

RUSSIAN BULLETIN OF HYGIENE

SCIENTIFIC MEDICAL JOURNAL

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PIROGOV RUSSIAN NATIONAL RESEARCH MEDICAL UNIVERSITY

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SUBMISSION <https://rbh.rsmu.press/>

COLLABORATION editor@rsmu.press

ADDRESS Ostrovityanov St. 1, Moscow, 119997, Russia

Indexed in RSCI. IF 2018: 0,5

Open access to archive



Issue DOI: 10.24075/rbh.2023-03

The mass media registration certificate PI series № FS77-80908 dated April 21, 2021

Founders: Burdenko Voronezh State Medical University (Voronezh, Russia)

Pirogov Russian National Research Medical University (Moscow, Russia).

Publisher: Pirogov Russian National Research Medical University; address: Ostrovityanov Street 1, Moscow 119997 Russia

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Approved for print 30.09.2023
Circulation: 100 copies. Printed by Print.Formula
www.print-formula.ru

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СОТРУДНИЧЕСТВО editor@rsmu.press

АДРЕС РЕДАКЦИИ ул. Островитянова, д.1, г. Москва, 119997, Россия

Журнал включен в РИНЦ, IF 2018: 0,5

Здесь находится открытый архив журнала



DOI выпуска: 10.24075/rbh.2023-03

Свидетельство о регистрации средства массовой информации серия ПИ № ФС77-80908 от 21 апреля 2021 г.

Учредители: Воронежский государственный медицинский университет им. Н.Н. Бурденко (Воронеж, Россия);
Российский национальный исследовательский медицинский университет имени Н.И. Пирогова (Москва, Россия)

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Подписано в печать 30.09.2023

Тираж 100 экз. Отпечатано в типографии Print.Formula
www.print-formula.ru

LITERATURE REVIEW

4

The effect of 5G wireless communication standard on adults and children

Tatarinchik AA

Влияние использования средств беспроводной связи стандарта 5G на взрослых и детей

А. А. Татаринчик

LITERATURE REVIEW

9

Substantiation of programs for hygienic training on prevention of disorders of the musculoskeletal system and the eye and adnexa

Khorosheva IV

Обоснование программ гигиенического воспитания по профилактике болезней костно-мышечной системы, глаза и его придаточного аппарата

И. В. Хорошева

ORIGINAL RESEARCH

15

Evaluation of efficiency and quality of mechanical cleaning of autopsy tools in ultrasonic cleaners

Milushkina OYu, Vasiliev DE, Timerzyanov MI, Valeyeva YuV, Kiyasova EV

Оценка эффективности и качества очистки секционного инструментария механизированным способом с помощью ультразвуковых моек

О. Ю. Милушкина, Д. Е. Васильев, М. И. Тиммерзянов, Ю. В. Валеева, Е. В. Киясова

ORIGINAL RESEARCH

19

Methodological approaches to assessing brightness and pulsation of small-sized mobile electronic device screens

Markelova SV, Tatarinchik AA, Ievleva OV

Методические подходы к оценке яркости и пульсации экранов мобильных электронных устройств, имеющих малую диагональ экрана

С. В. Маркелова, А. А. Татаринчик, О. В. Иевлева

LITERATURE REVIEW

23

Issues of reproductive health development in schoolchildren and preventive measures to address them

Solovyova YuV

Проблемы формирования репродуктивного здоровья школьников и профилактические мероприятия по их решению

Ю. В. Соловьева

ORIGINAL RESEARCH

27

Role of parents in hygienic and sexual education of children and adolescents

Demchenkov NO, Krasilnikova ED, Sheina NI, Korolik VV

Роль родителей в гигиеническом и половом воспитании детей и подростков

Н. О. Демченков, Е. Д. Красильникова, Н. И. Шеина, В. В. Королик

THE EFFECT OF 5G WIRELESS COMMUNICATION STANDARD ON ADULTS AND CHILDREN

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Introduction of the fifth-generation wireless networks (5G) will increase the number of 5G base stations and 5G-enabled devices. This review sought to find the answer to the key question: can such devices be harmful? The review covers scientific data published from 2009 to 2022 and available at eLibrary, PubMed, Google Scholar, Cyberleninka. We investigated the problems of definition, regulation, accumulation of data on 5G networks, and summarized the papers reporting how electromagnetic fields in 5G frequency bands affect adults and children. Despite the large amount of contradictory data, the available studies do not provide adequate information that could enable a meaningful assessment of the safety of 5G networks.

Keywords: electromagnetic fields, 5G, children and adolescents, overview, environmental factors, electronic devices

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Received: 19.06.2023 **Accepted:** 08.07.2023 **Published online:** 17.07.2023

DOI: 10.24075/rbh.2023.073

ВЛИЯНИЕ ИСПОЛЬЗОВАНИЯ СРЕДСТВ БЕСПРОВОДНОЙ СВЯЗИ СТАНДАРТА 5G НА ВЗРОСЛЫХ И ДЕТЕЙ

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Внедрение беспроводных сетей пятого поколения (5G) увеличит количество базовых станций и других устройств, работающих с этим стандартом связи. Целью настоящего обзора было найти ответ на главный вопрос: могут ли такие устройства оказывать негативное воздействие на здоровье? Поиск информации за период с 2009 по 2022 г. осуществляли с использованием информационных порталов и платформ eLibrary, PubMed, Google Scholar, Cyberleninka. В обзоре рассмотрены проблемы, связанные с определением, нормированием и накоплением данных по сетям 5G. Приведены работы по оценке влияния используемых в сетях 5G электромагнитных полей радиочастотного диапазона на взрослых и детей. Несмотря на большое количество противоречивых данных, имеющиеся исследования не предоставляют адекватной информации, которой было бы достаточно для значимой оценки безопасности сетей 5G.

Ключевые слова: электромагнитные поля, 5G, дети и подростки, обзор, факторы среды обитания, электронные устройства

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Статья получена: 19.06.2023 **Статья принята к печати:** 08.07.2023 **Опубликована онлайн:** 17.07.2023

DOI: 10.24075/rbh.2023.073

In the last few decades, we have seen the development of technologies that enable wireless communications, Wi-Fi and cellular networks in particular. The first mobile phones and first-generation base stations were introduced in the 1970s; they were available to few, but as the number of users increased, new generations of wireless communication networks (2G, 3G, 4G) were deployed, each making data transmission faster and relying on new technology. Each subsequent generation uses higher frequency electromagnetic waves to transmit ever larger amounts of data at higher speeds to more places. Currently, the next generation of mobile communication networks is being actively introduced all over the world.

5G is the fifth-generation wireless communication technology. It is the next evolutionary development that replaces 3G and 4G networks and offers improved mobile data transmission capabilities. 5G relies on waves of much higher frequencies (from 3 to 300 GHz). Deployment of 5G networks expectedly entails development of self-driving vehicles, virtual reality and the Internet of Things technologies.

The high frequency waves carrying data within 5G networks commonly fail to penetrate walls of buildings, vegetation, and bounce off steel structures. Therefore, good 5G signal reception in buildings requires amplifiers, and the network antennas must be placed every 100-300 meters, which is much closer than for the previous generation networks. These many sources of electromagnetic radiation can endanger health of the population [3].

This is especially important for preserving health of the young people, since children are sensitive to environmental factors, including those of physical nature. In the second decade of the 21st century, both stationary and mobile electronic devices have become ubiquitous in the educational and leisure activities of children, adolescents and youth, which means they are already constantly exposed to electromagnetic radiation emitted by base stations, Wi-Fi spots, smartphones, electronic learning tools. Expanding this list with 5G antennas only translates into greater irradiation.

We have reviewed scientific papers dedicated to the influence of electromagnetic fields of 5G networks on human beings. The papers were searched for in the eLibrary, PubMed, Google Scholar, Cyberleninka databases.

The commonization of electronic devices used for work, training, and leisure directly increases the intensity and time of exposure of people to electromagnetic fields (EMFs). Used in educational settings, electronic devices have a number of unique advantages: they expand capabilities and ensure equal access to education, enable learning personalization, instant feedback and evaluation of the results thereof, make the learning process independent of time and place, raise the effectiveness of classroom time, foster formation of new student communities, drive development of continued education, support self-training, facilitate assistance to students with disabilities. However, uncontrolled use of electronic devices increases the time of exposure to the radio frequency electromagnetic fields (RF EMFs) [4, 5].

The influence of this factor has already been shown both at the molecular and body level, as reflected in the fundamental works by the leading Russian scientists. The currently used wireless communication technology standards are 3G, 4G and 5G, and their combination translates into a complex effect of EMFs of various frequencies [6, 7].

To date, there have been published thousands of articles describing the biological effects of exposure to EMFs. There are strict restrictions on exposure to higher-level EMFs that can harm health of a human being; these restrictions are formulated in national and international rulebooks. However, researchers have not yet come to a consensus regarding the effects of low-level fields and their ability to trigger biological reactions in the body and affect how people feel [8].

At the same time, scientific community is growing increasingly concerned about the potential adverse biological consequences of practical application of RF EMFs and their impact on health. Most of the reports experts have written about the effects of exposure to EMFs do not contain information about potential harm to human beings [9–13].

At the same time, there have been published works in which scientists expressed their concern about the lightning-fast introduction of the modern data transmission systems, 5G networks in particular. Compared to the like systems common just a few decades ago, the respective new developments have unprecedented potential to create more intense levels of RF EMFs (e.g., with greater energy flux densities) a human being may be exposed to. At the same time, the currently available accumulated data on the safety of 5G networks are insufficient. The number of much longer term studies that suggest harmfulness of RF EMFs is growing [14–19].

In his work [20], J.W. Frank identifies four main problems associated with the use of 5G networks. The first is the lack of a clear understanding of what 5G is, because there is still no approved definition therefore, the meaning of this concept differs country to country.

The second problem is the rapidly growing number of laboratory studies demonstrating the destructive effects of high-frequency EMFs *in vitro* and *in vivo* [21]. The third problem is the insufficient quantity of high-quality epidemiological studies dedicated to the adverse effects exposure to 5G EMFs has on human health, but this one is offset by the emerging epidemiological data on the harmful impact of high-frequency EMFs emitted in the networks of the previous generations. In particular, we refer to the study [22] that presents convincing evidence of cancer affecting the brain, auditory nerve and the breast, the genesis of which is associated with exposure to strong RF EMFs peculiar to the networks of the previous generation.

