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Effects of Screen Time on Cardiac Arrhythmia in Children

Havazh-Baudi Shamhanovich Mezhidov[1], Ramin Azimovich Ibragimov[2], Dmitry Alexandrovich Dunets[3], Milana Eduardovna Shikova[3], Umaihat Imanshaphievna Zabitova[1], Fatima Ruslanovna Tsitsaeva[4], Larisa Tigranovna Gulyan[4], Artem Evgenievich Mishvelov[4,5*]

[1]*Saratov State Medical University named after V.I.Razumovsky, Saratov, RUSSIA.*
[2]*Rostov State Medical University, Rostov-on-Don, RUSSIA.*
[3]*Kabardino-Balkarian State University, Nalchik, Republic of Kabardino-Balkaria, RUSSIA.*
[4]*Stavropol State Medical University, Stavropol, RUSSIA.*
[5]*Socmedica, Skolkovo, Moscow, RUSSIA.*
**Corresponding Author (Tel: +79183500889, Email: ruslankalmykov777 @yandex.ru).*

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Abstract

A study of the influence of screen time on cardiac arrhythmia and other pathologies of the cardiovascular system in preschool and school-age children was conducted. The main reasons for the negative impact of personal computer displays and gadgets on children's health are described. The boundaries of the safe use of gadgets and personal computers are outlined.

Disciplinary: Medicine.

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1 Introduction

The result of excessive exposure to the electromagnetic field and ionizing radiation on a person is acute and chronic forms of violation of the physiological functions of the body. First of all, the cardiovascular and nervous systems suffer. The long-term influence of such a serious factor leads to a violation of the metabolism of nutrients in tissues and gene mutations in the future. To date, 45% of children aged 6 to 12 years spend more than 4 hours a day watching screens, and

teenagers aged 14 and older spend up to 15 hours a day [1]. This situation leads to the development of serious diseases in the long term, since the effect of the above-mentioned factors of high and ultra-high frequencies is cumulative. Diseases such as hypotension, bradycardia, slowing of intraventricular conduction (and other forms of rhythm disturbances), as well as changes in the rheological properties of blood due to an imbalance in the fibrinolytic and anticoagulation systems of blood plasma develop from the cardiovascular system [2-4].

This research work aims at studying the effect of screen time on cardiac arrhythmias and other pathologies of the cardiovascular system in preschool and school-age children, as well as to identify the correlation between the time spent behind the screen and the degree of negative consequences for other organs and organ systems.

2 The Influence of Physical Factors of PCs and Screen Gadgets on Health

The impact of gadgets and a personal computer on a person is very diverse and has a combined character. Modern computers are energy-saturated devices that consume up to 350 watts and contain several electrical and radio-electronic components and circuits with different physical principles of operation. As a result of this organization, computers and gadgets create around themselves several types of fields with a wide frequency spectrum and spatial distribution. For example, this is an electrostatic field, variable low-frequency electric, and variable low-frequency magnetic fields [5-8].

Some experts believe that among the potential harmful factors it is important to note the X-ray radiation of the cathode ray tube of the display (hereinafter CRT), the ultraviolet radiation of the CRT of the PC display, as well as electromagnetic radiation of the radio frequency range, which are considered the most negative with respect to the cardiovascular system. This is because the sources of alternating low-frequency electric and magnetic fields in PCs (personal computers) are nodes in which there is a high alternating voltage, and nodes operating with high currents. This means that in the spectrum of low-frequency electromagnetic fields generated by the display, there are components whose frequencies are significantly lower than the frame scan frequency. These are low-frequency electromagnetic oscillations from units of hertz to several tens of hertz, the frequencies of which are close to the frequencies of the biorhythms of the organs of the human body, therefore they are the most dangerous [9-11].

This is the fundamental difference between PC displays and gadgets in their potential environmental safety in comparison with other radiating technical means, which, by the nature of their use, can be in close contact with a person, and especially with a child [12,13]. Every day for several hours, PC users are in front of electronic display screens, which, if they do not comply with sanitary and hygienic norms and rules, can lead to the development of diseases [14,15].

