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## Features of Hemodynamic Parameters of 12–14-Year-Old Pupils with Hearing Impairment.

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### ABSTRACT

Full or partial deafness has a negative effect on the formation of the indicators of physical health of pupils with hearing impairment. Hearing impairment worsens functional activity of the vestibular system, which causes an increased anxiety and stress state in children of this category and has a negative impact on the cardiovascular system. This paper includes the comparative analysis of hemodynamic of 12-14-year-old pupils with hearing impairment and their healthy peers, performed with the use of the hemo-monitor "MARG 10-01". Hemodynamic study showed that 11 of the 16 indicators differ significantly between healthy and hard-of-hearing pupils. High parameters of heart rate (HR), pulse rate (PR), sympathetic activity index (S), and mean blood pressure (BP<sub>mean</sub>) have indicated the prevalence of excited sympathetic nervous system in the pupils, which is a result of manifestations of strong anxiety and stress. Low parameters of stroke volume (SV), left ventricle stroke volume index (LVS<sub>VI</sub>), microvessel ripple amplitude (MVRA) together with higher parameters of cardiac index (CI) and stroke index (SI) indicate a poor physique of hard-of-hearing children, which is largely resulted from their limited physical activity. The present study of the cardiovascular system of hard-of-hearing 12-14-year-old students states that certain indicators are on the upper or lower limit of normal, which can further lead to more severe impairments of the cardiovascular system activity. This circumstance requires specialized rehabilitative techniques that are based on the individualization of features of both deaf and hard-of-hearing pupils.

**Keywords:** Cardio-vascular system, hearing impairment, hemodynamics, sympathetic nervous system, anxiety.

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## INTRODUCTION

Currently, there is a clear tendency toward the health deterioration of Russian children and pupils. According to statistics of the Ministry of Health of the Russian Federation, about 12% of children have no functional abnormalities, 50% have some health problems, and 40% have chronic diseases and certain impairments of health, including hearing impairment.

The statistics indicate that more than 360 million people in the world suffer from partial or total hearing loss, 32 million of which are children under the age of 15. This is 5.3% of the world population. About 5 of each thousand of children have an innate hearing impairment or the same acquired in their early childhood. This is evidenced by the new global assessments of the prevalence of this problem made by the World Health Organization [1, 2].

Domestic and foreign authors point out that the total or partial deafness adversely affects the formation of physical qualities. Children with hearing deprivation differ from their healthy peers in low physical activity. This is typically due to the lack of hearing, as such children are more cautious and restrained, and, moreover, because of the presence of concomitant diseases, which are expressed in dysfunction of internal organs such as heart, lungs, kidneys and digestive system. All this should be reflected in the low adaptive capacity of the body and the poor performance of the cardiovascular system [3, 4, 5, 6].

There is a number of works that evidence poor performance of cardiovascular system of pupils with hearing impairment as compared with their healthy peers at rest (Robinson index) and after exercises (Ruffier index) [7, 8].

Based on the above stated, the objective of the study is to analyze the hemodynamic features of 12-14-year-old pupils with hearing impairment.

## RESEARCH TECHNIQUE

The study included 12-14-year-old pupils with hearing impairment of Elabuga special (correctional) boarding school, type 1 and 2, Tatarstan, Russia, in the amount of 17 people, and an appropriate number of their healthy peers from the secondary school No 10, Tatarstan, Russia. The study was conducted with the use of hemo-monitor "MARG 10-01". Hemodynamic parameters of the subjects were usually recorded from 8.00 until 10.00 a.m. in the morning, at rest, in prone position. Prior to the examination, the pupils were at complete rest for 5 minutes.

## RESULTS AND DISCUSSION

The absence or lack of acoustic system leads to a reduction of other functional parameters, as the human body constitutes a whole. The excited state of the nervous system of both deaf and hard-of-hearing people often results in the high level of anxiety, stress and low stress resistance.

The nervous system innervates and controls the whole body, including the cardiovascular system. Excessive stress and stiffness certainly affect the functions of the blood circulatory system. Based on previous studies using both the Ruffier and Robinson indices that characterize the state and performance of the cardiovascular system, we have found that hard-of-hearing children are behind their healthy peers in these indicators. For this reason, we decided to study this problem more deeply and thoroughly by using the hemo-monitor "MARG 10-01".

To analyze the cardiovascular system, we recorded 16 hemodynamic parameters of healthy and hard-of-hearing pupils at rest, in prone position. We compared the results with each other.

As can be seen from Table 1, these groups have significantly different HR (heart rate). Hard-of-hearing pupils have the highest heart rate in the upper limit of normal. This is due to strong anxiety and, therefore, the excitability of the nervous system. We also noticed the highest index of sympathetic activity in pupils with hearing impairment, which also differs significantly between the two groups and leads to excitation of the cardiovascular system. Pupils with hearing impairment, unlike healthy pupils, have disorders in their heart rate

indicators. Some authors [9] associate this disorder with atrial fibrillation. Several hard-of-hearing children have a mild disorder caused most likely by strong anxiety, which, in turn, leads to over-stress of the cardiovascular system (see Table 1).