And the last problem is the conflict of interests accompanying the work of many researchers that study EMFs. For example, a report [23] shows that studies funded by private organizations interested in the investigated sources of the EMFs, as a rule, find no connections, and studies funded by the state or independent organizations present quite the opposite conclusions.

However, not everyone agrees with such statements. An article [24] by the team of researchers compared the concern about the development of 5G networks with the panic around the spread of electricity in the early 20th century; to support such a comparison, they tried to investigate the problem from an engineering standpoint and formulated several questions: is there really evidence of a link between carcinogenesis and exposure to 5G network EMFs?; will the spread of 5G lead to an uncontrolled growth of the number of base stations and the level of EMFs?; are there no experimental studies covering radiation emitted by the 5G base stations? The team failed to

find irrefutable scientific evidence that would allow answering these questions in the affirmative. However, they recognize the need to assess any potential health effects of low-level RF EMFs generated by all devices, including those in close proximity to users (5G smartphones, tablets, laptops, etc.).

Another study [25] also reports that adoption of the 5G communication standard will not translate into more intense effect of EMFs on human beings. The researchers described measuring radio frequencies in a 5G network relying on low-power base stations mounted so people could be in their immediate vicinity. The measurements were taken near two NR base stations. One of them had an advanced antenna system capable of forming a beam, and the other a traditional microcell. The sites where the EMF's level was measured were located 0.5 to 100 m away from the stations; the researchers registered both the strongest and the time-averaged field levels at the maximum downstream traffic load. In addition, based on these measurements, they assessed the impact typical for various cases. A comparison with the maximum permissible exposure limits established by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) yielded the maximum exposure coefficients of 0.15 (professional case, at the distance of 0.5 m) and 0.68 (general public case, at the distance of 1.3 m). The effect on non-users was potentially much lower, depending on the activity of other users served by the base station and its beam-forming capabilities: 5 to 30 times lower for a base station with an improved antenna and almost 30 times lower for a traditional antenna base station.

Another study [26] reported similar results. In the worst-case scenario, the specific power was 62% of the maximum permissible level approved by the ICNIRP. However, the authors note that the radiation level increases significantly as the density of users grows and, consequently, there appear more emitting user devices. The level of exposure may increase even more in an environment with a large number of users.

Researchers from Madrid have demonstrated the adverse effects of 5G wireless communication networks [27]. They measured RF EMFs in real time on the street and inside houses, and surveyed residents; the latter revealed signs of unwellness (dizziness, headaches, sleep disorders, etc.).

The effect EMFs from 5G stations have on children and adolescents is a particularly interesting subject, since throughout their lives they are exposed to EMFs generated by stationary or mobile electronic devices [28]. For children, foreign scientists have proposed a comprehensive approach that allows factoring in the influence of all sources of EMFs on the body. For the purpose, they used spot and personal (portable) exposure meters that registered RF EMFs affecting children at school, at home, on playgrounds [29].

In a study conducted in Sweden [30], the effect of artificial EMFs on adolescents was assessed with the help of ExpoM-RF dosimeters. The researchers found that at school, smartphones generated much (67.2%) of the electromagnetic fields the students were exposed to, and the contribution of cellular base stations was only 19.8%. According to the dose calculations, exposure to the environmental sources (cellular network base stations, wireless phone base stations, LAN access points and mobile phones in the vicinity) averaged 6.0% of the brain irradiation dose and 9.0% of the whole body irradiation dose. Thus, the authors came to the conclusion that RF EMFs affecting the adolescents were mainly generated by their own mobile phones. The sources in the environment, like such cellular base stations, play a secondary role.

Another study revealed the relationship between the occurrence of psychomotor and cognitive function disorders in children and the intensity of their exposure to radiation from

base stations. Intense RF EMFs were associated with the arrested development of fine and gross motor skills, spatial working memory and attention in adolescent schoolchildren compared to their peers who were not exposed to such EMFs [31, 32].

At the same time, researchers have shown [33] that the somatic complaints from children cannot always be associated with exposure to base stations. Many authors second this position. In scientific papers, it is often stated that the intensity of EMF in classrooms and at home does not exceed the standards established in various countries, and therefore does not have a significant impact on health [34–37].

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Conclusion

The analysis of the scientific literature showed that, despite numerous studies and reviews dedicated to the influence of RF EMFs created by sources peculiar to the 5G standard networks, there is still no consensus in the scientific community about the possible negative impact associated therewith. There is no doubt that new technologies entail convenience for users and economic benefits. However, given the uncertainty, the task of assessing the potential risk to health of children and adults created by RF EMFs remains an urgent one.

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SUBSTANTIATION OF PROGRAMS FOR HYGIENIC TRAINING ON PREVENTION OF DISORDERS OF THE MUSCULOSKELETAL SYSTEM AND THE EYE AND ADNEXA

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The impact of modern factors of educational environment and extracurricular factors results in the risk of the development and progression of functional impairment and chronic diseases of the musculoskeletal system, as well as the diseases of the eye and adnexa in students. The study was aimed to substantiate the programs of hygienic education in terms of compliance with hygienic recommendations on prevention of the diseases of the musculoskeletal system and the eye and adnexa based on the analysis of scientific papers. The review of studies conducted in 2011–2023 by the Russian and foreign experts that were focused on the impact of the educational environmental factors and the daily routine components on the students' health status was performed using the E-Library, PubMed, Web of Science electronic databases. The impact of such risk factors, as irrational daily routine organization, on the health of students attending general schools, professional and higher educational institutions has been shown. The risk of disorders of the musculoskeletal system and the eye and adnexa resulting from the excess stay in digital environment, lack of physical activity, irrational leisure time organization has been assessed. It is necessary to develop the hygienic training programs involving teachers, lecturers and parents to prevent the effects of the risk factors for disorders of the musculoskeletal system and the eye and adnexa.

Keywords: students, healthy lifestyle, hygiene education

Author contribution: Khorosheva IV — study concept and design, data acquisition and processing, manuscript writing and editing.

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Received: 03.08.2023 **Accepted:** 08.08.2023 **Published online:** 29.08.2023

DOI: 10.24075/rbh.2023.074

ОБОСНОВАНИЕ ПРОГРАММ ГИГИЕНИЧЕСКОГО ВОСПИТАНИЯ ПО ПРОФИЛАКТИКЕ БОЛЕЗНЕЙ КОСТНО-МЫШЕЧНОЙ СИСТЕМЫ, ГЛАЗА И ЕГО ПРИДАТОЧНОГО АППАРАТА

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Воздействие современных факторов образовательной среды и внеучебных факторов обуславливает риски возникновения и прогрессирования функциональных отклонений и хронических заболеваний костно-мышечной системы, болезней глаза и его придаточного аппарата у обучающихся. Целью работы было обосновать программы гигиенического воспитания в части соблюдения гигиенических рекомендаций по вопросам профилактики возникновения болезней костно-мышечной системы, глаза и его придаточного аппарата посредством анализа научных публикаций. Проведен обзор выполненных в 2011–2023 гг. исследований российских и зарубежных специалистов, рассматривающих влияние факторов образовательной среды и компонентов режима дня на состояние здоровья обучающихся, с использованием электронных баз данных E-Library, PubMed, Web of Science. Показано влияние таких факторов риска, как нерациональная организация режима дня на здоровье обучающихся общеобразовательных организаций, организаций среднего профессионального и высшего образования. Оценены риски развития нарушений костно-мышечной системы, болезней глаза и придаточного аппарата, обусловленные избыточным нахождением в условиях цифровой среды, недостатком двигательной активности, нерациональной организацией досуга. Необходима разработка предполагающих участие педагогов, преподавателей и родителей программ гигиенического воспитания обучающихся, направленных на предупреждение влияния факторов риска развития болезней костно-мышечной системы, глаза и его придаточного аппарата.

Ключевые слова: обучающиеся, здоровый образ жизни, гигиеническое воспитание

Вклад авторов: И. В. Хорошева — концепция и дизайн исследования, сбор и обработка материала, написание и редактирование текста.

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Статья получена: 03.08.2023 **Статья принята к печати:** 08.08.2023 **Опубликована онлайн:** 29.08.2023

DOI: 10.24075/rbh.2023.074

Health preservation and creation of favorable environment for the students' growth and development are among the most important directions of the state policy of the Russian Federation [1].

Today, when speaking about the students' health status, a trend towards the decrease in morbidity can be noted that is reported by both Russian and foreign researchers [2, 3].

The learning period is characterized by the prolonged exposure to a combination of environmental factors. Educational process becomes more and more difficult every year, digital educational devices are widely used, and the amount of academic material to be learned is increased [4–6].

These circumstances, along with other factors of educational environment, lifestyle and the features of the diet, can significantly affect the students' health formation [7–9].

The daily routine of adolescents (high school seniors and college students) cannot be called rationally organized due

to insufficient or no physical activity, insufficient night sleep and day rest, irregular and unbalanced diet, and prolonged stay in the conditions of digital environment [10–12].

The above deficiencies, in turn, can be predisposing risk factors for occurrence and development of the disorders resulting from non-compliance with the hygienic recommendations on the rational daily routine organization, such as the musculoskeletal system functional impairment and chronic disorders, diseases of the eye and adnexa [13–16].

The study was aimed to substantiate the hygienic education programs in terms of compliance with the hygienic recommendations on prevention of the diseases of the musculoskeletal system and the eye and adnexa by analysis of scientific papers.

The review of the scientific papers focused on the impact of factors of educational environment and daily routine components on the students' health status that were published

in 2011–2023 in the E-Library, PubMed, Web of Science databases was performed.

Studying in general schools (secondary comprehensive schools, gymnasiums, lyceums) and secondary professional and higher educational institutions is characterized by the prolonged exposure to a combination of factors that can be roughly divided into educational and after-school risk factors. The former include the increase in educational load along with irrational organization of educational process, inadequate knowledge about healthy lifestyle formation and students' health preservation among teachers and lecturers, lack of communication between educational and medical institutions. It should be noted that the school, college and higher education often fails to consider individual characteristics of certain student's health status [17–20].

