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The Use of Computers in the Educational Process Affects the Psychophysiological and Somatic Indicators in Children Aged 7-12 Years

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Introduction.

Changes in the educational environment actualize monitoring studies aimed at evaluation of the influence of various learning technologies on the functional state of the body in children.

Aim: to study the influence of computer's screen time on indicators of the sensorimotor reactivity, physical development, and cardiovascular system in primary school students.

Methods.

We analyzed the data obtained in Moscow schools in 2006-2011.

Surveys were conducted twice a year (October and March-April) in 66 different educational organizations.

Testing in late March–early April corresponds to the beginning of the school year, and in late September–early October corresponds to the end of the school year.

In total, the study included the data for 4,525 primary students (grades 1-4; 7-12 years).

The number of examined samples of primary schoolchildren

Grades	Girls		Boys	
	autumn	spring	autumn	spring
1	576	379	568	369
2	215	146	98	109
3	350	405	171	131
4	429	400	120	57
Total	1570	1330	957	666
	2900		1623	
	4525			

The school and after-school screen time was scored by teachers based on national hygienic standards:

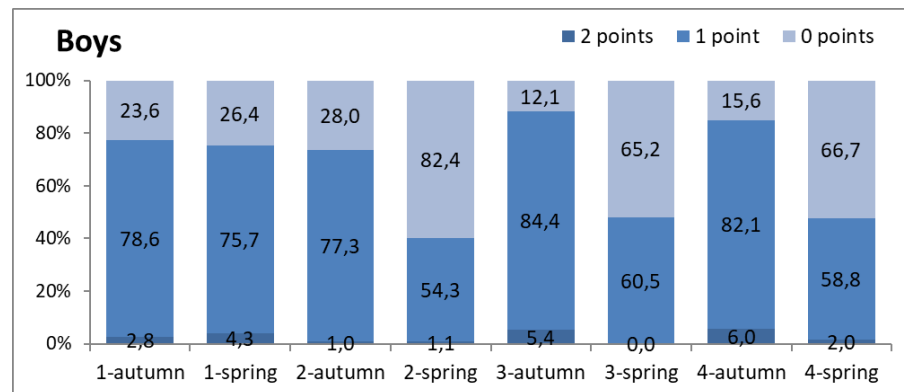
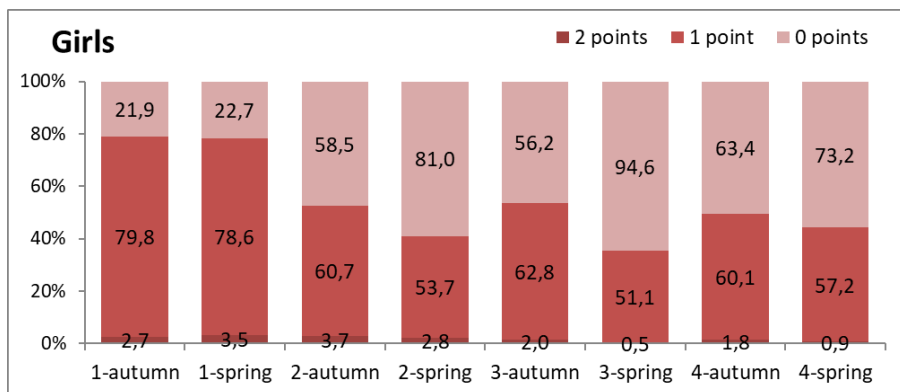
0 points – no load,

1 point - within recommended limits (15 min at school and 30 min out of school),

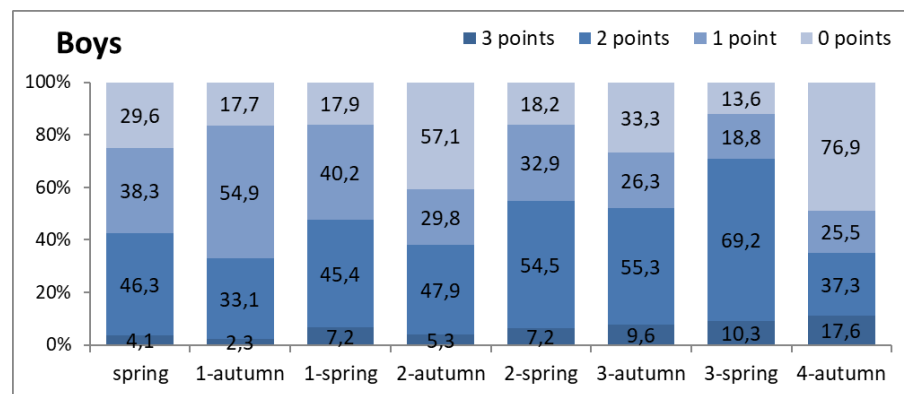
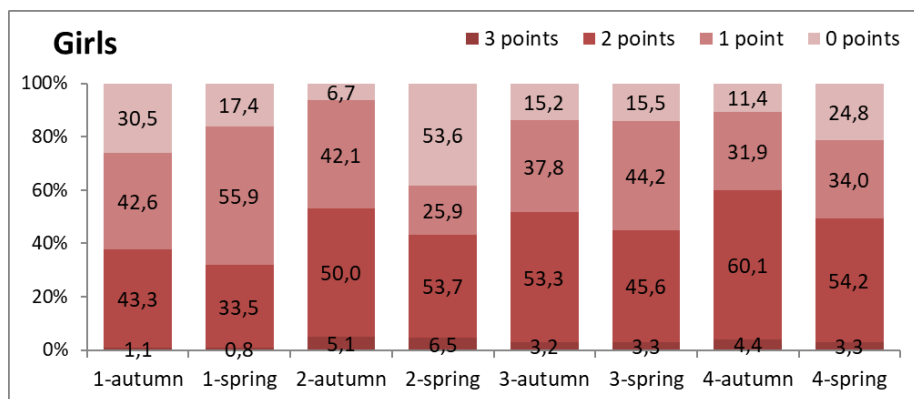
2 points – 2-fold exceed the recommended limits,

3 points - 3-fold exceed the recommended limits.

