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Changes in the Heart Pumping Ability in Children of Elementary School Age During Oral Answers at Theoretical Lessons

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Abstract: For the first time the reaction of the pumping function in the children of elementary school age during oral answers at the desk and at the blackboard was studied. The children were conventionally divided into two groups: the first group included the children that systematically do physical exercises and go in for sports according to the additional program (group of the advanced psychical activity). The second group consisted of children having only two-three lessons of PE according to the general educational program (control group). It was firstly detected that in children systematically engaged in sports activities the reaction of the heart pumping function by oral answers at theoretical lessons appeared to be substantially lower than in those that do not go in for sports. At the same time, it was found in all children the reaction of the heart pumping function by answering at the blackboard was lower than during answering at a desk. It was found that the reaction of the heart pumping function in boys is somewhat higher than in girls of the same age. It was found that in children with the advanced physical activity the decrease in the heart rate and stroke volume to the reference values after completion of oral answers proceeds faster than in children from the control group.

Key words: Control group, proceeds, completion, pumping function, systematically

INTRODUCTION

Starting the school education is one of the most important periods in the life of a child. At this stage, the rapid change of the social conditions takes place. The age period of 7-11 years is called the period of 'primary socialization' readiness for beginning of the school education. Transition to the school education results in significant increase in load on the entire children body and the cardiovascular system in particular. Due to the great volume of the educational load, additional classes, execution of the home task the rate of the children physical activity is reduced significantly while the mental load is increased (Abzalov and Sitdikov, 1999; Bykov and Prokopyeva, 2006). At the same time, the issue of adaptation of children of elementary school age to the study load remains to be the relevant, however, underinvestigated aspect.

The body of a child studying at a school is being subjected to a wide range of exposures, especially in the conditions of application of innovative pedagogical techniques. One of the most important body systems determining the physical and mental capacity of children and limiting the development of the adaptive reactions is the cardiovascular system (Abzalov and Sitdikov, 1999; Vanyushin and Sitdikov, 1997; Gavrilina, 2006; Bakhitov, 2011). The researchers show special interest in the study of reactivity of the children cardiovascular system as an adaptive capacity and maturity of operation. According to a number of researchers (Bezrukikh, 2004; Bykov and Prokopyeva, 2006; Gavrilina, 2006; Krivolapchuk, 2004) the pupils demonstrating high physical capacity are characterized by less expressed psychophysiological reactivity in the conditions of the test loads: this group of children features lesser heart rate values.

During the process of adaptation to the school education and active participation at lessons the significant changes in the heart function are observed in children. However, until recently these issues remained to be completely unclarified.

The most complete idea of the heart pumping function of children of elementary school age may be obtained in conditions of the direct active participation at theoretical lessons as well as during the recovery period after completion of an oral answer. Significant changes in the body take place during the process of active participation at theoretical lessons, i.e., during the oral answers. The more objective characteristic of adaptive

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capacities of children is specified directly by analysis of the heart pumping function reaction in the conditions of active participation at theoretical lessons. The heart extremely quickly reacts to the action of different factors (Nigmatullina, 1999; Sitdikov, 1974). Upon mental loads the body in whole and the heart in particular experiences great strain. The study of peculiarities of reaction of the heart pumping function in children of the elementary school age as well analysis of the recovery process after the answer completion appear to be relevant in terms of the age physiology and optimization of the process of education of the elementary school pupils.

MATERIALS AND METHODS

The objective: The study of peculiarities of reaction of the heart pumping function in children of the elementary school age subjected to different modes of physical activity during oral answers at theoretical lessons.

Procedure: The experiments involved children at the age of 7-11 years, i.e., elementary school pupils (1-4th grade). The experiments were performed at the Ayshinskaya secondary school and the college No. 9 of Zelenodolsk in the Republic of Tatarstan. The total number of children made 146 persons of which 75 children systematically going in for sports and 71 not going in for sports (children of the control group attending only 2 PE classes per week).