The researchers, both Russian and foreign, point out that among numerous after-school risk factors the most common are irrational organization of the daily routine components, such as physical activity, work-rest regime, night sleep, prolonged and often uncontrolled stay in digital environment, non-compliance with the basic principles of rational nutrition, stress resulting from the educational process intensification, and the fact that there are assessments in schools and the test/exam periods in the secondary professional and higher educational institutions [21–24].

Irrational daily routine organization, specifics and amount of educational materials that has to be learned by students within tight deadlines increase the risk of anxiety disorders and depression, functional impairment, disorders of the musculoskeletal system and the eye and adnexa [25–27].

The prolonged use of various electronic gadgets by schoolchildren and students both when preparing for lessons and training sessions and in their spare time results in postural distortion due to incorrect working posture. Poor working posture when reading or writing for a long time can lead to the lower back pain, paravertebral muscle fatigue, changes in biomechanics and impaired function of the spine [28, 29].

A significant increase in the “on-screen” time spent when doing homework using gadgets or playing games on computer or tablet, communicating in various messengers installed on the smartphones in leisure time results in the significant decrease in physical activity and night sleep duration, as well as in virtual exclusion of napping from the daily routine on weekends. The prolonged stay in digital environment disrupts optimal sleep pattern, multiplies the risk of sleep disorders and adversely affects the function of the visual analyzer and the musculoligamentary system [30–32].

Functional disorders of the musculoskeletal system, such as poor posture, arch disorders, flat foot, occupy one of the leading places in the morbidity structure of students [33]. Poor posture, the progression of which can result in scoliosis, can have a significant effect on the development of the respiratory, digestive, cardiovascular, and endocrine system disorders [34]. Flat foot is one of the factors limiting physical education, it leads to earlier tiredness and fatigue [35].

Low levels of motor activity, wearing shoes that are non-compliant with the hygienic recommendations and educational supplies, the weight of which significantly exceeds the levels recommended by sanitary rules are among the causes of the increased incidence of foot deformities among high school seniors and students [36, 37].

Physical education classes conducted in educational institutions with no physical activity during extracurricular time fail to sufficiently fill the natural need for movement required for students of various age groups. At the same time the

share of physical training and game sports in the time budget of the daily routine decreases considerably. The reasons for changes in the daily routine are often subjective. The today's students do not think that motor component is essential for the development of adherence to healthy lifestyle. In some students, both schoolchildren and undergraduates, understanding of healthy lifestyle is limited to abandoning conventional harmful habits, such as smoking and consuming various alcoholic beverages. Considering the fact that high school seniors and the youth attending colleges and higher educational institutions shape their daily routine and the duration of certain daily routine components on their own, in some cases physical activity is almost completely replaced by the prolonged stay in digital environment [38, 39].

Certain studies confirm the adverse effects of electronic gadgets on vision in schoolchildren and students. The prolonged use of electronic devices during the day results in the reduced duration of other daily routine components, such as sleep, physical activity, meals. Working in the digital space is not limited by the time spent in educational institutions and goes on at home [40, 41].

It has been found that students spending more than 4 h on their electronic gadgets when doing homework and in their leisure time more often complain of headache and the decrease in visual acuity throughout the year [42].

The findings of the study involving 2,238 schoolchildren aged 12–15 confirmed the high risk of myopia in students due to using computer for 4–6 h or more per week compared to students working on their computers for less than 4 h [43].

The subjective sensations experienced by users of various electronic gadgets, among which the most common are eyestrain and fatigue, eyes red and burning, are referred to as “computer vision syndrome” in the today's scientific literature. The researchers use the word “computer” to mean not only personal computer, but also other devices for information and communication technology with similar technical characteristics. An image displayed on the screen (for example, of smartphone or tablet), is a small, intensely bright raster image. Excess light can result in the glare that impedes perception of information. Working on computer involves the user's continuous engagement with the monitor and keyboard through constant change in the visual perception focus moving from one component to another, thereby leading to the eye muscle fatigue. Smartphone and tablet are gadgets designed for working in the near-field; these can become significant risk factors of myopia in case of prolonged use [44, 45].

Among benefits of the currently used gadgets, students also note usability in any place and at any time of the day regardless of the availability of organized workplace at home. At the same time, weakness of the erector and extensor muscles of the spine resulting from poor posture when reading of writing contributes to eyestrain and accommodative spasm that lead to myopia [46].

The review demonstrates a significant impact of today's environmental and lifestyle factors on students regardless of the schooling level. The intense prolonged use of various electronic gadgets during training in educational institutions, at home and in leisure time is a significant risk factor of functional impairment and chronic disorders of the musculoskeletal system and the eye and adnexa. The prolonged stay in digital environment results in significant reduction of time spent outdoors, physical activity and exertion, as well as in changes of the students' diet. All the above can be prevented by means of hygienic training and shaping adherence to healthy lifestyle [47–50].

CONCLUSION

It is necessary to develop programs for hygienic training of schoolchildren, students of colleges and higher educational institutions in terms of developing the knowledge and skills

related to compliance with the hygienic recommendations on prevention of disorders of the musculoskeletal system and the eye and adnexa to prevent the effects of risk factors. Participation of teachers, lecturers and the students' parents in preventive activities is appropriate.

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EVALUATION OF EFFICIENCY AND QUALITY OF MECHANICAL CLEANING OF AUTOPSY TOOLS IN ULTRASONIC CLEANERS

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Discharging their duties, doctors manning autopsy departments and forensic examiners contact infected biological objects and risk contracting infectious diseases. The risk they run is much higher than dangers faced by specialists involved in other aspects of forensic investigations. This study aimed to assess the effectiveness and quality of mechanized cleaning of autopsy tools in ultrasonic cleaners following standard operating procedures. We compared the results of sanitary and bacteriological examination of the said tools washed manually and mechanically, with the help of ultrasonic cleaners. McNemar's test used in the context of processing of the data allowed revealing the frequency of change of the monitored indicators between the two groups. Mechanical cleaning minimizes direct contact with the tools, allows decontamination of items of complex geometry (including their hard-to-reach parts) without damaging them and ensures high quality of cleaning. With ultrasonic cleaners, mechanized cleaning significantly shortens the time needed to clean medical tools, eliminates the need to wash them manually without compromising their operability, and brings down the risk of workplace injuries and occupational morbidity.

Keywords: forensic medical examination, ultrasonic washing, disinfection of autopsy tools, standard operating procedure

Funding: the study was conducted in the framework of the Kazan Federal University's Strategic Academic Leadership Program (Priority 2030) of the Educational Research Laboratory "New Professional Competencies in Health Saving" of the Institute of Fundamental Medicine and Biology of Kazan Federal University.

Author contribution: Milushkina OYu — manuscript editing; Vasiliev DE — conducting of the study, data collection, analysis and interpretation; Timerzyanov MI — study planning and organization; Valeyeva YuV — manuscript drafting; EV Kiyasova — preparation of the final version of the article, editing.

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Received: 17.07.2023 **Accepted:** 22.08.2023 **Published online:** 16.09.2023

DOI: 10.24075/rbh.2023.075

ОЦЕНКА ЭФФЕКТИВНОСТИ И КАЧЕСТВА ОЧИСТКИ СЕКЦИОННОГО ИНСТРУМЕНТАРИЯ МЕХАНИЗИРОВАННЫМ СПОСОБОМ С ПОМОЩЬЮ УЛЬТРАЗВУКОВЫХ МОЕК

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Врачи — судебно-медицинские эксперты, работающие в секционных отделениях, при выполнении судебно-медицинских экспертиз трупов напрямую контактируют с инфицированными биологическими объектами, рискуют заразиться инфекционными заболеваниями, причем риск этот многократно выше, чем у других сотрудников бюро судмедэкспертизы. Целью исследования было оценить эффективность и качество очистки секционного инструментария механизированным способом с помощью ультразвуковых моек путем применения стандартных операционных процедур. Проведен сравнительный анализ качества обработки инструментов ручным методом и механизированным способом с применением ультразвуковых моек по результатам санитарно-бактериологических исследований. Полученные данные были обработаны методами математической статистики с использованием теста Макнемара (оценка изменения частоты признака в двух группах). Очистка инструментов механизированным способом сводит к минимуму тактильный контакт медицинского персонала, позволяет обработать изделия сложной конфигурации в труднодоступных местах, не повредив их, обеспечивая высокое качество очистки. Механизированная очистка инструментов с применением ультразвуковой мойки позволяет значительно сократить время обработки изделий медицинского назначения, исключить ручную отмывку медицинских инструментов, сохранить рабочие свойства дорогостоящих медицинских инструментов и изделий, свести к минимуму риск производственного травматизма и профессиональной заболеваемости.

Ключевые слова: судебно-медицинская экспертиза, ультразвуковая мойка, дезинфекция секционных инструментов, стандартная операционная процедура

Финансирование: работа выполнена в рамках программы стратегического академического лидерства Казанского федерального университета (Приоритет-2030) Учебно-научно-исследовательской лаборатории «Новые профессиональные компетенции по здоровьесбережению» Института фундаментальной медицины и биологии Казанского федерального университета.

Вклад авторов: О. Ю. Милушкина — редактирование статьи; Д. Е. Васильев — проведение исследования, сбор, анализ и интерпретация данных; М. И. Тимерзянов — планирование и организация исследования; Ю. В. Валеева — подготовка черновика рукописи; Е. В. Киясова — подготовка окончательного варианта статьи и редактирование.

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Статья получена: 17.07.2023 **Статья принята к печати:** 22.08.2023 **Опубликована онлайн:** 16.09.2023

DOI: 10.24075/rbh.2023.075

According to statistics, 89% of all occupational diseases contracted by medical professionals are the result of exposure to biological factors [1]. Discharging their professional duties (autopsies, material evidence examination etc.), forensic experts run a high risk of infection, especially with bacterial and viral agents. It should be remembered that forensic investigations

department (FID) of the Forensic Bureau performs autopsies of bodies of people that led antisocial life and had various infectious diseases, including socially significant or highly dangerous ones, which, in many cases, remained undiagnosed because such people did not request medical assistance when they were alive [2–4].

