

Functional State Hardware Evaluation System in Educational Medium

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Abstract

Diagnosis of heart rate variability as an indicator of the impact of external and internal media can serve to make changes in the educational environment. The approach to the organization of the educational process is developed on the basis of quantitative indicators of the students' functional state using the hardware-software complex "Varikard".

Introduction

The aim of this paper is evaluation of the functional capabilities of the learning and

simultaneously analyzing its adaptive parameters based on quantitative instrumental methods. These data are important for the improvement of the training process in different kinds of education. Moreover it is known the growth of the information load and the officially recognized small percentage of the absolutely healthy students (no more than 10% of schoolchildren according to the Ministry of Education and Science of the Russian Federation). This, in turn, determines the specificity of the management of the educational process in educational institutions of all levels, including the higher, secondary and primary links.

The savings technologies acquire special significance in the period of the demographic crisis that dominates not only in Russia, but in the European space.

In this regard, the diagnosis of the functional state based on instrumental methods makes it possible to develop a new approach to the problem of healthcare and the system of vocational orientation of trainees.

The constancy of the internal state of biosystems is the opposition to disturbances from the external environment due to the autonomy and stability of their internal organization (homeostasis). In order to remain healthy, the human body systems

must be regulated in such a way that a stable internal balance remains under the constantly changing external conditions. The variability of the pulse rate of the circulatory system is an objective indicator of such stability.

The paper presents an attempt of such a differentiated analysis of adaptation opportunities and stress resistance of schoolchildren of middle and senior classes using the instrumental method based on the hardware-software complex "Varikard" of the Russian company "Ramena" Ryazan researcher Yu. Semenov. The complex can measure 40 parameters of the subject, based on measuring the variability of the heart rate.

The authors of this work were not sure of the success of the enterprise, since this method was previously applied to the examinees, whose formation of homeostasis was completed.

Results and Discussion

It is convenient to divide the state of the diagnosed into three levels, denoted conditionally "norm", "below the norm" and "above the norm," which allows us to characterize the functional state of the human being from the point of view of the risk of developing the disease.

As a basis for the analysis of the functional state of high schoolers (9th, 10th and 11th grades), in our opinion, the most representative indicators such as heart rate (pulse rate), stress index and average statistical deviation from fashion pulse rate. (Schoolchildren of the 9th grade are usually referred to as teenagers, and the 11th grades as the youth period.) Based on diagnostic results, histograms were plotted for each of the above measured values. On all the histograms in the center was placed the indicator corresponding to the "norm" state, to the left of it - "below the norm", and to the right - "above the norm".

Based on these indicators, conclusions were drawn about the functional state, which determined the physiological norm, the donorological norm (maintenance of life with a higher voltage of regulatory systems), premorbid states (the beginning of possible development of disease), and disruption of adaptation ma diseases).

In particular, studies carried out on the basis of the 57th Ryazan school of the city revealed a number of peculiarities about the change in the frequency of the rhythm of cardiac contraction by age and gender in schoolchildren of the 9th grade (mean age 15 years), the 10th grade (mean age 16.5 years) and 11th grade (the average age is 17.5 years).

The results obtained (Fig. 1) in the main confirm the results of the studies of the authors of the study who found a lowering of the pulse rate in schoolchildren in the upper grades compared with the younger (the prevalence of tachycardia in adolescents is a known medical fact). At the same time, our comparative analysis shows the dominance of this indicator in young men. Consideration of the same pulse rate distribution in the bradycardia, norm, and tachycardia groups shows the appearance of a bradycardia in the group of young people with age, which, we believe, is due to their more active involvement in sports. In general, the transition to the older group of subjects was characterized by the desire for the evolution of histograms to the law of normal statistical distribution. However, the condition of tachycardia is largely present in girls and boys, which may be due to the incompleteness of the development of the vegetative system or their small physical activity, in particular, the irrational organization of school and sectional physical training, as well as the illnesses considered organization of work and leisure. (Fig. 2)

The deviation from the norm indicates an overtension of the regulatory systems or their inadequate development. It turned out that, like the indicator of the rhythm statistical histogram. As for adolescent girls, the evolution of the stress index has already largely been completed, the age group of the 11th class does not have a state of the overtension of the regulatory systems, while for youths this component remains significant (about 10%).

