Bundesamt
für Strahlenschutz

Spotlight on EMF Research

Spotlight on “The effects of long-term prenatal exposure to 900, 1800, and 2100 MHz electromagnetic field radiation on myocardial tissue of rats” by Bozok et al. in Toxicology and Industrial Health (2022)

Category [radiofrequency, animal study]

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Competence Centre Electromagnetic Fields (KEMF)

1 Putting the paper into context by the BfS

Possible long-term effects of whole-body exposure to radiofrequency electromagnetic fields (RF EMF), beginning *in utero* and continuing after birth, were investigated in 2 large animal studies (NTP Technical Report on rats [2] & Falcioni et al. 2018 [3]). Both studies observed a statistically significant increased incidence of schwannomas of the heart in male rats of the highest exposure groups, i.e. 6 W/kg in the NTP study for 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 [4 - 6]. Therefore, further research in this area is indicated.

2 Results and conclusions from the authors perspective

The authors investigated the effects of prenatal exposure to RF EMF on myocardial tissue of male rats at varying durations and frequencies. Three pregnant female rats per group were exposed during gestational period (time between conception and birth) to 900 MHz for 24 h, 1800 MHz for 6, 12 or 24 h and 2100 MHz for 24 h over 20 days. The same signal generator was used for all three exposure frequencies with the external antenna placed centrally under the cage. The whole-body average SAR of pregnant rats was estimated to be 0.087 W/kg (900 MHz), 0.12 W/kg (1800 MHz), and 0.17 W/kg (2100 MHz), respectively. Sixty days after delivery, six male rats from each exposure group and the control group were randomly

selected and cardiac tissues were removed. Tissue sections were stained with hematoxylin and eosin (H&E) and evaluated for myocardial damage under a light microscope. In addition, malondialdehyde (MDA) and glutathione (GSH) levels which are associated with reactive oxygen species (ROS) were measured.

Histopathological evaluation of the tissues showed myocardial damage in all exposure groups, but not in the control group, with the severest damage observed in the 2100 MHz/24 h exposed group. MDA levels in the 24 h exposed groups were higher than in the control group and levels were increasing with increasing frequencies. GSH levels in the 24 h exposed groups were lower than in the control group and levels were decreasing with increasing frequency. In addition, MDA levels increased and GSH levels decreased with increasing exposure time per day in the 1800 MHz exposed groups.

According to the authors, their results, although preliminary, support the role of RF EMF in the formation of oxidative stress and show that RF EMF exposure has harmful effects on myocardial tissues. They conclude from their results that long-term RF EMF exposure at higher frequencies will have a comparably greater effect on myocardial tissue. For this reason, the authors raise concern that 5G will increase harmful effects on cardiac tissue.

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 information that would be needed to adequately assess the study's quality [7]: Neither the age of the pregnant rats nor if they were randomly assigned to the different exposure groups is indicated. There is no information on whether the exposure and experimental analyses were carried out in a blinded manner. It is not mentioned, if the groups were housed in the same room, how the cages were placed in the room and if exposure of the animals took place at the same time with an antenna under each cage. It is also not possible to discern from the information given, if the same experimental procedure was applied to the control group (i.e. with an antenna under the cage and RF generator turned off) and if it was exposed to the same environmental conditions. Because of the incomplete information given, a substantial risk of bias cannot be ruled out. Additionally, the number of animals per group was very small (n = 6) and the results must be considered preliminary as stated by the authors themselves.

One form of oxidative damage by ROS is lipid peroxidation and one minor end product of lipid peroxidation is MDA. However, MDA is not considered a valid marker of oxidative stress, because it is produced by many other processes, too [8]. Regarding the GSH levels the authors refer to a paper by Ellman, which does, however, not include a standard method for measuring GSH levels, like the recycling assay or high-performance liquid-chromatography-based methods [9, 10]. Furthermore, GSH is considered a valid biomarker only for in vitro studies [8]. From the point of view of the BfS, based on the methods and data, it cannot be deduced that RF EMFs play a role in the formation of oxidative stress, as stated by the authors.

Given the potentially high risk of bias, the small sample size, the limited meaningfulness of MDA levels and the inappropriateness of GSH measurement in vivo, firm conclusions on the effects of RF EMF exposure on cardiac tissue cannot be drawn from this study. For this reason, the study 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.

[1] Bozok S et al. The effects of long-term prenatal exposure to 900, 1800, and 2100 MHz electromagnetic field radiation on myocardial tissue of rats. Toxicol Ind Health eFIRST 2022-11: 7482337221139586. DOI: 10.1177/07482337221139586

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