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НАУЧНЫЙ МЕДИЦИНСКИЙ ЖУРНАЛ ВОРОНЕЖСКОГО ГОСУДАРСТВЕННОГО МЕДИЦИНСКОГО УНИВЕРСИТЕТА ИМ. Н. Н. БУРДЕНКО И РОССИЙСКОГО НАЦИОНАЛЬНОГО ИССЛЕДОВАТЕЛЬСКОГО МЕДИЦИНСКОГО УНИВЕРСИТЕТА ИМ. Н. И. ПИРОГОВА

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RUSSIAN BULLETIN OF HYGIENE **1, 2021**
ВЕСТНИК ГИГИЕНЫ

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Содержание

Dear colleagues,

We are delighted to announce a new academic journal, *The Russian Hygiene Bulletin*, co-founded by Pirogov Russian National Research Medical University and Burdenko Voronezh State Medical University.

This monodisciplinary journal addresses the problems of hygiene, the main preventive medical science that studies the impact of environmental factors on human health, work performance, life expectancy, the quality of life, and the health of future generations; as a science, hygiene also seeks to design measures for creating a favorable environment for human well-being.

We anticipate to have our journal indexed with Russian and international databases and to provide a platform for authors to share the key results of their doctoral and postdoctoral dissertations.

With a focus on prevention, it is only natural that our journal has joined the constellation of paper and digital scientific periodicals of Pirogov University that publish research into clinical medicine, biomedicine, and ethics in medicine and biology. The editorial board thank Denis V. Rebrikov, Dr. Sci. (Biol.), Provost for Research at Pirogov Russian National Research Medical University, Professor of the Russian Academy of Sciences, for his help in the implementation of this project.

As scientists, we advocate the diversity of scientific journals. So, our primary task is to make the publication process author-friendly and to ensure that published works are available to readers.

We are thrilled that the leading experts in hygiene have accepted our invitation to join the editorial board.

We invite our colleagues to collaborate with us, as we think that an exchange of opinions is the basis of any development. We encourage submissions from hygiene researchers and are looking forward to suggestions and proposals on the evolution of the journal.

We are open to constructive criticism and dialogue.

We hope that with your help our journal will become one of the leading scientific periodicals in the field.

Editor-in-chief, Milushkina OYu, Dr.Sci.(Med)
Deputy editor-in-chief, Popov VI, Dr.Sci.(Med)

Уважаемые коллеги!

Мы рады сообщить о выпуске нового научно-практического журнала «Российский вестник гигиены», соучредителями которого являются ФГАОУ ВО Российский национальный исследовательский медицинский университет им. Н.И. Пирогова и ФГБОУ ВО Воронежский государственный медицинский университет им. Н.Н. Бурденко Министерства здравоохранения Российской Федерации.

Журнал монотематический, направленный на рассмотрение научных вопросов и проблем гигиены — основной медицинской профилактической науки, изучающей влияние факторов среды обитания на здоровье человека, его работоспособность, продолжительность и качество жизни, здоровье будущих поколений и разрабатывающей мероприятия, обеспечивающие благоприятные условия жизнедеятельности.

Развитие журнала подразумевает дальнейшее продвижение и индексацию в российских и международных базах данных и возможность публикации основных научных результатов диссертаций на соискание ученой степени доктора и кандидата наук.

Журнал с профилактической направленностью логично влился в плеяду научных и научно-практических периодических изданий, в том числе электронных, выпускаемых РНИМУ им. Н.И. Пирогова, объединяющих различные направления клинической медицины, биомедицинских исследований, этических вопросов в медицине и биологии. Редакционная коллегия журнала благодарит за помощь в подготовке и реализации нового издательского научного проекта проректора по научной работе РНИМУ им. Н.И. Пирогова, профессора РАН, д.б.н., профессора РАН Д.В. Ребрикова.

Для нас как ученых, наличие выбора альтернативных научных журналов в интересующей области научных знаний является желаемым. Именно по этой причине наша основная задача как издателей — обеспечить авторам, публикующимся у нас, удобные условия размещения результатов своих научных работ, возможность доступа к публикациям для читателей.

Рады, что в составе редакционного совета нашего журнала дали согласие работать ведущие ученые в области гигиены.

Мы приглашаем к сотрудничеству всех своих коллег, считая обмен мнениями основой для любого поступательного развития. Приглашаем всех, занимающихся изучением гигиенических проблем авторов научных исследовательских работ, направлять свои статьи, а также предложения по совершенствованию журнала и его дальнейшему развитию.

Конструктивную критику приветствуем и всегда готовы к диалогу.

Рассчитываем, что с Вашей помощью наш журнал станет одним из лидирующих периодических научных изданий в области гигиены.

Главный редактор, д.м.н. О.Ю. Милушкина
Заместитель главного редактора, д.м.н. В.И. Попов

READINESS OF STUDENTS OF A MEDICAL UNIVERSITY TO USE DISTANCE LEARNING TECHNOLOGIES

Milushkina OYu[1], Popov VI[2], Skoblina NA[1] ✉, Markelova SV[1], Fedotov DM[3], Ievleva OV[1]

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This study aimed to assess the readiness of students of a medical university to use distance learning technologies. For the purpose, specialists of the Department of Hygiene of Pediatric Faculty at the Pirogov Russian National Research Medical University developed online questionnaires. The study involved 508 people studying at the Pirogov Russian National Research Medical University and the Northern State Medical University. The data obtained were processed with Statistica 13.0. Forty-five percent of the respondents stated their electronic device use skill was "high", while 53% considered it to be "basic". Seventeen percent of the students noted that they were stressed out. Following factors could have caused the stress reactions: 22.0% of the respondents reported worsened interpersonal relationships with their fellow students, 23.4% saw their relations with professors deteriorating, 13.0% noted their health has gone worse. The most common (91.9% of cases) learning quality control method applied relied on online tests. In 41.5% of cases, the tests were followed by an interview with the professor. This pattern of learning quality control was appreciated by 74.4% of the respondents. The score given by the respondents to the teaching staff for their performance was 3.9 ± 0.04 points out of 5; the total number of negative opinions given was 30.0%. The study revealed medical university students to be highly ready to use distance learning technologies. Careful attention should be paid to identifying individuals who have difficulties with adapting to the use of distance learning technologies, as well as to work aimed at development of students' health preservation competencies that are useful in both in-person and distance learning scenarios.

Keywords: students, electronic devices, distance learning

Author contribution: Milushkina OYu, Popov VI, Skoblina NA — scientific guidance, writing an article; Markelova SV, Fedotov DM, Ievleva OV — collection of material, statistical processing, literature analysis.

Compliance with ethical standards: This study was approved by the LEK Pirogov Russian National Research Medical University (Protocol № 203 dated 20.12.2020). Voluntary informed consent was obtained for each participant. The online survey for the adult population was conducted on a voluntary basis using an online service. The conducted research does not endanger the participants and complies with the requirements of biomedical ethics.

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ГОТОВНОСТЬ ОБУЧАЮЩИХСЯ МЕДИЦИНСКОГО ВУЗА К ИСПОЛЬЗОВАНИЮ ДИСТАНЦИОННЫХ ОБРАЗОВАТЕЛЬНЫХ ТЕХНОЛОГИЙ

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Целью исследования являлась оценка готовности обучающихся медицинского вуза к использованию дистанционных образовательных технологий. Для этого сотрудниками кафедры гигиены педиатрического факультета РНИМУ им. Н.И. Пирогова были разработаны опросники, распространяемые через онлайн-сервис. В исследовании приняли участие 508 человек, обучающихся в РНИМУ им. Н.И. Пирогова и ФГБОУ ВО СГМУ. Статистическая обработка проводилась с использованием Statistica 13.0. 45% опрошенных оценили свой навык использования электронных устройств как «высокий» и 53% как «базовый». 17,0% обучающихся отметили, что испытывали состояние стресса. Возможными причинами стрессовых реакций могли стать следующие факты: у 22% опрошенных ухудшились межличностные отношения между сокурсниками, у 23,4% ухудшились отношения с преподавателями, 13,0% отметили ухудшение состояния здоровья. В качестве формы контроля качества усвоения знаний, наибольшее (в 91,9% случаев) распространение получил он-лайн тестовый контроль, который в 41,5% случаев был дополнен устным собеседованием с преподавателем. 74,4% опрошенных оказались довольны формой контроля знаний. Работу профессорско-преподавательского состава респонденты оценили на 3,9 ± 0,04 из 5 возможных, общее число негативных оценок составило 30,0%. Показана высокая готовность обучающихся медицинского вуза к использованию дистанционных образовательных технологий. Пристальное внимание должно быть уделено выявлению лиц, имеющих трудности с адаптацией к использованию дистанционных образовательных технологий и работе по формированию у обучающихся компетенций связанных со здоровьесбережением, которые они могут реализовывать как при очном, так и при дистанционном обучении.

Ключевые слова: обучающиеся, электронные устройства, дистанционное обучение

Вклад авторов: Милушкина О.Ю., Попов В.И., Скоблина Н.А. — научное руководство, написание статьи; Маркелова С.В., Федотов Д.М., Иевлева О.В. — сбор материала, статистическая обработка, анализ литературы.

Соблюдение этических стандартов: Данное исследование было одобрено ЛЭК РНИМУ им. Н.И. Пирогова (Протокол № 203 от 20.12.2020). Добровольное информированное согласие было получено для каждого участника. Проведение онлайн-опроса для взрослого населения проводилось на добровольной основе с использованием онлайн-сервиса. Проведенное исследование не подвергает опасности участников и соответствует требованиям биомедицинской этики.

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The widespread integration of distance learning technologies into educational processes at various levels, including medical personnel training, is regulated by the Federal Law 273-FZ of December 29, 2012 "On Education in the Russian Federation" and Order of the Ministry of Education and Science of the Russian Federation of August 23, 2017 "On approval of e-learning, distance learning technologies application Procedure followed by educational institutions in the context of their primary activities" [1–2].

Distance learning offers a number of indisputable advantages, like the possibility of choosing the time and pace of learning, which is especially relevant to asynchronous curricula models. However, there are also some risks associated therewith. The most prominent of them are risks of students' physical and mental health deterioration resulting from improper organization of the educational process. Therefore, it is the task for higher education institutions to develop health preservation competencies of students and encourage them to lead a healthy lifestyle, including in the context of distance learning [3].

The epidemiological situation of 2020 calls for thorough consideration of the accumulated experience of distance learning in medical universities, as well as appraisal of the readiness of all educational process participants to implement distance learning practices.

This study aimed to assess the readiness of students of a medical university to use distance learning technologies and learn their opinion of this form of education provision.

MATERIALS AND METHODS

Specialists of the Department of Hygiene of Pediatric Faculty at the Pirogov Russian National Research Medical University developed online (Google Forms) questionnaires enabling assessment of readiness of the medical university students to practice distance learning [4]. The specialists are certified in General Hygiene, Hygienic Education, Hygiene of Children and Adolescents, Epidemiology. The questionnaires contained questions phrased to reveal the respondents' level of awareness of the risk factors associated with distance learning, specifics of organization of educational process when studying in absentia, and learn their opinions of this form of education provision.

The study involved 508 students (years 1 through 6) studying at the Pirogov Russian National Research Medical University and the Northern State Medical University. Eighty percent of the respondents are female. The inclusion criteria were status of a student, availability of a signed informed consent and a correctly completed questionnaire. The exclusion criteria were lack of the said status (not being a student), lack of a signed informed consent and a correctly completed questionnaire.

This study was approved by the Ethics Committee of Pirogov Russian National Research Medical University (Minutes #203 December 20, 2020). Each participant signed a voluntary informed consent form. The conducted study does not endanger the participants and complies with the biomedical ethics requirements.

Statistical processing of the data was enabled by Statistica 13.0 (StatSoft Inc.; USA).

RESULTS

As part of assessment of readiness of medical university students to use distance learning technologies there were developed three blocks of questions that allowed evaluating:

1) their technical readiness (availability of electronic devices, level of proficiency with information and communication technologies);

2) their psychological readiness (presence of stressful situations, rational self-organization of educational process, motivation for learning, communication with colleagues, professors, etc.);

3) their methodological readiness (respondents' satisfaction with the education provision and learning quality control methods applied at the universities).

The first block (technical readiness) revealed that 45% of the respondents believe their electronic device use skill is "high", while 53% consider it to be "basic". Only 2% of the study participants rated their electronic device use skill as "insufficient".

In 2020, distance learning was practiced for a long period of time (several months), so 85.5% of the respondents considered stationary electronic devices to be the most convenient appliances therefor, with 83.1% owning a desktop computer or a laptop and 70.5% using them to participate in distance learning activities. The rest used mobile electronic devices (smartphones, tablets) for the purpose.

As for the other distance learning prerequisites: 90.9% of respondents had access to the internet, 83.1% had their own stationary electronic device, 75.6% had a dedicated workplace, and 63.2% had a separate room. Such a high proportion of people with a separate room may be associated with the fact that many students left dormitories for the places of their permanent residence when COVID-19 restrictions were imposed.

Thus, the readiness of future doctors for distance learning in terms of electronic device use skills and the prerequisites therefor can be characterized as quite high.

As for the psychological readiness for distance learning, it was established that 83% of the respondents were able to quickly adapt to the new conditions. Only 4% of the respondents failed to adapt to the discussed education practices, which corresponds to the self-assessment of electronic device use skill expressed by study participants.

Subjective scores given by the respondents when assessing the level of stress during the distance learning period averaged at 2.5±0.06 points out of 5. However, 17.0% of the students noted that they experienced stress. Following factors could have caused the stress reactions: 22.0% of the respondents reported worsened interpersonal relationships with their fellow students, 23.4% saw their relations with professors deteriorating, 13.0% noted their health has gone worse.

The analysis of respondents' opinions of their daily regimen during the distance learning period revealed deterioration thereof in 37.0% of cases. Sixty percent of the respondents noted that they had more free time. Half of the students stated their preference for passive rest (reading, watching movies, playing computer games), which did not contribute to health preservation. Restriction imposed in most regions of the country that prevented active recreation could have played their part in this situation.

As for the methodological aspects of the distance learning process, the analysis shows that 79.8% of the respondents used Zoom and 46.9% relied on Skype. Thus, in the context of synchronous curricula, the possibility of live communication with the professors was preserved. Online lectures made up 72.2% of distance learning hours, 61.2% of cases evolved into full-fledged classes and a third took form of online discussions and consultations. In 64.0% of cases, duration of classes did not increase. Overall, 70.0% of the respondents were satisfied with presentation of the educational material.

During the distance learning period, most (71.1%) future doctors actively used online resources when preparing for classes (downloaded books, referred to materials published to the university website). As a result, according to 64.2% of the respondents, their homework and preparing time has increased. It should be emphasized separately that the students identified a number of subjects that, in their opinion, cannot be studied remotely: anatomy, histology, operative surgery, topographic anatomy, and a number of clinical disciplines.

The most common (91.9% of cases) learning quality control method applied relied on online tests. In 41.5% of cases, the tests were followed by an interview with the professor. This pattern of learning quality control was appreciated by 74.4% of the respondents. The score given by the respondents to the teaching staff for their performance was 3.9±0.04 points out of 5; the total number of negative opinions given was 30.2%.

Thus, it should be noted that most respondents expressed their positive opinion of using distance learning elements in the educational process. The negative scores given by 13.2% of the respondents may come from the difficulties with adaptation to the new conditions, stress and the ways the professors have organized the learning process in. In general, from the point of view of effectiveness, distance learning scored 3.3±0.05 points out of 5. Half of the respondents noted that in the conditions of distance learning, it is necessary to teach hygienic practices that pertain to the development of electronic device safe use skills and health preservation.

DISCUSSION

Development of the education system, transition to the new educational standards is associated with the continuously growing requirements for level of qualifications of specialists that have received higher education. This goal is achievable provided the volume and speed of mastering the information studied increase, same as the volume of work done by the students on their own, and if distance learning technologies are introduced to the educational process. Distance learning relies on stationary and mobile electronic devices, the use of which can have a negative effect on health of young people [5–8]. For medical educational establishments, the tasks of developing health preservation skills of future doctors and encouraging them to lead a healthy lifestyle acquire special importance [9].

Foreign experience also signals of possible problems associated with introduction of distance learning. In the context of medical education, students faced the duality of traditional and active teaching methods, which made them concerned about various (numerous) aspects of life [10, 11].

Same as us, the researchers abroad have shown that the majority of respondents perceive online lectures positively, but this does not apply to small group exercises, including autopsy sessions. Less than half of the respondents exhibited anxiety symptoms [12–14].

One of the most significant factors contributing to the success of distance learning is previous online learning experience ($p < 0.01$). This experience correlated positively with the students' assessment of and satisfaction with their current online education activities [15].

In the context of distance learning, it is necessary to improve the educational process, use active learning methods, such as web quests, business games [16, 17]. These technologies enable quick adaptation to online learning, with additional benefits being flexibility, mobility, agility, stability, cultural security and justice [18]. The variety of existing online platforms fit for distance learning purposes requires appropriate training of professors and teachers and improvement of their skills [19, 20].

