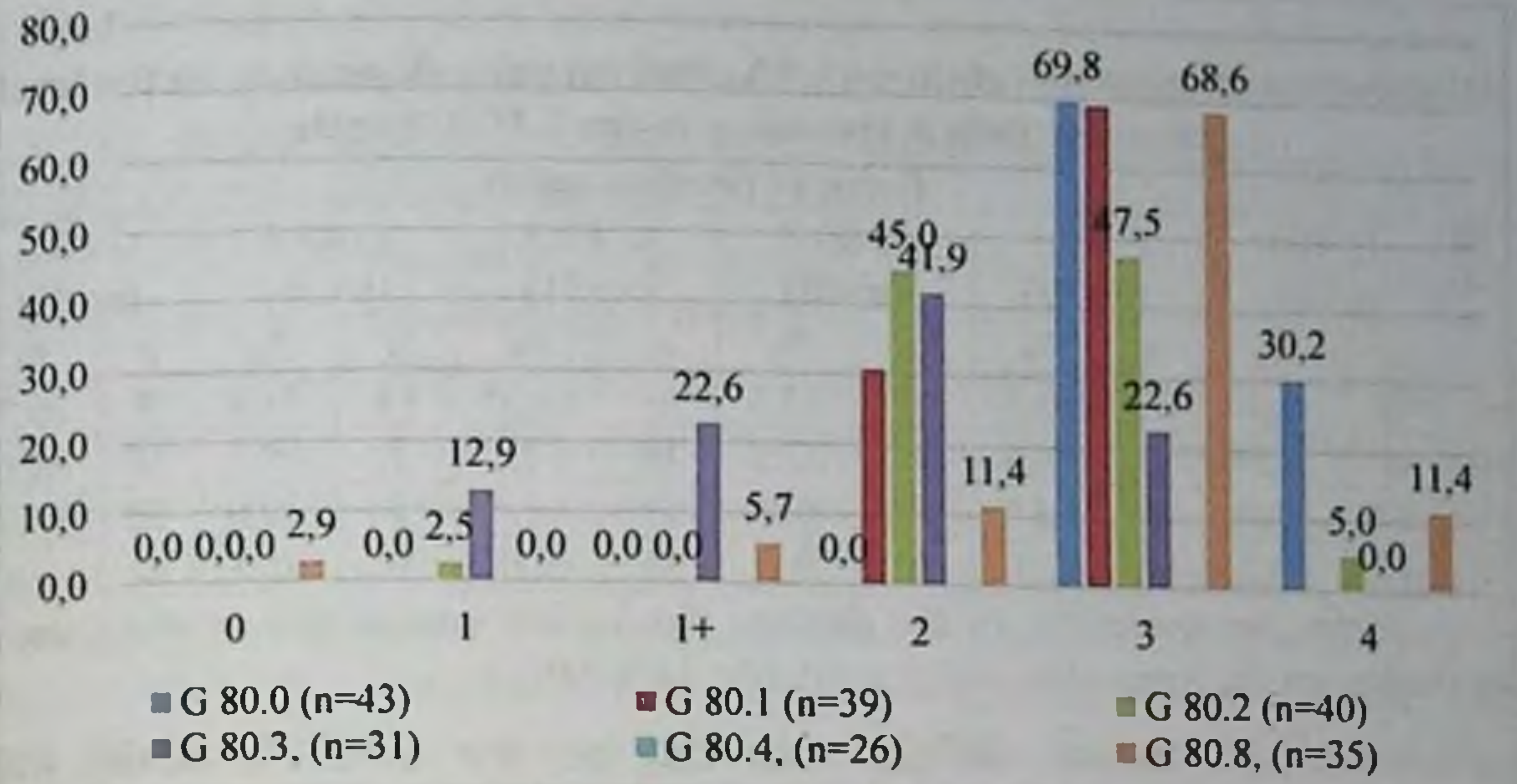


Figure 5. The level of spasticity of the lower limbs according to the modified Ashworth scale depending on the form of cerebral palsy

Flexion or extensor contracture in the lower extremities was significantly more common in quadriplegia (30.2%) in relation to all other studied topographic forms of cerebral palsy (P<0.01).

Thus, in cerebral palsy, the severity of muscle tone of both the upper and lower extremities depends on the topographic form of the disease. The diagnostic algorithm for assessing muscle tone in children with cerebral palsy will make it possible to objectively characterize the potential capabilities of the motor sphere and predict the prospects for rehabilitation in each case.

§3.3. Assessment of major motor functions according to the Global Motor Function Classification System scale, GMFCS

The analysis of the features of the functional status in certain forms of cerebral palsy according to the GMFCS scale showed that level I was not found in any case. Motor deficit of level II according to the GMFCS scale was found in most cases at G 80.2 (72.5%), at G 80.1 – in 56.4% of cases, at G 80.4 – in 53.9% of cases, the lowest percentage is observed at G 80.8 and G 80.3 – in 25.7% and 19.3% of cases, respectively. At G 80.0 II, the level of motor deficit did not occur (Table 9). Clinically, GMFCS level II was manifested by minor movement restrictions that did not require additional mobility aids (wheelchairs, walkers) and adult assistance.

Table 9
Distribution of examined children with cerebral palsy depending on the level of motor deficit according to the GMFCS scale

Level	Form of cerebral palsy											
	G 80.0 (n=43)		G 80.1 (n=39)		G 80.2 (n=40)		G 80.3 (n=31)		G 80.4 (n=26)		G 80.8 (n=35)	
	n	%	n	%	n	%	n	%	n	%	n	%
II	0	0,0	22	56,4	29	72,5	6	19,3*	14	53,9	9	25,7
III	6	14,0*	15	38,5	11	27,5	10	32,3	5	19,2	10	28,6
IV	24	55,8	2	5,1*	0	0,0	15	48,4	7	26,9	12	34,3
V	13	30,2	0	0,0	0	0,0	0	0,0	0	0,0	4	11,4*

Note: the reliability of the data to the lowest percentages in the groups depending on the form of cerebral palsy (P<0.05-0.01)

Level III motor deficit according to the GMFCS scale was registered in all forms of cerebral palsy among 214 examined children, with a predominance in the form G 80.1 (38.5%) and the lowest representation in the form of G 80.0 (14%), which was significant (P<0.01).

Level IV motor deficit on the GMFCS scale was not diagnosed at G 80.2, the highest percentage was noted at G 80.0 (55.8%), and the lowest at G 80.1 (5.1%), which was significant (P<0.01). 35% of children with mobility level IV were unable to move in the room, 20% left the house leaning on their hands (FMS level I).

Level V on the GMFCS scale was recorded significantly more often in G 80.0 (30.2%), at G 80.8 in 11.4% of patients, but in all other forms of cerebral palsy this level was not noted. Almost all children with GMFCS level V were immobilized, and only 7.7% had the ability to crawl independently.

In the clinical and neurological examination of children with cerebral palsy, the most commonly diagnosed spastic syndromes are adductor syndrome and hamstring syndrome. Adductor syndrome, characterized by spastic contraction of the adductor longus, adductor short, adductor major with the patient's hip adductor until they touch and intersect, is diagnosed most frequently in children with GMFCS levels IV and V, accounting for 90% and 92.3% respectively. Adductor syndrome contributed to significant difficulty standing and walking without additional support.

On palpation of patients with mm. gracilis, semimembranosus, and semitendinosus belonging to the internal knee flexors, in the position with a PEDt hip and slow extension of the knees, "hamstring syndrome" was revealed, the frequency of which correlated with the levels of GMFCS motor deficits, reaching up to 100% in children with a level of GMFCS V The incidence of spastic syndromes in children with cerebral palsy directly depended on the severity of motor deficit according to GMFCS and was significant ($p \leq 0.001$).

The relationship between the severity of cerebral palsy and the severity of motor disorders according to the GMFCS classification was revealed. In more severe forms of cerebral palsy, such as spastic cerebral palsy (G 80.0), GMFCS levels IV and V in the classification of motor abilities were 86%, which corresponded to pronounced impairment of motor functions, significant limitations in independent movement, and was almost always accompanied by the inability to self-care, including independent eating.

Spastic diplegia (G 80.1) and childhood hemiplegia (G 80.2), according to the data obtained, were the most favorable forms of cerebral palsy, in which the severity of motor disorders was less pronounced. In these children, motor function levels ranged from GMFCS level II – 56.4% at G 80.1 and 72.5% at G 80.2 to level IV – 5.1% at G80.1 and GMFCS level III at G 80.2 (27.5%). In the G 80.2 form, no GMFCS V was recorded in any case. The presence of a correlation between variables of medium strength (r-0.572 at $p < 0.05$) and negative directionality was reliably confirmed.

Thus, according to the results of the GMFCS scale, the level of motor deficit depending on the form of cerebral palsy was identified with the establishment of correlations. In the study of each level of functioning, the capabilities of the patient with cerebral palsy were evaluated, rather than the limitations and quality of the movement performed. At the same time, spastic syndromes (adductor syndrome and hamstring syndrome) were significantly more common in children with severe impairments of global motor functions.

§3.4. Assessment of the level of functioning of the upper limbs in children with cerebral palsy according to the Manual Ability Classification System

The level of activity according to the MACS scale was assessed depending on the form of cerebral palsy, the data obtained are presented in Table 10. Children with cerebral palsy G 80.1 demonstrate the best indicators of upper limb functioning, among them in most cases there is the 1st and 2nd level of activity (33.3% and 60.6%, respectively).

Table 10

Distribution of the examined children depending on the level of activity of the upper extremities according to the MACS scale

Form	Activity Level									
	1st		2nd		3rd		4th		5th	
	n	%	n	%	n	%	n	%	n	%
G 80.0 (n=27)	0	0,0	0	0,0	5	18,5	18	66,7	4	14,8*
G 80.1 (n=33)	11	33,3	20	60,6	2	6,1*	0	0,0	0	0,0
G 80.2 (n=35)	0	0,0	0	0,0	25	71,4	10	28,6*	0	0,0
G 80.3 (n=24)	1	4,2*	7	29,2	10	41,6	5	20,8	1	4,2*
G 80.4 (n=15)	1	6,7*	2	13,3	11	73,3	1	6,7*	0	0,0
G 80.8 (n=24)	1	4,2*	4	16,7	8	33,3	11	45,8	0	0,0

Note: the reliability of the data to the lowest percentages in the groups depending on the form of cerebral palsy (P<0.05-0.01)

Among these children, problems with the functioning of the upper limbs mainly consisted of a slight limitation of the speed of performance and accuracy, which did not affect the degree of independence in daily activities (Fig. 6). Also, the 1st and 2nd levels of activity were observed at G 80.3, G 80.4, G 80.8 – 4.2%, 6.7% and 4.2%, respectively, at the 1st level and G 80.3, G 80.4, G 80.8 – 29.2%, 13.3% and 16.7%, respectively, at the 2nd level, but these indicators significantly differed from the indicators of children with the G 80.1 form (P<0.05).

The absence of levels 1 and 2 of upper limb functioning at G 80.2 is explained by the fact that the study assessed the functioning of contralateral paretic upper limb rather than healthy ones. In children with spastic hemiparesis, we studied "mirror movements" - involuntary contractions of the muscles of the free arm. With the function of synergy preserved, the patient had to alternately perform 3 types of movements with his hands: clench and unclench the fist; oppose the 1st and 2nd fingers of the hand with a ring; And also alternately oppose the 1st finger to the rest of the fingers of the hand.

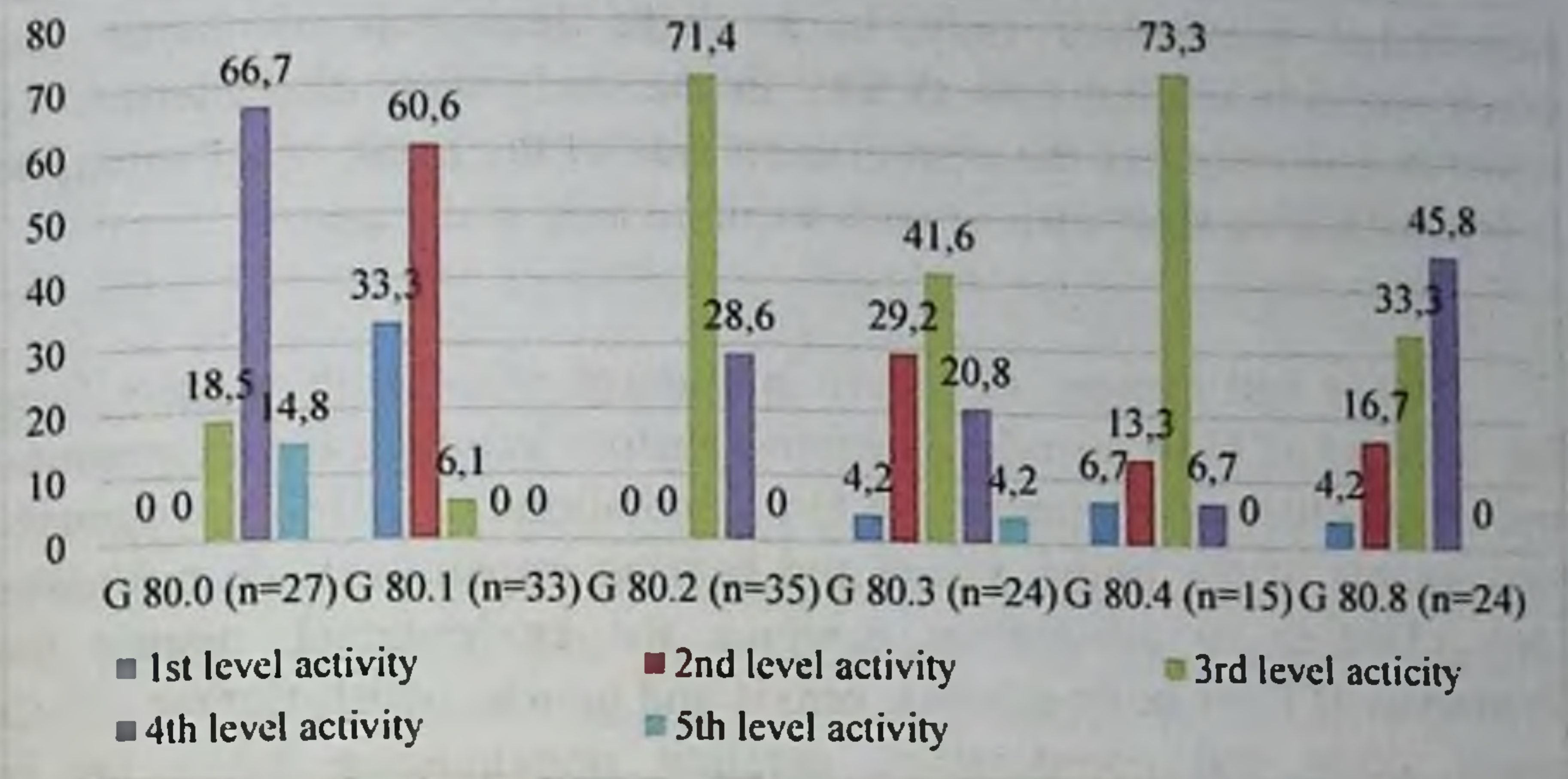


***Figure 6**. Occurrence of activity levels according to the MACS scale*

Among the examined children with cerebral palsy, in most cases, there was the 3rd type of activity of the upper limb, which was characterized by difficulty in functional capabilities, the children needed preparation for action or were forced to modify the action. The highest percentage of type 3 activity was recorded at G 80.4 (73.3%) and G 80.2 (71.4%), while the lowest was recorded at G 80.1 (6.1%), which was significant ($P<0.01$).

The 4th type of activity on the MACS scale was observed in most cases at G 80.0 (66.7%) and G 80.8 (45.8%), while the lowest at G 80.4 (6.7%), which was significant ($P<0.01$). Such patients have always needed assistance and adaptive equipment for any action and motor activity.

At the 5th level of activity, the subjects manipulated simple movements in a familiar environment, without grasping objects, and were characterized by severe, persistent limitations of elementary movements. This type of activity on the MACS scale was recorded more often at G 80.0 (14.8%) and significantly less often at G 80.3 (4.2%; $P<0.01$).

Thus, as a result of the assessment, the characteristic features of changes in bimanual activity on the MACS scale depending on the form of cerebral palsy were identified. A virtual lack of functional activity of the upper extremities was observed in such forms as G 80.0, G80.2 and G 80.3, while in G 80.1 one in three children successfully controlled most objects, and those with problems in manipulating objects manifested themselves only in a slight limitation of speed and carelessness. Children with G 80.2 in the study were characterized by better functionality of the contralateral side of the hand, often coping in everyday life on their own or with minimal help and support.

§3.5. Communication Function Classification System (CFCS)

Motor and sensory disorders in children with cerebral palsy from the moment of birth introduce negative factors into their lives for mental and intellectual development [35,59]. Limitations in mobility, voluntary movements of the limbs, visual and hearing impairments do not allow such children to adequately perceive the environment, disrupt the formation of their body schema, praxis and gnosis, which further affects motor skills and coordination, creating prerequisites for a lag in cognition, reading and writing skills [31].

The lag in elementary skills for healthy children causes impairments in the communication skills and socialization of such children, which requires active and in-depth study. In our study, communicative functionality in children with cerebral palsy was assessed by the CFCS scale in terms of the topographic form of the disease (Table 11).

A total of 27 (12.6%) children with cerebral palsy effectively exchange information both with family members and with strangers, including 28.2% at G 80.1, 30.0% at G 80.2, 3.2% at G 80.3, 7.7% at G 80.4, and 2.9% at G 80.8 (P<0.05). At G 80.0 in children, no level of CFCS I was reported in any case.

Table 11

Indicators of communicative functioning according to the CFCS scale depending on the form of cerebral palsy

Level	G 80.0 (n=43)		G 80.1 (n=39)		G 80.2 (n=40)		G 80.3 (n=31)		G 80.4 (n=26)		G 80.8 (n=35)	
	n	%	n	%	n	%	n	%	n	%	n	%
CFCS I	0	0,0	11	28,2	12	30,0	1	3,2*	2	7,7*	1	2,9*
CFCS II	3	7,0*	20	51,3	15	37,5	8	25,8	9	34,6	6	17,1*
CFCS III	26	60,5	8	20,5	10	25,0	18	58,1	11	42,3	19	54,3
CFCS IV	10	23,2	0	0,0	3	7,5*	4	12,9	4	15,4	9	25,7
CFCS V	4	9,3	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0

Note: the reliability of the data to the lowest percentages in the groups depending on the form of cerebral palsy (P<0.05-0.01)

Communicative functioning of the CFCS II level was recorded in 61 children with cerebral palsy (28.5%). In this group of children, there was a reduced rate of communication, both with strangers and familiar people. At the same time, misunderstandings were quickly eliminated and did not affect the effectiveness of communication. Most often, this level of communication was determined at G 80.1 – 51.3%, i.e. in almost every second child, least often at G 80.0 – 7.0% (P<0.01).

Ninety-two children (43.0%) effectively shared information, but only with family members, and were diagnosed with CFCS level III. Effective communication in communication with close people and inconsistent effectiveness in communication with strangers was noted in 60.5% of children with G 80.0, 58.1% with G 80.3, 54.3% with G 80.8, 42.3% with G 80.4, 25.0% with G 80.2, and the lowest percentage was recorded at G 80.1 - 20.5% (P<0.05).

In 30 children (14.0%), when assessing communicative functioning, it was noted that these children periodically effectively exchanged information and only with family members, which is characteristic of the CFCS IV level. This level was most often observed at G 80.8 (25.7%), while at G 80.0 – in 23.2%, at G 80.4 – in 15.4%, at G 80.3 – in 12.9%, the lowest number was found at G 80.2 – in 7.5%, which was significantly different from other forms of cerebral palsy (P<0.01). In spastic diplegia, CFCS IV levels were not observed.

In 4 children with G 80.0 (9.3%), communicative functioning was impossible, that is, there was no exchange of information, both with family members and with strangers, and the transmission and reception of information was extremely limited. In other forms of cerebral palsy, the level of CFCS V was not recorded.

Thus, children with cerebral palsy have a dysfunction of the communicative status, the severity of which depended on the topographic form of the disease and the severity of motor disorders. The incidence of communicative functioning disorders and cognitive impairment in children with quadriplegia (G 80.0) and other types of cerebral palsy (G 80.8) was statistically significantly higher than in children with unilateral spastic paralysis (G 80.2) and spastic diplegia (G 80.1).

§3.6. Assessment of children's functioning, disabilities and health according to the modified ICF scale

At a further stage, in order to unify the individual profile of a child with cerebral palsy, an analysis of the domains according to ICF was carried out, characterizing not only the assessment of pain, dysfunction of the motor and coordination spheres, but also taking into account environmental and personal factors. In accordance with the ICF-DP, the following factors were taken into account during rehabilitation: structural and functional disorders, including the diagnosis of existing clinical syndromes (motor, hyperkinetic, muscular hypotonia, speech, behavioral); the patient's activity and participation (taking into account the age of the child and the severity of the motor disorders identified in him/her, the ability to perform a particular activity); the social status of the family and the motivation of the parents, environmental factors, both facilitating and limiting the rehabilitation process; social activity, personal motivation and personal characteristics of a patient with cerebral palsy.

Analysis of the results of a study to determine the degree of social and domestic adaptation of children with cerebral palsy by studying the category of "environmental factors" using domains e115 – products and technologies for personal everyday use; e120 – Products and technologies for personal, indoor and outdoor mobility e125 – Means and Technologies of Communication, as well as e150 – Design, Nature of Design, Construction and Arrangement of Buildings for Public Use showed that 166 (77.6%) of the examined children were found to have an unadapted way of life with a predominance of absolute problems (Fig. 7).

Taking into account the ethno-cultural characteristics of the population, all 166 patients lived in the private sector, the sick child was placed in one room, deprived of the ability to move independently around the house, and he did not have access to living conditions. The life of children living in apartments was partially adapted - 48 (22.4%), in their house the thresholds between the rooms were removed, there are handrails, more often in the child's room. Bathrooms and toilets were not adapted for all the examined, i.e. the child could not satisfy basic physiological needs, carry out personal hygiene, and perform everyday household self-care skills without assistance.

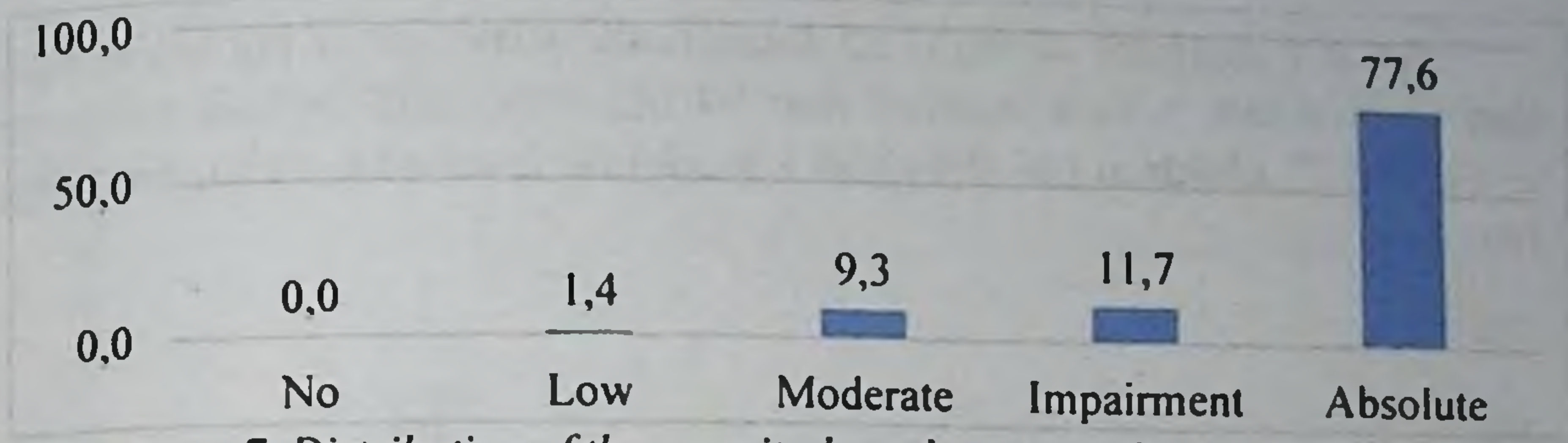


Figure 7. Distribution of the magnitude and severity of domain violations e 115-150 children with DCP

Analysis of the results of the study to determine the degree of "activity and participation" by means of ICF kits using the domains d415 - maintaining body position; d440 – Use of precise brush movements; d550 - food intake stated the following: 78 (36.4%) children had a moderate level, and 118 (55.1%) children had a severe level of impairment (Fig. 8).