Thus, more than 30 harmful and dangerous factors can have a chronic effect on a young user of a PC and screen gadgets at the same time. These factors appear due to:

1) violations of electromagnetic safety due to the lack of adequate protective grounding;

2) inconsistencies with the norms of visual parameters of displays, especially those with grain size (pixel) of 0.3 mm or more, and a frame rate of 50-75 Hz. Often the visual characteristics deteriorate compared to those declared by the manufacturer already at the workplace due to the influence of the increased magnetic field strength of the 50 Hz current. Meanwhile, even the tension, which is 100 times less than normal, and therefore safe for humans, can dramatically worsen the image quality, cause increased eye fatigue;

3) excessive energy flows of blue-violet light (in the visible wavelength range) from the display. At the same time, the clarity of the image on the retina worsens, the error rate increases, and the "computer visual syndrome" develops faster. This dramatically worsens the quality of blood, the work of the organ of vision, and the immune system, especially in winter, which contributes to the development of acute respiratory infections and ARVI, etc. [16-19].

3 Literature Review

To begin with, it must be said that the health of the child's cardiovascular system is much more susceptible to the appearance of pathologies due to physiological characteristics. The cardiovascular system of children differs significantly from the cardiovascular system of adults. The differences are clearly visible both during a routine examination and according to the results of electrocardiography. For example, if compared with the total body weight, the heart of a newborn is much larger than the heart of an adult, and at the same time rapid growth is noted, and by about three years the heart mass increases almost 3 times and by 6 years almost 11 times. Due to the peculiarities of the nervous regulation of the heart and the high intensity of metabolism, the heart rate in children is significantly higher than that of an adult, and only by about 15 years of age does the heart rate become like that of an adult [20]. The decrease in heart rate (HR) with the age of the child is directly related to the beginning of the influence of the vagus nerve on the heart.

In addition, children have noticeable sex differences in heart rate. So, boys have a lower heart rate than girls. But the main feature of the child's heart is respiratory arrhythmia, which is manifested by an increase in heart rate on inspiration and a slowdown in exhalation. In early childhood, arrhythmia is expressed slightly, and starting from preschool age and up to 15 years, respiratory arrhythmia is expressed to a significant extent. At the age of children over 15 years old, as a rule, there are already only isolated cases of respiratory arrhythmia [21,22].

The cardiac impulse in young children is strongly pronounced. This is due to the small amount of subcutaneous fat. With the age of the child, subcutaneous fat increases, as a result, the cardiac impulse becomes almost imperceptible [23,24].

The electrocardiogram of a child and an adult also has significant differences. First of all, arrhythmia, and secondly, due to the active growth and development of the heart muscle and pathways, changes in the QRS complex are possible, which are manifested by splitting of the complex. In addition, all ECG teeth are more pronounced in children than in adults. Migration of the atrial pacemaker through the atria may occur, which is due to the formation of new short-term

sources of excitation. Older children undergo remodeling of the conduction system of the heart, which causes the development of cardiac arrhythmia.

It was found that the duration of screen time directly affects the health of the cardiovascular system through the duration and quality of sleep, which is an extremely important factor for the child's body. Currently, computer screens and gadgets accompany a person's focus throughout almost the entire day, and this, in turn, leaves traces on the quality of sleep, especially if it is necessary to use them before leaving (for work or entertainment purposes).

So, sleep is a special genetically determined state of the body, characterized by a regular sequential change of certain polygraphic patterns in the form of cycles, phases, and stages. Sleep is essential for physical and mental health. The loss or disruption of sleep duration entails a violation of the function of various organs and systems. The report of the National Commission for the study of sleep disorders in residents of the United States of America, notes that almost 37% of adults have problems related to its disorders. At the same time, about 45 million Americans suffer from chronic sleep disorders, and 20-30 million have periodic insomnia, which poses a threat to various diseases [25]. In Russia, about 45% of adults are not satisfied with the quality and duration of their sleep, and almost 20% need serious treatment for sleep disorders, and among children - more than 15% have chronic sleep disorders [26-28].

