HEALTH RISK ANALYSIS: SOCIAL, ECONOMIC FACTORS

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ASSESSING HEALTH RISKS FOR SCHOOLCHILDREN AND STUDENTS CAUSED BY EXPOSURE TO EDUCATIONAL AND ENTERTAINING INFORMATION TECHNOLOGIES

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Information and communication technologies play a significant role in life of children, teenagers and young people as they are massively spread among these age groups. It is a new risk factor that can cause health disorders among oncoming generation. Our research objects were 465 senior schoolchildren living in Moscow and Moscow region and 598 students from Moscow and Arkhangelsk. Our research goal was to study influences exerted by information and communication technologies on health of senior schoolchildren and students; to do that, we applied risk assessment procedures, including hygienic, sociological, instrumental, and statistic techniques, as well as risk assessment itself. The obtained results revealed a negative trend and it was a growing number of young people with overweight and obesity.

We determined how and to what extent various frequency of electronic devices being in use influenced deviations in physical development of senior schoolchildren and students ($p<0.05$): a correlation between body weight and frequency of using a PC (0.60); fat mass and frequency of using a PC (0.67); control over fat mass and frequency of using a PC (–0.62); control over body weight and frequency of using a PC (–0.54); a fat mass fraction and frequency of using a PC (0.58). We detected an average and a high risk of myopia (RR – 6.62), disorders and diseases in the neuropsychic sphere (RR – 5.60) depending on how frequently young people used a laptop or a PC with an etiologic component being high in these two factors (62.4 % and 21.9 % accordingly). We also detected a cause-and-effect relationship between functional disorders and diseases of the musculoskeletal system (RR – 1.20–1.48) and using a PC, laptop or a pad with an attributive risk related to these factors being considerable (21.7 % for using a pad and 11.7 % for using a PC or a laptop). We determined a safe period of time for "overall" use of electronic devices in educational activities and for entertaining; this period should not exceed 3 hours.

Key words: *risks, schoolchildren, students, information and communication technologies, electronic devices, myopia, overweight, muscle strength.*

A child's body is constantly growing and developing; should the process be disrupted due to either endogenous or exogenous factors, it is considered hazardous for a child's health [1, 2].

Over the last decades new hygienic factors have occurred and influence exerted by them on formation of a child's body hasn't been studied in great detail. Application of information and

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communication technologies (ICT) is one of such factors. At present schoolchildren and students widely use ICT as it is almost impossible to imagine contemporary educational processes and socialization without them in a hyper-information society [3–7].

In 2015 the RF Government approved on the Concept of Information Security for Children; the document clarified how significant information technologies were for a child's development[1] .

As it is fixed in the Concept, information security for children means both protecting them from destabilizing impacts exerted by certain information products and creating favorable information environment that could support positive socialization and individualization, optimal social, personal, cognitive, and physical development and help preserving mental and psychological health and well-being as well as creating positive mentality.

But still, most contemporary research that dwells on examining impacts exerted by ICT on children's and teenagers' bodies focuses on effects produced on a human body by electromagnetic fields. Thus, intensity of electromagnetic radiation created by electronic appliances (EAs) was examined by Grigoryeva Yu.T et al (2017), Teksheva L.M. et al (2011), Vyatleva O.A., Kurganskiy A.M. (2018), **Ushakvo I.B. et al (2018),** HardellL. (2018) [8–12]. Peculiarities related to ICT use by children and teenagers and influence exerted by ICT on young people were analyzed and examined by Saprykina G.A. (2012), Medvedeva E.A. et al. (2014), Kuchma V.R. et al. (2016) [13–15]. A lot of research works focused on impacts exerted by ICT on participants in educational processes (Kuchma V.R. et al, 2015; Stepanova M.I. et al., 2015; BelandL.P., 2015) [16–18]. Scientific literature contains a lot of data on impacts exerted by ICT on psychological and psychophysiological parameters of a growing body and already grown one [19–23]. And there are only few works that focus on impacts exerted by ICT on development of a child's body [23]. Hygienic aspects related to children using ICT in leisure activities haven't been given sufficient attention; the situation is the same with hygienic standards fixed for such activities when ICT are used by children, teenagers, and young people.