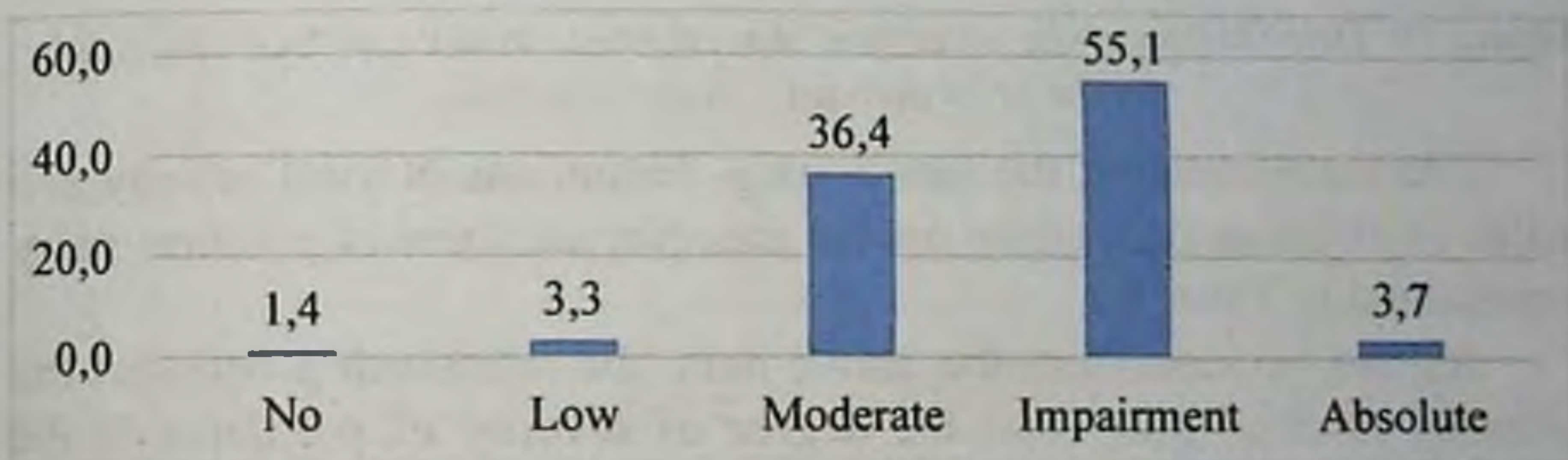


Figure 8. Distribution of the degree of impairment of social and domestic adaptation by means of domains d 415-550 according to ICF

Evaluation of the results of "body function" according to ICF for children with cerebral palsy revealed that 133 (62.1%) children had a moderate level of impairments, and 60 (28.0%) children had a severe level (Fig. 9).

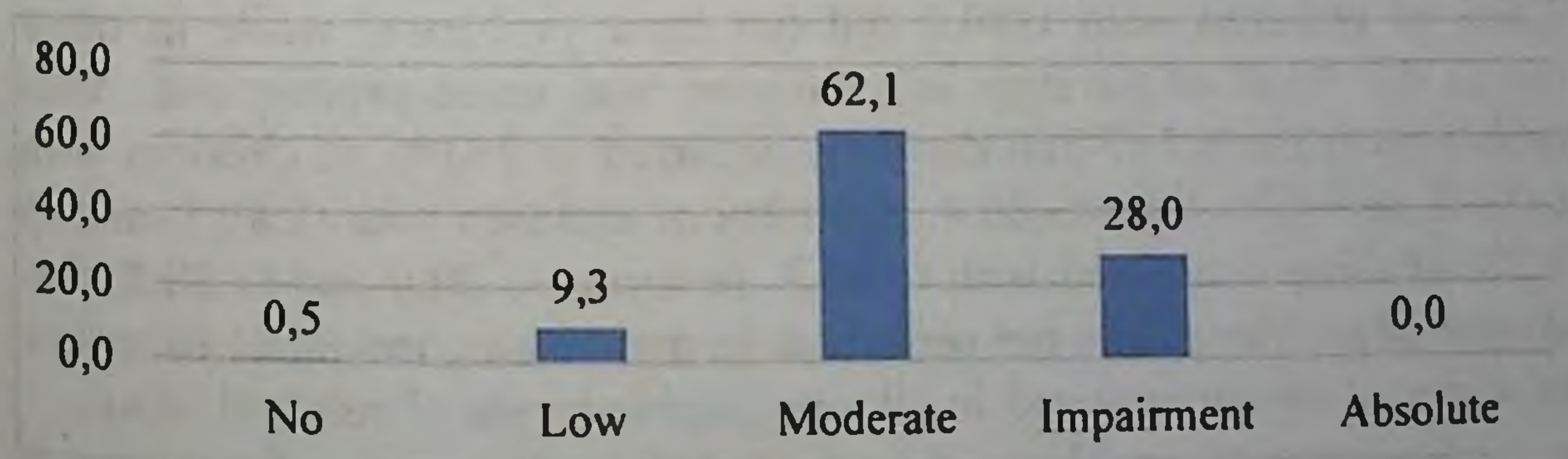


Figure 9. Distribution of the degree of violations according to the ICF by estimating domains b 117-760

An ICF analysis of the s110 domain, the structure of the brain, was also carried out, which showed that 94 (43.9%) children had a severe level, and 77 children (36.0%) had a moderate level of impairment (Fig. 10)

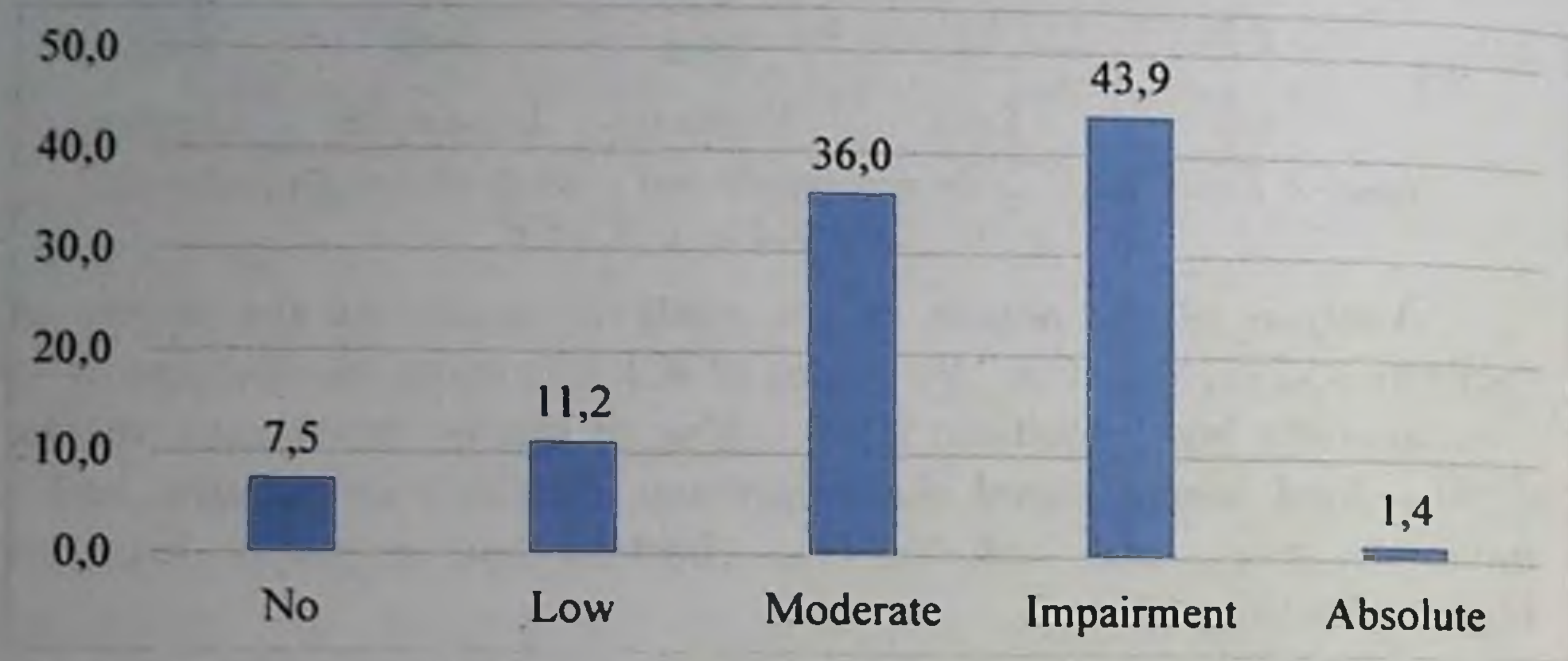


***Figure 10.** Distribution of the severity of disorders in children with cerebral palsy by the s110 domain – brain structure*

The assessment of the functioning, limitations of vital activity and health of children depending on the topographic form of cerebral palsy is presented in Table 12.

As can be seen from the above data, the relationship between the forms of cerebral palsy and the degree of severity of problems in the studied domains has been established. Thus, according to the components of the "body functions" section, we found that a severe level of problems was most often registered among children with G 80.0 (55.8%), and also occurred in almost every third child with G 80.3 (35.5%) and with G 80.8 (34.3%). Whereas the lowest number is at G 80.1 and G80.2 (10.3% and 10.0% respectively). It is worth noting that 2.5% of children with G80.2 did not have problems, while in other forms the level of severity of problems was more pronounced. Mild problems in the b 117-760 domains occurred in 25.0% of children with G 80.2, in 19.2% with G 80.4, in 10.3% of children with G 80.1, and in 3.2% of those examined with G 80.3. In forms G 80.0 and G 80.8, this degree of problems was not observed. In most cases, moderate to severe problems were encountered in all topographic forms of cerebral palsy.

No absolute problems were reported in the study of domains b 117-760.

Table 12

Assessment of Functioning, Disabilities and Health of Children by Means of ICF Domain Sets Depending on the Form of Cerebral Palsy

Domain	Trouble	Form of cerebral palsy											
		G 80.0 (n=43)		G 80.1 (n=39)		G 80.2 (n=40)		G 80.3 (n=31)		G 80.4 (n=26)		G 80.8 (n=35)	
		n	%	n	%	n	%	n	%	n	%	n	%
b 117-760	No	0	0,0	0	0,0	1	2,5	0	0,0	0	0,0	0	0,0
	Lungs	0	0,0	4	10,3	10	25,0	1	3,2*	5	19,2	0	0,0
	Moderate	19	44,2	31	79,4	25	62,5	19	61,3	16	61,6	23	65,7
	Heavy	24	55,8	4	10,3*	4	10,0*	11	35,5	5	19,2	12	34,3
	Absolute	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0
s 110	No	2	4,6	4	10,3*	3	7,5*	2	6,5	3	11,5	2	5,7
	Lungs	0	0,0	23	59,0	1	2,5*	0	0,0	0	0,0	0	0,0
	Moderate	8	18,6	12	30,7	20	50,0	12	38,7	11	42,3	14	40,0
	Heavy	30	69,8	0	0,0	16	40,0	17	54,8	12	46,2	19	54,3
	Absolute	3	7,0*	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0
d 415-760	No	0	0,0	0	0,0	3	7,5	0	0,0	0	0,0	0	0,0
	Lungs	0	0,0	4	10,3	3	7,5	0	0,0	0	0,0	0	0,0
	Moderate	4	9,3*	23	59,0	20	50,0	9	29,0	12	46,2	10	28,6
	Heavy	33	76,7	12	30,7	14	35,0	22	71,0	14	53,8	23	65,7
	Absolute	6	14,0*	0	0,0	0	0,0	0	0,0	0	0,0	2	5,7
and 115-580	No	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0
	Lungs	0	0,0	1	2,6	2	5,0	0	0,0	0	0,0	0	0,0
	Moderate	3	7,0*	7	17,9	4	10,0	2	6,5*	3	11,5	1	2,9*
	Heavy	5	11,6	6	15,4	2	5,0*	4	12,9	2	7,7	6	17,1
	Absolute	35	81,4	25	64,1	32	80,0	25	80,6	21	80,8	28	80,0

***Note:** the reliability of the data to the lowest percentages in the groups depending on the form of cerebral palsy ($P<0.05-0.01$)*

The category of "activity and participation" is reflected in domains d 415-760. When interpreting the data, it was found that 7.5% of children with G 80.2 did not have problems, in 7.5% of cases with this form of cerebral palsy, mild problems were identified, as well as in 10.3% of patients with form G 80.1. The incidence of moderate problems was most often recorded at G 80.1 (59.0%), and the lowest percentage was observed in children with G 80.0. 9.3 per cent. At G80.2, moderate severity of problems was recorded in every 2 children with cerebral palsy, and at G 80.4 in 46.2% of children. Severe problems were recorded in 76.7% of cases with G 80.0, in 71.0% with G 80.3, and in 65.7% of cases with G 80.8. Whereas 14.0% of children with quadriplegia (G 80.0) had absolute problems.

The highest frequency of establishing the absence of problems or a mild degree of severity of problems for the domain "s110 - brain structure" was found at G 80.1. (10.3% and 59.0%, respectively), whereas at G 80.0. Moderate and severe problems were registered for this domain (18.6% and 69.8%, respectively).

Limitation of motor development and speech in cerebral palsy has a significant impact on the formation of a child's personality. Even if the intellect of a child with cerebral palsy corresponds to age norms, there is an immaturity of the emotional sphere. In this regard, when studying personal factors, we also identified the characteristic features that depend on the forms of cerebral palsy, presented in Table 13.

When studying the "personal factors" component, it was found that cerebral palsy is characterized by the characteristic features of the influence of the above factor, which manifested themselves depending on the topographic form of the disease. Negative emotional impact was found in most cases at G 80.4 (73.1%), G 80.0 (65.1%), G 80.3 (64.5%), G80.2 (62.5%) and G 80.8 (54.3%), the lowest percentage was recorded at G 80.1 (35.9%). The emotionality of children with cerebral palsy was manifested by anxiety and irritability, less often by unmotivated aggression. An identical picture was obtained in the study of activity in behavior and activity. In the process of carrying out rehabilitation measures, in 53.7% of cases, it was necessary to face the fact that the activity that required purposefulness in the child led to a negative reaction; It was extremely difficult for the child to make an effort to finish what he had started.

Intellectual deficiency in children with cerebral palsy, of a disharmonious and uneven nature, was manifested not only by low cognitive activity, but also by lack of interest in classes, slowness and low level of concentration. Non-formal education, assessed as "negative", was registered in most cases with forms G 80.0 (88.4%), G 80.4 (84.6%), G 80.2 (67.5%), G 80.8 (57.1%).

At the same time, the lowest percentage was observed in the forms G 80.1 (43.6%) and G 80.3 (45.2%) ($P<0.05$).

Slow perception of verbal messages in the process of communication and lack of concentration in children with cerebral palsy were characterized as a "negative" influence of the personality factor and in more than half of the cases were registered in the following forms: G 80.0 (58.1%), G 80.3 (58.1%), G 80.4 (53.9%), G 80.8 (51.4%). Whereas in the form of G 80.1, the negative effect was found in only 30.8% of patients.

The use of ICF in rehabilitation activities for children with cerebral palsy makes it possible to deeply study its functionality in terms of clinical symptoms, environment and personality, as well as to conduct dynamic monitoring of changes and the achievement of the goal of rehabilitation at each stage.

Table 13

Features of the influence of personal factors depending on the form of cerebral palsy

Domain	Influence	Form of cerebral palsy											
		G 80.0 (n=43)		G 80.1 (n=39)		G 80.2 (n=40)		G 80.3 (n=31)		G 80.4 (n=26)		G 80.8 (n=35)	
		n	%	n	%	n	%	n	%	n	%	n	%
Emotionality	Positive	6	14,0	7	17,9	8	20,0	1	3,2	4	15,4	10	28,6
	Neutral	9	20,9	18	46,2	7	17,5	10	32,3	3	11,5	6	17,1
	Negative	28	65,1	14	35,9	25	62,5	20	64,5	19	73,1	19	54,3
Activity in behavior and activity	Positive	0	0,0	6	15,4	8	20,0	0	0,0	4	15,4	6	17,1
	Neutral	10	23,3	23	59,0	11	27,5	13	41,9	6	23,1	12	34,3
	Negative	33	76,7	10	25,6	21	52,5	18	58,1	16	61,5	17	48,6
Non-formal education	Positive	0	0,0	2	5,1	5	12,5	11	35,5	2	7,7	1	2,9
	Neutral	5	11,6	20	51,3	8	20,0	6	19,3	2	7,7	14	40,0
	Negative	38	88,4	17	43,6	27	67,5	14	45,2	22	84,6	20	57,1
Comprehension of verbal messages in communication	Positive	2	4,7	10	25,6	13	32,5	1	3,2	3	11,5	4	11,5
	Neutral	16	37,2	17	43,6	9	22,5	12	38,7	9	34,6	13	37,1
	Negative	25	58,1	12	30,8	18	45,0	18	58,1	14	53,9	18	51,4

Chapter IV. Characteristics of physical development of children with cerebral palsy depending on the form of the disease

§4.1. The level of physical development of children depending on the form of the disease

The basis of the health and physical well-being of any child is generally considered to be his/her physical development, changes in which can be due to a variety of reasons and, in most cases, malnutrition [19,27,46]. The study of physical development, as one of the main signs of children's health, is widely used in practical pediatrics, as it non-invasively reflects the endocrine and somatic status of the child and his nutrition [5,93].

Since it is necessary to assess the morphofunctional status of children with cerebral palsy in the process of comprehensive rehabilitation, we analyzed the main anthropometric parameters of physical development depending on the form of the disease. The obtained data on the study of somatomorphometric parameters are presented in Table 14.

As can be seen from the above data, the children with the G 80.0 form had the lowest body weight, which is 1.8 times lower than in the control group (15.8±1.2 kg versus 29.0±2.6 kg). Significantly low body weight was also observed in forms G 80.3, G 80.4 and G 80.8 (19.5±1.6 kg; 19.0+2.3 kg and 20.3±1.8 kg, respectively). In retrospective analysis, these patients not only showed insufficient gain, but also insufficient gain, but also the age of underweight. Only in the forms G 80.1 and G 80.2 did the body weight (23.8±1.8 kg and 25.3±1.8 kg, respectively) correspond to the average data in the control group and did not have a significant difference, although in relation to other forms of cerebral palsy they were significantly higher ($P<0.05$).

Short stature, as well as underweight, was significantly more common in topographic forms G 80.0, G 80.3, G 80.4 and G 80.8. The average height of these children was 108.4±3.2 cm; 114.1±3.3 cm; 111.3±4.4 cm and 115.3±3.7 cm, respectively, versus 124.8±4.1 cm in the control group; $P<0.05$-0.01. In children with such forms of cerebral palsy as spastic diplegia and childhood hemiplegia, the height of children did not differ significantly from the average in the control group (122.1±3.7 cm, 125.6±3.6 cm versus 124.8±4.1 cm, respectively; P<0.05).

Table 14

Morphometric characteristics of children with cerebral palsy depending on the form of the disease

Form	Body weight	Growth	GCG
G 80.0 (n=43)	15.8±1.2	108.4±3.2	53.3±0.9
Reliability to CG	P<0.001	P<0.001	P<0.001
G 80.1 (n=39)	23.8±1.8*	122.1±3.7*	59.5±1.4*
Reliability to CG	P>0,05	P>0,05	P>0,05
G 80.2 (n=40)	25.3±1.8*	125.6±3.6*	60.2±1.3*
Reliability to CG	P>0,05	P>0,05	P>0,05
G 80.3 (n=31)	19,5±1,6*^	114,1±3,3*^	56,5±1,3*^
Reliability to CG	P<0.01	P<0.01	P<0.01
G 80.4 (n=26)	19,0±2,3*^	111,3±4,4*^	54,7±1,3*^
Reliability to CG	P<0.01	P<0.01	P<0.01
G 80.8 (n=35)	20,3±1,8*^	115,3±3,7*^	56,6±1,3*^
Reliability to CG	R<0.05	R<0.05	R<0.05
Control group (n=40)	29.0±2.6	124.8±4.1	62.2±1.8

*Note: * - reliability of data G 80.0 to indicators G 80.1, G 80.2, G 80.3, G 80.4, G 80.8 (P<0.05-0.01); ^ - reliability of G 80.1 data to G 80.2, G80.3, G 80.4, G 80.8 (P<0.05-0.01)*

When studying such a somatometric indicator as CGC, it was revealed that its lowest parameters were recorded in children in forms G 80.0, G 80.3, G 80.4 and G 80.8 (53.3±0.9 cm; 56.5±1.3 cm; 54.7±1.3 cm and 56.6±1.3 cm, respectively; P<0.05-0.01), which had a significant difference from the data of the control group (62.2±1.8 cm) and were due to low body weight among children with these forms of cerebral palsy. Mean GCG values in forms G 80.1 and G 80.2 did not differ significantly from the data of the control group (P>0.05) and amounted to 59.5±1.4 cm and 60.2±1.3 cm.

Thus, children with cerebral palsy not only had a low body weight, but were short in relation to their peers from the control group. The lowest values in terms of somatometric parameters of body weight, height, and chest circumference were observed in such forms of CP as G80.0, G 80.3, G 80.4 and G 80.8.

§4.2. Index Assessment of Physical Development of Children with Different Forms of Cerebral Palsy

For a comprehensive assessment of the physical development of children with cerebral palsy, a combination of Rohrer, Piñer, Brugsch and Vervek indices was used. Comparison of the anthropometric characteristics showed the prevalence of disharmonious physical development among children with cerebral palsy, in contrast to children in the control group. Thus, in patients with cerebral palsy, when calculating the ratio of body size (longitudinal to transverse), in 49.1% (105 out of 214 examined) cases, a moderate or pronounced predominance of height in length, i.e. moderate or pronounced dolichomorphy with Verbeque index values of more than 1.25 units, was revealed.

In 31% of children with cerebral palsy, the Rohrer index was less than 10.7 kg/m3, which indicated low physical development. The study and comparative assessment of the parameters according to the Piñé index revealed significantly lower indicators of physical development in children with cerebral palsy (98.6%) than in children in the control group (17.5%). The characteristics of the examined children, calculated according to the Brugsch index, in children with cerebral palsy indicated narrow-chestedness: in 171 patients (79.9%), the value of the index was lower than the normative age indicators (Table 15). The constitutional body type was determined using the Verbecca index and showed a tendency to the absence of moderate or severe brachymorphia among children with cerebral palsy. The predominance of longitudinal over transverse dimensions was most often observed in the groups of children with G 80.0, G 80.3 and G 80.8, amounting to 79.1%, 51.6% and 51.4%, respectively. Significantly pronounced dolichomorphy was characteristic of patients with quadriplegia ($P<0.05$).

Table 15

Indicators of Comprehensive Index Assessment of Physical Development of Children with Cerebral Palsy Depending on the Form of the Disease

Indices		G 80.0 (n=43)		G 80.1 (n=39)		G 80.2 (n=40)		G 80.3 (n=31)		G 80.4 (n=26)		G 80.8 (n=35)		Control group (n=40)	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
Rorera	Low development	16	37,2*	10	25,6*	7	17,5*	2	6,5*	2	7,7*	8	22,9*	1	2,5
	Harmonious	16	37,2*	16	41,0	25	62,5	23	74,2	18	69,2	19	54,3*	25	62,5
	High	11	25,6	13	33,3	8	20,0*	6	19,3*	6	23,1	8	22,8	14	35,0
Piñé	Low	31	72,1*	25	64,1*	26	65,0*	22	71,0*	16	61,5*	18	51,4*	1	2,5
	below the average	10	23,3	14	35,9*	14	35,0*	9	29,0	9	34,6*	17	48,6*	6	15,0
	average	2	4,6*	0	0,0	0	0,0	0	0,0	1	3,8*	0	0,0	19	47,5
	Above average, normal	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	14	35,0
Brugsha	narrow-chested	38	88,4	32	82,1	31	77,5	24	77,4	22	84,6	24	68,6	18	45,0
	Normal chest	5	11,6*	7	17,9*	9	22,5*	7	22,6*	4	15,4	11	31,4*	22	55,0
	Broadness	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0
Verveka	severe brachymorphia	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0
	moderate brachymorphia	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	5	12,5
	Mesomorphic type	9	20,9*	26	66,6	29	72,5	15	48,4	13	50,0	17	48,6	33	82,5
	moderate dolichomorphy	27	62,8*	12	30,8*	10	25,0*	15	48,4*	10	38,5*	13	37,1*	2	5,0
	pronounced dolichomorphy	7	16,3	1	2,6	1	2,5	1	3,2	3	11,5	5	14,3	0	0,0

Note: ** - reliability of data for the control group (P<0.05-0.001)*

At the same time, the study of the body composition of children in the control group according to the Verbeque index in 82.5% of cases indicated harmonious physical development or a mesomorphic body type with an index value of 0.85-1.25 units.

