СКРИНІНГОВА ОЦІНКА ФІЗИЧНОГО РОЗВИТКУ СІЛЬСЬКИХ ДІТЕЙ, ЯКІ ПРОЖИВАЮТЬ ПОБЛИЗУ ЧОРНОБИЛЬСЬКОЇ ЗОНИ

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SCREENING ASSESSMENT OF PHYSICAL GROWTH AND DEVELOPMENT OF RURAL CHILDREN LIVING NEAR THE CHORNOBYL ZONE

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Keywords: physical growth and development, rural children, Chornobyl accident.

The children's population residing in areas adjacent to the Chornobyl zone lives in extremely adverse conditions characterized by irregularity of radioactive contamination of soils, a high rate of uptake of ^{137}Cs by plants, biotopical features of a region (deficiency in micro— and macroelements in the setting of iodine endemic disease), alteration of food rations, depressed economy of the region and low living standards [1-4]. In this context, it is important to study the physical growth and development (PGD) of children as one of the most important indicators of health of a growing child.

It was found that changes in the PGD by means of a deficit in or an excess of body weight in children may result from the pathological condition of both internal organs and the neuro-endocrine system and predispose the development of a number of somatic diseases.

There are various methods for assessing the PGD of children. Most of them are based on anthropometric data, the main of which are weight (W) and body length or height (H). In practice, the most widely used method is a non-parametric centile method of analysis of anthropometric data (body weight, body length and chest circumference).

In case of mass preventive examinations, there is a need for application of screening tests which can significantly reduce both time and financial costs associated with testing and at the same time allow to receive timely information on the PGD of a child in order to establish and carry out correction measures in time. Therefore, it can be promising to pass from the definition of measures characterizing the

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Дитяче населення, яке проживає на прилеглих до Чорнобильської зони територіях, перебуває у надзвичайно несприятливих умовах, що характеризуються нерівномірністю радіоактивного забруднення ґрунтів, високим коефіцієнтом надходження ^{137}Cs до рослин, біотопічними особливостями місцевості (дефіцит мікро- і макроелементів на тлі йодної ендемії), деформацією раціонів харчування, депресивним характером розвитку економіки районів та низьким рівнем життя людей.
У зв'язку з цим вкрай важливим є вивчення фізичного розвитку (ФР) дітей як одного з найважливіших показників здоров'я зростаючого організму.
Мета дослідження — оцінка ФР сільських дітей, які проживають на радіоактивно забруднених внаслідок Чорнобильської катастрофи районах Київської області, за допомогою індексів маси тіла і Рорера.
Матеріали та методи. Досліджувалося дитяче населення віком 6-17 років, яке проживає в Іванківському та Поліському районах, що безпосередньо межують з зоною відчуження. Основою для вивчення були антропометричні дані, отримані у рамках проведеного поглибленого обстеження дітей і підлітків районів у 2014-2015 роках. Аналізом охоплено 1275 школярів: 630 хлопчиків і 645 дівчаток. В якості скринінг-тестів оцінки відхилень у ФР використовували індекс маси тіла й індекс Рорера. Вивчення статево-вікових особливостей ФР проводилося за однорічними віковими групами та за укрупненими: 6-9 років, 10-14 років та 15-17 років. Стандартом ФР дітей слугували нормативні значення індексів маси тіла за статтю та віком, розроблені в Інституті громадського здоров'я ім. О.М. Марзєєва НАМН України. Математична обробка здійснювалася за допомогою таблиць Microsoft Excel 2010.
Результати. Показано, що серед обстежених в усіх вікових групах превалюють хлопчики і дівчатка з величиною індексів, що трактуються як норма. Частота дисгармонійно розвинених дітей варіювала у межах 32,0-41,0% залежно від статі і віку, а також скринінг-тесту, що використовувався. Серед дисгармонійних варіантів ФР у школярів Іванківського і Поліського районів переважали випадки з надлишком маси тіла, особливо у дівчаток. Діти молодшого та старшого шкільного віку є найбільш неблагополучними за ФР і вимагають ретельного спостереження та прийняття коригувальних заходів для попередження розвитку захворювань.