All the above-mentioned issues are to be resolved within implementing the Federal project entitled "Public health improvement" in 2019 and in future, 2020-2024; this project is an integral part of the National project called "Demography" which is being implemented with Rospotrebnadzor participation (the Order by Rospotrebnadzor No. 29 issued on January 25, 2019)[2].

Our research goal was to apply risk calculation procedures and to examine essence and an extent to which information and communication technologies influenced health of senior schoolchildren and students.

Research objects. 465 senior schoolchildren from Moscow city and Moscow region and 568 students from Moscow and Arkhangelsk took part in our research. The examined senior schoolchildren were 16 years old; students, 20. Those age groups were selected as our research objects due to senior schoolchildren and students being able to plan their use of information and communication technologies on their own, without any limitations imposed by their parents.

We chose those educational establishments where administrative staff and parents (at schools) gave their consent to our research. Schools selected for our research included comprehensive ones, schools with ad-

[1] The Concept of Information Security for Children / approved by the RF Government Order No. 2471-r on December 2, 2015. Available at: cronao.ru/images/DAR/InformSafe/Koncepciya-iform-bez-detey.pdf (date of visit March 02, 2019).

[2] Demography: The National project profile / approved by the minutes of the RF Presidential Council on strategic development and national projects No. 16 dated December 24, 2018. Available at: https://rosmintrud.ru/ministry/programms/demography (date of visit March 02, 2019).

vanced studies of some subjects, and grammar schools. There were two basic educational programs attended by students who took parts in our research, "Public Healthcare and Medical Sciences" and "Mathematics and Mechanics".

Our research didn't infringe on human rights and didn't cause any hazards for examined children; it conformed to all requirements fixed by biomedical ethics; it was planned and approved in accordance with GCP Rules by the Ethical Committee of N.I. Pirogov's Russian National Research Medical University. All examinations were performed according to ethical standards fixed by Helsinki Declaration and EU Directives (8/609EU)[3].

We applied the following research techniques: hygienic, sociological, instrumental, and statistical ones, and risk assessment procedures.

Physical development of children, teenagers, and young people is the most significant criterion showing how healthy they are; taking this into account, we analyzed body mass index and assessed fat mass of a body via biological impedance analysis (InBody 230 analyzer, Korea), standard anthropometric measurements, and dynamometry.

Highly qualified ophthalmologists examined health of senior schoolchildren and students; we also applied ARMIS firmware (Rostov-on-Don, Russia) to accomplish diagnostics. Data obtained via preventive examinations were analyzed with medical experts rendering their assistance in the process.

To assess influence exerted on health of senior schoolchildren and students by their life style as well as frequency and duration of ICT use, we accomplished questioning with standardized questionnaires developed by Scientific Research Institute for Hygiene and Children's Health Protection of the RF Public healthcare Ministry.

We examined educational conditions for children and teenagers at 12 educational establishments of different types; to do that, we performed sanitary-hygienic examination of educational establishments with subsequent analysis accomplished according to methodical procedures suggested by O.Yu Milushkina[4].

All the obtained data were statistically processed with Statistica 10.0 software package for statistical analysis (StatSoft, the USA).

Relative risk (RR or a probability of a certain outcome depending on an environmental factor) was determined as per evidence-based medicine rules using fourfold contingency tables.

Results. The obtained results allowed us to reveal a negative trend for an increase in number of senior schoolchildren and students who had overweight and obesity.

We analyzed how harmonious their physical development was and revealed that 60.6%±1.2% of the examined male senior schoolchildren and 56.8%±2.4% of the examined male students had normal (harmonious) physical development.

12.2%±2.1% of the examined male senior schoolchildren and 24.6%±1.2% of the examined male students had overweight, and students tended to have it two times more frequently than schoolchildren. Obesity was detected in 3.0%±0.9% and 8.3%±1.1% respectively, and students tended to have it 2.8 times more frequently. We didn't detect any regional peculiarities related to these parameters.