CONCLUSIONS

The study shows that medical university students are highly ready to use distance learning technologies. The key to increasing the effectiveness of distance education is the improvement of forms of teaching, introduction of their active varieties and improvement of skills of teachers and professors. Careful attention should be paid to identifying individuals who have difficulties with adapting to the use of distance learning technologies, as well as to work aimed at encouraging students to lead healthy lifestyles and development of their health preservation competencies that are useful in both in-person and distance learning scenarios.

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HYGIENIC ASSESSMENT OF THE EFFECTIVENESS OF USING DISTANCE EDUCATIONAL TECHNOLOGIES IN MEDICAL EDUCATION

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The aim of this study was to assess the impact of distance learning technologies (DLTs) on the daily routine and health of medical students during the COVID-19 pandemic. The questions included in the questionnaire were intended to measure the awareness of students about the risks associated with distance learning (DL), elicit their opinion about the organization of the learning process and subjectively assess DL as such. The study was conducted in December 2020. It enrolled 508 medical students of Pirogov Russian National Research Medical University (Moscow) and of Northern State Medical University (Arkhangelsk). Statistical analysis was performed in Statistica 13.0. For categorical variables, the significance of differences was assessed using Pearson's chi-square test. Differences were considered significant at $p \leq 0.05$. The analysis reveals that 80% of the respondents thought that DLTs were implemented effectively. The dynamics of academic performance were used as an objective indicator of content assimilation. No significant differences were discovered in the academic performance of students before, during and after the DL period. Although medical students are ready to use some elements of DLTs in the learning process, there is a need for introducing active teaching methods, refining teaching strategies, perfecting teaching skills and teaching students competencies that can be used to maintain their health in the classroom and in a distance learning setting.

Keywords: students, electronic devices, distance learning

Author contribution: Markelova SV, Fedotov DM — article writing; Khromova AV, Ievleva OV — collection of material, statistical processing, analysis of literature.

Compliance with ethical standards: this study was approved by the LEK Russian National Research Medical University named after V.I. N.I. Pirogov (Protocol № 203 dated 20.12.2020). Voluntary informed consent was obtained for each participant. The online survey for the adult population was conducted on a voluntary basis using an online service. The conducted research does not endanger the participants and complies with the requirements of biomedical ethics.

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ГИГИЕНИЧЕСКАЯ ОЦЕНКА ЭФФЕКТИВНОСТИ ИСПОЛЬЗОВАНИЯ ДИСТАНЦИОННЫХ ОБРАЗОВАТЕЛЬНЫХ ТЕХНОЛОГИЙ В МЕДИЦИНСКОМ ОБРАЗОВАНИИ

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Целью исследования являлась гигиеническая оценка использования дистанционных образовательных технологий (ДОТ) обучающимися медицинского ВУЗа в период пандемии COVID-19. Были разработаны анкеты, содержащие вопросы по уровню информированности обучающихся о факторах риска, связанных с проведением дистанционного обучения (ДО), об организации педагогического процесса в период ДО и субъективной оценке ДО. Исследование проведено в декабре 2020 года. В нем приняли участие 508 обучающихся ФГАОУ ВО РНИМУ им. Н.И. Пирогова и ФГБОУ ВО СГМУ (г. Архангельск). Статистическая обработка данных проведена с использованием Statistica 13.0. Статистическую значимость различий качественных данных оценивали с помощью критерия хи-квадрат Пирсона. Критический уровень значимости принимали при $p \leq 0,05$. Результаты свидетельствуют о том, что положительную субъективную оценку эффективности реализации ДОТ в период пандемии COVID-19 дали 80% опрошенных. В качестве объективного критерия усвоения материала при реализации ДОТ было проведено изучение динамики успеваемости опрошенных. Нами не выявлены статистически значимые различия в динамике успеваемости обучающихся до, во время и после перехода на ДО. Таким образом несмотря на высокую готовность обучающихся медицинского ВУЗа к использованию элементов ДОТ в образовательном процессе, требуется совершенствование форм преподавания, внедрение активных форм, совершенствование умений профессорско-преподавательского состава и формирование у обучающихся компетенций, связанных со здоровьесбережением, которые они могут реализовывать как при очном, так и при ДО.

Ключевые слова: обучающиеся, электронные устройства, дистанционное обучение

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Соблюдение этических стандартов: Данное исследование было одобрено ЛЭК РНИМУ им. Н.И. Пирогова (Протокол № 203 от 20.12.2020). Добровольное информированное согласие было получено для каждого участника. Проведение онлайн-опроса для взрослого населения проводилось на добровольной основе, с использованием онлайн-сервиса. Поведенное исследование не подвергает опасности участников и соответствует требованиям биомедицинской этики.

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The experience of delivering medical education through distance learning technologies (DLTs) during the COVID-19 pandemic which broke out in 2020 is yet to be understood. Although DLTs have been proved to facilitate the learning process, there are still doubts whether students and teachers are ready to use DLTs on a regular basis [1, 2]. According to a recently published meta-analysis, hybrid education, i.e. the combination of in-person classroom instruction and online learning, results in better knowledge assimilation by medical students in comparison with purely in-person or purely online learning [3].

Maintaining and improving student health is a priority, so the impact of DLTs on student health should be thoroughly

investigated. Higher education institutions play the leading role in shaping the personality of tomorrow's doctors and their competencies, even when faced with the challenges of DL [4, 5].

The aim of this study was to assess the impact of DLTs on the daily routine and health of medical students during the COVID-19 pandemic.

METHODS

The Department of Hygiene (Faculty of Pediatrics, Pirogov Russian National Research Medical University) designed an online survey distributed via Google Forms [6]; the authors of the survey were qualified in general hygiene, hygiene education, hygiene of children and adults, and epidemiology. The questions were intended to measure the awareness of students about the risks associated with DL, assess the organization of the learning process and elicit students' opinion about online education as such.

The study was conducted in December 2020 and enrolled 508 first to sixth year students of Pirogov Russian National Research Medical University (Moscow) and Northern State Medical University (Arkhangelsk). The mean age of the respondents was 20.5 years; 80% of the respondents were females. The study included students who gave informed consent to participate and returned clearly and accurately filled-in questionnaires. Exclusion criteria: not being a student, no informed consent to participate, the questionnaire form filled out incorrectly.

The study was approved by the Ethics Committee of Pirogov Russian National Research Medical University (Protocol No. 203 dated December 20, 2020). The study did not pose any health risks for the participants and met the standards of biomedical ethics.

Statistical analysis was carried out in Statistica 13.0 (StatSoft Inc.; USA). For categorical variables, the significance of differences was assessed using Pearson's chi-square test. The effectiveness of DLT implementation was assessed using regression analysis. Differences were considered significant at $p \leq 0.05$.

RESULTS

The survey revealed that 98% of the respondents did not have any difficulty using DLT because they were initially gadget-savvy and their ICT (information and communication technologies) skills were quite good.

When assessing the benefits of transitioning to DL, the students indicated that they did not have to use public transport and that DLTs were a time-saver (27%); they also found they had more time on their hands that could be spent on studies, sleep (24.5%) and work (20%); 10% of the respondents underscored the convenience of using ICT for learning and the high quality of online lectures.

The downsides of DL included the lack of skill practice (34.5%), declining motivation to study (15%), the absence of in-person communication with faculty and other students (15%), health problems (13%), and technical issues, such as the availability of electronic devices, workstation-related problems, problems with Internet access, poor ICT skills, etc. (5%).

When describing their daily routine and leisure activities during the distance learning period, 60% of the respondents reported they had more free time and 63% of the respondents reported an improvement in their daily routine. Of those respondents who had a part-time job (35.5%), 68.5% reported that it was easier for them to combine work and studies during the distance learning period. Faculty efforts were positively recognized by 70% of the participants.

A medical student has to master a variety of very complicated disciplines. So, the respondents were asked to name subjects that could not be mastered through purely online education. The list included anatomy, histopathology, biochemistry, pathological anatomy, topographic anatomy, emergency surgery, clinical subjects like internal diseases and pediatrics. DL-related stress and adaptation difficulties were reported by 17% of the respondents; 64.2% of the respondents reported that it took them longer to do their homework during the DL period.

The regression model ($p = 0.017$) describing the subjective assessment of students' emotional attitude to DL (values > 1 point designate positive attitude, values < 1 point designate negative attitude) does not contain variables associated with age, sex, year of study, academic performance, the ability to use electronic devices, and technology requirements for distance learning. The equation contains variables (1) associated with the absence of stress during the transition to DL, appreciation of the form in which learning materials were presented, and relationships between peers and between students and faculty:

$Y = 0.73 + 0.22X1 + 0.18X2 + 0.09X3 – 0.21X4 – 0.12X5 – 0.14X6$ (1), where

X1 is the absence of stress during the transition to DL;

X2 is the appreciation of the form in which learning materials were presented (the high quality of online lectures and classes);

X3 is the opportunity to combine work and studies;

X4 is the negative impact on daily routine and less free time due to spending more time on home assignment;

X5 designates a declining relationship between peers;

X6 designates a declining relationship between students and faculty.

That said, the quality of distance learning implementation can be inferred from the assessment of its effectiveness by students. The regression model ($p = 0.001$) describing the subjective assessment of DL effectiveness by students (values >3 points indicate positive assessment) contains variables (2) associated mostly with the organization of the learning process and faculty efforts:

$Y = 2.76 + 0.13X1 + 0.21X2 + 0.22X3 - 0.14X4 – 0.19X5 – 0.14X6$ (2), where

X1 is good health (self-assessment);

X2 is an improvement in daily routine and more free time;

X3 is the appreciation of faculty efforts;

X4 is difficulty adapting to DL;

X5 is a dislike of learning material presentation;

X6 is a dislike of knowledge assessment formats.

On the whole, 80% of the respondents thought that DLTs were implemented effectively.

The subjective assessment of DLT implementation reflects the student's perception, in the first place. Another important indicator of knowledge assimilation is the dynamics of academic performance. We asked the respondents to evaluate their academic performance before, during and after the distance learning period. The analysis of the obtained data did not reveal any significant differences in the dynamics of the learning process.

The number of students with excellent performance was stable (7.7%±1.2%). The same was true for the respondents with excellent or good performance (55.3±5.0%, 64.2±5.0%, 56.5±5.0%; $p = 0.21$). The proportion of students whose performance was different from good or excellent (e.g. satisfactory) remained unchanged, too. However, some students reported poor academic performance during and after the distance learning period. This can be explained by

decreased motivation to study online, difficulty self-disciplining and technical issues.

Of all students who had experienced DL, 78.7% said they would prefer in-person classroom learning, with small additions of DLTs. According to 66.7% of the respondents, the combination of traditional learning formats and DLTs could improve content assimilation. Only 9.8% of the students were opposed to using DLTs in the learning process.

Thus, medical students are ready to use DLTs in the learning process if they are not stressed, experience no adaptation difficulties, do not suffer from declining relationships between each other and faculty, and the learning process is organized (to the greatest possible extent) in a traditional manner (traditional presentation of learning materials, traditional knowledge assessment formats, having an opportunity to interact with teachers). About 47.8% of the respondents mentioned the need for being able to use and incorporating health-friendly technologies in the learning process.

DISCUSSION

DLTs involving the use of stationary and mobile electronic devices that impact students' health are a new element of the learning process [7, 8, 9, 10].

Foreign publications have identified a number of problems in teaching medical students. The integration of DLTs into the learning process has uncovered the ambivalence of traditional and active teaching methods, which raised concerns about their impact on different aspects of life [11, 12].

It was reported that the majority of medical students felt positive about transitioning to DL; however, this was not the case with small groups, including autopsy sessions. Less than a half of the respondents developed symptoms of anxiety [13, 14].

Active learning technologies allow both students and teachers, who should be able to use them in the learning process, to adapt to online education and offer a few extra advantages that ensure a flexible, dynamic, mobile, sustainable and culturally safe learning environment [15].

Teachers are expected to be competent and skilled in using various online learning platforms [16, 17].

CONCLUSIONS

This study demonstrates that medical students are ready to use some elements of DLTs in the learning process. However, such technologies raise the need for active teaching methods, refined teaching strategies and perfected teaching skills. The special focus should be placed on identifying students who find DLT challenging. It is imperative that students should be taught competencies that can be used to maintain their health in the classroom and in a distance learning setting.

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SIMULATION GAME TO EDUCATE MEDICAL STUDENTS ABOUT HEALTHY LIFESTYLE

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The aim of this study was to provide a rationale for and to assess the effectiveness of a simulation game in educating medical students who take a course in hygiene-related disciplines about the healthy use of electronic devices. The game was designed by the Department of Hygiene and focused on teaching skills for healthy use of ED. The game was a roleplay simulation, in which students played the role of doctors educating various populations (preschoolers, schoolers, college and higher institution students) about good hygiene practices. The study recruited 220 healthcare workers and 256 medical students. Inclusion criteria: informed consent to participate; submitting a properly completed questionnaire. Statistical analysis was conducted in Statistica 13.0. Of all the healthcare workers participating in the study, 30.0% did not have skills for using electronic devices healthily. The students gave 6.1±0.09 points out of 10 to their commitment to a healthy lifestyle and 5.6±0.12 points out of 10 to their willingness to educate their patients about healthy living. The proposed simulation game helps medical students to develop universal and generic professional competencies needed to lead and promote a healthy lifestyle. The game improves motivation to study, ensures better visibility of learning materials and opens up opportunities for creativity and initiative.

Keywords: students, simulation game, electronic devices

Author contribution: Milushkina OYu, Skoblina NA supervised the study; Markelova SV collected data for the study, performed statistical analysis and wrote the manuscript; Fedotov DM, Kaminer DD analyzed the literature; Ievleva OV, Savchuk PO collected data for the study.

Compliance with ethical standards: The study was approved by the Ethics Committee of Pirogov Russian National Research Medical University (Protocol № 159 dated November 21, 2016 and Protocol № 203 December 20, 2020). Voluntary informed consent was given by all study participants. Participation in the online survey was voluntary. The study followed the principles of biomedical ethics and did not pose any danger to the participants.

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ДЕЛОВАЯ ИГРА КАК МЕТОД ПОВЫШЕНИЯ ИНФОРМИРОВАННОСТИ ОБУЧАЮЩИХСЯ МЕДИЦИНСКОГО ВУЗА О НАВЫКАХ ЗДОРОВОГО ОБРАЗА ЖИЗНИ

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Целью исследования являлось обоснование необходимости и оценка эффективности использования деловой игры для повышения информированности обучающихся медицинского ВУЗа о навыках здорового образа жизни при использовании электронных устройств в рамках преподавания дисциплин гигиенического профиля. На кафедре гигиены педиатрического факультета РНИМУ им. Н. И. Пирогова разработана деловая игра «Формирование навыков безопасного использования электронных устройств». Деловая игра является «имитационно-ролевой», обучающиеся исполняют роли «врачей», которые проводят гигиеническое воспитание для контингентов различного возраста (дошкольники, школьники, обучающиеся колледжей, ВУЗов). В исследовании приняли участие 220 медицинских работников и 256 обучающихся. Критерии включения — наличие информированного согласия, корректно заполненный опросник. Статистическая обработка данных проводилась с использованием Statistica 13.0. У 30,0% опрошенных медиков не сформированы навыки безопасного использования электронных устройств. Обучающиеся охарактеризовали свою приверженность здоровому образу жизни на 6,1 ± 0,09 балла, а готовность давать рекомендации по здоровому образу жизни пациентам на 5,6 ± 0,12 из 10 возможных. Деловая игра способствует формированию универсальных и общепрофессиональных компетенций, направленных на формирование навыков ведения здорового образа жизни и пропаганды здоровьесбережения у будущих врачей. Проведение занятий в форме деловой игры повышает мотивацию к обучению, обеспечивает большую наглядность представления учебного материала и возможность проявления творческой инициативы.

Ключевые слова: обучающиеся, деловая игра, электронные устройства

Вклад авторов: Милушкина О.Ю., Скоблина Н.А. — научное руководство, Маркелова С.В. — сбор материала, статистическая обработка, написание статьи; Федотов Д.М., Каминер Д.Д. — анализ литературы; Иевлева О.В., Савчук П.О. — сбор материала.

Соблюдение этических стандартов: Данное исследование было одобрено ЛЭК РНИМУ им. Н. И. Пирогова (Протокол № 159 от 21.11.2016 года и Протокол № 203 от 20.12.2020 года). Добровольное информированное согласие было получено для каждого участника. Проведение онлайн-опроса взрослого населения проводилось на добровольной основе с использованием онлайн-сервиса. Исследование соответствовало требованиям биомедицинской этики и не подвергало опасности участников.

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Simulations games are used in higher educational institutions as an active learning technique for modeling professional activities. A simulation game encourages its participants to look for solutions to professional challenges, helps them to attain educational goals and facilitates personal growth [1, 2].