In children with cerebral palsy, in most cases, mesomorphic body type was observed in forms G 80.1 (66.6%) and G 80.2 (72.5%), with statistically significant differences in relation to other forms of cerebral palsy ($P<0.05$) (Fig. 11).

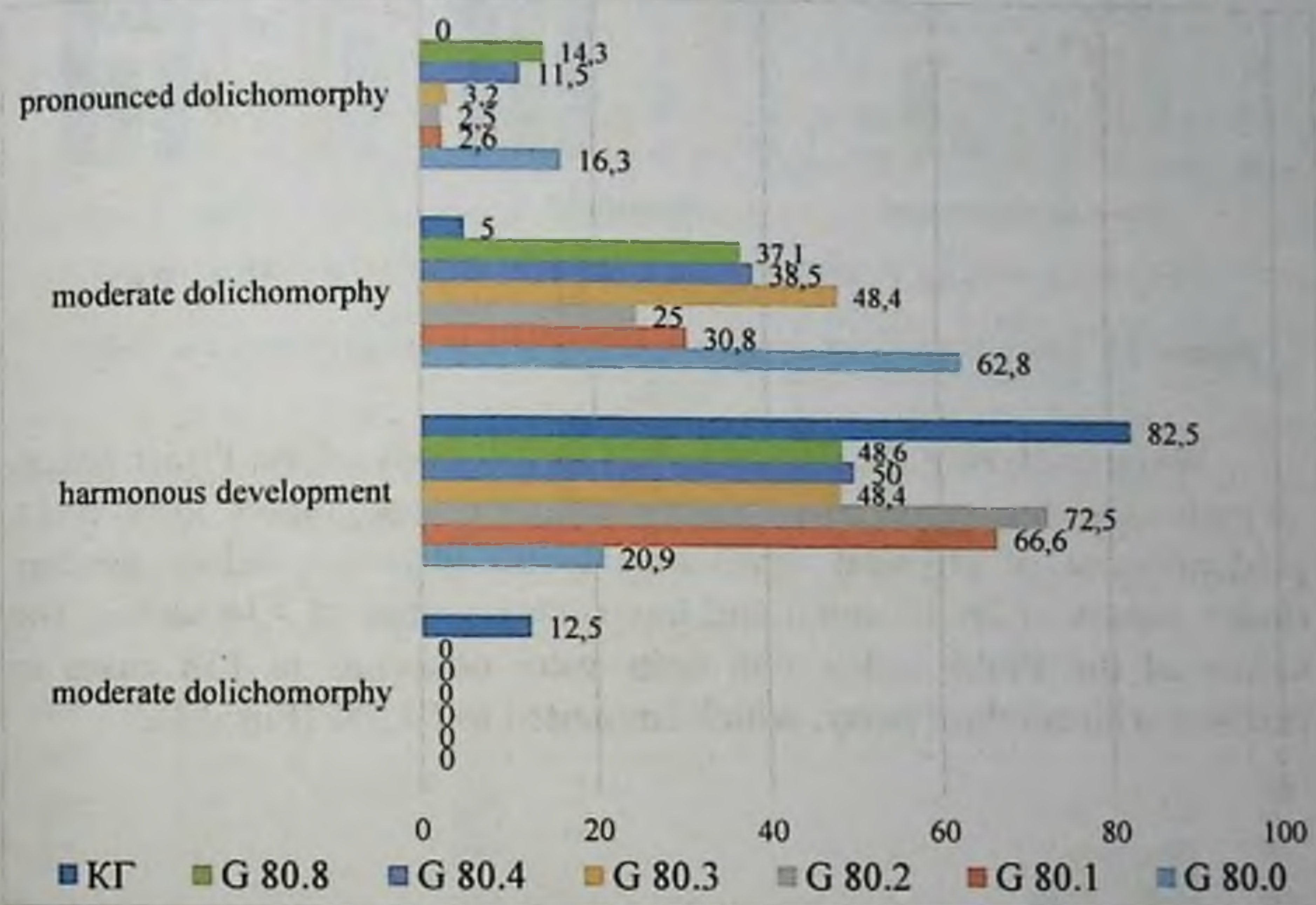


Figure 11. Distribution of children in the study groups by body type

A detailed study of body density according to the Rohrer index, shown in Fig. Table 12 showed that in 62.5% of cases children in the control group were characterized by average or normal physical development, with an index value of 10.7-13.7 kg/m^3. In 35% of cases in the examined children in the control group, the Rohrer index was higher than 13.7 kg/m^3, which corresponded to high physical development. Low physical development was observed in the majority of cases in forms G 80.0 (37.2%), G80.1 (25.6%) and G 80.8 (22.9%). It should be noted that 14.5% of children with cerebral palsy (31 patients out of 214), of which: 25.6% of children in the group with G 80.0; 19.3% in the form of G80.3; 23.1% of those examined with G 80.4 and 22.8% with G 80.8 met the values exceeding the standard values for the Rohrer index (>13.7 kg/m³), due to their deficit, both in body weight and height.

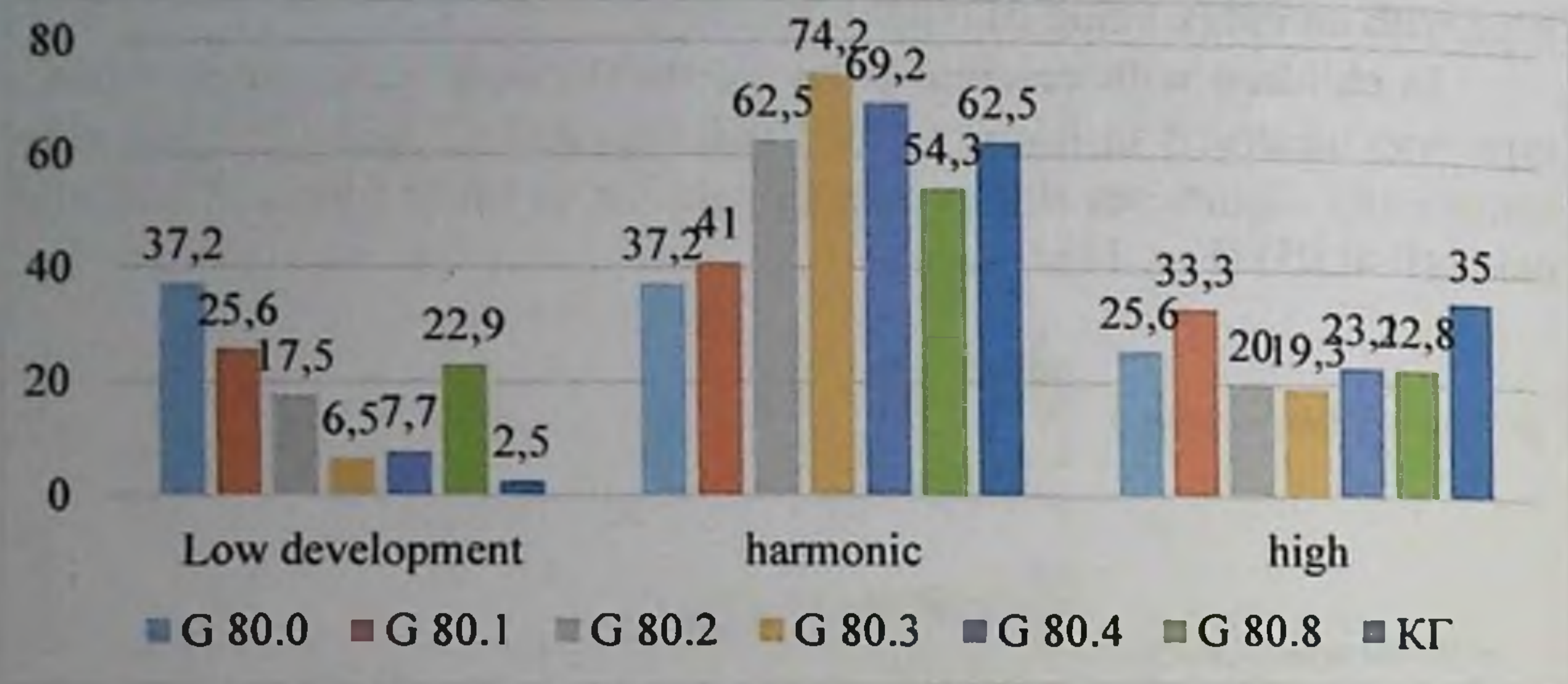


Figure 12. Level of physical development of children according to the Rohrer index

When analyzing the data obtained in the study of the Pinier index, all patients with cerebral palsy, regardless of the topographic form, had a predominance of physical development and physique below average (index values of 26-35 units) and low (index values of >36 units). The values of the Pinier index >36 units were observed in 138 cases in children with cerebral palsy, which amounted to 64.5% (Fig. 13).

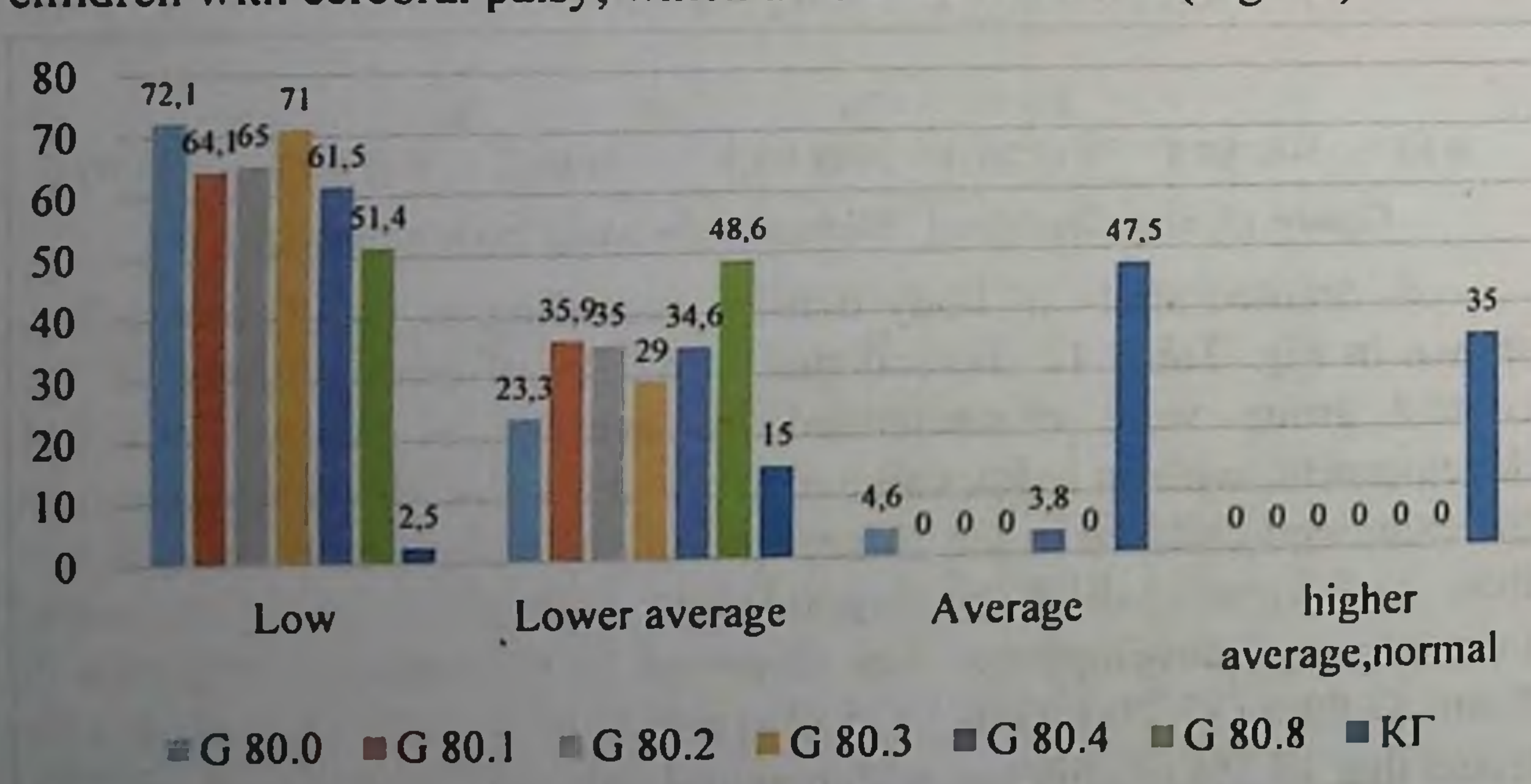


Figure 13. Indicators of children's physical development according to the Piñé index

At the same time, children with quadriplegia (72.1%) and atactic cerebral palsy (71.0%) were most often diagnosed with low physique and physical development. According to the results of the Pinier index of 26-35 units, in 34.1% of cases in children with cerebral palsy, poor physical development was noted, significantly more often in the group of children with form G 80.8 (48.6%). Normal or average physique and physical development were determined in 82.5% of children in the control group, while average physique with a Piñé index of 21-25 units was recorded only in forms G 80.0 and G 80.4 (4.6% and 3.8%, respectively).

The values of the Brugsch indices and proportionality indicate that children with cerebral palsy have a disharmonious and disproportionate physique, they have poor development of the chest (Fig. 14). Comparative characteristics of the Brugsch index showed the predominance of children with a disharmonious body type due to narrow-chested body in the following topographic forms of cerebral palsy: G 80.0 – 88.4%; G 80.4 – 84,6%; G 80.1 – 82,1%. Brugsch index values comparable to the age norm were observed in 55% of children in the control group and 20.1% of patients with cerebral palsy, with a predominance in the group of children with G 80.8, G 80.3 and G 80.2 (31.4%, 22.6% and 22.5%, respectively).

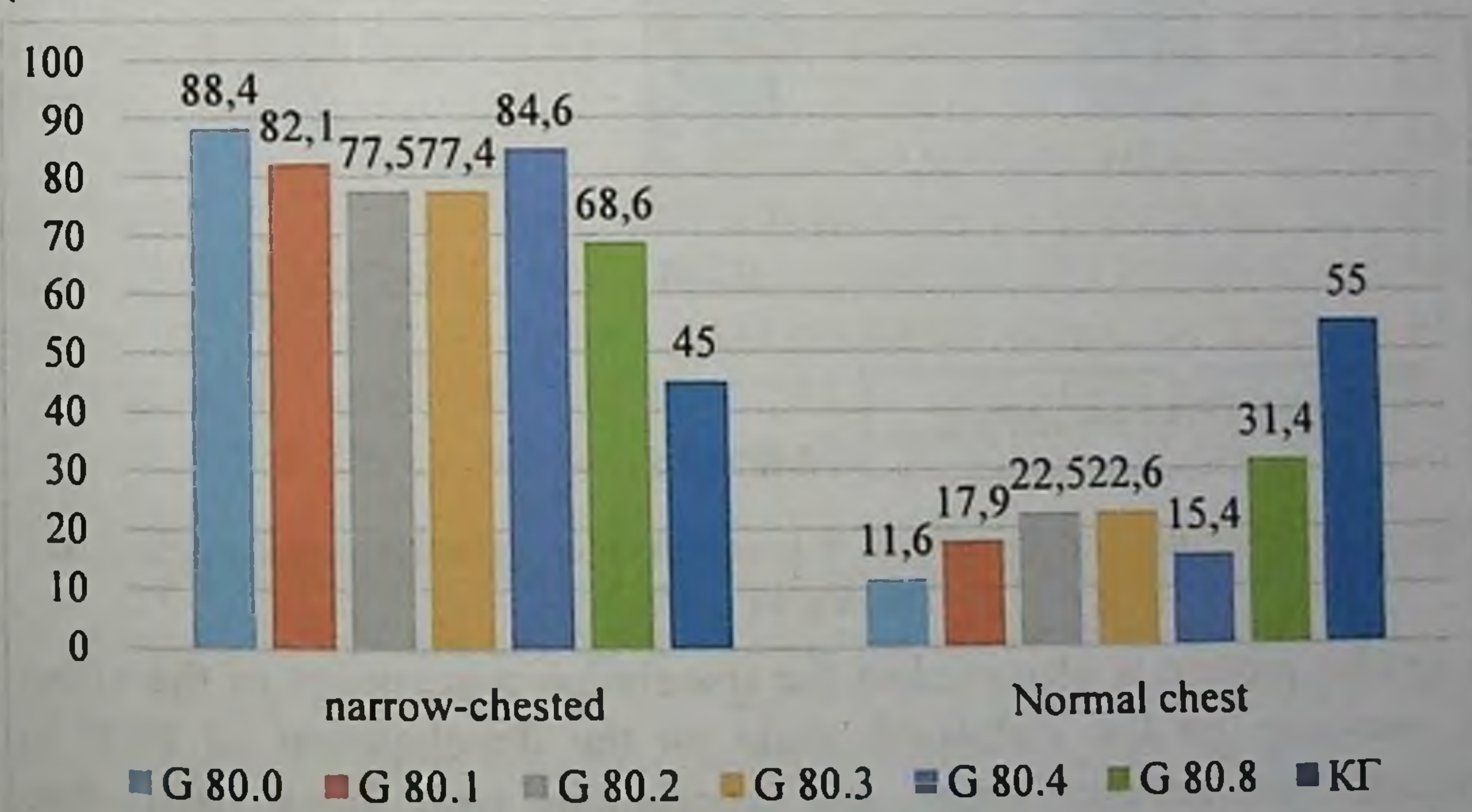


Figure 14. Morphometric characteristics of children according to the Brugsch index

§4.3. Relationship between Clinical and Neurological Status and Physical Development in Infantile Cerebral Palsy Taking into Account the Degree of Protein-Energy Deficiency

To assess the impact of neurological status and motor deficit in children with cerebral palsy on the development of PED and its severity, a correlation analysis was carried out using the GMFM-88, GMFCS, MACS, CFCS, and Ashworth scales, as well as the dependence on physical development assessment indices. Pearson's correlation coefficient was used to establish the correlation.

As a result, it was found that high scores when performing motor acts On the scale GMFM-88 correlate with a mild degree of PED, with an increase in the deficit of motor activity, there is an increase in the degree of PED, which is confirmed by the inverse correlation of the signs of a strong close relationship – r=0.705 (P<0.01). The findings are presented in Figure 15.

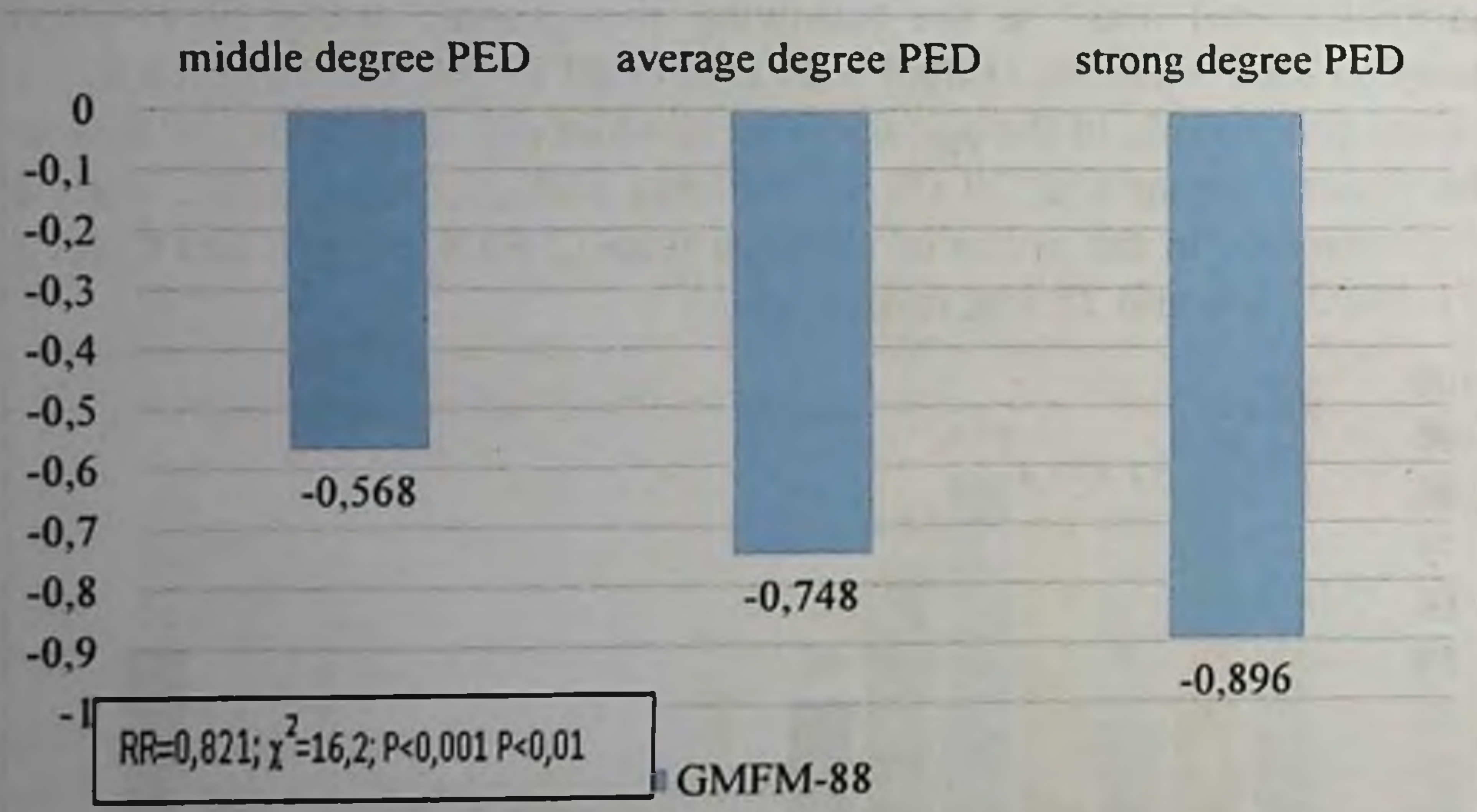


Figure 15. Indicators of correlation between the level of motor activity deficit and the degree of PED

A similar picture is observed in the correlation assessment of the effect of spasticity on the Ashworth scale on the development of PED in children with cerebral palsy, and correlations with Signs High close relationship – r=0.535 (P<0.05) (Fig. 16).

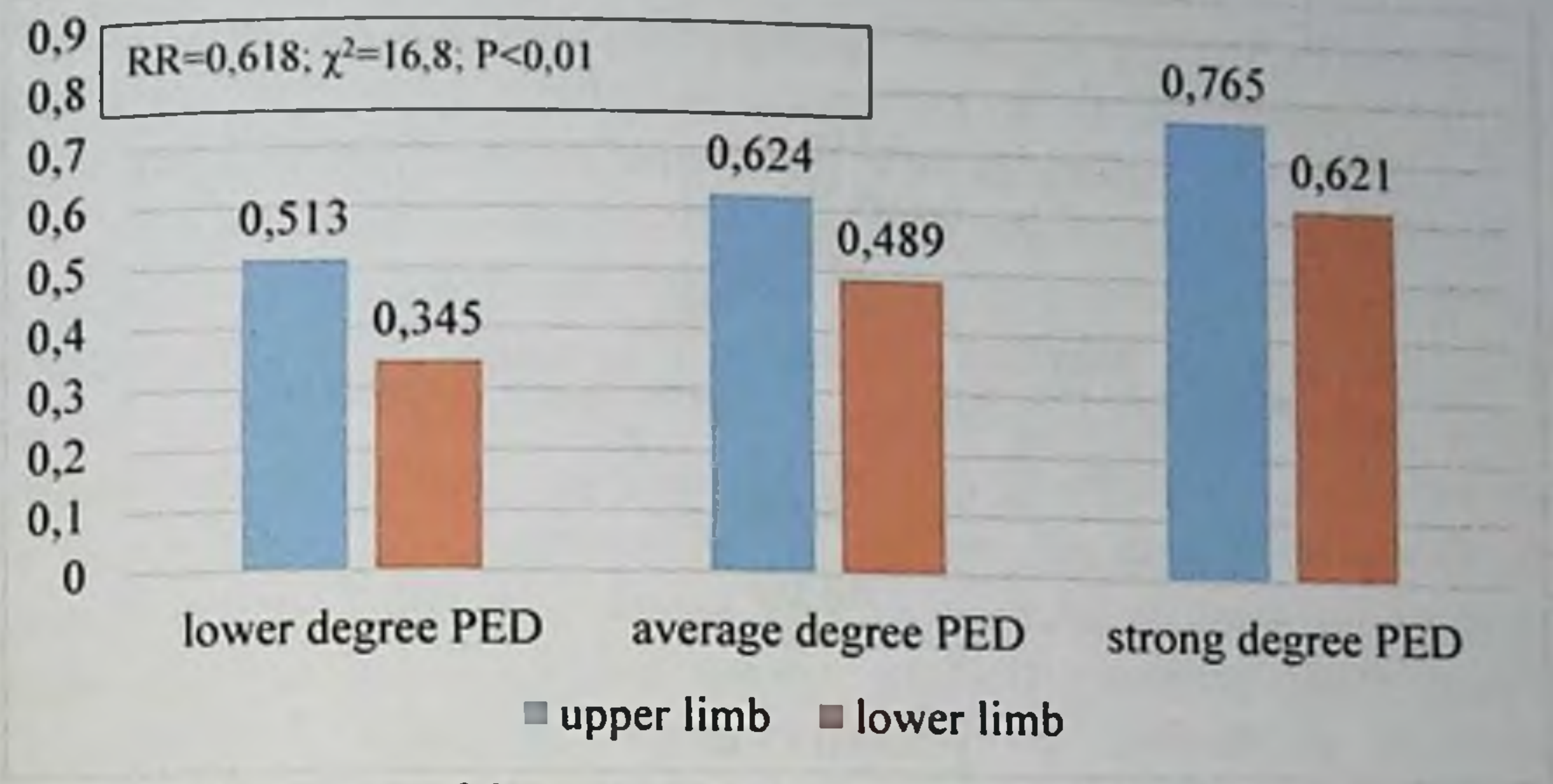


Figure 16. Indicators of the correlation between spasticity and the degree of PED

The diagram shows that the highest correlations between the development of PED were revealed in spasticity of the upper limbs in children with cerebral palsy compared to the lower limbs. For example, in mild PED, there were moderate relationships with spasticity of the upper extremities (r=0.513; $\chi2$=13.7; P<0.05), whereas in severe PED, there was a strong direct close relationship (r=0.765); $\chi2$=19,7; P<0.001.