The professional environment of a thanatologist is swarming with pathogenic microorganisms; its bacterial contamination potential is high and the associated processes intense. Clearly, such working conditions force the body to decrease the immune status and reactivity, which ups the risk of contracting various infections, including the highly dangerous ones [5].

To minimize the risk of infection for its medical staff, the bureau adopted special operating procedures (SOP) designed to improve biological safety of the employees [6].

One of the promising measures aimed at protecting specialists working at FID implies using ultrasonic washers in the process of mechanized cleaning of tools used for autopsies. This measure allows skipping the most injury-prone and labor-intensive stage: manual cleaning with the help of brushes and other mechanical aids that are often sharp and unhandy. Ultrasonic washers require medical staff to only load the trays and take the clean inventory ready for work once the cleaning cycle is complete. These devices allow decontaminating the tools up to 4.5 times faster [7, 8]. Moreover, ultrasonic cleaning eliminates the need to use organic solvents, and the waves can reach even the parts most hard to access. No joints, crevices, openings, orifices or cavities can compromise effectiveness of an ultrasonic washer; the process is totally safe and, at the same time, delicate.

Thus, the key advantages of mechanized cleaning of tools are obvious: minimization of direct contact with the cleaned tools; possibility to clean many tools within a short period of time; increase of the service life of expensive tools through curtailing the damage thereto associated with cleaning; high quality of cleaning of the hard-to-reach parts of tools of complex geometry [9, 10].

Ultrasonic washers are especially effective for mechanized disinfection and pre-sterilization cleaning of smaller piercing and cutting medical tools of complex geometries. By its nature, the contamination can be water-soluble and partially soluble, polar organic and non-organic compounds, blood, protein etc.; solid and liquid films of oil and fat of phytogetic, mineral (new tools) and animal origin, etc. [11].

For FID, ultrasonic washers are an optimal solution in the context of forensic investigation activities.

The purpose of this study was to evaluate the effectiveness and quality of mechanized cleaning of autopsy tools with ultrasonic washers based on the results of sanitary and bacteriological test.

MATERIALS AND METHODS

To evaluate the quality of cleaning of autopsy tools (trays, knives, scissors), we conducted a number of sanitary and

bacteriological tests at FID of the Republican Forensic Bureau of Healthcare Ministry of the Republic of Tatarstan, within the period from February, 3 through June, 18, 2021.

We compared the results of manual and mechanized cleaning of the said tools, the latter involving ultrasonic washers. Through the time period stated above, we collected 72 samples (swabs) and tested each for *S. aureus* coliform bacteria. All the samples were taken from the surface of the tools used for autopsy and washed mechanically afterwards. Collecting the samples, we followed guidelines given in MUC 4.2.2942-11 "Methods of Sanitary and Bacteriological Testing of the Environmental Objects and Air in Medical Facilities and Control of Sterility therein" [11]. We have not detected *S. aureus* neither in the experimental nor in the control group, therefore, all calculations and assessment of effectiveness were based on the data on contamination with coliform bacteria exclusively.

We formed two groups, experimental and control. The latter group included 36 samples swabbed from the tools cleaned by a forensic expert's aide at the end of the shift or an autopsy; the aides cleaned tools only of the experts they were working with through the shift. In other words, the pattern was "individual and decentralized manual cleaning of the tools." The samples were swabbed after washing and drying.

The experimental group included 36 samples swabbed from the tools that were cleaned after an autopsy or at the end of the shift as follows: primary disinfection, then rinsing with water, then, as per the respective SOP, disinfection and pre-sterilization treatment in an ultrasonic washer (lockable tools were put into the disinfecting solution open). Cleaning of all the tools was a centralized process that followed a single routine described in the SOP. There were no individual sets of tools. The samples were swabbed after washing and drying.

We used the mathematical statistics methods to process the resulting data; the software used for the purpose was Microsoft Excel 2010 (Microsoft; USA). McNemar's test was applied to assess the results of microbiological tests and find out the frequency of change of the monitored indicators between the two groups. The difference was considered significant at $p = 0.001$.

RESULTS

Sanitary and bacteriological testing of swabs from surfaces of tools aimed at detecting coliform bacteria revealed that such were significantly more often found in samples taken before application of SOP than after these procedures were carried out (Table 1).

Table 1. Presence (1) or absence (0) of coliform bacteria in swabs from surfaces of metal tools used in the FID of the Forensic Bureau of Healthcare Ministry of the Republic of Tatarstan.

Samples taken from	Before application of SOP				After application of SOP			
	Sampling dates in 2021							
	03.02	08.02	10.02	17.02	02.03	09.03	30.03	19.04
Tray	0	0	0	0	0	0	0	0
Knife	0	0	0	0	0	0	0	0
Scissors	1	0	1	0	0	0	0	0
Tray	0	0	0	0	0	0	0	0
Knife	0	0	0	0	0	0	0	0
Scissors	1	0	1	0	0	0	0	0
Tray	0	0	0	0	0	0	0	0
Knife	0	0	0	0	0	0	0	0
Scissors	0	1	0	0	0	0	0	0

Table 2. The 2 × 2 four-field table based on the results of tests of surface swabs (source - autopsy tools) for coliform bacteria

	A2 = 1	A2 = 0	TOTAL
A1 = 1	6	0	6
A1 = 0	30	36	66
TOTAL	36	36	72

Note: A1 — monitored indicator before the experiment; A2 — monitored indicator after the experiment.

Table 2 (2 × 2, four fields) shows the results of surface swabs tests for coliform bacteria, which allowed calculating the chi-squared value (χ^2) using the McNemar's test, the result of this calculation being 30. The drop in frequency of occurrence of the monitored indicator is significant, $p < 0.001$.

Thus, we can affirm that adoption of SOPs prescribing the order of treatment and disinfection of autopsy tools translated into a significantly less frequent detection of coliform bacteria.

DISCUSSION

As noted by a number of authors [6, 12, 13], introduction of standards in medical institutions increases their overall effectiveness and improves safety of the staff.

Assessment of results of sanitary and bacteriological tests has shown that the algorithm for processing autopsy tools, as adopted at the FID of Republican Forensic Bureau of Healthcare Ministry of the Republic of Tatarstan and established in the respective SOP, is the most effective one. It ensures the highest quality of cleaning and treatment of the tools. The algorithm includes washing the tools with cold and hot water, manual mechanical removal of large organic contaminants and primary disinfection by the sectional table, then rinsing with running water, mechanized disinfection and pre-sterilization in an ultrasonic cleaner and, finally, the final washing and drying of tools. The advantages of mechanized disinfection and pre-sterilization of tools have been conformed in several works [5, 14, 15].

The tests for coliform bacteria returned positive only for swabs taken from tools with a complex geometry (scissors), which suggests that the quality of manual washing and disinfection of tools is largely dependent on the human factor, when each forensic expert or his/her aide cleans their own tools and bears full responsibility therefor. Regulatory documents

of the Forensic Bureau prescribe no rules for treatment of tools nor responsibility for their violation. Washing the tools in an ultrasonic cleaner offsets this factor completely.

Based on the results of sanitary and bacteriological tests showing significant effectiveness of the experimental routine, the Republican Forensic Bureau of the Healthcare Ministry of Republic of Tatarstan has made a number of managerial decisions:

1) ultrasonic cleaners were purchased for the Bureau to be used for disinfection and pre-sterilization of the autopsy tools;

2) forensic experts were prohibited from using "personal" autopsy sets they could process individually, cleaning and disinfection became centralized;

3) Bureau's regulations were extended with the requirement to mandatorily and in a centralized manner clean and disinfect all tools used in autopsy and biomaterial sampling after each session, regardless of the cause of death;

4) forensic experts received instructions on standard operating procedures prescribing the order of mechanized disinfection and pre-sterilization of autopsy tools in ultrasonic cleaners, as well as the SOP outlining the process of assessment of the quality of cleaning in such devices.

CONCLUSIONS

Thus, adoption of the mechanized cleaning routines (including those involving ultrasonic cleaners) by medical institutions significantly shortens the time needed to clean medical tools, protects medical staff from dangerous infections, eliminates the need for manual washing, extends service life of the expensive tools significantly, and brings to naught the risk of workplace injuries and occupational morbidity. The use of new technology should be regulated by clear instructions, recommendations and SOPs for personnel, with control over their activities and quality of cleaning enabled by the equipment.

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METHODOLOGICAL APPROACHES TO ASSESSING BRIGHTNESS AND PULSATION OF SMALL-SIZED MOBILE ELECTRONIC DEVICE SCREENS

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Today, the existing regulatory and methodological documents provide no approved methodological approach to hygienic assessment of brightness and pulsation of mobile electronic devices (MEDs) with a small screen. The study was aimed to customize the current procedures used to assess brightness and pulsation of electronic devices with a large screen for hygienic assessment of brightness and pulsation of the small-sized MED screens. The design characteristics of 100 MEDs (smartphones and tablets) used by medical students in their leisure time and during training were estimated; pulsation and brightness of the MED screens were studied. The questionnaire survey of 173 medical students was performed that involved the use of the questionnaire developed by members of the Department of Hygiene, Faculty of Pediatrics, Pirogov Russian National Research Medical University; the students' visual acuity was assessed. Two thirds of medical students (67.5%) use MEDs with the screen size exceeding the average (5.5–6.8 inches). The average brightness of every second MED is less than 50.0% of the highest possible brightness. The decrease in the MED screen brightness results in the increase of pulsation coefficient (Spearman's rank correlation coefficient -0.462 ± 0.025 , $p \leq 0.05$), which can worsen the conditions of visual work. Three quarters of students (76.0%) experience shortage of battery charge during the day; every second student (52.2%) uses the "dark" theme. The development of computer vision syndrome in students is influenced by the MED screen small size (Pearson's contingency coefficient 0.791 ± 0.026 , $p \leq 0.05$) and its low brightness (Pearson's contingency coefficient 0.781 ± 0.027 , $p \leq 0.05$), which confirms a sanitary legislation provision on prohibition of the use of smartphones in educational activities (for training). The use of the proposed methodological approach will make it possible to improve the efficiency of vision problem prevention in the population.