The rheogram recording was performed with the use of the tetrapolar chest rheography method by Kubicek *et al.* (1966) in the following positions:

- Sitting at the desk before answering
- Sitting at the desk during the answers
- Standing at the desk
- Standing at the blackboard

According to the procedure the leads were placed as follows: 2 current electrodes: the first one at the forehead area, the second one on the leg above the ankle joint; 2 measuring electrodes: the first one within the neck area at the level of the 7th cervical vertebra, the second one at the chest area at the ensisternum level. The rheogram recording was performed automatically with the use of the rheo-attachment for the computer analysis RPKA 2-1 TU 9442-002-00271802-95 designed for operation as part of the medical hardware and software suite. The device is recommended for use in the medical practice by the committee on the new medical equipment at the Ministry of Healthcare of the Russian Federation.

RESULTS AND DISCUSSION

Changes in the performance of the heart pumping function in children at the age range from 7-11 years by oral answers at theoretical lessons: At the age of 7-8 years in children not going in for sports and doing muscular exercises the heart rate during the oral answers in position sitting at the desk was increased as compared to the reference values by approximately 9-10 BPM ($p \leq 0.05$). During answering standing at the desk the heart rate in these children made 14-15 BPM ($p \leq 0.05$). The heart rate reaction by answering at the blackboard appeared to be significantly higher and made 15-18 BPM ($p \leq 0.05$). Therefore, in children at the age of 7-8 years (studying in the first grade) the heart rate reaction during oral answers sitting and standing at the desk and at the blackboard does not depend on the level of physical activity. At the same time, the maximum heart rate reaction in all children was observed during answering standing at the blackboard and the minimum one during answering sitting at the desk. Moreover, we have not found significant differences in the heart rate reactions between the boys and the girls aged 7-8 during oral answers at theoretical lessons.

At the age of 8-9 years, the heart rate reaction during oral answers at theoretical lessons was significantly increased as compared to the age of 7-8 years. Thus, if the heart rate reaction during oral answers at the age of 7-8 years made at average 10-18 BPM then by the age of 8-9 years it increased significantly and reached 20-40 BPM ($p \leq 0.05$). In the boys and girls aged 8-9 years that were systematically going in for sports the heart rate reaction during answering sitting and standing at the desk made about 20-24 BPM ($p \leq 0.05$). The high rate reaction while answering standing at the blackboard in these boys and girls was significantly higher and made 33-34 BPM ($p \leq 0.05$). The heart rate reaction during oral answers in children of the age 8-9 years not going in for sports was significantly lower. Thus, in boys and girls aged 8-9 from the control group the heart rate reaction during answering sitting at the desk made 35-37 BPM during answering standing at the desk 27-28 BPM and during answering standing at the blackboard 50-51 BPM ($p \leq 0.05$). Thus, at the age of 8-9 years in boys and girls systematically going in for sports the heart rate reactions during oral answers appeared to be significantly lower than in the age-mates from the control group. Therefore, the systematic physical exercises result in decrease in the heart rate reactions during oral answers.

During the next age period (9-10 years) in the boys and girls systematically going in for sports while answering sitting and standing at the desk as well as at

the blackboard the heart rate reaction made 18-20, 18-17 and 28-29 BPM ($p \leq 0.05$), respectively. Therefore, in children systematically going in for sports the heart rate reaction during oral answers is significantly decreased by the age of 9-10 years. At the same time, the more expressed decrease in the heart rate reaction was observed in girls going in for sports. In children of the same age that were not going in for sports the heart rate reaction during oral answers was maintained at the high level as compared to the previous age. Thus, during the oral answers sitting and standing at the desk as well as at the blackboard the heart rate reaction in boys of the control group made 37-38, 28-30, 50-60 BPM ($p \leq 0.05$), respectively. At the same time in girls of the control group the heart rate reaction during the oral answers was somewhat lower than in boys of the same age. Therefore, at the age of 9-10 years a slight decrease in the heart rate function during the oral answers is observed in boys and girls systematically going in for sports. There was also noted a certain tending to decrease in the heart rate reaction at the age of 9-10 years in girls of the control group. At the same time, in boys of the control group the heart rate reaction during oral answers at theoretical lessons is maintained at a high level.

