The analysis of morphofunctional characteristics of 7-year-old boys, living in different environmental conditions

Galina Alexandrovna Pavlova*, Alexander Vladimirovich Gerasimov

ABSTRACT

Aim: The problem of anthropogenic impact on the environment is the most urgent topic of the research, as it directly affects the health and living conditions of the population. It is known, that children have a special sensitivity to the influence of unfavorable environmental factors. Growing organism is characterized by high reactivity to the external influences, and the degree of its adaptive capacity depends on the age-gender characteristics and other factors. Therefore, the urgency of studying the physiological systems, ensuring the adaptation of the organism to the environment, is quite obvious. Materials and Method: Based on this, a comprehensive study of the cardiovascular system functions, external respiration parameters, physical development of 7-year-old boys, attending secondary school (the first form), living in different environmental conditions, was carried out. In the study, the following methods were used: The method of directional contingent selection, physiological methods, and statistical methods. Result and Discussion: Based on the results of the study, the morphofunctional parameters of the studied group of children, depending on the environmental living conditions, were compared and analyzed. Conclusion: In the process of the study, it was found, that environmental pollution is one of the causal factors of declining physical development and adaptability of individual systems (cardiovascular, external respiration system) in the study group of 7-year-old children, living in different environmental conditions.

KEY WORDS: Cardiorespiratory system, External respiration, Heart, Physical development

INTRODUCTION

Significant part of the Russian Federation population lives in a territory, where further pollution of the environment can lead to negative consequences, threatening the state of health. The study of consequences of technogenic accumulation of toxic substances and anthropogenic pollution of the environment is extremely important for the health of the population at the present time. The scale of modern production growth is so large, that the amount of substances, emitted per unit of time is much greater than the amount, which can be neutralized by the environment.

Characteristic feature of large-scale industries is the relative stability of the harmful substances concentration in the air, their extremely slow decrease as they move away from the source of emissions, the large diffuse contamination of the air basin in adjacent residential areas by organic and inorganic compounds.

The reaction of the organism in the process of interaction with environmental factors proceeds in different ways, depending on the strength of the influencing factor, the time of exposure and the adaptive capabilities of the organism, which are determined by the availability of functional resources. Therefore, it is very important to assess the ability of the body to maintain homeostasis when environmental factors influence it.

In recent years, the interest of the researchers has increased for the children of the primary school age, when the backgrounds of performance efficiency, endurance, active life, and health level, are laid.

The child’s organism is characterized by the low perception threshold to the influence of pollutants, high reactivity to external influences, and the degree of adaptive capacity of the child depends on age, gender, and a number of other individual characteristics.

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Department of Physical Chemistry, Institute of Fundamental Medicine and Biology, Kazan Federal University, Kazan 420008, Russia

*Corresponding author: Galina Alexandrovna Pavlova, Institute of Fundamental Medicine and Biology, Kazan Federal University, 18 Kremlyovskaya Street, Kazan 420008, Russia. E-mail: gapavlova_72@mail.ru

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In recent years, a significant number of studies have been carried out to determine the influence of environmental pollution on the physical development and morbidity of children, but insufficient attention has been paid to compensatory adaptation and the development of nonspecific resistance of the children’s organism, in response to chronic exposure of atmospheric air admixtures, exceeding the maximum allowable concentrations.\[1,10]\n
To estimate the course of adaptive reactions, the process of adaptation to changing conditions of life, to various stresses, it is necessary to be able to determine the functional state of the organism and its individual systems (cardiovascular and respiratory systems). In regard to unfavorable environmental factors, cardiac rhythm parameters are the most informative. They give an insight into the nature of the current interaction of the cardiac rhythm control units, and thereby to assess the state and the degree of tension of regulatory mechanisms of the whole organism.\[2,11,12]\n
The working hypothesis of our study is the idea about the negative impact of adverse environmental conditions on the morphofunctional characteristics of 7-year-old boys. The purpose of the work is a comparative analysis of parameters of physical development, cardiovascular and respiratory systems, in 7-year-old boys, living in different environmental conditions.

**MATERIALS AND METHODS**

In the work, which has the form of comprehensive study, the following methods were used: The method of directional contingent selection, physiological methods, and statistical methods.

