UDC 613.9
DOI: 10.21668/health.risk/2022.4.06.eng

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Research article

ROUTINE USE OF MOBILE ELECTRONIC DEVISES BY SCHOOLCHILDREN AND STUDENTS AND ITS CORRECTION BY HYGIENIC EDUCATION

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Many research works have described negative effects produced by use of electronic devices, mobile ones (smartphone, tablets) included, on children, adolescents and youth. However, the problem has many aspects and not all of them have been explored profoundly.

In this study, our aim was to conduct hygienic assessment of routine use of mobile electronic devices by schoolchildren and students and to give grounds for its correction by hygienic education.

By conducting a survey, we obtained data on use of mobile electronic devices by 1218 schoolchildren and students both in their educational and spare time activities and created a profile of a work and rest routine when working with mobile electronic devices. 943 students and schoolchildren were examined by an ophthalmologist. Next, issues related to hygienic education were integrated into the training program for medical students at the Hygiene Department of the Pirogov Russian National Research Medical University. The emphasis was on creating a safe routine of using mobile electronic devices.

Schoolchildren and students who adhered to a healthy work and rest routine when working with mobile electronic devices complained about health disorders authentically less frequently ($p \leq 0.05$).We established a statistically significant relative risk for visual acuity if schoolchildren and students did not pursue a safe routine of using mobile electronic devices. Its level was RR = 3.07 (95 %, CI =1.88–5.03).

By the end of hygienic studies with their focus on creating a safe routine of using mobile electronic devices, medical students had an authentic ($p \leq 0.05$) increase in visual acuity due to decline in such states as routine accommodative excess and pre-myopia.

Work and rest routines accepted by children, adolescents and youth when they use mobile electronic devices are a manageable risk factor of health disorders in these population groups. This study shows that hygienic education may be quite effective for correcting a routine of using mobile electronic devices by schoolchildren and students.

Keywords: *schoolchildren, students, visual acuity, accommodation, mobile electronic devices, work and rest routine, hygienic education.*

Protection and strengthening of children's health is a priority trend in the development of the public healthcare and education in the Russian Federation. On July 26, 2017, the RF Government approved the Profile of the priority project 'Creation of a healthy lifestyle'. Its major goal is to raise a share of citizens who pursue a healthy lifestyle up to 60.0 % by the

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end of 2025; the project involves providing hygienic education to various population groups and spreading the best educational practices in the sphere.

Rapid development of the digital environment marked the beginning of the 21st century. The report by the UNICEF entitled The State of the World's Children 2017: Children in a Digital World was published 10 years after the first iPhone was introduced on the market; it stated that children tended to start using the Internet at a younger age and the trend was persistent. In Europe, more and more children aged 3–5 years become active Internet users and this involves using mobile electronic devices (MEDs) [1].

In 2015, the RF Government approved The Concept of Information Safety for Children (The RF Government Order issued on December 02, 2015 No. 2471-r). The document established a major strategic goal of the state policy as regards providing information safety for children. This goal is to secure harmonious development of rising generations due to minimizing effects produced by all the adverse factors associated with the digital environment[1].

The modern digital environment has substantial influence on educational activities of children, adolescents and youth, their spare time, socialization and lifestyle [2].

Experts believe that in primary school children should spend no more than 10 minutes working on a PC. In middle school, this time should not exceed 15 minutes in 5–7th grades and 20 minutes in 7–9th grades. In senior school, adolescents should spend no more than 30 minutes working on a PC during the first class and no more than 20 minutes during the second one[2].

Multiple studies have addressed effects produced by MEDs use on children, adolescents, and young people. It is noteworthy that students who use MEDs often have asthenopic complaints, functional state of their eyes (organs of sight) and musculoskeletal system is impaired, and they tend to suffer from developing psychological dependence etc. [3–8].

Previously, any potential hazard posed by MEDs use was associated only with exposure to physical factors and keeping mobile devices in the closest proximity to the head. Today, a smartphone is a compact but still very powerful PC, which keeps receiving audio- and video-data uninterruptedly; therefore, a potential hazard associated with using it is more and more frequently associated with timing of MEDs use [9–14].

