PEDIATRICS

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IMPACT OF ENVIRONMENTAL FACTORS ON THE LEVEL OF PHYSICAL GROWTH AND DEVELOPMENT OF CHILDREN IN KHARKIV REGION

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Abstract: The study deals with determination of the level of physical development in 2600 children who live in different areas of ecological well-being of Kharkiv region. Children living in environmentally disadvantaged areas were found to have accelerated linear growth, and the degree of an increase in this index depends on incorporation rate of conditionally toxic microelements (r=0.72). The study identified gender-specific impact of environmental factors on children's body weight. Body weight indices in boys living in environmentally disadvantaged areas were shown to be below age norms, whereas in girls a decrease in these indices was observed in environmentally favorable areas. Environmental deterioration results in imbalanced and impaired cycle of physical development, which has a negative effect on health in general.

KeyWords: children, physical development, ecology.

INTRODUCTION

Low resistance to harmful environmental factors in children has recently become the focus of great concern for medical community [1-2]. Despite a recent significant decline in Ukrainian industry, air pollution remains a pressing challenge. Road transport is regarded as one of the greatest sources of pollution with its overall emission of harmful substances in the air reaching 52%. Some scientists suggest that physical growth of children depends on the extent of environmental pollution – moderate pollution activates acceleration and high degree of pollution leads to growth rate reduction in children [3].

Physical growth and development (PGD) in children are known to be one of the main objective indices of general health. Main PGD criteria include weight, height, head and chest circumference et cetera. Growth and development were shown to have a nonlinear dependence on the child's age, but it is necessary to consider that these processes reflect physiological or pathological processes occurring in the body.

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Given the impact of environmental factors on the child's PGD indices, monitoring of PGD changes helps to analyze the reactions of the growing organism to exogenous factors. Moreover, follow-up control of the impact of environmental factors on PGD is effective in elaboration and administration of preventive measures against PGD impairment.

2 PURPOSES, SUBJECTS AND METHODS:

2.1 Purpose

The aim of the study was to establish growth rate characteristics of anthropometric indices in children and adolescents in relation to the environmental conditions of the area of residence.

2.2 Subjects

The method of expeditionary examinations of organized groups was used to examine 2600 children at the age rating from 7 to 17 years old, permanently residing in Kharkiv region. Groups of children were stratified on the basis of age, sex and environmental characteristics of the area of their residence. Thus, the

environmentally favourable area, where there are no large industrial enterprises, included 676 children (group I); relatively unfavourable areas, where the average power level enterprises, of mainly agricultural directionprevail included 1291 children (group II) and environmentally unfavourable areas with large industrial complexes and a large number of road transport included 633 children (group III).

2.3 Methods

The method of expeditionary survey of organized groups was used to examine 2600 children aged 7-17 years, permanently residing in Kharkiv region. The groups were divided according to the age, sex and environmental characteristics of the area of residence. Thus, 676 children (group I) lived in environmentally favorable areas without large industrial enterprises; while 1291 children (group II) lived in relatively unfavorable areas with medium power enterprises, mainly agricultural; 633 children (group III) resided in environmentally unfavorable areas with large industrial complexes and a considerable amount of road transport emissions. The program of expeditionary survey of the representative number of children implied clinical and history study, anthropometry, assessment of alimentary provision of nutritional homeostasis, determination of essential and conditionally toxic microelements in hair by mass spectrometry with inductively coupled plasma using "ElvaX" device (2008). Hair was selected as a biological material due to its exceptionally informative nature reflecting the exposure to microelements. ME status examination involved only the children who did not take vitamins or mineral substances for the last 2 months prior to the study.

Statistical analysis was carried out using parametric and non-parametric criteria (Student-Fischer test, Van-der-Waerden test, etc.), probability distribution of characteristics and correlation analysis.

The study was conducted according to the international biotic standards.

Conflict of interests

There is no conflict of interests.

3 RESULTS AND DISCUSSION

Evaluation of mineral composition of hair showed that microelement profile of group I children was characterized by an impaired balance of essential macro- and microelements (ME), namely calcium, magnesium and zinc secondary to a slight increase in cobalt, chromium and strontium (to not more than 15%). In group II children ME disorders resulted from an increase in conditionally toxic microelements with an increase in strontium by 20% and lead by 13%. Group III children were found to have a significant shortage of essential abovementioned ME and accumulation of strontium to more than 40%, lead to 30%, aluminum to 30% and other conditionally toxic microelements.

