Bundesamt
für Strahlenschutz

Spotlight on EMF Research

Spotlight on “Effect of WiFi signal exposure in utero and early life on neurodevelopment and behaviors of rats” by Wu et al. in Environmental Science and Pollution Research International (2023)

Category [radiofrequency, animal study]

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Competence Centre Electromagnetic Fields (KEMF)

1 Putting the paper into context by the BfS

Health effects of radiofrequency electromagnetic fields (RF-EMF) are generally well studied. However, most of the results relate to the effects of RF-EMF from mobile phones on adult humans or animals. The number of studies investigating the effects of RF-EMF, in this case Wi-Fi (Wireless Fidelity, equivalent to WLAN, Wireless Local Area Network) on developing organisms is much smaller. The results to date show no negative effects. In connection with the introduction of WLAN in schools, a possible risk for children is increasingly being discussed. The present study [1] investigated the effects of RF-EMF exposure during gestation and postnatal development on the behaviour and development of the nervous system in young rats.

2 Results and conclusions from the authors‘ perspective

For this experiment, twelve rats were continuously exposed to RF-EMF from the beginning of gestation and their pups from birth to 42 days of age, because the developing nervous system is particularly sensitive during this period. This was done using a wireless data transmission router 30 cm away from the cages (according to the authors: frequency: 2.45 GHz, electric field strength 2.1 V/m). The twelve pregnant rats and their pups in the control group were sham-exposed with the device switched off. Growth (based on weight), neuronal development (swimming performance, negative geotaxis, pain threshold), stereotyped and repetitive behaviour (self-grooming test), motor activity (open field test) and spatial orientation (Morris water maze) were investigated. Furthermore, the tissue of the brain, in particular the hippocampus (a brain region that is important for memory and spatial orientation) was examined microscopically and the expression and activity of neuronal growth markers, markers of programmed cell death (apoptosis) and markers of oxidative stress were determined.

No differences were found between exposed and unexposed female pups.

In contrast to this, exposed male pups were heavier than unexposed ones. They travelled a longer distance in the open field test at the same velocity and learned to orientate themselves more quickly in the Morris Water Maze than unexposed pups. The proteins CREB (cAMP Responsive Element Binding Protein, a transcription factor) and BNDF (Brain Derived Neurotrophic Factor) play a central role in neuronal processes, learning and memory. The expression of both proteins was increased in exposed male pups. However, analysis of the brain tissue showed no differences in the morphology of the hippocampus and no signs of neurodegeneration in the exposed animals. The analysis of markers of apoptosis and markers of oxidative stress showed no differences between exposed animals and the control group.

The authors conclude that pre- and postnatal RF-EMF exposure has no effect on hippocampal neurons, oxidative balance in the brain and neuronal and emotional development of young rats. Some effects of RF-EMF exposure were sex-dependent: increased body weight, improved spatial memory and learning function, and induced behavioural hyperactivity in young male rats.

3 Comments by the BfS

The question whether long-term exposure to RF-EMF from WLAN devices affects the developing nervous system is relevant from a radiation protection perspective. The authors investigated this question in rats from several aspects and using different methods (behavioural tests, histological tests, biochemical assays).

Methodological shortcomings and inadequate documentation, which makes independent reproduction of the results impossible, severely limit the validity of the study. For example, the information on exposure generation and determination is contradictory and insufficient. According to the authors, a Wi-Fi device was used as the RF-EMF source, but the IEEE 802.16e standard stated in the manuscript is not compatible with this (Wi-Fi is a marketing term for devices that comply with the IEEE 802.11 standard). It also remains unclear whether and how a controlled constant emission of RF-EMF was ensured and how the specified field strengths were determined. In commercially available devices, predefined data transfers are typically enforced, or software changes are made to ensure a defined exposure. However, the article does not provide any evidence of such a procedure. In the case of the stated mean electric field strength of 2.1 V/m, it is unclear whether this is a temporal or local average of the field strength and to which frequency range this value is to be assigned, because neither the measuring device used nor the procedure for the measurement are described. Since no analogue background field strength was determined for the control animals, an insufficient exposure contrast between the exposed and non-exposed animals cannot be completely ruled out. A well-defined exposure facility and the calculation of specific absorption rate (SAR) values in the anatomical model would be necessary to reliably generate the exposure and determine the body-internal exposure metric SAR of the animals and in particular of the brain, which is relevant for biological processes. As the article provides no evidence of a blinded and randomised experimental design, a bias in the results cannot be ruled out.

The Bonferroni correction for multiple testing was applied, thereby reducing the probability of false positive results.

The findings in the exposed male pups are consistent: larger animals covered a longer distance, they learnt better and at the same time the expression of the proteins required for this was increased in the brain. The question of why the observed differences under RF-EMF exposure were sex-specific remains unanswered.

Twelve pregnant rats per group were examined. Pups of exposed mothers were further exposed, pups of unexposed mothers served as control animals. It is not stated whether the number of pups per litter was reduced to a certain standardised number. A high number of pups per litter can have a negative effect on the weight and development of the animals [2]. Eight animals were used for the behavioural tests and six animals for histological examinations. This number is too small for a reliable statistical evaluation.

Furthermore, it is unclear according to which criteria the animals were selected for the tests, e.g. whether animals came from different litters in order to obtain independent results.

The markers of oxidative stress used (malondialdehyde and superoxide dismutase activity) are not very reliable for in vivo studies [3].

The results of the present study are consistent with the current state of scientific knowledge that exposures below the internationally recommended limit values are not expected to have any adverse health effects (including on the developing nervous system). Predominantly no effects were observed, and the few effects in male animals do not represent an impairment. This is consistent with older studies, which also found no negative effects of WLAN exposure on juvenile rodents [4,5]. However, due to the methodological shortcomings described above, the results of the study are not very conclusive and reliable.

References

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