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[3] Helsinki Declaration by World Medical Association / approved by the 18th World Medical Assembly, Helsinki, Finland, June 1964; revised by the 29th World Medical Assembly, Tokyo, Japan, October 1975, the 35the World Medical Assembly, Venetia, Italy, October 1983, the 41th World Medical Assembly, Hong Cong, September 1989 and the 48the General Assembly, Somerset West, SAR, October 1996. Available at:: https://rostgmu.ru/wp-content/uploads/2014/12/WMA_Helsinki.pdf (date of visit March 02, 2019).

[4] Milushkina O.Yu. Regularities in formation of morphofunctional parameters in children and teenagers under contemporary medical-social and sanitary-hygienic conditions: doctoral thesis … for a Doctor of Medical Sciences degree. Moscow, 2013, 313 p.

As regards female participants, we revealed that 61.2%±2.7% of the examined female senior schoolchildren and 63.3%±1.5% of the examined female students had normal (harmonious) physical development.

6.2%±1.1% of the examined female schoolchildren and 12.0%±1.5% of the examined female students had overweight and female students tended to have it two times more frequently. Obesity was detected in 2.0%±0.4% and 3.0%±0.4% respectively. We didn't detect any regional peculiarities related to these parameters.

Male senior schoolchildren tended to have average body mass index equal to 21.1± ±3.2 kg/m^2; and female senior schoolchildren, 20.1±3.3 kg/m^2 (standard for this age was equal to 18.5-24.9). Male students from Moscow and Arkhangelsk had average body mass index equal to 23.0±3.7 kg/m^2 and 23.4±4.5 kg/m^2. Female students from Moscow and Arkhangelsk had average body mass index equal to 21.3±3.5 kg/m^2 and 21.1±4.4 kg/m^2.

Male senior schoolchildren had their fat mass equal to 10.1±6.5 kg; female senior schoolchildren, 13.0±5.7 kg. Male students from Moscow had fat mass equal to 13.9±8.0 kg; female students from Moscow, 15.9±7.6 kg. Male students from Arkhangelsk had average fat mass equal to 14.8±9.5 kg; female students from Arkhangelsk, 15.6±6.6 kg.

We should note that there was an authentic ($p<0.05$) age-dependent increase in average fat mass regardless of a sex and height as it remained stable. Fat mass percentage also grew from 15.0±1.8% in boys to 19.0±2.0% in young males and recommended values for men should not exceed 15.3%. Fat mass percentage in girls authentically ($p<0.05$) grew from 23.0±1.8% to 26.0±3.5% and recommended values for women should not exceed 23.0%.

Control over fat mass (a quantity of fat mass in kilograms that should be lost or gained) indicates that male students on average have to lose 3 or more kg of fat mass; female students, 2 or more kg.

An existing negative trend for an increase in number of young people who have overweight or obesity requires searching for factors that cause this pathology.

Our research allowed us to reveal that multiple correlation coefficient for overweight was $R=0.55$, $p<0.05$ for senior students, the correlation being detected between overweight and educational conditions at educational establishments and factors related to life style. Standardized regression coefficients (Beta) indicate there is influence exerted by a set of factors including sanitary-epidemiologic well-being at an educational establishment (-0.57), an amount of time spent daily working at a PC (0.44), unfavorable microclimate in a family (frequency of conflicts) (0.33), having dinner 2 or less hours before going to bed (-0.25).

We detected averaged total time of ICT use with various electronic appliances; it amounted to 7 hours on a usual weekday both in studies and leisure activities for senior schoolchildren; 8.5 hours, for male students; 10 hours, for female students.

We also revealed that ICT use as an independent activity accounted for 15% of the overall available daily time for senior schoolchildren; 10.0%, for students.

A lot of time spent by senior schoolchildren and students on ICT during a day means they spend less time on other activities such as sleep, meals, doing sports, outdoor activities etc. Thus, time spent on sleep decreased by 9% among senior schoolchildren and by 7% among students; time spent on doing sports and outdoor activities decreased by 6.0% among senior schoolchildren and by 4.0% among students.

