

Teksheva L. M., Barsukova N. K., Chumicheva O. A., Khatit Z. Kh.

HYGIENIC ASPECTS OF CELLULAR COMMUNICATION IN SCHOOL AGE

Institute of Hygiene and healthcare of children and adolescents of the Scientific Centre of Child Healthcare, 105064, Moscow, Russian Federation

In the article there are presented the materials of research on the spread and usage of mobile phones among children and adolescents of different age groups in the Russian regions, the data of the performed tests of cellular communication devices, as well as the established effects of electromagnetic radiation (EMR) on biological objects. Risk groups of schoolchildren for adverse effect of EMR on health have been determined.

Key words: health of schoolchildren; mobile phones; electromagnetic radiation.

Problem of adverse effects of electromagnetic radiation (EMR) on human acquired currently highly topical in view of the increasing number of devices and mobile devices and their distribution among the population. The number of subscribers of mobile communication systems has increased dramatically in a very short time, and it continues to grow. Most use a mobile phone children and adolescents (over 90%), and in this group increased the number of children of primary school age.

Many scientists from around the world, including from Russia, allow a high risk of exposure to electromagnetic fields (EMF) of mobile phones on the human body [1, 2, 7, 8, 10, 12, 15, 16, 22].

Features of age physiology of children and adolescents, the greater vulnerability to adverse environmental factors, especially in the early stages of development, determine the relevance of studies of the effect of EMR at this age group [12, 14, 19, 21, 23, 24].

In addition, today's children, as adults, will have significantly more experience using mobile phones than adults today. In the literature, there are practically no information on the studies on the prevalence of cellular communication among children of different age groups, modes of use, the actual load EMF ultrahigh frequency (SHF) on the child's body and their negative impact on the health of children and adolescents. All this indicates not only the relevance of the problem of interaction of radiation with cellular organism of children and adolescents, but also about the timeliness of research.

As a result of the research found that in virtually all cell phones used by modern teenagers and are manufactured outside of the Russian Federation. Manufacturers in the appended to each phone technical documentation declare compliance values EMP recommendations of the International Commission on Non-Ionizing Radiation Protection (INCRIP). However, for the safety assessment of a cell phone in our country, this information does not matter, because there are fundamental differences between the recommendations INCRIP and regulations of the country in the monitored physical quantities, and the methods of implementation of instrumental measurements [3, 4, 9, 11].

In Russia, the main parameter is the normalized flux density of electromagnetic radiation. The legal limit when exposed to cell phone users is 100 mW/cm^2 . In order to protect the population is recommended to minimize the time of mobile radio and restrict the use of mobile phones by persons under 18 years of age, women during pregnancy, people with implanted pacemakers [4, 9].

We cannot ignore the lack of standards for maximum permissible exposure level of EMR mobile phone for children and adolescents, which should take into account the peculiarities of age physiology of children, greater sensitivity to EMF than that of adults, and the experience of Children's Exposure to electromagnetic radiation.

In this regard, the aim of the work was to study the prevalence and modes of use of cellular communication among children and adolescents, the impact of EMF emitted by mobile phones on their health.

The purpose of these studies has identified methodological basis of research work. All research methods can be divided into 4 groups:

1 Physical and analytical methods, is to carry out measurements of the levels of EMR operating range of mobile phones.

2 Epidemiological studies, consisting of students in the survey on the prevalence of mobile communication among them, the frequency and temporal characteristics of its use.

3 Biological studies on the effects of microwave radiation on the cell body.

4 Statistical data processing.

Flux density of radiation of mobile phones GSM-standard (800-2400 MHz) were carried out with the help of the domestic unit PB-33M developed "NTM-protection." The total volume was 984 studies measuring the flux density of the microwave radiation.