The pathophysiological mechanisms of this connection have not yet been fully investigated. In the case of sleep duration disorders, a chronic stressful situation arises for the body, which is accompanied by a response in the form of increased activity of the hypothalamic-pituitary-adrenal system and the sympathetic nervous system [29]. This leads to increased cortisol secretion and activation of the therenin-angiotensin-aldosterone system, resulting in an increase in heart rate, a decrease in heart rate variability and an increase in blood pressure, the secretion of pro-inflammatory cytokines and catecholamines, and other effects that play a key role in the development of cardiovascular pathology [30].

In addition, activation of the sympathetic nervous system in people with sleep duration disorders plays an important role in the development of insulin resistance and metabolic syndrome. This can contribute to endothelial dysfunction, progression of atherosclerosis, renal dysfunction, and progression of left ventricular remodeling processes. Thus, disorders of the autonomic nervous system and the neuroendocrine system to some extent can explain the causal relationship between the presence of sleep duration disorders and the risk of developing cardiovascular diseases [31-33].

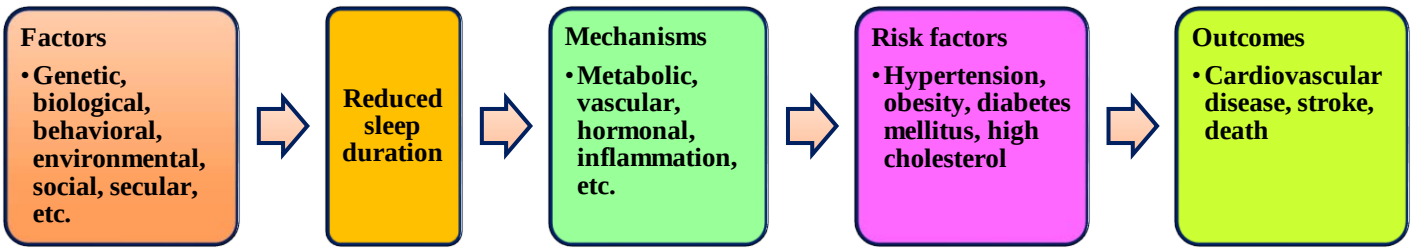

Figure 1: Mechanisms and effects of sleep duration disorders (according to Cappuccino F.P.(2011))

There is a whole range of factors that negatively affect sleep, and which lead to a violation of the functional health of the cardiovascular system.

Arterial hypertension (AH) remains one of the most significant medical and social problems. This is due to both the widespread of this disease and the fact that hypertension is the main risk factor for such cardiovascular diseases as myocardial infarction (MI) and stroke, which mainly determine mortality in Russia to this day. It is widely known that a decrease in systolic blood pressure (BP) by 10 mmHg or diastolic by 5 mmHg with antihypertensive therapy reduces the risk of MI by 22%, and stroke by 41% [34].

The relationship between the duration of sleep and the risk of arterial hypertension has been determined. The results of the SHHS (Sleep Heart Health Study) study indicate that people who sleep less than 5 hours a day are significantly more likely to be diagnosed with hypertension [35]. Similar results were obtained in another clinical study [36], showing that sleep duration of fewer than 5 hours per day increases the risk of hypertension by 60%. In addition, according to the results of the SHHS study, it was found that sleeping more than 9 hours is also not harmless and is associated with a greater risk of arterial hypertension in comparison with those who sleep 7-8 hours a day [37]. Regarding children, it is most likely that this has a cumulative effect. That is, the earlier there are violations in normal physiological sleep, the more the likelihood of health problems in the future increases. This is confirmed by the results of the Nord-Trondelag Health study (HUNT): there is a link between sleep duration and the risk of heart failure [38,39].

