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Prevalence and Evaluation of the Use of Electronic Devices in Teaching and Leisure Activities of Pupils 7-8 Classes

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ABSTRACT

Introduction: These innovations increase the duration and intensity of student's use of electronic devices with LCD screens: computers, laptops, mobile phones (smartphones), electronic tablets. In one of the schools in Moscow began, the systematic use of electronic tablets in the educational process has begun with the simultaneous use of interactive boards.

Methods: In order to assess the well-being of students in grades 13-15 years, a unified questionnaire survey conducted at the beginning of the school year with the introduction of electronic tablets in the educational process, and it was repeated after 2 months (October-November, 2018 and January, 2019). 224 children were interviewed. Statistical processing was performed using the statistical analysis package Statistica 6.0 (Stat Soft, USA) in 2019. The relationships between the indicators were described by the Pearson conjugacy coefficient (based on Chi-square statistics). Differences were considered statistically significant at $p<0.05$.

Results: The second survey found an increase in the frequency of complaints indicating the development of neurotic reactions in schoolchildren, the accumulation of fatigue in 52-54% of schoolchildren throughout the school day with insufficient night rest of children. Girls are found to have statistically more complaints than boys, especially about visual impairment, headaches, fatigue, sleep disorders, neck, back and legs muscle pain.

Conclusion: Gender differences were found in the prevalence of asthenopic complaints. A progressive increase in the number of children with visual impairment is observed in grades 5-7, which requires the use of a complex of preventive measures.

Relevance

In 2017, the Moscow Electronic School project was launched, and in 2018 the Government of the Russian Federation decided to launch a new priority project "Digital school". Digital devices of the latest generation (interactive boards and panels, computers, tablets, etc.) are widely introduced into the educational process. At the same time, research is being conducted around the world aimed at studying the impact of the modern digital environment on the mental and physical development of children, adolescents and young people, and the data obtained are largely contradictory [1-9]. Studies performed at the Institute of Hygiene and Protection for children and adolescents of the FGAU "National Medical Research Center of Children's Health" of the Ministry of Health of Russia, other research institutes and medical schools, indicate a deterioration in the health of the younger generation. According to in-depth

surveys of students conducted during selective scientific research, the leading place in the structure of functional disorders, the first ranking places are occupied by disorders of the cardiovascular system (mainly vegetative-vascular disorders); musculoskeletal system (posture disorders, flattening of the feet, chest deformities); visual disorders (myopia of a weak degree); disorders of the nervous system and the mental sphere (asthenic and neurotic reactions); disorders of the digestive system (functional disorders of the stomach and intestines, biliary dyskinesia); deviations in physical development (excess and deficit of body weight) [10-15].

All of the above health disorders can be attributed to school-related, because in the process of school ontogenesis their prevalence increases, and the course acquires unfavorable trends, especially in the eighth – eleventh grades [14,16]. It is assumed that long-term and daily use of information and communication technologies causes fatigue of the Central nervous system, the visual analyzer and the musculoskeletal system, contributes to the development of psychosomatic disorders and generally worsens the well-being of students and leads to the appearance of many complaints [1-8,10,15,17]. It is necessary to conduct a serious physiological-hygienic and psychological-pedagogical study of the impact of information and communication technologies on the visual analyzer, physical and mental health of students, as well as to determine the medical consequences of the use of these technologies. This type of research should be systematic and begin with the study of the most characteristic and common complaints made by schoolchildren [18].

Materials and Methods

Students of grades 7-8 (13-15 years old) were selected to determine the number of children examined, because according to a number of researchers [6,12-14] it is during this period of school ontogenesis that a sharp increase in the prevalence of school-related functional abnormalities and chronic diseases begins. The survey was conducted in two stages. The first stage: 224 students were interviewed, including 105 boys and 119 girls. The second stage: 196 students were interviewed, including 92 boys and 104 girls. These data were initially collected in October-November 2018, and in January 2019, data were obtained for stage 2. Statistical processing was performed using the statistical analysis package Statistica 6.0 (StatSoft, USA) in 2019. The validity of differences between groups was determined by the student's criteria. Differences were considered statistically significant at $p<0.05$. To describe the statistical relationship of qualitative indicators with a small number of discrete variants, we used the construction of conjugacy tables.