At the age of 10-11 years, we observed the general tending to decrease in the heart rate reaction during oral answers at theoretical lessons. In the boys systematically going in for sports the heart rate reaction during oral answers in the position sitting and standing at the desk and at the blackboard was significantly lower as compared to the previous age and made 24.7 BPM, 23.4 BPM and 19.7 BPM ($p \leq 0.05$), respectively. The most expressed decrease in the heart rate function was detected in girls systematically going in for sports. Thus, during oral answers at theoretical lessons the heart rate in these girls at the age of 10-11 years made only 18-19 BPM ($p \leq 0.05$). The same tending to decrease in the heart rate reaction during oral answers at theoretical lessons was observed in children from the control group. However, the heart rate reaction in children from the control group is significantly higher than in the age-mates systematically going in for sports. Thus, the heart rate reaction in children depends not only on the age but on the level of physical activity as well. Systematic muscle trainings substantially promote to the decrease in the heart rate reaction during oral answers.

As our studies showed in the boys and girls at the age of 7-8 years systematically going in for sports the stroke volume reaction during answering at the desk made about 7-8 mL ($p \leq 0.05$). About the same reaction was detected during answering standing at the desk 8.1 mL ($p \leq 0.05$). However, while answering at the desk the stroke volume reaction in these children appeared to be uncertain. In the boys and girls of the same age from the control group, i.e. not going in for sports the stroke volume reaction during oral answers at theoretical lessons did not significantly differ from the reaction of children referred to the group of the advanced physical activity. Thus, in all groups of pupils regardless of the level of physical activity the stroke volume was significantly increased only while answering sitting and standing at the desk. By answering at the blackboard the stroke volume was not subjected to significant changes. At that in children referred to the group of the advanced physical activity and in the control children the stroke volume reaction while answering at the desk and at the blackboard was expressed in equal measure. Therefore, the stroke volume reaction in children at the age of 7-8 years does not depend on the level of physical activity.

By analysis of changes in the stroke volume in boys and girls at the age of 8-9 years we found that in all groups of children regardless of the level of physical activity the stroke volume was significantly increased by answering while sitting and standing at the desk by approximately 8-9 mL ($p \leq 0.05$). By answering at the blackboard the stroke volume was not subjected to significant changes. Therefore, in children at the age of 8-9 years, we have not found any significant difference in the stroke volume reaction during oral answers neither with the age nor with the level of physical activity. At the age 9-10 years, we firstly detected some difference in the stroke volume reactions between the children from the control group and group of advanced physical activity. Thus, in children going in for sports we firstly detected certain tending to decrease in the stroke volume reaction during oral answers.

At the age of 10-11 years in boys and girls of the control group we found significant differences of the stroke volume during oral answers while sitting, standing at the desk and at the blackboard. In boys and girls of the same age that systematically go in for sports the stroke volume during answering sitting, standing at the desk and at the blackboard was not significantly changed as compared to the reference values. Therefore, in children that systematically do muscle training the stroke volume reaction is not subjected to significant changes as compared to the reference values.

By analyzing the dynamics of changes of the stroke volume during oral answers within the age range from 7-11 years, we identified the following features: significant change in the stroke volume reaction during oral answers

at theoretical lessons in children systematically going in for sports is observed at the age of 7-8 years. At further ages, i.e. from 9-11 years in these children the sustainable tendency to decrease in the stroke volume function during oral answers was observed. At the age of 10-11 years the stroke volume reaction becomes uncertain.

