

Latest Findings on the Health Risks of Excessive Mobile Phone Use

Vera Marković, Dejan Krstić¹, Olivera Pronić-Rančić, Zlatica Marinković, Dušan Sokolović²

Abstract – An overview of the latest research pertaining to biological effects of mobile phone radiation is presented in this paper. Having in mind the enormous popularity of mobile phone use worldwide, a serious concern about the health risks has appeared. Some research results in this area as well as recently published alert of the World Health Organization (WHO) on the biological effects of electromagnetic radiation are presented.

Keywords – Electromagnetic radiation, Mobile communication systems, Biological effects, Monitoring of electromagnetic radiation, WHO.

I. INTRODUCTION

Mobile communication systems have experienced an enormous expansion in recent years. The number of mobile phone subscribers is estimated at 6 billion globally. Mobile phones become more and more a necessary tool in our daily life enabling an easy communication with everyone at any place and any moment. Many surveys have shown, for instance, that adolescents and young adults spend more than an hour on the mobile phone every day on average [1]. Nowadays, with a growing range of multimedia features (music, video, Internet capabilities), it is no wonder that many people can be considered to be heavy or very heavy mobile phone users. Having that in mind, there is a serious concern about the effects of human exposure to electromagnetic fields (EMFs) on health.

RF (radio frequency) radiation belong to so-called non-ionizing radiation, that refers to any type of electromagnetic radiation that does not carry enough energy per quantum to ionize atoms or molecules, but has sufficient energy for excitation, the movement of an electron to a higher energy state [2]. The hazards of RF radiation depend on the ability to penetrate the human body and the absorption characteristics of different tissues. Namely, the propagation of EMF through biological tissue differs from the propagation through free space and depends on the frequency and on the electromagnetic properties of tissue. The degree of penetration of EMF into the body is described by the penetration depth,

Vera Marković, Olivera Pronić – Rančić and Zlatica Marinković are with the Faculty of Electronic Engineering, Aleksandra Medvedeva 14, 18000 Niš, Serbia, E-mail: vera.markovic@elfak.ni.ac.rs, olivera.pronic@elfak.ni.ac.rs, zlatica.marinkovic@elfak.ni.ac.rs

¹Dejan Krstić is with the Faculty of Occupational Safety, Čarnojevića 10a, 18000 Niš, Serbia, E-mail: dejank@zrnrfak.ni.ac.rs

²Dušan Sokolović is with the Faculty of Medicine, Bulevar dr Zorana Đinđića 81, 18000 Niš, Serbia, E-mail: soko@medfak.ni.ac.rs

inversely proportional to the square root of frequency. For instance, it is of the order of centimeter at GSM900 frequencies [3]. That means that at higher frequencies internal organs are less exposed than the organs near the skin. At the frequencies used by mobile phones, most of the energy is absorbed by the skin and other superficial tissues, resulting in slight temperature rise in some regions of the head or other parts of the body.

The mobile phones, the most common sources of RF radiation close to the human body, are low-powered RF transmitters operating at frequencies between 450 and 2700 MHz with peak powers in the range of 0.1 to 2 W. Actually, in the human history, a radiating device has never been closer to the head than a mobile phone.

The effects of EMFs of different frequencies on biological systems have been investigated for many years [4]-[7], including epidemiological, in vivo, and in vitro research. Because of widespread use of mobile phones, the most research efforts have been done at frequencies of today's mobile communication systems around 900 MHz, 1800 MHz and 2 GHz. In order to provide protection against known adverse health effects, some guidelines for limiting EMF exposure have been established [5], [8], defined as safety standards. In establishing exposure limits, the results of numerous laboratory and epidemiological studies, as well as expert opinions were used, taking most often only the thermal effects into account.

The main focus of this paper is on the state-of-the art investigations whether health effects might occur at exposure levels below established limits, especially in relation to long term exposure at such low levels.

II. SAFETY STANDARDS

The limits for EMF exposure are usually given either in terms of *specific absorption rate* (SAR), which is defined as the radiation power absorbed per mass of tissue (and has units of W/kg), either in terms of *power density* (PD), (usually given in mW/cm²). While power density can be readily measured in air, outside the body, SAR is usually calculated by computational techniques like the Finite Difference Time-Domain method (FDTD), the Finite Element Method (FEM), Method of Moments (MoM), etc.