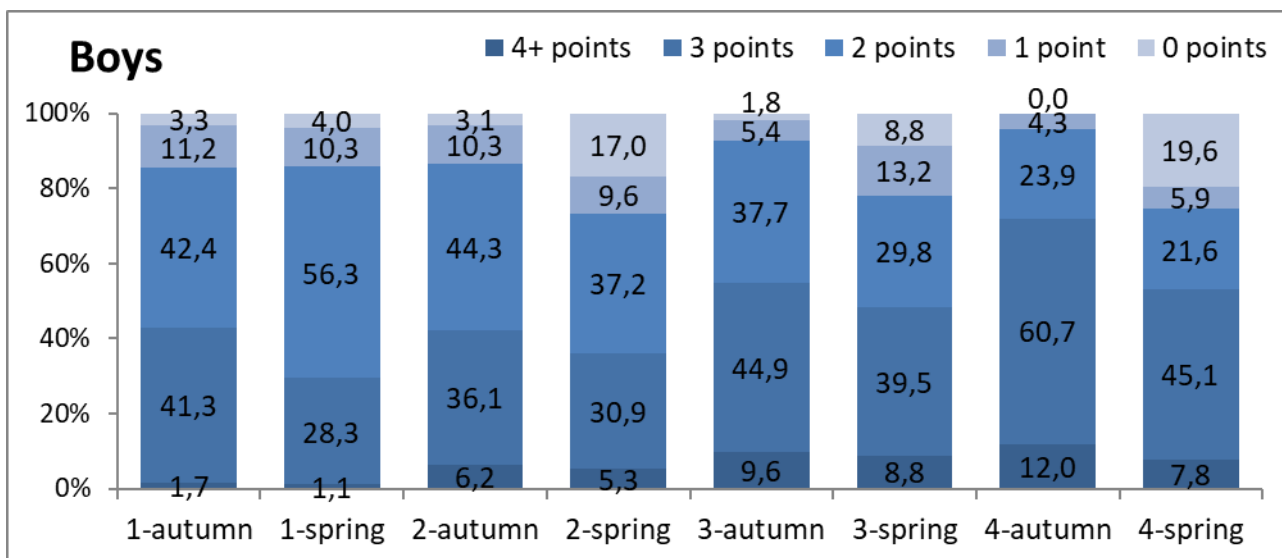
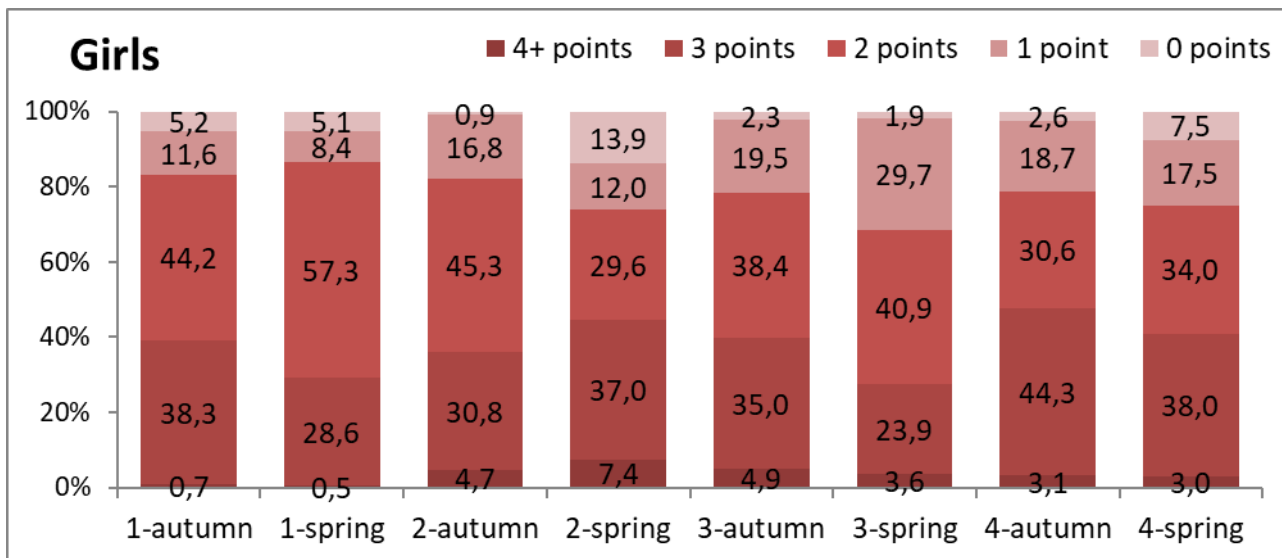
Lessons computer load (school screen time)



Out-of-school computer load (screen time)



Total (lessons + out-of-school) screen time



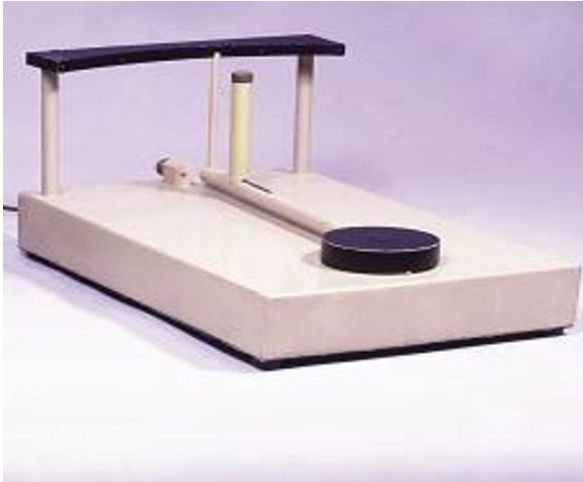
The sensorimotor reactivity was assessed by reaction time (RT) of simple sensorimotor reactions to visual (light) and acoustic (sound) stimuli and their ratio RTA/RTV.

The following somatic parameters were evaluated:

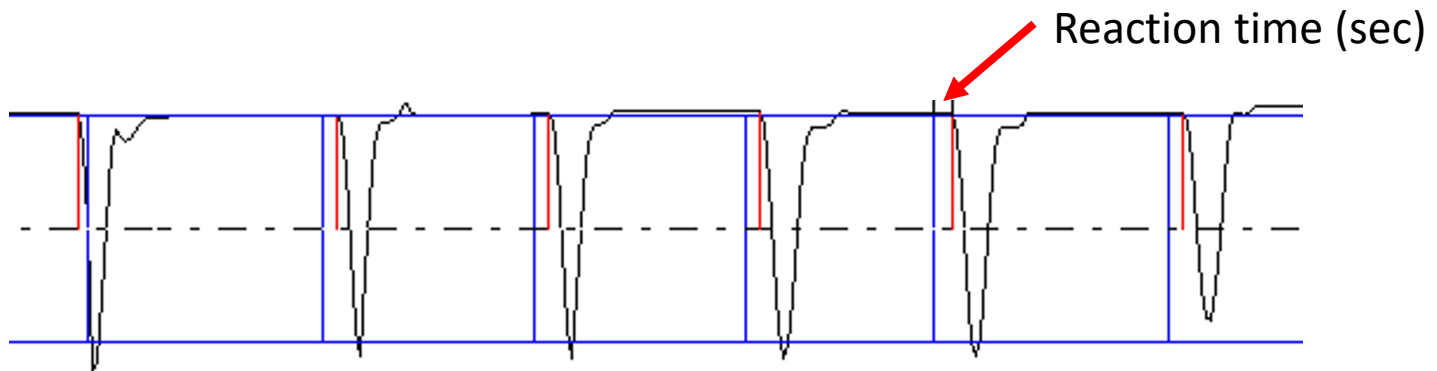
- body mass index (BMI),
- heart rate variability (HRV), blood pressure (BP) and its variability (BPV).