Keywords: mobile electronic devices, smartphones, tablets, screen brightness, screen pulsation, measurement technique, hygienic assessment

Author contribution: all authors made equal contributions to manuscript preparation.

Compliance with ethical standards: the study was approved by the Ethics Committee of the Pirogov Russian National Research Medical University (protocols № 203 of 20 December 2020 and № 209 of 28 June 2021). The study was in line with the principles of biomedical ethics and did not endanger the subjects; the informed consent was obtained for all study participants.

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Received: 24.07.2023 **Accepted:** 29.08.2023 **Published online:** 18.09.2023

DOI: 10.24075/rbh.2023.076

МЕТОДИЧЕСКИЕ ПОДХОДЫ К ОЦЕНКЕ ЯРКОСТИ И ПУЛЬСАЦИИ ЭКРАНОВ МОБИЛЬНЫХ ЭЛЕКТРОННЫХ УСТРОЙСТВ, ИМЕЮЩИХ МАЛУЮ ДИАГОНАЛЬ ЭКРАНА

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В настоящее время в действующих нормативно-методических документах отсутствует апробированный методический подход к гигиенической оценке яркости и пульсации мобильных электронных устройств (МЭУ) с малой диагональю экрана. Целью работы было адаптировать действующие методики измерения яркости и пульсации экранов электронных устройств, имеющих большую диагональ экрана, для гигиенической оценки яркости и пульсации экранов МЭУ, имеющих малую диагональ. Изучены конструктивные характеристики 100 МЭУ (смартфонов и планшетов), используемых студентами-медиками во время досуга и обучения, изучены пульсация и яркость их экранов. Выполнено анкетирование 173 студентов-медиков с использованием опросников, разработанных сотрудниками кафедры гигиены педиатрического факультета РНИМУ имени Н. И. Пирогова, проведена оценка остроты их зрения. Две трети студентов-медиков (67,5%) используют МЭУ с диагональю экрана больше средней (5,5–6,8 дюймов). Средняя яркость экрана каждого второго МЭУ составляет менее 50,0% от максимально возможной. Снижение яркости экрана МЭУ повышает коэффициент его пульсации (коэффициент ранговой корреляции Спирмена $-0,462 \pm 0,025$, $p \leq 0,05$), что может ухудшить условия зрительной работы. Три четверти студентов (76,0%) испытывают дефицит заряда аккумулятора в течение дня; каждый второй студент (52,2%) использует «темную» тему. На возникновение компьютерно-зрительного синдрома у студентов оказывают влияние малая диагональ экрана МЭУ (коэффициент сопряженности Пирсона $0,791 \pm 0,026$, $p \leq 0,05$) и его низкая яркость (коэффициент сопряженности Пирсона $0,781 \pm 0,027$, $p \leq 0,05$), что подтверждает положение санитарного законодательства о запрете использования смартфонов в образовательной деятельности для целей обучения. Использование предложенного методического подхода позволит повысить эффективность профилактики нарушения зрения у населения.

Ключевые слова: мобильные электронные устройства, смартфоны, планшеты, яркость экрана, пульсация экрана, методика измерения, гигиеническая оценка

Вклад авторов: все авторы внесли равный вклад в подготовку публикации.

Соблюдение этических стандартов: исследование одобрено этическим комитетом РНИМУ имени Н. И. Пирогова (протоколы № 203 от 20 декабря 2020 г. и № 209 от 28 июня 2021 г.). Исследование соответствовало требованиям биомедицинской этики и не подвергало опасности участников, для каждого участника было получено добровольное информированное согласие.

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Статья получена: 24.07.2023 **Статья принята к печати:** 29.08.2023 **Опубликована онлайн:** 18.09.2023

DOI: 10.24075/rbh.2023.076

The literature provides data on the impact of physical factors associated with technical characteristics of electronic devices (EDs) on the human body [1, 2].

The researchers have proven that the irrationally arranged information displayed on the ED screen and other ED technical characteristics contribute to the visual analyzer rapid fatigue [3–7].

Mobile electronic devices (MEDs — smartphones, tablets) that show considerable technical and audiovisual differences from the stationary EDs are the most common and affordable information and communication technology (ICT) tools; the features of their effects on the body are poorly understood.

Preventive measures considering the diversity of technical characteristics of various EDs are needed to reduce the ED adverse effects on health [8, 9].

The existing regulatory and methodological documents provide no methodological approaches to recording and assessment of brightness and pulsation of small-sized MED screens.

The development of methodological approach to safety assessment of brightness and pulsation of the MED screens will make it possible to ensure safe conditions for visual work and reduce the prevalence of functional impairments and chronic eye disorders in the population.

The study was aimed to customize the current procedures used to assess brightness and pulsation of EDs with a large screen for hygienic assessment of brightness and pulsation of the small-sized MED screens.

METHODS

In 2020–2021, a questionnaire survey of 173 students of the Faculty of General Medicine and Faculty of Pediatrics, Pirogov Russian National Research Medical University, was conducted that involved the use of the questionnaire developed by members of the Department of Hygiene, Faculty of Pediatrics, Pirogov Russian National Research Medical University, having the following board certificates: “General Hygiene”, “Hygiene of Children and Adolescents”, “Epidemiology”.

The design characteristics of 100 MEDs (smartphones and tablets) used by students in their leisure time and during training were studied, and technical characteristics of these MEDs provided by the manufacturers were assessed. Instrumental assessment of brightness (100 measurements) and pulsation (100 measurements) of their screens was performed. Pulsation and brightness of the MED screens were studied in the dark or with the screened windows, with the general artificial lightning turned on.

The MED screen brightness was measured according to the method [10] customized in accordance with the goals and objectives of the study. Assessment was performed using the Argus-02 luminance meter (VNII OFI; Russia) equipped with radiation transducers, the maximum permissible error of which did not exceed 10%. The meter had a state-recognized calibration certificate.

The MED screen pulsation was measured using the TKA-PKM-08 luxmeter + pulsemeter (“TKA” Scientific Instruments; Russia) equipped with radiation transducers, the maximum permissible error of which did not exceed 10%, according to the method provided in the TKA-PKM-08 user manual and customized in accordance with the goals and objectives of our study. The device had a state-recognized calibration certificate.

When measuring the MED screen pulsation, the MED was on the tabletop. The user took a comfortable position and set the screen brightness to a comfortable level. The study was

performed in the mode of working with the text document opened in conventional word processor. Furthermore, the absence of shadows from the surrounding objects, meter, and a person conducting the measurement was controlled. The color of the text processor background was also recorded in the protocol. The meter was placed at a distance of 1–5 cm from the center of the screen. The parameter was recorded for 1 min. The results were documented in the protocol.

When measuring the MED screen brightness, the luminance meter lens was screened to prevent stray light from entering. The MED was on the tabletop during measurement. Brightness of the working surface of the table was tested for compliance with the established safety requirements before measurement [11]. When performing measurement, the user set the MED screen brightness to the comfortable level considering comfortable body position and the distance from the eyes to the screen. The luminance meter lens was positioned at the eye level of the user in such a way that the optical axis matched the line of sight. The user opened the text in conventional text processor. The color of the text processor background was also recorded. The resulting average screen brightness was calculated as the mean of three direct measurements.

Assessment was performed in the classroom at the Department of Hygiene, Faculty of Pediatrics, Pirogov Russian National Research Medical University, where medical students used MEDs for work. To adjust the study conditions to standard conditions, the measurements were performed in the room reserved for the use of MEDs for work, the luminance level of which complied with the hygienic requirements established for this type of activity.

The luminance parameters of the classroom were measured using the TKA-PKM-43 luxmeter (NTM Ltd.; Russia) with the range of 10–200,000 lx and a maximum permissible error of 8.0%. The meter was calibrated and had a state-recognized calibration certificate. The values obtained during measurement were tested for compliance with the established safety requirements [11].

Statistical processing of the results was performed using the Statgraphics software package (Statpoint Technologies; USA), as well as Microsoft Office Excel (Microsoft; USA) and Statistica 13 PL (StatSoft; USA). Descriptive statistics was used: the mean (M), root-mean-square deviation (m), standard deviation (σ). The relationships between traits were assessed using the Pearson's contingency coefficient (k) and the Spearman's rank correlation coefficient (r). $P \leq 0.05$ was considered to be a critical significance level.

RESULTS

The average ($M \pm \sigma$) MED screen size was 5.6 ± 0.1 inches. MEDs were divided into two groups based on the screen size: MEDs with smaller screen size of 4.7–5.4 inches (32.5%) and that with larger screen size of 5.5–6.8 inches (67.5%).

The MED screen small size made it difficult to measure its brightness and pulsation using the existing regulatory and methodological documents, which was the basis for customization of methodological approaches in accordance with the goals of the study.

Luminance of the working surface of the table was within the range of 300–500 lx, which was consistent with the existing safety requirements for this type of activity [11]. The pulsation coefficient of the general lightning sources did not exceed 5%.

The average screen brightness set by medical students on their MEDs was 145.2 ± 11.7 cd/m², which was less than 50.0% of 300–550 cd/m² (maximum possible brightness

specified in technical characteristics). Such screen brightness was reported by every second medical student ($59.0 \pm 3.0\%$). The average pulsation coefficient was $8.2 \pm 1.5\%$.

It was found that the decrease in the MED screen brightness increases its pulsation coefficient, which can worsen the conditions of visual work involving the use of MED (Spearman's rank correlation coefficient -0.462 ± 0.025 , $p \leq 0.05$).

Just every fourth student (24.0%) has reported that the battery charge is enough for a whole day. This forces students to use power saving techniques for the MED battery. Every second student (52.2%) uses the "dark" theme, while others (47.8%) prefer using the "light" one.

It has been found that the development of computer vision syndrome in students is influenced by the MED screen small size (Pearson's contingency coefficient 0.791 ± 0.026 , $p \leq 0.05$) and its low brightness (Pearson's contingency coefficient 0.781 ± 0.027 , $p \leq 0.05$).

