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eculiarities of adaptation of the cardiovascular system of the disabled children to the conditions of teaching at school


Peculiaridades de la adaptación del sistema cardiovascular de los niños discapacitados a las condiciones de enseñanza en la escuela


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Received/Recibido: 09/12/2020 Accepted/Aceptado: 10/15/2020 Published/Publicado: 11/20/2020 DOI: <http://doi.org/10.5281/zenodo.4484856>

Resumen

The article presents the results of a study of the cardiovascular system of girls aged 7 and 8 years with vision impairment, and also presents the data of their comparative analysis with the hemodynamic parameters of healthy children. The features of the functional state of the cardiovascular system in children with visual impairment at relative rest, as well as at the beginning, middle and end of the school week at school, have been revealed. The study showed that the girls aged 7 and 8 years with visual impairment compared with healthy girls, at relative rest, have a lower level of functioning of hemodynamics, a negative shift in blood pressure and heart rate, and a tendency to a decrease in stroke volume and minute stroke volume. This may indicate the development of detraining of the cardiovascular system, the formation of a state of asthenia, due to forced hypodynamia and a decrease in the motor activity of visually impaired children. Regardless of age, all schoolgirls with visual impairment from the beginning to the middle of the school week have an increase in their blood pressure and heart rate, and at the end of the school week - a sharp decrease in cardiac output. That is, the observed functional rise of the circulatory system in the middle of the week is carried out due to a sharp increase in sympathetic influences, and a decrease in the contractile function of the heart indicates a low efficiency of the functioning of the cardiovascular system of visually impaired schoolgirls aged 7 and 8 years.

Keywords: cardiovascular system, visually impaired children, adaptation to mental stress.

Abstract

El artículo presenta los resultados de un estudio del sistema cardiovascular de niñas de 7 y 8 años con discapacidad visual, y también presenta los datos de su análisis comparativo con los parámetros hemodinámicos de niños sanos. Se han revelado las características del estado funcional del sistema cardiovascular en niños con discapacidad visual en reposo relativo, así como al inicio, mitad y final de la semana escolar en la escuela. El estudio mostró que las niñas de 7 y 8 años con discapacidad visual en comparación con las niñas sanas, en reposo relativo, tienen un nivel más bajo de funcionamiento de la hemodinámica, un cambio negativo en la presión arterial y la frecuencia cardíaca y una tendencia a la disminución del accidente cerebrovascular. volumen y volumen sistólico minuto. Esto puede indicar el desarrollo de un desentrenamiento del sistema cardiovascular, la formación de un estado de astenia, debido a la hipodinámica forzada y una disminución de la actividad motora de los niños con discapacidad visual. Independientemente de la edad, todas las escolares con discapacidad visual desde el principio hasta la mitad de la semana escolar tienen un aumento en la presión arterial y la frecuencia cardíaca, y al final de la semana escolar, una fuerte disminución en el gasto cardíaco. Es decir, el aumento funcional observado del sistema circulatorio a mediados de la semana se lleva a cabo debido a un fuerte aumento de las influencias simpáticas, y una disminución en la función contráctil del corazón indica una baja eficiencia del funcionamiento del sistema cardiovascular. de escolares con discapacidad visual de 7 y 8 años.

Palabras Clave: sistema cardiovascular, niños con discapacidad visual, adaptación al estrés mental

Introduction

The solution to the problem of social adaptation of visually impaired children and their social integration are impossible without fundamental research of the functional state of the leading physiological systems¹. The undoubtedly dominant role of the visual analyzer in assessing the external environment and the feeling of one's place among the surrounding objects. It is difficult to overestimate the importance of the visual sensory system in the formation of relationships with other sensory systems^{2,3}. All this is a functional basis for the adaptation of a growing organism. The connection between the mechanisms of neuroendocrine regulation and visual function has been proven^{4,5}. Visual impairments, accompanied by decreases in visual afferentation, lead to restructuring of neurodynamic processes in the brain, changes in the functional and adaptive capabilities of physiological systems⁶.