Conducted surveys in 2700 schoolchildren aged 6 to 18 years in three regions of Russia: Moscow, St. Petersburg and Voronezh. The questionnaire contained 30 questions with programmed responses. All questions on the content can be divided into 5 units:

- The prevalence of mobile phones among schoolchildren;
- Features and modes of use of mobile phones;
- Features and modes of use of personal computers (related radiation);
- Morbidity and functional state of the organism;
- Social indicators.

Biological studies were to determine the changes of cell motility of a microorganism (for example, bull semen) under the influence of aggressive media. Regulatory document for research is MU 1.1.037-95 "Biotesting production of plastics and other materials." The essence of the technique was to investigate the acute toxicity of aqueous extract of the test article with the cell of the test object. Studied the variation depending on the motor activity of sperm from time to time under the influence of microwave radiation and chemicals.

Statistical data processing was carried out using the ARCADA. Comparison of numerical samples was carried out by the average value of the series, the standard error, the number of observations based on the distribution of data in a row. In the analysis of the statistical significance of differences between the samples included the most common in biomedical research nonparametric statistical methods: the method of Smirnov, Welch and Wilcoxon.

The main thrust of this research was to study the actual load of the microwave radiation of mobile phones on children and adolescents. In the analysis of regulatory documentation (SanPin 2.2.4. / 2.1.8.055-96 and GN 2.1.8 / 2.2.4.019-94) attention is drawn to methods of measuring the flux density of the microwave radiation. Usually, when measuring this value is regulated to stand away from the radiation source (mobile phone) to the receiving element of the measuring instrument. As part of the GSM standard, this distance is not less than 36 cm. However, our studies have shown that when talking on a cell phone is very small percentage of children enjoyed a special device «hands free»: from 1 to 3% use constantly and from 6 to 15% are often. The most popular device is the schoolchildren of 11-13

years (from 3 to 15%). In the age group of 6-10 years showed the highest number of children who do not use the «hands free», - 68%.

As a result of these measurements were able to determine the actual intensity of the microwave cellular acting directly on the user's head. It is found that the energy flux density of mobile phones depends not only on the machine model, but also the time and place of measurement, range and service provider. Radiation power studied at stand 82 phones is the range from 0.4 to 65.3 mW / cm² in the most intense for cellular time (12.00-16.00).

Obtained is a clear direct relationship between the level of EMR mobile phone on the distance to the base station. Measurement of the flux density of radiation during conversations in the urban environment (Moscow - Moscow) and in a medium city - region (Moscow - Shatura) shows an increase in the radiation power in the second case 1,5-16,4 times (47,8- 72,9; 19,4-318,1 mW / cm²) and has resulted in exceeding several times the current remote control (100 mW / cm²).

Register microwave radiation in 4 modes of mobile communication (wait - sound; Vibrate, Vibrate + sound; operation) revealed that different types of handsets of the same company differ in the average level of radiated power. Measurement of power flow microwave field for work of the same phone with sim-cards of different operators at a fixed location measurements revealed a significant difference ($p \leq 0,001$) in terms of radiation. Measurements carried out in the premises Institute of Hygiene and health of children and adolescents suggest that the range of emissions for the operator MTS ranged from $1,2 \pm 0,4$ to $12,7 \pm 2,4$, the operator Megafon - from $3,8 \pm 2,1$ to $19,2 \pm 2,1$, for the operator of Bee Line - from $10,4 \pm 1,7$ to $34,5 \pm 5,2$ mW / cm². Results are attributed to the presence of antennas MTS and MegaFon in the immediate vicinity of the building, providing easy retrieval and communications support, and allow us to recommend for each school building operator, ensuring minimal impact cellular schoolchildren.

Extremely difficult to estimate the moment remains absorbed energy EMF and its distribution in the brain of the user, which is indicated by several researchers [5, 6, 8, 13, 17, 18, 20, 22].

In accordance with the identified variations in EMR mobile phone energy absorbed by the brain, too, will vary depending on hardware power, carrier frequency, and the communication range of other factors.