In sick children with forms G 80.0 and G 80.8, the correlation between PED and spasticity severity was more pronounced with signs of a medium close relationship, which averaged r=0.715 (P<0.05) in the forms.

Analyzing the data of the correlation analysis of the influence of functional status on the basis of the assessment of large motor functions according to the GMFCS scale, a direct, medium and strong dependence of the degree of PED on the level of motor deficit in children with cerebral palsy was established (Fig. 17), so with a mild degree of PED - r=0.412 (P<0.05), moderate - r=0.511 (P<0.05), severe - r=0.702 (P<0.01).

As can be seen from the data presented in the diagram, a severe degree of PED has a strong correlation with level V on the GMFCS scale. This is due to the fact that at level V, a child with cerebral palsy has pronounced impairment of motor functions against the background of a significant limitation of independent movements and a decrease in the ability to self-care, including independent eating.

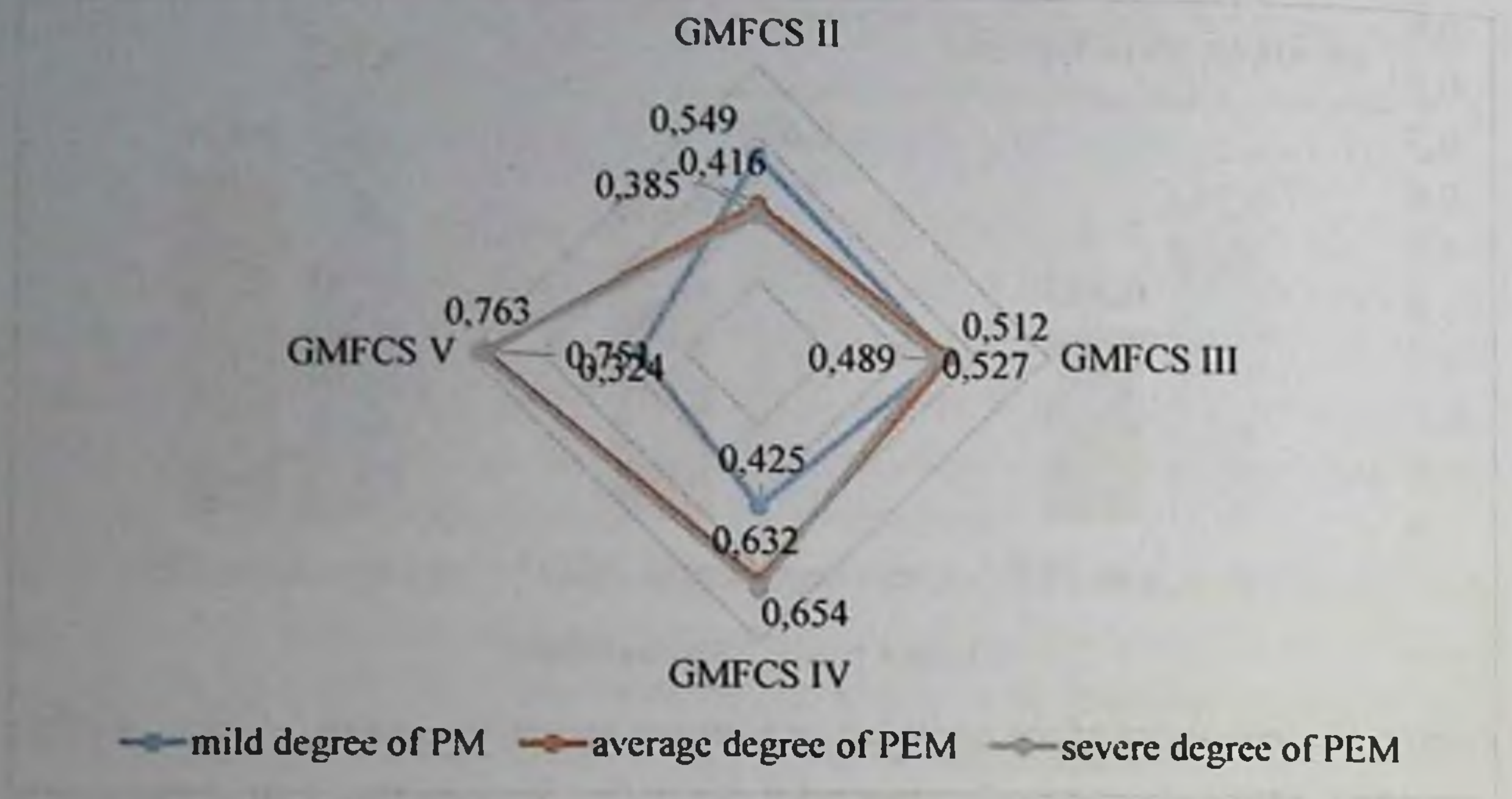


Figure 17. Indicators of correlation between the level of motor deficit according to the GMFCS scale and the degree of PED

An assessment of the correlation between the degree of PED and the level of activity of the upper extremities according to the MACS scale revealed signs of medium and high closeness of the connection (Fig. 18). As can be seen from the above data, in children with cerebral palsy, there is a correlation between the severity of PED and the level of activity of the upper limb according to the MACS scale. Thus, at the 1st level of activity of the upper extremity, there are signs of a direct close relationship with a mild degree of PED (r=0,623; P<0.01), whereas at the 5th level of activity there is a high direct close relationship with a severe degree of PED (r=0.778; P<0.01).

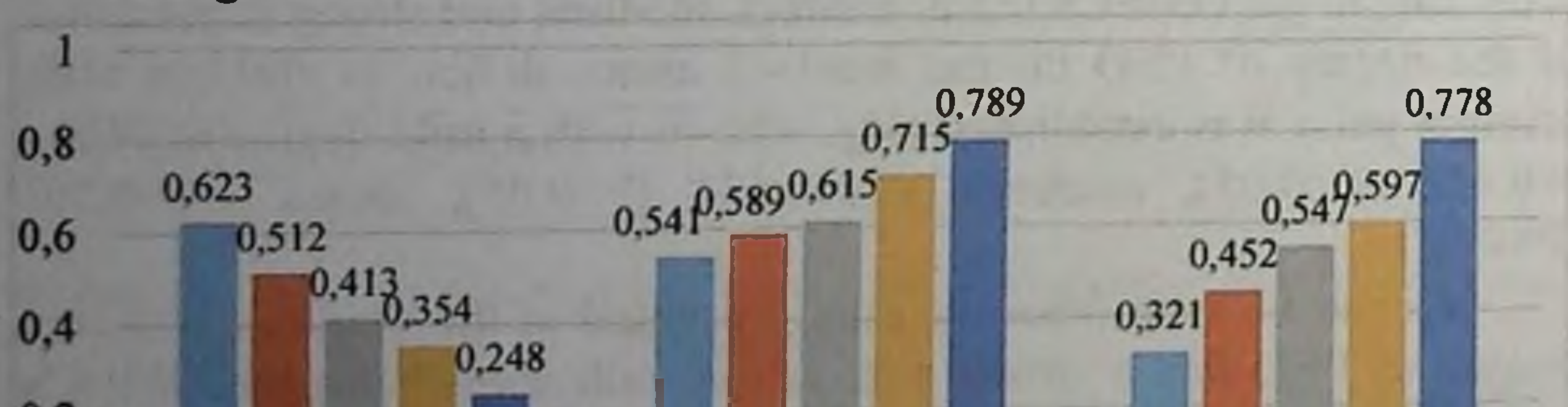


Figure 18. Indicators of correlation between the level of motor activity deficit in the upper extremities and the degree of PED

The data obtained suggest that the level of activity of the upper limb according to the MACS scale has a direct impact on the development of PED and its severity in cerebral palsy.

As mentioned above, in children with cerebral palsy, there was a dysfunction of the communicative status, the severity of which depended on the topographic form of the disease and the severity of motor disorders. When comparing the impact of communicative status dysfunction on the development and severity of PED, it was found that the more severe the dysfunction, the deeper the degree of nutritional status disorders. Thus, it is shown that the increase in the severity of the degree of PED is proportional to the level of communicative activity from CFCS I, when the child was able to effectively exchange information not only with family members, but also with strangers, up to CFCS Y, when communication proved ineffective even with close partners. Have been established the medium and high indicators of close connectivity are shown in Figure 19. It has been found that with a mild degree of PED - $r=0.389$ ($P<0.05$), moderate - $r=0.522$ ($P<0.05$), severe - $r=0.769$ ($P<0.01$).

This fact has a logical basis, since cognitive impairment is one of the non-nutritional factors that affect food intake and nutritional status in children with cerebral palsy. And a decrease in communication skills leads to the child's inability to communicate hunger and demand food or drink.

At a further stage, we carried out a correlation analysis of the prediction of the development and severity of PED depending on the physical development of children with cerebral palsy. When comparing the anthropometric characteristics obtained, the predominance of disharmonious physical development among children with cerebral palsy was diagnosed, in contrast to the examined children of the control group.

The analysis of the correlation with the Rohrer index was not carried out, since according to this index, most of the children with cerebral palsy had harmonious development, which cannot correlate with the severity of PED, since almost all children were short and underweight.

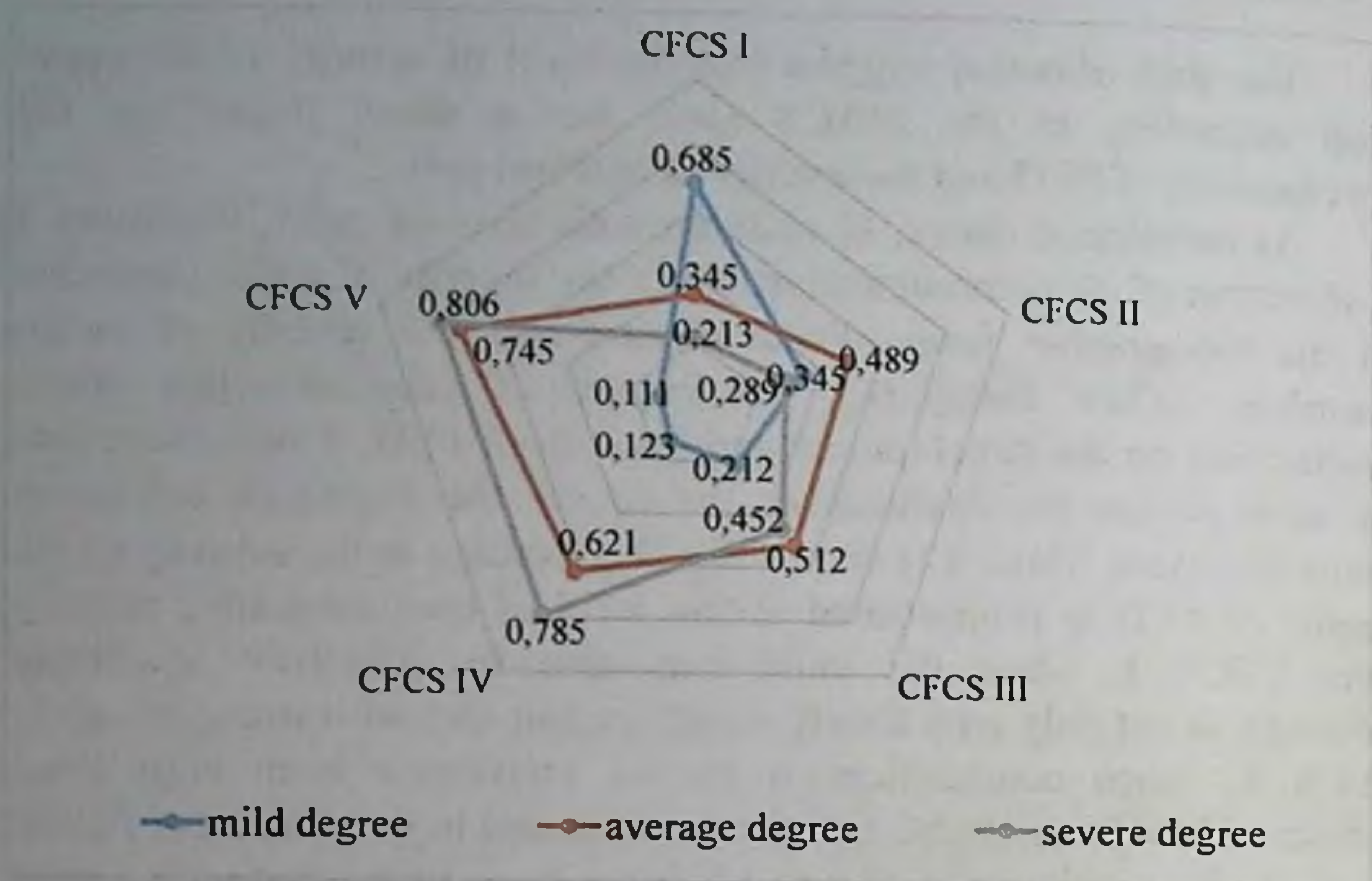


***Figure 19.** Indicators of correlation between the level of communicative activity and the degree of PED*

The most optimal for the correlation between anthropomorphometric parameters and the development of PED is the Pinier index, which characterizes the child's body type, taking into account body weight, height, and chest circumference. In children with cerebral palsy, when calculating this index, low physical development and physique prevailed - 64.5%, 34.1% below average, and only 1.4% - average. In the course of correlation analysis, it was found that the development of PED and the severity of its course are inversely proportional to the physical development of this cohort of children, i.e. the higher the severity of PED, the lower the physical development of the child (Fig. 20).

As a result of the analysis, a significantly high correlation was established with a severe degree of PED and low physical development of the child ($r=-0.892$; $\chi2=19.3$; $P<0.001$), whereas with a mild degree of PED, a strong feedback relationship was established with the average physical development of a child with cerebral palsy ($r=-0.685$; $\chi2=16.3$; $P<0.01$).

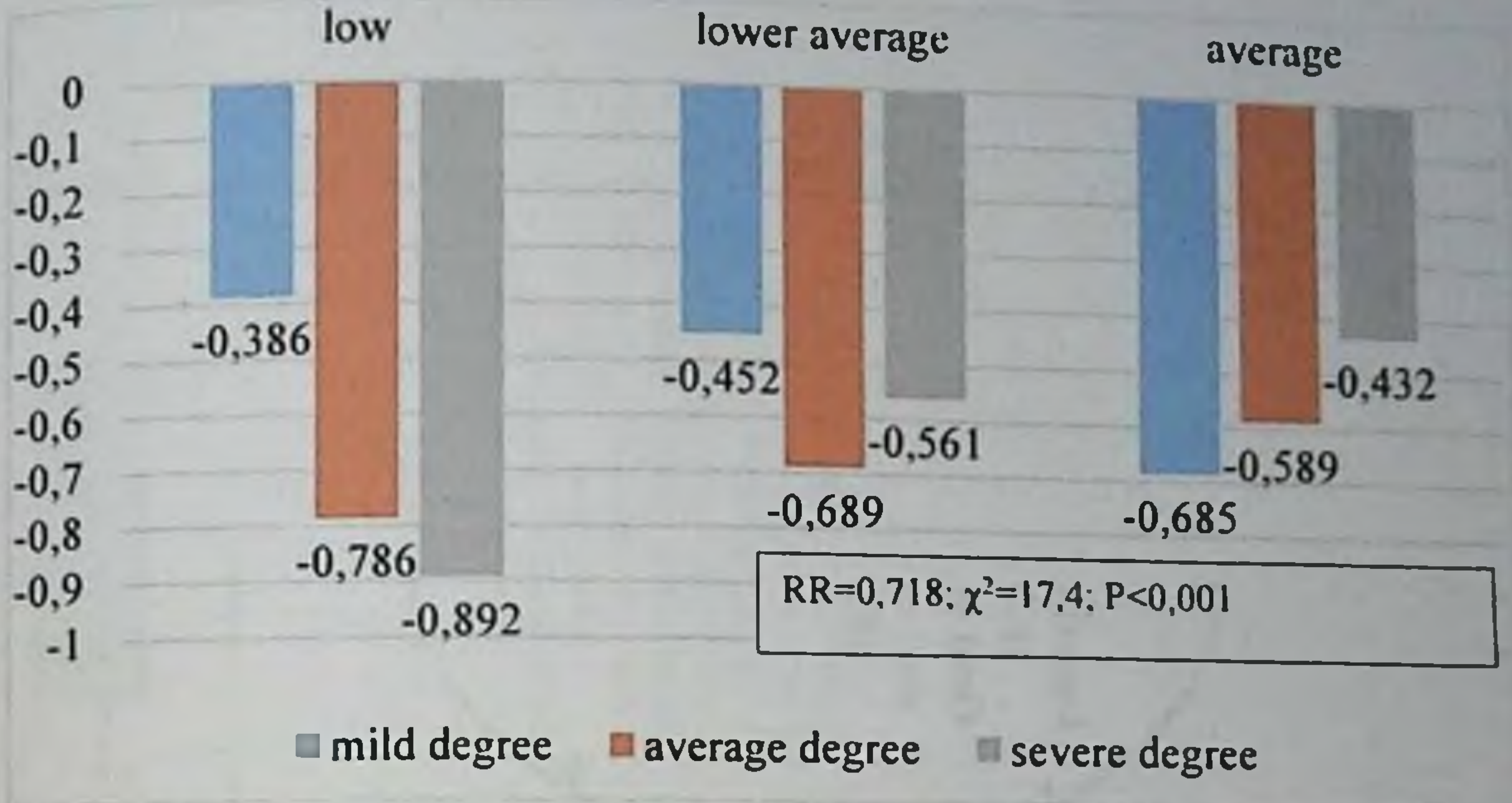
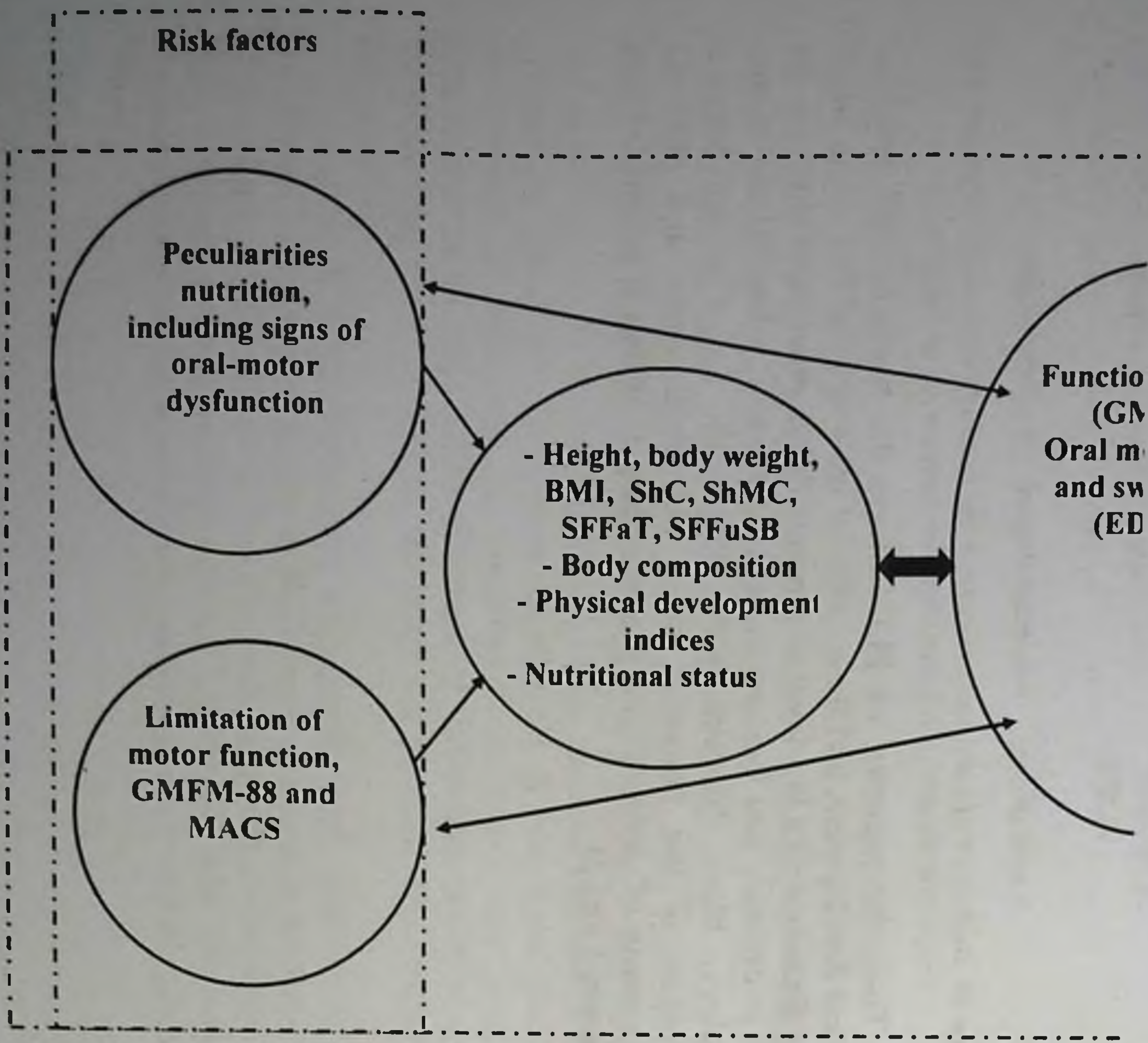


Figure 20. *Indicators of correlation between the level of physical development and the degree of PED in children with cerebral palsy*

Thus, the presence of PED affects the harmony and level of physical development, and the severity of the course of PED contributes to the formation of a low level of physical development and physique. In order to optimize and increase the effectiveness of rehabilitation in this pathology, block diagrams were drawn up for a comprehensive assessment of the functional state, nutritional status and physical development of children with cerebral palsy in different periods of life (Schemes 1 and 2).