The relationships between the indicators were described by the Pearson conjugacy coefficient (based on Chi-square statistics), which is in the range from 0 to 1. An increase in the coefficient indicates an increase in the degree of connection. For the same purposes, the Kramer coefficient was used according to the method Of V. E. Deryabin [19]. The sensitive indicators that reflect the state of the visual analyzer, changes in the activity of the Central and vegetative parts of the nervous system, the psycho-emotional state of students, the presence or absence of manifestations of psychosomatic disorders are complaints of children and adolescents. In addition, it was taken into account that long-term use of devices leads to overstrain of certain groups of skeletal muscles and the appearance of complaints of pain in the neck, back, lower back, and joints. It was advisable to use a questionnaire to identify children's complaints. The survey of schoolchildren using a standardized questionnaire has a high sensitivity exceeding 80%, which is proved by scientific research [17,18,20-24]. It should be noted that the questionnaire used is anonymous, it only indicates the gender and age of the child.

Research Organization

The survey of students in grades 7 and 8 was conducted in one of the Moscow secondary schools implementing the project "Analytical support for interactive educational technologies". Two lessons a week in these classes used Samsung electronics tablets with the Android operating system, with a 10-inch diagonal, a screen size of 25x1600, and a weight of 547 g. All students had personal tablets. The classrooms where classes were held for students in grades 7-8 were equipped with an interactive SMART Board, a direct projection with a diagonal of 77 inches, the size of the interactive surface of 1565x1172 mm. before conducting the research, signed voluntary informed consent was received from the parents of students.

The First Stage

A survey at the beginning of the school year-at the time of the beginning of the use of electronic tablets in educational activities in the school. The second stage: the survey of the same students using the same questionnaire was conducted after 2 months, when the students adapted to the use of new technologies. All information obtained during the survey was entered in the database.

Results

Most often, children use mobile phones (mainly smartphones) as a means of communication, communication in social networks, searching for information on the Internet, electronic games, etc. 97.5% of respondents use them Daily. 51.6% of students use tablets daily, 38.0% use computers, and 31.0% use laptops. For example, 48.7% of school children use smartphones for more than 4 hours on school days, 55.4% on weekends, and 47.9% on holidays; computers and laptops (together) are used by 27.1%, 35.0%, and 50.3%, respectively. The use of electronic tablets in the educational process at school increased the time of using the above devices by 2 hours per week. Table 1 provides information on the prevalence of complaints about Central nervous system disorders detected in school children during the first and second surveys. Data from Table 1 indicate a high prevalence of neurotic and asthenic reactions

among students in grades 7-8. One of the most common complaints is a complaint about headaches that occur more often than once a week. However, girls were twice as likely to report unexplained headaches in the first survey as boys (27.7% *vs.* 14.3%; p<0.01), in the second survey, the difference became even more significant (26.9% *vs.* 9.8% p<0.001).

Table 1: Prevalence of complaints of central nervous system violations.

Complaints	Prevalence of complaints identified in the first student questionnaire (September)%			Prevalence of complaints identified in the second questionnaire (November) %		
	Boys N=105	Girls N=119	Both genders N=224	Boys N=92	Girls N=104	Both genders N=196
Headaches (more often 1 times a week)						
causeless	14.3	27.7#	21.4	9.8	26.9#	19.1
at nervousness	11.4	21.9#	16.9	18.5	20.2	19.4
After or at physical load	7.6	15.1	11.6	7.6	17.3#	12.8
after visiting school	12.4	36.9#	25.4	23.9#	28.9	26.5
In the morning	5.7	14.3#	10.3	10.8#	10.6	10.7
In the evening before going to bed	3.8	10.9	7.6	11.9#	22.1#**	17.3***
Weakness, fatigue after school	41.9	60.5#	51.8	41.3	64.4#	53.6
Tearing (more often 1 times a week)	6.7	16.8#	12.1	13.0	16.4	14.8
frequent mood swings	20.0	38.7#	29.9	28.3	52.8#**	41.3***
Fear of school attendance (monitoring, interviewing, etc.	13.3	41.2#	28.1	25.0	35.6#	30.6
Sleep disorders including: long falling asleep	17.1	37.8#	28.1	31.5*	42.3#	37.6***
light sleep	8.6	13.1	8.9	13.4	10.6	11.7
difficult awakening	39.1	49.6#	44.6	47.8	62.5#**	55.6***
long disinhibition	10.5	15.1	12.9	11.9	17.3	14.7
persuasive movements	20.9	30.3#	25.9	25.0	44.2#**	35.2**
in total	233.3	429.9	355.5	319.7	472.1	400.9

Notes: *Statistically significant difference between the frequency of complaints in boys in the second survey compared to the first survey ($p < 0.05$);

**Statistically significant difference between the frequency of complaints in girls in the second survey compared to the first survey ($p < 0.05$);

*** Statistically significant difference between the frequency of complaints in all students (both sexes together) in the second survey compared to the first survey ($p < 0.05$);

#Statistically significant difference between the frequency of complaints of boys and the frequency of complaints of girls ($p < 0.05$, $p < 0.01$, $p < 0.001$).