It should be noted that the normalization of this indicator in the sense of the previously noted stabilization of the pulse rate of the circulatory system in the

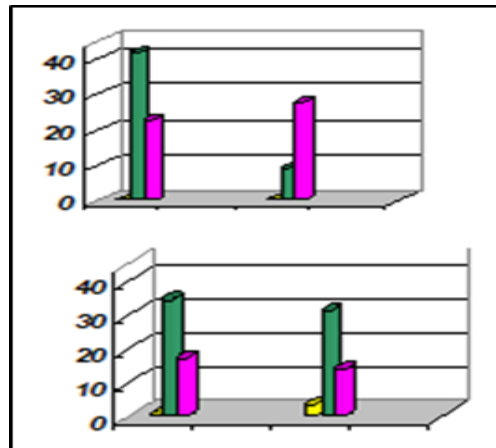


Figure 1. The main indicators of the heart rate: 9 class (upper histograms), 11 class (lower histograms): the left columns are the girls, the right ones are youths.

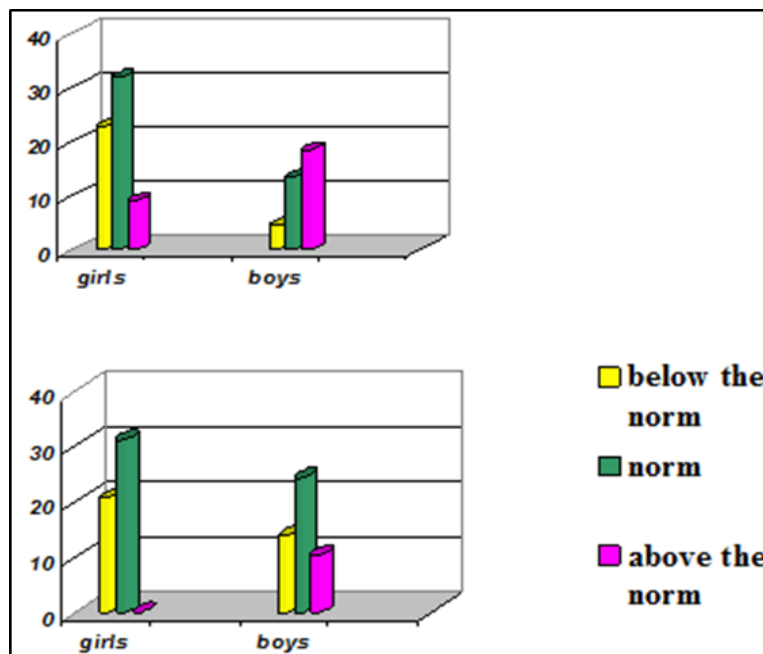


Figure 2. Stress index: 9th grade (upper histograms), 11th grade (lower histograms): the left columns are the girls; the right ones are the boys.

comparable sex and age groups.

The third parameter was the mean square deviation (MSD) of variability of heart rhythm. Its statistical norm ranges from 30 to 100 conventional units (Fig. 3). It is known from observations of astronauts that during the first intense minutes of the rise to the orbit the histogram, whose width is determined by the MSD, sharply contracts, and the transition to a calm state of adaptation is characterized by an increase in this index [1]. The stability of this indicator was noted in the group of girls with increasing age, while in young people there is little in the teenage MSD, and its normalization (increase) is found in 11th form.

Although in general all the previously discussed characteristics of the tenth grade repeat the revealed patterns, but they also reveal differences.

These results were obtained in the autumn period of the school year. It was interesting to consider the role of vacation time on diagnosed indicators, as well as their change at the end of the lessons compared with their beginning.

We believe that this feature is related to the lack of final exams or testing. Indeed, this was found on the characteristic indicators of the functional state. In the following fig. 4-6, the results of such a survey of tenth-grade students in the first week after the spring break.

From the presented results of the rhythm of heartbeats analysis it is evident that the beginning of lessons is characterized by an increased frequency in girls (found 45% of tachycardia conditions), which significantly decreased by the end of the school day (till 15%), passing into a normally distributed state for this indicator.

At the same time, youths on this indicator shown out about stability (5% of the state of tachycardia at the beginning and the same level at the end of the lessons), and 30% of the total number of boys students was normal on the heart rate of contraction. It turned out that, as well as the rate of heart rate in boys of the 10th grade, it stabilized in comparison with the students of the 9th

grade, specifically, this indicator is "above the norm" (0%) both at the beginning of the day and at its end. The revealed peculiarity is its small value at the beginning of the school day (10%) and a slight increase (15%) at the end of the lessons, the same as for students in the 9th grade. This indicates the incompleteness of the formation of regulatory systems to 10 years of schooling.

As for girls, the stress index at the beginning of lessons is slightly increased (about 20% above norm) with its next decrease by 4 times - the stage of weakening by the end of the training load.

A similar change shows the mean square deviation (MSD) of heart rate variability (statistic from 30 to 100). The stability of this indicator in girls with increasing age was revealed, while in adolescents there is little, and its normalization (increase) is revealed only by the 11th year of education.