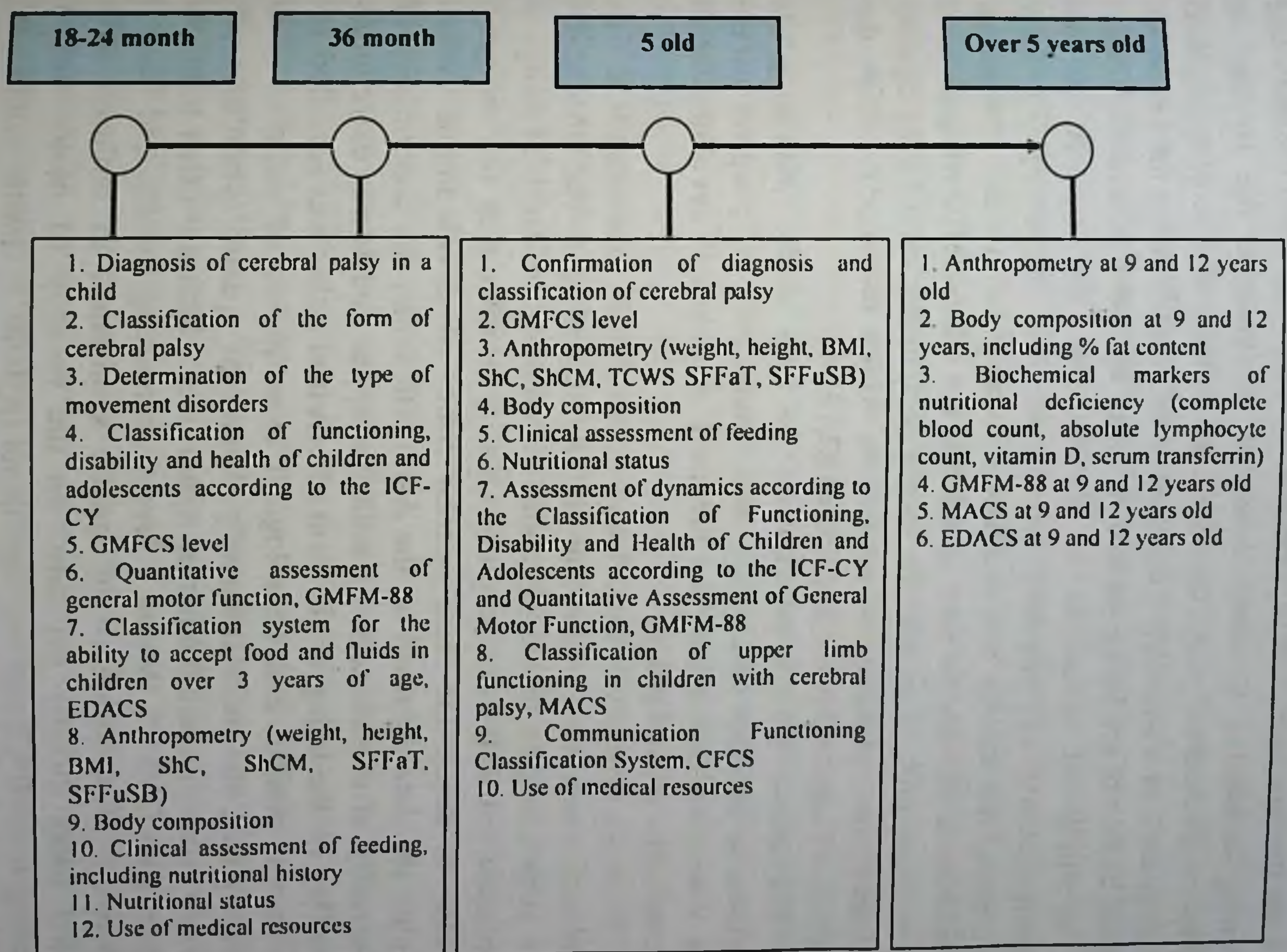


Figure 2. Clinical and neurological examination of children with cerebral palsy in different periods of life

CONCLUSION

In the new millennium, scientific research has been initiated and is being conducted in many countries to optimize the therapy of patients with cerebral palsy, therefore, the aspects of assessing physical development, as a significant component of rehabilitation interventions in such children, are being studied in detail by many scientists. Today, the attention of scientists is focused on the aspects of the etiopathogenesis of physical retardation, the frequency of their occurrence, the variety and multidirectionality of clinical symptoms, rehabilitation and correctional problems, the dependence of quality of life on them, and, of course, the issues of dynamic monitoring against the background of adequate resolution, which ultimately affects the prognosis of cerebral palsy in children [2,15,36].

The above was a prerequisite for this study, indicating its relevance in modern conditions, and determined the purpose of the work - to study and assess the harmony of physical development of patients with cerebral palsy.

With an objective clinical and neurological assessment, it was found that when analyzing motor activity according to the GMFM-88 scale, depending on the topographic distribution of cerebral palsy, it is possible not only to accurately identify problems at the moment, but also to determine their nearest zones of development. When studying the data obtained on the Ashworth scale, the dependence of the severity of muscle tone of both the upper and lower extremities depending on the topographic form of cerebral palsy was revealed.

In the clinical and neurological examination of children with cerebral palsy, the most frequently diagnosed spastic syndromes are adductor syndrome and hamstring syndrome, which are often noted in children with GMFCS IV and V levels, amounting to 90% and 92.3%, respectively. The incidence of spastic syndromes in children with cerebral palsy directly depended on the severity of motor deficit according to GMFCS and was significant ($p \leq 0.001$): spastic syndromes were significantly more common in children with severe impairments of global motor functions. These data are consistent with the studies of other authors [26,66,102].

When studying physical development, children with cerebral palsy not only had low body weight, but were short in relation to their peers from the control group. The lowest values in terms of somatometric parameters of body weight, height, and chest circumference were observed in such forms of cerebral palsy as G 80.0, G 80.3, G 80.4 and G 80.8. Similar data were obtained by Ruzieva N.K. et al. (2016), who studied anthropometric parameters and found that the height of children with cerebral palsy in all age groups is less than that of healthy children, and body weight changes unevenly [55]. Ovcharenko E.S. (2014) et al. It was found that children with cerebral palsy had statistically significantly lower height, body weight, and head circumference compared to the control group [8].

In children with spastic forms of cerebral palsy (diplegia and hemiplegia), compared to other forms of the disease, higher body weight is noted, and the authors explain less muscle mass in children with hyperkinetic forms by constant muscle spasm, which characterizes them [28]. In our studies, overweight and obesity were not diagnosed in all analyzed topographic forms of cerebral palsy.

Somatometric measurements and assessment of the physical development of children with cerebral palsy according to the Rohrer, Piñer, Brugsch and Verveck indices allow us to conclude that such children have a significantly inhibited adaptive ability, and there is a disharmony of physical development, which is revealed when studying anthropomorphometric parameters.

For example, the study of body density according to the Rohrer index showed that in 62.5% of cases, children in the control group are characterized by average or normal physical development, with an index value of 10.7-13.7 kg/m3. Whereas in cerebral palsy there was a low physical development, in most cases in the forms G 80.0 (37.2%), G 80.1 (25.6%) and G 80.8 (22.9%).

Analysis of the data obtained in the study of the Pinier index in children with cerebral palsy, regardless of the topographic form, indicated the predominance of physical development and physique below average (index values of 26-35 units) and low (index values of >36 units). The values of the Pinje index >36 units were noted in 138 cases in children with cerebral palsy, which amounted to 64.5%.

The study of proportionality on the basis of the Brugsch index indicates that children with cerebral palsy have a disharmonious and disproportionate physique, they have a weak development of the chest. Comparative characteristics of the Brugsch index showed the predominance of children with a disharmonious body type due to narrow-chested body in the following topographic forms of cerebral palsy: G 80.0 – 88.4%; G 80.4 – 84,6%; G 80.1 – 82,1%. At the same time, Brugsch index values comparable to the age norm were observed in 55% of children in the control group and 20.1% of patients with cerebral palsy, with a predominance in the group of children with G 80.8, G 80.3 and G 80.2 (31.4%, 22.6% and 22.5%, respectively).

The obtained data on the interpretation of the Pinier index of 26-35 units in 34.1% of children with cerebral palsy indicated poor physical development, significantly more often in the group of children with form G 80.8 (48.6%). Normal or average physique and physical development were determined in 82.5% of children in the control group, while average physique with a Piñé index of 21-25 units was recorded only in forms G 80.0 and G 80.4 (4.6% and 3.8%, respectively).

According to the data obtained by a number of authors, 30% or more of children with cerebral palsy have disharmony of physical development, often as a consequence of oral-motor dysfunction, including problems with sucking (57%), dysphagia (38%), and lack of independence in the process of eating (80%) [45].

On the basis of the data obtained, a program for a comprehensive assessment of the physical development of children with cerebral palsy by the method of indices has been developed, which makes it possible to increase the accuracy of assessing disharmonious development among this category of children. Functionality of the program: registration of the patient's card, anthropometric measurements, collection, input, storage of data on clinical, neurological, anthropometric studies. The program makes it possible to comprehensively assess the physical development of children with cerebral palsy and build an individual program of rehabilitation measures taking into account the data obtained.

The implemented program made it possible to conduct a correlation analysis of the prediction of the development and severity of PED depending on the physical development of children with cerebral palsy. The most optimal for correlation is the Pinier index, which characterizes the body type of the child, taking into account body weight, height and chest circumference. According to the data obtained, when calculating the Piñé index, children with cerebral palsy had a predominant low physical development and physique - 64.5%, 34.1% below average, and only in 1.4% of cases average physical development and mesomorphic body type were revealed. In the course of the correlation analysis, it was found that the development of PED and the severity of its course are inversely proportional to the physical development of this cohort of children, i.e. the higher the severity of PED, the lower the physical development of the child. A significantly high correlation was found with a severe degree of PED and low physical development of the child ($r=-0.892$; $\chi2=19.3$; $p<0.001$), whereas with a mild degree of PED, a strong feedback was established with the average physical development of a child with cerebral palsy ($r=-0.685$; $\chi2=16.3$; $p<0.01$). A number of studies have shown that the physical development of children with GMFCS level I does not differ from that of the control group, whereas with an increase in the level of GMFCS from II to V, the number of children with cerebral palsy with pronounced deviations in physical development increases [45].

Table 16

Program for calculating the physical development of children with cerebral palsy

№	Index	Formula	Age	Result	Interpretation	Points
1	*Rorera Index I (kg/m^3)*	*W/H3*, where W is the body mass (kg), H is the body length (m)	Children & Teens	<10.7 kg/m^3	Low physical development	1
				10.7-13.7 kg/m^3	harmonious, average or normal physical development of children	2
				> 13.7 kg/m^3	Overgrowth or high physical development	3
2	*Piñé Index I (units)*	*H – (W + CC), where H is the body length (cm)*, W is the body weight (kg), CC is the chest circumference in the expiratory phase (cm)	Children & Teens	>36 units	Physical development and physique are low, very weak	0
				26-35 units	Physical development and physique below average, weak	1
				21-25 units	Physical development and physique are average	2
				10-20 units	Physical development and physique above average, normal	3
				<10 units	Strong physique and high physical development	4
					Medium build 2-3 liters – 23, 6-7 л – 30-35, 8-15 л – 26-35.	
3	*Brugsch Index I (%)*	*OGK × 100/H*, where OGK is the chest circumference (cm); H – body length (cm)	up to 1 year	<65	narrow-chested	1
				65-68%	Normal chest	2
				>68%	Broadness	3
			2-3 years	<60	narrow-chested	1
				60-64%	Normal chest	2
				>64%	Broadness	3
			up to 7 years	<52%	narrow-chested	1
				52-63%	Normal chest	2
				>63%	Broadness	3
			over 7 years old	<50%	narrow-chested	1
				55-50%	Normal chest	2
				>55%	Broadness	3
4	*Index Verveka I (ed.)*	*H/(2×W +OGK)*, where H is the length of the body (cm); W is the body weight (kg); OGK – chest circumference (cm)	Childhood and adolescence	<0.75 units	severe growth retardation, severe brachymorphia	0
				0.75-0.85 units	moderate stunting, moderate brachymorphia	1
				0.85-1.25 units	Mesomorphic body type, harmonious development of the child	2
				1.25-1.35 units	moderate dolichomorphy, predominance of height in length	3
				>1.35	pronounced dolichomorphy, tall stature	4

INDINGS

1. Analysis of the assessment of motor activity in children with cerebral palsy according to the GMFM-88 scale reveals the lowest level of motor skills performance in quadriplegia - 35.3±3.4% (P<0.01); practically no functional activity of the upper extremities according to the MACS scale at G80.0 (66.7%), G 80.2 (28.6%) and G80.8 (45.8%). Incidence of communicative functioning disorders in children with quadriplegia (G 80.0) and other types of cerebral palsy (G 80.8) were statistically significantly higher (P<0.01) than in children with unilateral spastic paralysis (G 80.2) and spastic diplegia (G 80.1). According to the analysis of the ICF questionnaire, disorders of the structure and function, activity and participation of the patient, the social status of the family and the motivation of the parents, environmental factors and personal characteristics of the patient with cerebral palsy, the severity of which significantly prevailed in the forms of G 80, were established. 0, G 80.3 and G80.8 (P<0.01).

2. Assessment of the physical development of children with cerebral palsy according to the Rohrer, Piñe, Brugsch and Verveck indices demonstrates a noticeable decrease in the adaptive ability of the body with a disharmonious type of development and characteristic anthropometric features (weight loss, short stature and narrow-chestedness). Anthropometric parameters and their assessment showed a significant decrease in them with an increase in the degree of neurological disorders in cerebral palsy. Significantly low indicators of physical development were revealed in 98.6% of children with cerebral palsy, and narrow-chested - in 79.9%.

3. BMI assessment for diagnosing developmental disorders in children with cerebral palsy is insufficient to obtain an adequate analysis. In this regard, the study of this cohort of children should include an assessment of the % fat content, which will allow for a more accurate assessment and identification of changes for their subsequent correction. In the G 80.0 form, the % fat content deviated from the control group by 38.1%, in the G 80.1 form by 14.2%, in the G80.2 form by 21.3%, in the G 80.3 form by 27.7%, in the G 80.4 form by 25.2%, and in the G 80.8 form by 28.4%.

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APPLICATION

Annex 1

International Classification of Functioning, Disability and Health, Children and Youth Version, ICF-CY

	Body structures n= 1
s110	Structure of the Brain
	Bodily functions n= 8
b117	**Intelligent Features** Common mental functions required to understand and constructively integrate various mental functions, including all cognitive functions and their development throughout life. Included: Smart Growth Features; Intellectual Delay, Mental Retardation, Dementia Excluded: Memory functions (b144); Thinking Functions (b160) High-Level Cognitive Functions (b164)
b134	**Sleep Functions** The general mental functions of periodic, reversible, and selective physical and mental withdrawal directly from the environment, which is accompanied by characteristic physiological changes. Included: Sleep Quantity, Falling Asleep, Sleep Maintenance and Sleep Quality Functions; functions involved in the sleep cycle, such as the development of insomnia, hypersomnia, and narcolepsy Excluded: functions of consciousness (b110); volitional and motivating functions (b130); Attentional functions (b140) Psychomotor Functions (b147)
b167	**Mental Functions of Speech** Specific mental functions of recognizing and using signs, symbols, and other components of language. Included: Functions for perceiving and deciphering spoken, written, or other forms of language, such as sign language; functions of expression in the form of spoken, written speech or other forms of language; integral functions of language, speech, and writing, e.g., those responsible for the appearance of aphasia of perception, expression, Broca, Wernicke, and conduction.
b210	**Vision Functions** Sensory functions related to the perception of light, as well as the sensation of shape, size, contour, and color of visual stimuli. Included: Visual Acuity Features; visual field functions; quality of vision; functions of light and color perception, distance and near visual acuity, monocular and binocular vision; panoramic vision; disorders such as nearsightedness, farsightedness, astigmatism, hemianopsia, color

	blindness, tunnel vision, central and peripheral scotoma, diplopia, night blindness, and impaired adaptation to light Excluded: perceptual functions (b156)
b280	**Sensation of pain** A feeling of discomfort indicating potential or actual damage to some structure of the body. Included: sensations of generalized or localized pain in one or more multiple parts of the body, dermatome pain, cramping pain, burning pain, dull pain, aching pain; disorders such as myalgia, analgesia, hyperalgesia
b 710	**Joint Mobility Functions** Functions of volume and freedom of movement in the joints. Included: mobility functions of individual or multiple joints, vertebral, shoulder, elbow, wrist, hip, knee, ankle, small joints of the arms and legs; joint mobility is general; disorders such as excessive joint mobility, joint stiffness, shoulder stiffness, arthritis Excluded: joint stability functions (b715); Control of Voluntary Motor Functions (b760)
b 735	**Functions of Muscle Tone** Functions related to muscle tension at rest and resistance exerted during passive movement. Included: functions related to the tone of isolated muscles and muscle groups, muscles of one limb, one side of the body and the lower half of the body, muscles of all limbs, muscles of the trunk and all muscles of the body; disorders such as hypotension, hypertension, muscle spasticity Excluded: Muscle Strength Functions (b730); Muscular Endurance Functions (b740)
b760	**Control of voluntary motor functions** Functions related to the control and coordination of voluntary movements. Included: Control of Simple Voluntary Movements and Complex Voluntary Movements, Coordination of Voluntary Movements, Supporting Functions of Arm and Leg, Motor Coordination Right - Left, Eye Coordination - Hand and Eye Coordination - Leg; disorders such as control and coordination problems, dysdiadochokinesis Excluded: Muscle Strength Functions (b730); involuntary motor functions (b765); Gait Stereotype Functions (b770)
	Activity and participation of the organism n= 8
d 415	**Maintaining Body Posture** Staying in the required position for as long as required, such as sitting or standing at work or school. Included: lying, squatting, kneeling, standing and sitting
d 440	**Using precise hand movements** Performing coordinated hand actions with objects, grasping,

	manipulating, and releasing them with the hand, fingers, and thumb, such as picking up coins from a table, dialing a phone number, or pressing a pen. Included: pick-up, grab, manipulate and release Excluded: lifting and moving objects (d430)
d450	**Walking** Moving on the surface on foot, step by step, so that one foot is always touches the surface, e.g. when walking, walking forward, backward, sideways. Included: short or long distance walking; walking on various surfaces; Walking around obstacles Excluded: body locomotion (d420), locomotion in ways other than walking (d455)
d460	**Getting Around in Different Places** Walking and moving around in a variety of places and situations, such as walking from room to room in an apartment, within a building, or along a city street. Included: moving within the confines of one's dwelling and other buildings, crawling or overcoming obstacles within one's dwelling and other buildings; walking and moving around outside your home and outside other buildings
d530	**Physiological Dispatches** Preparation and implementation of physiological functions (during menstruation, urination and defecation) and subsequent implementation of hygienic measures. Included: regulation of urination, defecation and activities related to menstruation Excluded: washing (d510); Body Parts Care (d520)
d550	**Meal** Performing coordinated actions and requirements when eating, bringing food to the mouth, consuming it in culturally appropriate ways, e.g., cutting, breaking food into pieces, opening bottles and jars, using cutlery, eating, eating at a banquet or lunch. Excluded: Drinking (d560)
d710	**Basic Interpersonal Interactions** Engaging with people in a way that is appropriate and socially acceptable, such as showing attention and respect on appropriate occasions, or responding to the feelings of others. Included: respect and cordiality in relationships, positive perception of relationships, showing tolerance in relationships; criticism in relationships, hints in relationships; Acceptable Physical Contact in a Relationship
d760	**Family Relations**

	Creating and maintaining family and kinship relationships, e.g., with the immediate and extended family environment, with the foster and adoptive family, as well as other more distant levels of kinship, e.g., with second cousins, guardians. Included: parent-child relationships, children-parents, children in the family, with distant relatives
	Environmental factors n=8
e115	**Products & Technologies for Personal Everyday Use** Equipment, products and technologies used by people on a daily basis, including adapted or specially designed types of them, located in, on the body or near the individual using them. Included: Basic and auxiliary products and technologies for personal use
e120	**Products and technologies for personal, indoor and outdoor transport** Equipment, products and technologies used by people on a daily basis for movement and movement inside and outside buildings, including adapted or specially designed types of them located inside, on the body or near the individual using them. Included: basic and auxiliary products and technologies for personal, indoor and outdoor transportation
e125	**Communication Tools and Technologies** Equipment, products and technologies used by people in their activities to exchange and receive information, including adapted or specially adapted developed species of them located in, on the body, or near the individual using them. Included: Basic and Auxiliary Communication Tools and Technologies
e150	**Design, nature of the design, construction and arrangement of buildings for public use** Products and technologies for the arrangement of the internal and external environment that are planned, designed and implemented for public use, including adapted or specially designed types thereof. Included: Design, nature of design, construction and arrangement of entrances and exits, interior amenities and signage
e310	**Family & Immediate Relatives** Individuals related by birth, marriage, or other culturally recognized relationships, such as spouses, partners, parents, blood siblings, children, guardians, adoptive parents, and grandparents. Excluded: Distant relatives (e315); Care and Assistance Personnel (e340)
e320	**Friends** Individuals with whom close and ongoing relationships are characterized by complete trust and mutual assistance.
e460	**Public Attitudes**

	General or specific opinions and points of view, generally shared by people of the same culture, society, subculture or some other social group, about other individuals or issues concerning social, political and economic problems that affect the individual or group behaviour and actions of individuals.
e580	**Health services, administrative systems and policies** Services, administrative systems and policies for disease prevention and treatment, provision of medical rehabilitation and promotion of healthy lifestyles. Excluded: services, administrative systems and general social support policies (e575)

xxxx.0 NO problems (none, none, negligible,...) 0-24%
xxx.1 MILD problems (minor, mild,...) 5-24%
xxxx.2 MODERATE problems (medium, significant,...) 25-49%
xxx.3 SEVERE problems (high, intense,...) 50-95%
xxx.4 ABSOLUTE problems (complete,...) 96-100%
xxx.8 not defined

Annex 2

Gross Motor Function Measure, GMFM-88

Position A (17 acts): Lying Down and Rolling Over	Number of points				NT
1. **Lying on the back, head in the midline:** turns the head with symmetrical limbs	0 □	1 □	2 □	p. 3□	1.
2. **Lying on your back:** brings your hands to the middle line, joins your fingers together	0 □	1 □	2 □	p. 3□	2.
3. **Lying on your back:** raises your head 45°	0 □	1 □	2 □	p. 3□	3.
4. **Lying on your back:** fully PEDds the right hip and PEDds the right knee	0 □	1 □	2 □	p. 3□	4.
5. **Lying on the back:** fully PEDds the left hip and PEDds the left knee	0 □	1 □	2 □	p. 3□	5.
6. **Lying on the back:** stretches the right hand towards the toy, the hand crosses the median line in the direction of the toy	0 □	1 □	2 □	p. 3□	6.
7. **Lying on the back:** reaches with the left hand towards the toy, the hand crosses the median line in the direction of the toy	0 □	1 □	2 □	p. 3□	7.
8. **Lying on the back:** rolls over onto the stomach through the right side	0 □	1 □	2 □	p. 3□	8.
9. **Lying on the back:** rolls over onto the stomach through the left side	0 □	1 □	2 □	p. 3□	9.
10. **Prone position:** lifts the head up	0 □	1 □	2 □	p. 3□	10.
11. **Prone position with support on the forearms:** raise the head up, arms extended at the elbows, chest raised	0 □	1 □	2 □	p. 3□	11.
12. **Prone position with support on the forearms:** load on the right forearm, the opposite arm is fully extended forward	0 □	1 □	2 □	p. 3□	12.
13. **Prone position with support on the forearms:** load on the left forearm, the opposite arm is fully extended forward	0 □	1 □	2 □	p. 3□	13.
14. **Prone position:** rolls over onto the back through the right side	0 □	1 □	2 □	p. 3□	14.
15. **Prone position:** rolls over onto the back over the left side	0 □	1 □	2 □	p. 3□	15.

16. **Prone position:** Rotates 90° to the right using the limbs	0 □	1 □	2 □	p. 3□	16.
17. **Prone position:** turns 90° to the left using the limbs	0 □	1 □	2 □	p. 3□	17.
TOTAL PARAMETERS "A"					
Position B (20 acts): Seated position	**Number of points**				**NT**
18. **Supine position (the examiner holds the child's hands):** pulling himself up, he tries to take a sitting position while controlling the position of the head, holding the head	0 □	1 □	2 □	p. 3□	18.
19. **Supine position:** rolls to the right side, takes a sitting position	0 □	1 □	2 □	p. 3□	19.
20. **Supine position:** rolls to the left side, takes a sitting position	0 □	1 □	2 □	p. 3□	20.
21. **Sitting position on a mat (mat); the therapist supports the chest:** raises the head up, holds it for 3 seconds	0 □	1 □	2 □	p. 3□	21.
22. **Sitting position on a mat (mat); the therapist supports the chest:** holds the head in the middle position for 10 seconds	0 □	1 □	2 □	p. 3□	22.
23. **Sitting on a mat (mat), leaning on the arm(s):** maintains the position for 5 seconds	0 □	1 □	2 □	p. 3□	23.
24. **Sitting position on the mat (mat):** maintains the position without leaning on the hands for 3 seconds	0 □	1 □	2 □	p. 3□	24.
25. **Sitting on a mat (mat) with a small toy in front:** leans forward, touches the toy or picks up the toy, returns to the starting position without leaning on the hands	0 □	1 □	2 □	p. 3□	25
26. **Sitting position on the mat (mat):** touches the toy or takes the toy located 45° behind the child on the right side, returns to the starting position	0 □	1 □	2 □	p. 3□	26.
27. **Sitting position on the mat (mat):** touches the toy or picks up a toy located 45° behind the child on the left side, returns to the starting position	0 □	1 □	2 □	p. 3□	27.