Every fifth or sixth student noted the connection of headaches with anxiety. Girls complained of headaches during agitation more often than boys (21.9% *vs.* 11.4% (p<0.05) in the first survey; in the second survey, the gender differences for this complaint were smoothed out. 12-13% of students report headaches after and during physical activity. The prevalence of this complaint in the group of girls was higher compared to the group of boys, which is reliably confirmed by the data of the second survey: 17.3% *vs.* 7.6%, respectively (p<0.05). One in four respondents indicated that headaches occur after attending school. In addition, this complaint is much more common in the group of girls compared to boys, which was especially noticeable in the first survey (36.9% *vs.* 12.4%; p<0.001). In the second survey, the gender difference in indicators decreased markedly. Attention is drawn to the frequency of complaints of headaches in the morning, which affect about 10% of students. This complaint was almost 3 times more common in girls compared to boys in the first survey (14.5% *vs.* 5.7%; (p<0.05).

Analysis of the prevalence of complaints of headaches in the evening and before going to bed showed an increase in the second survey: among children of both sexes, from 7.6% to 17.3% (p<0.05); in the group of boys, from 3.8% to11, 9% (p<0.05), in the group of girls, from 10.9% to 22.1% (p<0.05). There was a significant increase in the frequency of complaints in girls compared to boys according to the second survey: 22.1% *vs.* 11.9% (p<0.01). The data obtained indicate fatigue and, in some cases, overwork of students, especially girls, in the afternoon. More than half of students 51.5-

53.6% experience weakness and fatigue after school, and according to the first survey, girls are more likely than boys (60.5% *vs*. 41.9% (p<0.001). Asthenic reactions, manifested as tearfulness more often than once a week, were noted by 2 times more girls than boys: 16.8% against 6.7% in the first survey (the difference is statistically significant (p<0.05). In the second survey, the gender differences in the frequency of this complaint were smoothed out (13.0% - boys and 16.4% - girls).

Similar trends were found when analyzing the prevalence of complaints about frequent mood swings. There was a significant increase in the prevalence of this complaint in the group of girls from 38.7% to 52.8% (p<0.05) and in the whole surveyed student population from 29.9% to 41.3% (p<0.01). The data obtained indicate the accumulated fatigue of students over 2 months of study and the unfavorable psych emotional state of students in the middle of the first half of the school year. 28.1-30.6% of respondents indicated their fear of school attendance, including the fear of tests, whiteboard surveys, and other types of knowledge testing. In the second survey, the differences in the frequency of this complaint were significantly higher in the boys ' group: 25.0% *vs*. 13.3% (p<0.01). The prevalence of this complaint increased significantly from 28.1% to 37.6% during the study period (p<0.05). A statistically significant increase in the index also occurred in the boys ' group: from 17.1% to 31.5% (p<0.01).

39.1% of boys and 49.6% of girls reported difficulty waking up in the morning during the first survey (the difference is significant (p<0.05). In the second survey, the indicators increased significantly, especially in the group of girls: from 49.6% to 62.5% (p<0.05). In General, the frequency of this complaint increased significantly from 44.6% to 55.6% (p<0.05) for the entire cohort of observed students, which indicates the accumulation of fatigue throughout the day in students and insufficient night rest. Thus, the data from Table 1 shows an increase in the number of complaints among school children during the first 2 months of study, the accumulation of fatigue throughout the day in the observed school children and their insufficient night rest [1,13,17]. In addition, girls are much more likely than boys to present all the main complaints that indicate neurotic and asthenic reactions that develop in the course of educational activities. It should be noted that according to the second survey, the gender differences in the prevalence of most of the complaints considered became less pronounced, since the frequency of complaints in the boys 'group increased more than in the girls' group.