All the above stated requires analyzing effects produced by different routines of MEDs use on health and, in particular, eyes of students; another necessity is to search for effective ways to compensate them.

In this study, we aimed to conduct hygienic assessment of routine use of mobile electronic devices by schoolchildren and students and to give grounds for its correction by hygienic education.

Materials and methods. In 2017–2021 academic years, we conducted a one-time examination and questioning of 1218 schoolchildren and students in Moscow and the Moscow region (150 of them attended primary school; 225, middle school; 200, senior school; 643, freshmen and sophomores). Data on routine MEDs use by schoolchildren and students were obtained by using a standardized questionnaire recommended by the Research Institute of Hygiene and Health of Children and Adolescents for multi-centered surveys. All the participants had been using a MED for at least one year prior to the survey. We examined a period and variants of combined MEDs use by schoolchildren and students of different age, how often and for how long they used MEDs during classes, weekends and holidays.

[1] Kontseptsiya informatsionnoi bezopasnosti detei [The Concept of Information Safety for Children]. *GARANT: information and legal portal*. Available at: https://www.garant.ru/products/ipo/prime/doc/71167034/ (August 14, 2022) (in Russian).

[2] SanPiN 1.2.3685-21. Gigienicheskie normativy i trebovaniya k obespecheniyu bezopasnosti i (ili) bezvrednosti dlya cheloveka faktorov sredy obitaniya [SanPiN 1.2.3685-21. Hygienic standards and requirements to providing safety and (or) harmlessness of environmental factors for people]. *KODEKS: electronic fund for legal and reference documentation*. Available at: https://docs.cntd.ru/document/573500115#6560IO (August 14, 2022) (in Russian).

All the obtained data were supplemented with those obtained by using our own questionnaires developed by experts of the Hygiene Department, Pediatrics Faculty at Pirogov's Russian National Research Medical University; all these experts were certified in such fields as Common Hygiene, Hygienic Education, Children and Adolescents Hygiene, and Epidemiology. The questionnaires had questions about conditions of MEDs use (an organized workplace, a possibility to keep a comfortable working posture, sufficient lighting of a working surface); routines of their use (any breaks during work, their frequency and duration); any accomplished prevention activities and their description (a number of breaks and their timeliness, prevention activities occurring during them); 'screen time' of MEDs use. Schoolchildren in senior school and students were offered to fill in the questionnaires by using Google Forms. Two hundred schoolchildren in senior school and 518 freshmen and sophomores took part in the survey.

We copied some results of examinations performed by an ophthalmologist; overall, 943 schoolchildren and students were examined to establish their visual acuity. The examination results were written down as follows: $Vis^{without/}_{correction}$ (OD = …, OS = …).

We applied several criteria to include participants into our sampling. First, a participant should attend either a school or a higher educational institution (HEI); second, a written informed consent was submitted; a participant was examined by an ophthalmologist and the examination results were available; a questionnaire was filled in correctly by a respondent or his or her legal representative (for children in primary school); duration of MEDs use was one year and longer. Several criteria were applied to exclude a participant: other age group; an informed consent was not submitted; results of an examination by an ophthalmologist were not available; a participant suffered from chronic diseases of the eye that allowed ranking him or her as having the 4^{th} or 5^{th} health group; a correctly filled-in questionnaire was not submitted; duration of MEDs use was shorter than one year.

In 2018–2019, hygienic education was integrated into the training program for medical students at the Hygiene Department, Pediatrics Faculty at Pirogov's Russian National Research Medical University; its focus was on priority trends in developing skills of safe use of electronic devices (EDs) and on hygienic principles of eyesight protection. Students who were getting basic medical education or specialized in pediatrics were being taught by using active learning (case studies, active trainings, etc.). Effectiveness of the accomplished activities was checked based on certain objective indicators (visual acuity) at the beginning of the training at the Hygiene Department and after it was completed. One hundred and twenty-eight medical students in the test group and 128 in the reference one were observed in dynamics. Both groups were comparable as per age and sex, duration of EDs use, health, functional abnormalities and chronic diseases of the eye.