Specifically held under the theme of studies on the relative ability of EMR absorption of microwave range (900-1800 MHz) different media revealed that the maximum absorption of microwave radiation has a living organic matter (man's hand). Almost 60% of mobile phone radiation absorbed by human tissue. These data are practically confirmed the results of previous studies by other authors, which indicate that the human brain can absorb up to 70% of the impact on him of energy. The results of studies, along with the literature data on the depth of penetration into the child's brain EMF 835 MHz (up to 5.14 cm in the five-year and 4.77 cm in ten children) due to the well-known thermal effect of microwave radiation, as well as the negative effects of its specific impact on the human body give reason to consider cell phones as a risk factor for human health, and especially children and adolescents [19, 25].

Fig. 1 The radiation power from different planes mobile phone (in mW / cm²).

In the study of the specificity of different media EMR absorption measurements were made of the intensity of the output radiation is not only a working panel, but with the sides of the mobile device and its upper part. Interestingly, the TT radiation different surfaces mobile phone is not redistributed in space, and evenly absorbed by the receiver of the radiation (see Fig. 1). If the maximum output power is observed on top of the operation panel (2 times more radiation sidewalls and 6 times more radiation front panel), then 60% of the absorbed energy on this side of the phone body is determined to 6 times greater impact than from the front (working) panel. This fact can be attributed to children who wear the

phone on a cord around his neck, to be at risk. In the call, subject to the damaging effects the thyroid gland. The highest proportion of children (12.7%) prefer to carry the phone on a cord around his neck, we noted in the age group of 6 to 10 years.

The data obtained are alarming, as there is information on the effects of EMR GSM-standard endocrine function, in particular a decrease in the plasma concentration of certain hormones (eg, TSH).

The study also showed that the prevalence of mobile phone users among children and adolescents in Russia is very high and reaches 98.3%, while personal phones have 93.1% of the students. The number of mobile users increases with age from 96.4% among children 6-10 years to 99.2% among schoolchildren aged 14-15 and 98.2% - 16-18 years. Number of children with a personal phone, also increases with age from 83.4% in the group of children of 6-10 years to 95.7% among schoolchildren aged 14-15 and 94.5% of students aged 16-18.

The share of students of all age groups who use mobile phones is very high and is 97,5-98,8% in all three studied cities (Moscow, St. Petersburg, Voronezh).

The most common way of wearing mobile phones, regardless of age, - in the pockets of the 2nd layer of clothing - 69.1%, and only 38.2% of the students are mobile phone in your briefcase, purse, backpack.

With hygiene products wearing number on the chest and in the pockets of school clothes is a risk factor for cellular users.

In parallel with the study of the prevalence of mobile phone among children and adolescents has been studied in the presence of families of fixed telephony. The findings suggest that the presence of fixed-line phones in the family does not reduce the burden on children provider.

In the study of sexual specificity using mobile phones a significant difference between boys and girls 11-18 years in the number of mobile phone conversations, according to the total time of calls a day. Thus, it was found that girls in 1.4-2 times more talking on the phone than boys.

Dependence of the spread of mobile communication of material well-being in the family can be traced indirectly by the difference between the frequency and duration of conversations students of private and public schools. Thus, in the group of students 11-14 years old, enrolled in a private school, a significant difference between the number, average and total talk time per day on a cell phone, compared with children enrolled in public school. The total time of calls a day from students in private schools is nearly 20 minutes in a public school - no more than 17.5 minutes.

The possible influence of EMR cellular health and well-being of children was conducted in three areas that characterize health: frequency of headaches, difficulty sleeping, and the number of cases per year with an increase in temperature.

A set of indicators characterizing the state of health, selected according to the frequency of their occurrence in subject literature on research using survey or experiment. Some authors believe that the increase in complaints of headaches directly related to the use of cell phones [1, 5, 7, 12, 18].

In scientific investigations, it was a very important conclusion: the number of complaints of headache and fatigue depends on the duration of mobile talks throughout the day.

