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FEATURES OF CHANGES IN THE PARAMETERS OF HEART PUMPING FUNCTION AND EXCRETION OF CATECHOLAMINES IN PRIMARY SCHOOL CHILDREN WHEN GIVING THE ORAL ANSWERS AT THEORETICAL LESSONS

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Abstract.

It was revealed for the first time that changes in the indices of cardiac pump function of the first graders during oral responses either at a desk or at the blackboard do not depend on the level of physical activity. During the subsequent years of study, the reaction of the heart pumping function of children subjected to enhanced motor activity decreases significantly when giving oral responses at the theoretical lessons. It was found that, from age to age, all children examined have a significant reduction in their stroke volume response when answering at a desk or standing at the blackboard.

The reaction of the parameters of heart pumping function of first and fourth graders is slightly higher in boys than in girls. It was found for the first time that the reaction of the parameters of cardiac pumping function in the examined children is lower when answering at the blackboard. It was also revealed that the excretion of adrenaline and noradrenaline during oral responses in the first class does not depend on the level of physical activity. It was found for the first time that the children of control group have greater epinephrine excretion when giving oral answers both at the desk and at the blackboard, while the children with enhanced motor activity have greater excretion of norepinephrine.

Keywords: Heart rate, stroke volume response when giving answers at a desk and at the blackboard, primary school children, epinephrine, norepinephrine.

Introduction.

Starting schooling poses high demands on the functioning of a child's organism. Due to the large volume of training load, extra classes, homework, etc., the level of motor activity of children decreases to a large extent [1,2,4,7]. At the same time, the significant but little studied aspects of the adaptation of children to mental stress are the study of both

indicators of cardiac pumping function and biochemical background of regulation functions of the body in terms of catecholamine excretion, as an indicator of activity of the sympathetic component of the autonomic regulation [7,8].

Objective of the research was to study the features of changes in the parameters of heart pumping function and excretion of catecholamines in primary school children, subjected to various physical activity, when giving the oral answers at theoretical lessons.

Research methods: The experiments involved 74 children - first and fourth graders of Ayshin secondary school and the lyceum No.9 of Zelenodolsk, Republic of Tatarstan. The pupils were divided into two groups. The first group included children regularly going in for sports. These children in addition to two or three compulsory sport lessons at school were additionally engaged in other sports and included in the group of enhanced physical activity (EPA). The second (control) group consisted of children engaged in physical education within the school curriculum, and pursuing a sedentary lifestyle.

Stroke volume (CRM) was determined by Kubicek's tetrapolar chest rheography [9]. Quantitative determination of norepinephrine and epinephrine in the urine was performed by HPLC with electrochemical detection (chromatograph Shimadzu LC-20AD with an electrochemical detector ECD DECADE II). Rheogram records and urine sampling in children for the analysis of catecholamines were performed in several stages. The first rheogram was recorded in a sitting position at the desk. Immediately after that, the urine samples were taken from the children in the treatment room for their analysis. These values were considered initial. Further, rheogram recording was carried out during oral answers at the desk. Immediately after oral answer, the urine samples were collected. The next rheogram recording was performed during oral answers at the blackboard, also followed by urine sampling.

Results:

After analyzing the changes in the parameters of heart pumping function in primary school children, subjected to various physical activity, when giving the oral answers at theoretical lessons, we revealed the following features. The reaction of the heart rate of first grade boys and girls during oral responses at a desk or at the blackboard differs significantly and does not depend on the level of physical activity, i.e., regardless of the level of physical activity, all first graders, had equally expressed changes in heart rate during oral answers at the theoretical lessons. It should be noted that changes in the heart rate of the first graders during the answers at the blackboard were slightly higher than during the answers at the desk. Further, the recovery of heart rate level to initial values after oral answers occurred mostly 1 minute after completing the answer.

After analyzing the changes in the heart rate of fourth grade boys and girls of both control and study groups, we revealed the following features:

- the boys of the control group had significantly higher heart rate ractions when answering at the desk and at the blackboard than the boys of the group of enhanced physical activity. Furthermore, the recovery of heart rate to initial values after completing the answers occurred much later in the boys of the control group than in the boys of the group of enhanced physical activity;

- the girls of EPA group had significantly lower changes in heart rate during answers at the desk and at the blackboard ($P<0.05$) than the girls of the same age from control group.