DISCUSSION

The MED user guides issued by manufacturers provide information about such design feature, as screen size measured in inches.

Two thirds of medical students (67.5%) use advanced models of MEDs, the most common screen size is 5.5–6.8 inches. Brightness is one more MED screen feature. The default brightness of smartphones is 100%, however, users often adjust it manually to reduce, since such brightness rapidly decreases the battery life. Thus, more than a half of medical students ($59.0 \pm 3.0\%$) use screen brightness that is below 50.0% of the maximum possible value declared by the manufacturer.

As is known from physical patterns, there is a relationship between the screen brightness and the pulsation coefficient. In our study the relationship was described using the

Spearman's rank correlation coefficient (r), since the distribution of values was non-normal. The Spearman's rank correlation coefficient was -0.462 ± 0.025 ($p \leq 0.05$). This suggests that the screen brightness used (reduced to 50% or lower) increases the pulsation coefficient, thereby worsening the conditions of visual work involving the use of MED.

The design theme, "light" or "dark" is another smartphone screen feature. The "light" theme is based on positive contrast (dark text on light background); the "dark" theme is based on negative contrast (light text on dark background). The theme that can be manually set by the user affects the battery life, extending it. Furthermore, some users like the "dark" theme more. Our study has shown that every second medical student (52.2%) subjectively prefers the "dark" theme.

The findings are consistent with the data obtained by other researchers that suggest the relationship between the ED technical characteristics, the image displayed on the screen, and the user's health problems [4, 5].

The relationship between the development of computer vision syndrome and the MED screen small size (Pearson's contingency coefficient 0.791 ± 0.026 , $p \leq 0.05$) together with its low brightness (Pearson's contingency coefficient 0.781 ± 0.027 , $p \leq 0.05$) confirms validity of the sanitary legislation provision on prohibition of the use of smartphones in educational activities (for training).

CONCLUSIONS

Customization of the existing methods to measure brightness and pulsation of the EDs with a large screen size for hygienic assessment of the small-sized MED screens will make it possible to objectively estimate the risk of vision problems, effectively control brightness and pulsation of the small-sized MED screens, thereby contributing to prevention of vision problems in the population.

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ISSUES OF REPRODUCTIVE HEALTH DEVELOPMENT IN SCHOOLCHILDREN AND PREVENTIVE MEASURES TO ADDRESS THEM

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Currently, there are many problems with the reproductive health of schoolchildren, which can have an adverse effect on the future generations. This article overviews the current papers highlighting the most common problems that negatively affect reproductive health. The key conclusions include statements of the existing problems and suggested measures to counter them. Statements: as a rule, schoolchildren lack sufficient knowledge and skills in the field of reproductive health; often, they do not know the physiological characteristics of their body or cannot navigate them, do not recognize what is normal and what is not in the context of the age-driven development of the body. Measures: educational establishments need to develop and implement preventive measures and programs aimed at teaching schoolchildren the correct reproductive behavior.

Keywords: reproductive health, risk factors, schoolchildren, parents, teachers, medical professionals, knowledge

Author contribution: Solovyova YuV – collection and analytical processing of the topical data, article authoring, final approval of the published version.

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Received: 25.08.2023 **Accepted:** 04.09.2023 **Published online:** 22.09.2023

DOI: 10.24075/rbh.2023.077

ПРОБЛЕМЫ ФОРМИРОВАНИЯ РЕПРОДУКТИВНОГО ЗДОРОВЬЯ ШКОЛЬНИКОВ И ПРОФИЛАКТИЧЕСКИЕ МЕРОПРИЯТИЯ ПО ИХ РЕШЕНИЮ

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В настоящее время существует множество проблем с репродуктивным здоровьем школьников, что может сказаться и на здоровье последующих поколений. В статье представлен обзор современных литературных источников, содержащих сведения о наиболее часто встречающихся проблемах формирования репродуктивного здоровья. К числу основных выводов можно отнести то, что современные школьники, как правило, имеют недостаточно знаний и навыков в области репродуктивного здоровья; школьники часто не знают физиологические особенности своего организма или не могут ориентироваться в них, не распознают, что такое норма, а что нет с точки зрения перестроек организма, возникающих в разные возрастные периоды; необходимы разработка и реализация образовательными организациями профилактических мер и программ, направленных на воспитание правильного репродуктивного поведения школьников.

Ключевые слова: репродуктивное здоровье, факторы риска, школьники, родители, педагоги, медицинские работники, знания

Вклад авторов: Ю. В. Соловьева — сбор и аналитическая обработка данных по теме публикации материала, написание работы, окончательное утверждение версии для публикации.

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Статья получена: 25.08.2023 **Статья принята к печати:** 04.09.2023 **Опубликована онлайн:** 22.09.2023

DOI: 10.24075/rbh.2023.077

Maintaining good reproductive health of schoolchildren is one of the urgent tasks for modern society that is related to education. World Health Organization (WHO) defines reproductive health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity, in all matters relating to the reproductive system and to its functions and processes." In the context of overall health of a human being, reproductive health is understood as the most important component of his/her biography; it is an attribute of the life path valuable in itself, a significant factor of personal and social well-being [1–3]. Currently, young families that experience difficulties with having children are the cause of public concern, and they require close attention from medical professionals, educationists, and social services workers [4–7].

We have reviewed academic papers published in the databases E-Library, PubMed, Cyberleninka in 2013–2023.

From the viewpoint of demographics, modern society exhibits decreasing fertility rates against the background of deterioration of the reproductive health of the younger generation.

The rate of development of schoolchildren is constantly increasing, and in this connection, it is very interesting to

investigate hormonal disorders that have been often diagnosed in children and adolescents. There is evidence in the scientific literature that even a mild deficiency of, for example, thyroid hormones can trigger premature sexual development in girls, heterosexual pattern, which means they exhibit signs of puberty peculiar to the opposite gender within the first 10 years of life [8]. Late sexual development, on the contrary, is common among adolescents with hypothyroidism. For example, girls may have menarche at the age of 16–17, and it is often combined with menorrhagia (a physiological condition when the amount of period blood exceeds the norm), or so-called oligomenorrhea (a pathological condition characterized by infrequent menstrual bleeding), or amenorrhea (lack of menstruation) [9, 10].

There is a study [11] that attributes this situation mainly to the risky patterns of reproductive behavior common among young people, including early sexual debut, bad habits, low level of education of young parents, disadvantaged social status, problems in the family and personal life, early (minor age) pregnancy [12–14].

Another study [15], which involved residents of Samara, mentions iron deficiency as one of the etiological factors affecting reproductive health of modern girls and women. Inter

alia, the report describes their diets, which is mainly plant-based for 46.0% of participating girls and 23.0% of women and dairy-based for 30.0% and 16.0% of them, respectively. Other conditions noted as causing iron deficiency are abundant and prolonged menstruation lasting over 4 days (40.0% and 8% of cases), chronic diseases of the gastrointestinal tract (12.0% and 4.0%), chronic kidney diseases (5.0 and 1.0%).

Currently, children and adolescents frequently consume fast food dishes, sweet carbonated drinks. Medical professionals, including pediatricians, gastroenterologists, nutritionists, and endocrinologists, believe this trend creates prerequisites not only for overweight and obesity, but also for other metabolic disorders, including diabetes mellitus. This means that childhood and adolescence are the periods when it is necessary to monitor blood sugar and restrict intake of fast digesting carbohydrates contained in fast food dishes. In this regard, attention of teachers, parents, doctors and children themselves should be drawn to proper eating behavior, nutrition culture, as well as healthy lifestyle principles and adherence thereto, especially if the family has a burdened history, since such families run a higher risk of diabetes mellitus and severe course of type I diabetes. Both parents and children should remember that even if a child has diabetes mellitus, adequate and timely insulin replacement therapy ensures normal sexual development, menstrual and childbearing function [16–18]. In case of children and adolescents, there is a direct link between disadvantaged socio-economic living conditions and irrational nutrition, which translates into excessive or insufficient body weight [19]. If a family has financial constraints and neither older nor younger generation in that family is properly literate about food and nutrition, children and adolescents therefrom tend to eat cheaper, flavored products with enhancers, which may lead to not only various metabolic disorders but also up the risk of allergic diseases, and as a consequence — endocrine pathology and reproductive health disorders [20].

Recently, digitalization brought both children and adolescents to computer displays, tablets, phones, with which they spend much time. Often, they remain static throughout this time, which can compromise blood supply and promote development of not only carpal tunnel syndrome, but also hinder blood flow to the pelvic organs, which can subsequently lead to disorders of both urinary and reproductive systems [21].

The matter of frequent use of e-cigarettes by schoolchildren and adolescents and its connection with reproductive health requires special attention. As a rule, inhaled vapors contain propylene glycol, glycerin, flavors, nicotine, as well as toxic metals such as lead, chromium, nickel, manganese, which can affect reproductive health of schoolchildren (future parents), cause various allergic reactions and so-called "cellular lung" (alveolitis), as well as, potentially, miscarriage and even stillbirth [22, 23].

Tattoos are another source of danger. They have recently become common among teenagers, especially those tending to behave aggressively, which raises concerns, since tattoos, which are made even next to the genitalia, can cause infection, fungal skin lesions, up the risk of contracting HIV, hepatitis, lichen planus. In the future, keloid scars may appear at the site of the tattoo.

Male teenagers today can neglect personal hygiene rules, practice unsafe reproductive behavior (frequent change of partner, several partners at the same time, lack of contraception), fail to follow medical recommendations. Young people in general often opt for self-treatment based on advice heard from acquaintances, bloggers, internet sources, and medical professionals are contacted only when the disease progresses.

Since it is more difficult for boys than girls to properly practice personal hygiene (due physiology of the reproductive system organs), the combination of all these factors often leads to inflammation and makes the condition (urethritis, phimosis, balanitis) chronic [24].

Modern schoolchildren, as a rule, do not have enough knowledge and skills in the field of reproductive health. At the same time, both boys and girls tend to grow faster and enter puberty at an earlier age today [25].