4 Method

A retrospective analysis was carried out, which included the medical histories of 46 children (32 boys and 14 girls) who sought medical help at two medical institutions in the city of Stavropol (Russia). In all children, the features of the anamnesis, the results of the examination, and the data of instrumental examinations were analyzed. A special focus was directed on the cardiological history.

The selection of case histories was carried out by the continuous sampling method. Statistical data analysis was performed using the Microsoft Excel application and the BioStat LE 7.6.1 package. Research methods were used in the work: statistical, descriptive, comparative, and analytical.

5 Result and Discussion

The study included the medical histories of 46 children. Of these, 32 boys (69.57%) and 14 girls (30.43%) aged 13 to 17 years (average age of 14.9 years) who sought medical help at the "City Children's Polyclinic No. 3" and the Family Medical Center "Doctor Knows" in Stavropol.

The classification of children by age was adopted by the World Health Organization in 2018 as the basis for the distribution of children by age. According to our study, children of secondary school age from 11-14 years 16 people (34.78%), children of senior school age (15-18 years) – 30 people (65.22%) were included.

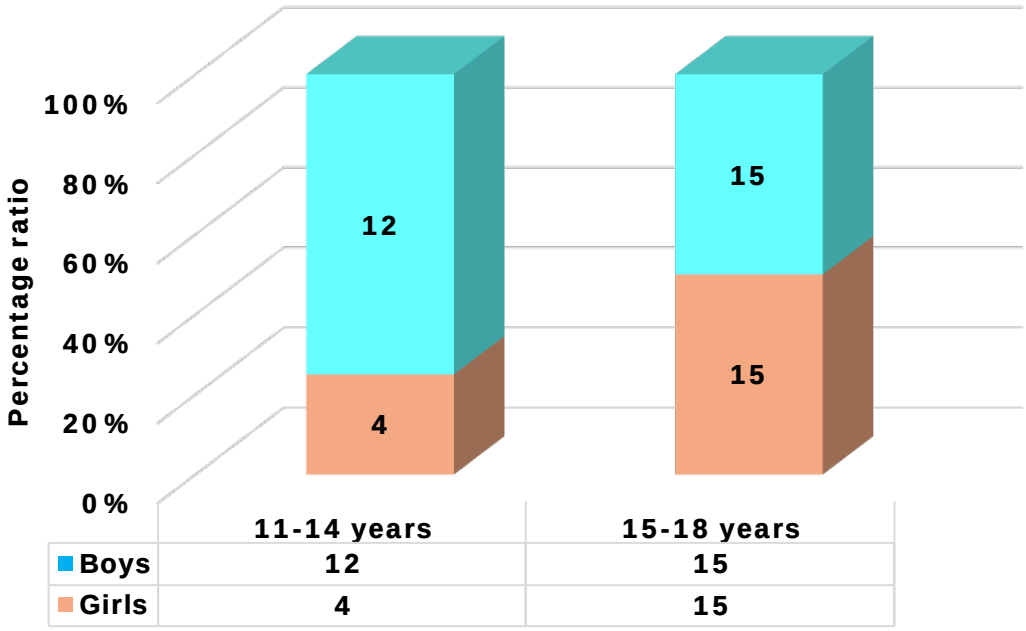

Figure 2: Distribution of children by age

According to the analysis, all 46 children had certain pathologies of the cardiovascular system, and arrhythmias of various genesis were observed in all. Rhythm and conduction disorders were diagnosed in 26 people (56.2%), ventricular and atrial septal defects in 14 people (30.4%), and mitral valve prolapse in 6 people (13.04%). At the same time, posture disorders or osteochondrosis were detected in 34 patients (73.9%). In 14 children, a burdened cardiological history was revealed (30.4%). Persistent increase in blood pressure – in one patient of 14 years. ARVI prevailed among the concomitant diseases, two had Covid, and according to the cardiological spectrum prevailed: atrioventricular block (AV block) of various degrees, wandering pacemaker, and dysfunction of various nodes.