Ключові слова: фізичний розвиток, сільські діти, Чорнобильська катастрофа.

Table 1

Normative values of the BMI for boys aged 6-17 years, (kg/m²)

Age, years	Group				
	Cachexia	Underweight	Normal Weight	Overweight	Obesity
6	11.91-13.16	13.17-14.41	14.42-16.93	16.94-18.18	18.19-19.43
7	11.96-13.38	13.39-14.82	14.83-17.70	17.71-19.13	19.14-20.56
8	11.52-13.12	13.13-14.74	14.75-17.98	17.99-19.59	19.60-21.21
9	12.76-14.16	14.17-15.58	15.59-18.42	18.43-19.83	19.84-21.25
10	12.04-13.64	13.65-15.24	15.25-18.46	18.47-20.07	20.08-21.68
11	12.97-14.67	14.68-16.38	16.39-19.81	19.82-21.52	21.53-23.24
12	10.67-12.94	12.95-15.22	15.23-19.79	19.80-22.07	22.08-24.35
13	14.44-15.93	15.94-17.44	17.45-20.45	20.46-21.95	21.96-23.46
14	13.49-15.36	15.37-17.24	17.25-21.02	21.03-22.91	22.92-24.79
15	13.13-15.50	15.51-17.88	17.89-22.65	22.66-25.04	25.05-27.42
16	13.15-15.28	15.29-17.42	17.43-21.71	21.72-23.85	23.86-26.00
17	14.29-16.35	16.36-18.43	18.44-22.59	22.60-24.66	24.67-26.74

Table 2

Normative values of the BMI for girls aged 6-17 years, (kg/m²)

Age, years	Group				
	Cachexia	Underweight	Normal Weight	Overweight	Obesity
6	11.54-12.80	12.81-14.07	14.08-16.63	16.64-17.90	17.91-19.17
7	11.28-12.70	12.71-14.13	14.14-16.99	17.00-18.42	18.43-19.85
8	11.78-13.24	13.25-14.71	14.72-17.66	17.67-19.13	19.14-20.60
9	11.96-13.58	13.59-15.22	15.23-18.50	18.51-20.13	20.14-21.77
10	10.76-12.84	12.85-14.93	14.94-19.12	19.13-21.21	21.22-23.30
11	12.32-14.00	14.01-15.68	15.69-19.06	19.07-20.75	20.76-22.43
12	12.73-14.56	14.57-16.40	16.41-19.79	20.10-21.92	21.93-23.76
13	13.37-15.24	15.25-17.12	17.13-20.89	20.90-22.77	22.78-24.65
14	14.77-16.25	16.26-17.73	17.74-20.72	20.73-22.20	22.21-23.69
15	13.96-15.82	15.83-17.69	17.70-21.43	21.44-23.29	23.30-25.16
16	14.79-16.60	16.61-18.41	18.42-22.05	22.06-23.86	23.87-25.68
17	12.64-14.87	14.88-17.11	17.12-21.59	21.60-23.83	23.84-26.07

Table 3

Division of examined school children aged 6-17 years into the groups depending on the BMI value (%, P±m)

Age, years; (number)	Group				
	Cachexia	Underweight	Normal Weight	Overweight	Obesity
6 (n=116)	1.72±1.21	6.03±2.21	69.83±4.26	13.79±3.20	8.62±2.61
7 (n=107)	0.93±0.93	16.82±3.62	69.16±4.46	6.54±2.39	6.54±2.39
8 (n=112)	0.89±0.89	16.96±3.55	60.71±4.61	8.93±2.69	12.50±3.13
9 (n=110)	0.00	13.64±3.27	62.73±4.61	10.91±2.97	12.73±3.18
10 (n=106)	12.73±3.18	13.21±3.29	66.98±4.57	11.32±3.08	6.60±2.41
11 (n=119)	2.52±1.44	24.37±3.94	53.78±4.57	9.24±2.65	10.08±2.76
12 (n=119)	0.84±0.84	11.76±2.95	62.18±4.45	10.08±2.76	15.13±3.28
13 (n=109)	6.42±2.35	22.09±3.97	42.20±4.73	9.17±2.76	20.18±3.84
14 (n=123)	3.5±1.60	11.38±2.86	42.28±4.45	26.83±4.00	16.26±3.33
15 (n=110)	3.64±1.79	13.64±3.27	54.55±4.75	21.82±3.94	6.36±2.33
16 (n=102)	0.00	5.88±2.33	69.61±4.55	14.71±3.51	9.80±2.94
17 (n=42)	0.00	4.76±3.29	45.24±7.68	28.57±6.97	21.43±6.33
6-17 (n=1275)	1.96±0.39	13.88±0.97	58.75±1.38	13.65±0.96	11.76±0.90