The conducted study did not pose any danger for its participants and fully conformed to biomedical ethics and provisions stipulated in the Declaration of Helsinki (1983 revision); it was approved by the Ethics Committee of Pirogov's Russian National Research Medical University (The meeting proceedings No. 159 dated November 21, 2016 and No. 203 dated December 20, 2020).

All the data were statistically analyzed with Statistica 13 PL software package.

Results. The study made it possible to identify the leading risk factors that could cause negative health outcomes for the eye. They included non-compliance with the rules for safe MEDs use as well as absence of healthy lifestyle components in daily routines of schoolchildren and students as regards MEDs use.

A smartphone is the most frequently used MED in educational and spare time activities of children, adolescents and youth. Duration of its use is not regulated by any valid sanitary standard and this device is not enlisted among those recommended for use in the educational process. In primary school, a smartphone accounts for about 50.0 % of the total daily time spent on MEDs use in educational and spare

time activities during an academic year; in middle school, 55.0 %; in senior school and HEI, 65.0 %. During holidays, schoolchildren in primary and secondary school tend to use a smartphone for a longer period, on average, by 15–40 minutes longer.

When using a smartphone, schoolchildren and students made their first asthenopic complaints after 30 minutes in 44.00 ± 3.5 % of the cases whereas it was in 12.0 ± 2.3 % of the cases when a stationary ED was used.

We established that schoolchildren and students who adhered to safe routines of MEDs use complained about their health authentically rarer ($p \leq 0.05$); only 7.5 % of the respondents with routine MEDs use conforming to the safe standards complained about head aching and heaviness whereas 92.5 % of those who did not use MEDs safely had such complaints. Computer vision syndrome was detected in 17.8 % and 82.2 % of the respondents accordingly (Pearson's contingency coefficient was 0.511 ± 0.034, $p \leq 0.05$).

Functional impairments and chronic diseases of the eye in schoolchildren and students were associated ($p \leq 0.05$) with their failure to comply with rules for safe MEDs use: insufficient lighting (Pearson's contingency coefficient was 0.713 ± 0.037), an irrational working posture (Pearson's contingency coefficient was 0.822 ± 0.030), absence of proper breaks in work (Pearson's contingency coefficient was 0.836 ± 0.031), absence of a 'smartphone-free day' a week (Pearson's contingency coefficient was 0.827 ± 0.031), failure to do eye gymnastics (Pearson's contingency coefficient was 0.709 ± 0.039), using MEDs in transport (Pearson's contingency coefficient was 0.813 ± 0.032).

To explore a correlation between routine MEDs use by children, adolescents, and youth and the functional state of their eyes, we applied Spearman's correlation analysis. Statistically significant inverse correlations ($p \leq 0.05$) were established between visual acuity of the right eye (OD) and the total time of MEDs use (r = -0.308) on a weekday. We also established statistically significant inverse correlations ($p \leq 0.05$) between visual acuity of the left eye (OS) and the total time of MEDs use (r = -0.32) on a weekday. The obtained correlations were moderate according to the Chaddock scale.

Statistically significant inverse correlations ($p \leq 0.05$) were also established between visual acuity of the right eye (OD) and uninterrupted MEDs use (that is, a period of work with MEDs that was followed by a break) (r = -0.392) on a weekday. We established statistically significant inverse correlations ($p \leq 0.05$) between visual acuity of the left eye (OS) and uninterrupted MEDs use (r = -0.335) on a weekday. The obtained correlations were mostly moderate as per the Chaddock scale.

We established a statistically significant relative risk of impaired visual acuity due to unsafe MEDs use by schoolchildren and students; its value was RR = 3.07 (95 %, CI = 1.88–5.03).

The next stage in the study involved substantiating a possibility to correct a routine of MEDs use by providing hygienic education for medical students.