Equipment: computer movement meter

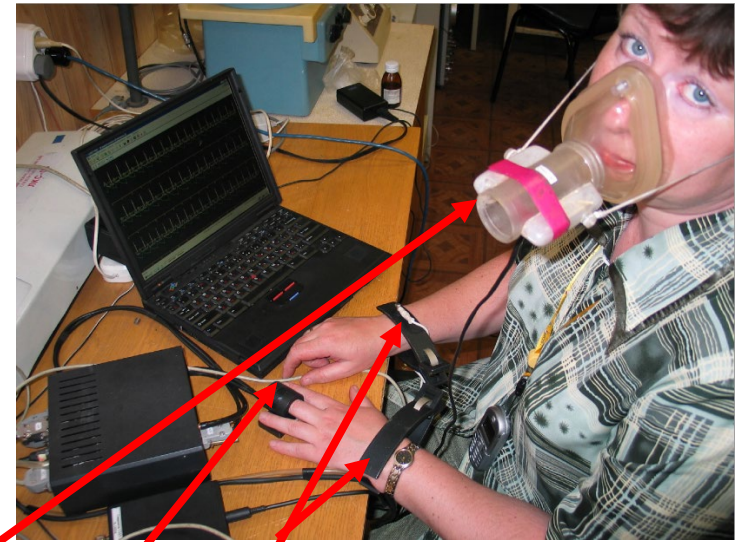
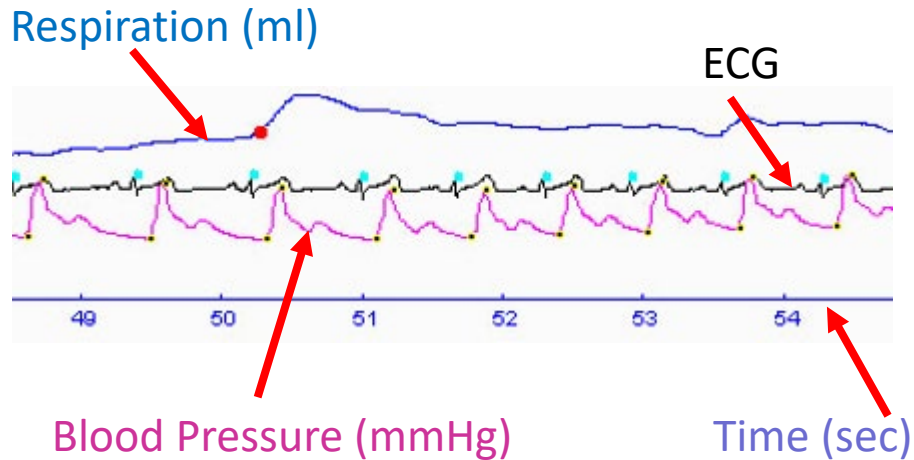
Appearance of the computer movement meter (CMM) device



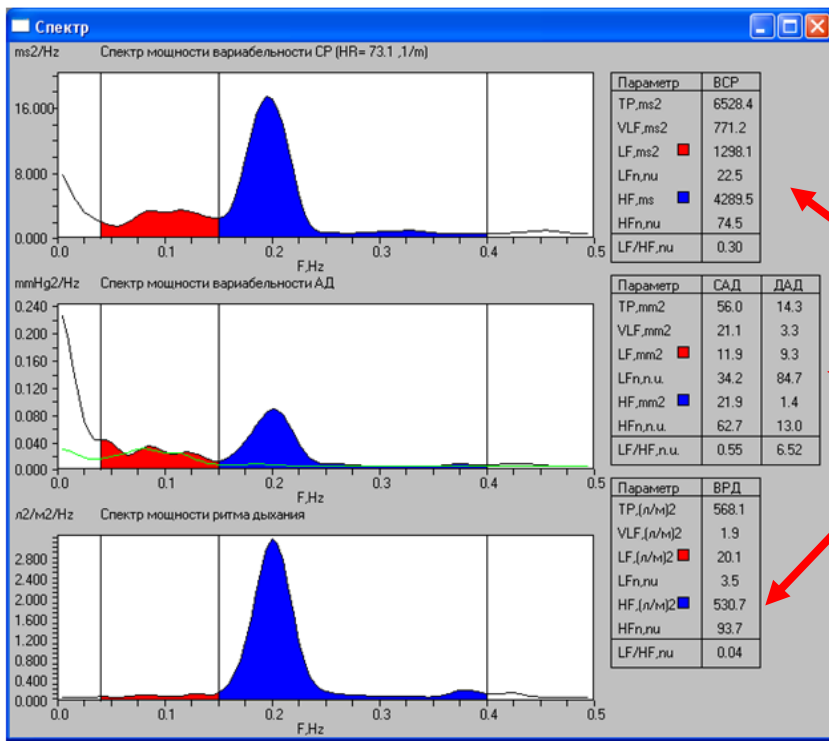
Hand position during CMM testing and movement direction for right hand



Equipment: spiroarteriocardiorhythmograph



Spiro Arterio Cardio Rhythmograph



Spectrum of Heart Rate Variability

Spectrum of Blood Pressure Variability (systolic and diastolic)

Spectrum of Respiration (air velocity)

Parameters: Total Power, absolute and relative power of VLF, LF and HF ranges (ms², mmHg², l/m²)

Results.