PGD and the assessment of its level and normality to the index system. As it is known, an index is a measure that reflects the relationship between several (usually two) measures. With respect to the present context, the indices of the PGD should be regarded as the reflection of relations between various anthropometric measures that will help to identify deviations from the norm and a risk group and carry out its in-depth examination.

Based on the above, *the aim of this study* was to assess the PGD of school children from rural areas radioactively contaminated as a result of the Chornobyl accident using the body mass index and Rohrer's index.

The subject of the study was the child population aged 6-17 years living in Ivankov and Polesie districts that directly border the Exclusion Zone. The results of the routine clinical examination of children and adolescents from these areas carried out in 2014-2015 served as the basis for the study of the chosen question. A single-step analytical examination covered 1275 school children (the average age of whom was 11.2 ± 0.09): 630 boys (49.4%) and 645 girls (50.6%). All examined children were distributed into the same year age groups taking into account their calendar age.

The study of age peculiarities of the PGD of children was also performed in enlarged groups: *a younger* group — 6-9 years, that corresponds to the primary school age, *a middle* group — 10-14 years (secondary school age) and a senior group — 15-17 years — adolescents. Anatomical and physiological features of a child, social status and the degree of adaptation to environment associated with the specificity of the child's care and upbringing were taken as criteria for forming age groups [5].

Anthropometric measures (length and body weight) were studied in compliance with standard conditions and using standardized anthropometric measurement techniques [6, 7], as well as following the rules of bioethics and with the signature of informed parental consent for each child.

The most available and informative body mass index (BMI) was calculated as a criterion for

*СКРИНИНГОВАЯ ОЦЕНКА ФИЗИЧЕСКОГО
РАЗВИТИЯ СЕЛЬСКИХ ДЕТЕЙ, ПРОЖИВАЮЩИХ
ВБЛИЗИ ЧЕРНОБЫЛЬСКОЙ ЗОНЫ*
Дубовая Н.Ф., Бандажевский Ю.И.
*Детское население, проживающее
на прилегающих к Чернобыльской зоне
территориях, находится в чрезвычайно
неблагоприятных условиях, характеризующихся
неравномерностью радиоактивного загрязнения
почв, высоким коэффициентом поступления
^{137}Cs в растения, биотопическими
особенностями местности (дефицит микро-
и макроэлементов на фоне йодной эндемии),
деформацией рационов питания, депрессивным
характером развития экономики районов
и низким уровнем жизни людей. В этой связи
крайне важным является изучение физического
развития (ФР) детей как одного из важнейших
показателей здоровья растущего организма.*
Цель исследования *— оценка ФР сельских
детей, проживающих в радиоактивно
загрязненных вследствие Чернобыльской
катастрофы районах Киевской области, с
помощью индексов массы тела и Рорера.*
Материалы и методы. *Исследовалось детское
население в возрасте 6-17 лет, проживающее
в Иванковском и Полесском районах, которые
непосредственно граничат с зоной отчуждения.
Основой для изучения послужили
антропометрические данные, полученные
в рамках проведеного углубленного
обследования детей и подростков районов*
*в 2014-2015 годах. Анализом охвачено 1275
школьников: 630 мальчиков и 645 девочек.
В качестве скрининг-тестов оценки отклонений
в ФР использовались индекс массы тела
и индекс Рорера. Изучение поло-возрастных
особенностей ФР проводилось по одногодичным
возрастным группам и по укрупненным: 6-9 лет,
10-14 лет и 15-17 лет. Стандартом ФР детей
служили нормативные значения индексов массы
тела по полу и возрасту, разработанные
в Институте общественного здоровья
им. А.Н. Марзеева НАМН Украины.
Математическая обработка осуществлялась
с помощью таблиц Microsoft Excel 2010.*
Результаты*. Показано, что среди
обследованных во всех возрастных группах
превалировали мальчики и девочки с величиной
индексов, трактуемых как норма. Частота
дисгармонично развитых детей варьировала
в пределах 32,0-41,0% в зависимости от пола
и возраста, а также используемого скрининг-
теста. Среди дисгармоничных вариантов ФР
у школьников Иванковского и Полесского
районов преобладали случаи с избытком массы
тела, особенно у девочек. Дети младшего
и старшего школьного возраста являются
наиболее неблагополучными по ФР и требуют
тщательного наблюдения и принятия
корректирующих мер для предупреждения
развития заболеваний.*
***Ключевые слова: физическое развитие,
сельские дети, Чернобыльская катастрофа.***