Often, schoolchildren do not know physiological characteristics of their body or cannot navigate them; they do not understand what is normal and what is not in the context of age-driven development of the body. Such illiteracy leads to schoolgirls not recognizing the onset and formation of menstruation, for example, which is not a rare situation [26].

Schoolchildren lack clear and correct concept of reproductive health. The School of Reproductive Health project was launched in the children's polyclinics of Russia to address this problem; it targets adolescents of both genders. The project aimed to study what can motivate teenagers (15-year-olds, grades 9 and 10) to preserve reproductive health, and to learn specifics of their actual sexual behavior with the help of questionnaires containing questions on reproductive health. The School of Reproductive Health was found to stimulate adolescents to preserve their reproductive health, with girls being the gender group more compliant to the innovative educational program than boys [27, 28].

As practice shows, accelerated growth, early sexual development and debut during school years make both children and their parents concerned about prevention of infections, including those transmitted sexually. This issue is particularly worrying for parents of teenagers. Educational work can effectively mitigate these problems. It should be aimed at improving reproductive health literacy and sexual behavior culture not only among schoolchildren, but also among parents, teachers, as well as the so-called social environment of children and adolescents, which is extremely important, since children and adolescents copy the behavior of adult family members and those commonly around them. Currently, overloaded educational process at school often prevents teachers from paying sufficient attention to giving knowledge and skills in the field of preserving and reinforcing reproductive health [27].

Conclusion

Thus, currently, there are many issues with reproductive health of schoolchildren that adversely affect future generations. This proves the importance and global scale of this problem. Improving literacy in matters of hygienic education from the standpoint of preserving and strengthening reproductive health is an important and sought-after effort.

Reinforcement of reproductive health of both children and adolescents requires a comprehensive approach that unites inputs from everyone involved, including pediatricians, gynecologists, urologists, psychologists, nutritionists, educators, and parents. It is necessary to enlighten schoolchildren about reproductive health both in the classroom (for example, at biology and safety of living classes) and in the context of extracurricular activities, which can be open lessons, webinars included in the program that cover this topic and involve respective medical professionals.

The results of implementation of such preventive measures should be accessible and take the form of various visual materials — informational posters, banners, brochures, memos intended for both children and parents. The list

of activities designed to promote reproductive health preservation at school can include group lessons in the classroom (at school), individual tasks that imply writing reports covering this problem, as well as work with groups of boys

and groups of girls, conducting open Q&A sessions dedicated to reproductive health for schoolchildren and leading teachers, psychologists, as well as involvement of doctors (pediatricians, family doctors, obstetricians-gynecologists, urologists).

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ROLE OF PARENTS IN HYGIENIC AND SEXUAL EDUCATION OF CHILDREN AND ADOLESCENTS

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The issue of protecting reproductive health is closely related to the children's and adolescents' awareness of the negative impact of early sexual activity and pregnancy, as well as sexually transmitted diseases. At the same time, awareness of parents involved in raising children is poorly understood. The study was aimed to estimate the parents' competence (awareness) in the field of children's sexual and hygienic education by conducting a webinar and an online questionnaire survey. Parents were surveyed in 2022–2023. A psychologist conducted the webinar, after which the online questionnaire survey was carried out in order to assess the effectiveness of the webinar as a relevant tool to improve the parents' competence. It was found that almost all parents believed it was necessary to discuss the issue of sexual education with children, however, among them only 64.4% actually addressed the issue. Parents had no consensus on the age of starting sexual education in children. The main difficulties in communication with children were shyness, insufficient knowledge and the lack of methods to inform the child. According to 91% of women and 66% of men, the webinar conducted by psychologist was the best method to improve the parents' competence. It appeared to be informative for 90% of parents. The joint efforts of parents, doctors, psychologists, and teachers are the solution to the problem of sexual and hygienic education. Furthermore, informational and educational work with parents and the family is important, since the child's sexual and hygienic education is started since early age.

Keywords: sexual and hygienic education, parents, online questionnaire survey, webinar

Author contribution: Demchenkov NO — conducting the online questionnaire survey, processing and describing the study results, manuscript editing; Krasilnikova ED — conducting the webinar and online questionnaire survey, data processing and interpretation; Sheina NI — study concept, literature review, describing the results, manuscript writing and editing; Korolik VV — editing and formatting the final version of the article.

Compliance with ethical standards: the anonymous online questionnaire survey did not violate human rights, did not endanger the respondents and was compliant with the biomedical ethics requirements.

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Received: 29.08.2023 **Accepted:** 16.09.2023 **Published online:** 26.09.2023

DOI: 10.24075/rbh.2023.078

РОЛЬ РОДИТЕЛЕЙ В ГИГИЕНИЧЕСКОМ И ПОЛОВОМ ВОСПИТАНИИ ДЕТЕЙ И ПОДРОСТКОВ

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Проблема охраны репродуктивного здоровья тесно связана с уровнем информированности детей и подростков об отрицательном влиянии ранних половых отношений и беременности, а также заболеваний, передающихся половым путем. При этом осведомленность родителей, участвующих в воспитании детей, изучена недостаточно. Целью работы было оценить компетентность (осведомленность и информированность) родителей в области полового и гигиенического воспитания детей путем проведения вебинара и онлайн-анкетирования. Анкетирование родителей выполняли в 2022–2023 гг. Психолог провел вебинар, после которого также был проведен онлайн-опрос для оценки эффективности вебинара как актуальной формы повышения грамотности родителей. Установлено, что почти все родители считали необходимым обсуждать тему полового воспитания с детьми, однако лишь 64,4% из них действительно затрагивали данную тему. Родители не имели единого мнения о возрасте начала полового воспитания детей. Основными трудностями при общении с детьми были стеснительность, отсутствие достаточных знаний и способов донесения информации детям. По мнению 91% женщин и 66% мужчин, наилучшим способом повышения грамотности родителей был проведенный психологом вебинар. Он оказался познавательным для 90% родителей. Решением проблемы полового воспитания и гигиенического образования детей является совместная деятельность родителей, врачей, психологов и педагогов, при этом важна информационно-образовательная работа с родителями и семьей, поскольку половое и гигиеническое воспитание начинается с раннего возраста ребенка.

Ключевые слова: половое и гигиеническое воспитание, родители, онлайн-анкетирование, вебинар

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Соблюдение этических стандартов: анонимное онлайн-анкетирование не ущемляло права человека, не подвергало опасности респондентов и соответствовало требованиям биомедицинской этики.

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Статья получена: 29.08.2023 **Статья принята к печати:** 16.09.2023 **Опубликована онлайн:** 26.09.2023

DOI: 10.24075/rbh.2023.078

The issue of the development and protection of reproductive health is of great medical and biological significance, it is closely related to demographic processes. In recent years, this issue is discussed not only by doctors in the context of treatment of inflammatory and infectious disorders, but also by hygienic physicians in the context of preventive care. They try to identify the causes leading to reproductive health deterioration in the

youth. Awareness of children, adolescents, and young adults of the reproductive function development, negative impact of early sexual activity and pregnancy, as well as sexually transmitted diseases is among important aspects of the issue [1–3].

The researchers report low awareness of adolescents of different ages (school-age girls, female students of medical college, university students) of the issues related to reproductive

health protection. The scientists believe that the lack of awareness among adolescents is closely tied to the lack of specialized programs on the issue in the educational process, i.e. with the information awareness degree. Thus, medical college students believe that it is better to acquire information related to sexual maturation on one's own at the age of 16–17 years, while university students think that understanding of the issues related to sexual sphere is achieved only at the age over 13 years [4–8].

In contrast to Russia, in European countries (such as the Netherlands, Scandinavian countries) parents are used to talk to children on the issues related to sex starting from preschool age [9]. Many researchers in our country have the same opinion, since conversations between parents and the young child in the format the child understands open the door for understanding the issue in the future [10]. We believe that the problem of assessing the parents' awareness of the children's sexual education is important in this context, however, there are sporadic papers on the issue in the available literature.

The study was aimed to estimate the parents' competence (awareness) in the field of children's sexual and hygienic education by conducting a webinar and an online questionnaire survey.

METHODS

The study was performed in 2022–2023 by conducting the anonymous online questionnaire survey. The questions of the questionnaires were designed by the authors based on the literature data analysis.

The study was carried out in three phases. A total of 445 parents (32% males, 68% females) were surveyed to understand the awareness level. Then a webinar (lecture and seminar) for parents was conducted together with the psychologist, which was attended by 33 people (48% males, 52% females). During the third phase, after the event, the parents were also offered an online questionnaire survey aimed at assessing the effectiveness of the webinar as a relevant tool to inform parents.

The search for respondents was performed on public sites dedicated to bringing up children, as well as in the social media parent groups. Only people with children, who filled the questionnaire form correctly, were included in the sample of respondents.

Analysis of the results was performed considering the gender and age characteristics, as well as the number of children from parents of the studied cohort. Statistical data processing involving the use of Student's *t*-test and *z*-test

was carried out in the Microsoft Office Excel 2013 (Microsoft; USA) and Biostatistics version 4.03 (Stanton A. Glantz; USA) software packages. The *z*-test was used to estimate the share of positive responses given by females and males; the shares were compared, the hypothesis of equal shares in both groups was tested, standard error and significance level were calculated. When the significance level was set as $p \leq 0.01$, positive responses of females and males differed significantly with the likelihood of 99%

RESULTS

The gender-based differences in responses to almost all questions of the questionnaire were revealed in parents, who took part in the questionnaire survey on sexual education: women were more active, mobile, and progressive. The need to discuss the issue with children was supported by the majority of parents: 95% females and 84% males under the age of 35 years, 45% parents over the age of 45 years. However, a smaller number of parents actually talked to children: the issue was most often discussed by females (78.8%) aged 26–35 (43.2%) having two or more children (56.2%), while among males only 50% of parents were able to talk about it with children. The share of females, who discussed the issue of sexual education, was significantly higher relative to males (significant based on *z*-test, $p \leq 0.01$).