We analyzed the stroke volume response in the first and fourth graders during oral answers at the theoretical lessons. The first grade boys of the control group, i.e., not regularly engaged in physical culture and sports, had their stroke volume in a sitting position at the desk equal to 22.4±1.7 ml. When answering in a standing position at the desk, their stroke volume increased in comparison with the initial values and reached 30.7±1.4 ml ($P<0.05$). Stroke volume recovery to the level of initial values occurred 2 minutes after the oral response. When answering at the blackboard, stroke volume of boys of this group increased by only 4.4 ml ($P<0.05$).

The first grade girls of control group had an increase in their stroke volume during oral answers at the desk and at the blackboard in comparison with the initial values by 8.2 ml and 4.7 ml, respectively ($P<0.05$). Consequently, the boys and girls not engaged in regular physical activity have nearly the same stroke volume reaction during oral responses at the desk and at the blackboard expressed.

The first grade boys of EPA group, i.e., regularly engaged in physical culture and sports, had their stroke volume in a sitting position at the desk equal to 21.9±1.7 ml. When answering in a standing position at the desk, their stroke volume increased by 8.1 ml in comparison with the initial values and reached 30.0±1.7 ml ($P<0.05$). When answering at the blackboard, stroke volume of boys of this group increased by 4.9 ml ($P<0.05$). Stroke volume response in the girls of EPA group during oral answers at the desk and at the blackboard was 8.2 ml and 5.1 ml, respectively ($P<0.05$).

Thus, the stroke volume response in first graders during oral answers does not depend on the level of physical activity. It should be noted that the examined groups of boys and girls had their stroke volume response much higher during oral answers at the desk was than during answers at the blackboard. Nearly equally expressed changes in stroke volume in the first graders of both control and EPA groups during oral answers at the desk and at the

blackboard are most likely due to the following circumstances. The education process in the first grade is mostly gamified. A teacher encourages and supports all pupils. As a rule, the pupils receive no points for their answers, i.e. not graded on a 5-point scale. All this contributes to a significant activation of the children at the lessons. Children do not hesitate to express their thoughts and considerations. Subject to the foregoing, children's excitement during oral answers is usually minimal. As a consequence, the stroke volume reaction is also less pronounced. Moreover, after completion of oral answers, the indicators of stroke volume of children quickly recover to their initial values.

For comparison, we also analyzed the stroke volume responses of the fourth graders. According to our studies, the fourth grade boys of control group had their stroke volume in a sitting position at the desk equal to 29.3±1.7 ml. When answering in a standing position at the desk, their stroke volume increased by 10.4 ml and reached 39.7±1.3 ml ($P<0.05$). When answering at the blackboard, stroke volume of boys of this group increased by 9.4 ml, in comparison with the initial values ($P<0.05$). We observed nearly the same stroke volume response in the girls of control group during oral answers at the desk and at the blackboard (10.9 ml and 8.9 ml, respectively). Thus, the stroke volume response of the fourth grade boys and girls of control group during oral answers at the desk and at the blackboard has increased in comparison with the changes in stroke volume of the first graders. For example, when the stroke volume response of the first graders was 4-8 ml, it increased up to 9-11 ml by the time of fourth grade ($P<0.05$). It should be noted that the most expressed increase in the stroke volume response of the fourth graders was observed when answering at the blackboard.

The fourth grade boys of EPA group had their stroke volume in a sitting position at the desk equal to 38.1±1.7 ml. When answering in a standing position at the desk, their stroke volume increased by 4.7 ml and reached 42.8±1.2 ml ($P<0.05$). This stroke volume response was 3.4 ml less than that of the first graders when answering at the desk. A ignificantly lower stroke volume response was found in forth grade boys of EPA group when answering at the blackboard, equal to only 3.1 ml ($P<0.05$). We also observed a significant decrease in the stroke volume response of the fourth grade girls of EPA group during oral answers. When answering at the desk and at the blackboard, the stroke volume response of these girls increased only by 5.4 ml and 4.7 ml, respectively ($P<0.05$), as compared with initial values. Thus, the children of EPA group by the fourth grade experience a significant reduction in their stroke volume response during oral answers at the desk and at the blackboard. Therefore, it can be argued that the systematic muscle training contribute significantly to the reduction of stroke volume response during oral answers in children of primary school age. And otherwise, the stroke volume response of children, pursuing a sedentary lifestyle,

