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Comparison Study of External Respiration System of 9-Year-Old Boys

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ABSTRACT

Of the goal of study is to investigate the dynamics of the parameters of the respiratory system, determined at resting state, and the reactivity of the system, assessed by the degree of changes in lung volume and ventilatory lung capacity under the influence of static load. The study involved boys aged 9 years with an average level of physical development, belonging to the first and second groups of health.

The values obtained in the resting state were taken as a control of the parameters of external respiration. The change in the parameters of external respiration to the test sample was recorded in the first minute after the static load was completed. Correlation analysis of interrelations between all analyzed parameters of the respiratory system was carried out.

A comparative analysis of external respiration system of the 9-year-old boys during the academic year showed that positive age dynamics of lung volume parameters and ventilatory lung capacity are observed in a resting state. Dosed isometric exercise causes unfavorable shifts in external respiration rates, a decrease in the reserve capabilities of the respiratory system. By the end of the second academic year 9-year-old boys in response to a static load get an increase in reactivity and a decrease in the effectiveness of respiratory system reactions.

Key words: Respiratory system, Adaptation, Mid childhood

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INTRODUCTION

The beginning of educational activity is accompanied by the emergence of a complex of loads and adverse factors that affect the health of children. The discrepancy between the intellectual and physical components of the loads, an increase in the intensity of the educational programs, and the manifestation of "school hypokinesia" are in evidence for this period All these factors cause the formation of long-term passive adaptation, the emergence of functional shifts in the children's body systems [1]

The breathing system is one of the most important physiological systems that determine both mental and physical performance capability of children in the process of ontogeny and adaptation to learning activity [2,3]. The required levels of minute volume of respiration can be provided only if there is a corresponding functional reserve and the maturity of the regulatory mechanisms [4,5].

It is known that the age of 7-10 years is on the border of two important periods of the development of the respiratory system:

1. 6-7 years, when there is a significant decrease in airways resistance, which leads to an increase in the volume of inspiration and expiration.
2. 10-11 years the period of intensive increase in lung volume. The age of 7-10 years is characterized by smooth changes in morphofunctional indicators, increase of reserve and functional capabilities of external respiration.

With age there is a tendency to decrease the relative value of the minute volume of breathing, deepen and lower the respiratory rate. The minute volume of breathing of 7 years old girls increases more than the minute volume of breathing of boys of the same age. The volume velocities of breathing decrease on exertion, indicating fatigue of the respiratory muscles [6-8].

The immaturity of the mechanoreceptor and central mechanisms of breathing regulation is noted in child's body, which can cause inadequate physiological changes in the respiratory system in the process of adaptation of younger schoolchildren to the academic load. There are works devoted to the study of the influence of learning activity on the functions of external respiration in literature [9].

The adaptation of the respiratory system of children and adolescents to physical exertion of different capacities, meteoclimatic and environmental conditions was studied in most research works [10]. The study of the effect of static loads on the functions of external respiration of schoolchildren is also of scientific interest. The purpose of our work is to study the adaptive responses of the 9-year-old boys' respiratory system for to the dosed isometric load in the dynamics of the school year.

METHODS

During the school year (autumn, winter, spring) we analyzed both the dynamics of the external respiration parameters, determined at resting state, and the reactivity of the system, assessed by the degree of changes in lung volume and ventilatory lung capacity under the influence of isometric loading. The study involved 38 9-year-old boys with an average level of physical development, belonging to the first and second health groups, studying in the second grade of the general school in Kazan. The automated cardiopulmonary complex AD-03M on the basis of Pentium 3 was used for the analysis of external respiration parameters.

Such respiratory system parameters as vital capacity of lungs (VCL), respiratory minute volume (RMV), respiratory volume (RV), respiratory rate (RR), reserve volume of inspiration (RVI) and exhalation (RVE), reserve volume at balanced lung ventilation (RVBLV), maximum breathing capacity (MBC) were estimated in the research. To assess the efficiency of breathing, the ratio of the inhalation and expiration time to the total duration of the respiratory cycle was studied. Lung volume and indices of ventilation capacity of lungs are given in the BTPS system.

The dosage isometric load created by the handgrip test method [1] was used as the functional muscle test: the research subject in the sitting position squeezed the dynamometer with his left hand for 1 minute with a force equal to 50% of the maximum. The average of three attempts was taken for the indicator of the maximum effort. The values obtained in the resting state were taken as a control of the parameters of external respiration. The change in the parameters of external respiration to the test sample was recorded in the first minute after the static load was completed. Correlation analysis of interrelations between all analyzed parameters of the respiratory system was carried out. The statistical processing of the results of the study was carried out in accordance with the standard methods of variation statistics, the standard values of the Student's t-test were used to estimate the statistical significance of the differences.