Thermal effects are well-understood effects of RF radiation, where a living tissue is heated by rotations of polar molecules induced by the EMF. At RF frequencies, heating is the major effect of absorption of electromagnetic energy. For instance, at the levels of absorbed electromagnetic energy that cause a

body temperature increase in excess of 1–2°C, a large number of physiological effects have been characterized in many studies [5]. It has been proven that under conditions of a partial-body exposure to intense EMF, a significant thermal damage can occur in the sensitive tissue such as the eye and reproductive system.

First attempts to investigate the effects of EMFs on living tissues and to estimate danger EMF levels were done in the 1950s. It was assumed that heating was the only effect of EMFs and the models were developed to represent the size and presumed electrical characteristics of various animals. Appreciable heating occurred in these models only at levels of 100 mW/cm² or above, therefore, incorporating a safety factor of ten, an exposure limit of 10 mW/cm² for humans was proposed at that time. This level was accepted by the industry and the military, and in 1960s the American National Standards Institute (ANSI) recommended it as a guideline for worker safety. Later, in the late 1980s and the early 1990s, the models used for establishing safety standards became more sophisticated, but the safety limits did not change much.

In Europe, the exposure limits were set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) in order to protect biological tissue from the temperature increase [5], [9]. Two classes of guidance are presented: “basic restrictions”, which are restrictions on exposure to time-varying electric, magnetic, and electromagnetic fields that are based directly on established health effects, and “reference levels”, which are provided for practical exposure assessment purposes to determine if there is a probability that the basic restrictions will be exceeded. According to the ICNIRP guidelines, the basic restrictions for general public exposure to RF EMFs are: whole-body average SAR of 0.08W/kg, localised SAR for head and trunk of 2W/kg and localised SAR for limbs of 4W/kg. Localized SAR averaging mass is any 10 g of contiguous tissue. These values are given for the general population involving individuals of all ages and of different health status that are usually unaware of their exposure to EMFs. On the other hand, less stringent exposure restrictions (5 times higher limits) are valid for the occupationally exposed population, comprising the adults who are trained to be aware of potential risk and to take appropriate precautions. However, the governments and regulatory bodies in some countries in Europe, as Italy, Austria, Poland, Russia, etc. have established more stringent national exposure criteria than those recommended by ICNIRP. For instance, concerning the power density, the exposure limit in Salzburg is only 0.1μW/cm² at 900 MHz.

In Serbia, the Law on protection from non-ionizing radiation was adopted in 2009, [10], where the basic restrictions and reference levels are defined. The defined basic limit exposures are identical as those set by ICNIRP guidelines.

In Table 1, a comparison of the reference levels established by the Serbian law on protection from non-ionizing radiation with those given by ICNIRP standards at frequencies 900 and 1800 MHz, as well as over 2GHz, is presented. It can be seen that comparing to ICNIRP more stringent exposure criteria is established by the Serbian law.

TABLE 1

REFERENCE EXPOSURE LEVELS ESTABLISHED BY ICNIRP (SHADED) AND BY SERBIAN LAW [9]

| f (GHz) | 0.9 | 1,8 | 2-300 |
|--------------------------|--------|-------|-------|
| E (V/m) | 16.5 | 23.3 | 24.4 |
| | 41.2 | 58.3 | 61.0 |
| H (A/m) | 0.044 | 0.063 | 0.064 |
| | 0.110 | 0.160 | 0.160 |
| B (μT) | 0.0552 | 0.078 | 0.08 |
| | 0.1380 | 0.195 | 0.20 |
| PD (mW/cm ²) | 0.072 | 0.144 | 0.16 |
| | 0.450 | 0.900 | 1.00 |

III. NON-THERMAL EFFECTS OF RF RADIATION

There are different theories about the mechanisms of the so-called non-thermal effects which occur at the low levels of RF radiation. Some researchers have argued that non-thermal effects could be interpreted as a normal cellular response to an increase in temperature, activating the production of heat shock proteins to defend the cell against metabolic cell stress caused by heat [11]. Some other researchers believe the stress proteins are unrelated to thermal effects, since they occur for both ELF and RF, which have very different energy levels. In [7], the opinion is given that most probably the physical mechanisms of the non-thermal effects must be based on quantum-mechanical approach and physics of non-equilibrium and nonlinear systems.

Over the last two decades, a large number of studies have been performed to assess whether biological effects (physiological, biochemical or behavioral changes induced in an organism, tissue or cell) occur as a result of RF radiation at low levels of the absorbed electromagnetic energy and a long-term exposure and whether such kind of exposure pose a potential health risk. It should be noted that the observation of a biological effect does not necessarily suggest the existence of a biological hazard or health effect. A biological effect only becomes a safety hazard when it causes detectable impairment of the health [2]. A number of recent studies have reported DNA damage, cell damage, or cell death, induced by mobile telephony or similar RF radiations at non-thermal intensity levels like those presented in [12]-[14].