In accordance with the transition to the Federal State Educational Standard for Higher Education 2020, the Hygienic Education module was included into the training program for medical students. Among the topics it covered, it is noteworthy to mention 'Developing skills of safe use of electronic devices' with its aim to create general cultural and occupational competences in safe EDs use including those necessary to perform occupational activity as a physician with basic medical education or specializing in pediatrics. This concerns accomplishing the occupational function 3.1.4 'Accomplishment of prevention activities including educational ones among children and their parents' by a pediatrist and the occupational function 3.1.5 'Accomplishment of activities aimed at prevention and creating a healthy lifestyle as well as sanitary-hygienic education of the population with control of their effectiveness' by a physician with basic medical education.

Training provided for medical students within the Hygienic Education module involved using active learning methods (case studies, role plays, active trainings, etc.). They created necessary conditions to effectively motivate students to master the learning materials on their

own using initiative and a creative approach and developed students' skills in preparing and implementing hygienic educational programs among patients and population in general with their aim to promote hygienic knowledge.

Examining basic requirements to a rest and work routine in EDs use became the major trend in training within the Hygienic Education module for medical students as future doctors and healthy lifestyle promoters. These requirements covered the total daily time of use; duration of uninterrupted use; regulation of breaks in work with MEDs and recommended activities during them; having a 'MED-free day' a week; ending MEDs use at least 1 hour prior to going to bed; hygienic requirements to lighting at a workplace; hygienic requirements to workplace ergonomics; doing eye gymnastics; etc.

Practical classes enabled medical students to acquire and master skills and competences as regards the following:

– assessing whether a patient is well informed about how to use MEDs safely, developing and implementing hygienic education schemes on the matter;

– searching, analyzing, systematizing and providing reliable information about how to prevent adverse effects produced by unsafe MEDs use on health, the eye included; to achieve this, students were provided with relevant regulatory and methodical documents;

– working with open access sources including those available in the Internet. Medical students got acquainted with official web-sites of medical organizations dealing with prevention, for example, the National Health and Research Center of Preventive Healthcare, Rospotrebnadzor's Center of Hygienic Education for Population, the Yamal Center for Public Health and Medical Prevention as well as web-sites of social movements working in the sphere. The aim was to get acquainted with information provided on these web-sites and to use it when accomplishing tasks within a practical class.

At the beginning of the module, visual acuity of the students from the test and reference groups did not have any authentic differences and was equal to 0.60 ± 0.04 (OD), 0.60 ± 0.04 (OS). At the end of the module, we established that visual acuity improved authentically ($p \leq 0.05$) in the medical students from the test group and equaled 0.85 ± 0.03. It was achieved due to a decrease in such states as usual accommodative excess and pre-myopia and this was an objective indicator. We did not detect any changes in visual acuity of the students from the reference group (Figure).

The Hygienic Education module included into the training programs for future physicians makes it possible to develop both general cultural and occupational competences as regards essentials of health protection. This has a positive effect on the functional state of students' eyes.

Discussion. MEDs use by children, adolescents and youth is accompanied with an increase in the static component, elevated visual loads, nervous and emotional involvement thereby creating a wide range of risk factors able to cause health disorders including diseases of the eye.

MEDs have certain well-known construction peculiarities, which can have drastic influence on schoolchildren's and students' health. There are several unresolved issues that determine health risks associated with their use: irrational keyboard (QWERTY) ergonomics; uncomfortable interface that makes user's hands keep a forced position, difficulties in using a device when walking (it influences one's walk and raises a possibility of getting injured) [15–17].

Big-sized MED's sensory screens were established to have an obvious advantage over smaller sensor screens as regards available space that could be used to accommodate and transfer graphical information. Some studies revealed that users thought a tablet to be the most useful in a situation when precision of graphical interpretation is important and there are no time limits [18].

A text size and wider interlineage also make a text much easier and more comfortable to read on a tablet but screen oversaturation requires much more time for reading and processing data [19].