We examined essence and extent to which various frequency of EAs application influenced occurrence of deviations in physical development of senior schoolchildren and students; we revealed the following statistically significant correlations ($p<0.05$):

– between body weight and frequency of PC use (0.60);

– between fat mass and frequency of PC use (0.67);

– between control over fat mass (a quantity of fat mass in kilograms that should be gained or lost) and frequency of PC use (-0.62);

– between control over weight (a quantity of body weight in kilograms that should be gained or lost) and frequency of PC use (-0.54);

– between fat mass percentage frequency of PC use (0.58).

Obtained statistically significant correlations between deviations in physical development of young people due to overweight and duration of stationary EAs use confirmed it was necessary to control time spent uninterruptedly at such devices as frequent and long use of EAs could increase static loads on a growing body.

We can show consequent steps in this influence with the following scheme: more frequent and longer EAs use → greater static load / lower physical activity → an increase in fat mass → deviations in physical development caused by overweight.

This hypothesis can be tested with risks calculation. We determined statistically significant values of relative risks (RR) related to different frequency of stationary EAs use (a PC or a laptop) for overweight and obesity occurrence in senior schoolchildren and students (Table 1).

When relative risk is higher than 1, and in our case it is equal to 1.59, we can conclude that a factor (frequent use of a PC or a laptop) increases frequency of adverse outcomes, notably overweight and obesity (direct correlation) among young people. Etiologic fraction in this factor amounts to practically 10%, however, there are undoubtedly other influencing factors.

Table 1

Relative risk of overweight and obesity in senior schoolchildren and students depending on frequency of stationary EAs use ($p \leq 0.05$)

Outcome	Factor	RR	EF, %	Se	Sp
Overweight and obesity	Frequency of PC or laptop use	1.59	9.8	0.67	0.47

Note:
RR is relative risk;
EF etiologic fraction (attributive risk);
Se is sensitivity of a technique;
Sp is specificity of a technique.

We determined statistically significant relative risk values related to different frequency of a PC or laptop use for another important parameter that characterized physical development of children and teenagers. This parameter was muscle strength in hands; a decrease in this parameter often occurs together with overweight and obesity (Table 2).

When relative risk is higher than 1, and in our case it is equal to 1.08 when a PC is used, and to 1.11, when a laptop is used, we can conclude that the factor increases frequency of such adverse outcomes as reduced muscle strength. Etiologic fraction in these factors amounts to 13.0% and 25.0% respectively; undoubtedly, there are other influencing risk factors.

Table 2

Relative risk of a decrease in muscle strength in hands in senior schoolchildren depending on frequency of stationary EAs use ($p \leq 0.05$)

Outcomes	Factor	RR	EF, %	Se	Sp
Reduced muscle strength	Frequency of a PC use	1.08	13.0	0.33	0.69
Reduced muscle strength	Frequency of a laptop use	1.11	25.0	0.67	0.73

Our research results indicate it is vital to develop hygienic standards for total time spent on ICT during a day for senior schoolchildren and students; these standards should take into account both educational and leisure activities while existing standards fixed in regulatory documents predominantly cover only educational activities.

Taking into account significance of everyday EAs use, we set a task to determine how much time spent on them a day wouldn't cause overweight among senior schoolchildren and students (Figure 1).

Having analyzed the data, we concluded that total time equal to up to 3 hours a day spent on EAs use both in educational and leisure activities was a safe limit for deviations in physical development of young people.

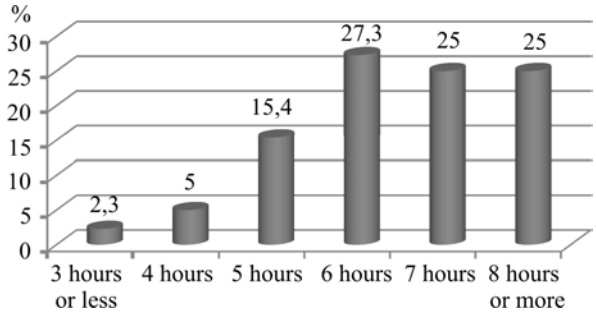

Figure 1. Frequency of deviations in physical development due to overweight in senior schoolchildren and students depending on time spent on EAs use a day, %

We also obtained some data on influence exerted by frequency of EAs use on health disorders in senior schoolchildren and students (Table 3).