In a simulation game, students are actively engaged in a search for new information, but their teacher does not act as the main source of information, although he/she guides and controls the learning process. Importantly, a simulation game involves thinking, action, speech acts, emotional and personal perception, i.e. all types of activity a student should engage in [3, 4].

In the past few years, educational programs for medical students have been implemented amidst the transition to

updated third-generation federal academic standards for higher education. Some of them were approved in 2017 and 2018, but most took effect in 2020. According to these standards, a higher educational institution graduate is expected to have a range of universal, generic and domain-specific professional competencies. For example, a pediatric specialist is expected to have expertise in hygiene allowing him/her to educate the population about good hygiene practices and find solutions to challenges associated with disease prevention. Besides, a pediatric specialist is expected to have mastered a competency in health protection (a universal competency UK-7) and healthy lifestyle (a generic professional competency OPK-2) [5].

The Priority Project on promoting healthy lifestyle and improving public health is to be implemented by 2025 [6]. The project seeks to increase the number of Russian residents leading a healthy lifestyle to 60% by 2025 and thus dictates the importance of finding novel approaches to teaching hygiene-related disciplines. The development of health protection technologies is one of the goals of the Project for basic research that will be implemented in Russia in 2021–2030 [7].

Simulation games have been used at our Department of Hygiene (Faculty of Pediatrics, Pirogov Russian National Research Medical University) since 2018. So far, the Department has amassed some experience in educating its students about the healthy use of electronic devices (ED); this experience needs to be analyzed and summarized.

The aim of this study is to provide a rationale for and to assess the effectiveness of a simulation game in educating medical students who take a course in hygiene-related disciplines about the healthy use of electronic devices.

METHODS

We started off by conducting a survey among 220 healthcare workers from 19 Russian regions in order to assess their awareness of health risks associated with ED. The staff of the Department of Hygiene certified in hygiene education, general hygiene, hygiene of children and adolescents, and epidemiology had designed questionnaires distributed via Google Forms [8]. The respondents were asked about the risks associated with excessive use of ED and skills necessary to use ED healthily. The following inclusion criteria were applied: being a healthcare worker; a properly completed questionnaire. Exclusion criteria: other occupation; the absence of a properly completed questionnaire.

Having analyzed the questionnaires returned by the respondents, we identified the major problems related to the lack of skills allowing healthcare workers to use their ED healthily. These data were used to design questions for the simulation game.

In the second phase of the study, we recruited 256 second-year medical students of the Faculty of Pediatrics. The game offered to the students had been designed by the Department of Hygiene and focused on teaching skills for healthy use of ED. The game was a roleplay simulation, in which students played the role of doctors educating various populations (preschoolers, schoolers, college and higher institution students) about good hygiene practices. Time allocated for the game was 90 min.

The game was played by 128 participants (the main group). Classic teaching techniques were used in the control group (n = 128). The following inclusion criteria were applied: a student of Pirogov Russian National Research Medical University; voluntary informed consent to participate. Exclusion criteria: not being a student; failure to give informed consent to participate. In addition, 5 teachers took part in the game as facilitators. The effectiveness of the game was assessed based on the academic performance of the participants.

No human rights were violated during the study; the study did not pose any danger to its participants and complied with the principles of biomedical ethics formulated in the Declaration of Helsinki and the European Council Directive 8/609 EC. The study was approved by the Ethics Committee of Pirogov Russian National Research Medical University (Protocol № 159 dated November 21, 2016 and Protocol № 203 December 20, 2020).

Statistical analysis was conducted using descriptive statistics, the Mann–Whitney U-test, in Statistica 13.0 (StatSoft Inc.; USA). Differences were considered significant at $p \leq 0.05$.

RESULTS

The respondents (healthcare workers) were asked to answer a series of questions about the eye health of today's children, adolescents and young people; 65% of the respondents described the vision of the younger generation as "satisfactory" or "poor". This suggests that healthcare workers realize there is a problem.

When asked "How often do you take a break from the screen when working with an electronic device?", 41.8% of the respondents said they took a break once every 30-60 min, which meets the principles of good eye hygiene. Others said they took breaks less frequently, and 19.1% of the respondents admitted they did not take any screen breaks at all. Only 14.1% of the respondents said they would not work on their ED in dim lighting, adhering to the principles of good eye hygiene. But 35.5% of the respondents were ready to work in any lighting conditions. Of all the respondents, 47.3% had an organized workstation where they could use their ED. Others said they could use ED in bed, etc.

About 40.0% of the respondents said they could not spend a single day without ED. At the same time, the rest reported they could eliminate ED from their daily activities at least once a week, for example at the weekend. For healthcare workers, the primary source of information about healthy lifestyle was the Internet (55.9%), professional literature (47.7%), and colleagues (30.5%); 6.4% of the respondents were not interested in healthy lifestyle.

To improve their health, most of the respondents avoided unhealthy habits (55.5%), ate healthily (41.4%) and maintained a work-rest balance (35.90%); 15.9% of the respondents did nothing to improve their health. Considering the obtained figures, we conclude that about 30% of healthcare workers do not know how to use ED healthily.

Thus, a lot can be done to educate future healthcare workers about the risk factors associated with ED and healthy lifestyle while they are still students. Commitment to a healthy lifestyle would indeed be an inspiring example to their patients.

That said, students gave 6.3±0.09 points out of 10 to the health risks of ED, 6.1±0.09 points out of 10 to their commitment to a healthy lifestyle and 5.6±0.12 points out of 10 to their willingness to educate their patients about healthy living. This suggests the importance of including the proposed simulation game Skills for healthy use of ED in the learning process.

Based on the obtained data, we identified the main problems associated with the use of ED to be included in the simulation game: work-rest balance, lighting conditions, workstation organization. Visuals for the simulation game included posters, memos written by the students, information on the prevention of risks associated with technical and

audiovisual characteristics of ED (EM field, air ionization, screen size, screen brightness, etc.), indoor environment in the room where ED are used, workstation ergonomics, work-rest balance, information about prophylaxis and rehabilitation for those whose sight is already declining (the recommendations are available on the official websites of the National Medical Research Center for Therapy and Preventive Medicine, the Center for Public Hygiene Education of Rospotrebnadzor and other organizations working in the field of preventive medicine. So, the players learnt to use Internet resources developed by the leading experts that provide information on various aspects of learning and promoting a healthy life style among different populations.

The analysis revealed that our simulation game had improved the students' motivation to study. In the main group, the students received 9.8±0.07 points out of 10 for their academic performance during the class, whereas in the control group, the students received 8.9±0.08 points out of 10 ($p = 0.001$).) Besides, the players reported a subjectively better understating of the visually presented information and said the game gave them better opportunities for creativity and initiative.

DISCUSSION

ED are increasingly used by different groups of the population at school, at work, and outside the workplace. This means, the users should have skills allowing them to use ED safely and healthily. Medical students are expected to develop these skills as part of their competencies associated with promoting a healthy lifestyle and protecting public health [9–12].

Previously, simulation games demonstrated a good effect as a tool for teaching other medical disciplines. This active learning technique was reported to improve motivation to study, allow students to translate accumulated knowledge into actual practice, promote systematization of the obtained knowledge, and provide general understanding of the medical science [13–15].

The analysis of experience amassed by the faculty shows that simulation games improve motivation to study and increase the effectiveness of the learning process.

With regard to teaching hygiene-related disciplines, simulation games can be integrated into the modules that focus on healthy lifestyles, healthy eating, the rational use of information and communication technologies, hygienic aspects of prevention of infections and non-infectious diseases. The choice of modules depends on their significance for "field work", i.e. educating the population about good hygiene practices. It is also important to consider the visibility of the learning materials, the level of independence the student has in the game and the realization of the importance of this activity by the student.

CONCLUSIONS

This study demonstrates the need to bring more attention to the problem of educating medical students and healthcare workers about the healthy use of ED. The study proposes an effective solution: a simulation game that can be integrated into the process of learning hygiene-related disciplines. This active learning technique could encourage future healthcare workers to lead and promote a healthy lifestyle.

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SPECIFICS OF THE DAILY TIME BUDGET OF VLADIVOSTOK HIGHER SCHOOL STUDENTS DURING THE COVID-19 PANDEMIC

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In 2020, the spread of the new coronavirus infection made the education system change significantly, the changes emergency by nature. This could not but affect lifestyle and health of students. This report presents the results of an investigation aimed at studying (hygienic assessment) the peculiarities of the daily time budget of Vladivostok students in the context of the COVID-19 pandemic. Six hundred and thirty four students (years 1 through 4, aged 18 through 24) filled the questionnaires and thus reported on their educational activity, sleep, physical activity, nutrition. It was found that smartphone was the favorite e-learning tool among the respondents, with 5.84±0.93% of them having it is the only means of communication. Distance learners, compared with those studying in-person, significantly more often exceeded hygienic recommendations prescribing time limitations for continuous work with a computer/laptop (39.39±2.21% versus 28.47±3.76% χ^2=5.69, p=0.018). Also, the former have significantly more often exceeded the 7-8 hour night sleep time (15.92±1.65% versus 6.94±2.12%, χ^2=7.49, p=0.007) ... It was established that among students studying online there were significantly fewer people eating once (9.8±1.34% versus 24.31±3.57%, χ^2=20.59, p<0.001) and shortly before sleep (52.24±2.26% versus 64.58±3.99%, χ^2=6.85, p=0.009). Distance learners significantly more often went for a walk than those who attended full-time classes (56.73±2.24% versus 29.86±3.81%, χ^2=8.32, p=0.004). Thus, distance learning allowed continuing the educational process itself, however, it changed the usual regimes and forced redistribution of the time costs.

Keywords: students, distance learning, electronic devices, lifestyle, physical activity

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ОСОБЕННОСТИ СУТОЧНОГО БЮДЖЕТА ВРЕМЕНИ ОБУЧАЮЩИХСЯ ВУЗОВ Г. ВЛАДИВОСТОКА В ПЕРИОД ПАНДЕМИИ COVID-19

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В 2020 г. в связи с распространением новой коронавирусной инфекции система образования претерпела существенные изменения, которые носили экстренный характер, что не могло не сказаться на образе жизни, а также, здоровье обучающихся. Представлены результаты исследования по гигиенической оценке особенностей суточного бюджета времени студентов Владивостока в условиях пандемии COVID-19. Методом анкетирования проведено изучение режима учебной деятельности, сна, двигательной активности, питания у 634 обучающихся 1–4 курсов в возрасте 18–24 года. Установлено, что излюбленным средством электронного обучения у респондентов был смартфон, а для 5,84±0,93% исследуемых он являлся единственным предметом коммуникации. Определено, что обучающиеся дистанционно значимо чаще превышали гигиенические рекомендации по продолжительности непрерывной работы с компьютером/ноутбуком, в сравнении со студентами, находящимися на традиционном обучении (39,39 ± 2,21% против 28,47 ± 3,76% χ^2 = 5,69, p = 0,018), а также значимо чаще превышали временной регламент ночного сна в 7–8 часов (15,92 ± 1,65% против 6,94 ± 2,12%, χ^2 = 7,49, p = 0,007). Определено, что среди студентов, находящихся на онлайн обучении, было значимо меньше людей, питающихся однократно (9,8 ± 1,34% против 24,31 ± 3,57%, χ^2 = 20,59, p < 0,001) и незадолго до сна (52,24 ± 2,26% против 64,58 ± 3,99%, χ^2 = 6,85, p = 0,009). Обнаружено, что обучающиеся дистанционно значимо чаще совершали прогулки, чем посещавшие занятия очно (56,73 ± 2,24% против 29,86 ± 3,81%, χ^2 = 8,32, p = 0,004). Итак, дистанционное образование позволило не прерывать учебный процесс, однако, способ образования сопровождался изменением привычных режимов и перераспределения временных затрат.

Ключевые слова: студенты, дистанционное обучение, электронные устройства, образ жизни, двигательная активность.

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Соблюдение этических стандартов: Выписка из протокола заседания Междисциплинарного комитета по этике № 9 от 29 мая 2020 г.

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Modern society holds person as the most valuable entity, and person, human being, is the main beneficiary of the country's socio-economic growth and development. For every person, the necessary components of a full life are comfortable conditions of existence and the possibility of self-fulfillment, i.e., active and personal realization of one's creative, intellectual and spiritual potential. Therefore, one of the most acute problems in the world today is the creation of conditions for successful socialization and full-scale development of the younger generation in the context of its education. And, as is well known, improving the quality of education ensures a constant and sustainable improvement of mental and somatic health of the country's population. The health preservation skill should be trained in students at the higher school establishments they go to [1–5].

In March 2020, all subjects of the Russian Federation announced the self-isolation regime due to the spread of the

new coronavirus infection. As a result thereof, educational establishments switched to distance learning. In this connection, preservation of health of student youth became one of the most urgent tasks for the society. In today's world, with its lack of social, economic and political stability, this population group experiences the greatest negative effect from the environment and cannot always adapt to new, changed conditions of living, studying, and high mental stress. The studies conducted during this period show that the transition of universities to teaching and working with students online triggered emergence of innovative education provision methods and affected health of the future specialists. Thus, during the COVID-19 pandemic, health deterioration manifestations such as burnout syndrome, depression and anxiousness, as well as somatic symptoms, were identified in university students from different countries [6–12]. Such studies were never conducted in our region. The outlined circumstances determined the purpose and objectives of this study.

The purpose of this investigation was to study the daily time budget of Vladivostok higher school students during the COVID-19 pandemic.

MATERIALS AND METHODS

This was a prospective cohort study. A specially developed questionnaire was offered for filling to Vladivostok higher school students. The material was collected in October and November 2020. In total, 634 students of years 1 through 4 and ages 18 through 24 took part in the survey, 362 female and 272 male. The questionnaire contained questions about their patterns of educational activity, sleep, physical activity, nutrition. We analyzed the priority activities implying use of electronic means of communication (EMC) by students, the frequency and mode of use of various gadgets. The obtained data were processed applying the parametric and nonparametric analysis method. We calculated the mean values (M), standard errors of the mean (m), mean square (standard) deviations (σ), relative values (P), errors of relative values (mp); in the comparative analysis of the studied indicators, Student's t-test and Pearson's criterion χ^2 were used; to study the relationship of features, Pearson correlation test (r), Spearman rank-order correlation coefficient (R) were carried out and calculated. The study checked statistical significance of the obtained coefficients, indicating the achieved level of significance (p) and the actual value of the criterion. Statistical processing of the obtained materials relied on the Statistica 10.0 software package run under Windows 2010 operating system [13].

RESULTS

The analysis of educational activities showed that in this time period, students of Vladivostok universities studied relying on distance learning technologies (DLT). In this manner, 27.13±1.77% of respondents had a third of the classes relying on DLT, for 18.3±1.54% DLT enabled half of the disciplines, 17.03±1.49 had more distance lessons than in-person classes and 15.14±1.42% studied with the help of DLT exclusively. In-person classes only were given to 22.71±1.66% of the respondents.

To master the disciplines, the students used the following EMCs: computer — 29.34±1.81%, laptop — 44.32±1.97%, tablet — 12.78±1.33%, smartphone — 13.56±1.36 %. The duration of the use of gadgets for educational purposes was 3.89±1.17 hours. For students taking DL classes, this indicator was significantly higher than for those who attended in person (5.17±1.12 hours versus 2.08±0.97 hours, respectively, t=2.09, p=0.037).

At the same time, the study participants used gadgets not only for educational purposes. It was determined that the most popular (with the exception of use for educational purposes) type of activity enabled by EMCs among the respondents was communication in social networks (90.22±1.18%), followed by watching video and listening to music (72.24±1.78%), reading fiction (44.79±1.97%) and playing online computer games (18.61±1.55%). The EMC of choice was smartphone. Absolutely all university students used one every day for any purpose. It should be noted that only for 5.84±0.93% of the respondents a smartphone was the only means of communication, while the majority of respondents (63.56±1.91%) used another gadget on a daily basis, 19.09±1.56% had two devices and 11.51±1.27 — three gadgets. Table shows the preferences of respondents in choosing EMCs for various types of activities.

For survey participants, the total duration of use of various EMCs per day was 6.12±1.87 hours. However, a comparative analysis did not reveal significant differences in screen time between students studying with the help of DLTs and those studying in person (6.31±1.75 hours versus 5.34±1.49 hours, p>0.05). At the same time, it was established that distance learners, compared with those studying in-person, significantly more often exceeded hygienic recommendations prescribing time limitations for continuous work with a computer/laptop (39.39±2.21% versus 28.47±3.76% χ^2=5.69, p=0.018).