IV. RESULTS OF SOME STUDIES IN SERBIA

Several experimental studies concerning the influence of RF EMFs on biological matter were conducted by a multidisciplinary team of researchers at the University of Niš (Faculty of Occupational Safety, Faculty of Medicine, and Faculty of Electronic Engineering). The biological effects of EMF, generated by mobile phones on mice and rats, were analyzed. Observed functional abnormalities of hepatic cell membranes, accompanied by increasing lipid peroxidation, support the hypothesis that the liver is one of the major organ targets of EMF cytotoxicity. The obtained results support the

view that EMF stimulates oxidative stress response and that the possible functional liver disorders during prolonged exposure may be in part due to oxidative modification of biomolecules [15].

In addition, the animals exposed to the mobile phone radiation showed more aggressive behavior with obvious panic reactions, disorientation, and higher degree of anxiety. Simultaneously, they had lower body mass increase and lower level of gravidity in relation to non-exposed animals.

The currently available results suggest that some aspects of cognitive functions and some direct measures of brain and body physiology may be affected by the exposure to mobile phone radiation. It remains to be seen whether repeated exposure to EMFs could have long-lasting effects on brain physiology and cognitive function [16].

Within the second experimental study, Wistar rats were exposed to microwave radiation during 20, 40, and 60 days. Four groups were formed: control group I – animals treated by saline, intraperitoneally (i.p.) applied daily during follow-up, group II – rats treated daily with melatonin (2 mg/kg body weight i.p.), group III – rats exposed to microwaves, and group IV – rats exposed to microwaves and simultaneously treated with melatonin (2 mg/kg body weight i.p.). A significant increase in the brain tissue malondialdehyde (MDA) and carbonyl group concentration was registered during exposure. Decreased activity of catalase (CAT) and increased activity of xanthine oxidase (XO) remained after 40 and 60 days of exposure to mobile phones. It was found that mobile phones cause oxidative damage biochemically by increasing the levels of MDA, carbonyl groups, and XO activity, and by decreasing CAT activity. It was also concluded that the treatment with melatonin significantly prevents oxidative damage in the brain (it prevented the increase in the MDA content and XO activity in the brain tissue after 40 days of exposure), whereas it is unable to prevent the decrease of CAT activity and increase of carbonyl group contents [17].

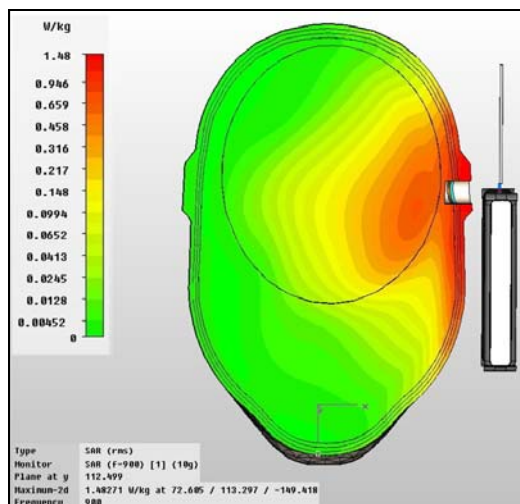


Fig. 1. SAR_{10g} distribution in the head

In addition to the experimental studies on animals, numerical techniques were applied by the same team of researchers in order to simulate the absorbed EMF in the

human head. The models of the head and various types of mobile phones as sources of RF radiation were developed and an example of simulation is shown in Fig.1 [18], [19]. It should be point out that the results were analysed by combining the simulation of fields and energy penetrating with magnetic resonance imaging (MRI) of the tissue, as illustrated in Fig. 2 [18].