The data analysis demonstrated that all patients violated the daily norm of screen time and on average spent from 5 to 7 hours behind the screen, with the largest number of complaints observed from patients who spent more time behind the screen than others (complaints of frequent headaches, sleep problems, weather dependence, migraines, increased blood pressure, hyperactivity). Figure 2 shows the distribution of screen time for children of different age groups. After the correction of screen time and pharmacotherapy, the number of complaints in each available age group (as well as the nature of complaints) decreased (Table 1).

Table 1: Clinical picture and complaints "before" and "after" treatment and correction of screen time in both age groups

Age, years	Prevailing complaints before treatment	Condition after treatment
11-14	hyperactivity, sleep problems, increased emotionality, heart rhythm disturbances, nutrition problems, weather dependence	sleep improved, children became calmer, episodes of arrhythmias decreased quantitatively
15-18	headaches, eye pain, weather dependence, arrhythmias, arterial hypertension	headaches, migraines, pain in the eyes almost did not appear during therapy, episodes of arrhythmias decreased quantitatively

Patients were observed on average for two weeks to 1.5 months. Everyone was strongly recommended to limit psychoemotional loads, minimize the use of multimedia devices and exclude them 2 hours before bedtime; as well as observe the daily routine and walking in the fresh air. A diet included milk enriched with bioavailable forms of potassium, magnesium, and zinc and vitamin therapy (vitamins B and D) [40-42]. Many patients took drugs from the following groups: nootropics (Semax, Cortexin, Omarone, Nooklerin), sedatives (Adaptor), metabolites (Elcar, Mildronate), cardiotonic agents (Kudesan), calcium-phosphorus metabolism regulators (Aquadetrim), as well as Mexidol, Nooklerin, Bellataminal, Selank, AEVIT, Doppelhertz Omega, Cytoflavin, zinc preparations stabilized in milk.