Table 2 presents data on the prevalence of complaints among students indicating violations of the functioning of the autonomic nervous system. Complaints that indicate violations of the autonomic nervous system include complaints of increased sweating and the appearance of red spots on the skin during agitation, dizziness, fainting and semi-fainting States, cardialgia, heart palpitations [12,20,25]. From 10-14% of respondents indicated dizziness and instability when changing their body position. The frequency of these complaints is significantly higher in the girls 'group compared to the boys' group, which is confirmed by both surveys. In the first survey, the ratios were: 17.7% *vs*. 1.9% (p<0.001); in the second, 20.2% *vs*. 6.5% (p<0.01). Pain and discomfort in the heart region are noted by 9.5% of boys and 17.7% of girls, the sex difference is significant (p<0.05). The second survey showed that the number of boys reporting these complaints decreased to 6.5%, while the number of girls increased to 18.3%, and the reliability of the differences became more pronounced (p<0.01).

Table 2: Prevalence of complaints of vegetative nervous system.

Complaints	Prevalence of complaints detected while first questioning of students (September), %			Prevalence of complaints detected while second questioning of students (November), %		
	boys n=105	girls n=119	both genders n=224	boys n=92	girls n=104	both genders n=196
Excessive sweating or red spots on skin while feeling excited	4,8	7,6	6,3	6,5	9,7	8,2
Dizziness, imbalance while changing a body position	1,9	17,7#	10,3	6,5	20,2#	13,8
Fainting, semi-conscious	0,9	5,9	3,6	0,0	2,9	1,5
Pain, bad feelings in the heart area	9,5	17,7#	13,8	6,5	18,3#	12,8
Periodic heartbeat, "disruption in heart activity"	1,9	7,6	4,9	4,3	9,6	7,1
Total	19,0	56,5#	38,9	23,8	60,7	43,4

Note: # - statically credible distinction in frequency of complaints between boys and girls (p<0,05, p<0,01, p<0,001).

Thus, according to surveys, the phenomenon of autonomic dysfunction is more common among girls compared to boys. However, there is no data on the increase in the number of complaints about violations of the autonomic nervous system during the two-month use of electronic tablets in the educational process at school. Based on the data from the scientific literature, it was possible to assume a high prevalence and an increase in the frequency of complaints characteristic of computer-visual syndrome (asthenopia) [1,2,15,26]. Table 3 shows complaints that may indicate developing asthenopia. In the first survey, it was

found that 19.1% of boys and 46.2% of girls complain of visual impairment; the gender difference is highly reliable (p<0.001). Complaints of visual impairment are significantly more common in girls, both in the first survey (46.2% for girls *vs*. 19.1% for boys; p<0.001) and in the second (32.7% for girls *vs*. 22.8% for boys; p<0.05). Twice as many girls as boys complained of feeling "tired eyes": in the first survey, 48.7% *vs*. 21.9% (p<0.001); in the second survey, 46.2% *vs*. 27.2% (p<0.01).

Table 3: Prevalence of complaints of eyesight.

Complaints	Prevalence of complaints, detected while the first survey of students (September), %			Prevalence of complaints detected while the second survey of students (November), %		
	boys n=105	girls n=119	both genders n=224	boys n=92	girls n=104	both genders n=196
Blurred vision	19,1	46,2#	33,5	22,8	32,7#	28,1
Having deteriorating eyesight do you experience any of the following:						
-feeling eye fatigue	21,9	48,7#	36,2	27,2	46,2#	37,2
- pain in the area of eyes (eyeballs)	10,5	14,3	12,5	8,7	22,1#	15,8
-lack of focus	13,3	39,5#	27,2	15,2	26,9#	21,4
-seeing spots	8,6	15,9#	12,5	9,8	14,4	12,2
-gritty eyes	4,8	10,0	7,6	6,5	13,5	10,2
Total	78,2	174,6#	129,5	90,2	155,8#	124,9

Note: # - statically credible distinction in frequency of complaints between boys and girls (p<0,05, p<0,01, p<0,001).

Pain in the eye area (eyeballs) was experienced more often by girls: in the first survey, the difference was not reliable 14.3% *vs*. 10.5%, and in the second survey, the difference was statistically significant (22.1% *vs*. 8.7% (p<0.01). Girls were three times more likely to complain about blurring images in the first survey compared to boys (39.5% *vs*. 13.3% (p<0.001); in the second survey, the difference decreased, but remained reliable (26.9% *vs*. 15.2% (p<0.05). Complaints about the feeling of flashing before the eyes were less often made by boys. In the first survey, the gender difference was significant (8.6% *vs*. 15, 9% (p<0.05); in the second, the difference was at the trend level of 14.4% *vs*. 9.8% (t=1.92). The complaint of "feeling " sand" in the eyes" is more common among girls, but the difference with boys is only at the trend level (t=1.92 at the first examination and t=1.97 at the second examination). Analysis of the conjugacy of complaints made by children using the Deryabin V. E. method [19] did not reveal their conjugation, which indicates that complaints are scattered and there is no convincing evidence of the emerging computer - visual syndrome.