increases when giving oral answers. We should also note that the recovery of stroke volume response in the fourth graders of EPA group to the initial values after the oral answers occurred much faster than in children of control group. Regular physical activity and sport training make significant changes in stroke volume reaction in primary school children when giving the oral answers at theoretical lessons. In our opinion, this is due to the fact that the systematic muscle training cause significant changes in extracardiac regulation mechanisms of the heart of primary school children. Probably, these changes substantially inhibit the stroke volume response in stressful situations, which are the oral answers the children of primary school age give at a desk and at a blackboard. R.A. Abzalov and F.G. Sitdikov indicate in their study [1] that muscle training help children to reduce the effects of the sympathetic and increase at the same time the parasympathetic influences on their heart rate. According to I.Kh. Vakhitov [4], a systematic muscle training started at an earlier age, cause a significant increase in parasympathetic effects on the pumping function of the heart of children. The higher tone of the parasympathetic nervous system, caused by an increased level of physical activity, has a positive effect on the processing of information in the stressful conditions [3]. According to I.A. Krivolapchuk [6], the pupils demonstrating high physical activity are characterized by less severe psychophysiological reactivity under testing loads: this group of children has lower values of heart rate recorded.

In order to study the adaptive abilities of primary school children to mental stress, we studied the excretion of catecholamines in various conditions of mental activity.

According to our study, the first grade boys and girls have certain features in the excretion of catecholamines. The children of control group, i.e., not regularly engaged in physical activities and sports, had increase in the excretion of epinephrine and norepinephrine while answering when sitting at a desk. The excretion of epinephrine in this case was slightly higher. After answering while standing at the blackboard, the urine concentration of epinephrine and norepinephrine did not differ significantly from the values obtained when answering while sitting at a desk. The children of EPA group during oral answers had a slightly lower epinephrine excretion, and a higher norepinephrine excretion as compared with the values of the children of the same age from the control group. Therefore, the children, additionally engaged in physical activities and sports, showed a steady decrease in excretion of epinephrine and a simultaneous increase in norepinephrine to the stimuli, which are the oral answers given at the theoretical lessons.

After analyzing the changes in the values of epinephrine and norepinephrine in the fourth grade boys and girls, we found that the control group of children during an oral answer at the desk and at the blackboard has a significant

increase in the excretion of norepinephrine, while the epinephrine excretion, on the contrary, changes slightly. However, norepinephrine excretion in children of the control group is lower than that of children of EPA group. The children of the same age from EPA group have a significant increase in the value of norepinephrine during oral answers while sitting at a desk or standing at the blackboard. At the same time, changes in norepinephrine were more pronounced during answers given at the blackboard, and were 27-28 ng/min. Whereas the reaction of children of the same age from the control group was only 23-24 ng/min. Therefore, children of the control group have an increased excretion of epinephrine during answers given when sitting at a desk or standing at the blackboard. Children of this age from EPA group, on the contrary, have a significant increase in the excretion of norepinephrine during answers given when sitting at a desk or standing at the blackboard.

Thus, having analyzed the excretion of catecholamines in children with age, i.e., from the first through the fourth grades, when giving oral answers at the theoretical lessons, we found that the pupils systematically engaged in physical activities and sports had decrease in the excretion of both epinephrine and norepinephrine during oral answers by the fourth grade, while the excretion of both epinephrine and norepinephrine in children of the control group has remained at a relatively high level.

Summary.

1. The reaction of the heart pumping function of children subjected to enhanced motor activity decreases further significantly when giving oral responses at the theoretical lessons.

2. The reaction of the parameters of heart pumping function is slightly higher in boys than in girls of the same age.

3. The children systematically engaged in physical activities and sports have a decrease in the excretion of both epinephrine and norepinephrine during oral answers by the fourth grade.

4. The excretion of both epinephrine and norepinephrine in children not engaged in muscle training (control group) has remained at a relatively high level.

Conclusion. Due to the increase in the volume and intensity of education in the modern school, the researchers, teachers, and parents are largely concerned about the way they could protect their children from the effects of stress during adaptation to mental stress, or decrease their level. In our opinion, regular exercise and various sports in the primary school age contribute to the improvement of mental performance and mental stability, and to the formation of hormonal status. This sharply reduces the excretion of epinephrine in stressful situations, which is a positive factor in the adaptation of children to school stress. Thus, our data show that physical activity reduces the excessive

emotional stress during the oral answers at the theoretical lessons. Other authors also support this opinion and point out that physical activity reduces the psycho-physiological level of children in adaptation to mental stress [5,10]. According to other authors [3.8], adaptation of psychophysiological indicators to mental stress depends on the systematic physical exercise.

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