the assessment of the PGD [8]. The BMI is defined as the body mass in kilograms divided by the square of the body length in metres — a measure that helps to assess whether the human weight is appropriate to the height, and thus indirectly to define whether someone is underweight, of normal weight or overweight.

The normative values of the BMI by sex and age developed by the Institute of Hygiene and Medical Ecology named after A.N. Marzeev of the National Academy of Medical Sciences of Ukraine and presented in tables 1-2 were taken as standard of the PGD of children [9]. These normative values of the BMI allow to give findings on the PGD of a child and the assessment of its normality and determine its 5 levels: normal PGD, abnormal PGD due to a deficit in or an excess of body weight, severely abnormal PGD due to cachexia or obesity.

The assessment of normality of PGD was also performed with the help of a weight-height Rohrer's index calculated according to the formula: Rohrer's index (RI) = weight (kg) / body length3 (m). The normal or moderate PGD of children was di-

agnosed if the index value varied from 10.7 kg/m^3 to 13.7 kg/m^3, the PGD was assessed as low if the RI value was less than 10.7 kg/m^3, a high level of the PGD was stated with the RI value of more than 13.7 kg/m^3 [10].
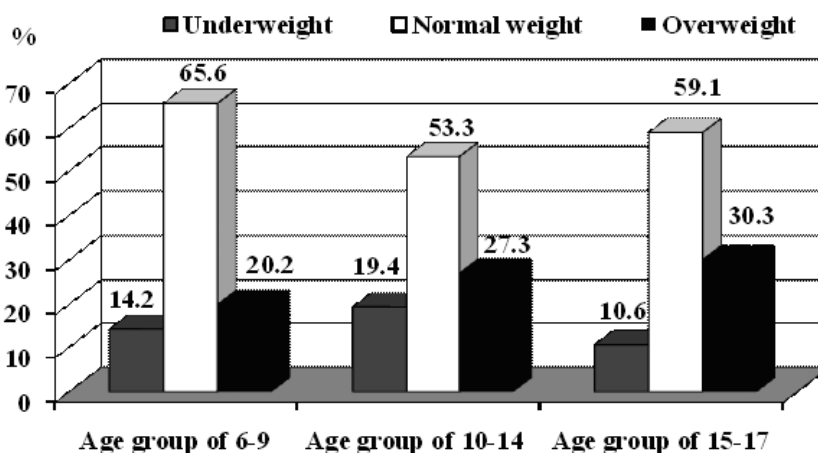
Mathematical processing was performed using Microsoft Excel 2010 spreadsheets.

The normality assessment carried out using the BMI normative values made it possible to determine the structure of

the PGD abnormalities and calculate the ratio of each of the age group of school children (table 3).

The school children with the BMI level interpreted as the norm were found to prevail in all age groups, their proportion varied from 42.2% to 69.8%, amounting to 58.75 ± 1.38% in the sample. Among the abnormal cases of the PGD in children, the abnormality caused by overweight and obesity dominated in

Fig. 1
**Assessment of normality of physical growth and development
in school children from Ivankiv and Polesie districts
of Kiev region according to the BMI with regard to age, %**

most cases. This group of children statistically significantly (t=6.02, p<0.05) was 1.6 times larger than the group of school children with abnormal PGD due to cachexia and underweight (25.4% versus 15.9%).