The cardiovascular system (CVS) is most sensitive to exo- and endogenous influences, characterized by the immature regulatory mechanisms in childhood⁷. The processes of maturation of the child's body, the formation of mechanisms of urgent long-term adaptation to external environmental stress are in constant interaction and mutually condition each other. CVS is a sensitive indicator of these relationships⁸. School workloads and accompanying psychoemotional stress influence, as a rule, in a unidirectional pressure mode. During study and in the child's daily life, static posture tension prevails⁹, and motor activity is reduced, which causes a state of overstrain of the body, leads to maladjustment and the development of the disease^{10,11}. There is reason to believe that visually impaired children developing under conditions of forced hypodynamia, against the background of age-related immaturity of the CVS regulatory mechanisms, will experience significant functional changes in the circulatory system under the influence of school environment factors.

The relevance of the considered problem allowed us to formulate the objective of our work - this is a study of the hemodynamic features of visually impaired schoolchildren, its changes under the influence of mental stress in the dynamics of the school week.

Methods

The study was conducted in a Kazan boarding school for children with disabilities and involved visually impaired girls aged 7 and 8 years, studying in grades 1 and 2 (48 people). The study group included children with strabismus, myopia, and operated retinal detachment. As a control group, we studied secondary school girls of the same age without pathology of the visual analyzer. Children were examined three times during the school week - at the beginning, in the middle and at the end.

The method of obtaining and evaluating a rheogram is widely used in the study of the circulatory system¹². We used a rheographic complex complete with a digital converter and a computer. The resulting rheogram made it possible to calculate the stroke volume (SV), heart rate (HR) and secondary - cardiac output (CO). Blood pressure (BP) was measured by auscultation. Systolic blood pressure (SBP), diastolic blood pressure (DBP) and mean pressure (MP) were determined based on the blood pressure indicators.

Results and Discussion

At the first stage of the research, the CVS indicators of girls aged 7 and 8 years were analyzed at relative rest at the beginning of the school week. Also, the age-related dynamics of the parameters was assessed, a comparative analysis was carried out with the data of the control group. It was found that regardless of the state of the visual analyzer, 7-year-old girls have no significant differences in heart rate indicators. In the visually impaired group, it is 78.40 ± 1.30 bpm, and in healthy girls - 76.50 ± 3.04 bpm (Fig. 1a). A similar situation is revealed in relation to SV and CO (Fig. 1b, c), which are 37.75 ± 1.38 ml and 39.50 ± 1.77 ml, 2.95 ± 1.50 L and 3.10 ± 2.80 L in both groups, respectively. The most significant differences are observed in blood pressure indicators: SBP in visually impaired schoolgirls was 117.80 ± 2.90 mmHg, and 122.44 ± 1.07 mmHg in healthy girls (Fig. 1d), which is 4.64 mm Hg. more and mathematically significant ($p < 0.05$). Diastolic blood pressure in children of the control group was also high - 78.60 ± 1.37 mmHg, whereas in schoolgirls with pathology it did not exceed 74.10 ± 4.7 mmHg. ($p < 0.05$) (Fig. 1e). The exception was observed for MP: in both study groups it ranged from 88.60 ± 1.30 to 92.80 ± 1.45 mmHg (Fig. 1f), the differences were not significant.

Both 8- and 7-year-old children with visual impairment, in comparison with healthy schoolgirls, had characteristic differences in the CVS parameters, namely, their de-

creased values in the study group. The most striking differences were found between blood pressure and cardiac output. Thus, SBP in schoolgirls with visual impairment was 101.50 ± 8.50 mmHg, while in the control group it was 112.57 ± 1.06 mmHg, which is 11.07 mm. Hg higher, the difference is mathematically significant at $p < 0.05$. Differences in DBP were 11.03 mmHg with a predominance of the parameter in the control group ($p < 0.05$). Relative increase in MP in healthy girls by 6.5 mm Hg looked as a trend.