The average nighttime sleep duration among the students was registered at 6.94±1.41 hours. The duration of night sleep

Table. Preferences of Vladivostok higher school students in choosing EMCs for various types of activities

Electronic means of communication (EMC)	Number of students preferring EMCs by type of activity									
	Learning the educational material, preparing for classes		Social media communication		Watching movies, listening to music		Computer games		Reading fiction	
	Abs.	P ± m_p, %	Abs.	P ± m_p, %	Abs.	P ± m_p, %	Abs.	P ± m_p, %	Abs.	P ± m_p, %
Computer	186	29.34 ± 1.81	24	4.2 ± 0.84	56	12.23 ± 1.53	49	41.53 ± 4.54	no gadget was not used for this activity	
Laptop	281	44,32 ± 1.97	48	8.39 ± 1.36	247	53.92 ± 2.33	41	34.75 ± 4.38	no gadget was not used for this activity	
Tablet	81	12.78 ± 1.33	116	20.28 ± 1.68	63	13.76 ± 1.61	28	23.72 ± 3.92	164	57.75 ± 2.93
Smartphone	86	13.56 ± 1.36	384	67.13 ± 1.96	92	20.09 ± 1.87	no gadget was not used for this activity		72	25.35 ± 2.58
E-book	no gadget was not used for this activity		no gadget was not used for this activity		no gadget was not used for this activity		no gadget was not used for this activity		48	16.9 ± 2.22

was sufficient and amounted to 7–8 hours for 44.79±1.97% of students, 41.32±1.96% of the respondents slept less than 7 hours and 13.88±1.37% — more than 9 hours. Compared to the students taking full-time classes, students who studied remotely had significantly less often observed the nighttime sleep limit of 7–8 hours and significantly more often exceeded it (43.27±2.24% versus 52.78±4.16%, χ^2=4.06, p=0.04 and 15.92±1.65% versus 6.94±2.12%, χ^2=7.49, p=0.007, respectively).

It was established that 50.79±1.19% of survey participants had 3-4 meals a day every day, 36.12±1.91% had 2 meals and 13.09±1.39% ate once a day only. About half of the respondents (44.95±1.98%) had dinner less than 2 hours before bedtime, and 74.29±1.74% of the study participants regularly noted 5-6-hour pauses between meals. Comparative analysis revealed that among distance learners there were significantly fewer people eating once (9.8±1.34% versus 24.31±3.57%, χ^2=20.59, p<0.001) and shortly before sleep (52.24±2.26% versus 64.58±3.99%, χ^2=6.85, p=0.009).

Study participants stayed out in the fresh air for 2.21±0.37 hours every day. In 49.37±1.99% of cases, this stay was associated with the need to move to an educational institution and/or work. It was found that students relying on DLT significantly more often walked in the open than their peers who attended classes in person (56.73±2.24% versus 29.86±3.81%, χ^2=8.32, p=0.004). The motor activity of the interviewed students was 5482.98±240.27 steps per day.

Correlation test has shown a significant and direct link between the share of classes attended online and the general length of use of EMCs by the students (R=0.16, p=0.03), more specifically, use of EMCs for educational purposes (R=0.21, p=0.03), number of meals taken a day (R=0.18, p=0.01). Also, a significant inverse correlation was uncovered between the total gadget screen time and night sleep duration (r=–0.17, p = 0.02).

DISCUSSION

The results obtained are consistent with those reported by Russian and foreign scientists. In 2020, V.R. Kuchma et al. have studied the characteristics of life and well-being of 5–11 year schoolchildren in 79 regions of Russia, and found that during the distance learning period, they mainly relied on smartphones (73.1% of respondents), which consequently raised their continuous screen time [1]. A number of researchers have also pointed to the almost 2-fold growth of continuous screen time in the context of DLT application. Scientists noted that distance learning is associated with violations of the students' daily routines, in particular, their patterns of sleep and nutrition, which is also reflected in the data obtained through the present study [2, 3, 6]. A study in Iran showed that, compared to the working population of the country, medical students were significantly more stressed, anxious and depressed, which influenced quality of their night sleep and need for food [11]. Italian researchers surveyed the younger generation (18-35 years old) of the country's residents during the spread of the new coronavirus infection; they reported increased screen time before bed, longer night sleep, later awakening and poor quality of sleep. Some other daily routine violations noted were decreased physical activity, less time in the open air and, as a consequence, in sunlight [12]. Haider AS, Al-Salman S (2020), studying 775 Jordanian students during the COVID-19 pandemic, found that more than 80% of the respondents had their sleep deteriorating as a result of prolonged use of digital learning tools, and 90% of students reported fatigue associated with screen time, while 89% of the surveyed showed symptoms of nervousness and tension connected therewith. Seventy three percent of students do not recommend continuing with the online learning model, since it is socially and psychologically unhealthy [5].

Some foreign colleagues have studied the psychological and somatic health of students during the spread of the new coronavirus infection. Patricia A (2020) worked with the students of a US East Coast state university; she reported that during the online learning period, their motivation was going down, same as self-efficacy and cognitive activity, and this is against the background of all the students having free access to supportive academic resources and devices [10]. Indian students, when switched to distance learning, were seen developing such somatic symptoms as headaches, insomnia, digestive problems, hormonal imbalance and fatigue [9]. Bolatov AK et al (2020) surveyed students of medical universities in Kazakhstan and found that during the distance learning period they were less prone to burn out, get depressed or anxious compared to the in-person studying, but communicating online had a negative impact on interpersonal relations of students [4].

It should be noted that scientists from central Russia, Europe and Central Asia pointed to shorter open air time and, as a consequence thereof, decreased physical activity [1–4, 12], but in the capital of the Russian Far East we found that students, on the contrary, began to spend more time outside. Such differences may be explained by the fact that regions of the Russian Federation, with the exception of its European part, did not impose strict restrictions on outside movement, or have imposed such for only a short period.

The analyzed results of research efforts by Russian and foreign colleagues confirm the urgency of the problem and the need for further in-depth study thereof.

CONCLUSIONS

The data obtained allowed determining the time Vladivostok higher school students spend on studying, sleep, motor activity, nutrition during the COVID-19 pandemic. Significant differences of the listed factors were determined among students studying online and in-person. Also, we uncovered links between the share of curriculum delivered online and time spent on various components of the students' daily routine.

There is no doubt that the restrictions imposed to counter the disease have significantly affected life of every individual. Distance learning allowed keeping the educational process uninterrupted, despite the restrictions. However, this mode of provision of knowledge is associated with routine changes and reallocation of the time budget units, which is clearly demonstrated in this study. We consider it expedient to further study the effect of DLT on various aspects of life and health of students.

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ACTUAL NUTRITION OF SCHOOL STUDENTS DURING DISTANCE EDUCATION IN CONNECTION WITH COVID-19

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Healthy diet has a complex protective impact on physical well-being, it ensures optimal functioning of all processes in the child's body, especially during the pandemic. To assess actual dietary intake in secondary school students during remote learning due to COVID-19 quarantine and restrictive measures. Descriptive study aimed to assess actual dietary intake in 5th and 6th grade secondary school students aged 12–13 was carried out; the students lived in different mono-cities of Kemerovo region, and their parents had approved their participation in the study. Actual dietary intake was assessed using the 24-hour dietary recall (n=40). Comparison of the diet composition qualitative and quantitative characteristics was carried out based on the current sanitary regulations, as well as the latest issue of the Federal Research Centre of Nutrition, Biotechnology and Food Safety guidelines. Insufficient intake of fish and seafood, eggs, milk and dairy products, vegetables, fruit, and juices was revealed in children. The daily diet included excessive amounts of bakery products, pasta, sausage products, confectionery products, and sugar. Energy value of the diet in secondary school students exceeded physiological requirements recommended during quarantine. The diet was unbalanced in terms of micronutrient content: along with sufficient contribution of protein and carbohydrates to the total calorie value, the excessive amount of fat together with insufficient amount of vegetable fat was detected. The eating pattern shaped during homestay lead to insufficient intake of micronutrients (vitamins B1, B2, PP, A), as well as to imbalanced intake of phosphorus, calcium, magnesium, and sodium. The study has shown that the diet of secondary school students staying at home due to quarantine does not confirm with healthy eating principles and is not rational in terms of the food product set.

Keywords: set of food products, physiological norms of consumption, schoolchildren, actual nutrition

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Compliance with ethical standards: Voluntary informed consent was obtained for each participant. The online survey was conducted on a voluntary basis using an online service. The conducted research does not endanger the participants and complies with the requirements of biomedical ethics

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ФАКТИЧЕСКОЕ ПИТАНИЕ ШКОЛЬНИКОВ В ПЕРИОД ДИСТАНЦИОННОГО ОБУЧЕНИЯ В СВЯЗИ С COVID-19

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Рацион здорового питания оказывает мультикомпонетное протективное влияние на состояние здоровья, обеспечивает оптимальное функционирование всех процессов в организме ребенка, особенно в период пандемии. Изучить фактическое питание школьников среднего звена обучения в период карантинных ограничительных мероприятий по COVID-19, обучающихся дистанционно. Проведено выборочное исследование по оценке фактического питания школьников среднего звена обучения 5–7 классов в возрасте 12–13 лет, проживающих в разных моногородах Кемеровской области, родители которых дали согласие. Фактическое потребление пищи изучалось методом 24-часового воспроизведения питания (n = 40). Сравнение качественных и количественных характеристик состава пищевого рациона проводилось на основании действующих норм санитарного законодательства и вновь изданных методических рекомендаций ФГБУН «Федеральным исследовательским центром питания, биотехнологии и безопасности пищи». Результаты. В питании детей отмечается дефицит потребления рыбы и морепродуктов, яиц, молока и молочных продуктов, овощей, фруктов, соков. В суточных рационах в избытке хлебобулочные и макаронные изделия, колбасные и кондитерские изделия, сахар. Энергетическая ценность рационов питания школьников превышает нормы физиологической потребности, рекомендованные в период карантина. Питание разбалансировано по содержанию макронутриентов: на фоне достаточного вклада белков и углеводов в общую калорийность рационов выявлен избыток жиров, недостаток квоты растительных жиров. Сформированная дома модель питания школьников привела к дефициту поступления с рационом микронутриентов: витаминов B1, B2, PP, A, а также к дисбалансу потребления фосфора, кальция, магния и натрия. Проведенные исследования выявили, что рацион питания школьников во время пребывания дома на карантине не отвечает принципам здорового питания, нерационален по продуктовому набору.

Ключевые слова: набор продуктов питания, физиологические нормы потребления, школьники, фактическое питание

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Соблюдение этических стандартов: Добровольное информированное согласие было получено для каждого участника. Проведение онлайн-опроса проводилось на добровольной основе с использованием онлайн-сервиса. Проведенное исследование не подвергает опасности участников и соответствует требованиям биомедицинской этики.

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Today, there is a difficult global epidemiological situation due to spread of the novel coronavirus infection COVID-19. Countries take a number of sanitary-epidemiological and social measures to prevent the infection spread, from closure of social institutions and restaurants to transfer of schoolchildren and students to remote learning [1–3]. Numerous studies indicate that any precarious situation (changes in daily routine, dietary pattern, mode of study; the pandemic) may result in exertion of adaptation mechanisms and decline in children's functional capabilities [4–8]. Currently, adults must clearly understand that the immune response to infection would be determined by the family meal patterns and by the diet quality. After all, healthy diet has a complex protective impact on physical well-being. It underpins human vital activities ensuring optimal functioning of all bodily processes [9]. Achieving a perfectly healthy diet in adults and children is still a topical issue in our country. However, the other risk factors associated with quarantine measures cannot be excluded, such as uncontrolled access of children to information and communication technologies, diet violations in secondary school students, and insufficient physical activity. Nutrition remains a major environmental factor affecting the body's resistance to harmful environmental conditions [10, 11]. Rational nutrition and balanced diet during the pandemic of the novel coronavirus infection COVID-19 provide the human body with essential vitamins and minerals. It has been found that vitamins A, C, D, E, B2, B6 and B12, folic acid, iron, selenium and zinc are essential to ensure the body's immunocompetence [12–15]. The foreign and national studies show that inadequate essential micronutrient supply results in reduced function of immunocompetent organs, as well as in the increased risk of infection and complications. During the pandemic, children must be provided with dietary protection against harmful environmental conditions by means of achieving safe and balanced diet at home based on the child's age-associated physiological needs.

To assess actual dietary intake in secondary school students during remote learning due to COVID-19 quarantine and restrictive measures.

Fifth- and sixth-grade secondary school students aged 12–13 studying in secondary general education institutions (n = 40: 18 boys and 22 girls) were enrolled, who lived in different cities of Kemerovo region, and whose parents had approved their participation in the study. The randomly selected children were assessed individually at home in the presence of one of the parents using Zoom platform in October 2020. The novel coronavirus infection epidemiological features were the reason to use the Zoom platform. Inclusion criteria: age peculiarities, belonging to a Slavic ethnic group, remote learning for at least a week, existence of scales for weighting dishes or food products at home; one of the parents staying at home during the day. Children, who showed signs of acute respiratory disease during the survey period, were excluded from the sample.

Actual dietary intake of the children staying at home was assessed using the 24-hour dietary recall (24HR). The questionnaire was completed throughout the week. The rules for completing the children's food diaries were previously explained to parents, the "Album of Food Portion Sizes" allowing one to determine the size of food portions consumed by children was distributed [16].

The nutritional and biological value of the children's diet was evaluated in accordance with the existing regulations [17, 18]. In addition, the loss of nutrients during thermal food processing was taken into account. The consumed set of food products was compared with the set recommended by the Federal Research Centre of Nutrition, Biotechnology and Food Safety to children staying at home because of self-isolation or quarantine due to COVID-19 [19]. Statistical processing of the results was performed using the Statistica 6.0 software package based on the data distribution through calculation of the analyzed indicators' statistical characteristics (Me — median, 25; 75th percentile — interquartile range); $p < 0.05$ was considered to be statistically significant.

Self-isolation and quarantine measures due to global pandemic of COVID-19 modified the daily routine in both adults and school-age children. When staying at home with their children, the parents had to plan the food purchase carefully, preferably for a long time. At the same time, they had to create a meal plan, and to follow the family dietary pattern. The enforcement of children's self-isolation affects their level of physical activity. The latter decreases significantly relative to physiological needs in moving, and, as a consequence, results in energy consumption reduction by 200–400 kcal/day and more in children aged 3–18 [18]. However, parents do not take this fact into consideration; the meal plan is created based on the family dietary habits.

Regardless of the epidemiological situation, the child's diet should include all traditional food products. The study results showed that the daily average food product set and the children's food intake during quarantine and self-isolation were not optimal. Comparison of food product set calculations for the children's diet is presented in Table 1.

Stereotypes toward eating behavior are developed in families. Both the choice between various food products and food preparation are directly influenced by parents. Analysis of the food product set during the pandemic revealed problems of various food products consumption, typical for many Russian families [4–6]. Overconsumption of pasta (by 140% of the recommended dietary allowance), cereal grains and legumes (by 28%), sausage products (by 173%), confectionery products (by 64%), and sugar (by 68%) was detected in children during self-isolation. Access to food products and the presence of spare time allowed the children to make extra breaks for snacks (sandwiches, cookies, slices, gingerbread, etc.). Furthermore, the wait time between meals was reduced to 2.5–3 hours.

It is noteworthy that regardless of the recommended sausage products and sugar intake reduction during self-isolation, the average daily intake of those still exceeded the recommended dietary allowance by 2.7–3.2 times and 1.6-1.8 times respectively. Regardless of the epidemiological situation, the insufficient use of such food products as fish at home was detected. In the secondary school students, the fish consumption was reduced to 52–68% of RDA.

As we can see, the preference of poultry dishes had been shaped in children. The poultry intake exceeded the recommended daily allowance by 30–36%/day. Consumption of cottage cheese reduced by 15% of recommended daily allowance, eggs by 45%, and juices by 40% was detected.

Gastrointestinal tract is one of the most active microbial ecosystem of the body playing a vital part in immunological status. Therefore, probiotics, both contained in fermented dairy products and vegetables, fruit, cereal grains, would boost the child's immunity. However, it has been shown that the diet of the child staying at home is characterized by reduced intake of milk and fermented dairy products (by 26% of RDA), vegetables (by 27%), and fruit (by 30%).

The children's food intake analysis results are consistent with the previous studies conducted in the other regions of the country.