In the children of the control group, i.e. not going in for sports from the age of 7-11 years the sustainable tendency to increase in the stroke volume function during oral answers was observed. Thus, if at the age of 7-8 years the stroke volume reaction during oral answers made about 8-9 mL then by the age of 10-11 years, it was increased up to 10-11 mL ($p \leq 0.05$). Therefore, systematic muscle trainings promote to decrease in the stroke volume function in children during oral answers at theoretical classes.

By comparing the dynamics of changers in the heart rate and stroke volume reactions during oral answers at theoretical lessons at the age from 7-11 years, we found that in children systematically going in for sports at the age from 7-9 years the heart rate reaction during oral answers is increased and then by the age of 11 years is decreased gradually. The stroke volume reaction at the age from 7-9 years is maintained at the same level and then is consistently decreased by the age of 11 years. Consequently, by the age of 10-11 years both the heart rate and the stroke volume reactions are decreased in children systematically going in for sports. Thus, systematic muscle trainings promote to better adaptation of children to the educational process at school. Low heart rate and stroke volume reactions during oral answers at theoretical lessons are indicative of the less expressed physiological reaction of the body to a stimulus, i.e., the answer at theoretical lessons.

Recovery of the heart pumping function in children upon completion of oral answers: At the age of 7-8 years both in boys and girls systematically going in for sports upon completion of oral answers the recovery of the heart rate to the reference values took place primarily during the first minute. In the children of the same age from the control group that is not going in for sports the heart rate recovery upon completion of oral answers also took place during the first minute. Therefore, at the age of 7-8 years the time of the heart rate recovery to reference values upon completion of oral answers does not depend on the level of physical activity.

At the age of 8-9 years, the time of the heart rate recovery upon completion of oral answers increased significantly. Thus, both in boys and girls systematically going in for sports the recovery of the heart rate to the reference values took place primarily by the fifth minute after completion of the oral answer. At the same time in boys and girls not going in for sports the heart rate recovery to the reference values took place even later. The heart rate decrease to the reference values in these children took place not earlier than by the sixth and seventh minute. Therefore, in children systematically going in for sports the recovery of the heart rate upon completion of oral answers proceeds much faster than in children not going in for sports.

In children at the age of 9-10 years, the time of the heart rate recovery after oral answers was significantly reduced as compared to the previous age. At that in children systematically going in for sports the time of the heart rate recovery appeared to be much shorter than in children of the same age from the control group. Thus, in boys and girls from the group of advanced physical activity the heart rate recovery took place by the third and fourth minute after completion of oral answers at the desk and at the blackboard. At the same time, it shall be noted that after completion of the oral answer at the blackboard the heart rate was recovered much faster than while answering sitting and standing at the desk. In boys and girls at the age of 9-10 years not going in for sports the recovery of the heart rate after completion of oral answers was achieved later, i.e., by the fourth and fifth minutes. Therefore, systematic muscle trainings promote to significantly faster heart rate recovery after completion of oral answers at theoretical lessons.

At the age of 10-11 years, the heart rate recovery after completion of oral answers proceeded somewhat faster than at the previous page. In children systematically going in for sports the heart rate recovery upon completion of oral answers at the desk at the blackboard took place primarily during the first minute after the answer completion. Therefore, systematic muscle trainings promote to reduction of the heart recovery time after completion of oral answers. In the boys and girls from the control group at the age of 10-11 years the recovery of the heart rate to the reference values after completion of oral answers took place primarily during the second and the third minutes. Therefore, in children of the control group the recovery of the heart rate to the reference level after completion of the oral answers proceeds somewhat later than in children of the same age from the group of the advanced physical activity.

Thus, by summarizing the above said one may state that the significantly faster heart rate recovery is observed in all children at the age of 7-8 years (Fig. 1).