Similar differences were observed in 8-year-old children with regard to CO - this hemodynamic indicator was higher in the control group than in study group (2.803 ± 2.61 L and 3.762 ± 1.53 L, respectively), while the difference was not mathematically significant.

Summarizing the results, we can come to the conclusion that the functional state of girls aged 7 and 8 years, both visually impaired and healthy, has significant differences. Schoolgirls aged 7 and 8 years with visual impairment have a degree of hemodynamic stress, the level of its functioning is lower than in healthy ones. There is a decrease in SBP, DBP and HR (7 years), a tendency to decrease in SV and CO. At the age of 7 to 8 years, the established differences become even more pronounced in visually impaired

girls aged 8 years, with a decrease in blood pressure, there is a relative tachycardia, a drop in systolic output compared to control. Thus, we can talk about the manifestation of an asthenic state in girls with visual impairment against the background of a decrease in motor activity, which is consistent with the literature data²⁻⁵.

At the next stage of the research, the dynamics of CVS indicators during the school week was studied in order to assess the effect of school load on visually impaired children. A comparative analysis of the results obtained with the indicators of children in the control group made it possible to reliably judge the specific influence of visual pathology on the adaptation of children to the conditions of schooling. It was found that visually impaired girls aged 7 years during the school week have pronounced changes in hemodynamics. So, from Monday to Wednesday and Friday, an increase in heart rate is traced, respectively, by 2.6 bpm and 7.85 bpm ($p < 0.05$) (Fig. 2a), while at the beginning of the school week it does not exceed 77.60 ± 1.21 bpm. During the school week, an increase in blood pressure is observed - SBP increases from Monday to Wednesday from 113.90 ± 4.30 mm Hg up to 118.70 ± 2.83 mm Hg ($p < 0.05$); by Friday the nature of the changes remains; there is an increase in this indicator by 3.63 mm Hg compared to Monday (Fig. 2d).

Fig. 1

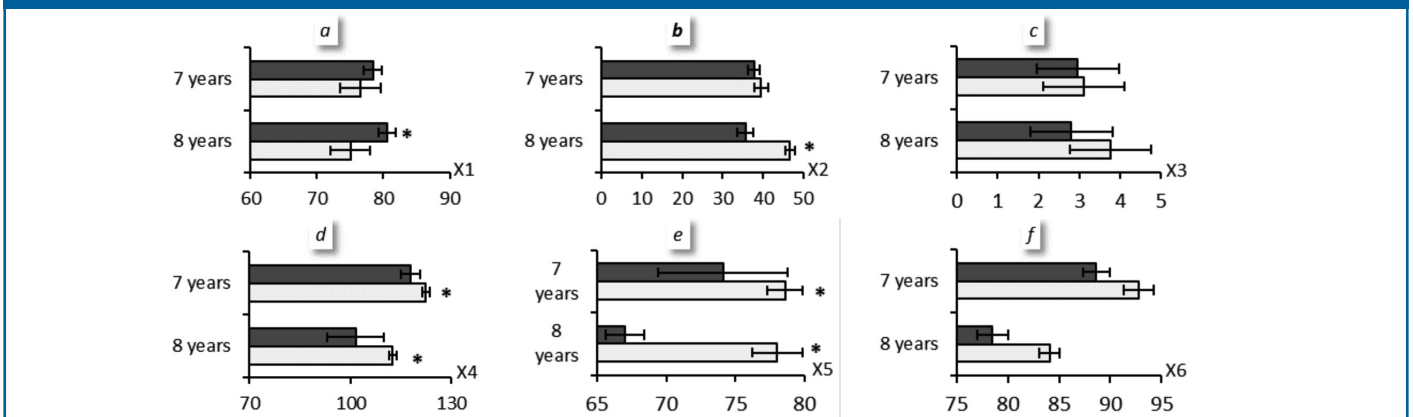


Fig. (1). Indicators of the cardiovascular system in visually impaired and healthy children 7 and 8 years old.