From the received results it is possible to assert, that the diagnostics resulted above, can be applied for schoolboys of 16 years and is more senior.

The method [1] of the estimation of the regulatory capabilities of the organism from all the analyzed indicators into a unified characteristic, called the functional state of the subjects. From histograms for girls and youths (Fig. 6) it follows that for 5% of girls, the greatest stress is at the beginning of the learning process (the state of adaptation failure is the fourth column of the histogram). This state disappears at the end of the educational process, in young men it does not arise.

The indices of this category from the point of view of variance and mathematical expectation of random variables, the measured parameters are close to standard results. This also follows from the results of the comparison of the given data with the results of our early research and their reproducibility. Comparison of overstress of regulatory systems and their magnitude at the beginning and at the end of lessons on the deviation of the stress index from the norm is essential when choosing the direction of career guidance work with students.

Conclusion

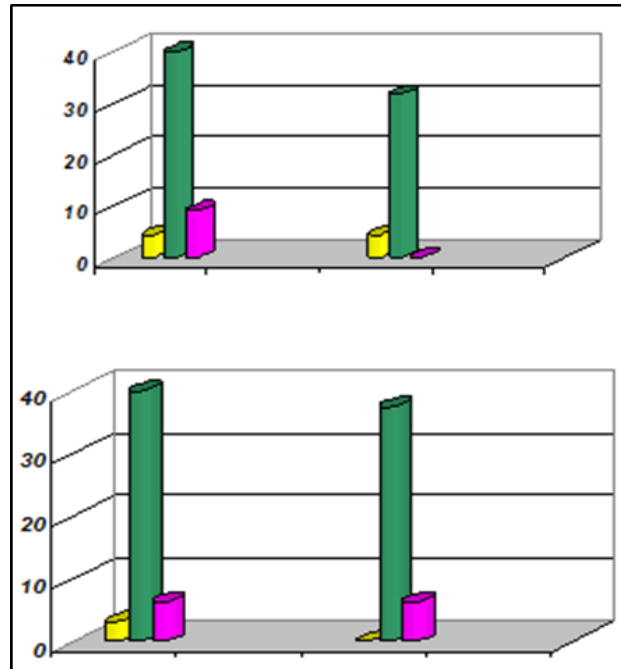


Figure 3. Mean square deviation: 9th grade (upper histograms) and 11th grade (lower histograms).