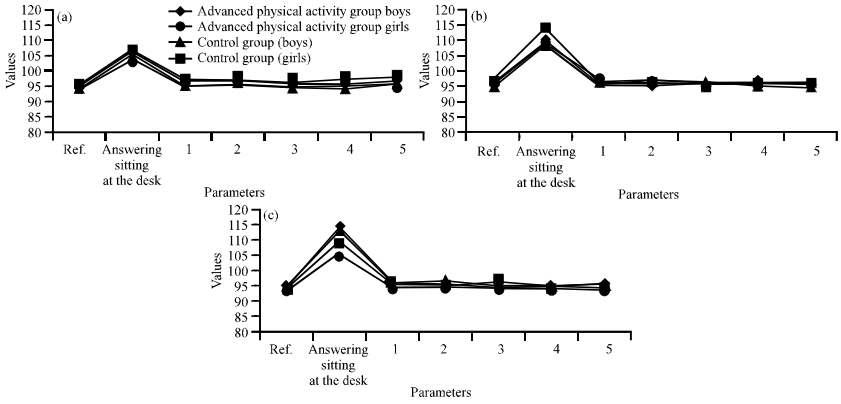

Fig. 1: Recovery of the heart rate in children at the age of 7-8 years after completion of oral answers

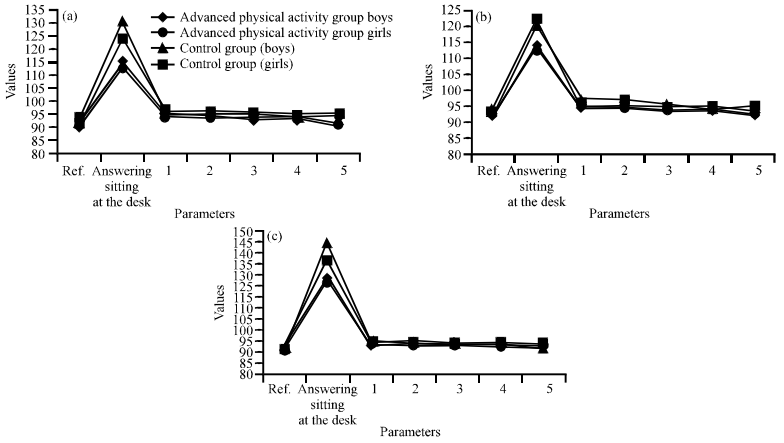

Fig. 2: Recovery of the heart rate in children at the age of 8-9 years after completion of oral answers

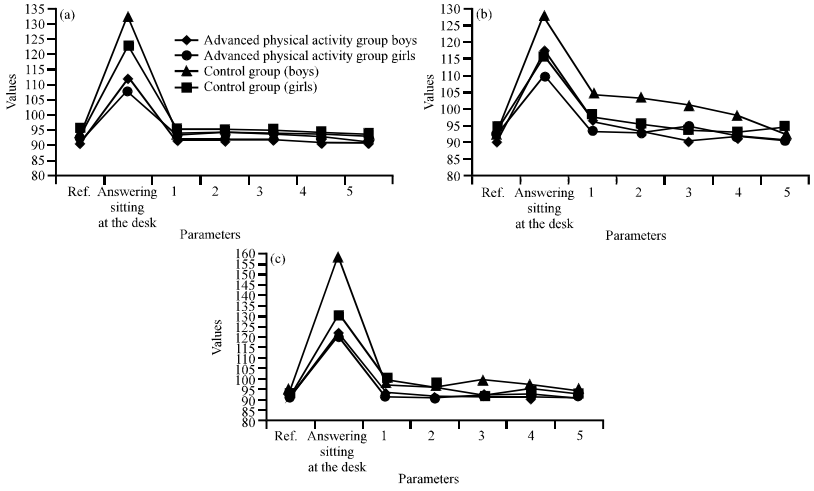

Fig. 3: Recovery of the heart rate in children at the age of 9-10 years after completion of oral answers