Note: a - HR; b - SV; c - CO; d - SBP; e - DBP; f - MP; abscissa X1 - bpm; X2 - ml; X3 - l; X4 - mmHg; X5 - mmHg; X6 - mmHg; ordinate - age (year); □ - visually impaired children; □ - healthy children; * - differences are significant between visually impaired and healthy children: $p < 0.05$.

Fig. 2

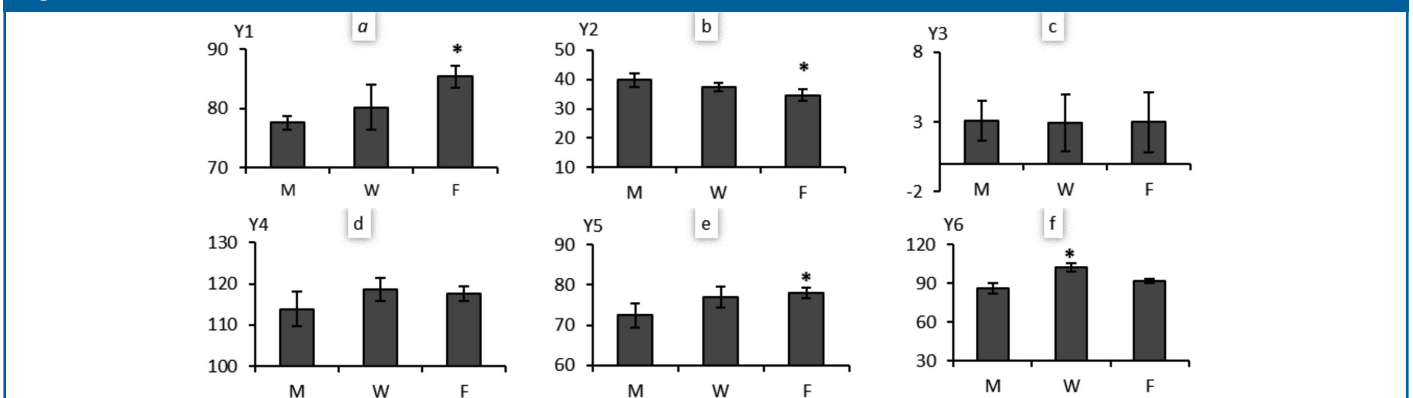


Fig. (2). Dynamics of indicators of the cardiovascular system during the school week in visually impaired children of 7 years.

Remark: (a) Heart rate; (b) stroke volume; (c) minute blood volume; (d) systolic blood pressure; (e) diastolic blood pressure; and (f) average hemodynamic blood pressure; Horizontally (abscissa): days of the week: M - Monday, W - Wednesday, F - Friday;

Vertically (ordinate): Y1 - bpm; Y2 - ml, Y3 - l; Y4 - mmHg, Y5 - mmHg; Y6 - mmHg; ■ - visually impaired children; * - differences are significant at: $p < 0.05$.

Similarly, the MP values change: if at the beginning of the week it is 86.23 ± 3.75 mm Hg, then by the middle of the week it increases to 102.50 ± 3.50 (by 16.27 mm Hg at $p < 0.05$). At the end of the week, MP remains high - 91.75 ± 1.45 mm Hg (Fig. 2f). Diastolic pressure, like heart rate, acquires the highest values on Friday and is 78.02 ± 1.41 mm Hg, which is 5.6 mm Hg higher than on Monday ($p < 0.05$) (Fig. 2e). A different situation is revealed in relation to the SV: in contrast to the heart rate and blood pressure, the systolic output from the beginning to the end of the week decreases significantly. If on Monday the SV does not exceed 39.71 ± 2.90 ml, then by Friday it decreases to 34.58 ± 2.05 ml, which is mathematically significant at $p < 0.05$ (Fig. 2b). A similar trend is observed in the dynamics of the CO - on Monday its volume is 3.08 ± 1.40 L, on Wednesday and Friday it does not exceed 2.903 ± 2.04 L (Fig. 2c). It is known that Tuesday and Wednesday are considered days of high efficiency and mobilization readiness of schoolchildren. However, the functional rise of the circulatory system, observed in visually impaired schoolgirls, is probably due to a sharp increase in sympathetic influences, while the contractile function of the heart is reduced. This may indicate a low efficiency and depletion of the circulatory system in girls aged 7 and 8 years it visual impairment.

