ISSN 0362-1197, Human Physiology, 2014, Vol. 40, No. 3, pp. 352–354. © Pleiades Publishing, Inc., 2014.
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SHORT COMMUNICATIONS

Changes in Stroke Volume in Primary School Children during Oral Answers at Theoretical Lessons

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Received July 4, 2012

Abstract—The study of stroke volume response in first- and fourth-year schoolchildren during oral answers has shown that stroke volume response during oral answers substantially reduces by the fourth year at school in students engaged in systematic muscle training. Therefore, systematic muscle training contributes to less marked changes in stroke volume during oral answers of primary school students. At the same time, the stroke volume response during oral answers in children leading a sedentary life increases with age. Moreover, stroke volume decreases to initial values much faster after the oral answers of fourth-year schoolchildren from the group of vigorous physical activity compared to the control.

Keywords: response of heart pumping function during answers when standing at a desk and at the blackboard, primary school children.

DOI: 10.1134/S0362119714030190

One of the most important periods in a child's life is the initial period of study at school [1, 2]. This stage of a child's life is characterized by drastic changes in social conditions. The age of six to seven years is called a period of "primary socialization," i.e., the readiness to start schooling [3]. The transition from preschool institution to school results in substantially higher loads on a child's nervous system. At school, children have to mobilize their psychic activity in the context of adaptation to the new conditions of activity. The beginning of schooling imposes significant requirements on the child's cardiovascular system. Due to the large amount of learning load, extra classes, home task performance, etc., the level of motor activity in children considerably decreases [1]. During the adaptation to school, with active participation in theoretical lessons, the functions of the child's body substantially change. However, these problems have not been completely elucidated until recently, and researchers have not come to a consensus.

The goal of this work was to study stroke volume response in the children of primary school age during oral answers at the desk and at the blackboard at theoretical lessons (mathematics and Russian language).

The experiments were performed in 74 first- and fourth-year students of the Aishinskaya Secondary School and Lyceum no. 9 (Zelenodolsk, Tatarstan Republic, Russia). The children were conventionally divided into two groups. The children of the first group were systematically engaged in physical culture and sports; i.e., they went in for other sports in addition to compulsory physical culture lessons (the group of vigorous physical activity, VPA). The children of the second group (control) did not go in for sports systematically and led a sedentary life.

Stroke volume (SV) was determined by the method of tetrapolar chest rheography according to Kubicek [4].

According to the above method, the electrodes were mounted as follows: two current electrodes (one to the head in the forehead area and the other to the shank above the ankle joint) and two measuring electrodes (one in the neck area at the level of the seventh cervical vertebra and the other in the chest area at the level of the xiphisternum). Rheograms were recorded automatically with an RPKA 2-01 TU 9442-002-00271802-95 rheograph for computer analysis, designed as a component of medical hardware-and-software systems. The instrument is recommended to be used in medical practice by the Committee for Novel Medical Equipment of the Ministry of Health of the Russian Federation (Certificate of Compliance ROSS RU. 0001. 11IMO2 no. 3434630).

Rheograms were recorded in children under different conditions. The first recording was taken when the children sat at a desk, and it was assumed to be the initial value. Then rheograms were recorded during oral answers of children standing at a desk and in the recovery period after completing the answer. The next rheogram was recorded during oral answers of children standing at the blackboard and after completing the answer.

The changes in SV response were analyzed in the first- and fourth-year students during their oral

Stroke volume response in students of primary school age during oral answers

Group	Gender	Stroke volume, mL							
		1 grade				4 grade			
		sitting at a desk	answer standing at a desk	sitting at a desk	answer standing at the blackboard	sitting at a desk	answer standing at a desk	sitting at a desk	answer standing at the blackboard
Intensified motor activity	Boys	21.9 ± 1.7	30.0 ± 1.4*	22.5 ± 1.8	37.4 ± 1.3*	38.1 ± 1.7	42.8 ± 1.2*	38.8 ± 1.7	41.9 ± 1.3*
	Girls	22.4 ± 1.8	30.6 ± 1.4*	21.5 ± 1.2	36.6 ± 1.7*	38.9 ± 1.5	44.3 ± 1.7*	37.9 ± 1.4	42.6 ± 1.8*
Control	Boys	22.4 ± 1.7	30.7 ± 1.4*	21.9 ± 1.2	36.3 ± 1.4*	29.3 ± 1.7	39.7 ± 1.3*	28.9 ± 2.4	38.3 ± 1.4*
	Girls	21.5 ± 1.7	39.7 ± 1.4*	22.7 ± 2.3	37.4 ± 1.7*	28.8 ± 1.4	39.7 ± 1.8*	27.3 ± 1.7	36.2 ± 1.4*

* Significant differenceinitial values (P £ 0.05).

answers at theoretical lessons. Our studies showed (table) that the first-year schoolboys of the control group, i.e., those not engaged in physical culture and sports, had a SV of 22.4 ± 1.7 mL when sitting at a desk. When answering while standing at a desk, their stroke volume increased by 8.3 mL compared to the initial values and reached 30.7 ± 1.4 mL ($P < 0.05$). SV decreased approximately to the level of the initial values during the second minute after completing the oral answer. When answering at the blackboard, SV in the boys of this group increased only by 4.4 mL ($P < 0.05$).

In the first-year schoolgirls of the control group, the stroke volume increased during oral answers at a desk and at the blackboard by 8.2 and 4.7 mL, respectively, compared to the initial values ($P < 0.05$). Consequently, SV response in the boys and girls not engaged in regular physical exercise was approximately the same during oral answers at a desk and at the blackboard.