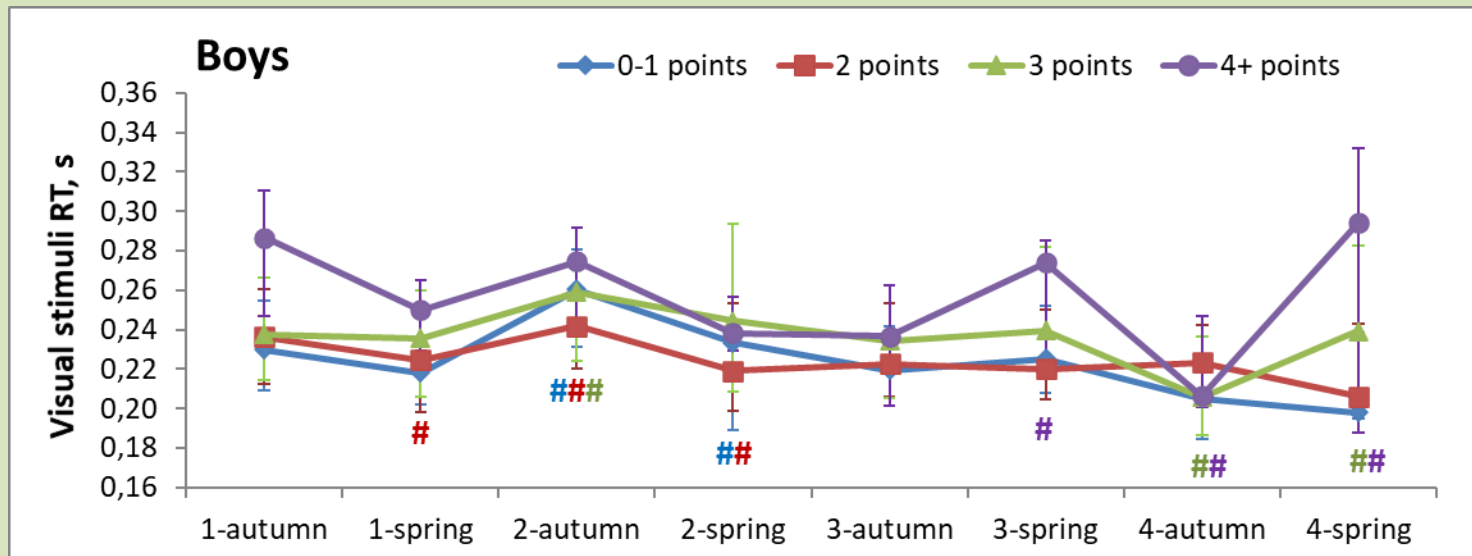
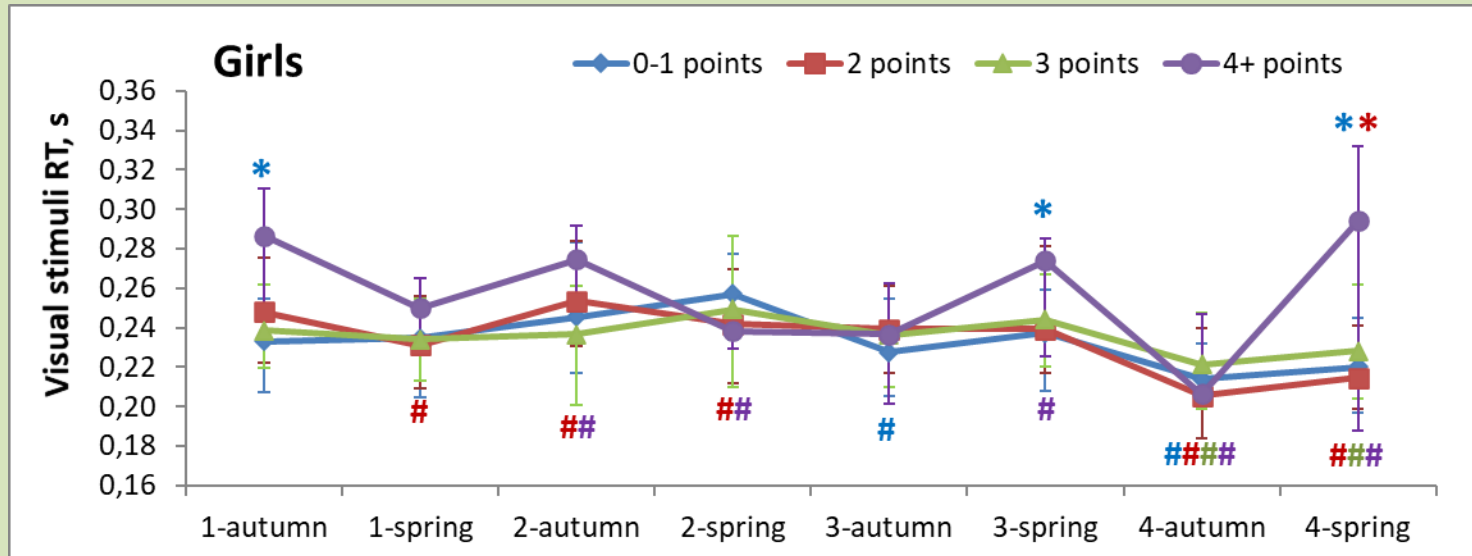
A correlation was found between RT (both RTV and RTA) **and total (school and after-school) screen time**. Excessive screen time (3 points) leads to an increase in RTV during spring testing; this increase was most pronounced in third- and fourth-grade girls. Moreover, seasonal variability of RTA/RTV appears in the form of a decrease in this indicator during spring testing most pronounced in third- and fourth-grade boys.

Figures legend.