In 8- and 7-year-old visually impaired schoolgirls, hemodynamic parameters change during the school week, while multidirectional shifts in HR, BP, SV and CO are more pronounced. From Monday to Wednesday, relative tachycardia is noted - there is a significant increase in heart rate from 80.30 ± 1.50 bpm to 84.20 ± 2.83 bpm ($p < 0.05$), however, by Friday there is a tendency to decrease to 79.45 ± 1.17 bpm (Fig. 3a). Similar changes were revealed in the SRS indicators - on Monday it does not exceed 80.43 ± 1.20 mm Hg, and in the middle of the week it becomes 7.03 mm Hg higher ($p < 0.05$). By the end of the week, the dynamics leveled out, although MP remains at an elevated level (Fig. 3f). The maximum values of DBP for this age group are recorded on Friday and amount to 79.02 ± 1.57 mm Hg, which is 9.21 mm Hg higher than on Monday,

when its value does not exceed 70.40 ± 2.50 mm Hg (Fig. 3e). At the same time, SBP changes are smoother, fluctuations in its values are not significant - from 112.90 ± 1.23 mm Hg up to 115.73 ± 1.40 mm Hg (Fig. 3d). An analysis of cardiac output indicators revealed a characteristic weekly dynamics for visually impaired schoolgirls, which consists in a progressive decrease in SV and MV from Monday to Friday. Thus, SV, which at the beginning of the week is 41.41 ± 1.30 ml, decreases to 35.40 ± 1.43 ml by the middle of the week. On Friday, the decrease in SV is 2.92 ml compared to Wednesday and 8.87 ml compared to Monday ($p < 0.05$) (Fig. 3b). The greatest differences in CO parameters were found between Monday and Friday: in the first case, CO is 3.32 ± 203 L, and in the second - 2.64 ± 1.14 L, which is 0.68 L less, at $p < 0.05$ (Fig. 3c). That is, in visually impaired schoolgirls aged 7 and 8 years old, hemodynamic parameters change during the school week in the same way - from the beginning to the middle and the end of the week, there is an increase in HR, BP, and a decrease in SV and CO.

The situation is different in healthy girls without, who practically have no changes in the state of the CVS during the school week. Thus, the heart rate during the school week ranges from 84.50 ± 1.00 bpm to 88.03 ± 1.88 bpm with only a slight tendency to increase on Friday (Fig. 3a). BP is also at a stable level: SBP in the range of 115.90 ± 1.30 mm Hg (on Monday) up to 118.40 ± 1.98 mm Hg (on Friday); DBP at the beginning of the week is 75.34 ± 1.02 mm Hg, in the middle and at the end of the week - 76.90 ± 2.60 mm Hg and 78.20 ± 1.13 mm Hg, respectively. The exception is the MP values, which significantly decrease on Friday and average 71.45 ± 1.49 mm Hg, which is 7.1 mm Hg lower than on Wednesday (Fig. 3). There were no significant changes in the dynamics of the SV and CO; they practically did not change from Monday to Wednesday: SV averaged 39.86 ml, and CO - 3.425 L. This shows that the adaptation of healthy schoolgirls to the educational load occurs without significant tension of the vegetative functions but with maintained reserve capabilities of the CVS.