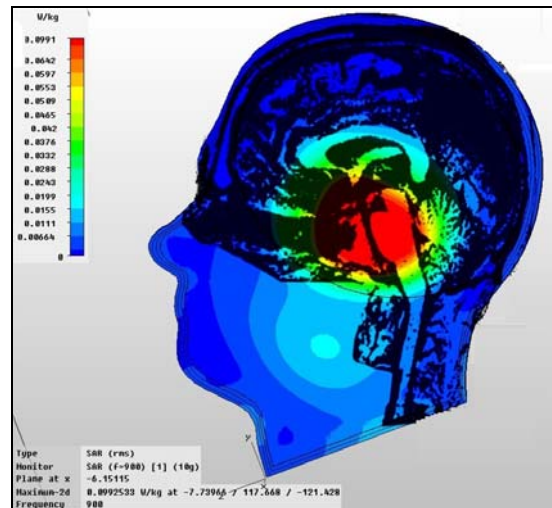


Fig. 2. SAR_{10g} with real structure of brain generated by MRI

V. EPIDEMIOLOGICAL STUDIES ON HEALTH EFFECTS OF MOBILE PHONE RADIATION

Worldwide, the numerous scientific studies have investigated possible health risks of mobile phone radiation. Diverse effects (effects on brain electrical activity, cognitive function, sleep, heart rate, blood pressure, etc.) have been subject of research. Large epidemiological studies, examining potential long-term risks from RF exposure, have mostly looked for an association between brain tumors and mobile phone use. This is not an easy task because many cancers are not detectable until many years after the interactions that led to the tumor, and since mobile phones were not widely used until the early 1990s. For instance, a large Danish study about the connection between mobile phone use and cancer incidence was published in 2006 [20]. It followed over 420,000 Danish citizens for 20 years and found no evidence for increased risk of cancer. After that, however, this report has been considered as inconclusive by several authors and bodies.

In response to public and governmental concern, the World Health Organization (WHO) established the International Electromagnetic Fields Project in 1996 to assess the scientific evidence of possible adverse health effects from EMFs [21]. The published results of research are occasionally reviewed by several scientific committees to assess overall risks. An assessment was published in 2006 by the European Commission Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) [6]. At that time it was concluded that the three lines of evidence: animal, in vitro, and epidemiological studies, indicate that "exposure to RF

fields is unlikely to lead to an increase in cancer in humans". However, since then, the findings have been updated as advances are made in identifying the adverse health effects. The new findings are mainly based on several large multinational epidemiological studies that have been completed or are ongoing.

The largest epidemiological study of this kind ever undertaken is a 13 nation retrospective case-control study Interphone [22] coordinated by the International Agency for Research on Cancer (IARC). This large and rigorous study was designed to determine whether there are links between the use of mobile phones and head and neck cancers in adults. There were several reports published by different study groups. A Swedish Interphone study group reported in 2005 that the data do not support the hypothesis that mobile phone use is related to an increased risk of glioma or meningioma, the most common types of brain tumor [23]. In the same year, a British Interphone group published the conclusion that there is no substantial risk of acoustic neuroma, a type of benign brain tumor, in the first decade after starting mobile phone use [24]. However, they claim that increasing in risk after long-term use could not be excluded. Regarding this type of brain tumor, a Swedish scientific team suggested a little bit earlier (2004) that regular use of a mobile phone over a decade or more was associated with an increased risk of acoustic neuroma, and that the increase was not noted in those who had used phones for fewer than 10 years [25].

A certain degree of concern can be seen in some other reports. For instance, a German Interphone study group stated (2006) that no overall increased risk of glioma or meningioma was observed among these cellular phone users, however, for long-term cellular phone users, the results would need to be confirmed before firm conclusions can be drawn [26]. Similarly, a joint study conducted in northern Europe presents the conclusion that, although their results overall do not indicate an increased risk of glioma in relation to mobile phone use, the possible risk in the most heavily exposed part of the brain with long-term use needs to be explored further before firm conclusions can be drawn [27].

A comprehensive review of published epidemiological papers was published by Swedish authors in 2007 [28]. Some of these studies were part of the Interphone investigation and two publications included results from different studies. It is found: that cell phone users had an increased risk of malignant gliomas, that there is a link between cell phone use and a higher rate of acoustic neuromas, that tumors are more likely to occur on the side of the head where the cell handset is used, and finally that one hour of cell phone use per day significantly increases tumor risk after ten years.

Some publications in 2009 and 2010 presented conclusions that current mobile phones are not safe for long-term exposure [29] - [31]. Especially, it was emphasized that the use of cell phones before age 20 increased the risk of brain tumors by 5.2, compared to 1.4 for all ages [29].