By the time of entering secondary school, the students' dietary habits have been already shaped. During self-isolation, cooking of main dishes and pastry is the most common, the

Table 1. Average daily food product set, Me (25;75)

Food products	Absolute, grams (n = 40)	RDA, SanPiN	% of RDA (n = 40)	RDA, Guidelines 2.3.1071-20	% of RDA
Wheat bread	180 (169; 210)	200	90 (85;105)**	180	122 (113; 149)**
Rye bread	40 (35; 48)	80	53 (46; 72)		
Pasta	48 (41; 56)	20	240 (205;280)	20	240 (205;280)
Cereal grains, legumes	64(52; 66)	50	128 (104;132)	50	128 (104;132)
Potatoes	155 (144; 175)	188	82 (77; 93)**	160	97 (90; 109)**
Vegetables	234 (198; 257)	320	73 (62; 80)	320	73 (62; 80)
Fresh fruit and berries	130 (108;151)	185	70 (58; 82)	185	70 (58; 82)
Fruit juices	121 (100; 156)	200	60 (50; 78)	200	60 (50; 78)
Meat	69 (64; 78)	78	88 (82;100)	78	88 (82;100)
Poultry	69 (49; 72)	53	130 (92;136)	53	130 (92;136)
Sausage products	41 (31; 48)	19	215 (168; 253)**	15	273 (206; 320)**
Fish (fillet)	25 (19; 37)	77	32 (24; 48)	77	32 (24; 48)
Milk, fermented dairy products	357 (267; 388)	480	74 (55; 80)	480	74 (55; 80)
Cottage cheese	51 (35; 60)	60	85 (58; 100)	60	85 (58; 100)
Cheese	11 (7;14)	12	91 (72; 116)	12	91 (72; 116)
Sour cream	12 (7;14)	10	120 (70;140)	10	120 (70;140)
Eggs	22 (18; 35)	40	55 (45; 87)	40	55 (45; 87)
Butter	21 (20; 27)	35	60 (57; 77)**	25	84 (80; 108)**
Vegetable oils	16 (12; 16)	18	89 (67; 89)	18	89 (67; 89)
Confectionery products	41 (29; 49)	15	273 (193; 327)**	25	164 (116; 196)**
Sugar	42 (38; 45)	45	93 (84; 100)**	25	168 (152; 180)**

Note: RDA — recommended dietary allowance according to SanPiN 2.4.5.2409–08 * RDA — recommended dietary allowance according to Guidelines 2.3.1071-20 ** — significant differences between groups ($p < 0.05$)

intermediate goods (dumplings, Russian ravioli) are widely used. It has been found, that secondary school students do not limit themselves when choosing dishes and food products. They consume foods in accordance with the already shaped family dietary habits. Secondary school students also consume items not recommended to children of their age (mayonnaise dressing, ketchup, deep-fried buns, roasted potatoes, various spicy seasonings).

Table 2. Nutrient composition of secondary school students' diet

Nutrients	PR*	Absolute (n = 40)	% of PR (n = 40)
Energy value, kcal	2400	2360 (2067; 2534)	98 (86;106)
Protein, g	72	71 (69; 74)	98 (95;103)
Animal protein, g	43.2	42 (41; 45)	97 (95;104)
Fat, g	80	92 (87; 104)	115 (109;130)
Vegetable fat, g	26.6	23 (21; 25)	86 (79; 94)
Carbohydrates, g	348	335 (301; 356)	96 (84;102)
Mono- and disaccharides, g	60	82 (80; 89)	137 (133; 149)
Dietary fiber, g	17.5	16 (12; 17)	93 (68; 97)
Thiamine (B_1), mg	1.3	0,9 (0,8; 0,96)	69 (67; 74)
Riboflavin (B_2), mg	1.5	1,1 (1,03; 1,17)	73 (77; 78)
Vitamin C, mg	65	67 (60; 77)	103 (92; 118)
Vitamin A, μg RE	900	838 (771; 908)	93 (86; 100)
Niacin, mg	18	15,3 (13,6; 16,8)	85 (76; 93)
Calcium, mg	1200	689 (646; 785)	57 (54; 65)
Phosphorus, mg	1200	1268 (1173; 1271)	105 (97; 106)
Magnesium, mg	300	296 (274; 317)	99 (91; 105)
Iron, mg	13.5	14 (14; 16)	104 (104;118)
Sodium	1100	2189 (1550; 2240)	199 (141; 204)

Note: PR* — physiological requirements (average values for discussed age group).

Nutritional diversity (adequate levels of main nutrients, dietary fiber, vitamins and minerals consumption) is the basis of the rational protective diet. Numerical values describing energy consumption and nutrient intake in children are presented in Table 2.

Due to reduced physical activity during self-isolation, the Federal Research Centre of Nutrition, Biotechnology and Food Safety recommended to reduce the daily calorie intake both in adults and children. In spite of the fact that physiological requirements (PR) of secondary school students allow for daily calorie intake of 2400 kcal/day, during self-isolation the children aged 7–18 are recommended to consume 1600–2000 kcal/day. Based on the energy value, the actual daily average food intake did not exceed the PR. However, recommendations were not adopted; in the context of children's physical inactivity the energy value of the diet exceeded the values recommended to children self-isolating at home during quarantine by 18–47%. Distribution of percentiles for a number of micronutrient intake values showed that significant (in terms of children's health) protein and animal protein content of the diet was within the normal range (95–105%).

It should be noted that excessive amount of such foods as sausage products and mayonnaise dressing in the children's diet results in predominance of fats in the food. The fat content of the daily diet exceeded physiological requirements by 1.1–1.3 times. At the same time, compared to normal consumption of carbohydrates (96% of PR/day), the intake of mono- and disaccharides in children exceeded the recommended dietary allowance by 33–49% of PR. Reduced dietary fiber intake was revealed, the content of dietary fiber varied between 68-93% of daily dietary allowance. The daily average consumption of protein, fat and carbohydrates was unbalanced (1:1.2:4.7).

Analysis of vitamin and mineral intake with food showed that the lowest daily average intake values were obtained for vitamin B1 (69% of PR), vitamin B2 (73% of daily dietary allowance), and vitamin PP (niacin) (85% of PR). The intake of vitamins A (expressed in terms of retinol equivalents) and C was within the range of physiological needs. Analysis of mineral intake revealed reduced intake of calcium (to 35–46% of daily requirements) in secondary school students, along with excessive intake of sodium (the sodium level was elevated by 2 times on average). Adequate intake of phosphorus, magnesium and iron with food was detected. Normal absorption of calcium requires rational ratio to phosphorus, however, the level of phosphorus in foods consumed by children was 1.8 times higher than required. That reduced availability of calcium for absorption in the child's body.

DISCUSSION

The diet composition in secondary school students, forced to stay at home because of self-isolation due to COVID-19 and studying remotely, can be characterized as not optimal and not rational. According to the Federal Research Centre of Nutrition, Biotechnology and Food Safety guidelines, during the long-term homestay, the energy requirements should be reduced by means of reduced intake of some food products. During self-isolation, the insufficient physical activity is considered a risk factor for weight gain, as well as for impaired motor and evacuation function of the gastrointestinal tract.

However, due to access to food and presence of spare time in secondary school students, as well as to lack of set daily routine, and frequent breaks for snacks, the daily energy value of the food consumed was excessive; the nutrient composition of the food was unbalanced, since the children's dietary habits had not changed [11]. Regardless of the fact that protein and carbohydrate intake (absolute values) was close to normal, the fat intake was excessive. Analysis of vitamin and mineral intake in secondary school students revealed reduced absolute content of vitamins B1, B2, and calcium, along with excessive intake of sodium. This is in line with the results of previous studies carried out in other regions of the country during the period of epidemiological well-being. Results of a number of studies show that carbohydrate and fat rich dietary pattern is shaped in the modern secondary school students [20, 21]. Analysis of foreign literature also provides evidence of health problems in foreign children due to malnutrition, eating disorders, etc. [22, 23]. The revealed imbalance of macro- and micronutrients is associated with insufficient intake of specific food groups. Thus, during self-isolation, the secondary school students have not managed to reduce the intake of salt, sugar, saturated and trans fatty acids at expense of the food products being the main source if those (bakery products, sweet sparkling drinks, nectars, various sausages, cheese with fat contents exceeding 30%, mayonnaise, etc.) [19]. The secondary school students' daily diet included excessive amount of sausage products (by 2.1 times), confectionery products and sugar (by 1.6 times), pasta (by 2.4 times), bakery products (by 1.2 times). The diet was extremely scarce in terms of the amount of fish and seafood, eggs, milk and dairy products, vegetables, fruit, and juices. The secondary school students did not follow one of the major principles of rational nutrition, such as daily routine of eating. Parents paid little attention to menu planning based on the children's age peculiarities. Adjusting the supply of vitamins and minerals only through cooking traditional dishes and culinary display does not work.

Analysis of actual dietary intake in modern secondary school students, especially during the pandemic, remains of key importance, since the analysis results reflect home meal planning in families, as well as the impact of the regional socio-economic situation. The study results showed that the secondary school students' diet during self-isolation at home was not optimal. The imbalance of macro- and micronutrient intake is associated with imbalanced food product set: excessive intake of high-fat foods, sugar, and confectionery products along with insufficient intake of fish, dairy products, vegetables, and fruit. Eating pattern and dietary habits of the family depend on the parents' education on nutrition, which should be taken into account when developing guidelines on optimizing nutrition. In order to adjust micronutrient composition of the secondary school students' diet, it is necessary to include specific food products, nutritional supplements, as well as complexes of vitamins and minerals boosting body's immune resistance during the pandemic.

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NUTRITIONAL STATUS AND RISK OF OBESITY IN WORKING-AGE MEN

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The aim of this study was to estimate the energy content, macronutrient intake and their impact on the somatometric parameters in older working-age men. A total of 284 men included in the study were asked to fill out the questionnaire and underwent a physical examination. Dietary patterns were studied using a 24h recall method. The following measurements were taken: body height and weight, waist and hip circumference. BMI was calculated. The participants were divided into 3 groups by the level of their physical activity (PA): low PA (energy expenditure 2300≤PA<2700 kcal/day), moderate PA (2700≤PA<3100), high PA (3100≤PA<4000). Of all study participants, 22.3% had normal BMI, 31.7% were generally obese, and 27.1% had abdominal obesity. Individuals with abdominal obesity made up 93.3±3.7% of the general obesity group. On average, energy intake was within the reference range for 60.3±2.9% of the participants, was higher than recommended in 21.7±2.4% of cases and below the recommended level in 17.9±2.3% of cases. The risk of obesity for individuals whose dietary energy intake exceeded the recommended levels was OR=1.9 [1.05–3.67], χ^2=2.7; p=0.05. The diet of subjects with BMI ≥ 30 had higher protein, cholesterol and starch content than in other groups. The high PA group was at risk of abdominal and general obesity (OR=3.6 [1.5–7.7], p=0.005 and OR=3.6 [1.5–7.7], p=0.005, respectively). In the low PA group, increased BMI was observed in 47.4±3.4% of the subjects, and 12.3±5.8% had abdominal obesity. Our findings may be useful for developing nutritional guidelines for the working-age population.

Keywords: diet, energy value, macronutrients, total obesity, abdominal obesity, risk, men of working age

Author contribution: Efimova NV — collection of material, statistical processing, writing an article, analysis of literature.

Compliance with ethical standards: Voluntary informed consent was obtained for each participant. The study was biomedical ethical and did not endanger the participants.

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ИЗУЧЕНИЕ ПИЩЕВОГО СТАТУСА И РИСК РАЗВИТИЯ ОЖИРЕНИЯ У МУЖЧИН ТРУДОСПОСОБНОГО ВОЗРАСТА

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Цель исследования: изучить энергетическую ценность рациона, потребление макронутриентов и их влияние на соматометрические параметры у мужчин старшей группы трудоспособного возраста. Проведено анкетирование и физикальное обследование 284 мужчин. Фактическое питание изучали с использованием метода 24-часового воспроизведения питания в компьютерной программе. Все респонденты прошли соматометрическое обследование, включающее длину и массу тела, обхват талии, обхват бедер, расчет индекса массы тела (ИМТ). Деление на группы по уровню физической активности (ФА) представлено следующим образом: низкая ФА (расход энергии 2300 ≤ ФА < 2700 ккал/сут), средняя (2700 ≤ ФА < 3100), повышенная (3100 ≤ ФА < 4000). Нормальный уровень ИМТ имели 22,3% обследованных, общее ожирение 31,7%, а абдоминальное — 27,1%. В группе лиц с общим ожирением доля лиц с абдоминальной формой составила — 93,3 ± 3,7%. По средним величинам энергетическая ценность рациона соответствовала норме в 60,3 ± 2,9%, выше потребностей — 21,7 ± 2,4%, ниже — 17,9 ± 2,3%. Риск ожирения у лиц, рацион которых превышает физиологическую норму — OR=1,9 [1,05-3,67], χ^2 = 2,7; p = 0,05. У обследованных с ИМТ ≥ 30 выше, чем в других группах поступление белков, холестерина, крахмала. В группе с повышенной физической активностью отмечен риск как абдоминального OR = 3,6 [1,5–7,7], p = 0,005, так и общего ожирения OR = 3,6 [1,5–7,7], p = 0,005. У обследованных с низкой физической активностью повышенный ИМТ выявлен в 47,4 ± 3,4% случаев, абдоминальное ожирение — 12,3 ± 5,8%. Полученные результаты могут быть полезны для обоснования рекомендаций по питанию организованного трудоспособного населения.

Ключевые слова: пищевой рацион, энергетическая ценность, макронутриенты, общее ожирение, абдоминальное ожирение, риск, мужчины трудоспособного возраста

Вклад авторов: Ефимова Н.В. — сбор материала, статистическая обработка, написание статьи, анализ литературы.

Соблюдение этических стандартов: Добровольное информированное согласие было получено для каждого участника. Исследование соответствовало требованиям биомедицинской этики и не подвергало опасности участников.

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Obesity and other non-communicable nutrition-related diseases are a sign of serious public health challenges facing the world population [1, 2]. In Russia, profound social and economic changes of the past decades have engendered changes in lifestyle and diet [3, 4]. Some of them were potentially positive, including better access to varied foods, which actually resulted in energy and nutrient surfeit, and improvements in food safety [4-7]. However, looking at the world's past experience, these changes may have repercussions, such as poor food choices and nonadherence to the principles of healthy eating by members of different age-, sex- and social groups [1, 8]. So far, there have been quite a few studies of food hygiene and dietary practices in Russia [4, 9–11]. Dietary assessment and diet optimization for the working-age population seek to preserve public health and improve employee productivity and thus are an important area of research [3, 10, 12]. Energy and macronutrient intake is an interesting subject for analysis due to the diversity of dietary preferences among different social groups and varying availability of some foods across Russia. The World Health Organization (WHO) and the Food

and Agriculture Organization (FAO) have published nutritional recommendations, or population reference intakes (PRI), for major nutrients [13, 14], which allows assessing the diet of the Russian population against international standards. The aim of this study was to measure the energy content of the participants' diets, analyze the macronutrient consumption and assess their impact on somatometric parameters in the older working-age male population.

METHODS

The study complied with the Declaration of Helsinki and recruited men residing in the south of Irkutsk region. Informed consent was obtained from every participant. The initial sample size was 364 men; of them, 284 men were included in the final sample (72 men aged 40–49 years and 212 men aged 50–59 years). The following inclusion criteria were applied: age between 40 and 59 years, Irkutsk region residency, the absence of chronic diseases that required a special diet (gastrointestinal or urinary tract disorders, diabetes mellitus), answers to all questions in the questionnaire and during the interview. Besides, the following additional exclusion criteria were applied after conducting a physical examination: energy consumption falling within the reference range for males engaging in moderate and low physical activity (800–4,000 kcal/day), body mass index (BMI) > 18.4 [1].

The questionnaire contained questions about age, chronic conditions, job, residency, education, smoking, diet patterns, physical activity during the week and at the weekend. Consumption of foods, beverages and nutrients was assessed by means of a 24-hour dietary recall using the software developed by the Federal Research Centre of Nutrition and Biotechnology and a quantitative food frequency assessment method. This study presents data on dietary energy value (E), protein intake (PI), total fat (TF) intake, intake of saturated fatty acids (SFA), intake of polyunsaturated fatty acids (PUFA), intake of n-3 and n-6 fatty acids, total carbohydrate (TC) intake, intake of monosaccharides, disaccharides, and added sugar.

All respondent underwent a somatometric examination; the following measurements were taken: body height and weight (BW), waist circumference (WC), and hip circumference (HC). BMI was calculated as described in [13] and expressed in kg/m2. All study participants were divided in 3 groups: normal BW (BMI ≤ 24.9), overweight (25 ≤ BMI≤ 29.9) and obesity (BMI ≥ 30). WC > 102 cm was interpreted as abdominal obesity; participants with WC > 102 cm formed a separate group.

The level of physical activity (PA) was calculated considering energy costs of physical labor in the workplace, energy costs of activities off work and the basal metabolic rate. The following PA groups (groups II-IV) were formed according to the guidelines in [15]: low PA (energy expenditures 2170 ≤ PA < 2618 kcal/day), moderate PA (2618 ≤ PA < 2992 kcal/day), high PA (2992 ≤ PA < 3553 kcal/day). The adequacy of macronutrient intake was assessed using international [13, 14] and Russian guidelines [15].

Statistical analysis was performed in Statistica.V.10. Normality of data distribution was tested using the Kolmogorov-Smirnov test. For quantitative variables, results are presented below as mean values with 95% confidence interval (M CI) and standard deviations (Std). For qualitative variables, results are presented as frequencies per 100 participants. Intergroup comparisons were done using Student's *t*-test with the Bonferroni correction for independent samples. Proportions were compared using the chi-squared test (χ^2) with the Yates correction. Associations were assessed using Pearson's correlation coefficient. Odds ratios with 95% CI (OR CI) were calculated to confirm the discovered associations. Statistical significance was assumed to be at $p<0.05$.