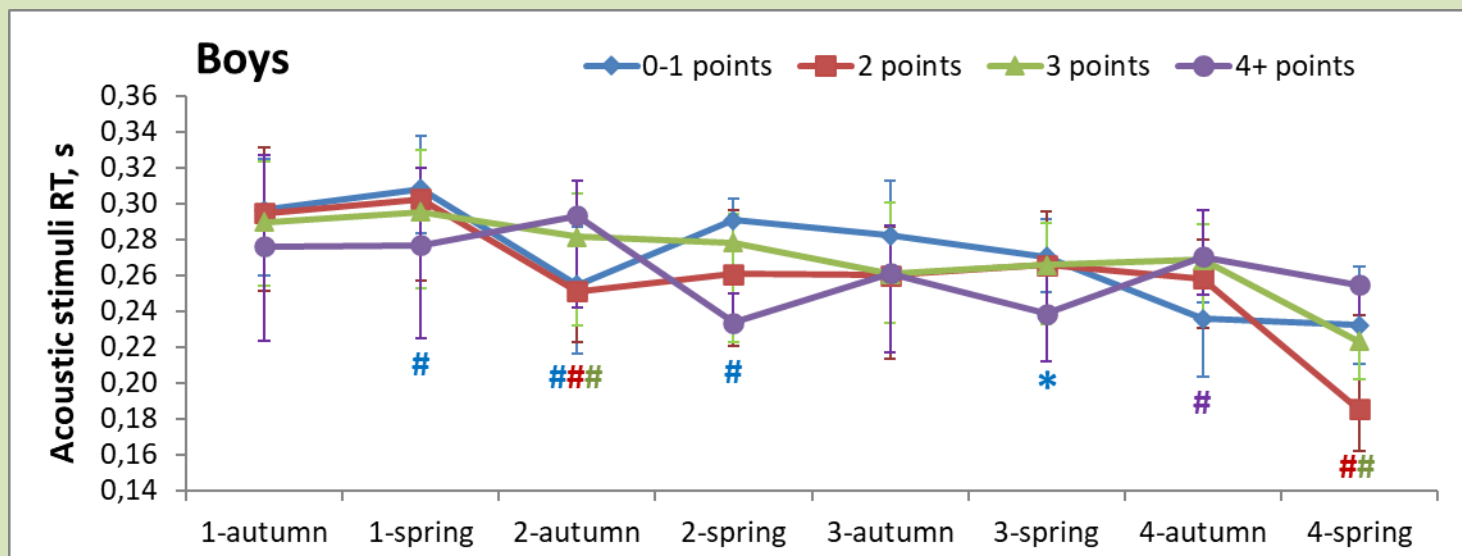
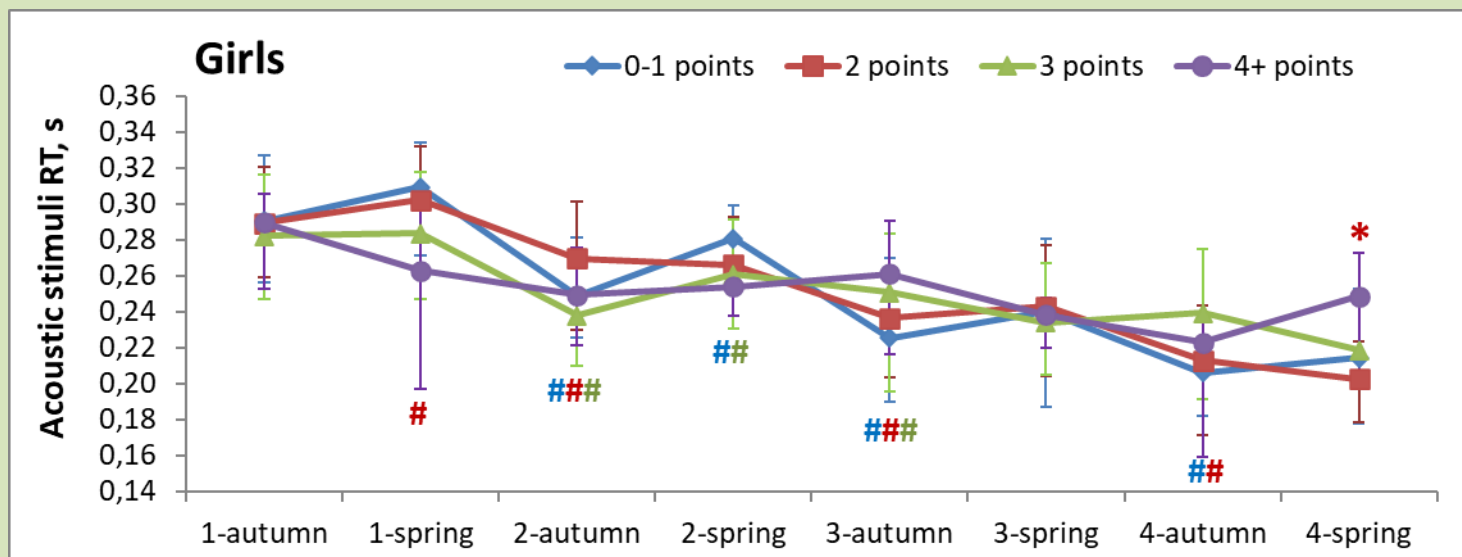
The designations of time periods: “a” - autumn, “s” - spring, numbers denote grade. Statistically significant differences from other groups at the same testing point (according to Kruskal-Wallis test) are indicated by an asterisk of the corresponding color. Statistically significant differences from the previous test point (according to Mann-Whitney test) are indicated by the “#” mark of the corresponding color.

All data are presented as a median and interquartile range.

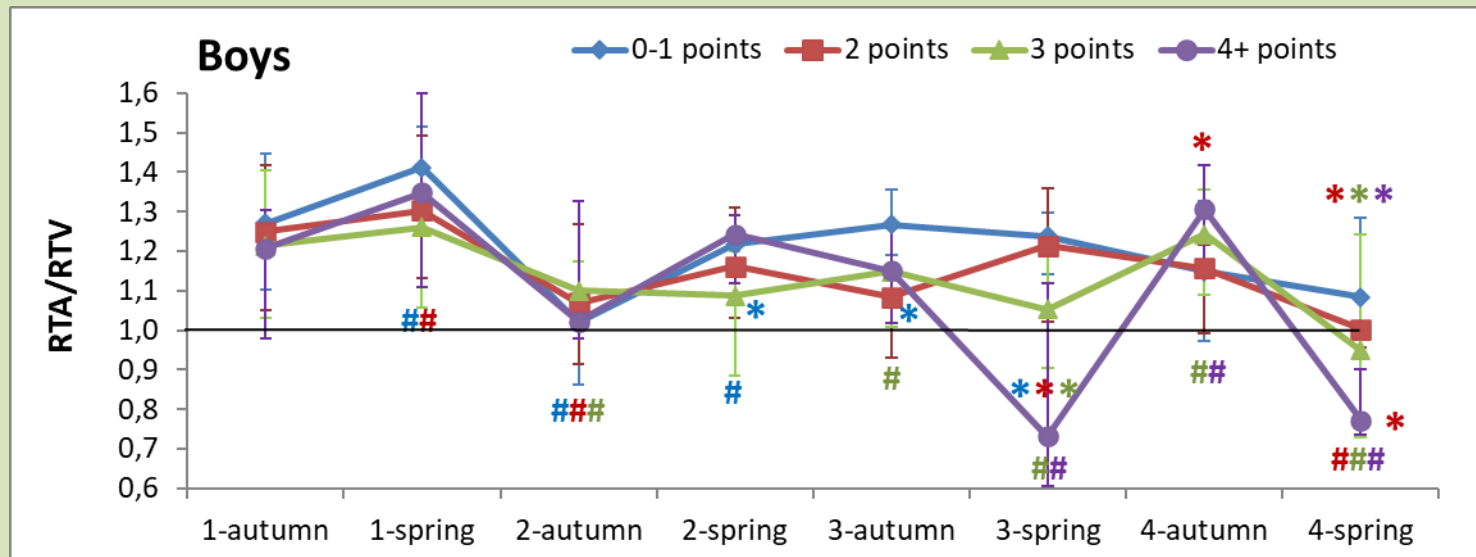
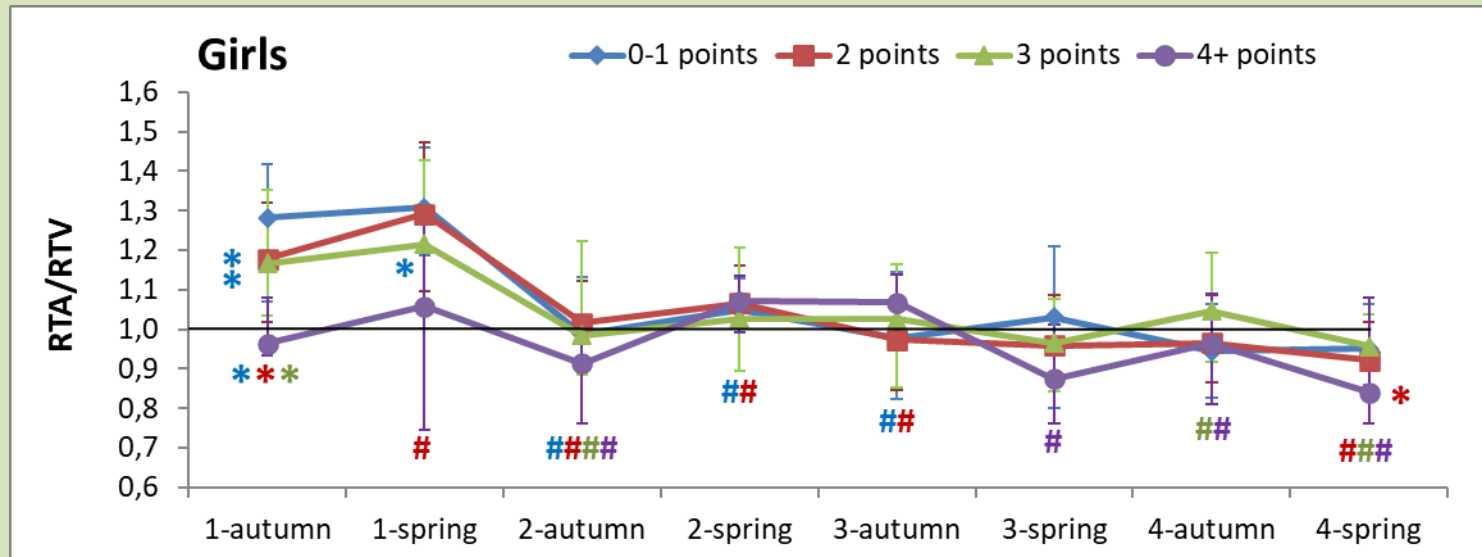
Reaction time of simple sensorimotor reactions to visual stimuli (RTV)