We confirmed a risk of average and grave myopia (RR – 6.62), and neuropsychic disorders and diseases (RR – 5.60) depending on frequency of a PC or laptop use with etiologic fraction of these factors being high (62.4% and 21.9% respectively).

We detected a cause-and-effect relation between functional disorders and diseases in the musculoskeletal system (RR – 1.20 – 1.48) and use of a PC, laptop, or a pad with etiologic fraction of these factor being significant (21.7% when a pad was used and 11.7% when a PC or a laptop was used). We also revealed risks of functional disorders or diseases in the hearing organs depending on how frequently EA with headphones were used; the risks were 2.41 and etiological fraction was equal to 10.0%.

Discussion. Contemporary electronic industry offers a wide range of EAs to consumers; these devices can satisfy any need a customer might have and it stimulates greater interest in them among children, teenagers, and young people [14].

Previously it was shown that more frequent and longer use of EAs changed life styles of contemporary schoolchildren and students, violating normal ratios of activities in their daily routines and influencing their health [24]; the situation seems alarming to hygienists and requires developing standards for ICT use by children, teenagers, and young people in their educational and leisure activities.

Our research allowed us to determine total permissible amount of time that can be spent on ICT during a day and it shouldn't exceed 3 hours; this amount wouldn't cause any adverse effects on young people's health that could result in overweight.

Our data are well in line with research results obtained via examining influence exerted by ICT on emotional and behavioral disorders among teenagers[5].

Table 3

Relative risk of health disorders among senior schoolchildren and students depending on frequency of EAs use ($p \leq 0.05$)

Outcomes	Factor	RR	EF, %	Se	Sp
Average or grave myopia	PC or laptop, frequency of use	6.62	62.4	0.96	0.47
Neuropsychic functional disorders and diseases	PC or laptop, frequency of use	5.60	21.9	0.80	0.65
Functional disorders and diseases in the musculoskeletal system	PC or laptop, frequency of use	1.20	11.7	0.33	0.77
Functional disorders and diseases in the musculoskeletal system	Pad, frequency of use	1.48	21.7	0.53	0.69
Functional disorders and diseases in the hearing organs	Frequency of use of EAs with headphones	2.41	9.5	0.72	0.51

[5] Labutieva I.S. Hygienic assessment of influence exerted by contemporary life activities of studying teenagers on occurrence of emotional and behavioral disorders: thesis ... for a Candidate of Medical Sciences degree. Moscow, 2018, 23 p.

Our research proved there was a cause-and-effect relation between health disorders among young people (average or grave myopia, neuropsychic disorders or diseases, functional disorders or diseases in the musculoskeletal system and hearing organs) and frequency of different EA use. The results we obtained determine a necessity to introduce a differentiated approach to standardizing safe levels of exposure to adverse factors related to ICT use; this approach should take into account a type of used EA, age and health of a user, regime and conditions under which an EA is used etc.

Use of ICT is widely spread among young people at present; use of EA is proven to cause risks of adverse effects on a goring body; people tend not to be aware of how safely to use EA; there is no successive system of hygienic education. Taking all the above-mentioned factors into account, we should state is it obviously necessary to perform further research in the sphere in order to develop a set of preventive activities [25, 26]. A significant trend in prevention should be strengthening and enhancing primary prevention of diseases which are typical for a hyper-information society via creating and maintaining efficient methodical and technical information resources on developing and applying skills related to safe EAs use. Here we should also take into account basic ways used by contemporary young people to obtain information as well as how this information is introduced and implemented into everyday life. Subject web-sites and blogs on healthy life style, including those for active EAs users, may be quite useful in this respect. This research should become an integral part of scientific work planned within "The Program for multi-centered research on providing digital educational technologies that are safe for children's health".

Conclusion. Given all the above-mentioned, we can state that at present it is necessary to search for the most efficient ways to create healthy life-style attitudes among children, teenagers, and young people. Today any issues related to preserving young people's health should be solved by experts from various fields of knowledge (hygienists, ophthalmologists, pediatricians, teachers, psychologists, etc). Creation of unified prevention space requires combining efforts made by all participants in prevention processes and a whole society as well.

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