RESULTS

Table 1 shows anthropometric data of study participants grouped by age. Statistical significance is shown for parameters that reflect the level of nutrition. In the group of subjects aged 50–59 years, WC was larger than in those aged 40–49 years (108.4 (106.1–110.7) cm vs. 102.6 (97.7–107.5) cm), and BMI was also higher (28.5 (27.9–29.1) vs.27.3 (26.6–28.1)).

Only 22.3% of the participants had normal BMI; 31.7% of the participants were generally obese, 27.1% of the participants had abdominal obesity (Table 2).

No significant correlations were detected when studying the effect of age on the frequency of increased BMI in the groups (pairwise comparison: BMI ≤ 24.9 χ^2 = 0.01, p = 0.915; BMI ≥ 30 χ^2 = 0.96, p = 0.327; comparison by 3 BMI ranges: χ^2 = 1.99, p = 0.369). The prevalence of abdominal obesity did not differ between the groups (χ^2 = 1.52, p = 0.218). Because age was not a significant factor, further analysis made no distinction by age. It should be noted that abdominal obesity accounted for 93.3±3.7% of all obesity cases in the general obesity group. The chi-squared test demonstrated that the distribution of the participants by waist circumference differed between the groups with different BMI (p=0.000). The risk of abdominal obesity in men with 25 ≤ BMI ≤ 29.9, compared to the group with normal BMI, was 4.4 (95% CI (1.7–11.5)). For the group with BMI ≥ 30, OR was 7.9 CI (3.1-19.9) relative to the subjects with BMI ≤ 24.9 and OR was 1.8 CI (1.4–2.3) relative to the individuals with increased BMI.

Nutritional value and metabolizable energy contents in the consumed diet are grouped by BMI values in Table 3.

On average, energy intake was within the reference range for 60.3±2.9% of the participants; excess energy intake was observed in 21.7±2.4% of cases, whereas low energy intake, in 17.9±2.3 % of cases. The risk of obesity was statistically higher for individuals whose diet exceeded the physiological norm for daily energy intake (OR=1.9 [1.05–3.67], χ^2=2.7; p=0.05). The analysis of nutrient intake revealed a few significant differences

Table 1. Average anthropometric parameters of male study participants aged 40–59

Age groups		Age	Waist circumference	Hip circumference	Body height	Body weight	BMI
40–49 years (n = 72)	M	45.3	102.6	95.4	176.8	85.5	27.3
	Std	3	14.1	7.1	5.5	10. 6	3.3
	CI	44.6–46.0	97.7–107.5	92.9–97.9	175.5–178.1	83.1–87.9	26.5–28.1
50–59 years (n = 212)	M	55.8	108.4	97.2	175.4	87.8	28.5
	Std	3	13.2	10	6.3	14.1	4.3
	CI	55.3–56.3	106.0–110.8	95.4–99.0	174.5–176.3	85.8–89.8	27.9–29.1
t-test (p)		24.6 (0.00)	2.0 (0.037)	1.1 (0.223)	1.7 (0.071)	1.4 (0.149)	2.4 (0.017)

Table 2. BMI and waist circumference in different age groups (%)

Parameter	40–49 years		50–59 years		Total	
	Abs.	%	Abs.	%	Abs.	%
Normal BMI	18	25	46	21.7	64	22.3
Increased BMI	36	50	94	44.3	130	45.8
General obesity	18	20.5	72	33.9	90	31.7
Abdominal obesity	15	20.8	62	29.2	77	27.1

between the studied groups. The highest protein intake was observed for study participants with BMI ≥ 30 and equaled 90.7 (87.8-93.5) g/day vs. 86.2 (82.6-89.7) g/day for individuals with normal BMI (p = 0.050) and 85.1 (82.9-87.3) g/day for those with increased BMI (p = 0.003). Besides, cholesterol intake was higher among study participants with BMI ≥ 30: 380.9 (348.3-413.5) mg/day vs. 331.0 (299.0–362.9) for individuals with BMI ≤ 24.9 (p=0.033) and 338.2 (312.9–363.5) for those with 25 ≤ BMI ≤ 29.9 (p = 0.043). The groups with increased BMI and obesity tended to differ in terms of SFA intake: 40.1 (38.4–41.7) g/day vs. 37.9 (36.3–39.0) g/day, respectively (p = 0.06). Although TC intake did not differ between the groups, individuals with BMI ≥ 30 had significantly more starch in their diet than individuals with BMI ≤ 24.9 (p = 0.05), and the amount of added sugars in their diet was lower than in the diet of those with 25 ≤ BMI ≤ 29.9 (p = 0.029).

Regardless of their PA levels, the majority of the participants exceeded the recommended level of macronutrient intake [15] (Table 4). In the group with high PA, the diet was low in proteins in 60.2 % cases, low in fats in 44.6% of cases, and low in carbohydrates in 92.6% of cases. At the same time, in this group the diet was characterized by excess energy content in 11.5±2.5% of cases and excess fat intake in 33.7±5.2% of cases. Regarding the low PA group, protein intake exceeded the norm in 39.4±5.5 cases per 100 participants, which was at least twice as frequent as among moderately and highly active individuals. Dietary fat surplus occurred at the same frequency in all studied groups. In the moderate PA group, macronutrient intake was within the recommended reference range in 68.7%, 68.1% and 60.0% of cases for proteins, fats, and carbohydrates, respectively, i.e. met the nutrient needs of 86±3.6% of the participants in terms of dietary energy content.

DISCUSSION

Our study focused primarily on the consumption of macronutrients by older working-age men, aiming to identify the impact of diet on the risk of obesity. The study is particularly interesting from this standpoint because obesity, along with other non-communicable nutrition-related diseases poses a serious threat to public health. As diets are becoming more energy-dense, it is becoming increasingly important to analyze the dietary intake of macronutrients and its impact on the risk of obesity. For 16.2±2.1% of the participants included in our study, dietary E exceeded the recommended level by 7.8–30.1% in the low PA group, by 0-19.5% in the moderate PA group and by 11.7–34.8% in the high PA groups. A similar situation was reported by other authors studying the working-age population in other Russian regions [6, 16, 17]. According to studies conducted by Frolova OA and Bocharov EP, male Tatarstan residents aged 40–59 years with type I PA consumed 2510.6 kcal with their daily meals, which exceeds the recommended

Table 3. Nutritional value and metabolizable energy contents in the diet of men aged 40–59 years

Parameter	BMI ≤ 24,9		25 ≤ BMI ≤ 29,9		BMI ≥ 30	
	M (CI)	Std	M(CI)	Std	M(CI)	Std
Energy	2768.3 (2668.6–2768.1)	406.8	2751.2 (2687.1–2815.3)	371.3	2799.9 (2716.5–2883.3)	404.2
Protein, g/day	86.2 (82.6–89.5)	14.6	85.1 (82.9–87.3)	12.7	90.7 (87.8–93.5)	13.8
Total fat, g/day	114.8 (109.5–121.2)	21.9	112.1 (107.7–116.6)	25.8	115.6 (111.0–120.2)	22.1
SFA,%	39.4 (37.3–41.4)	8.5	37.9 (36.3–39.5)	9.3	40.1 (38.4–41.7)	8.2
PUFA,%	24.8 (23.4–25.2)	5.7	24.9 (23.8–26.0)	6.5	25.0 (23.8–26.3)	6
n-6 PUFA,%	22.4 (21.2–23.6)	5.2	22.5 (21.5–23.5)	5.8	22.6 (21.5–23.7)	5.5
n-3 PUFA,%	3.0 (2.8–4.1)	0.8	2.9 (2.8–3.1)	0.8	3.0 (2.8–3.1)	0.7
Cholesterol	331.0 (299.0–362.9)	130.6	338.2 (312.9–363.5)	146.3	380.9 (348.3–413.5)	158
Monosaccharides, disaccharides, g/day	127.5 (118.7–138.7)	35.8	127.7 (121.0–134.0)	36.4	122.1 (113.6–130.7)	41.2
Added sugar, g/day	57.7 (50.4–65.0)	30	60.6 (54.8–66.4)	33.4	50.6 (43.7–57.5)	33.4
Starch, g/day	193.1 (182.6–204.5)	42.9	195.9 (188.7–203.1)	41.8	206.3 (197.8–214.8)	41.2
Total carbohydrates g/day	320.6 (305.9–335.8)	59.8	323.6 (314.4–223.8)	53.3	328.5 (316.3–340.7)	59

Note: BMI — body mass index; SFA — saturated fatty acids; PUFA — polyunsaturated fatty acids; n-3 PUFA — omega-3 polyunsaturated fatty acids; n-6 PUFA — omega-6 polyunsaturated fatty acids; M (CI) — mean value with 95% confidence interval; Std — standard deviation.

Table 4. Intake of macronutrients by groups with different levels of physical activity (per 100 participants)

Relation to the norm	Physical activity	Proteins	Fats	Carbohydrates
Below	low (1)	2.8 ± 2.7	2.8 ± 2.7	30.3 ± 8.0
	moderate (2)	15.6 ± 2.9	6.2 ± 1.9	38.7 ± 3.8
	high (3)	60.2 ± 5.4	44.6 ± 5.5	92.6 ± 1.7
Significance of differences		$^{1-2}p = 0.001$ $^{1-3}p = 0.000$ $^{2-3}p = 0.000$	$^{1-2}p = 0.305$ $^{1-3}p = 0.000$ $^{2-3}p = 0.000$	$^{1-2}p = 0.344$ $^{1-3}p = 0.000$ $^{2-3}p = 0.000$
Meets	low (1)	42.2 ± 8.0	76.8 ± 7.5	60.1 ± 8.5
	moderate (2)	68.7 ± 3.7	68.1 ± 3.7	60.0 ± 3.9
	high (3)	19.3 ± 4.3	21.7 ± 4.5	2.4 ± 1.7
Significance of differences		$^{1-2}p = 0.003$ $^{1-3}p = 0.013$ $^{2-3}p = 0.000$	$^{1-2}p = 0.299$ $^{1-3}p = 0.000$ $^{2-3}p = 0.000$	$^{1-2}p = 0.991$ $^{1-3}p = 0.000$ $^{2-3}p = 0.000$
Above	low (1)	39.4 ± 5.5	30.3 ± 8.0	9.5 ± 5.0
	moderate (2)	15.6 ± 2.9	25.6 ± 3.4	1.2 ± 0.9
	high (3)	20.5 ± 4.4	33.7 ± 5.2	2.4 ± 1.7
Significance of differences		$^{1-2}p = 0.000$ $^{1-3}p = 0.008$ $^{2-3}p = 0.353$	$^{1-2}p = 0.550$ $^{1-3}p = 0.761$ $^{2-3}p = 0.194$	$^{1-2}p = 0.103$ $^{1-3}p = 0.181$ $^{2-3}p = 0.531$

dietary energy intake by 19.6%; for 57.1% of the participants, E was increased. The average EC in the diet of our subjects with type 2 PA was 2286.7 kcal, which is within the reference range, but in 38.8% of cases the amount of consumed calories exceeded the recommended level [6].

In our cohort, protein intake was higher than recommended for individuals with types I–III PA [15] (88 CI (86-90) g/day on average), regardless of the participants' age or physical activity. Protein intake relative to the total energy content (13.3% E) was above the upper limit of the reference range recommended by WHO (0.83 g/kg body weight for adults, which is about 12% of energy intake) [13]. In our study, 21.3±2.5% of the participants had excess protein in their diet, 48.4±3.1% consumed the recommended amount of protein, and 29.8±2.8% had too little protein in their diet. However, considering that dietary energy content was excessive in the studied cohort, their protein intake can be described as increased. Our findings differ from the results of another study that investigated macronutrient consumption across Russia and found that protein intake amounted to 9.3–11.5% E [18]. Surveys show that average protein consumption across European populations is the same or higher than the reference intake, reaching 15% E [19, 20]. Clinical studies have found that protein intake which exceeds the recommended norm no more than twofold can be considered safe for adults although it does not meet the criteria for a healthy diet. Daily protein consumption over 45% E may lead to unfavorable outcomes [20]. Long-term excess protein intake is associated with impaired renal function. Other side effects of high-protein diets are associated with insulin resistance and glucose tolerance [21, 22]. On the other hand, it is postulated that high-protein diets promote weight loss [2].

At present, total fat intake recommended by WHO and FAO is 20%–35% E [23], which ensures the right amount of essential fatty acids and energy and facilitates digestion of fat-soluble vitamins. In our cohort of patients, total fat intake did not meet these recommendations (38.4 % E; the lowest total fat intake was 28.1% E, the highest total fat intake was 47.8% E). Of all study participants, 8.9±1.8% were above the upper limit of the recommended fat intake. Our findings are consistent with the data reported by Evstratova VS et al. [18], who found that across Russia, total fat intake was above the recommended level (33.2-38.8% E). According to another study, 30.6±2.9% of its participants consumed a high-fat diet [15]. It is well known that excess dietary fat promotes ischemic heart disease, atherosclerosis and thrombosis. Besides, high-fat diets can reduce or worsen insulin resistance and may be associated with increased risk for cardiovascular disorders [13, 24]. By contrast, high-PUFA diets are associated with reduced risk for cardiovascular disorders. The recommended PUFA intake is 6-10% EC. In our cohort, the average PUFA intake observed in 91.5±1.8% of the participants was 7.5% E, which meets the dietary requirements. According to WHO and FAO, daily SFA intake should amount to 10% E [23], similar to the recommendations of Russian authors [15]. For the overwhelming majority of our participants (95.5±1.3%), SFA intake was higher than recommended. This worrying trend was noticed by some other authors [6, 17, 19, 25]. According to the European Nutrition and Health Report [25], the average SFA dietary intake among adults varies from 9% to 26% E; the lowest SFA intake levels were reported in Southern Europe. In our study, n-3 PUFA intake was 0.9% E and met the dietary recommendations set by WHO/FAO [23] in only 32.0±2.9% of cases. Pronounced nutritional imbalances were also noted in the diet of the working-age residents of Samara region, including increased dietary fat content (45% E) due to saturated fatty acids and added sugar consumption (13% E) [17].

It is well known that carbohydrates have a number of important physical, chemical and physiological properties: they control body weight and the development of diabetes and cardiovascular disorders. To assess the quality of diet, one should distinguish between different types of carbohydrates and dietary sources, because the amount of naturally occurring and added sugars, as well as fibers, is currently the major dietary health concern. WHO and FAO [13] recommend that TCH amount to at least 50% E. In our study, average TCH amounted to 48.3% E, differing from the results obtained in other Russian regions, where TCH made up 50.3-56.4% E, compared to the recommended 50-60% E [18]. TCH intake was lower than recommended for the corresponding PA level in 59.3±3.1% of the participants.

The balance of macronutrients is one of the key criteria for dietary adequacy. In our study, total fat intake was higher

than recommended in 30.6±2.9% of the participants and lower than recommended in 59.3±3.1% of the participants. Macronutrient imbalances were discovered in the diet of 15.9±2.3% of the participants; protein-fat imbalances were observed in 31.0±2.9% of cases, and protein-carbohydrate imbalances occurred in 10.5±1.9% of cases. Most often, dietary imbalances were observed in the high PA group and included high fat intake (59.0±5.4% of the participants), high carb intake (13.2±3.7%) and a combination of both (19.3±4.3%). In groups with low and moderate PA, the imbalances manifested as high fat intake in 21.2±7.1% and 15.9±2.7% of cases, respectively.

According to some reports, BMI changes with age, indicating excess body weight and obesity [2]. In Tatarstan, the lowest (18.2%) percentage of individuals with normal BMI was observed in the cohort of 50–59-year-old individuals [6]. In our study, 21.7% of the participants had BMI ≤ 24.9; no differences were detected between two age groups included in the study (40-49 and 50-59 years). The analysis of associations between somatometric parameters and consumption of major nutrients revealed that the number of statistically significant associations differed between the groups with different BMI. For individuals with BMI ≤ 24.9, the correlation coefficients were as follows: r_{xy}=0.43, p=0.032 for the association between WC and mono/disaccharide intake; r_{xy}=0.39, p=0.040 for the association between WC and total carbohydrates. For individuals with 25 ≤ BMI ≤ 29.9, WC was associated with dietary energy content (r_{xy}=0.24, p=0.044), protein intake (r_{xy}=0.36, p=0.002), TF intake (r_{xy}=0.26, p=0.033), and SFA intake (r_{xy}=0.30, p=0.011). For individuals with BMI ≥ 30, the were fewer associations between WC and diet: WC was associated with dietary energy content (r_{xy}=0.29, p =0.036), protein intake (r_{xy}=0.28, p=0.041) and TCH intake (r_{xy}=0.27, p=0.046). These findings may indicate the involvement of metabolic disorders in the development of obesity in the group with BMI ≥ 30. Besides, it should be born in mind that there are 3 contributors to overweight and obesity: environmental, genetic and epigenetic factors [26].