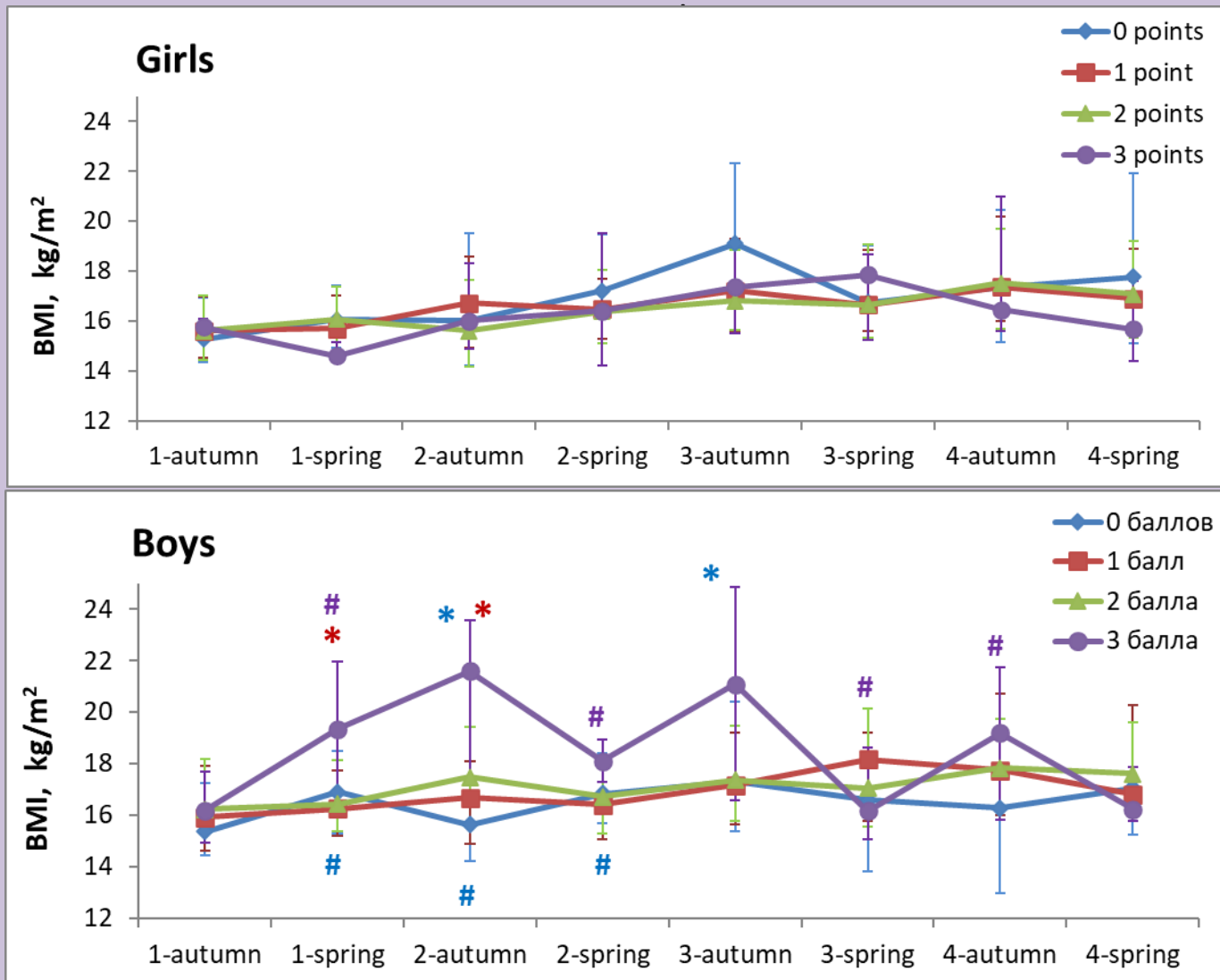
Reaction time of simple sensorimotor reactions to acoustic stimuli (RTA)