Severely abnormal PGD was observed in 13.7% of the examined children. The proportion of

the group of school children with severely abnormal PGD due to obesity ranged from 6.36% to 21.43%, on an average — 11.76 ± 0.90%, and significantly (p<0.05) was higher than the proportion of school children with severely abnormal PGD due to cachexia. Among all the examined children, the proportion of children with cachexia ranged from 0% to 6.4% (depending on age), on the average 1.96 ± 0.39% in the sample.

The analysis of PGD of school children in enlarged groups showed that with age, the proportion of children with normal PGD is statistically significantly decreasing as a result of the increase in the proportion of children with overweight (fig. 1). Thus, when normal PGD was recorded in 65.6% of cases

among younger school children and the proportion of children with overweight was 20.2%, at the same time among the older school children, normal PGD was found in 59.1% of the examined children and 30.3% of children were overweight.

In the group of children with abnormal PGD due to overweight, girls statistically significantly prevailed, while in the group with abnormal PGD due to underweight the proportion of boys was higher but statistically significantly did not differ from values of girls (fig. 2). It should be noted that among all examined children the lowest figures of normality of PGD and the highest incidence of abnormal cases of PGD were seen among school children aged 10-14 years, both among boys and girls.

The Rohrer's index (RI) was calculated to receive a more accurate assessment of PGD of children and adolescents. The measure has a number of advantages, namely: it does not require special tables with normative values that need to be updated every five years and may be different in different regions. It does not depend on gender, age and body length of children and can be widely used during screening preventive examinations when only child's body weight and height are measured. Moreover, it enables to identify borderline cases which frequently during the use of only centile weight and height charts appear to be in the range of average values.

The assessment of calculated RI values showed that 68.2% of examined school children, both boys and girls, showed values indicating normal PGD (fig. 3).

The frequency of abnormal (low and high) PGD was 31.8%. Furthermore, the school children with high PGD (with overweight) 2.1-3.4 times significantly exceeded the proportion of children with low PGD (with underweight).

The analysis of frequency of age-related figures of PGD of children according to the RI proved that in comparison with school children aged 6-9 years, there was a slight rise in the percentage of children with normal development in the age group of 10-14 years and 15-17 years (fig. 4). The proportion of un-

Fig. 2
Distribution of school children from Ivankov and Polesie districts of Kiev region with abnormal physical growth and development due to overweight by gender and age (according to the BMI), %
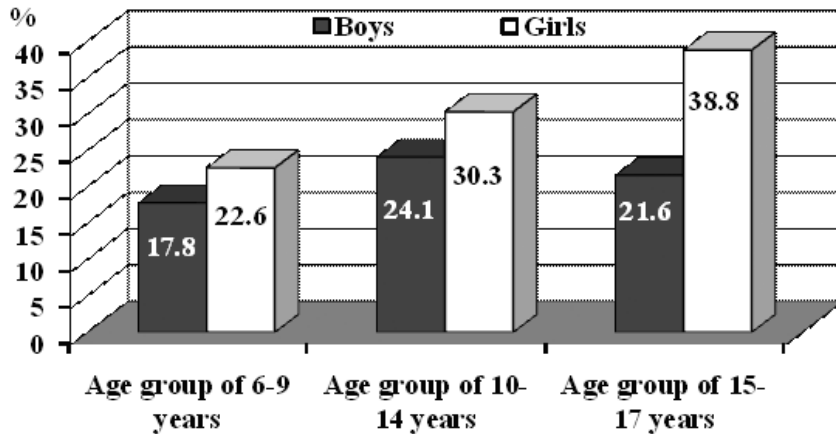