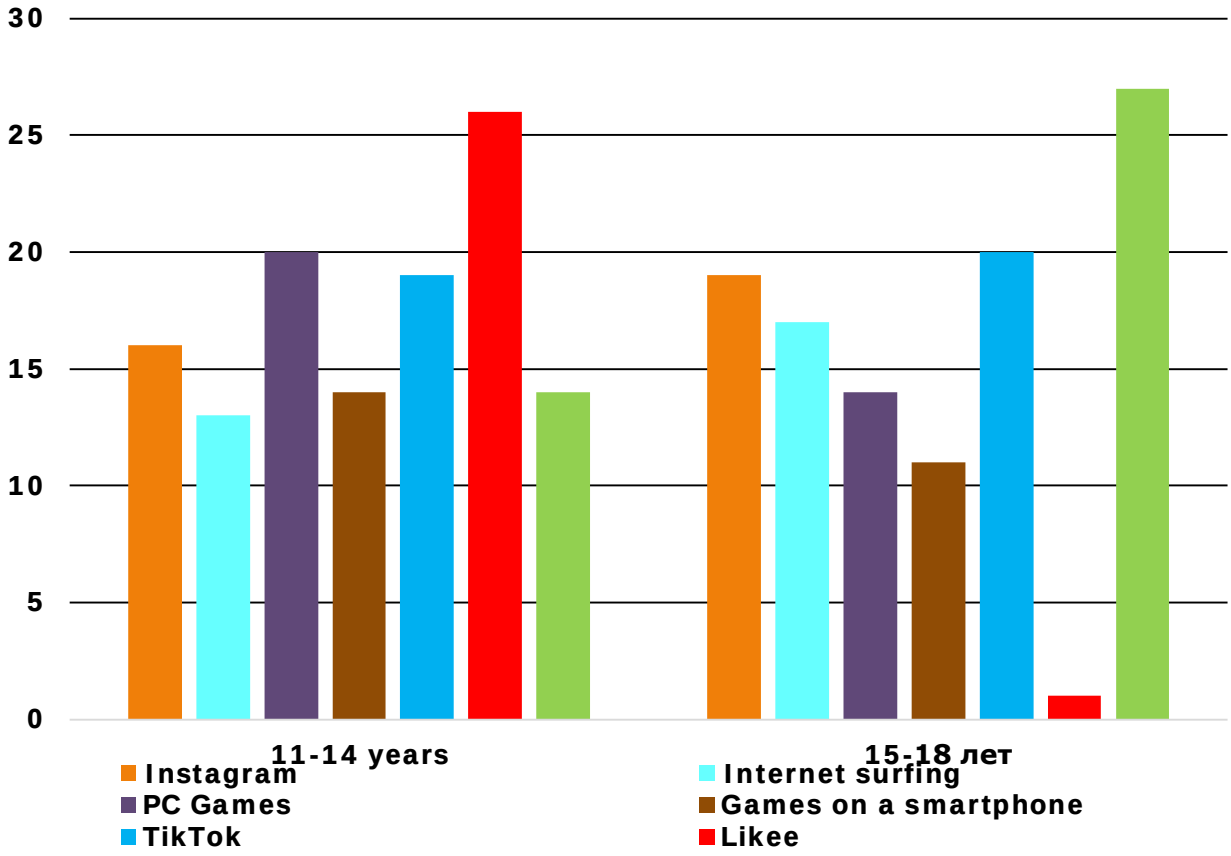

Figure 2: Correlation of screening time with age category

After the appointment of therapy and recommendations regarding the daily routine and correction of screen time at repeated appointments, the following results of the study were revealed (heart rate indicators during daytime and nighttime, blood pressure, episodes of extrasystole, the number of blockades and episodes of arrhythmia per day, the nature and number of complaints were taken as a basis):

1. Changes in heart rate. There is a stabilization of the heart rate by an average of 44.5% during the day and 62.5% at night, while in the older age group there are significant changes, on average by 7.5%. (Tables 2 and 3).

2. Change of rhythm. According to the study, before treatment, 16 children (27%) had sinus arrhythmia, 20 (17%) had wandering pacemakers, 14 (23%) had a lower atrial rhythm, and the rest 20 (33%) had a normal sinus rhythm (60%). After the course of screen time correction and treatment, all children had a normal sinus rhythm (Figure 3).

Table 2: Change in heart rate "before" and "after" treatment and correction of screen time in a group of children from 11 to 14 years.

Change in resting heart rate (group of children aged 11 to 14 years)				
	Boys (average heart rate 72-78)		Girls (average heart rate is 70-80)	
	Before treatment and reduction of screen time	After treatment and reduction of screen time	Before treatment and reduction of screen time	After treatment and reduction of screen time
Day	an average of 64 beats per minute	an average of 71 beats per minute	an average of 67 beats per minute	an average of 72 beats per minute
Night	an average of 49 beats per minute	an average of 56 beats per minute	an average of 51 beats per minute	an average of 57 beats per minute

Table 3: Change in heart rate "before" and "after" treatment and correction of screen time in a group of children from 15 to 18 years

Change in resting heart rate (group of children aged 15 to 18 years)				
	Boys (average heart rate 68-70)		Girls (average heart rate is 64-72)	
	Before treatment and reduction of screen time	After treatment and reduction of screen time	Before treatment and reduction of screen time	After treatment and reduction of screen time
Day	an average of 86 beats per minute	an average of 69 beats per minute	an average of 79 beats per minute	an average of 68beats per minute
Night	an average of 55 beats per minute	an average of 64 beats per minute	an average of 49 beats per minute	an average of 62 beats per minute

