THERMAL EFFECTS OF MOBILE PHONES – NEW MEASUREMENTSRadoje Jevtić¹, Dragana Jevtić², Jovan Ničković³, Vanja Ničković⁴**ТЕРМИЧКИ ЕФЕКТИ МОБИЛНИХ ТЕЛЕФОНА – НОВА МЕРЕЊА**

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Summary

Heating of the mobile phones presents consequence of their usage. Thermal effects are presented through SAR (Specific Absorption Rate) and increasing of temperature of exposed part of body (tissue), so it is necessary to detect and measure these values. Thermal effects could be detected with special devices, such as thermal camera or IC thermometer. New versions of mobile phones present multimedia devices with lot of different functions and possibilities. All that tasks demand great waste of energy. After confirmed facts that the time of usage of mobile phones constantly increases, there is a question does this usage increase the mobile phone temperature and, on that way, present the danger to their user. This work gives results of temperature changes of ten different mobile phones for different usage purposes, such as temperature changes of head region while and after mobile phone usage.

Key words: thermal effects, mobile phones, heating, research.

Сажетак

Грејање мобилних телефона представља последицу њиховог коришћења. Термални ефекти су представљени кроз SAR (Specific Absorption Rate – специфична стопа апсорпције), као и повећање температуре изложених делова тела (ткива), па је неопходно детектовати и мерити њихове вредности. Термални ефекти се могу детектовати посебним уређајима, као што је термална камера или IC термометар. Нове верзије мобилних телефона представљају мултимедијалне уређаје са много различитих функција и могућности. Све то захтева велику потрошњу енергије. Након потврђене чињенице да време коришћења мобилних телефона стално расте, поставља се питање да ли таква употреба повећава температуру мобилног телефона, која тако увећана представља опасност за њихове кориснике. Овај рад даје резултате температурних промена десет различитих мобилних телефона за различите намене коришћења, као што су промена температуре региона главе за време и после употребе мобилног телефона.

Кључне речи: термални ефекти, мобилни телефони, грејање, истраживање.

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INTRODUCTION

Mobile phones have become important and indivisible part of the modern human life. The construction of these devices has technically improved in past several years so that these are not only the mobile phones-these are complex multifunctional portable devices with lot of different functions and possibilities, such as internet access, video games, measuring of different dimensions, data transfer, photo and video services etc. The number of users of mobile phones is bigger and bigger from year to year, but the age of users is lower and lower and nowadays there are a lot of very young users of mobile phones, for example, from age of 7 to 10, what is appropriate to school age from the first to the fourth class. This fact is very serious, according to several aspects: healthy, ethic, social... Of course, the most important aspect is healthy aspect. There were presumptions that mobile phones, such as other electrical devices, could affect on humans health on different way. There are lots of different explorations, researches, studies, opinions related to this topic. Many of them claim that mobile phones could present danger for human life, many of them claim opposite.⁽¹⁾

For example, in one case, the Italian Supreme Court ruled that a businessman's brain tumor was caused by his use of a mobile for five or six hours a day for 12 years, paving the way for a potential host of legal actions from employees against employers.⁽²⁾

In May 2009, 5 scientists published a review of the long-term epidemiologic data in a respected scientific journal, *Surgical Neurology*, which concluded that „there is adequate epidemiologic evidence to suggest a link between prolonged cell phone usage and the development of a same-side brain tumor.“⁽³⁾

The rate of MWR absorption is higher in children than adults because their brain tissues are more absorbent, their skulls are thinner, and their relative size is smaller. Fetuses are particularly vulnerable, because MWR exposure can lead to degeneration of the protective

sheath that surrounds brain neurons, they report. Multiple studies have shown that children absorb more MWR than adults. One found that that the brain tissue of children absorbed about two times more MWR than that of adults, and other studies have reported that the bone marrow of children absorbs 10 times more MWR than that of adults. Simulations realized on simulation models showed that, definitely, electromagnetic radiation penetrates much deeper through the head of child than the adult. Electromagnetic radiation causes thermal and no thermal effects.^(4, 6)

Opposite to noted facts, there were also lots of facts in order that mobile phones don't cause any healthy risk. For example, according to the UK's largest program of research, there is no evidence of mobile phones causing any health risks. Following 11 years of research, the mobile telecommunications and health research program (MTHR) has published its final report on the matter. It found that there is no evidence that the use of mobile phones leads to an increased risk of cancer. It also found that there was no evidence that exposure to mobile phone base station emissions during pregnancy affects the risk of developing cancer in early childhood.⁽⁷⁾

One of the longest and the most expensive studies for mobile phones (the duration was about six years and the research was almost 17 million of euros) realized in Germany claims that there are no risk from mobile phones on human health.⁽⁸⁾

However, there were more times confirmed facts that, from year to year, the time of mobile phones usage increases, and, according to that, potential effects also increase. Very important fact is that very young people become users of mobile phones. This paper was written to confirm some of the noted facts, particularly facts according to the increase time of mobile phone usage and their thermal effects.