Table 4: Prevalence of complaints, pointing to abnormalities of musculoskeletal system of students.

Complaints	Prevalence of complaints, detected while the first survey of students (September), %			Prevalence of complaints detected while the second survey of students (November), %		
	boys n=105	girls n=119	both genders n=224	boys n=92	girls n=104	both genders n=196
Pain and/or feeling of heaviness, including:						
-in neck and back muscles	11,4	31,9#	22,3	16,3	28,9#	22,9
-muscles of legs	21,9	31,9#	26,8	17,4	27,9#	22,9
Back pain while walking long distances and sitting, body leaning	9,5	19,3#	14,7	15,2	19,2	17,3
Pain in joints, including:						
hip joint	0,9	0,0	0,5	2,2	0,9	1,5
knee joint	13,3	15,9	14,7	10,9	14,4	12,8
other joints	7,6	5,9	6,7	7,6	6,7	7,1
Total	64,6	104,1#	85,7	69,6	98,0#	84,5

Note: # - statically credible distinction in frequency of complaints between boys and girls (p<0,05, p<0,01, p<0,001).

Thus, it was found that complaints about visual disturbances and unpleasant sensations in the eye area are much more common for girls, but there was no increase in the number of these complaints in the process of working with electronic tablets. Table 4 presents complaints that reflect disorders of the musculoskeletal system that may be associated with prolonged tension of the skeletal

muscles when forced to sit [8,23,27,28]. When analyzing the survey data, it was found that girls are significantly more likely to complain of pain in the back and neck muscles than boys: according to the first survey: 31.9% *vs*. 11.4% ($p<0.001$), according to the second survey: 28.9% *vs*. 16.3% ($p<0.01$). In General, the prevalence of these complaints is 22-23%. Complaints of pain in the leg muscles are noted by 23-27% of students in grades 7-8. There were significant gender differences in the prevalence of this complaint, which was more common in girls, both in the first survey (31.1% *vs*. 21.9%, ($p<0.05$), and in the second survey (27.9% *vs*. 17.4% ($p<0.05$). Thus, it was found that girls are significantly more likely to suffer from pain in the muscles of the back, neck and legs than boys. However, during the two-month interval between surveys, the prevalence of these complaints among students, both girls and boys, did not increase.

Conclusions

1) The study revealed an increase in the number of complaints indicating the development of fatigue and neurotic reactions in students in grades 7-8 during the first two months of the school year. Data from a survey of school children indicate that 52-54% of the observed students experience fatigue during the entire school day and lack of night rest for children.

2) Statistical analysis of complaints made by children did not establish their correlation, which indicates that the complaints are scattered and there is no convincing evidence of the emerging computer - visual syndrome.

3) According to the survey data, there were significant gender differences in the prevalence of the following complaints:

a) Girls are more likely than boys to complain of visual impairment, a feeling of "eye fatigue", pain in the eye area (eyeballs), blurring of the image, flashing before the eyes, a feeling of " sand in the eyes»;

b) Girls are more likely to indicate that they have complaints indicating the presence of neurotic and asthenic disorders of the personological level (neurotic and asthenic reactions);

c) Girls are more likely to complain of pain in the muscles of the back, neck and legs.

4) There is a progressive increase in the number of children with visual impairments. The most significant growth rate is observed in grades 5-7.

1. The results of the study made it possible to justify a set of preventive measures that should be implemented in schools to prevent overwork of students and the adverse effects of electronic devices. Activities include:

a) Hygienic rational scheduling of lessons using information and communication technologies,

b) Hygienically correct organization of the lesson itself, where information and communication technologies are used;

c) Conducting physical training minutes in the classroom with performing gymnastic exercises to relieve tension in the back, neck and legs muscles, as well as performing eye exercises, including using ophthalmic trainers, to relieve tension in the oculomotor and ciliary muscles;

d) Conducting hygienic training and education of schoolchildren for the rational organization of their educational and leisure activities using electronic devices;

e) Hygienic education of parents on the organization of the daily routine and extracurricular activities of children, to reduce the fatigue of training sessions and to include physical education and sports in the leisure activities of students.

2. The purpose of the study was to study the impact of information and communication technologies used in the process of education at school on the well-being of students.

Contribution

The obtained scientific data will allow us to develop scientifically based recommendations for reducing the adverse impact of electronic devices on the health of schoolchildren.

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All authors confirm no conflict of interest to declare.

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