Bundesamt
für Strahlenschutz

Spotlight on EMF Research

Spotlight on “Effects of Heat and WiFi (2.4 GHz) Exposure on Rat Cardiovascular System” by Jafari et al. in Health Scope (2022)

Category [radiofrequency, animal study]

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Competence Centre Electromagnetic Fields (KEMF)

1 Putting the paper into context by the BfS

To get a hint on possible long-term health effects of RF EMF exposure on humans, several large animal studies were conducted that investigated the long-term effects of whole-body exposure to radiofrequency electromagnetic fields (RF-EMF) (NTP Technical Reports [2,3] & Falcioni et al. 2018 [4]). In these studies, a statistically significant increased incidence of schwannomas of the heart was observed in male rats of the highest exposure groups, i.e. 6 W/kg in the NTP study on CDMA-modulated RF exposure and 0.1 W/kg in the study by Falcioni et al. Although both findings are comparable in terms of tumor type and gender specificity, they differ significantly in terms of the exposure level at which the effects were observed, and their significance is hampered by several methodological problems [5, 6]. Therefore, further research in this area is needed.

2 Results and conclusions from the authors perspective

The authors evaluated the effects of exposure to WiFi on histopathological changes in the cardiovascular system of rats.

32 adult male rats were divided into control (neither exposed to heat nor WiFi), WiFi (exposed to 2.45 GHz for 52 consecutive days for 2 h/day), heat (water bath of 43°C for 10 min/day for 52 consecutive days), and heat+WiFi groups (exposed to 2.45 GHz and then water bath of 43°C). On the 52nd day, the hearts were removed, and total volume and weight were determined using stereological techniques. The number of cardiomyocytes (cells of the heart muscle) nuclei and the volume of the myocardium were determined.

Blood samples were collected to measure glutathione (GSH), total antioxidant capacity (TAC), and malondialdehyde (MDA). Data were analyzed by standard statistical methods (ANOVA, Kruskal-Wallis, and Mann-Whitney U tests).

The heart weight and volume density (number of myocytes per volume) of the myocardium was statistically significantly increased in both, the WiFi and heat+WiFi treated groups, compared to the control group. The total number of cardiomyocyte nuclei statistically significantly decreased in all treated groups in comparison to the control group. Exposure to both, heat-only and heat+WiFi, also resulted in statistically significantly increased MDA levels. TAC and GSH levels were statistically significantly decreased in all treated groups compared to the control group. Thus, the authors conclude, that RF EMF may cause structural changes and oxidative stress in the heart.

3 Comments by the BfS

The authors address an issue of high relevance for radiation protection. However, the methodological description of the study misses several important pieces of information that would be required to adequately assess the study's quality [7]. There is no information on whether the exposure and experimental analyses were carried out in a blinded manner. Only the weight, but not the age of the rats used in the experiment is provided. The exposure was performed by four antennas at 2,45 GHz, but there is no information about radiated power, distance and the resulting SAR-values (specific absorption rate). It is not specified, if the groups were housed in the same room and how the cages were placed into the exposure room and if the 2h exposure took place at the same time of the day. No information is given, if the same experimental procedure was applied to the control group (e.g. placed into the exposure room with exposure device switched off) and if it was exposed to the same environmental conditions. Furthermore, it is unclear if the control and WiFi group were also exposed to a bath without heating, e.g. at body temperature. A bath itself, especially a hot bath, is stressful for rats, so a hot bath in comparison to no bath will always cause a pronounced effect [8]. Furthermore, in dependence of temperature opposite effects may be achieved [9]. Therefore, a sham bath without heating is necessary to disentangle the effect of the warmth from the effect of the bath. Because of the incomplete information given, a substantial risk of bias cannot be ruled out. Additionally, the number of animals per group was small (n = 8) and the results must be considered preliminary.

The heart morphology is investigated by stereologic methods using a systematic random sampling procedure and stereology software developed at the University of Medical Sciences, Yasuj, Iran. Such an automated method may to some extent counteract the missing blinding. However, there is no publication and no documentation if and if so, how the method was validated.

The terminology "heat-irradiated" used is not correct. The animals were treated with a hot bath and not with infrared radiation.

The interpretation of the results is difficult. There is no effect on heart volume, but heart weight increased in all treated groups. The results for WiFi and Heat+WiFi groups are marked as significant, but the p-values given in the text deviate from those in Figure 3A. In the same figure, the increase in heart weight in the heat-only treated group is larger than in the WiFi-group, but apparently not statistically significant. As the data variability does not appear to be much larger as in the other groups, these results seem not to be plausible. The total number of myocytes decreased significantly in the heat and heat+WiFi groups and slightly less but still significantly in the WiFi group. Solely the volume density of myocardium seems not to be affected by the heat alone. It increases in the WiFi and heat+WiFi groups. However, it is difficult to understand that in the WiFi treated groups the heart volume remains unchanged, the total number of myocytes decreases (Fig. 3D), and at the same time the numerical density of cardiomyocyte nuclei increases (Fig. 3C). This seems paradoxical since with a decreasing total number of cells within the same volume the density is expected to decrease as well.

For the markers of oxidative stress, the effects of heating were also more apparent than the effects of WiFi. MDA, as a minor end product of lipid peroxidation, is one biomarker of oxidative damage by reactive

oxygen species (ROS). However, MDA is not considered a valid marker of oxidative stress, because it is produced by many other processes, too [10]. GSH is a useful biomarker of oxidative stress only for in vitro studies showing a real time course, but not for in vivo studies [10]. It is unclear, how the measurement of TAC was performed. The authors refer to a specific method, but in the given reference [11] TAC was not analyzed. Therefore, the authors' conclusion that their study indicates that RF EMF exposure decreases total antioxidant activity in the heart tissue, is not comprehensible due to missing methodological information and inappropriate biomarkers used.

Regarding the high probability of bias, the small sample size and the inappropriateness of biomarkers used, firm conclusions on the effects of RF EMF exposure on cardiac tissue cannot been drawn from the results presented. The study, therefore, does not provide a reliable contribution to the current state of knowledge regarding RF EMF and effects on the heart.

References

The first reference is always the manuscript at hand and the reference in the curly braces at the end of a reference {xx} correspond to a reference in the manuscript at hand and is consistent with the manuscripts reference style.

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Impressum

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