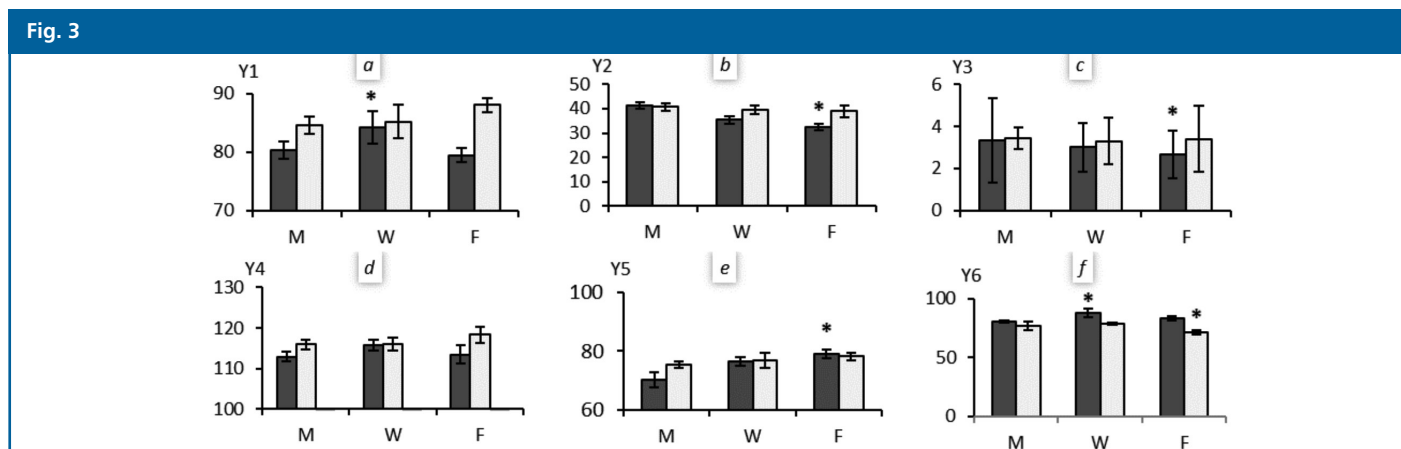


Fig. (3). Dynamics of indicators of the cardiovascular system during the school week in visually impaired and healthy children of 8 years.

Remark: (a) Heart rate; (b) stroke volume; (c) minute blood volume; (d) systolic blood pressure; (e) diastolic blood pressure; and (f) average hemodynamic blood pressure; Horizontally (abscissa): days of the week: M – Monday, W – Wednesday, F – Friday;

Vertically (ordinate): Y1 - bpm; Y2 - ml, Y3 - l; Y4 - mmHg, Y5 - mmHg; Y6 - mmHg; ■ - visually impaired children; □ - healthy children; * - differences are significant at: $p < 0.05$.

1. The 7-year-old schoolgirls with visual impairment, in comparison with healthy girls, at relative rest, show a decrease in all types of blood pressure. The 8-year-old schoolgirls have the persisting tendencies towards a decrease in blood pressure, and moreover, there is a negative trend in the parameters of heart rate, stroke and minute blood volume.
2. All schoolgirls with visual impairment, from the beginning to the middle of the school week, have a significant increase in blood pressure and heart rate, and by the end of the week - a decrease in stroke and minute blood volumes. Healthy schoolgirls have stable hemodynamic parameters during the school week, and only on Friday there is a slight tachycardia and an increase in systolic blood pressure.

Thus, the pathology of the visual analyzer has a significant impact on the functional and adaptive capabilities of the cardiovascular system of a growing child's body. Insufficient physical activity in girls with visual impairment leads to the development of an asthenic state at the age of 7 and 8 years, characterized by a relative decrease in the level of hemodynamic functioning in comparison with children without visual impairment. This affects the adaptation of children to the academic load at school - by the middle of the school week they show signs of functional stress, and by the end - fatigue in the circulatory system. The revealed features of the functional state of CVS in children with visual impairment dictate the need for an individual approach in organizing the educational process at school, introducing a moderate learning regime for visually impaired students.

ACKNOWLEDGMENTS

The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

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