28. **Right Side Rotated Seated (Right Side Seat):** Maintains a non-arm-supported position for 5 seconds.	0 □	1 □	2 □	p. 3□	28.
29. **Left Side Turn Seated (Left Side Seat):** Maintains a non-arm-supported position for 5 seconds.	0 □	1 □	2 □	p. 3□	29.
30. **Sitting position on the mat (mat):** lowered to get into a prone position with control	0 □	1 □	2 □	p. 3□	30.
31. **Sitting on a mat (mat) with legs stretched forward:** gets on all fours through the right side	0 □	1 □	2 □	p. 3□	31.
32. **Sitting on a mat (mat) with legs stretched forward:** gets on all fours through the left side	0 □	1 □	2 □	p. 3□	32.
33. **Sitting position on the mat:** swivels 90° hands-free	0 □	1 □	2 □	p. 3□	33.
34. **PEDch Sitting Position:** Maintains a position with free arms and legs for 10 seconds	0 □	1 □	2 □	p. 3□	34.
35. **Standing position:** Takes a sitting position on a low PEDch	0 □	1 □	2 □	p. 3□	35.
36. **Floor Position: Reaches** a sitting position on a low PEDch	0 □	1 □	2 □	p. 3□	36.
37. **Floor Position: Reaches** a sitting position on a high PEDch	0 □	1 □	2 □	p. 3□	37.
TOTAL PARAMETERS "B"					
Position C (14 acts): Crawling and kneeling	**Number of points**				**NT**
38. **Prone position:** Crawls forward 1.8 m (6 ft)	0 □	1 □	2 □	p. 3□	38.
39. **Four-Point Position:** Holds weight on hands and knees for 10 seconds	0 □	1 □	2 □	p. 3□	39.
40. **Four-point position:** sitting, sitting, not leaning on the hands	0 □	1 □	2 □	p. 3□	40.
41. **Prone position:** gets on all fours, holds the weight on the hands and knees	0 □	1 □	2 □	p. 3□	41.
42. **Four-point position:** extends the right arm forward, the hand is above shoulder level	0 □	1 □	2 □	p. 3□	42.
43. **Position on points:** stretches the left arm forward, the hand is above shoulder	0 □	1 □	2 □	p. 3□	43.

level					
44. **Four-point position:** Crawls or jerks forward 1.8 m (6 ft)	0 □	1 □	2 □	p. 3□	44.
45. **Four-point position:** Crawls 1.8 m (6 ft) forward (alternating arm and leg movements)	0 □	1 □	2 □	p. 3□	45.
46. **Four-Point Position:** Climb 4 steps up the ladder on the hands and knees (feet)	0 □	1 □	2 □	p. 3□	46.
47. **Four-Point Position:** Descends 4 steps down the stairs on the hands and knees (feet)	0 □	1 □	2 □	p. 3□	47.
48. **Sitting on a mat (mat)** takes a kneeling position with the body straightened, maintains the position, hands are free for 10 seconds	0 □	1 □	2 □	p. 3□	48.
49. **Kneeling position with the body straightened:** takes a standing position on one right knee with the body extended using the arms, maintains the position, hands free for 10 seconds	0 □	1 □	2 □	p. 3□	49.
50. **Kneeling position with the body straightened:** takes a standing position on one left knee with the body extended using the arms, maintains the position, hands free for 10 seconds	0 □	1 □	2 □	p. 3□	50.
51. **Kneeling position with the body straight:** 10 steps on the knees without the use of hands	0 □	1 □	2 □	p. 3□	51.
TOTAL PARAMETERS "C"					
Position D (13 acts): Standing position	**Number of points**				**NT**
52. **On the floor:** pulls himself up to get into a standing position at a high PEDch	0 □	1 □	2 □	p. 3□	52.
53. **Standing position:** maintains the position, hands free, for 3 seconds	0 □	1 □	2 □	p. 3□	53.
54. **Standing position:** holding a high PEDch with one hand, lifts the right leg for 3 seconds	0 □	1 □	2 □	p. 3□	54.
55. **Standing position:** holding a high PEDch with one hand, lifts the left leg for 3 seconds	0 □	1 □	2 □	p. 3□	55.

56. **Standing Position:** Maintains the position, hands free, for 20 seconds	0 □	1 □	2 □	p. 3□	56.
57. **Standing position:** lifts the left leg, hands free, for 10 seconds	0 □	1 □	2 □	p. 3□	57.
58. **Standing position:** lifts the right leg, hands free, for 10 seconds	0 □	1 □	2 □	p. 3□	58.
59. **Sitting on a low PEDch:** Takes a standing position without using your hands	0 □	1 □	2 □	p. 3□	59.
60. **Kneeling position with the torso straight:** achieves a standing position by moving to a standing position on the right knee without using the hands	0 □	1 □	2 □	p. 3□	60.
61. **Kneeling position with body straight:** Achieves a standing position by moving to a standing position on the left knee without using the arms	0 □	1 □	2 □	p. 3□	61.
62. **Standing position:** lowers to a sitting position on the floor with control, hands free	0 □	1 □	2 □	p. 3□	62.
63. **Standing position:** squats without using hands	0 □	1 □	2 □	p. 3□	63.
64. **Standing position:** picks up an object from the floor, hands in a free position, returns to the starting standing position	0 □	1 □	2 □	p. 3□	64.
TOTAL PARAMETERS "D"					
Position E (24 acts): Walking, running and jumping	**Number of points**				**NT**
65. **Standing position with both hands on a high PEDch:** walks 5 steps to the right sideways	0 □	1 □	2 □	p. 3□	65.
66. **Standing position with both hands on a high PEDch:** 5 steps to the left sideways	0 □	1 □	2 □	p. 3□	66.
67. **Standing position, two hands held by the therapist:** walks forward 10 steps	0 □	1 □	2 □	p. 3□	67.
68. **Standing position, therapist holding one hand:** walks forward 10 steps forward	0 □	1 □	2 □	p. 3□	68.
69. **Standing:** Takes 10 steps forward	0 □	1 □	2 □	p. 3□	69.

70. **Standing:** Takes 10 steps forward, stops, turns 180°, returns	0 □	1 □	2 □	p. 3□	70.
71. **Standing position:** walks backwards 10 steps	0 □	1 □	2 □	p. 3□	71.
72. **Standing:** Takes 10 steps forward, carrying a large object with both hands	0 □	1 □	2 □	p. 3□	72.
73. **Standing:** Takes 10 consecutive steps forward between parallel lines 20 cm (8 inches) apart	0 □	1 □	2 □	p. 3□	73.
74. **Standing position:** Takes forward 10 consecutive steps in a straight line 2 cm wide (less than an inch)	0 □	1 □	2 □	p. 3□	74.
75. **Standing position:** steps over the stick at knee level, starts with the right foot	0 □	1 □	2 □	p. 3□	75.
76. **Standing position:** steps over the stick at knee level, starts with the left foot	0 □	1 □	2 □	p. 3□	76.
77. **Standing:** Runs a distance of 4.5 m (15 ft), stops and returns	0 □	1 □	2 □	p. 3□	77.
78. **Standing position:** kicks the ball with the right foot	0 □	1 □	2 □	p. 3□	78.
79. **Standing position:** kicks the ball with the left foot	0 □	1 □	2 □	p. 3□	79.
80. **Standing position:** jumps up 30 cm (12 inches), pushing off with both feet at the same time	0 □	1 □	2 □	p. 3□	80.
81. **Standing position:** jumps 30 cm (12 inches) forward, pushing off with both feet at the same time	0 □	1 □	2 □	p. 3□	81.
82. **Standing position:** Jumps on the right leg 10 times inside a 60 cm (24 in) diameter circle	0 □	1 □	2 □	p. 3□	82.
83. **Standing:** Jumps on the left leg 10 times inside a 60 cm (24 in) diameter circle	0 □	1 □	2 □	p. 3□	83.
84. **Standing position, holding the railing on one side:** climbs 4 steps up, alternating legs	0 □	1 □	2 □	p. 3□	84.
85. **Standing position holding the railing on one side:** descends 4 steps down, alternating legs	0 □	1 □	2 □	p. 3□	85.

86. **Standing position:** climbs 4 steps up, alternating legs without holding on to the railing	0 □	1 □	2 □	p. 3□	86.
87. **Standing position:** descends 4 steps down, alternating legs without holding on to the railing	0 □	1 □	2 □	p. 3□	87.
88. **Standing position on a 15 cm (6 in) high step:** jumps down on both feet while pushing with both feet	0 □	1 □	2 □	p. 3□	88.
TOTAL PARAMETERS "E"					

Does this assessment reflect the child's "permanent" condition?

□ □ net

Scoring for Single Acts

The scoring for each act is based on a four-point scale using the following symbols:

0 = does not start (the child is not able to start any part of the activity when asked to try to perform the act, there is no response)

1 = stimuli present, trying, but no movement (less than 10% completion of the task)

2 = Partially Completes Movement (10% to less than 100% Job Complete)

3 = Completes movement (100% job complete)

NT = not tested (the act has not been used / the child refuses to attempt to perform the act and there is reason to believe that he is able to at least partially complete it / fails to elicit a response from the child to perform the act because the child has surpassed it in his development)

Quantification according to GMFM-88

Options	Calculation of the point value of the % parameter	Target Area (check □V)
A. Lying Down and Rolling Over	$\frac{\text{Total parameters «A»}}{51} = \times 100$ =% $\frac{}{51}$ -	A. □
C. Sitting position	$\frac{\text{Total parameters «B»}}{60} = \times 100$ =% $\frac{}{60}$ -	B. □
C. Pedefit and kneeling position	$\frac{\text{Total parameters «C»}}{42} = \times 100$ =% $\frac{}{42}$ -	C. □
D. Standing Position	$\frac{\text{Total parameters «D»}}{39} = \times 100$ =% $\frac{}{39}$ -	D. □
E. Walking, running, and jumping	$\frac{\text{Total parameters «E»}}{72} = \times 100$ =% $\frac{}{72}$ -	E. □
TOTAL POINTS = $\frac{\%A+\%B+\%C+\%D+\%E}{5}$		
TOTAL GCAL POINTS = Sum of % points for each parameter set as the target area		
Number of Target Areas		

Comments:____

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Annex 3

Global Motor Function Classification System, GMFCS

GMFCS E & R between 6th and 12th birthday: Descriptors and illustrations

GMFCS Level I

Children walk at home, school, outdoors and in the community. They can climb stairs without the use of a railing. Children perform gross motor skills such as running and jumping, but speed, balance and coordination are limited

GMFCS Level II

Children walk in most settings and climb stairs holding onto a railing. They may experience difficulty walking long distances and balancing on uneven terrain, inclines, in crowded areas or confined spaces. Children may walk with physical assistance, a hand-held mobility device or used wheeled mobility over long distances. Children have only minimal ability to perform gross motor skills such as running and jumping.

GMFCS Level III

Children walk using a hand-held mobility device in most indoor settings. They may climb stairs holding onto a railing with supervision or assistance. Children use wheeled mobility when traveling long distances and may self-propel for shorter distances.

GMFCS Level IV

Children use methods of mobility that require physical assistance or powered mobility in most settings. They may walk for short distances at home with physical assistance or use powered mobility or a body support walker when positioned. At school, outdoors and in the community children are transported in a manual wheelchair or use powered mobility.

GMFCS Level V

Children are transported in a manual wheelchair in all settings. Children are limited in their ability to maintain antigravity head and trunk postures and control leg and arm movements.

GMFCS descriptors: Palisano et al. (1997) Dev Med Child Neurol 39:214-23
CanChild: www.canchild.ca

Annex 4

Ashworth Scale for Grading Spasticity, modified Bohannon and Smith, 1964

Degree	Description	Initial Inspection	Follow-up Inspection
0	No increase in muscle tone		
1	Slight increase in muscle tone, minimal tension at the end of the range of motion when flexing or extending the affected limb		
1+	A slight increase in muscle tone, which is manifested when grasping objects and is accompanied by minimal resistance (tension) of the muscle in less than half of the total range of motion		
2	A moderate increase in muscle tone throughout the range of motion, but passive movements are not hindered		
3	Significant increase in muscle tone, passive movements are difficult		
4	Rigid flexion or extensor position of the limb (flexion or extensor contracture)		

Annex 5

Manual Ability Classification System, MACS

Level	Characteristic
Activity Level 1	**The upper limbs are used successfully and with ease.** Basically, problems in object manipulation manifest themselves in minor speed limits and sloppiness. Minor limitations do not affect the degree of independence in daily activities. Children are limited in their ability to manipulate very small, heavy and fragile objects. Limitations manifest themselves in new, unfamiliar situations.
Activity Level 2	**The child is able to manipulate most objects, but some actions are of lower quality and/or are slower.**Children are able to perform manipulations, can grasp most objects with a slight limitation in quality and/or speed. Certain types of manipulation are not available or cause a certain amount of difficulty; The patient can use alternative ways of performing manipulations, but the possible amount of hand motor skills does not affect the degree of independence in daily activities.
Activity Level 3	**Functional capabilities are difficult, the patient needs to be prepared for the action and/or has to modify the action.** Holds an object with difficulty, needs outside help to prepare for grabbing the object and/or adapting to the environment for this and there are no time constraints. Manipulations are slowed down, the quality of the action and the possible number of repetitions are limited.
Activity Level 4	**Limited function, it is possible to use the limb satisfactorily in an adapted situation.** They need constant help in the process of action and can only take part successfully in part of the activity. Can capture a limited number of objects that are easy to manipulate in an adapted situation. Needs constant assistance and adaptive equipment even for partial performance of activities.
Activity Level 5	**It is practically not a functional limb, even simple movements are significantly limited.** The patient can participate in the activity with only simple movements in an adapted environment. Does not grasp objects and has a heavy persistent limitation even in simple movements. He needs total help from the outside.

Annex 6

Communication Function Classification System (CFCS)

Communication Methods	
	Speech
	Sounds
	Eye movements, facial expressions, gestures, and/or pointing (e.g., body part, pointer, laser)
	Gesture system
	Communicative book, table and/or pictures
	Voice Communicator
	Other

CFCS I – effectively communicates with both family members and strangers. Effective communicator with unfamiliar and familiar partners. A person who independently alternates the roles of addressee and addressee with most people in most situations. Communication is simple and at a comfortable pace, equally with unfamiliar and familiar conversation partners. Misunderstandings are quickly eliminated (errors are corrected) and do not affect the overall effectiveness of communication.

CFCS II is an effective but slow exchange of information, both with family members and with strangers. An effective communicator with a reduced pace of communication with unfamiliar and/or familiar partners A person who independently alternates between the roles of addressee and addressee with most people in most situations, but the pace of conversation is slow, which makes communicative interaction difficult. The communicator needs more time to understand the message, compose the message, and/or correct the misunderstood. Misunderstandings are quickly resolved (errors are corrected) and do not affect overall efficiency Communication.

CFCS III – Communicates effectively, but only with family members. Effective communicator with familiar partners. Alternates the roles of addressee and addressee with familiar (but not unfamiliar) communicative partners in most situations. When communicating with strangers, the effectiveness of communication is not stable, but when communicating with loved ones, communication is usually effective.

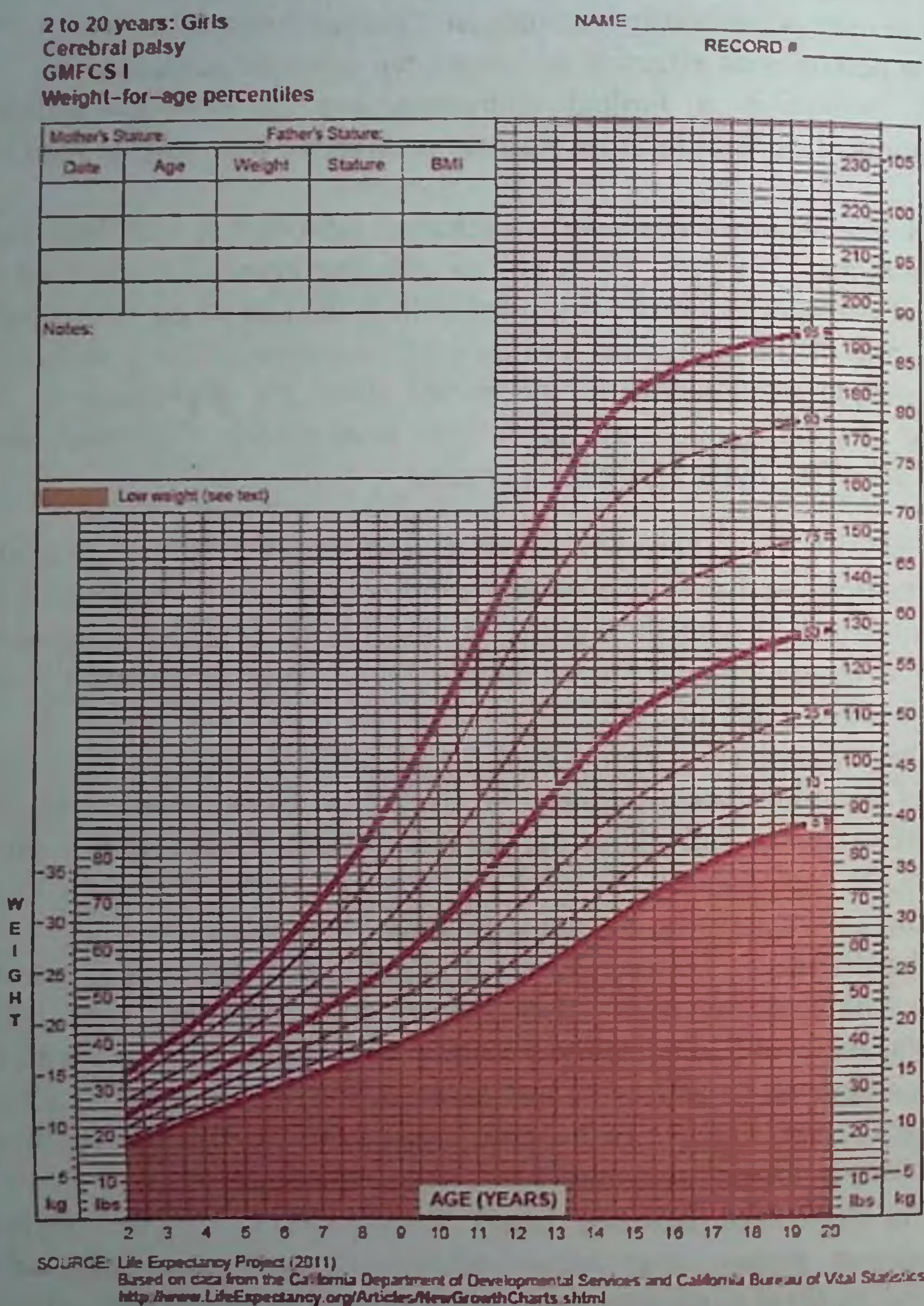
CFCS IV – Periodically effective in exchanging information only with family members. Inconsistent (unstable) communicator with familiar partners. A person who inconsistently alternates between the roles of addressee and addressee. The following options may occur:
A) Man only occasionally becomes an effective communicator
B) The person is an effective addressee, but a limited addressee;
C) A person is a limited addressee, but an effective addressee. Communication with familiar partners is effective from time to time.

CFCS V – it is not possible to exchange information with both family members and strangers. He is not an effective communicator even with familiar partners. A person is limited both in the role of the addressee and in the role of the addressee. The subject's communication is difficult for most people to understand. The person gives the impression of being limited in understanding messages from most people. Communication is rarely effective, even with close partners.

- The difference between **Level 1 and Level 2** is the pace of the conversation. At Level 1, a person communicates at a comfortable pace without delays or with short pauses to understand, compose a message, or clarify a misunderstood (misunderstood). At level 2, a person is more likely to need extra time.
- The difference between **Level 2 and Level 3** concerns the pace and type of communicative partner. At level 2, a person is effective in the roles of addressee and addressee, but it is difficult for him to maintain the pace of the conversation. At level 3, a person is quite effective with close communicative partners, but not with unfamiliar partners.
- The difference between **Level 3 and Level** 4 is how consistently a person changes the roles of addressee and addressee with familiar partners. At level 3, a person is generally able to communicate with close partners both as an addressee and as an addressee. At level 4, a person does not communicate with loved ones consistently. There may be difficulties in formulating and/or receiving a message.
- The difference between **Level 4 and Level** 5 is the degree of difficulty a person experiences when communicating with familiar partners. At level 4, the person has some success as an effective addressee and/or an effective addressee with close partners. At Level 5, a person is rarely able to

Annex 7

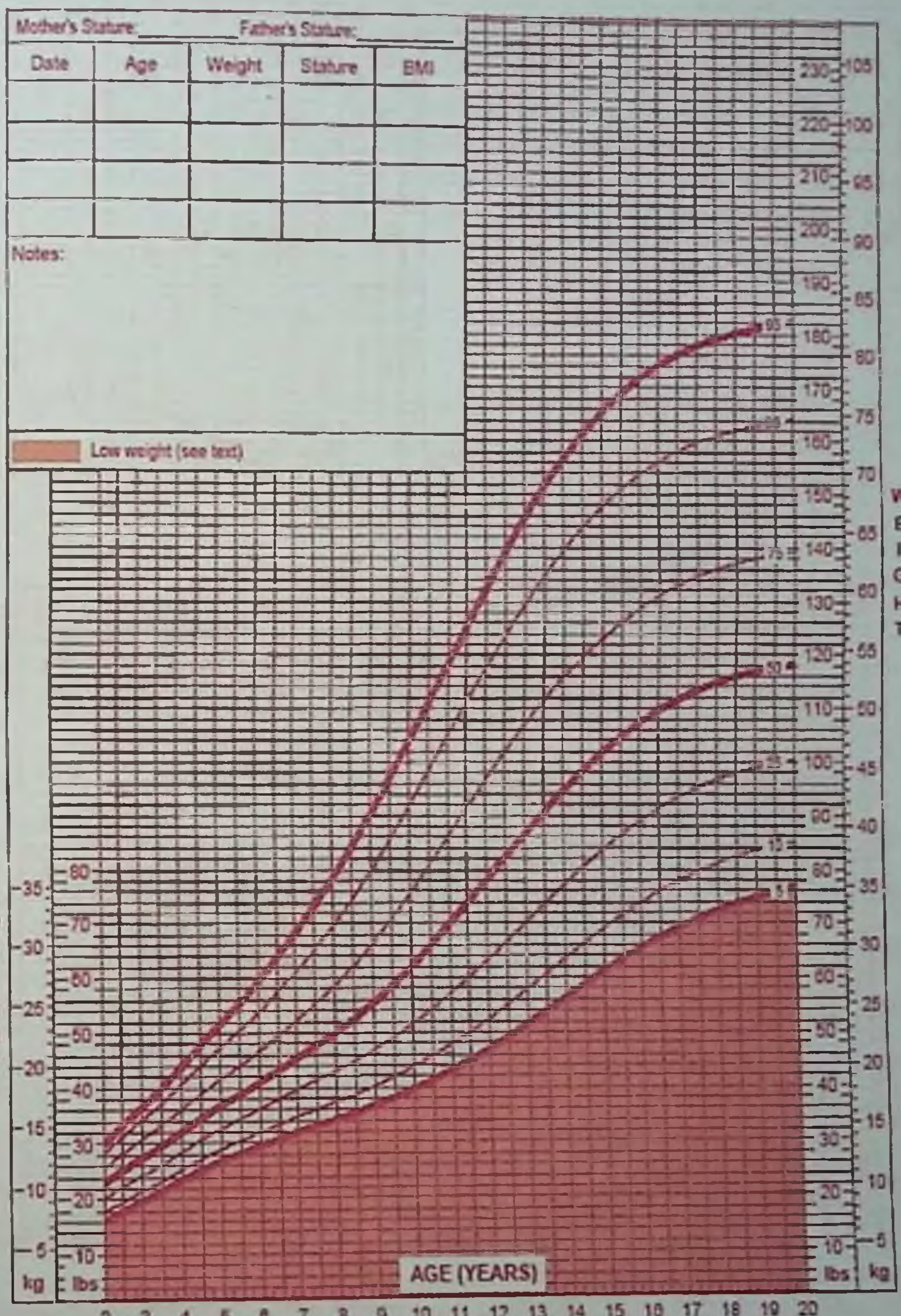
Brooks Charts for Aged Girls with Cerebral Palsy 2-20 years GMFCS Level I