Assessment of PGD in children of Kharkiv region at large showed a reduction in growth rates which may be explained by significant socio-economic difficulties of the last decade, namely dietary intake quality deterioration, unbalanced and irregular meals, reduced motor activity of children and adolescents, etc.

The study of the growth rates in groups under investigation identified marked gender-specificity of the environmental impact. Thus, the increase in linear growth in boys of all ages was significantly higher in group III children than in children of groups I and II ($p < 0.05$) and a similar dependence was observed in boys of the group II and group I ($p < 0, 05$) (Table 1).

Thus, boys, permanently residing in environmentally unfavorable conditions show acceleration in linear growth indices, and its degree depends on the extent of conditionally toxic ME accumulation ($r = 0.72$), due to biostimulating heterosis-like effect of industrial chemicals polluting the environment.

Table 1.

Age-sex height changes (cm) of children living in Kharkiv region

group/sex	I group		II group		III group	
Age	girls	boys	girls	boys	girls	boys
7 years old	120.3	120.5	121.6	121.5	118.3	122.4
8 years old	125.0	123.9	128.1	127.0	122.6	1349
9 years old	134.8	126.0	132.6	131.5	125.7	138.8
10 years old	139.7	127.5	137.3	137.4	139.9	142.8
11 years old	143.6	134.9	142.5	142.8	144.6	148.9
12 years old	152.5	138.7	147.0	147.4	151.5	152.5
13 years old	159.9	142.8	153.5	156.2	157.9	160.8
14 years old	166.5	149.8	161.1	159.2	166.0	163.0
15 years old	166.7	156.8	166.9	160.9	169.8	164.5
16 years old	169.8	160.3	173.1	164.2	174.1	168.3
17 years old	171.8	163.8	175.9	168.8	177.6	176.1

Assessment of linear growth indices in girls aged 7-14 years living in different ecological conditions did not reveal any significant differences. An increase in this index was also observed in group III girls. However, in puberty, at the age from 15 to 17 years, girls of groups I and III were found to have significant differences in growth indices, with an increase in this index in girls from environmentally unfavorable areas ($p < 0.05$).

Evaluation of body weight changes indicated an absence of distinct gender relation as opposed to growth. Thus, boys under 11 and girls under 16 were shown to have no significant differences in the dependence of body weight indices on the environmental characteristics of the area (Table 2). It should be noted that body weight indices in boys of this age were slightly higher among group I boys than in boys of groups II and III ($p > 0.05$). Besides, body weight in boys in puberty living in environmentally unfavorable areas was below age norms compared to PGD in children living in Kharkiv region.

Table 2.

Age-sex changes in body weight (kg) of children living in Kharkiv region

group/sex	I group		II group		III group	
Age	girls	boys	girls	boys	girls	boys
7 years old	24.5	21.7	24.7	25.0	24.3	23.3
8 years old	28.5	27.7	29.5	26.8	27.9	28.9
9 years old	31.7	31.4	31.2	27.8	30.2	29.0
10 years old	35.0	34.6	34.4	33.0	34.8	35.2
11 years old	39.5	43.2	37.3	37.5	40.2	36.2
12 years old	45.0	46.9	42.5	42.3	47.0	40.1
13 years old	50.0	52.4	49.6	48.3	49.3	45.6
14 years old	52.3	58.6	52.0	51.3	53.8	50.4
15 years old	56.9	64.0	56.5	52.9	56.3	57.5
16 years old	58.0	67.3	59.4	62.0	66.1	54.8
17 years old	60.7	68.8	66.5	64.0	68.8	56.4

As for girls in puberty, it should be mentioned that weight indices in group I girls were lower than the corresponding indices in group III girls ($p < 0.05$), whereas body weight in 17-year-old girls of group I was slightly lower as opposed to group II girls ($p < 0.05$).

Proper PGD is known to be characterized by cyclicity with accumulation of body weight prior to an increase in linear growth, which primarily provides good health in general. Evaluation of PGD growth rate in children under investig - tion showed a significant impact of environmental factors on PGD cyclicity. Thus, the largest increase in body weight in group I children was observed in 12-year-old girls and 11-year-old boys ($p < 0.05$). Alternatively, the maximum increase in height was observed in 14-year-old girls and 13-year-old boys ($p < 0.05$). Consequently, PGD processes in children permanently residing in areas of conventional environmental well-being relate to age criteria of the child's development.