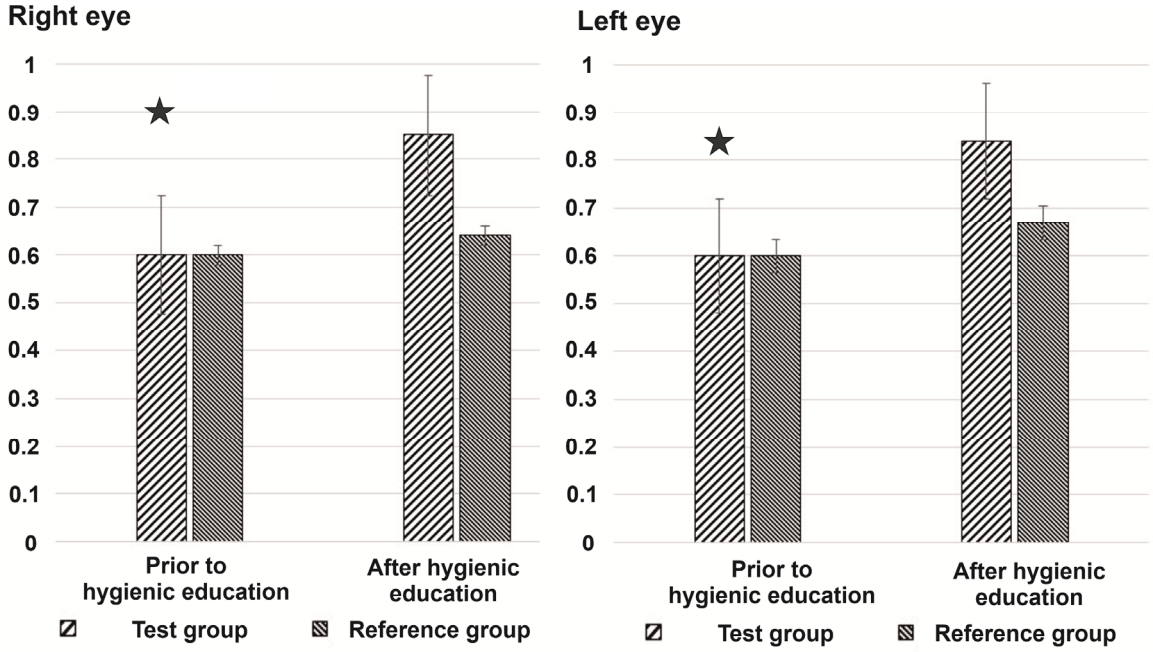

Figure. Visual acuity of the medical students from the test and reference groups prior to and after hygienic educations addressing major aspects in eyesight protection, M ('asterisk' corresponds to $p \leq 0.05$)

There are also several studies addressing influence exerted by routine MED (smartphones, tablets) use in spare time activities [20].

Still, available research data on influence exerted by different routines of MEDs on young people's health cannot be considered comprehensive and reflect only certain aspects of the issue.

Several studies revealed that imposing a limitation on time spent by schoolchildren and students on MED's use both produces favorable effects on the functional state of the body as a whole by preventing fatigue and makes for prevention of functional abnormalities and chronic diseases of the eye.

Therefore, it is still vital to explore harmful effects produced on health by constructive peculiarities of various MEDs. The issue requires further investigation. But another significant issue is absence of any healthy lifestyle components as regards safe MEDs use in schoolchildren's and students' daily routines. This study has established that it is possible to correct MEDs use by hygienic education. Effectiveness of hygienic education, which was confirmed by such objective indicator as visual acuity, was exemplified by its inclusion into training programs for medical students.

Conclusions:

1. Use of mobile electronic devices (tablets and smartphones) is widely spread among schoolchildren in primary, middle and senior school as well as among HEI students.

2. Work and rest regime of MED use by children, adolescents and youth is a manageable health risk factor for the rising generation.

3. The study has shown effectiveness of using hygienic education for correcting routine MEDs use by schoolchildren and students.

Funding. The research was not granted any financial support.

Competing interests. The authors declare no competing interests.

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Milushkina O.Yu., Skoblina N.A., Pivovarov Yu.P., Markelova S.V., Mettini E., Ievleva O.V., Tatarinchik A.A. Routine use of mobile electronic devises by schoolchildren and students and its correction by hygienic education. Health Risk Analysis, 2022, no. 4, pp. 64–71. DOI: 10.21668/health.risk/2022.4.06.eng

Received: 18.05.2022
Approved: 26.09.2022
Accepted for publication: 18.12.2022