In 2010, the International Journal of Epidemiology published an international pooled analysis of data gathered from participating countries in the Interphone project, related to the case-control study of glioma and meningioma, [32]. The published results show that overall no increased risk of glioma

or meningioma with mobile phone use of more than 10 years was observed. However, there are some indications of an increased risk of glioma for those who reported the highest 10% of cumulative hours of cell phone use, although there was no consistent trend of increasing risk with greater duration of use. The researchers concluded that biases and errors limit the strength of these conclusions and prevent a causal interpretation. It is pointed out, that the observations at the highest level of cumulative call time and the changing patterns of mobile phone use since the period studied by Interphone, particularly in young people, mean that further investigation of mobile phone use and brain cancer risk is merited [33].

VI. RECENT FINDINGS ON THE CARCINOGENICITY OF RF FIELDS

In May 2011, a working group of 31 scientists from 14 countries coordinated by IARC in Lyon, France, assess the potential carcinogenic hazards from exposure to radiofrequency electromagnetic fields. IARC (International Agency for Research on Cancer) is a specialized research agency of the WHO with a mission to coordinate and conduct research on the causes of human cancer, the mechanisms of carcinogenesis, and to develop scientific strategies for cancer control. International experts shared the complex task of tackling the exposure data, the studies of cancer in humans, the studies of cancer in experimental animals, and the mechanistic and other relevant data.

The working group members considered hundreds of scientific articles which were reviewed carefully and critically [34], [35]. They found the evidence to be limited for carcinogenicity of RF EMFs, based on positive associations between some brain tumors and exposure [21]. Finally, on May 31, 2011, IARC classified radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B), based on an increased risk for glioma, a malignant type of brain cancer associated with wireless phone use. Group 2B, a category used when a causal association is considered credible, but when chance, bias or confounding cannot be ruled out with reasonable confidence. The IARC categorizes agents, mixtures and exposures into five categories: The highest category is Group 1: carcinogenic to humans. It is followed by Group 2A: probably carcinogenic to humans and Group 2B: possibly carcinogenic to humans. Next is Group 3: not classifiable as to its carcinogenicity to humans, and, finally, Group 4: probably not carcinogenic to humans.

The conclusion of the IARC was mainly based on the Interphone study, which found an increased risk for glioma in the highest category of heavy users (30 minutes per day over a 10-year period), although no increased risk was found at the lower exposure. The evidence for other types of cancer was found to be "inadequate".

Although the IARC working group reviewed a lot of scientific articles, the most influential role in the working group conclusion played the following papers: the Interphone study [32], [36], Swedish pooled analysis [37], and an acoustic neuroma study from Japan [38]. The Interphone

study reported increased risks of 40% for gliomas, and the risks tended to be greater in subjects who reported usual phone use on the same side of the head as their tumor than on the opposite side of heavy users. A 270% increase in risk was found in Swedish pooled analysis [37] for the most common type of glioma, astrocytoma, for mobile phone use longer than ten years. A similar conclusion was reached from these two studies for acoustic neuroma, although the case numbers were substantially smaller than for glioma. Evidence of an increased risk (from 10 to 300%) for acoustic neuroma associated with the use of mobile phones on the same side of the head is found in the study from Japan [38].

The announcement of IARC working group caught a great attention of the public and researchers and there were lots of responses and comments after that. Some other groups of epidemiologists, reviewing the same data or papers, have concluded that the increased risk was entirely explicable by various biases or errors, believing that there is little possibility that mobile phone use could increase the risk of glioma or acoustic neuroma in users. For example, a month after the IARC conclusion, the International Commission for Non-Ionizing Radiation Protection (ICNRP) Standing Committee on Epidemiology, which includes two members from the Interphone group, published a lengthy commentary on the risk of gliomas [39]. They concluded that within about 10–15 years after the first use of mobile phones there is unlikely to be a material increase in the risk of gliomas in adults. It is important to recall from brain tumor incidence trends that the latency of brain tumor development is considerably longer than 10–15 years.

Shortly after publication of the ICNIRP commentary, two separate and different reports appeared, written by different members of the Interphone study group, [40], [41]. The objective of both analyses was to evaluate whether gliomas occur preferentially in the areas of the brain having the highest RF energy absorption from mobile phone exposure.

The analysis [40] included 888 gliomas between 2000 and 2004 from seven European Interphone study countries: Denmark, Finland, Germany, Italy, Norway, Sweden, and Southeast England. The tumor midpoints were defined by neuroradiologists on a three-dimensional grid based on radiological images obtained from computerized X-ray tomography or magnetic resonance imaging. The obtained results did not indicate that gliomas in mobile phone users are preferentially located in the part of the brain with the highest deposition of RF fields from mobile phones.