The maximum increase in body weight in group II children was observed in 16-year-old boys and 17-year-old girls. However, the highest increase in linear growth in boys was observed at the age of 13 years ($p < 0.05$), and in girls at the age of 14 years ($p < 0.05$), which may be regarded as a pathological basis for further PGD of the child. Disruption

of PGD cyclicity in group II children comprised 4 ± 0.35 years on average ($p < 0.05$).

The most unfavorable PGD was observed in group III boys, with the maximum increase in body weight at the age of 15 years (it made up not more than 15% on average, $p < 0.05$), and the maximum increase in linear growth index at the age of 13 years (it made up 12% on average, $p < 0.05$) and at the age of 17 years old (it made up 12% on the average, $p < 0.05$), which indicates a distinct imbalance in the whole PGD process in boys permanently residing in envir-?nmentally unfavorable areas of Kharkiv region. The maximum increase in body weight in group III girls was observed at the age of 16 years (it made up 20% on average, $p < 0.05$), the maximum increase in linear growth occurred at the age of 10 years (it made up 20% on average, $p < 0.05$). This disruption of PGD cyclicity in girls of this group made up 6 ± 0.4 years on average ($p < 0.05$), which certainly conditioned its impact on physical health of children.

Environmental deterioration can lead to an imbalance of certain PGD indices, which definitely affects general health of children and requires elaboration of a framework of preventive measures.

4 CONCLUSIONS

1. Children permanently residing in unfavorable environmental conditions were found to have an increase in linear growth indices, which can be explained by biostimulating heterosis-like effect of industrial chemicals polluting the environment.
2. The degree of growth indices acceleration in children correlates with the degree of accumulation of conditionally toxic microlements ($r = 0.72$).
3. Body weight indices in boys in puberty living in ecologically unfavorable areas were slightly lower than the age norms for physical development of children in Kharkiv region, whereas these indices were lower in girls living in environmentally favorable areas.
4. Environmental deterioration leads to an imbalance of physical processes and deregulation of cyclic processes of body weight accumulation and linear growth rates.

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РЕЗЮМЕ

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ЕКОЛОГІЧНИЙ ВПЛИВ НА РІВЕНЬ ФІЗИЧНОГО РОЗВИТКУ ДІТЕЙ ТА ПІДЛІТКІВ ХАРКІВСЬКОГО РЕГІОНУ.

У роботі наведені результати дослідження рівня фізичного розвитку 2600 дітей, які мешкають у різних екологічних умовах харківського регіону. Встановлено, що у дітей з несприятливо екологічних районів відбувається прискорення лінійного зросту, а ступінь прибавки цього показника у дитячому віці має кореляційну залежність від ступеню накопичення умовно-токсичних мікроелементів ($r=0,72$). Виявлені певні гендерні особливості впливу екологічних факторів на показники маси тіла дітей. Так, у хлопчиків мешканців екологічно несприятливих районів маса тіла нижче вікових нормативів, тоді як у дівчаток нижчі показники маси тіла спостерігаються у мешканців екологічно сприятливих районів. Погіршення екологічного становища призводить до дисбалансу та порушення циклічності фізичного розвитку, що негативно впливає на рівень здоров'я в цілому.

Ключові слова: діти, фізичний розвиток, екологія.

РЕЗЮМЕ

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ВЛИЯНИЕ ЭКОЛОГИИ НА УРОВЕНЬ ФИЗИЧЕСКОГО РАЗВИТИЯ ДЕТЕЙ И ПОДРОСТКОВ ХАРЬКОВСКОГО РЕГИОНА

В работе представлены результаты исследования уровня физического развития 2600 детей, которые проживают в разных по экологическому благополучию районах харьковского региона. Установлено, что у детей, проживающих в экологически неблагоприятных районах, происходит ускорение показателей линейного роста, а степень прибавки данного показателя зависит от степени накопления условно-токсических микроэлементов (r=0,72). Установлены гендерные особенности влияния экологических факторов на показатель массы тела детей. Так, у мальчиков, проживающих в экологически неблагоприятных районах, показатели массы тела ниже возрастных нормативов, тогда как у девочек снижение этих показателей отмечается в экологически благоприятных районах. Ухудшение экологического состояния приводит к дисбалансу и нарушению цикличности физического развития, что негативно влияет на состояние здоровья в целом.

Ключевые слова: дети, физическое развитие, экология.

Received: 01-Feb. – 2016
Accepted: 20-Mar. - 2016