The study of sleep disorders under the influence of EMF mobile studied by both domestic and foreign researchers [2, 5, 8, 12, 13, 18, 24]. In these studies confirmed that the effect of cell phones on the brain can cause headache, fatigue, insomnia.

Already in 2001, the Office for Research of the European Parliament published a report where possible violations of health under the influence of EMF cell phones called predisposition to epilepsy, the weakening of the immune defense. The incidence of morbidity with increasing temperature in the

present study was considered as a decrease in resistance of the body due to the weakening of his immune system.

Studies have revealed the cumulated effect of the negative impact of mobile phones depending on the length of cellular communication. Study of indicators characterizing the state of health of school groups with experience using 2-3 years, 4-5 years and 6-7 years showed deterioration with increasing time using the phone. Thus, the frequency of headaches increased by 3.2% at the experience of 4-5 years compared to 2-3 years of experience. Difficulty falling asleep were detected by 2.5% more often in the group with experience of 6-7 years compared to the group with the experience of 2-3 years. The most significant deterioration manifested itself in terms of the number of cases per year, with an increase in temperature. The incidence increased by almost 9% with certainty $p \leq 0,03$ (see. Table).

Slight differences in the data obtained for each of the three regions (Moscow, Saint Petersburg, Voronezh), allowed to spend their averaging and reliably ascertain significant daily load of microwave radiation on cellular organism children and adolescents. According to the recommendations of the Russian National Committee on Non-Ionizing Radiation Protection, the duration of a conversation should not exceed 3 minutes, and the total per day - no more than 15 minutes. The average time of a single conversation among students 14-15 and 16-18 equivalent to almost 4 minutes ($3,8 \pm 0,4$ and $3,8 \pm 0,5$ min, respectively). School children 6-10 and 11-13 years do not exceed the limit ($2,1 \pm 0,2$ and $2,8 \pm 0,3$ min, respectively). At the same time of the day for a total of 11-18 years, schoolchildren talk exceeding the recommended threshold (see Fig. 2). At the age of 11-13 years, talk on a cell phone every day take more than 15 minutes ($15,2 \pm 0,7$), aged 14-15 years - up to 19 min ($18,9 \pm 0,8$), 16-18 years old - over 20 min ($20,8 \pm 1,2$). School children 6-10 years of talking on a cell phone about 6 minutes per day ($6,5 \pm 0,7$).

Limiting the duration of a single conversation allows you to protect children from electromagnetic radiation of mobile communication.

It should be noted that the statistical analysis of the collected information on indicators describing the state of health, reveals the dependence of certain indicators of the length of mobile calls to different groups of children. So, all students 11-18 years marked a significant association with the frequency of headaches, and children 6-10 years - with the number of cases per year. In the group of girls from 6 to 15 years marked a significant correlation with the duration of one call number of cases per year. In boys, this relationship is manifested in groups 6-10 and 16-18 years. In the groups of boys 11-13 and 14-15 years, there was a significant correlation between the duration of calls per day and the frequency of headaches.

For all three indicators of health were significant correlations ($p \leq 0,001$, $p \leq 0,05$) for children aged 14-15 years. It can be assumed that this group at puberty is the most sensitive to the effects of EMF provider.

Thus, the data obtained by the testimony that the child's body is not indifferent to the effects of microwave radiation from mobile phones, and confirm the concerns of scientists from different countries at high risk of EMF exposure on cellular children and adolescents.

The studies have provided a comprehensive approach to the evaluation of EMF exposure of low and ultra-high frequencies on the child's body.

It should be noted that today's students are simultaneously exposed to low frequency EMF (Personal computers - PC) and microwaves (mobile phones). To study the complex effects on the child's body EMF different frequency bands have formed a group of children for the duration of the work for the PC, depending on age.

Thus, children 6-10 years were divided into two groups: a computer running at least 30 minutes per day and more than 30 minutes a day, pupils 11-13 years were divided into groups as follows: PC less than 1 hour and a 1 hour daily and so on. Interestingly, regardless of age correlation reliable communication, showing a negative impact on children's health prolonging talks on a mobile phone appeared in the groups most engaged with your PC. This trend was especially between the ages of 14 to 15 years. Teenagers the group most susceptible to the effects of cellular Busy the computer over 2 hours a day.