GMFCS Level II

2 to 20 years: Girls
Cerebral palsy
GMFCS II
Weight-for-age percentiles

NAME ____________
RECORD # ________

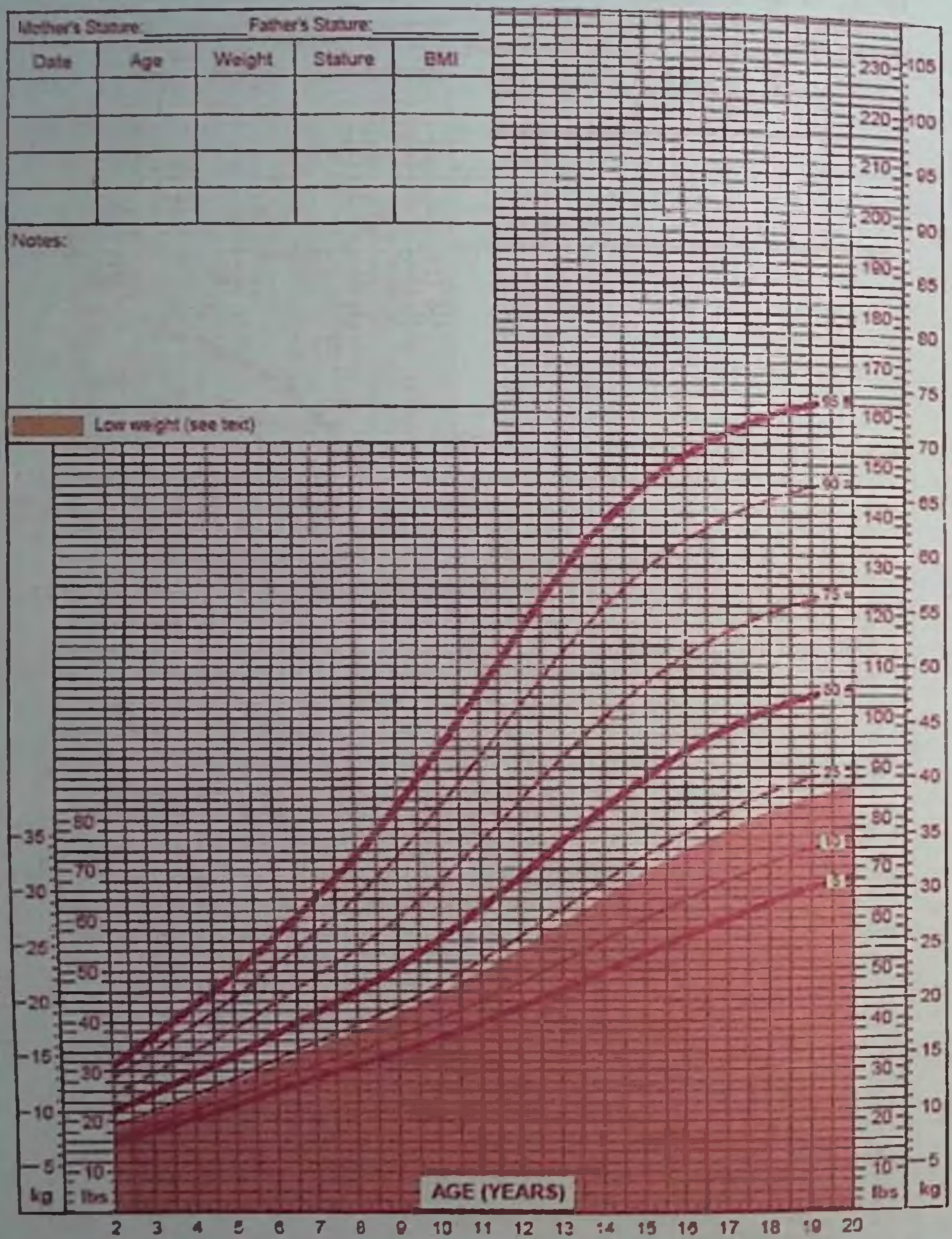


SOURCE: Life Expectancy Project (2011)
Based on data from the California Department of Developmental Services and California Bureau of Vital Statistics
http://www.LifeExpectancy.org/Articles/NewGrowthCharts.shtml

GMFCS Level III

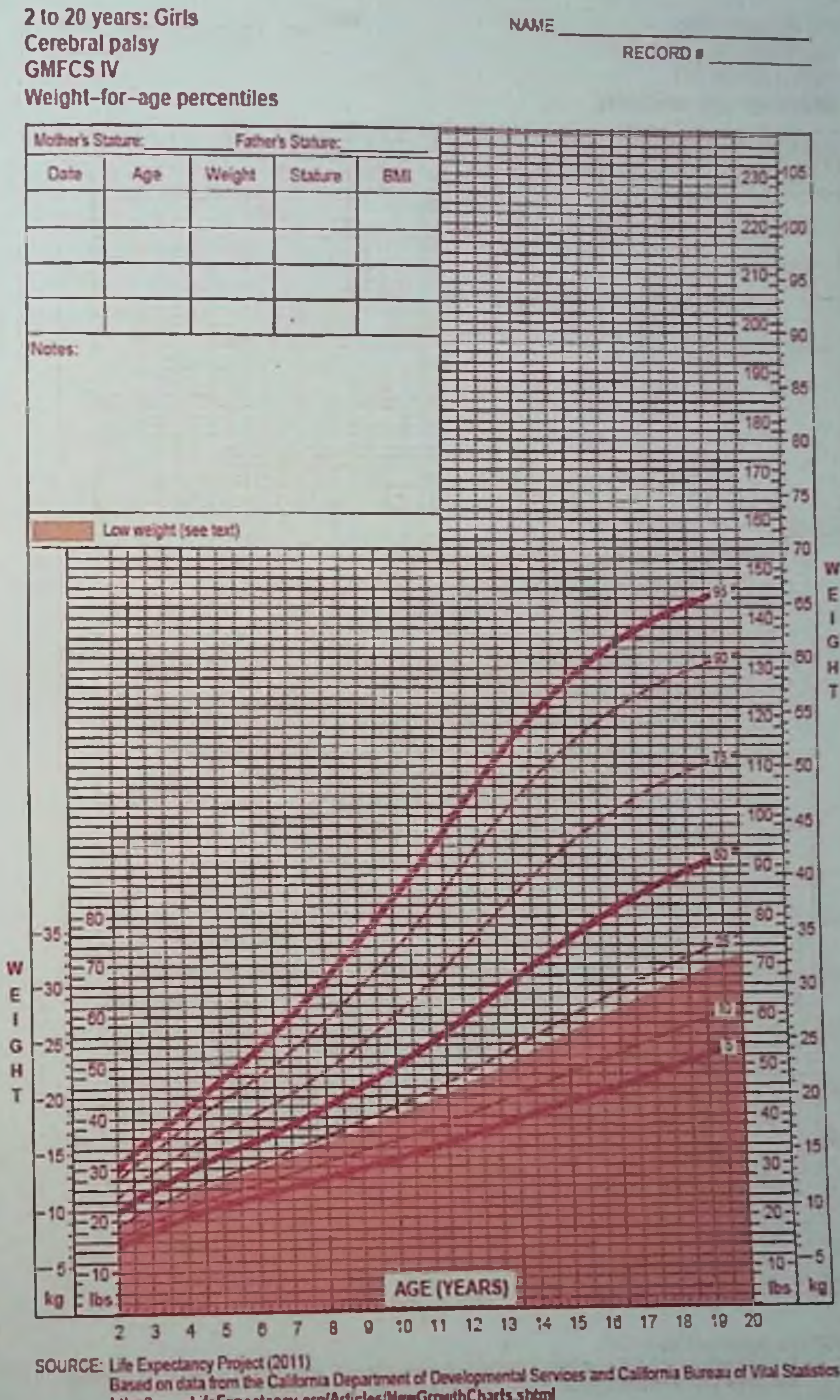
2 to 20 years: Girls
Cerebral palsy
GMFCS III
Weight-for-age percentiles

NAME ____________
RECORD # ________



SOURCE: Life Expectancy Project (2011)
Based on data from the California Department of Developmental Services and California Bureau of Vital Statistics
http://www.LifeExpectancy.org/Articles/NewGrowthCharts.shtml

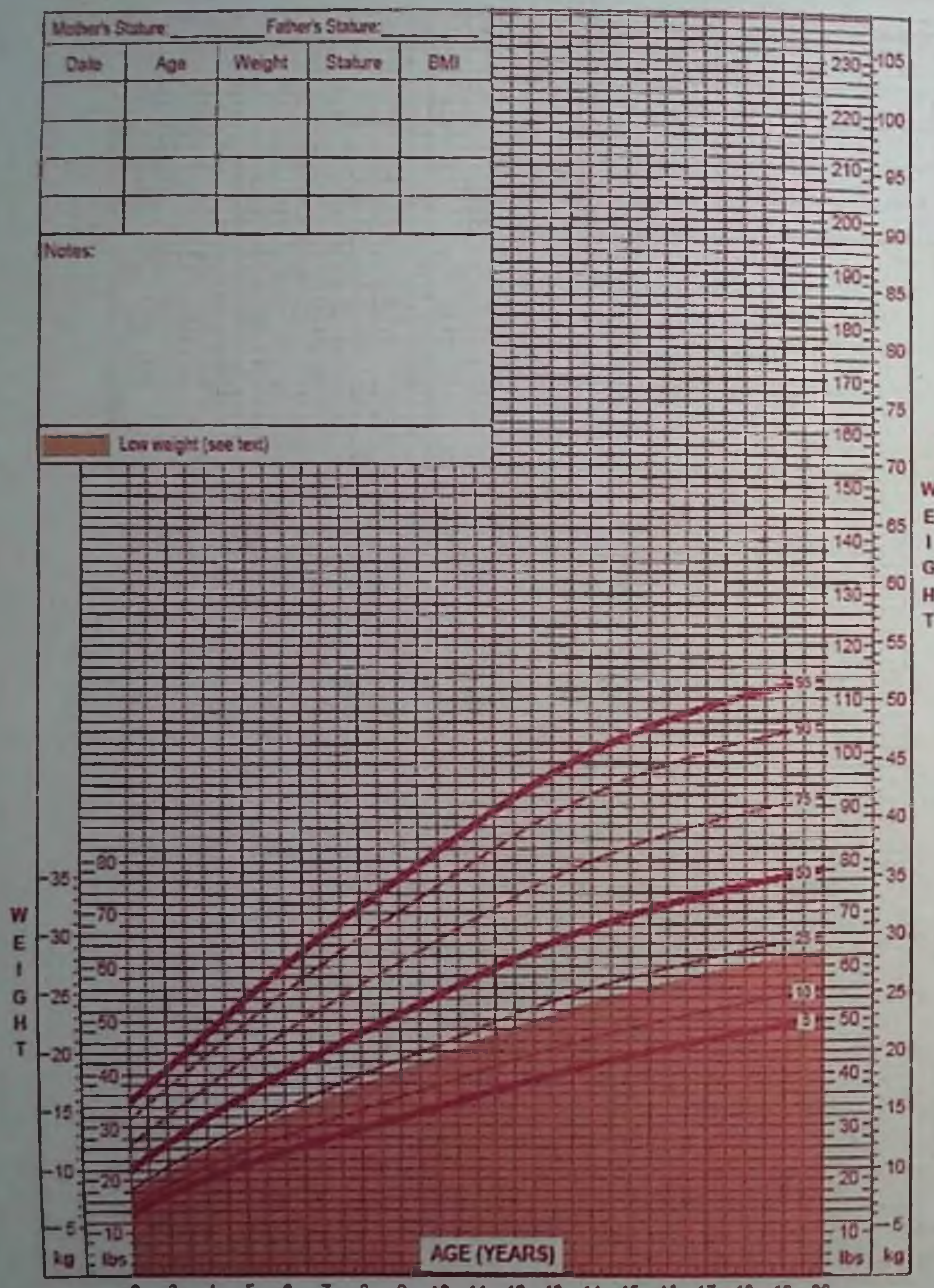
GMFCS IV Level



GMFCS V level, nasogastric tube or gastrostomy feeding

2 to 20 years: Girls
Cerebral palsy
GMFCS V, tube fed
Weight-for-age percentiles

NAME ____________
RECORD # ________

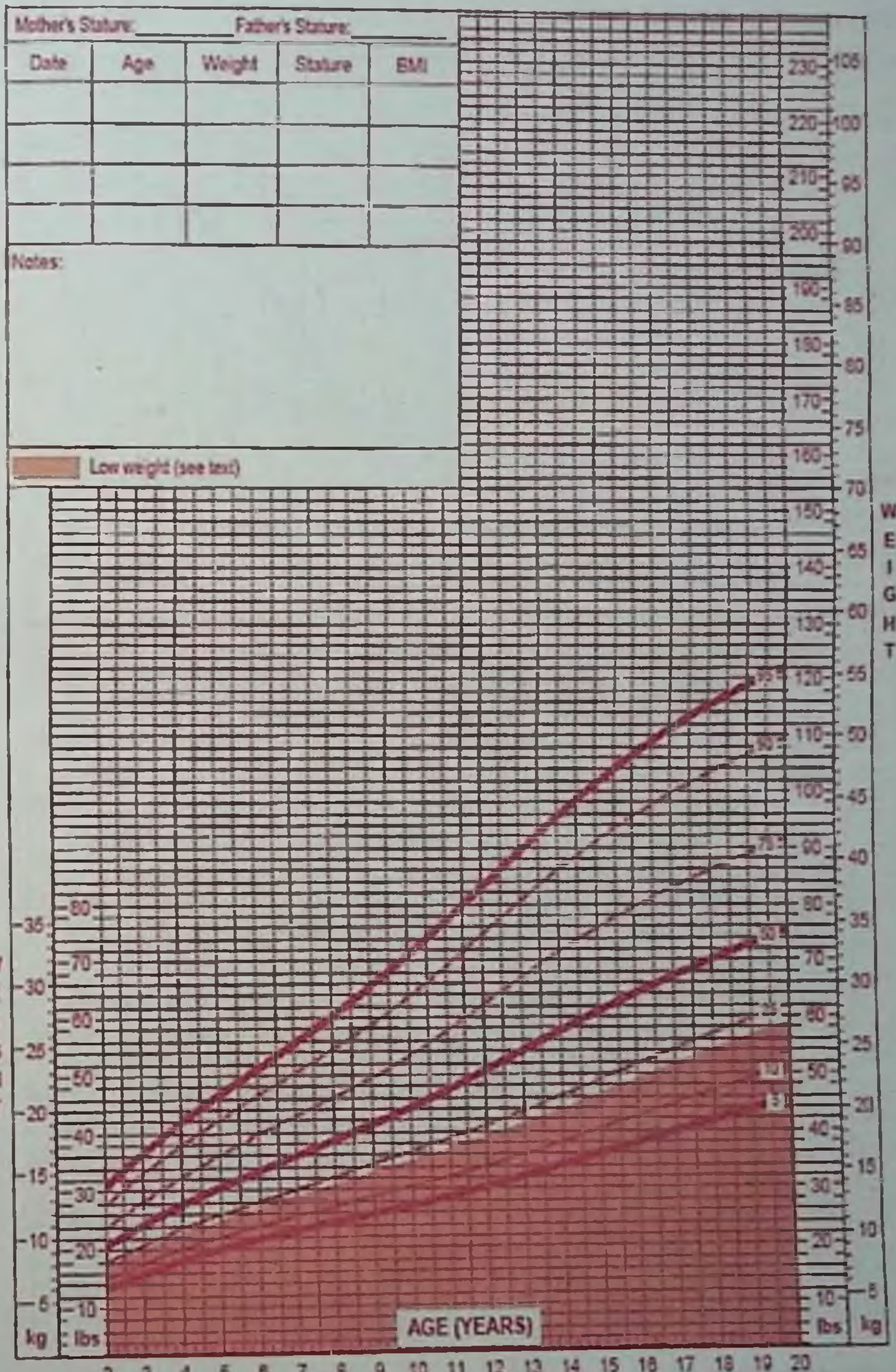


SOURCE: Life Expectancy Project (2011)
Based on data from the California Department of Developmental Services and California Bureau of Vital Statistics
http://www.LifeExpectancy.org/Articles/NewGrowthCharts.shtml

GMFCS V level, nutrition per os

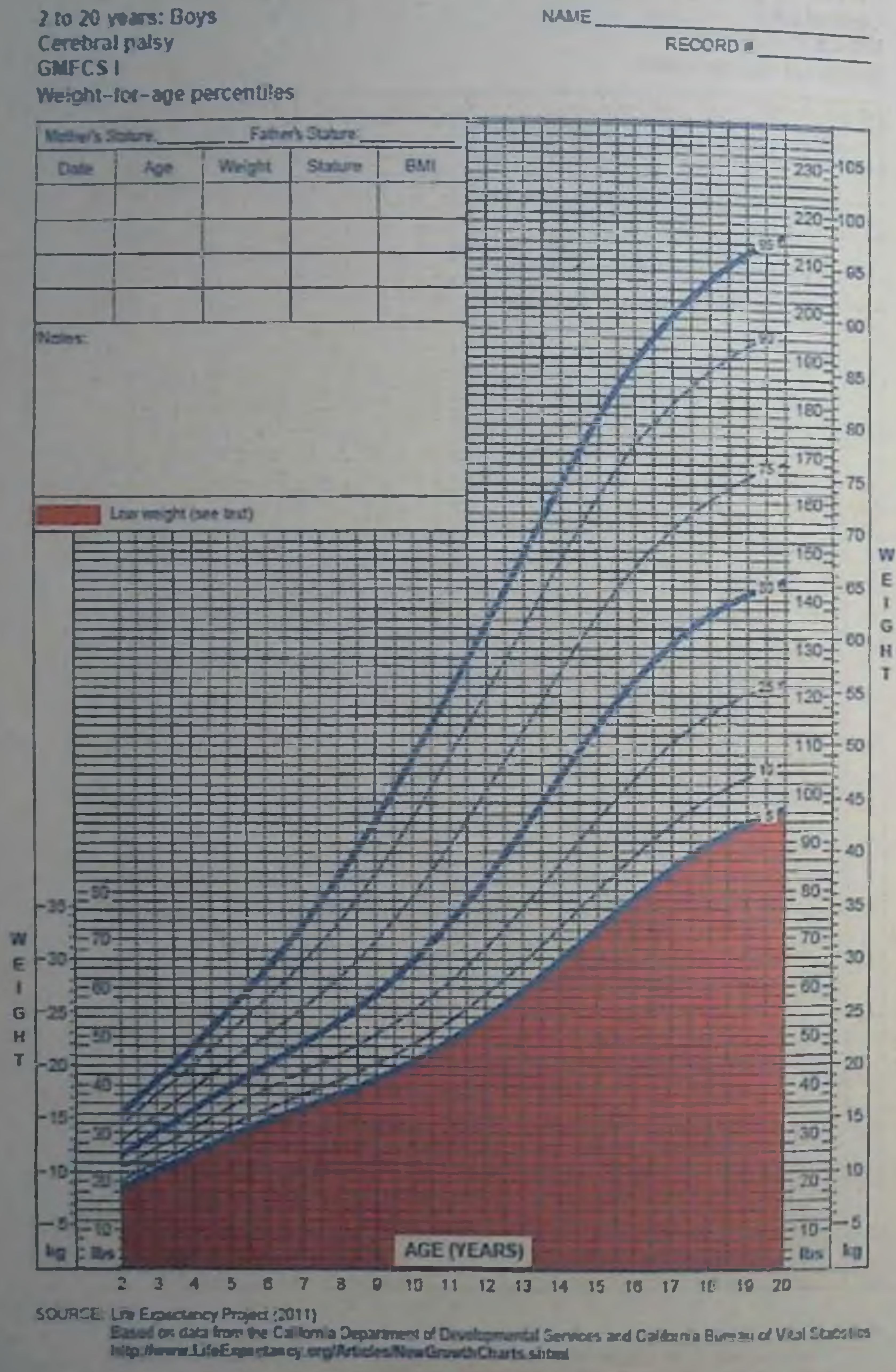
2 to 20 years: Girls
Cerebral palsy
GMFCS V, feeds orally
Weight-for-age percentiles

NAME ____________
RECORD # ________



SOURCE: Life Expectancy Project (2011)
Based on data from the California Department of Developmental Services and California Bureau of Vital Statistics
http://www.LifeExpectancy.org/Articles/NewGrowthCharts.shtml

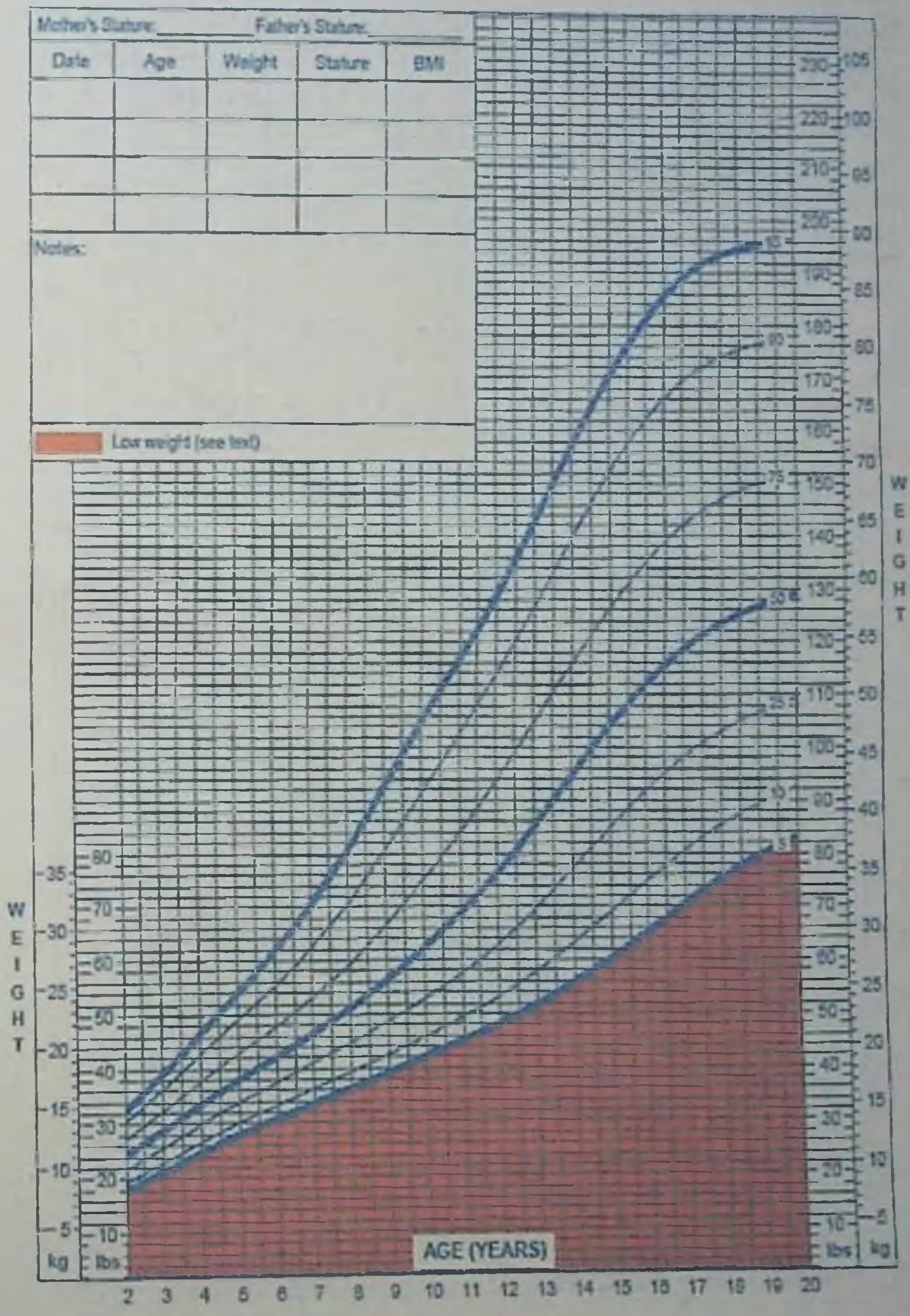
Brooks Charts for Boys with Cerebral Palsy Ages 2-20
GMFCS Level I