Further on at the age of 8-9 years the speed of the heart rate recovery is reduced significantly (Fig. 2). During the next age period of 9-10 and 10-11 years the sustainable tending to reduction of the heart rate recovery time is observed (Fig. 3 and 4). At the same time, in children of the elementary school age the time of the heart rate

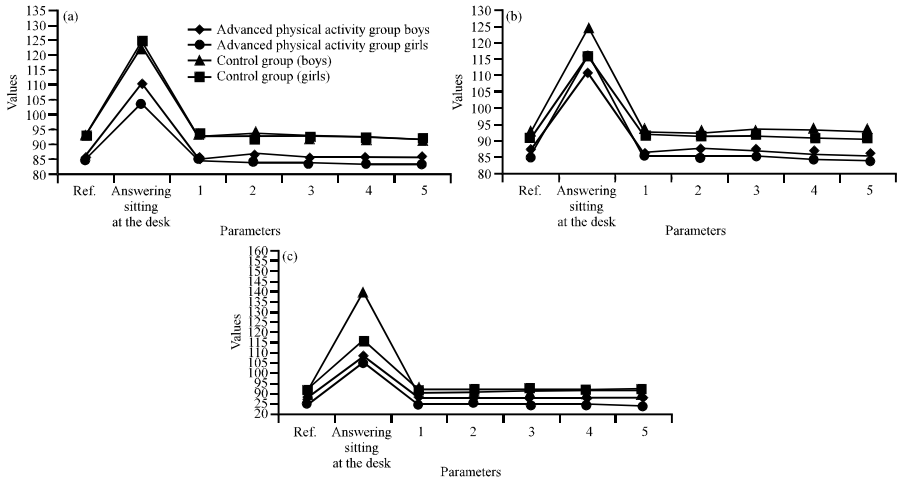

Fig. 4: Recovery of the heart rate in children at the age of 10-11 years after completion of oral answers

recovery after completion of oral answers to a great extent depends on the level of physical activity. The higher the level of physical activity is the faster the heart rate is recovered after completion of oral answers.

By analyzing, the time of the stroke volume recovery after completion of oral answers in children of the elementary school age we found certain peculiarities. At the age of 7-8 years in children systematically going in for sports the stroke volume recovery took place primarily during the 2nd minute after completion of an oral answer (Fig. 5). In boys and girls of the same age not going in for sports the stroke volume recovered somewhat later, that is primarily during the 3rd and 4th min. Therefore, systematic muscle trainings promote to significantly faster recovery of the stroke volume upon completion of oral answers.

In the children aged 8-9 years, we detected later stroke volume recovery after completion of oral answers as compared to the previous age (Fig. 6). Thus, in boys and girls aged 8-9 years that were systematically going in for sports the recovery of the stroke volume took place primarily in the sixth minute after completion of an oral answer. In children of the same age not going in for sports the stroke volume recovery after completion of oral answers took place primarily during the seventh minute.

At the age of 9-10 years, the time of the stroke volume recovery after completion of oral answers was somewhat improved as compared to the children of the previous age (Fig. 7). In the boys and girls aged 9-10 years systematically going in for sports the stroke volume recovery after completion of oral answers took place primarily during the 3rd and 4th min. In the children of the same age that were not going in for sports the recovery took place somewhat later that is during the 5th and 6th min.

In the children aged 10-11 years, the time of the stroke volume recovery after completion of oral answers was significantly reduced as compared to the previous age (Fig. 8). At the same time, it shall be noted that in children systematically going in for sports the stroke volume recovery proceeded much faster (by the 3rd min) as compared to that of children of the same page in the control group (during the 4th and 5th min).