RESULTS

The results of the study and their discussion:

According to the results of the study of the 9 years old boys' respiratory system in the state of physiological rest at the beginning of the academic year, the RMV was 11.54 ± 0.36 l/min, RV=0.59 ± 0.09 L, RR-19.49 ± 0.3 cycles per minute, VCL-1.85 ± 0.17 liters. The indicators reflecting the reserve volumes of the lungs-RVE, RVI, RVBLV and MBC-were 0.35 ± 0.07 l, 1.00 ± 0.08 l, 63.87 ± 1.18 l and 73.23 ± 1, 04 L respectively.

The study of adaptive reactions of the respiratory system of the boys at the beginning of the second academic year to the isometric load showed that the value of the RMV increased to 13.26 ± 0.29 l/min (by 14.81%, $p \leq 0.05$), RR - up to 21.04 ± 0.39 cycles per minute (by 7.9%, $p \leq 0.05$), while RV remained practically unchanged (Figure 1). Consequently in the first period of the study isometric loading leads to an increase in the RMV of boys only due to the spectral component of pulmonary ventilation (RR).

The magnitude of the VCL and indicators reflecting the reserve volumes of the lungs in response to the functional test, on the contrary, tended to decrease (Figure 1). VCL after the load decreased to 1.71 ± 0.15 L, RVI to 0.83 ± 0.119 L, RVE to 0.33 ± 0.12 L, and the magnitude of RVBLV and MBC statistically significant decreased. Thus the magnitude of the RVBLV after the load

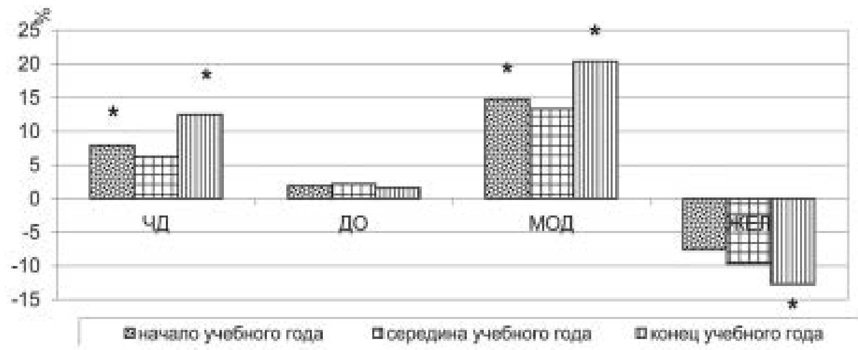

Figure 1: The dynamics of external respiration parameters of 9-year-old boys in response to the dosed isometric load during the school year (% in relation to the indicator at rest); RR: Respiratory Rate; RV: Respiratory Volume; RMV: Respiratory Minute Volume; VCL: Vital Capacity of Lungs; *The difference with the resting state is statistically significant (p<0.05).

was 55.8 ± 1.05 liters, MBC-68.44 ± 1.08 liters (decrease by 12.6 and 6.5% respectively, p ≤ 0.05).

In general the results of the study of adaptive responses, obtained at the beginning of the academic year, reflect the insufficient preparedness of the boys' respiratory system for isometric load. In the middle of the academic year the basic values of the respiratory system indicators (at resting state) of the boys of the second year of study, with a stable upward trend, did not, however, have statistically significant differences with the results of the previous study period.

Isometric loading led to a slight increase in respiration and an increase in RMV, the RV value remained unchanged. At the same time after the end of the load, a decrease in the VCL was recorded (from 1.85 ± 0.18 to 1.67 ± 0.15 L), RVBLV (from 66.35 ± 1.04 to 52.90 ± 1.06 L) and MBC (from 76.18 ± 1.07 to 65.57 ± 1.11 L) and, as a consequence, a decrease in the ratio of RVBLV/MBC (p ≤ 0.05).

The obtained results testify to the unfavorable nature of adaptive reactions of biomechanical parameters of respiration in response to isometric loading and reflect the low reserve capabilities of the respiratory system. The value of the other parameters of external respiration did not differ significantly from the background state after isometric loading.

The studies carried out at the end of the second academic year showed that, in comparison with the previous analyzed periods, the values of RMV, RR, RVBLV, and MBC at resting state were significantly increased. RMV was 15.07 ± 0.41 l/min, RR-23.76 ± 0.38 cycles per minute (p ≤ 0.05), RVBLV-69.70 ± 1.27 l, MBC-79.59 ± 1.20 liters, whereas in the dynamics of RV, VCL, RVE and RVI, only a trend towards a positive age-related growth of indicators was noted.