At the same time, 29% of women believed that it was necessary to foster hygienic skills and understanding of sexual identity before the child was 5 years old, however, children aged 8–10 (onset of puberty) also required particular attention. The early start of talking to the child was supported mainly by young women under the age of 35 years, while among older women this view was shared only by 8%. Almost twice less males (significant based on *z*-test, $p \leq 0.01$) believed that children had to be educated before they were 5 years old, while 27% of males believed that it was better to start later (only at the age of 5–7 years) (Fig. 1). A significantly lower number of parents (4% females and 11% males, non-significant due to small sample size) proposed to start sexual education of adolescents at the age of 15 years, convinced they had already got information from other sources.

When performing the questionnaire survey, we tried to find out the reasons for the parents' low activity regarding the issues of personal hygiene and sexual education of children in the family. It was found that 21.9% of females and 58.4% of males forgot information they had got at school in biology lessons, they did not attend the hygienic training events and had

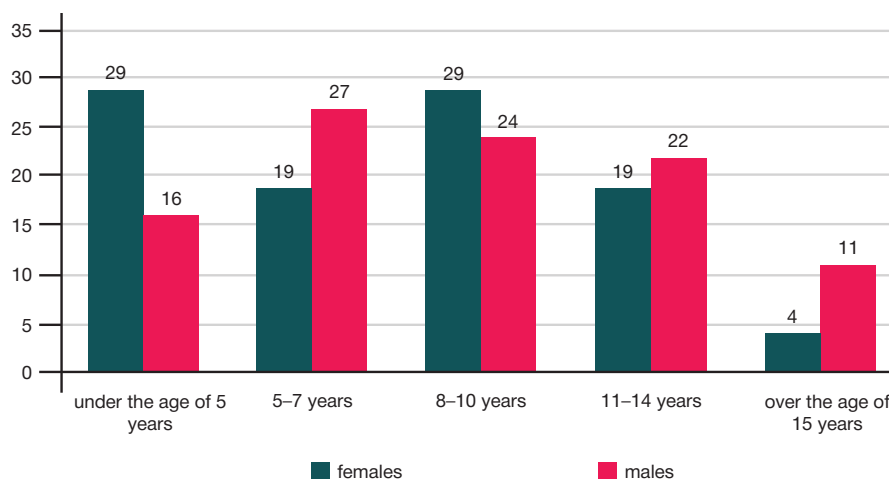


Fig. 1. Views of women and men (per 100 respondents) of the terms of starting sexual education in children

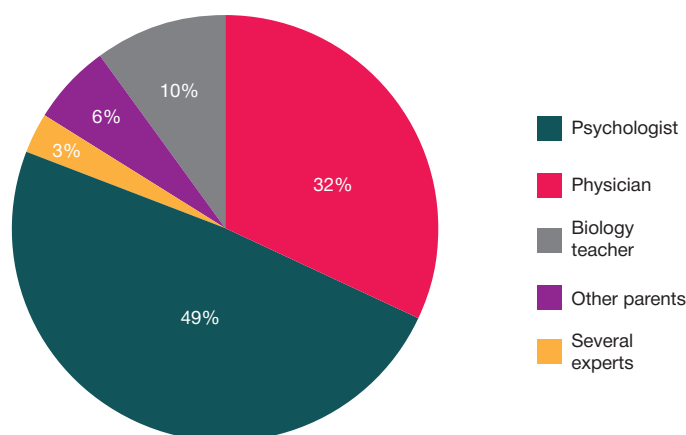


Fig. 2. Experts, whose opinions about sexual and hygienic education parents would like to know (%)

no communication skills with children. Furthermore, parents (41.5%) were frustrated by their individual characteristics (being quiet and shy, poor vocabulary).

Parents believe that various forms of information acquisition can become the solution to this problem: “book, magazine or other literature” (53.6%) or “lecture, webinar”, the majority of respondents voted for (91% females and 66% males). Furthermore, 49% of parents expressed their desire to listen to a lecture by psychologist, 32% of respondents would like a medical professional to explain the issue. Only 3% of parents wished to hear opinions of several specialists in various fields (Fig. 2). A total of 10.3% of parents believed that medical professional (pediatrician), who was in contact with the child during the visit to the outpatient clinic, could correctly explain the features of the reproductive development and personal hygiene rules.

Based on the findings we conducted a webinar together with psychologist to inform parents about the issues of children’s hygienic and sexual education. During the theoretical phase (lecture) the majority of parents managed to master new information and the terms for calm and trustful discussion of the sexual education issues with children, 91.0% of parents became feeling confident when communicating with children, 85.7% of respondents noted accessibility and clarity of information presentation, as well as logical structure of the theoretical part (Fig. 3).

During the practical phase of the webinar for parents, the method to talk to children (78.9%) became clearer, together with the way of behaving when discussing sexual education with the child (95.2%). Parents (90.5%) developed understanding of how the children felt when discussing the issues of hygienic and sexual education. No significant differences in the shares of positive responses regarding attendance and efficiency

of webinars for parents between females and males were revealed.

Thus, 95.2% of parents would advise their friends or acquaintances to attend a webinar on the issue, while 66.7% would like to attend it again. Among parents, who wanted to attend a webinar one more time, 100% were ready to pay for attendance. In terms of price females estimated the webinar 27.7% higher than males. Parents would like a physician to be a speaker during the next online event (78.6%), however, it was impossible to choose a definite format of the event: 38.1% of respondents preferred the distance format, the same number of parents chose the mixed format of the event, the least number of parents (23.8%) chose the face-to-face format.

DISCUSSION

The findings suggest that the majority of parents understand the importance of discussing the issues related to reproductive function development and features, adherence to the principles of personal hygiene with children in the family, since these are parents the newborn child contacts the first. However, only 78.8% of females and 50% of males have managed to address these issues when talking to children. The parents’ low awareness hampers the child’s harmonious development and healthy lifestyle formation. As a result, the family raises children and adolescents with poor reproductive competences. Such adolescents usually get not quite reliable information from the web-sites, friends or mates. We believe that this is due to early sexual intercourse and the desire to “be mature” in adolescents, increased incidence of sexually transmitted diseases and abortions, which is confirmed by earlier scientific research [11, 12].

In this regard the issue of the child’s age when hygienic and sexual education should be started, as well as who should



Fig. 3. Parents’ opinions (%) about the benefits of the webinar theoretical phase

provide such education, become of paramount importance. The majority of researchers distinguish four periods of children's sexual education based on age and the child's reproductive system development stage. However, the first stage (young and preschool age children) is the basic and most important one. During this period parents are recommended to teach their children basic hygienic skills and rules of behavior, inform children about their sexual identity, about infections and parasitic infestations [13, 14]. Understanding of their gender identity by children represents one of the bases of conventional different-sex family ensuring reproduction. At the same time today there are various forms of unisexuality (transness) cultivated in sexual education classes and manifested in the form of same-sex marriage and surrogacy in such European countries, as Germany, Sweden, France, Austria, which adversely affect natural demographic processes.

Parents also play an important role during all phases of sexual and hygienic education, since the foundations of hygienic and sexual education are laid and cultivated in the family. Furthermore, the sanitary and educational work with parents is of great importance: they should be prepared to talking to the child in terms of theory and practice, considering the child's gender, age, and psycho-emotional features. Actually, our findings suggest that about a third of women agree with the statement that it is necessary to start talking to the child before he/she is 5 years old, while men believe that it is necessary to start at the age of 5–7 years.

The questionnaire survey conducted has shown that the majority of parents understanding their lack of competence would like to improve their awareness by taking part in the webinar, acquire theoretical knowledge and consolidate it in practice. However, the realities of modern life are that the majority of parents (49%) primarily want to hear information from psychologist and 32.0% — from physician; only 3% of parents would like to get information from several specialists, which suggests that parents underestimate the complex nature of the issue. Nevertheless, the questionnaire survey of parents conducted after the webinar with psychologist showed its effectiveness, since more than 90% of parents got additional information, mastered the forms and methods of talking to children.

It is beyond doubt that bringing up a healthy young generation is a complex problem that includes psychological, civic, pedagogic and no less important medical and biological aspects. In this regard, it can be recommended to conduct a webinar not only with psychologist, but also with general practitioner, which is of extra importance for young parents. In this case parents would be able to get necessary information about anatomical and physiological characteristics of the body in various age periods, as well as about various children's developmental abnormalities capable of affecting further reproductive system development, prevention of various disorders and personal hygiene rules [6–8, 15, 16].

On the other hand, the role of teachers in sanitary and educational work with schoolchildren, college students, and university students within the framework of educational process is important. That is why academic teachers recommend to develop and introduce a special academic discipline on hygienic and sexual education in the school and university educational programs, conduct open lessons on the issue, which we can agree on [17, 18]. However, our studies revealed no importance of the teacher's role in hygienic and sexual education of children for parents: only 10% of parents would like to discuss the issue with teachers.

As for raising awareness, the majority of parents believe that today webinars represent the most effective communication form, despite the fact that about 24% of parents would prefer face-to-face communication.

To summarize, we can say that despite the fact that the issue related to sexual and hygienic education has multiple aspects, the parents' educational role is important, since these are parents who represent the source of life origin. At the same time, the lack of awareness in adult males and females suggest the increasing importance of informational and educational work with parents and their families. There is a possibility of creating complex informational programs, special web-sites, where experts (physicians, psychologists, teachers) could share their knowledge of the young generation sexual and hygienic education with parents. The integrated competent approach of patients and specialists to addressing the issue taking into account gender and age, as well as individual approach to the child, would actually yield positive results.

CONCLUSIONS

The majority of parents (95% females and 84% males) attach great importance to discussing the issue of sexual education with children, however only 78.8% of females and 50% of males actually address the issue when talking to children. The main difficulties in communication with the child are shyness, insufficient knowledge, and the lack of methods to inform the child about the issue. Parents have no consensus on the age of starting the children's sexual education: women believe that it can be started before the child is 5 years old, while men think that it should be started later. The respondents (both male and female) consider a webinar conducted by psychologist (49% of parents) or physician (32% of patients) as a modern effective form of raising the parents' awareness of sexual and hygienic education. The theoretical phase of the webinar conducted by psychologist appeared to be informative for most patients (more than 90%): parents gained further knowledge and learned the essential terms, then during the practical phase they mastered forms and methods to communicate with children, became more confident in the issues of sexual and hygienic education.

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