In the first-year schoolboys systematically engaged in physical culture and sports, i.e., those assigned to the group of vigorous physical activity (VPA), the stroke volume in the sitting position was 21.9 ± 1.7 mL. SV during the answer while standing at a desk increased by 8.1 mL compared to the initial values and reached 30.0 mL ($P < 0.05$). When answering at the blackboard, these boys exhibited an SV increase by 4.9 mL ($P < 0.05$). In girls of the VPA group, i.e., those systematically engaged in physical culture and sports, SV responses during oral answers at a desk and at the blackboard were 8.2 mL and 5.1 mL, respectively ($P < 0.05$).

Thus, the stroke volume response in first-year students during oral answers does not depend on the level of their physical activity. At the same time, it should be noted that SV responses in the boys and girls of all tested groups during oral answers at a desk proved to be much higher than when answering at the blackboard. Similarly, the SV responses during oral answers at a desk and at the blackboard in students of the control and VPA groups most probably can be explained as follows: (i) learning in the first grade is carried out mostly as playing, the teacher encourages and supports all students in every possible way; and (ii) as a rule, first-year students' answers are not estimated, i.e., not marked on the five-point scale. All the above contributes to considerable activation of students at lessons. Children are not too shy to express their thoughts and considerations. As a result, their excitement during oral answers is usually minimal. Consequently, SV response is less pronounced. Moreover, the SV indices of children are quickly restored to the initial values after completion of oral answer.

For comparison, we also analyzed SV responses in fourth-year students. Our studies showed that the stroke volume in fourth-year schoolboys of the control group in the sitting position was 29.3 ± 1.7 mL. During the answer while standing at a desk, SV increased by 10.4 mL and reached 39.7 ± 1.3 mL ($P < 0.05$). During the answer at the blackboard, SV in this group of students increased by 9.4 mL compared to the initial values ($P < 0.05$). Nearly the same SV response was revealed during orals answers at a desk and at the blackboard for girls of the control group (10.9 mL and 8.9 mL). Thus, SV response in the fourth-year schoolboys and girls of the control group during answers at a desk and at the blackboard increased in comparison with the response recorded in the first grade. SV response in these students was about 4–8 mL in the first grade but increased to 9–11 mL in the fourth grade ($P < 0.05$). At the same time, it should be noted that the most marked increase in SV response was observed by the fourth grade during answers at the blackboard.

In the boys systematically engaged in physical culture and sports, i.e., those included in the VPA group, the stroke volume in the fourth grade was 38.1 ± 1.7 mL in the sitting position. During answers while standing at a desk, SV increased only by 4.7 mL and reached 42.8 ± 1.2 mL ($P < 0.05$). This SV response proved to be less by 3.4 mL compared to SV response recorded in the first grade during answers at a desk. A much lower SV response was shown in boys of the VPA group when

answering at the blackboard, where it was only 3.1 mL ($P < 0.05$).

In the fourth-year schoolgirls of the VPA group, we also showed a substantial decrease in SV response during oral answers. When answering at a desk, SV in this group of girls increased only by 5.4 mL and 4.7 mL, respectively, compared to the initial values ($P < 0.05$). Thus, SV response in children from the VPA group when answering at a desk and at the blackboard substantially decreases by the fourth grade.

Consequently, it may be stated that systematic muscle training considerably contributes to a decrease in SV response during oral answers in students of primary school age. In children leading a sedentary life, SV response during oral answers, on the contrary, increases with age. It should also be emphasized that SV in the fourth-year students from the group of vigorous physical activity after completion of oral answers decreased to the initial values much quicker than in students of the control group.

Systematic physical culture and sporting activities substantially alter the stroke volume response in students of primary school age during oral answers at theoretical lessons. We believe that this is related to considerable changes in the mechanisms of extracardiac regulation of the heart rhythm in children of primary school age as a result of systematic muscle training. Probably, these positive changes substantially restrain SV responses in stress situations such as oral answers at a desk and at the blackboard for students of primary school age. Abazalov and Sitnikov [5] have noted that the muscle training of children promotes a decrease in sympathetic effect and a simultaneous increase in parasympathetic effect in heart rate regulation. Vakhitov [6] believes that systematic muscle training started at an earlier age substantially increases the parasympathetic effect on regulation of the pumping capacity of a child's heart. A higher tone of parasympathetic nervous system determined by a higher level of physical work capacity has a positive effect on information processing under intense activity [7]. According to the data of Krivolapchuk [8], the students with high physical work capacity are characterized by a lower psychophysiological reactivity under testing load conditions: the children of this group have lower heart rate values.

It has been shown that SV response during oral answers of children from the group of vigorous physical activity (i.e., those engaged in systematic physical training) considerably decreases by the fourth grade compared to SV values of the first grade. Consequently, systematic muscle training of children of primary school age contributes to reduction of SV response during oral answers at a desk and at the blackboard. At the same time, SV responses during oral answers at a desk and at the blackboard in children leading a sedentary life slightly increase with age. Moreover, SV of the fourth-year students engaged in systematic muscle training (the VPA group) decreases to initial values after completion of oral answers much quicker than in children of the same age from the control group, i.e., those not engaged in physical culture and sports.

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Translated by E. Makeeva

SPELL: 1. Bezrukikh, 2. Prokop'eva, 3. nauchnoi