RTA/RTV

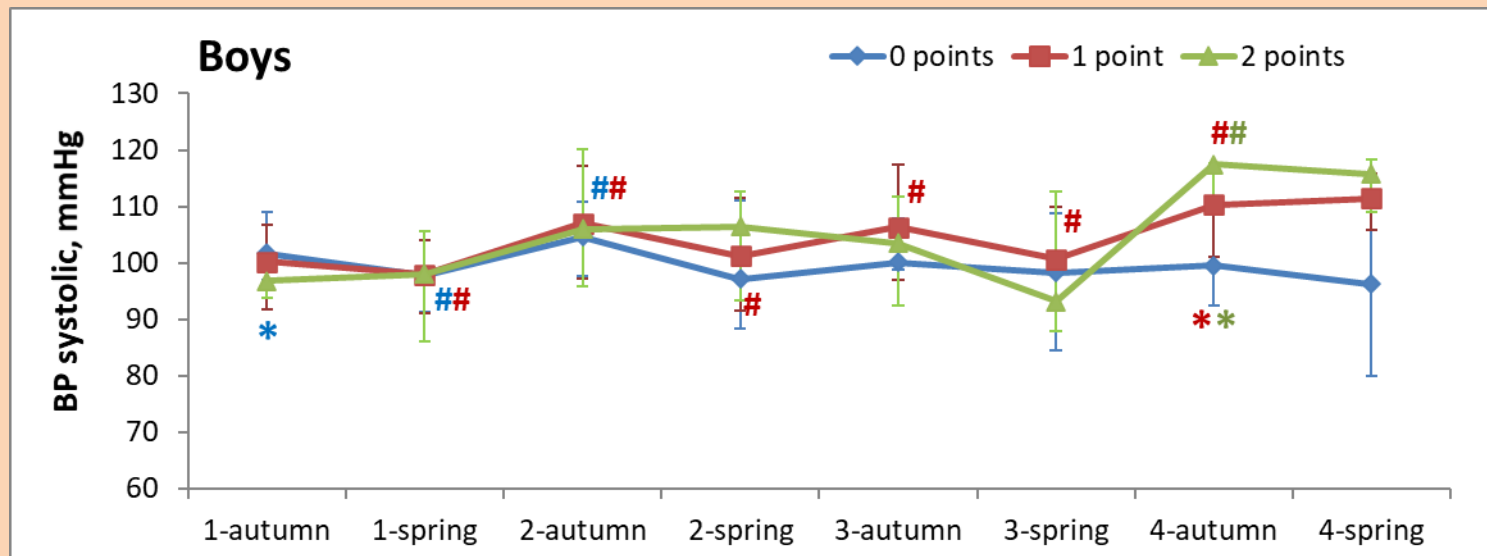
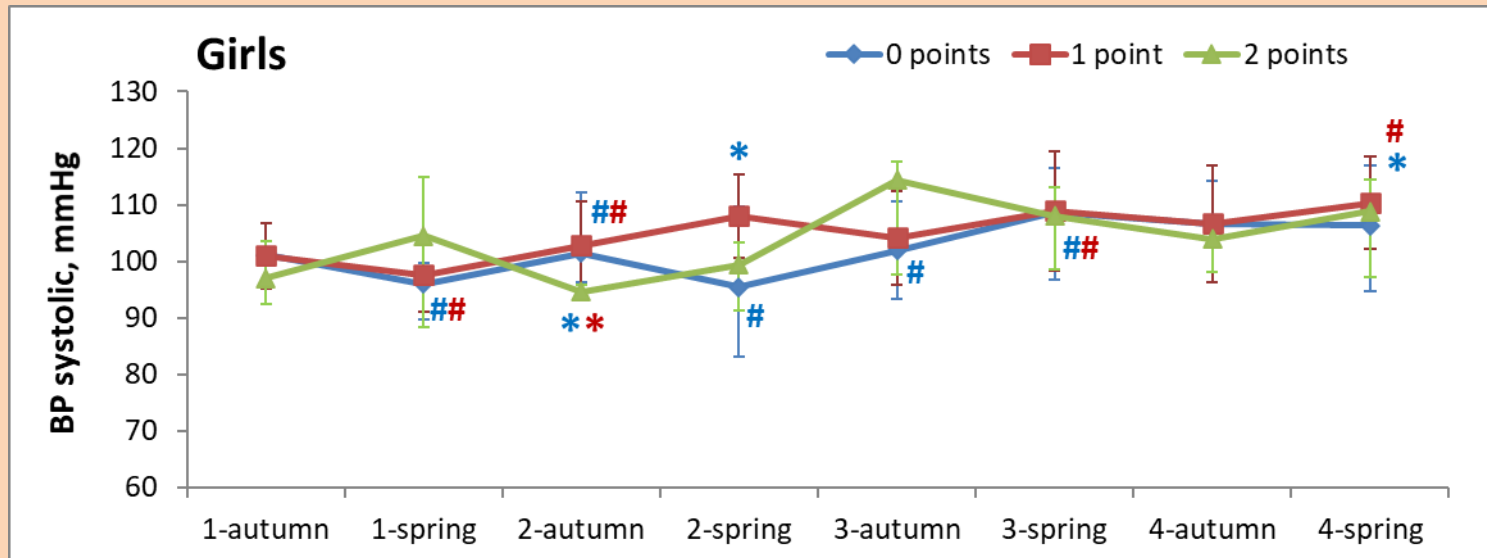


Analysis of indicators of physical development revealed a correlation only between the level of **out-of-school screen time** and BMI and only in boys: high load (3 points) was associated with BMI increase and changes in its seasonal variability from an increase during winter period to a significant increase during summer