The other analysis [41] included patients with brain tumors from the Australian, Canadian, French, Israeli, and New Zealand components of the Interphone study. Brain tumors localized by neuroradiologists were analyzed. The analysis included 553 glioma cases and 1762 controls. The mean age of glioma cases was 47.2 years, and 62% were men. An increased risk of glioma was seen at higher specific RF absorptions, above 3,500 J/kg, corresponding to individuals with long-term and heavy uses of mobile phones. The relative risk for glioma was 1.35 in subjects with a localized tumor and 1.66 in subjects with tumor centers estimated by a neuroradiologist. These results are suggestive of an increased

risk of glioma in long-term mobile phone users with high RF exposure.

Although there are methodological differences in the analyses [40] and [41], the obtained results are very perplexing. It seems likely that the interval of observation of about 10 years between the subjects' use of mobile phones and the occurrence of tumors is too short to allow detection of an effect, if there is one, since brain tumors are known to have latencies longer than 10 years and maybe as long as 30 years. Therefore, having in mind large number of mobile phone users worldwide, and the enormous popularity of mobile phone use particularly among young people, and therefore a potentially longer lifetime of exposure, WHO has promoted further investigations. For instance, several international studies investigating potential health effects in children and adolescents are underway. Further research efforts in this area should provide a significant contribution of scientific knowledge on this very important public health issue.

VII. CONCLUSION

A large number of studies have been performed over the last two decades, part of them in Serbia as well, to assess whether mobile phones pose a potential health risk. Epidemiological research examining potential long-term risks from RF exposure has mostly looked for an association between brain tumors and mobile phone use. However, because many cancers are not detectable until many years after the interactions that led to the tumor, and since mobile phones are widely used for only 15 years, epidemiological studies at present can only assess those cancers that become evident within shorter time periods. The Interphone study (coordinated by the International Agency for Research on Cancer, a WHO specialized agency), being the largest retrospective case-control study to date on adults, has classified RF electromagnetic fields as possibly carcinogenic to humans (Group 2B), based on an increased risk for glioma, a malignant type of brain cancer, associated with wireless phone use. The increasing use of mobile phones and the lack of data for long-term mobile phone use warrant further research of mobile phone use and brain cancer risk.

WHO promotes further research activities in this area, especially those investigating potential health effects in children and adolescents.

ACKNOWLEDGEMENT

This work was supported by the project III-43012 of the Serbian Ministry of Education and Science.

This paper is an extended version of the paper: Vera Marković, Dejan Krstić, Olivera Pronić-Rančić, Dušan Sokolović, "Safety of mobile communication system radiation – recent findings", presented at the international conference: *Safety of technical systems in living and working environment* STS -11, October 2011, Niš, Serbia, pp. 219-224, ISSN/ISBN 978-86-6093-035-6.