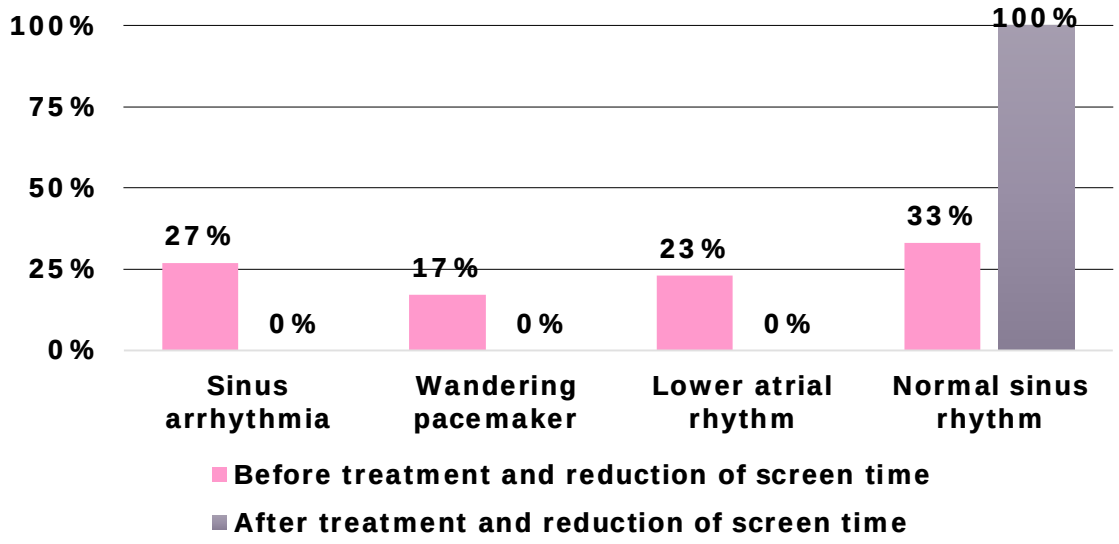

Figure 3: The change of the pacemaker against the background of the correction of the screen time of compliance with the regime of the day.

6 Conclusion

Excessive screen time affects the child's psyche and also aggravates the clinical picture in children with cardiovascular pathologies.

Minimizing screen time as part of the therapy of arrhythmias and other heart pathologies, its effect on hyperactivity and the quality of night sleep is effective, since changes in heart rhythm, heart rate, reduction of pauses (post ectopic pauses decreased by an average of 48%, and post-

extrasystolic by 45%), extrasystoles, reduction of hyperactivity in behavior were observed when used, improving the quality of sleep, which contributes to the speedy recovery of the child.

Those children who have cardiovascular pathologies and who prefer aggressive PC games are more likely to develop a "computer neck", curvature of the spine, and, as a result, problems with blood vessels and the heart.

7 Availability of Data and Material

Data can be made available by contacting the corresponding author.

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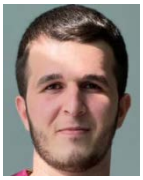
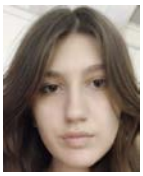


Havazh-Baudi Shamhanovich Mezhidov is a student at Saratov State Medical University named after V.I.Razumovsky, Saratov, Russia.

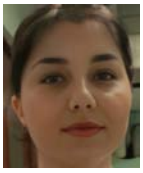
Ramin Azimovich Ibragimov is a student of Rostov State Medical University, Rostov-on-Don, Russia.

Dmitry Alexandrovich Dunets is a student at Kabardino-Balkarian State University, Nalchik, Republic of Kabardino-Balkaria, Russia

Milana Eduardovna Shikova is a student of Kabardino-Balkarian State University, Nalchik, Republic of Kabardino-Balkaria, Russia



Umaihat Imanshaphievna Zabitova, student of Saratov State Medical University named after V.I.Razumovsky, Saratov, Russia



Fatima Ruslanovna Tsitsaeva, student of Stavropol State Medical University, Stavropol, Russia.

Larisa Tigranovna Gulyan is a student of Stavropol State Medical University, Stavropol, Russia.

Dr.Artem Evgenievich Mishvelov is a Junior Researcher at the 3D Technology Laboratory of Stavropol State Medical University, Stavropol, Russia. He is Head of Project Activities in the North Caucasus Federal District, Socmedica, Skolkovo, Moscow, Russia.