GMFCS Level II

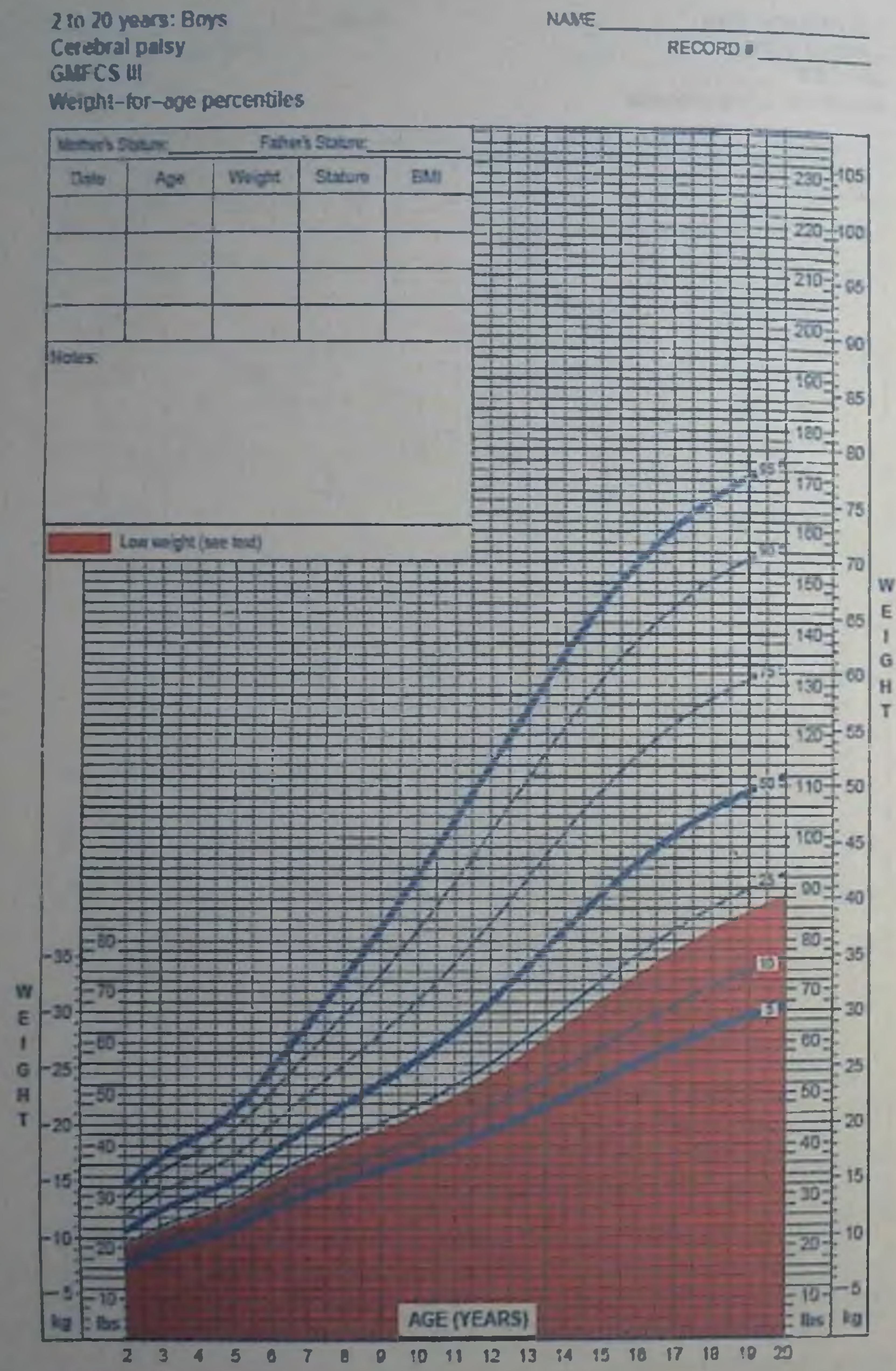
2 to 20 years: Boys
Cerebral palsy
GMFCS II
Weight-for-age percentiles

NAME ____________
RECORD # ________



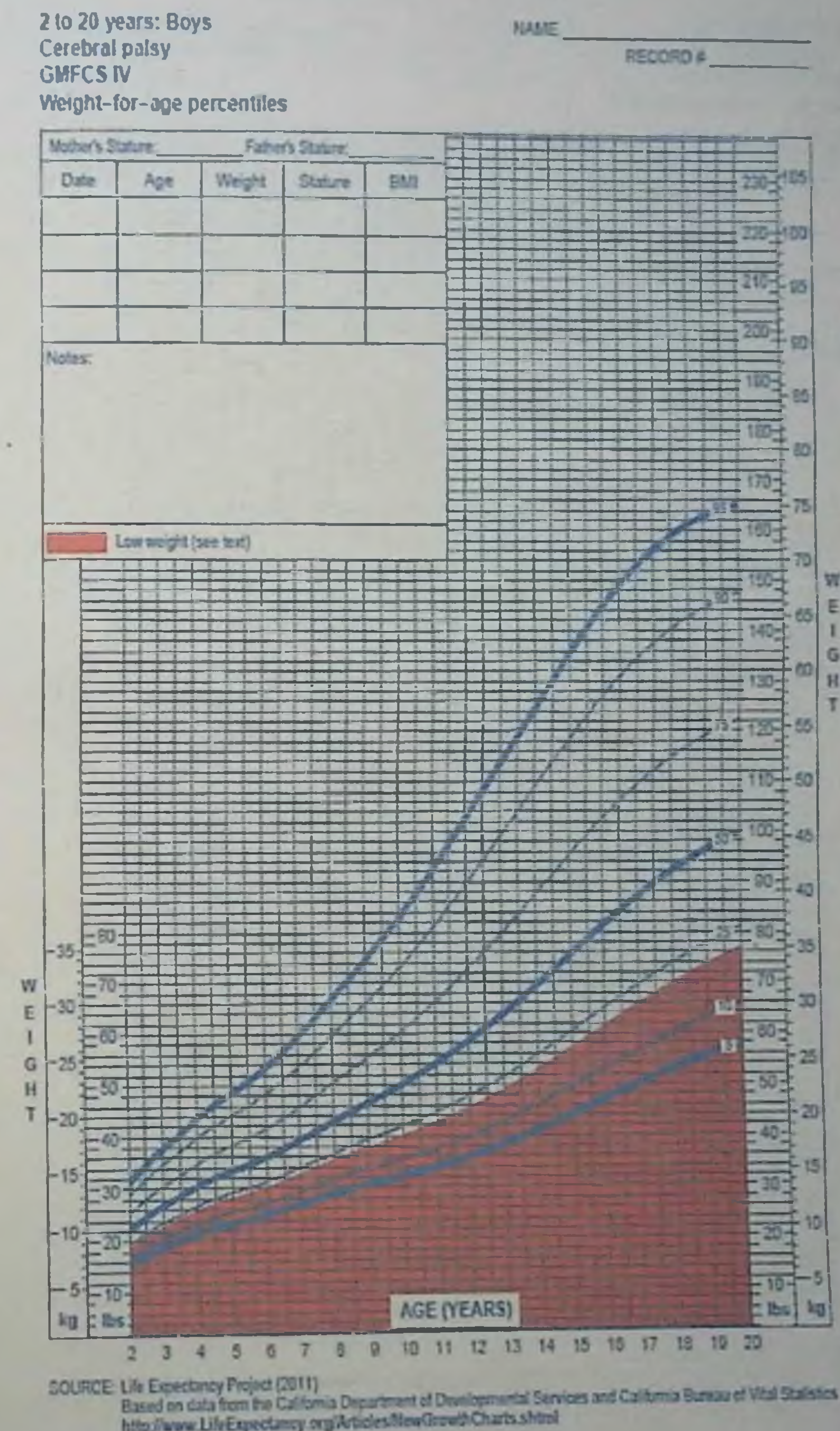
SOURCE: Life Expectancy Project (2011)
Based on data from the California Department of Developmental Services and California Bureau of Vital Statistics
http://www.LifeExpectancy.org/Articles/NewGrowthCharts.shtml

GMFCS Level III

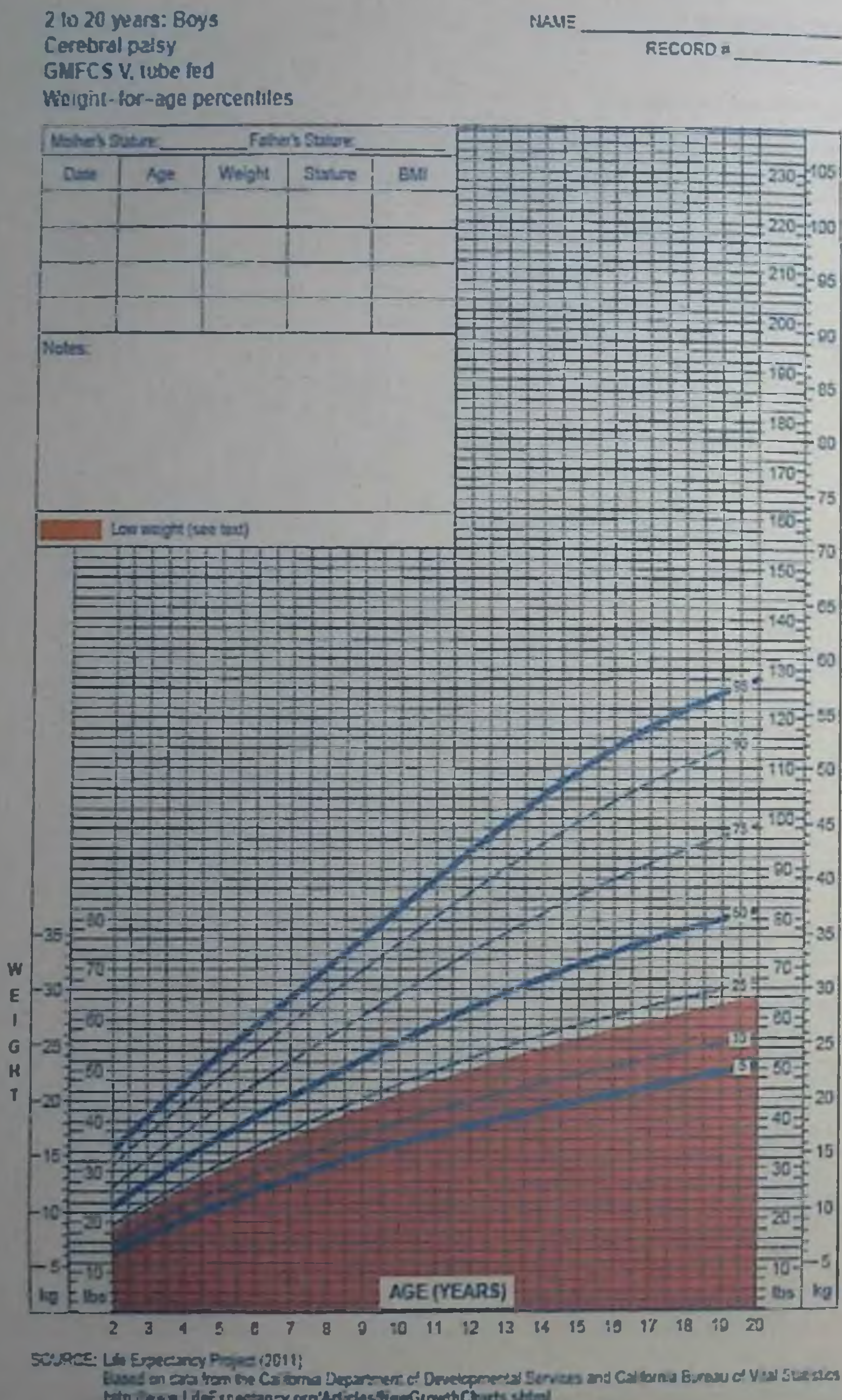


SOURCE: Life Expectancy Project (2011)
Based on data from the California Department of Developmental Services and California Bureau of Vital Statistics
http://www.LifeExpectancy.org/Articles/NewGrowthCharts.shtml

GMFCS IV Level



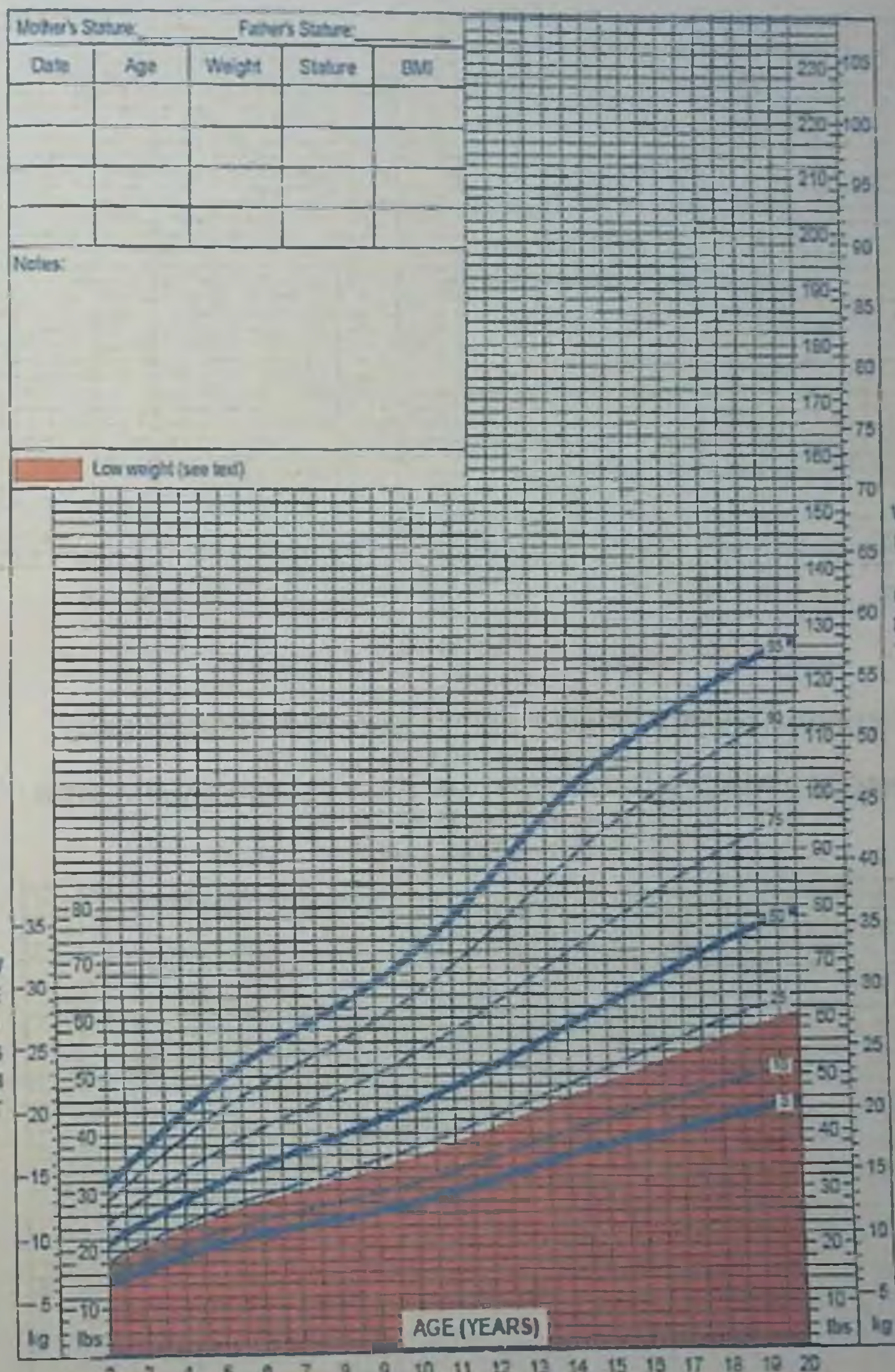
GMFCS V level, nasogastric tube or gastrostomy feeding



GMFCS V level, nutrition per os

2 to 20 years: Boys
Cerebral palsy
GMFCS V, feeds orally
Weight–for–age percentiles

NAME ____________
RECORD # ________

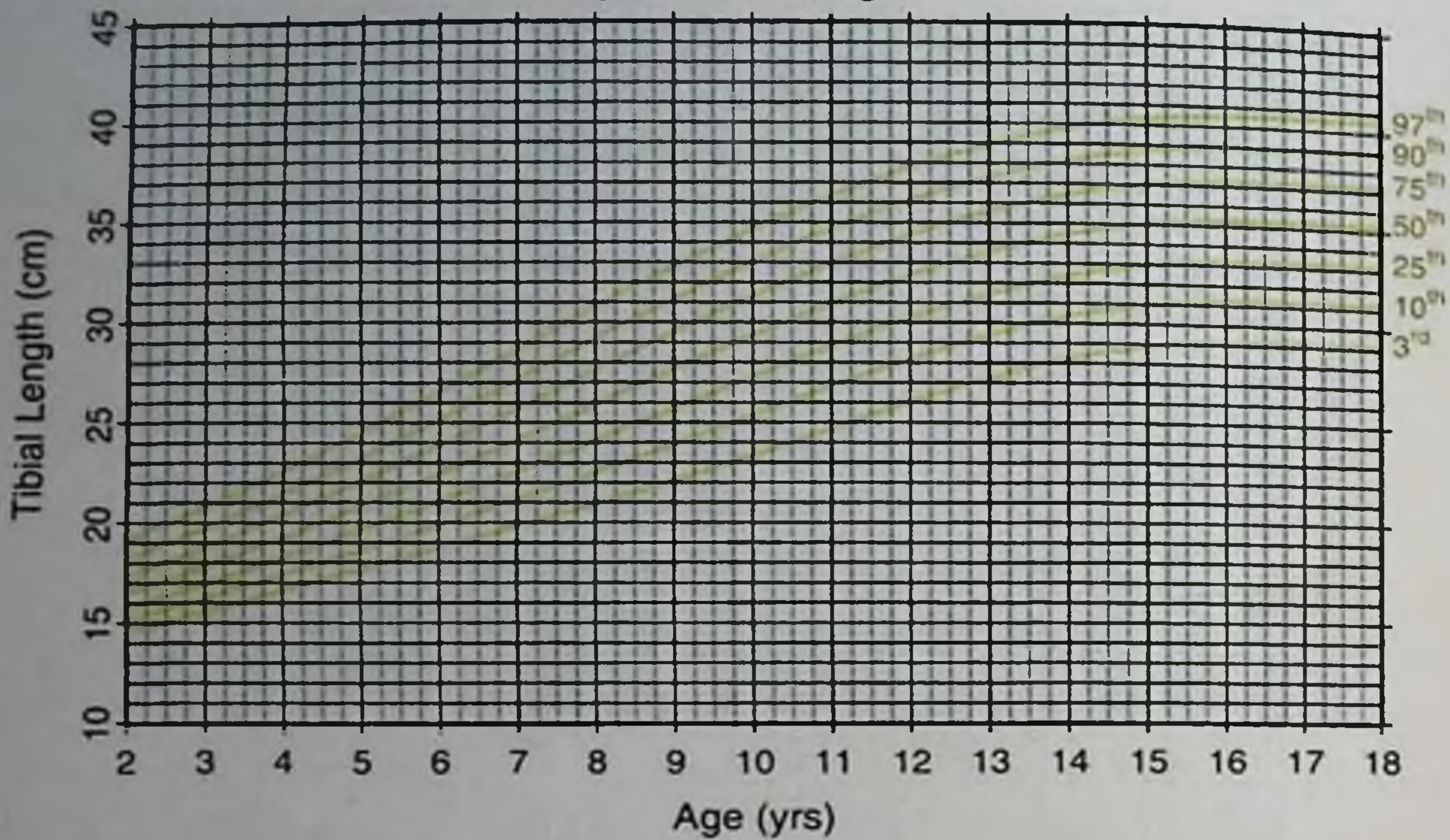


SOURCE: Life Expectancy Project (2011)
Based on data from the California Department of Developmental Services and California Bureau of Vital Statistics
http://www.LifeExpectancy.org/Articles/NewGrowthCharts.shtml

Annex 8

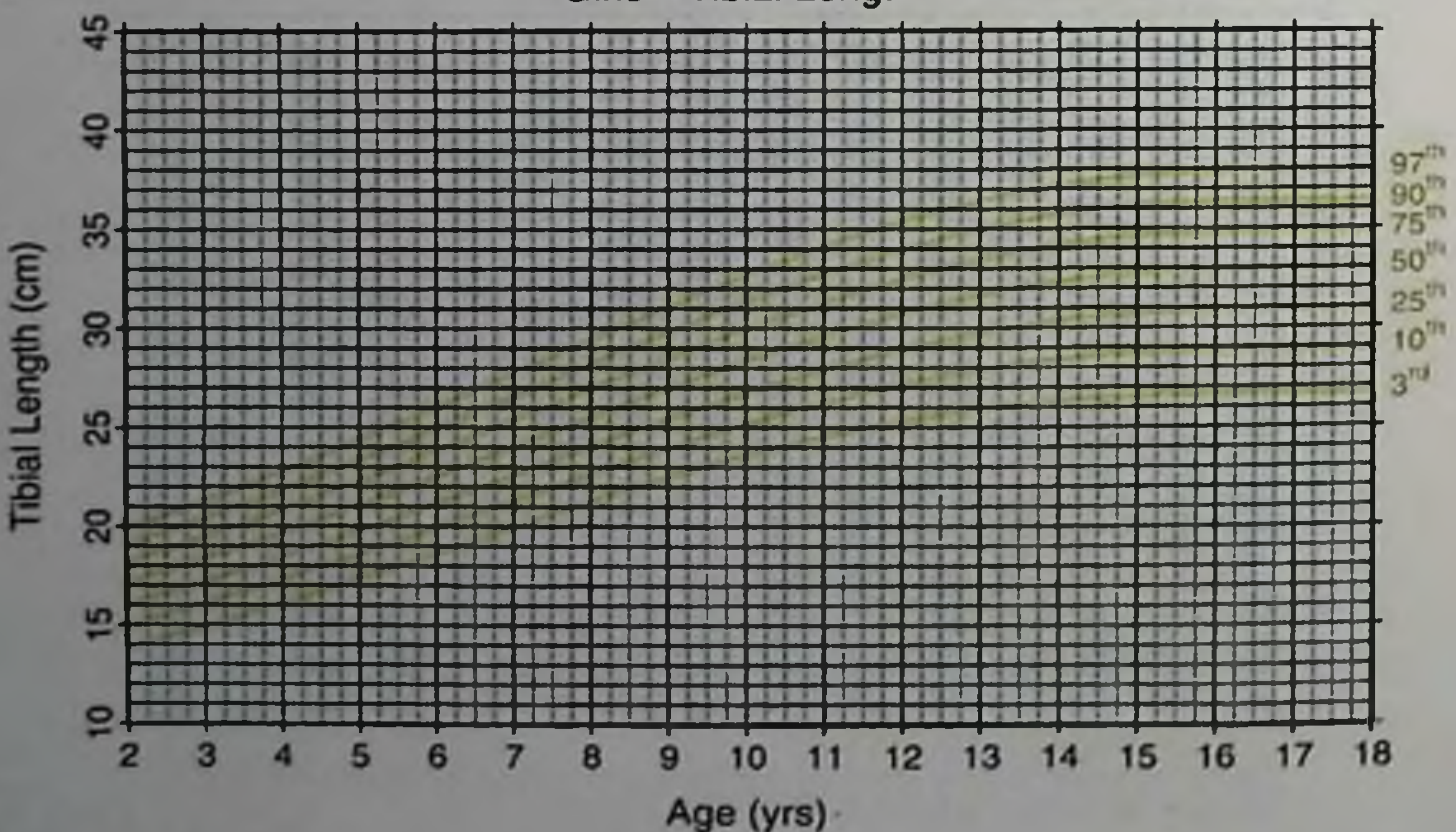
Percentile tables for tibia length in boys with cerebral palsy GMFCS III-V (ages 2-18)

NAGCPP RESEARCH GROWTH CHART v1.0 (University of Virginia)
Cerebral Palsy, GMFCS III–V
Boys – Tibial Length



Percentile tables for tibia length in girls with cerebral palsy GMFCS III-V (ages 2-18)

NAGCPP RESEARCH GROWTH CHART v1.0 (University of Virginia)
Cerebral Palsy, GMFCS III–V
Girls – Tibial Length



EDITED BY MAVLYANOVA ZILOLA FARKHADOVNA

PHYSICAL DEVELOPMENT OF CHILDREN WITH CEREBRAL PALSY

Monograph

Publisher license number: 143413

Managing editor — Dildora TURDIEVA
Proofreader – Olim RAKHIMOV
Technical editor – Akmal KELDIYAROV
Layout — Dilshoda ABDIAKHATOVA
Designer — Davron NURULLAYEV

Printed in the printing house "SARVAR MEXROJ BARAKA"
Certificate number - 704756. 140100. Samarkand,
st. Mirzo Ulugbek, 3.
Signed for printing *28.02.2024* **Protocol** *7*
Format 60x84$^{1/16}$. "Times New Roman" **typeface.** Con. prin .sh 6,74
Circulation: *200* copies. **Order No.** *76/2024*
Tel / fax: +998 94 822-22-87. **e-mail:** sarvarmexrojbaraka@gmail.com

9 789910 771422