REFERENCES

- [1] J.C Lin, "Cell-Phone Popularity, Addiction, and Funding for Biological Effect Research", *Microwave Magazine, IEEE* vol. 11, 2010, pp. 118 – 120.
- [2] K-H Ng: "Non-ionizing radiations – sources, biological effects, emissions and exposures", *Proceedings of the International Conference on Non-Ionizing Radiation ICNIR*, 2003.
- [3] A. Vander Vorst: "Microthermal and isothermal biological effects under microwave exposure", *Microwave Review*, vol. 11, no. 2, 2005, pp. 34-37.
- [4] G. Hyland: "Non-thermal bioeffects induced by low intensity irradiation of living systems", *Engineering Science and Education Journal*, vol.7, 1998, pp. 261-269.
- [5] "Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (ICNIRP guidelines)", *Health Physics*, vol. 74, no. 4, 1998.
- [6] "Possible effects of Electromagnetic Fields (EMF) on human health", adopted by the SCENIHR (Scientific Committee on Emerging and Newly Identified Health Risks), July 2006.
- [7] I. Belyaev: "Non-thermal biological effects of microwaves", *Microwave Review*, vol. 11, no 2, 2005, pp. 13-29.
- [8] <http://www.kombeg.org.rs/Slike/CeTranIRazvojTehnologija/2010Januar/pravilnik%202.pdf>
- [9] V. Marković, D. Krstić, "Standardi za izloženost RF zračenju u uslovima ekspanzije bežičnih komunikacionih sistema", *XXIII simpozijum o novim tehnologijama u poštanskom i telekomunikacionom saobraćaju*, Belgrade, 2005, pp. 229-240.
- [10] "Pravilnik o granicama izlaganja nejonizujućim zračenjima", *Službeni glasnik RS 104/09, br.110-00-58/2009-05*.
- [11] R. Glaser, "Are thermoreceptors responsible for "non-thermal" effects of RF fields?" *Edition Wissenschaft (Bonn, Germany: Forschungsgemeinschaft Funk)* vol. 21, OCLC 179908725, 2005.
- [12] D.J Panagopoulos, E.D Chavdoula, I.P Nezis, L.H Margaritis: "Cell death induced by GSM 900MHz and DCS 1800MHz mobile telephony radiation", *Mutation Research*, 2007, pp. 69-78.
- [13] E. Markova, L. Hillert, L. Malmgren, B.R Persson, I.Y Belyaev: "Microwaves from GSM mobile telephones affect 53BP1 and gamma-H2AX foci in human lymphocytes from hypersensitive and healthy persons", *Environ Health Perspect.* 2005, vol. 113(9), pp. 1172-1177.
- [14] D. Krstić, B. Đinđić, D. Sokolović, V. Marković, D. Petković, S. Radić: "The results of experimental exposition of mice by mobile telephones", *Microwave Review*, 2005, vol. 11, no.1, pp. 34-37.
- [15] D. Krstić, B. Djindjić, V. Marković, S. Radić, D. Petković, D. Sokolović, "Involvement of 50 Hz electromagnetic field in oxidative liver injury", *International Symposium on Coherence and Electromagnetic Fields in Biological Systems*, CEFBIOS-2005, Prague, Czech Republic, 2005.
- [16] B. Djindjić, S. Radić, D. Krstić, D. Sokolović, T. Pavlović, D. Petković, J. Radosavljević: "Exposure to electromagnetic fields by using mobile telephone and its influence of the brain function", *Facta Universitatis, Series: Working and Living Environmental Protection*, vol 2, no 4, 2004, pp. 311-316.
- [17] D. Sokolović, B. Djindjić, J. Nikolić, G. Bjelaković, D. Pavlović, G. Kocić, D. Krstić, T. Cvetković, V. Pavlović: "Melatonin reduces oxidative stress induced by chronic exposure of microwave radiation from mobile phones in rat brain" *J Radiat Res (Tokyo)*, vol. 49(6), 2008, pp. 579-86
- [18] D. Krstić, "The influence of electromagnetic radiation frequency GHz band on biological tissue". Doctoral dissertation, Faculty of Occupational safety, 2010.
- [19] D. Krstić, D. Zigar, D. Petković, D. Sokolović: "Calculation of absorbed electromagnetic energy in human head radiated by mobile phones", *PES2011*, Niš, pp: 1-14.
- [20] J. Schüz, R. Jacobsen, J.H Olsen, J.D Boice, J.K McLaughlin, C. Johansen: "Cellular telephone use and cancer risk: update of a nationwide Danish cohort". *Journal of the National Cancer Institute*, vol. 98, December 2006, pp. 1707–1713.
- [21] "IARC classifies radiofrequency electromagnetic fields as possibly carcinogenic to humans", Lyon, France, IARC press release no.208, May 31, 2011.
- [22] <http://www.mmfa.org/public/interphone.cfm>
- [23] S. Lönn, A. Ahlbom, P. Hall, M. Feychting (Swedish Interphone Study Group): "Long-term mobile phone use and brain tumor risk", *American Journal of Epidemiology*, Vol. 161 (6), 2005, pp. 526–35.
- [24] M.J Schoemaker, A.J Swerdlow, A. Ahlbom, A. Auvinen, K.G Blaasaas, E. Cardis, H. Christensen, H. Collatz, M. Feychting, et al.: "Mobile phone use and risk of acoustic neuroma: Results of the Interphone case-control study in five North European countries", *British Journal of Cancer*, vol.93 (7), 2005, pp. 842–848.
- [25] S. Lönn, A. Ahlbom, P. Hall, M. Feychting: "Mobile phone use and the risk of acoustic neuroma", *Epidemiology*, vol. 15 (6), 2004, pp. 653–659.
- [26] J. Schüz, E. Böhler, G. Berg, B. Schlehofer, I. Hettinger, K. Schlaefer, J. Wahrendorf, K. Kunna-Grass et al.: "Cellular phones, cordless phones, and the risks of glioma and meningioma (Interphone Study Group, Germany)", *American Journal of Epidemiology*, vol. 163 (6), 2006, pp. 512–20.
- [27] A. Lahkola, A. Auvinen, J. Raitanen, M.J. Schoemaker, H.C. Christensen, M. Feychting, C. Johansen, L. Klæboe et al.: "Mobile phone use and risk of glioma in 5 North European countries", *International Journal of Cancer*, vol. 120 (8), 2007, pp. 1769–1775.
- [28] L. Hardell, M. Carlberg, F. Söderqvist, K.H. Mild, L.L Morgan: "Long-term use of cellular phones and brain tumours: Increased risk associated with use for ≥ 10 years", *Occupational and Environmental Medicine*, vol. 64, no. 9, 2007, pp. 626–632.
- [29] C. Sage, D.O. Carpenter: "Public health implications of wireless technologies". *Pathophysiology*, Vol. 16 (2–3), 2009, pp. 233–46.
- [30] L. Hardell, M. Carlberg, M.K. Hansson: "Epidemiological evidence for an association between use of wireless phones and tumor diseases", *Pathophysiology*, vol. 16 (2–3), 2009, pp. 113–22.
- [31] SSM:s Independent Expert Group on Electromagnetic Fields, "Recent research on EMF and health risk seventh annual report" Report number: 2010:44, December 2010.
- [32] Interphone Study Group: "Brain tumour risk in relation to mobile telephone use: Results of the INTERPHONE international case-control study", *International Journal of Epidemiology*, 2010, vol. 39 (3), pp. 675–694.
- [33] International Agency for Research on Cancer: "Interphone study reports on mobile phone use and brain cancer risk (Press release)", 17 May 2010, http://www.iarc.fr/en/media-centre/pr/2010/pdfs/pr200_E.pdf