After an isometric load at the end of the school year, the boys registered a significant increase in RMV (up to 18.94 ± 0.58 L, p ≤0.05), due to the increase in RR (up to 27.49 ± 0.49 cycles per minute, p ≤ 0.05). The growth of the RMV was 20.4%, RR-14.8%. The value of RV after the load did not change (Figure 1). At the same time there was a significant decrease in the majority of external respiration indices: RVBLV (to 57.00 ± 1.07 l, p ≤ 0.05), MBC (to 71.33 ± 1.01 L, p ≤ 0.05), VCL (from 1.89 ± 0.03 to 1.65 ± 0.03 l, p ≤ 0.05), RVI (from 1.02 ± 0.11 to 0.60 ± 0.10 L, p ≤ 0, 05).

The RVE value tended to decrease (from 0.44 ± 0.18 to 0.38 ± 0.14 L), and the ratio of RVBLV / MBC statistically significant decreased (p ≤ 0.05). At the end of the school year there is a tendency to increase the ratio of expiratory time to the total duration of the respiratory cycle and to decrease the ratio of inspiratory time to the total duration of the respiratory cycle (from 0.47 ± 0.08 to 0.53 ± 0.08 s and from 0.53 ± 0.07 to 0.47 ± 0.06 s, respectively, p ≤ 0.05), which indicates a decrease in the efficiency of external respiration during this period of the study.

Comparative analysis of the age dynamics of pulmonary volume and indices of ventilation capacity of lungs of 9-year-old boys during the academic year showed that all parameters of the respiratory system, determined at resting state, have a definite tendency to increase from the beginning to the end of the school year. The most significant increase was noted for such indicators as RMV (12.5%, p ≤ 0.05) and RR (12.5%, p ≤ 0.05). The increase in RV is expressed to a lesser extent and is only 1.6% (Figure 1).

It is noteworthy that in the dynamics of the academic year, the increase in the value of the RMV at resting state takes place with the participation of both the frequency and the volume component of ventilation, which is indicative of a rather favorable age-related dynamics of the respiratory system indices of 9 years old boys. A positive fact is the age-related increase in indicators reflecting the reserve capabilities of the respiratory system.

By the end of the academic year, there was a significant decrease in RVBLV (18.2%, $p \le 0.05$) and MBC (13.4%, p=0.05). During all periods of the study the indicators VCL, RVI, RVE, MBC, RVBLV decrease compared to their level at resting state, negative correlations between RMV-RV-RR appear, which indicates an adverse reaction of the system to the test sample.

DISCUSSION

First of all, it is needed to grasp the mechanism for respiratory system and then in following we will investigate the comparison through an academic year for 9 years old boys. In the discussion part we are determined to describe this mechanism.

The cells of the human body require a constant stream of oxygen to stay alive. The respiratory system provides oxygen to the body's cells while removing carbon dioxide, a waste product that can be lethal if allowed to accumulate. There are 3 major parts of the respiratory system: the airway, the lungs, and the muscles of respiration. The airway, which includes the nose, mouth, pharynx, larynx, trachea, bronchi, and bronchioles, carries air between the lungs and the body's exterior.

The lungs act as the functional units of the respiratory system by passing oxygen into the body and carbon dioxide out of the body. Finally, the muscles of respiration, including the diaphragm and intercostal muscles, work together to act as a pump, pushing air into and out of the lungs during breathing. The nose and nasal cavity form the main external opening for the respiratory system and are the first section of the body's airway—the respiratory tract through which air moves. The nose is a structure of the face made of cartilage, bone, muscle, and skin that supports and protects the anterior portion of the nasal cavity. The nasal cavity is a hollow space within the nose and skull that is lined with hairs and mucus membrane. The function of the nasal cavity is to warm, moisturize, and filter air entering the body before it reaches the lungs. Hairs and mucus lining the nasal cavity help to trap dust, mold, pollen and other environmental contaminants before they can reach the inner portions of the body. Air exiting the body through the nose returns moisture and heat to the nasal cavity before being exhaled into the environment.

CONCLUSION

Thus the increase in RMV in response to the isometric load is mainly due to the contribution of the respiratory rate (RR) against the background of a slight change in RV. By the end of the second academic year, the boys showed an increase in reactivity and a decrease in the effectiveness of respiratory system reactions to the static load, which reflects the intense functioning of the analyzed system by the end of the school year.

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