Thus, summarizing the above-said it may be stated that the significantly faster stroke volume recovery after completion of oral answers is observed at the age of 7-8 years. The latest stroke volume recovery after completion of oral answers is observed at the age of 8-9 years. During the following age periods, the time of the stroke volume recovery in children is somewhat improved and approximates by the age of 10-11 years to the time of the stroke volume recovery in the children aged 7-8 years. At the same time, in children of all ages that systematically go in for sports the time of the stroke volume recovery after completion of oral answers is significantly shorter than in children of the control group that is not going in for sports. Therefore, systematic muscle training promote to faster stroke volume recovery after completion of oral answers.

By comparing, the time of the heart rate and stroke volume recovery in children we found that the heart rate recovers to the reference level much faster than the stroke volume. It shall also be noted that the degree of the stroke volume reaction in children during answers at theoretical classes was significantly lower than the heart rate reaction.

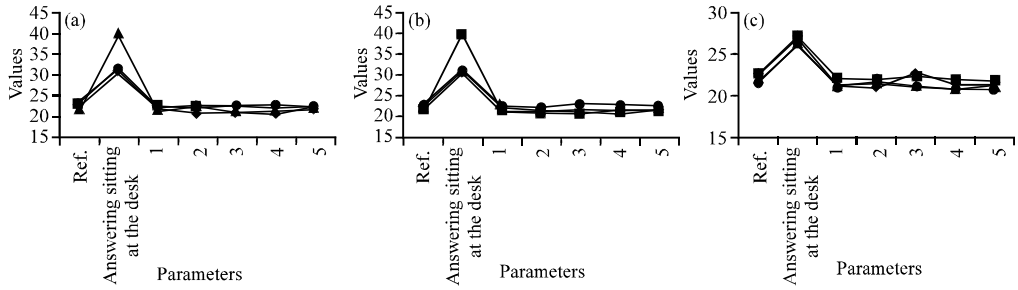

Fig. 5: Recovery of the stroke volume in children aged 7-8 years after completion of oral answers

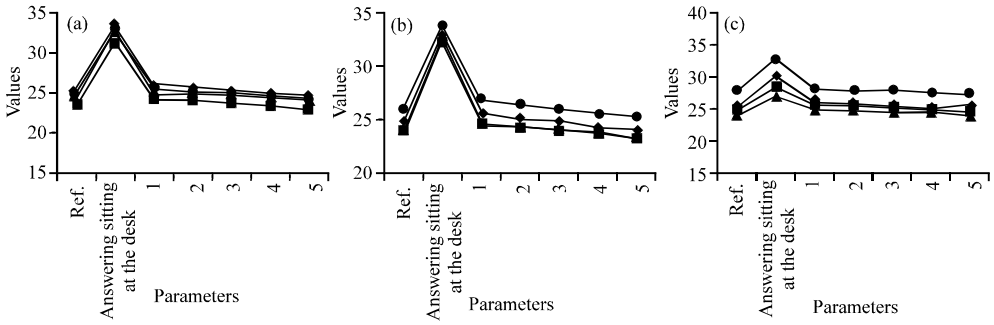

Fig. 6: Recovery of the stroke volume in children aged 8-9 years after completion of oral answers

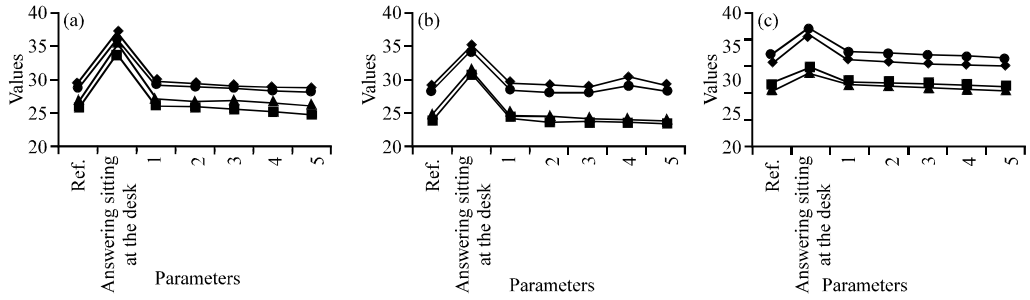

Fig. 7: Recovery of the stroke volume in children aged 9-10 years after completion of oral answers