- [34] International Agency for Research on Cancer: "Interphone study reports on mobile phone use and brain cancer risk (Press release 208)", 31 May 2011, http://www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208_E.pdf
- [35] J.C Lin, "Are Radio Frequency or Cell Phone Fields Possibly Carcinogenic to Humans", *Microwave Magazine, IEEE* vol. 13, 2012, Page(s): 30 – 32
- [36] E. Cardis and the INTERPHONE Study Group, "Acoustic neuroma risk in relation to mobile telephone use: Results of the INTERPHONE international case-control study," *Cancer Epidemiol.*, vol. 35, no. 5, pp. 453–464, 2011.
- [37] L. Hardell, M. Carlberg, and K. H. Mild, "Pooled analysis of case-control studies on malignant brain tumours and the use of mobile and cordless phones including living and deceased subjects," *Int. J. Oncol.*, vol. 38, no. 5, pp. 1465–1474, 2011.
- [38] Y. Sato, S. Akiba, O. Kubo, and N. Yamaguchi, "A case-case study of mobile phone use and acoustic neuroma risk in Japan," *Bioelectromagnetics*, vol. 32, no. 2, pp. 85–93, 2011.
- [39] A. J. Swerdlow, M. Feychting, A. C. Green, L. Kheifets, D. A. Savitz, and International Commission for Non-Ionizing Radiation Protection Standing Committee on Epidemiology, "2011 mobile phones, brain tumors, and the INTERPHONE study: Where are we now?" *Environ. Health Perspect.*, vol. 119, no. 11, pp. 1534–1538, 2011.
- [40] S. Larjavaara, J. Schuz, A. Swerdlow, M. Feychting, C. Johansen, S. Lagorio, T. Tynes, L. Klæboe, S. Reidar Tonjer, M. Blettner, G. Berg-Beckhoff, B. Schlehofer, M. Schoemaker, J. Britton, R. Mäntylä, S. Lönn, A. Ahlbom, O. Flodmark, A. Lilja, S. Martini, E. Rastelli, A. Vidiri, V. Kähärä, J. Raitanen, S. Heinävaara, and A. Auvinen, "Location of gliomas in relation to mobile telephone use: A case-case and case-specular analysis," *Am. J. Epidemiol.*, vol. 174, no. 1, pp. 2–11, 2011.
- [41] E. Cardis, B. K. Armstrong, J. D. Bowman, G. G. Giles, M. Hours, D. Krewski, M. McBride, M. E. Parent, S. Sadetzki, A. Woodward, J. Brown, A. Chetrit, J. Figuerola, C. Hoffmann, A. Jarus-Hakak, L. Montestrucq, L. Nadon, L. Richardson, R. Villegas, and M. Vrijheid, "Risk of brain tumours in relation to estimated RF dose from mobile phones: Results from five Interphone countries," *Occup. Environ. Med.*, vol. 68, no. 9, pp. 631–640, 2011.