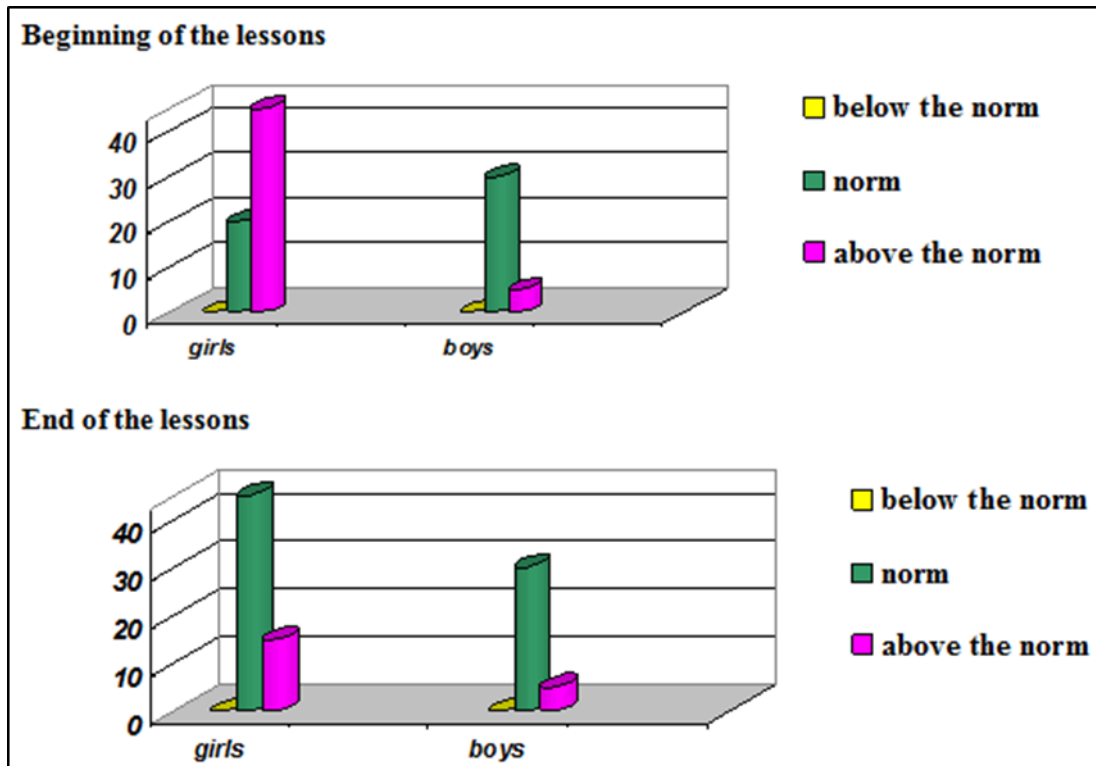


Figure 4. The main parameters of the heart rate (the norm 55-80) of the tenth grade at the beginning (upper histograms) and the end of the school day (lower histograms).

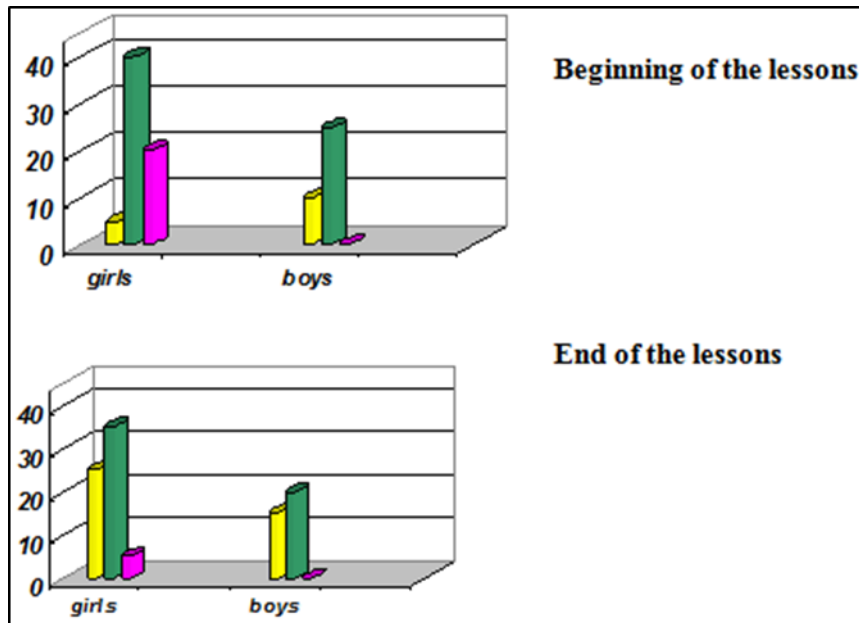


Figure 5. The stress index (norm 50-150) at the beginning (upper histograms) and to the lesson end (lower histograms).

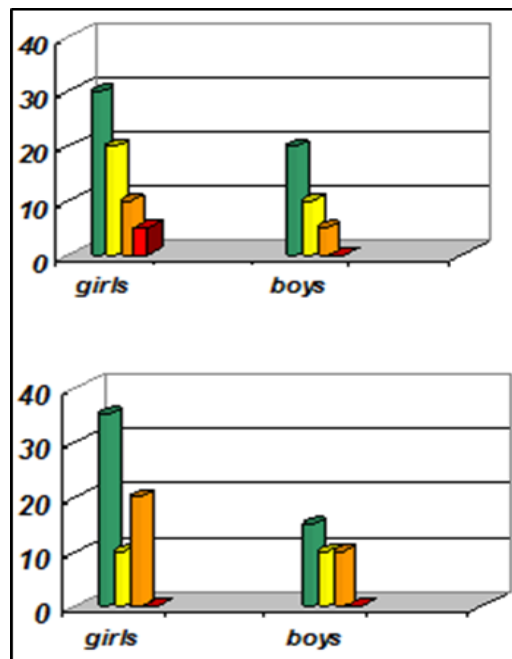


Figure 6. The indicator of the functional state at the beginning (upper histograms) and to school day end (lower histograms).

The considered capabilities of the hardware-software complex "Varikard" allow it to recommend for diagnosing the functional condition of high schoolers. The other task of the work was to answer the question of the possibility at a quantitative level to determine the difference in the evolution of these indicators, to reveal differences in the sex-age characteristics of schoolchildren of the 9th, 10th and 11th grades based on the analysis of the variation in the rhythm of cardiac contractions, which was previously not known in the literature was discussed. Consequently, recording the time interval of R-R peaks on a cardiogram allows you to judge the health status of the schoolboys surveyed.

From the comparative survey, conclusions are drawn about the applicability of instrumental methods for analyzing the functional state of schoolchildren and the possibility of correcting educational and educational work on this basis.

References

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