The association between general and abdominal obesity was confirmed by correlations between BMI and WC (r_{xy}=0.61, p=0.001), BMI and HC (r_{xy}=0.51, p=0.007). According to current estimates, chronic noninfectious diseases associated with nutrition account for 46% of morbidity cases and 60% of deaths; the risk of death from cardiovascular diseases is especially high [1, 27]. In our study, individuals with elevated blood pressure prevailed in the abdominal obesity group (RR=2.6 [1.4–5.1], p=0.003).

In the high PA group, there was a risk of abdominal (OR=3.6 [1.5–7.7], p=0.005) and general (OR=3.6 [1.5-7.7], p=0.005) obesity. Paradoxically, despite excess macronutrient intake and excess dietary energy content, there were no individuals with general obesity in the low PA group; in this group, increased BW was observed in 47.4±3.4% of cases and abdominal obesity in 12.3±5.8% of cases. Perhaps, this can be explained by the insufficient accuracy of the applied dietary assessment method, which was based on the data provided by the respondents. Similar uncertainty in estimates was indicated by Russian [7, 17] and foreign [8, 21, 27, 28] researchers. Ashton LM et al. conducted a meta-analysis and concluded that the results of research into associations between the quality of diet and obesity depend on a variety of factors, including study design, methods applied, the physical activity of the respondents, etc. [8].

Despite some uncertainty of the obtained data, information about the diet of working-age individuals residing in an industrial Russian region might be essential for developing dietary recommendations and public health strategies aimed at improving the quality of life of the Russian population.

CONCLUSION

The dietary patterns of older working-age male residents of Irkutsk region were significantly different from dietary guidelines of international and Russian authorities. Those patterns were characterized by energy surfeit, increased intake of proteins and fats. Our study found that only 22.3% of the participants had normal BMI, 31.7% were generally obese, and 27.1% had abdominal obesity. Macronutrient imbalances were observed in 15.9±2.3% of the participants, imbalances between protein and fat intake, in 31.0±2.9% of cases, and imbalances between carbohydrate and protein intake, in 10.5±1.9% of cases. Low intake of major macronutrients was common in the high PA group (60.2% of its members had protein deficiency, 44.6% had fat deficiency, and 92.6% had carbohydrate deficiency). However, due to such imbalances, dietary energy deficiency was detected in only 2.5% of the respondents. Total fat surfeit was observed in only 25.6-33.7% of the respondents. In the moderate PA group, macronutrient intake was within the recommended reference range in 68.7%, 68.1% and 60.0% of cases for proteins, fats, and carbohydrates, respectively, i.e. met the nutrient needs of 86±3.6% of the participants in terms of dietary energy content.

The study has detected associations between abdominal obesity and the energy value of the consumed diet, total carbohydrate, mono- and disaccharide, fat and protein intake. These associations were weaker in the group of subjects with general obesity. Our findings may be useful for updating the existing nutritional guidelines for the working-age population and setting new goals for public nutrition.

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HYGIENIC ASSESSMENT OF PUBLIC HEALTH RISKS CAUSED BY FOOD CONTAMINATION WITH ORGANOCHLORINE PESTICIDES

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Accumulation of anthropogenic contaminants in food is one of the by-products of economic and other activities practiced by humankind. This study aimed to analyze the public health risks associated with ingestion of organochlorine pesticides (HCH, DDT) widely used in agriculture. The risk assessment was enabled by Nutri-prof software package; the data collected covered actual dietary patterns of 1798 people (823 men and 975 women) aged 18 to 65. Assessment of the level of contamination of food with organochlorine pesticides relied on the results of analysis of 16510 food product samples belonging to various groups. Bread and bread products, vegetables and melons, potatoes, milk and dairy products were shown to be the source of HCH in the amounts causing the greatest non-cancerogenic risk associated therewith. The list of products delivering the largest amounts of DDT into the body and thus posing the greatest non-cancerogenic risk associated therewith includes bread and bread products, vegetables and melons, meat and meat products, milk and dairy products. With the median DDT and HCH concentrations factored in, the highest joint cancerogenic risk level a person may be exposed to reaches the third range, which is acceptable for occupational groups. From the age of 45, consumption of bread and bread products leads to the related endocrine system risks growing beyond background levels, and from 65, these risks, considered negligible up to this age, become moderate. The results of this study support effectiveness of the sanitary and epidemiological food safety control system; the considered methodological approach to risk assessment allows making timely management decisions that account for the nature of work and dietary peculiarities.

Keywords: health risk, food, evolutionary risk model, organochlorine pesticides, DDT, HCH

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Compliance with ethical standards: Voluntary informed consent was obtained for each participant. The study was biomedical ethical and did not endanger the participants.

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ГИГИЕНИЧЕСКАЯ ОЦЕНКА РИСКА ДЛЯ ЗДОРОВЬЯ НАСЕЛЕНИЯ, ОБУСЛОВЛЕННОГО КОНТАМИНАЦИЕЙ ПИЩЕВЫХ ПРОДУКТОВ ХЛОРОРГАНИЧЕСКИМИ ПЕСТИЦИДАМИ

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Хозяйственная деятельность человека приводит к накоплению в пищевых продуктах антропогенных контаминантов. Целью исследования был анализ риска для здоровья населения, обусловленный пероральным поступлением хлорорганических пестицидов (ГХЦГ, ДДТ), широко применявшихся в сельском хозяйстве. Оценка риска осуществлялась с учетом данных о фактическом питании 1798 человек (823 мужчин и 975 женщин) в возрасте от 18 до 65 лет с применением программного комплекса «Нутри-проф». Для оценки контаминации пищевых продуктов хлорорганическими пестицидами проанализировано 16510 проб различных групп пищевых продуктов. Наибольший неканцерогенный риск, обусловленный поступлением в организм с пищевыми продуктами ГХЦГ, обусловлен потреблением хлеба и хлебных продуктов, овощей и бахчевых, картофеля, молока и молочных продуктов, наибольший неканцерогенный риск при поступлении ДДТ с пищей обусловлен потреблением хлеба и хлебных продуктов, овощей и бахчевых, мяса и мясных продуктов, молока и молочных продуктов. Наивысший уровень суммарного индивидуального канцерогенного риска для ДДТ и ГХЦГ с учетом медианной концентрации соответствует третьему диапазону и приемлем для профессиональных групп. Превышение фоновых значений риска для эндокринной системы при потреблении хлеба и хлебопродуктов наступает в 45 лет, переход с пренебрежимо малого уровня риска на уровень умеренного риска наступает в 65 лет. Полученные результаты указывают на эффективность системы санитарно-эпидемиологического надзора за безопасностью пищи, рассматриваемый методический подход к оценке рисков позволяет своевременно принимать управленческие решения с учетом характера трудовой деятельности и особенностей питания.

Ключевые слова: риск здоровью, пищевые продукты, эволюционная модель риска, хлорорганические пестициды, ДДТ, ГХЦГ

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Food safety plays one of the key parts in ensuring public health [1]. Contamination of food stock with anthropogenic pollutants caused by human economic activity can lead to the development of pathological conditions in people [2,3,4]. Organochlorine pesticides are among the anthropogenic contaminants polluting food stock in the context of agricultural activities [5].

DDT (dichlorodiphenyltrichloromethylmethane) and HCH (hexachlorocyclohexane), both organochlorine pesticides, are insect control chemicals applied to seasonal and perennial crops [6]. These contaminants, which are taken by people with food, have potential teratogenic, carcinogenic, hormonal, neurological and immunological properties [7, 8, 9].

Food contamination control, as well as the analysis of health risks associated with ingestion of foreign agents, are the key tools supporting and promoting food security in the Russian Federation. They are also an integral part of the country's demographic policy [10].

This study aimed to analyze the public health risks associated with ingestion of organochlorine pesticides, with the results of this analysis enabling evaluation of the effectiveness of sanitary and epidemiological control operations in the Samara region and generation of the new approaches to risk assessment relying on evolutionary models.

MATERIALS AND METHODS

The assessment of dietary patterns peculiar to various occupational categories involved collecting data from the participating residents of Samara region, the collection relying on surveys powered by Nutri-prof software [11]. The participants of the study were 1798 people aged 18 to 65 years, 823 male and 975 female. The surveys allowed learning their food habits structured by the main food groups. The occupational categories the participants were grouped by reflected nature of their work and gender specifics; they were "education", "healthcare", "industrial production", "office", "agriculture". Food contamination with organochlorine pesticides was determined in the laboratory of the Samara Region Center for Hygiene and Epidemiology, the gas-liquid chromatography tests aimed at identifying concentrations of such compounds as HCH and DDT. A total of 16510 samples were analyzed. Automated assessment of carcinogenic and non-carcinogenic risks, which factored in exposure of the occupational groups to organochlorine compounds, relied on the Food Contamination Database. The assessment considered combined exposure to the contaminants, their median and 90th percentile concentrations.

RESULTS

Organochlorine pesticides (HCH, DDT) were found in bread and bread products, vegetable oil and other fats/oils, milk and dairy products, meat and meat products, eggs, fish and fish products, sugar and sweets/pastries, fruits and berries, vegetables and melons, and potatoes. Their median and 90th percentile concentrations were established (Table 1).

Analysis of the HCH content in food showed that eggs, vegetable oil and other fats have the maximum median concentrations, the lowest values were registered in such plant products as vegetables, fruits and potatoes (in the range of 0.0163–0.0032 mg/kg). As for DDT, the highest concentrations thereof were found in meat and meat products, and vegetable oil and other fats had it in concentrations ranging from 0.0143 to 0.0044 mg/kg.

The subsequent assessment of exposure and hazard ratios associated with ingestion of organochlorine contaminants factored in the specifics of their consumption in various occupational groups, these specifics reported by the participants when describing their actual dietary patterns.

The maximum non-carcinogenic risk associated with taking HCH with food was 0.01 (median), and with the 90th percentile accounted for — 0.096. Women falling into the "industrial production" category were specifically exposed to this risk due to consumption of bread and bread products, vegetables and melons, potatoes, milk and dairy products.

The maximum non-carcinogenic risk associated with ingestion of DDT with food (median) was established in the "agriculture" group among males, with the value being 0.24, and among females of the "industrial production" group, with the same value. By the 90th percentile, females of the "industrial production" group ran the highest risk (0.66). The risks arose from consumption of bread and grain products, vegetables and melons and gourds, meat and meat products, milk and dairy products contaminated with DDT.

The joint hazard index (∑ HI) describing concurrent and long-term exposure to (intake of) HCH and DDT showed that females of the "industrial production" group ran the highest risk (Table 2).

According to the "Guidelines for assessing public health risks associated with exposure to environment pollutants" (R 2.1.10.1920-04), liver and the endocrine system are the organ and system critically affected upon exposure to DDT, therefore, females of the "industrial production" group run the highest risk of negative consequences from oral contact with organochlorine contaminants.

Accounting for the exposure and the slope factors (SFo) of the studied contaminants, we evaluated the risk of carcinogenic effects they may have on representatives of the various occupational groups. The highest level of individual and population carcinogenic risks associated with median concentration for DDT was established for the male part of the "agriculture" occupational group (4.1×10^{-5} and 0.41 cases per 10,000 people, respectively). Same group ran the highest risk of cancer associated with DDT ingestion (0.000184 and 1.84 per 10 000 population). Females in the "industrial production" group had the highest DDT-induced individual and population carcinogenic risk level, which amounted to 0.00011 and 1.11 cases, respectively. As for HCH, in this occupational group the

Table 1. Median and 90th percentile content of organochlorine pesticides in food (mg/kg)

Food groups	HCH		DDT	
	Me	90	Me	90
Bread and bread products	0.0051	0.0543	0.0053	0.0065
Vegetable oil and other oils/fats	0.0147	0.0296	0.0095	0.0276
Milk and dairy products	0.0061	0.0072	0.0049	0.0054
Meat and meat products	0.0047	0.0188	0.0143	0.0362
Egg	0.0162	0.0163	0.005	0.005
Fish and fish products	0.0046	0.0073	0.0052	0.0114
Sugar and sweets/pastry	0.0049	0.0072	0.0048	0.0078
Fruits and berries	0.0042	0.0049	0.0051	0.006
Vegetables and melons	0.0035	0.1048	0.0047	0.0248
Potatoes	0.0032	0.0735	0.0044	0.0334

Table 2. Total hazard indices in occupational groups, median and 90th percentile HCH and DDT concentrations

Occupational group	∑ HI		∑ HI	
	Me		90	
	female	male	female	male
"education"	0.23	0.198	0.68	0.5
"health care"	0.182	0.176	0.51	0.48
"industrial production"	0.25	0.239	0.756	0.693
"office"	0.167	0.156	0.456	0.428
"agriculture"	0.2209	0.241	0.6	0.71

individual risk arising from ingestion of this chemical was at the level of 0.00147, and the population risk amounted to 17.4 cases per 10000 people.

With the median DDT and HCH concentrations factored in, the total individual and population carcinogenic risk arising from the combined effects of DDT and HCH in all studied occupational groups falls within the third range (individual risk throughout life ranging from 1×10^{-4} to 1×10^{-3}), which is acceptable for occupational groups and unacceptable for the general population. With the 90th percentile DDT and HCH concentrations factored in, the total individual carcinogenic risk associated with these chemicals affecting the body jointly in all studied occupational groups falls within the fourth range, which is considered unacceptable (individual risk throughout life ≥0.001) neither for occupational groups nor for the general population and requires urgent mitigation measures on the organizational level.

Assessment of the contribution of individual food groups to the total risk load revealed that consumption of bread and bread products aggravates the cumulative risk associated with exposure to organochlorine pesticides. Using the paired relationships reflecting the influence of alimentary factors shaped by contamination of this food group with organochlorine pesticides we developed evolutionary models showing health risks accumulation and accounting for damage to the most vulnerable organs and systems. At the given level of risk and considering life-long and ever growing exposure to contaminants, health disorders are likely to develop in the case investigated. Thus, it is possible to model the likelihood of disease development for the given contaminant exposure values and make management decisions aimed at prevention. According to the literature, HCH and DDT have a negative effect on the endocrine system. Relying on the median pesticide concentrations, we built an evolutionary model of non-carcinogenic risk for the endocrine system associated with consumption of bread and bread products, which showed that, starting from the age of 45, the evolutionary risk grows beyond background levels, and from 65, these risks, considered negligible up to this age, become moderate (Figure).

DISCUSSION

Most organochlorine pesticides, including HCH and DDT, are persistent organic pollutants contaminating environment in general and food in particular. These chemicals cause the risk of development of non-carcinogenic and carcinogenic diseases [12,13].

The Russian Federation food security concept relies on the multi-stage system for assessing risks associated with food contamination. The methodological approaches to modeling the evolution of risk that are currently practiced in our country underlie the methodology for chemicals-related public health risks assessment and food (goods) safety appraisal, which is recommended by the Eurasian Economic Commission [14]. Both in our country and other countries of the Eurasian Economic Union (EAEU), there functions a multi-level legislative system regulating the health risks assessment procedure, the list of such risks including those arising from food contamination [15, 16].

This study has shown that in the Samara region, the state sanitary and epidemiological control system ensures food safety through permitting sale of food containing permissible levels of organochlorine contaminants. Nevertheless, the analysis of risk associated with contamination of food stock with these compounds revealed the most vulnerable occupational groups, those bearing the highest risk load, including risks arising from the consumption of contaminated food with high values of pesticide content (90th percentile).

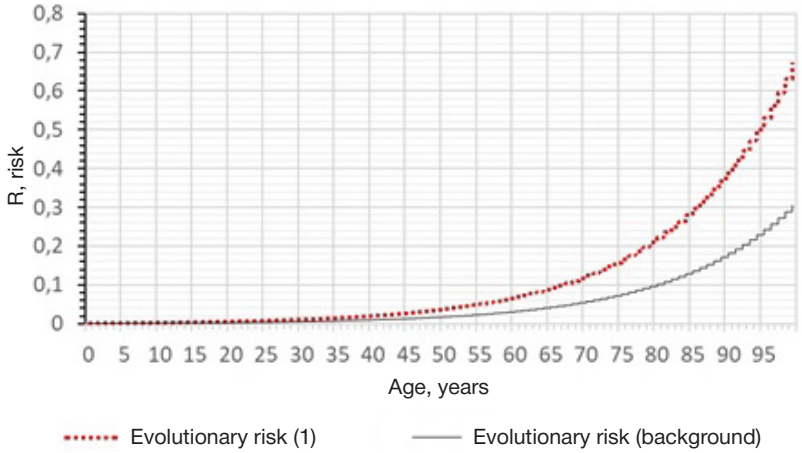

Fig. Evolutionary model of non-carcinogenic risk from endocrine system arising from ingestion of contaminants with bread, bread products (median concentrations)

We analyzed the actual dietary patterns of various population groups (although, from the methodological viewpoint, risk assessments typically rely on Rosstat data reflecting average annual consumption) and received data on exposure to organochlorine pesticides in specific occupational groups. The maximum carcinogenic risk associated with ingestion of DDT and HCH was established in the "agriculture" group among males and in the "industrial production" group among females. The maximum carcinogenic risk associated with exposure to DDT and HCH was established for females of the "industrial production" group. In all occupational groups, the level of carcinogenic risk, with the growth of median concentration factored in, falls in the third range. We have built a non-carcinogenic risk evolutionary model revealing the development of endocrine system disorders; this model shows that the key contributors to aggravation of such disorders are bread and bread products, and that starting from the age of 45, the evolutionary risk grows beyond background levels, and from 65, these risks, considered negligible up to this age, become moderate. The suggested herein methodological approach to risk assessment factors in dietary specifics and structure, as well as food habits, exposure to contaminants depending on the pesticide ingestion scenario, which can be based on median concentration values or maximum concentrations, the latter a pessimistic scenario. With this approach, risk analysis and subsequent management decisions are made in a more differentiated manner, which ultimately affects the effectiveness and appropriateness of preventive measures.