**Table 1: Hemodynamics parameters of both hard-of hearing and healthy 12-14-year-old pupils**

Hemodynamic parameters	Hard-of-hearing pupils (n = 17)	Healthy pupils (n = 17)	P
SpO2 (%)	97.2±1.1	97.8±0.9	0.116
PR (bpm)	80±11.7	73.2±7.6	0.001
MVRA (rel.un.)	122.7±67.4	129.6±62.1	0.016
S (%)	53.6±16.6	48.9±13.6	0.042
Sys BP (mm.Hg)	104.1±8.7	101.9±6.6	0.106
Dia BP (mm.Hg)	60.6±3.6	60.2±3.2	0.002
BP <sub>mean</sub> (mm.Hg)	73.8±4.9	70.4±4.4	0.001
RR (breaths per min.)	19.3±3.5	18.8±3.3	0.360
HR (bpm)	80.3±11.9	73.2±7.6	0.002
SV (ml/b)	90±27.2	93.5±24.7	0.006
MBV (l/min)	7.1±2.2	6.9±2.1	0.057
SVI (ml/m <sup>2</sup> )	60.9±12.2	58.2±9.1	0.026
CI (l/min/m <sup>2</sup> )	4.9±1.2	4.6±0.9	0.024
LVSVI (g <sup>*</sup> m/b/m <sup>2</sup> )	59.2±13.9	61.2±12	0.016
ODI (ml/min/m <sup>2</sup> )	773.4±188.2	778.3±161.7	0.752
TPRI (dyn/s*cm <sup>5</sup> )	1217.3±277.8	1208.7±212.9	0.739

Note: SpO2 – blood oxygen saturation rate; PR - pulse rate; MVRA - micro-vascular ripple amplitude or capillary blood flow; S - sympathetic activity index; SBP - systolic blood pressure; DBP - diastolic blood pressure; BP<sub>mean</sub> - mean blood pressure; RR - respiration rate; HR - heart rate; SV - stroke volume; MBV - minute blood volume; SVI - stroke volume index; CI - cardiac index; LVSVI - stroke volume index of the left ventricle; ODI - oxygen delivery index; TPRI - total peripheral resistance index.

MVRA rate (micro-vascular ripple amplitude or capillary blood flow) also differs significantly between the groups. The healthy pupils have the highest rate. It depends on the tone of blood vessels, heart stroke volume and the state of excitation of the sympathetic nervous system. Decreased stroke volume of the heart and increased excitation of the sympathetic nervous system leads to lower hemodynamic rate of MVRA, which is reflected in the hard-of-hearing pupils as showing lower results than their healthy peers.

SBP (systolic blood pressure) indicates the level of pressure at the contraction of the left ventricular myocardium. As the table shows, the differences between groups are insignificant, however, the hard-of-hearing pupils have average rate slightly higher than the healthy. Lower SBP rates are associated with both age characteristics and the horizontal position of the body of subjects during testing; nevertheless, both groups have SBP within normal limits.

DBP (diastolic blood pressure) indicates the level of pressure at the time of total relaxation of the myocardium [10]. These indicators have significant differences between the groups, however, are within normal limits.

BP<sub>mean</sub> (mean blood pressure) indicates the level of peripheral blood flow and serves to ensure a water-salt homeostasis [11]. Mean indicators have significant differences between the groups; while the hard-of-hearing pupils have a higher mean blood pressure, which is most likely associated with higher systolic and diastolic pressure.

One of the indicators of cardiac performance is a stroke volume (SV) and LVSVI (stroke volume index of the left ventricle). These indicators have significant differences between the groups, however, are within normal limits. The healthy pupils have higher rates, which indicates the higher cardiac performance. SV and LVSVI findings indicate a higher motor activity of healthy pupils, which leads to better contractility and compliance of the left ventricular myocardium [12], as compared with the hard-of-hearing pupils.

MBV indicator (minute blood volume) also has significant differences between the healthy and hard-of-hearing pupils, however, stays within normal limits. Hard-of-hearing pupils show a slightly higher average MBV, which is due to high heart rate. MBV depends largely on HR and SV. Hence, MBV in healthy children is more compensated by SV, while the hard-of-hearing pupils have MBV compensated by HR, which indicates more careful operation of the heart of healthy pupils.

SpO<sub>2</sub> (blood oxygen saturation rate) and ODI (oxygen delivery index) have insignificant differences between the groups, and are within normal limits. Therefore, neither of these indicators are a limiting element of hemodynamics of both healthy and hard-of-hearing pupils.

Average CI (cardiac index) and SI (stroke index) have significant differences between the pupils, and the hard-of-hearing pupils have the highest rates. These results largely depend on SV and MBV, as well as on the area of the body, which largely reflects the physical development of the body. Higher rates among the pupils with hearing impairment indicate that these children are slightly behind their peers in their physical development. This is also largely due to their social withdrawal and limited physical activity.

TPRI (total peripheral resistance index) largely reflects the blood circulation in the vessels. The growth of this indicator leads to a high cardiac load. TPRI has insignificant differences between groups and is within normal limits.

### SUMMARY

The study of hemodynamics parameters of pupils with hearing impairment showed that the majority of the results differ significantly with the same of healthy pupils. High HR, PR, S and BP<sub>mean</sub> in these pupils indicate the prevalence of excitation of the sympathetic nervous system, which implies a high level of anxiety and stress. Low SV, LVSVI, MVRA, and higher CI and SI also indicate poor physical development of hard-of-hearing children because of their limited physical activity.

### CONCLUSION

The study of the cardiovascular system of hard-of-hearing students has shown that certain parameters are on the upper or lower limit of normal. This may further lead to more severe impairments of the cardiovascular system, if no due consideration is paid to correctional activities. Therefore, physical education of both deaf and hard-of-hearing children requires using a specialized correctional approach and new methods and means of physical education, which shall promote the increase in physical activity.

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### Conflict of Interests

The author declares that the provided information has no conflicts of interest.

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