The study was conducted in the secondary school No 130, in the region of the petrochemical enterprise location, which was selected as a relatively environmentally unfavorable region (REUR) and in secondary school No 40, located in a relatively environmentally favorable region (REFR) in Kazan.

30 pupils of the first form, practically healthy, with an average level of physical development, participated in the studies. The survey was conducted in the morning hours, during the whole week. For our research, we have formed qualitatively homogeneous groups of children in the REUR and REFR. The method of directional contingent selection was used for the creation of homogeneous groups.

The conventional method of V.V. Bunak was used for the research and estimation of the physical development of children (height (H), body mass (M), chest circumference (CC), and surface area of the body). The study of heart rhythm variability was conducted using a program, based on the method of Baevskiy et al.\[21]\n
The device of the diagnostic analysis system of electrocardiogram signals “Reakard” was used as the equipment for input and collection of information.

Based on the results of statistical and autocorrelation analysis of the dynamic ranges of cardio intervals, heart rhythm variability parameters were estimated. For the experimental study of external respiration parameters, an assessment of broncho-conduction was carried out, with the help of the program “breath analyzer AD-02M.”

To determine the reliability, the standard values of the Student’s test were used.

**RESULTS AND DISCUSSION**

The comparative analysis of the physical development parameters of 7-year-old boys, living in different environmental conditions, showed the following results. Thus, 7-year-old boys living in a REUR, had lower parameters of the CC (59.91 ± 1.14 cm and 65.15 ± 1.03 cm, \(P < 0.01\)), body length (126.25 ± 1.35 cm and 130.86 ± 1.54 cm, \(P < 0.05\)), and body weight (23.76 ± 0.71 kg and 28.65 ± 1.64 kg, \(P < 0.01\)) compared with the children, living in a REFR. Taking into account, that the surveyed contingent of children was formed on the principle of “the couple copy”, and that children were not exposed to production factors, did not have bad habits and most of the time they were in children’s institutions, having the same conditions and regime, it could be concluded, that there was a negative influence of environmental pollution on the physical development of children.

7-year-old boys, living in REUR, had the heart rate 100 ± 1.45 beats per minute, whereas children, living in REFR, had significantly lower heart rate, amounted to 86.6 ± 3.18 beats per minute (\(P < 0.01\)). Significantly high figures of heart rate may indicate an uneconomical regime of blood circulation. The analysis of the changes in the parameters of heart rhythm revealed, that in children living in the REUR, the variation parameter ΔX, characterizing the state of the parasympathetic system in the age group of 7-year-old children, was significantly lowered 219 ± 13.6 ms, compared to the study group, living in REFR 264 ± 22.0 ms (\(P < 0.01\)). In 7-year-old
boys, living in REUR, sigma values were 40.2 ± 2.36 relative units, which is significantly lower than the parameters of sigma in boys, living in REFR, 53.1 ± 5.03 relative units, \( (P < 0.01) \). That indicates a high influence of the parasympathetic department of the autonomic nervous system in children, in relation to the environmentally favorable region of living. The tension index of 7-year-old boys, living in REUR was 130 ± 19.3 relative units, whereas, the tension index of children, living in REFR was 100 ± 20.8 relative units. Parameter “tension index” indicates an increase in the central mechanism of controlling the heart rate and indicates an increase in the tension of the regulatory mechanisms. This is explained by the fact that the usual level of physiological systems functioning is ensured with minimal activation of the central control mechanisms. In this case, despite the maintaining of homeostasis, adaptive balancing with the medium occurs due to the growth of the regulatory processes tension. “Mode amplitude” parameters of 7-year-old boys, living in different environmental conditions were practically the same and amounted to 29.8 ± 1.6% and 28 ± 2.62%. Thus, in children, living in REUR, the sympathetic influence of heart rate control mechanisms are more pronounced, and the activity of the parasympathetic system is decreased (decrease of \( \Delta X \), \( \sigma \), increase of mode amplitude, and tension index). Such shifts point to the tension of regulatory mechanisms of heart rate control. A significant decrease of parasympathetic influences on cardiac activity in children, living in REUR may indicate a prolonged adaptive response to unfavorable environmental conditions and lead to a reduction of the reserve and adaptability of children of primary school age.