Biological studies of the effect of EMP on the functions of a living organism have been conducted on mobile single-celled organisms (bull semen). In biological experiments revealed that an increase in exposure time from 2 to 10 min spontaneous motility of unicellular organisms was significantly reduced ($p \leq 0,02$) by 1.9%. When cells were exposed to the chemical load (formaldehyde at a concentration of 2 mg / l), cell motility reduced by 33.3%. The combined effect of physical factors (UHF radiation intensity of 25 mW / cm² for 10 minutes) and chemical (formaldehyde at a concentration of 2 mg / l) the nature causes significant ($p \leq 0,09$) stronger inhibition of cell culture (36%) compared with independent physical and chemical stresses.

It can be assumed that microwave radiation, increasing the permeability of cell membranes facilitates delivery of toxic substances into the cell and causes destruction of its DNA.

Continued research on the combined effects of physical and chemical factors on living organisms is extremely relevant, since such an effect is typical for modern ecological situation in residential areas.

The practical significance of the research is to develop hygienic recommendations for cellular users to reduce the real burden of microwave radiation from mobile phones.

Fig. 2 Frequency and duration of use of mobile phones by children and adolescents in the day.

The studies lead to the following conclusions:

1 Established that the energy flux density of mobile phones not only depends on the device model, but also on the time and place of the measurement range and carrier.

2 It is revealed that 60% of microwave radiation from mobile phones is absorbed by living organic matter (human hand), with the known thermal effect of microwave radiation, as well as the negative effects of its specific effects on the human body leads to the need to examine the cellular communication as a risk factor to human health, and especially for children and adolescents.

3 The prevalence of cellular communication among children and adolescents is high and increases with age to 98%.

4 The most common regardless of age wearing a mobile phone in their pockets 2nd layer of clothing, as well as on the chest (on a shoestring). With hygiene products carrying mobile device on the chest and in the pockets of the school uniform is a risk factor.

5 The frequency of and duration of mobile phone use by children of different ages. Total 3 regions found that the total time of calls a day in schoolchildren 6-10 years of age is $6,5 \pm 0,7$ min, 11-13 years - $15,2 \pm 0,7$ min, 14-15 years - $18,9 \pm 0,8$ min, 16-18 years - $20,8 \pm 1,2$ min.

6 Found is that the total duration of calls per day was significantly higher in girls than in boys, regardless of age; the greatest difference occurs between the ages of 14-15 years. At the same time the boys correlations observed with a frequency of headaches ($r \leq 0,1$), the girls - with difficulty falling asleep ($p \leq 0.05$) and the number of diseases ($r \leq 0,01$).

7 There were significant correlations ($p \leq 0.05$) between the deterioration of indicators characterizing the state of health (difficulty falling asleep, the frequency of headaches, cases of illness with fever), and an increase in the actual load in the day from cellular communication.

8 Established is cumulative effect of the adverse effects of microwave radiation from mobile phones, depending on the duration of use (in years). The data obtained show a decrease in resistance of the organism to the adverse effects of the environment under the influence of SVChizlucheniya.

9 It was found that the combined effect of computer load (low frequency EMF) and mobile phone (EMF microwave) has the greatest negative impact on the health of school children 14-15 years working for the PC more than 2 hours per day, with a maximum time of calls per day on a mobile phone more than 22 minutes.

10 Found is that children between the ages of 14 to 18 years enrolled in private schools longer use mobile phones a day, than students in public schools.

11 Revealed is that the combined effect of physical factors (microwave radiation) and chemical (formaldehyde) nature leads to a significant and stronger inhibition of cell culture compared with independent chemical and physical loads, indicating a more pronounced negative effect of microwave radiation in a chemical pollution.

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