Fig. 3
Assessment of normality of physical growth and development of school children from Ivankiv and Polesie districts of Kiev region aged 6-17 years according to the Rohrer's index with regard to gender, %
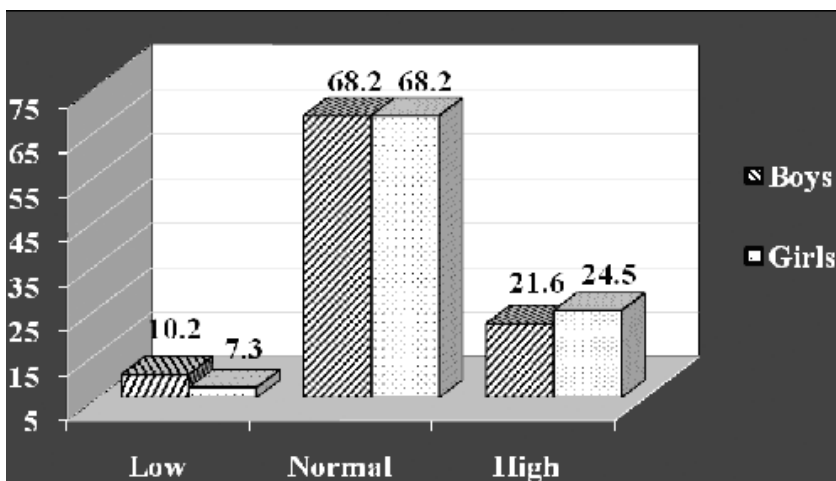
derweight children significantly increases with age (p<0.05): a decrease by 1.5 times in the frequency of overweight children in the group of children aged 10-14 years and 15-17 years was statistically unreliable (p>0.05).

The age structure of PGD of boys and girls according to the RI presented in tables 4-5 indicates the high frequency of overweight children among boys and girls aged 6-9 years and among girls in the age group of 15-17 years.

Conclusions. Thus, the obtained results show that the school children with normal physical growth and development comprise the highest proportion among the examined children from Ivankov and Polesie districts.

The frequency of children with abnormal physical growth and development ranged from 32.0-41.0% depending on sex and age, as well as the applied screening test. Among cases of abnormal physical growth and development, cases of overweight, especially in girls, prevail. The children of primary and senior school ages are the most troubled in terms of physical development and require careful monitoring; also corrective measures to prevent the development of diseases must be adopted.

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Fig. 4

Division of children into the groups of physical development according to the Rohrer's index with regard to age, %
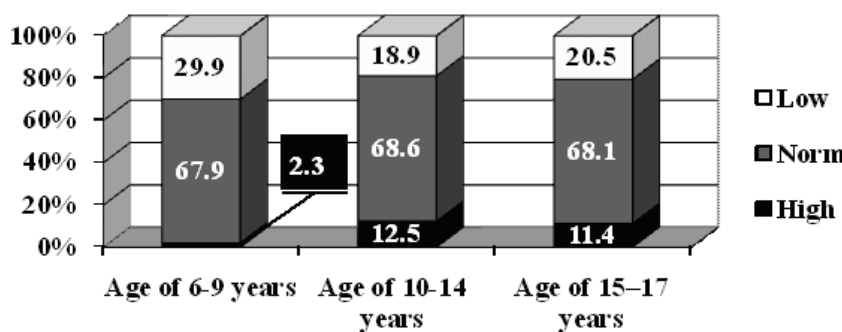

Table 4

Division of boys aged 6-17 years into the groups of physical development according to the Rohrer's index (%, M±m)

Age, years	Physical growth and development of boys		
	Low	Normal	High
6-9 (n=219)	2.7 ± 1.10	65.3 ± 3.22	32.0 ± 3.15
10-14 (n=286)	12.2 ± 1.94	70.3 ± 2.70	17.5 ± 2.25
15-17 (n=125)	18.4 ± 3.47	68.8 ± 4.14	12.8 ± 2.99
6-17 (n=630)	10.2 ± 1.20	68.3 ± 1.85	21.5 ± 1.64

Table 5

Division of girls aged 6-17 years into the groups of physical development according to the Rohrer's index (%, M±m)

Age, years	Physical growth and development of girls		
	Low	Normal	High
6-9 (n=226)	1.8 ± 1.77	70.4 ± 3.04	27.8 ± 2.98
10-14 (n=290)	12.8 ± 1.96	66.9 ± 2.76	20.3 ± 2.36
15-17 (n=129)	4.7 ± 1.85	s67.4 ± 4.13	27.9 ± 3.95
6-17 (n=645)	7.3 ± 1.02	68.2 ± 1.83	24.5 ± 1.69