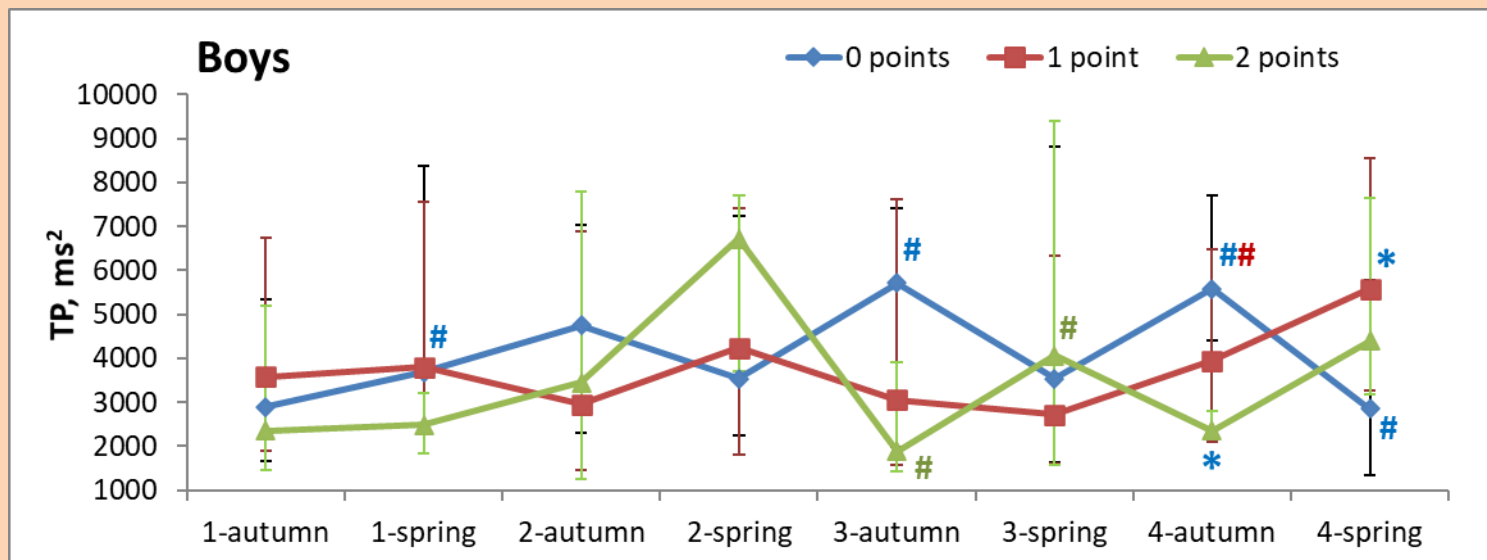
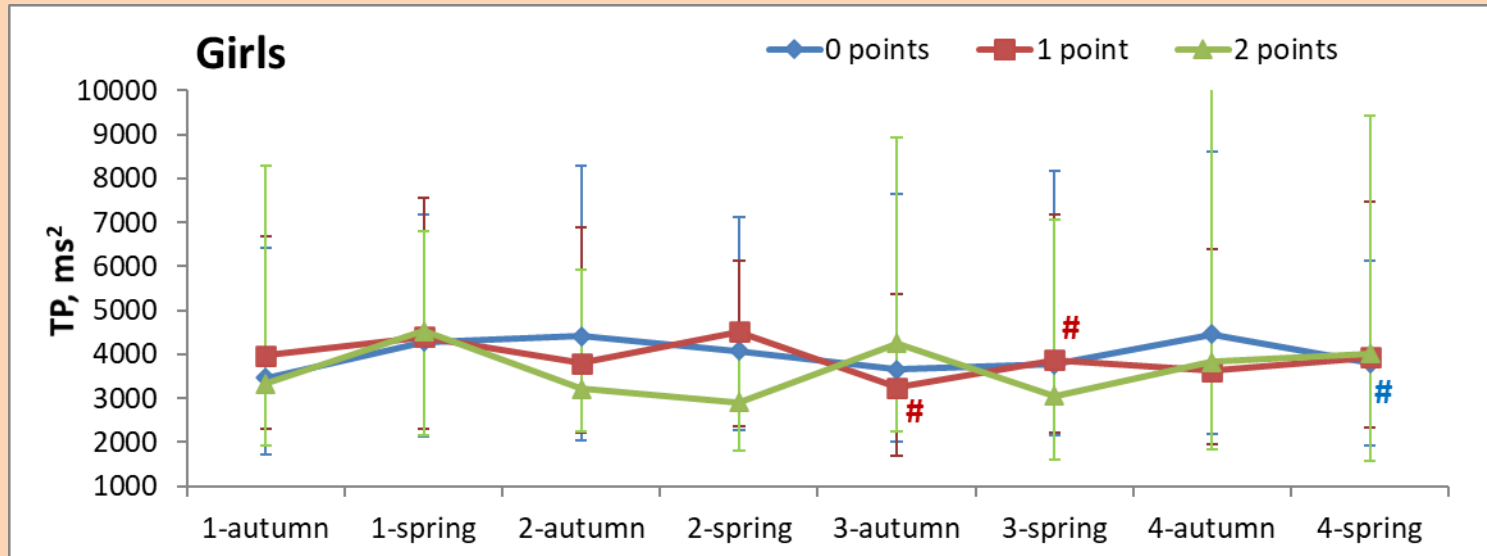


Analysis of cardiovascular system parameters showed that **school screen time** of 1 point is associated with an increase in systolic BP within the normal limits in girls by the end of the 2nd and 4th grades and in boys at the beginning and end of the 4th grade. Excessive screen time (2 and 3 points) had no additional effect on BP. However, the pattern of seasonal variability in the total power of the HRV spectrum (TP) in boys under these conditions became opposite to that observed in children who do not use computers at school: TP values became higher during spring testing.

Blood Pressure systolic, mmHg



HRV, TP, ms²



Conclusion.

These findings attest to pronounced influence of computer loads on the functional state of primary school students.

The described changes, in our opinion, reflect the development of an adaptive response in the body of children in response to a change in the educational environment.

Additional Information:

The study was financially supported by the Russian Foundation for Basic Research. Project #19-29-14104 “Instrumental assessment of the impact of digitalization of education on the physiological balance of the body”.

Linked publications:

Pankova N.B., Alchinova I.B., Kovaleva O.I., Lebedeva M.A., Khlebnikova N.N., Cherepov A.B., Noskin L.A., Karganov M.Yu. [The relationship between the dynamics of primary schoolchildren's physical development and the amount of screen time]. *Science for Education Today*. 2020; 10(3): 196-210. DOI: <http://dx.doi.org/10.15293/2658-6762.2003.11> (in Russian)

Pankova N.B., Lebedeva M.A., Noskin L.A., Khlebnikova N.N., Karganov M.Yu. [The Effect of different volumes of computer load on the latent periods of a simple sensorimotor reaction in primary schoolchildren]. *Psikhologiya. Psikhofiziologiya. [Psychology. Psychophysiology.]*. 2020; 13(2): 112-122. DOI: <https://doi.org/10.14529/jpps200210> (in Russian)

Continuation of the research:

Pankova N.B., Alchinova I.B., Kovaleva O.I., Lebedeva M.A., Khlebnikova N.N., Cherepov A.B., Noskin L.A., Karganov M.Yu. [Correlation between the accuracy and speed of hand control in primary schoolchildren and the amount of screen time]. *Science for Education Today*. 2021; 11(3): 142-160. DOI: <http://dx.doi.org/10.15293/2658-6762.2103.08> (in Russian)

Pankova N.B., Alchinova I.B., Kovaleva O.I., Lebedeva M.A., Khlebnikova N.N., Cherepov A.B., Noskin L.A., Karganov M.Yu. Effects of screen time and seasons on the cardiovascular system indicators in primary schoolchildren. *Human Physiology* (accepted for publication).