CONCLUSIONS

Thus, the hygienic assessment of public health risks associated with contamination of food with organochlorine pesticides has shown that the current sanitary and epidemiological control practices adopted in the Samara region to ensure food safety are effective and aimed at preserving and improving health of the population. The methodological approach to evolutionary risk models, which relies on software and factors in the actual dietary patterns found in various occupational groups, allows full assessment of nutritional risks, identification of the most vulnerable occupational groups and timely management decisions aimed at mitigation of the factors that shape negative health impact in specific populations.

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20-YEAR MONITORING OF PHYSICAL DEVELOPMENTAL CHARACTERISTICS IN SCHOOL-AGE CHILDREN AND ADOLESCENTS LIVING IN KURSK

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The study was aimed to compare physical developmental characteristics in children and adolescents aged 7–18 living in Kursk for the years 2000–2001 and 2019–2020. The study was carried out in general educational institutions located in different urban areas of Kursk in 2000–2001 and 2019–2020. The standard anthropometric measurements, instruments and statistical methods were used. A total of 20,083 school-age children and adolescents were examined. The inclusion criteria were as follows: school-age children and adolescents staying at the educational institution at the time of the study, informed consent form properly completed, anthropometric measurements correctly performed. Statistical processing of the results was carried out using the Statistica 10.0 software package. The 20-year monitoring of physical development characteristics performed in school-age children and adolescents living in Kursk revealed the significant increase in height and body weight in all age and gender groups. The harmonious body acceleration manifestations associated with the muscle strength increase were observed in the context of sociomedical progress in Kursk.

Keywords: school-age children, physical development, monitoring, long-term longitudinal data

Author contribution: Chernykh AM — academic advising, data acquisition, manuscript writing; Kremleva AS, Belova AI — data acquisition, statistical processing, literature search.

Compliance with ethical standards: Ethics Committee protocol № 108 dated October 24, 2016. The informed consent was obtained for all study participants. The study does not harm the participants and is consistent with ethical principles of biomedical research.

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МОНИТОРИНГ ФИЗИЧЕСКОГО РАЗВИТИЯ ШКОЛЬНИКОВ ГОРОДА КУРСКА В ДИНАМИКЕ ДВАДЦАТИ ЛЕТ НАБЛЮДЕНИЯ

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Целью данного исследования явилась сравнительная оценка показателей физического развития детей 7–18 лет, проживающих в г. Курске за периоды 2000–2001 гг. и 2019–2020 гг. Исследование проводилось на базе общеобразовательных организаций, размещённых в различных районах г. Курска в период с 2000–2001 гг. и 2019–2020 гг. Использовалась стандартная антропометрическая методика, инструментарий и методы статистической обработки. Общее количество обследованных школьников составило 20083 ученика. Критерии включения в выборку – дети и подростки школьного возраста, находящиеся в момент проведения исследования в образовательной организации, наличие корректно заполненного информированного согласия и корректно проведенного антропометрического исследования. Статистическая обработка полученных данных проводилась с использованием пакета статистического анализа Statistica 10.0. Проведенный в данном исследовании мониторинг физического развития школьников города Курска в динамике двадцати лет наблюдения выявил достоверное увеличение показателей длины и массы тела во всех возрастно-половых группах школьников. На фоне положительных медико-социальных изменений в городе Курске зафиксированы проявления процесса акселерации, которые носят гармоничный характер и сопровождаются увеличением показателей мышечной силы.

Ключевые слова: школьники, физическое развитие, мониторинг, многолетняя динамика

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The long-term longitudinal studies of physical development characteristics as a measure of country's children health are an important issue, because these allow the researchers to yield a long-term forecast and propose measures to improve the country's reproductive and labor potential, as well as the demographic situation [1–8].

Currently, the physical developmental characteristics in children and adolescents are considered the criterion of their health, which includes assessment of the level and harmony of physical development [9, 10].

The reports has been published concerning the long-term longitudinal data on the children's physical development obtained both in different regions of the Russian Federation and abroad [11–14].

The study demonstrates the 20-year longitudinal data on the physical developmental morphofunctional characteristics in school-aged children and adolescents living in Kursk.

Aim. Comparison of physical developmental characteristics in children and adolescents aged 7–18 living in Kursk for the years 2000–2001 and 2019–2020.

METHODS

The study was carried out in general educational institutions located in different urban areas of Kursk in 2000–2001 and 2019–2020. The standard anthropometric measurements, instruments and statistical methods were used [15–17].

A cohort of 20,083 school-age children and adolescents was examined. Inclusion criteria: school-age children and adolescents staying at the educational institution at the time of the study, informed consent form properly completed, anthropometric measurements correctly performed.

The study did not harm the participants or infringe upon their rights in accordance with ethical principles of biomedical research mandated by the World Medical Association Declaration of Helsinki (2013).

Statistical processing of the results was carried out using the Statistica 10.0 software package (StatSoft, USA).

Results

When analyzing the 20-year longitudinal data on the physical developmental characteristics of children and adolescents aged 7–18 attending general educational institutions in Kursk, the improvement can be seen (Tables 1, 2).

The significant ($p \leq 0.01$–0.05) height increase was observed in all age and gender groups. In 2000–2001 the height of boys aged 7 was 117.0 cm, and in 2019–2020 it was 121.6 cm, i.e. the increase was 4.6 cm. In 2000–2001 the height of girls aged 7 was 115.8 cm, and in 2019–2020 it was 119.6 cm, i.e. the increase was 3.8 cm.

In 2000–2001, by the end of growth, the young men aged 18 had the height of 166.1 cm, and in 2019–2020 they had the height of 176.1 cm, i.e. the increase was 10.0 cm. In 2000–2001 the height of girls aged 18 was 157.3 cm, and in 2019–2020 it was 170.6 cm, i.e. the increase was 13.3 cm.

The annual change in average height starts to decline after 17 in young men, and after 15 in girls, since the growth ends, however, the growth curves are typical.

The significant ($p \leq 0.01$) body weight increase was observed in school-age children and adolescents of all age and gender groups. Thus, in 2000–2001 the 7-year-old boys' body weight was 21.7 kg, and in 2019–2020 it was 23.4 kg, i.e. the increase was 1.9. In 2000–2001 the body weight of girls aged 7 was 21.4 kg, and in 2019–2020 their body weight was 23.1 kg, i.e. the increase was 1.5 kg.

In 2000–2001, the 18-year-old young men's body weight was 58.7 kg, and in 2019–2020 it was 65.2 kg: the increase was 6.5 kg. In 2000–2001 the body weight of girls aged 18 was 52.1 kg, and in 2019–2020 their body weight was 58.9 kg: the increase was 5.8 kg.

The increase in height and body weight was accompanied by an increase in muscle strength of the hand in school-age children and adolescents of all age and gender groups (see Figure).

Table 1. Height of school-age children and adolescents living in Kursk, measured in 2000–2001 and 2019-2020, M±m

Age, years	Number of observations	M ± m	σ	Number of observations	M ± m	σ	*p*
	2000-2001 гг.			2019-2020 гг.			
Boys							
7	247	117,0±0,29	4,57	320	121,6±0,26	4,92	p≤0,01
8	419	121,0±0,26	5,41	351	126,2±0,26	5,07	p≤0,01
9	469	125,3±0,26	5,81	375	130,4±0,21	6,24	p≤0,01
10	452	128,3±0,30	5,32	448	135,9±0,26	5,65	p≤0,01
11	371	133,1±0,30	5,89	323	140,1±0,25	4,73	p≤0,01
12	329	137,7±0,37	6,97	283	145,4±0,26	4,57	p≤0,01
13	224	142,2±0,41	6,12	275	150,5±0,21	5,32	p≤0,01
14	168	147,8±0,42	5,48	153	155,9±0,28	4,84	p≤0,01
15	154	154,7±0,56	6,88	242	163,7±0,20	4,85	p≤0,01
16	184	161,1±0,44	6,11	145	170,2±0,27	3,34	p≤0,01
17	141	165,3±0,50	5,99	123	174,5±0,27	3,11	p≤0,01
18	70	166,1±0,73	6,03	112	176,1±0,29	3,24	p≤0,05
Girls							
7	249	115,8±0,29	4,71	291	119,6±0,31	4,93	p≤0,01
8	488	120,0±0,18	4,22	432	123,7±0,20	5,48	p≤0,01
9	463	124,1±0,21	4,68	412	127,8±0,25	5,33	p≤0,01
10	519	128,4±0,22	5,21	451	134,1±0,24	5,2	p≤0,01
11	432	132,1±0,27	5,83	415	140,8±0,25	4,35	p≤0,01
12	363	139,0±0,64	5,16	381	147,2±0,23	5,82	p≤0,01
13	252	144,2±0,36	5,95	426	153,7±0,21	5,68	p≤0,01
14	236	150,8±0,69	6,11	353	159,4±0,27	4,27	p≤0,01
15	226	153,9±0,35	5,34	212	162,1±0,34	5,04	p≤0,01
16	205	155,6±0,33	4,79	184	164,6±0,35	4,89	p≤0,01
17	137	156,6±0,38	4,58	112	167,7±0,43	3,57	p≤0,01
18	69	157,3±0,62	5,33	109	170,6±0,38	4,43	p≤0,01

Table 2. Body weight of school-age children and adolescents living in Kursk, measured in 2000–2001 and 2019-2020, M±m

Age, years	Number of observations	M ± m	σ	Number of observations	M ± m	σ	*p*
	2000-2001 гг.				2019-2020 гг.		
Boys							
7	247	21,7±0,15	2,47	320	23,4±0,15	2,75	p≤0,01
8	419	23,6±0,12	2,68	351	25,7±0,14	2,78	p≤0,01
9	469	25,7±0,16	3,53	375	28,1±0,14	3,04	p≤0,01
10	452	27,4±0,13	2,86	448	30,6±0,13	2,93	p≤0,01
11	371	30,1±0,19	3,94	323	34,5±0,18	3,34	p≤0,01
12	329	32,9±0,19	3,81	283	37,4±0,21	3,65	p≤0,01
13	224	36,2±0,25	3,89	275	41,6±0,21	3,57	p≤0,01
14	168	41,1±0,30	4,03	153	46,5±0,22	3,64	p≤0,01
15	154	46,4±0,28	3,57	242	53,2±0,21	3,23	p≤0,01
16	184	52,3±0,30	4,05	145	59,7±0,21	2,68	p≤0,01
17	141	56,4±0,23	3,14	123	63,3±0,19	2,21	p≤0,01
18	70	58,7±0,32	2,74	112	65,2±0,24	2,24	p≤0,01
Girls							
7	249	21,4±0,14	2,46	291	23,1±0,17	2,42	p≤0,01
8	488	22,9±0,10	2,48	432	25,3±0,15	2,76	p≤0,01
9	463	24,8±0,10	2,45	412	26,9±0,19	3,02	p≤0,01
10	519	27,1±0,12	2,86	451	29,6±0,14	2,23	p≤0,01
11	432	29,9±0,12	2,74	415	34,4±0,11	2,45	p≤0,01
12	363	33,6±0,16	3,18	381	37,9±0,13	2,81	p≤0,01
13	252	37,9±0,20	3,34	426	43,8±0,13	2,92	p≤0,01
14	236	42,7±0,19	4,03	353	48,5±0,16	2,21	p≤0,01
15	226	46,3±0,20	3,11	212	53,6±0,21	2,13	p≤0,01
16	205	49,0±0,28	4,07	184	57,1±0,23	2,24	p≤0,01
17	137	51,7±0,31	3,69	112	58,8±0,27	2,87	p≤0,01
18	69	53,1±0,44	3,72	109	58,9±0,22	2,34	p≤0,01

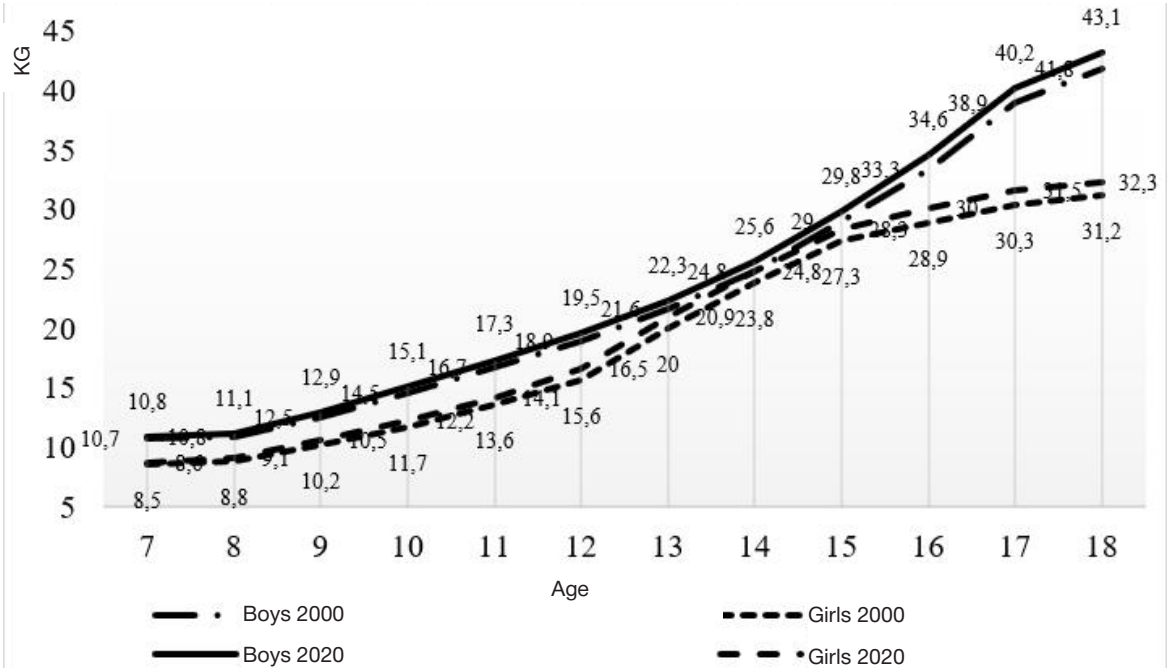

Fig. Muscle strength measurements of the hand in girls and boys aged 7–18 living in Kursk, obtained in 2000–2001 and 2019-2020, M

During the 20-year monitoring the muscle strength of the right hand in 18-year-old young men (by the end of growth) increased by 1.3 kg, and in girls the muscle strength of the right hand increased by 1.1 kg.

DISCUSSION

Realization of growth is driven by genetic and environmental factors: the inherited genetic program is implemented under the influence of a complex set of factors. Negative factors can cause growth retardation and developmental delay, and the positive factors can cause the opposite. Sociomedical progress, which took place in the Kursk Region in the recent decades according to official statistics, ensured the conditions favorable to children's growth and development. This was manifested by the positive trend in the changes of physical developmental morphofunctional characteristics in school-age children [18].

Similar changes are observed both in the regions of Russia and abroad, for example in BRIC countries. Thus, the study performed in Kolkata (India) revealed positive trend in changes of height and body weight of children and adolescents aged 7–16 associated with improvement of sociomedical conditions related to socioeconomic progress in India over the recent decades [19].

Improvement of children's physical developmental characteristics associated with economic development together with the decrease of inequalities between urban and rural areas are observed in Guangzhou (China). However, the gross domestic product growth positively correlates with the prevalence of obesity both in urban and rural areas (R>0.90 with p<0.05) [20].

According to a number of authors, economic development and urbanization trigger such problems as obesity [21, 22].

At the same time, the muscle strength decrease is observed in children and adolescents in many countries. Thus, meta-analysis performed from 1969 to 2017, which included 1,746,023 children and adolescents from 14 countries (China, Finland, Sweden, Belgium, New Zealand, Denmark, Spain, Norway, Mozambique, Poland, USA, Lithuania, Portugal, Canada), showed a constant decline in strength in the young people [23].

Our study revealed the improvement of dynamometric performance. This in fact highlights the harmonious pattern of body acceleration manifestations in the region.

CONCLUSION

The 20-year monitoring of physical development characteristics performed in school-age children and adolescents living in Kursk revealed significant increase in height and body weight in all age and gender groups. The harmonious body acceleration manifestations associated with the muscle strength increase were observed in the context of sociomedical progress in Kursk.

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