The studies of recent years, carried out in the framework of environmental physiology in various regions, show a high sensitivity of the external respiration system to anthropogenic impact. As a result of our studies, the indicator of the lung pulmonary vital capacity (LPVC), indicating the degree of development of pulmonary structures in 7-year-old boys, living in REUR, at rest was 1.97 ± 0.12 L, while in children, living in REFR, the value of the investigated parameter was 1.96 ± 0.07 L. The respiratory volume in 7-year-old boys, living in REUR, at rest was 0.63 ± 0.04 L, while in the boys, living in REFR, the studied parameter was 0.69 ± 0.03 L. The respiratory rate in 7-year-old boys, living in REUR, at rest was 16.6 ± 1.1 times per minute, while in the children of this age group, living in REFR, the studied parameter was lower and amounted to 14.9 ± 0.96 times per minute. Respiratory minute volume in 7-year-old boys, living in REUR, was 10.7 ± 1.07 L/min, while in boys of the same age group, living in REFR, the respiratory minute volume was 10.26 ± 0.85 L/min.

Thus, the researchers show a high sensitivity of the external respiration system to anthropogenic impact. Children, living in a REUR, have lower values of the studied parameters, compared to children, living in a REFR.

**DISCUSSION**

Children of primary school age, living in REUR have lower parameters of physical development than children living in REFR. 7-year-old boys, living in REUR have significantly low parameters of CC (\( P < 0.01 \)), low height (\( P < 0.05 \)), and low body weight (\( P < 0.01 \)). The parameters of the heart rhythm of 7-year-old children, living in REUR, indicate a decrease in the degree of adaptation. That is proved by the statistically significant increases of the heart rate (\( P < 0.05 \)), significant decrease of sigma (\( P < 0.05 \)), and \( \Delta X \), an increase of the “mode amplitude” parameters (\( P < 0.05 \)) and tension index, compared with children, living in REFR. This dynamics of changes in the parameters of the heart rate is noted in 7-year-old boys, depending on the environmental conditions of living.

The tension of the body’s functional reserves and the reduction of the adaptation degree is confirmed by significant changes in the values of the external respiration parameters (lung pulmonary vital capacity, respiratory volume, respiratory rate, and respiratory minute volume) in children, living in different environmental conditions.

**CONCLUSIONS**

The results of the study allow us to conclude, that environmental pollution is one of the causal factors in the reduction of physical development parameters, as well as the adaptive capabilities of individual systems (cardiovascular and respiratory system) in children of primary school age. Thus, the parameters of the physical development of 7-year-old boys have significantly low values in a REUR, in comparison with REFR. Significantly low parameters of CC (\( P < 0.01 \)), height (\( P < 0.05 \)), and body weight (\( P < 0.01 \)) were detected in children, living in REUR, compared to children, living in REFR. The obtained results of the study are consistent with the data of a number of authors, who have revealed changes in the parameters of the physical development of children, depending on the degree of air pollution from industrial enterprises.

The dynamics of changes in the parameters of the heart rhythm, reflects more pronounced sympathetic influence of heart rate control mechanisms, and the decrease of the parasympathetic system activity (decrease of \( \Delta X \), \( \sigma \), increase of mode amplitude, and tension index) in children of primary school age, living in REUR, compared to children, living in REFR. Such
shifts point to the tension of regulatory mechanisms of heart rate control. A significant decrease of parasympathetic influences on cardiac activity in children, living in REUR may indicate a prolonged adaptive response to unfavorable environmental conditions and lead to a reduction of the adaptability of children.

High sensitivity of the external respiration system to anthropogenic impact is reflected by low values of the investigated parameters in children of primary school age, living in REUR, compared with children, living in REFR. This fact indicates a tension of the functional reserves of the body and a decrease in the degree of adaptation. The reaction of the cardiorespiratory system to the influence of environmental factors and changes in its functions can lead to the disorder of oxygen supply of the whole organism. As a consequence of this fact, there is the tension of the body’s functional reserves, the reduction of the degree of adaptation, the disruption of adaptation. Having investigated this issue, it can be affirmed, that environmental pollution is one of the causative factors of reducing of morpho-functional parameters in children, and the degree of adaptation depends on the environmental conditions of living, age, gender, and other individual characteristics of the organism.

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