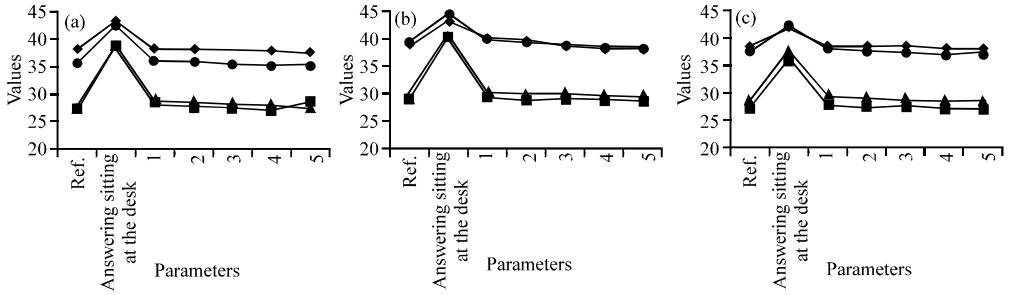

Fig. 8: Recovery of the stroke volume in children aged 10-11 years after completion of oral answers

CONCLUSION

Based on the results of our research, it may be concluded that in the pupils of elementary school that systematically exercise advanced physical activity the reaction of the heart pumping function during oral answers at theoretical lessons is less expressed than in children not going in for sports. During oral answers in

children not going in for sports the heart rate is changed to a great extent while in the children systematically going in for sports the stroke volume does. In children exercising muscle training the recovery of the heart rate and stroke volume after completion of oral answers proceeds much faster than in children of the control group.

In our opinion, at the elementary school age systematic physical exercises, going in for different kinds of sports promote to activation of the mental capacity and improvement of the mental stability. According to our records, the advanced physical activity significantly relieves the emotional tension during oral answers at theoretical lessons.

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REFERENCES

Abzalov, R.A., F.G. Sitdikov, 1999. The developing heart and the motor operation. Kazan, pp: 95.

Bezrukikh, M.M., 2004. Health-saving school. M.: Moscow Psychological and Social Institute, pp: 240.

Bykov, E.B. and M.N. Prokopyeva, 2006. Comparative assessment of the functional state of the cardio-respiratory system of children with different levels of physical activity. Materials of the IVth Russian scientific forum "ReaSpoMed". M., pp: 23.

Bakhitov, I.H., 2011. Peculiarities of establishment of the heart pumping function in children exercising muscle training. Pediatrics, Moscow, 90 (5): 138-140.

Gavrilina, A.V., 2006. Effect of emotional tension on the accuracy of the time perception in an extreme situation. Materials of the scientific students' conference at the Dubna University, pp: 27.

Krivolapchuk, I.A., 2004. Non-drug prevention and correction of consequences of the school stress: possible physical exercises. Physical Education: Education and Training, 1: 10.

Kubicek, W.G., J.W. Kamegis, R.P. Patterson, D.A. Witsoe and R.H. Mattson, 1966. Development and evaluation of an impedance cardiac output system. Aerospace Med., 37: 1208-1212.

Nigmatullina, R.R., 1999. Heart pumping function of a growing body and regulation thereof during muscle training: Abstract of the thesis of doctor of biological sciences. Kazan, pp: 40.

Sitdikov, F.G., 1974. Mechanisms and age peculiarities of the heart adaptation to a long-term sympatic action. Thesis of the doctor of biological sciences. Kazan, pp: 312.

Vanyushin, Y.S. and F.G. Sitdikov, 1997. Adaptation of the sportsmen heart activity and gas exchange to physical activity. Human Physiol., 23 (4): 69-73.