RESEARCH

The large research was realized in the Electro technical school „Nikola Tesla” in Niš, on February and March of 2015. The sample was 500 pupils from all of four classes of the school. Schools populations are one of the biggest and the most frequent users of mobile technologies. Similar researches were done several years ago and this research was an excellent way to compare realized results in the sense of increasing of some effects.^(9, 13)

The figures from fig. 1 to fig. 7 present results of the realized research. The research was related to number of pupils that possesses mobile phone according to the complete number of examined pupils, the number of mobile phones by user, mobile phones types, duration of average time of one call, duration of average time of all calls in one day, average time of sent messages in one day and number of pupils that use mobile phone for some other activity then communication. The very important thing to note is the fact that the most number of examined mobile phones were with price more than 100 euros, which showed the pupils wish and need to have a device like that.

Figure 1. Research results for possession of mobile phones for 500 pupils.

Figure 2. Research results for number of possessed mobile phones by user for 500 pupils.

Figure 3. Research results for type of mobile phones for 500 pupils.

Figure 4. Research results for duration of average time of one call for 500 pupils.

Figure 5. Research results for duration of average time of all calls in one day for 500 pupils.

Figure 6. Research results for average number of sent messages for 500 pupils

Figure 7. Research results for number of pupils that use mobile phone for some other activity than communication for 500 pupils

Through realized results could be clearly seen one general trend of increase usage of mobile phones by all of its aspects. More options, more functions, more possibilities give more time spent in mobile phones usage.

WORK METHOD

While usage, mobile phones increase their temperature and warm head, hands and other part of their users bodies in dependence of where they were positioned. Because of the fact that modern mobile phones present multi-functional media portable devices, they could be used not only for conversation between users but for internet usage, Facebook usage, video games playing, music listening and many other similar operations and functions. All of noted operations and functions demand certain consumption of electrical energy from their batteries and certain warm of mobile phones, which cause to the temperature increase.

The best way for temperature increase measurements is with special measurement devices, such as thermal camera and infrared thermometer. These devices are presented on fig.8 and fig. 9.

Figure 8. Thermal camera VARIOSCAN hr compact 3021 ST used for measurements of mobile phones thermal effects

Figure 9. Infrared thermometer TM 959 used for measurements of mobile phones thermal effects

Presented instruments were used for temperature measurements of mobile phones and human head area overtaken with mobile phones activity.

According to realized research, there were ten different mobile phones elected and measured their temperature increase while internet surfing (in duration of 30 minutes), video games playing (in duration of 30 minutes), conversation with other mobile phone (in duration of 5 minutes) and the temperature of the human head region overtaken by mobile phones while conversation (in duration of 5 minutes).⁽¹⁴⁾

REALIZED RESULTS

Figure 10. Temperature increase of mobile phones while internet surf in duration of 30 minutes

Figure 11. Temperature increase of mobile phones while video games playing in duration of 30 minutes **Figure 12.** An example of compared measurement at the start of the measurement (mobile phones LG and Samsung Galaxy Trend GT-S7560) **Figure 13.** An example of compared measurement at the end of the measurement after 5 minutes (mobile phones LG and Samsung Galaxy Trend GT-S7560) **Figure 14.** Temperature increase of mobile phones while conversation with other mobile phone in duration of 5 minutes

Figure 15. Thermal presentation of the mobile phone conversation at the start of the conversation

Figure 17. Thermal presentation of the human head region after conversation with mobile phones in duration of 5 minutes

Figure 16. Thermal presentation of the mobile phone conversation at the end of the conversation with duration of 5 minutes

Figure 18. Temperature increase of human head region after 5 minutes

DISCUSSION OF THE RESULTS

Realized results showed, generally, that the usage of mobile phones constantly increases. Reasons for that could be found in noted facts that mobile phones become multifunctional media devices, big number of additional functions, internet access, very beneficial conditions from mobile phone dealers and operators, lacks of classical phones and many other factors. Although mobile phones have lot of advantages and productive things for improvement of everyday life quality, there are several very important things that must be mentioned. Mobile phone is, of course, very useful thing and the thing that should be used, but the way of its usage must be change in the sense of the time decrease of conversations with mobile phones. Here is and the fact that modern mobile phones increase their temperature not only with conversation but with usage of many other functions, operations, services, which usage generally increase complete temperature of mobile phone and, at the same way, increase the hand temperature and the temperature of human head region, which could be seen on fig. 15 and fig. 16.

Of course, it is very important to mentioned that the mobile phones radiation is the least where the reception of signal is the best, which implies that mobile phones should be used outdoor as much as possible. The usage of headphones and speaker options on mobile phones are also references for minimal absorbed radiation.

CONCLUSION

It is obvious fact that mobile phones have been becoming the indispensable part of modern human's life. Their options and possibilities can greatly improve the quality of everyday life. Of course, that means their proper usage, especially in healthy sense. Very important thing which demands very analytic approach and constantly open question is the usage of mobile phones at children population. The realized results showed increase usage of mobile phones in several aspects, which should be change, with some additional education or maybe even with some limited interdict.^(16, 18)

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