Bundesamt für Strahlenschutz

Spotlight on EMF Research

Spotlight on “Effects of mobile phone electromagnetic fields on brain waves in healthy volunteers” by van der Meer et al. in Scientific Reports (2023)

Category [radiofrequency, human study]

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Competence Centre Electromagnetic Fields (KEMF)

1 Putting the paper into context by the BfS

Exposure to radiofrequency electromagnetic fields (RF-EMF) from mobile phones has repeatedly been shown to affect human brain activity measured by electroencephalogram (EEG). Studies in waking volunteers predominantly show effects (mostly an increase) in the EEG power in the alpha frequency band [2]. However, there are also studies showing a decrease in the alpha power, effects in other EEG frequency bands, or even no effects. The variability of the results seems to depend on the various experimental protocols [3]. So far, there is no evidence that the observed very small effects observed so far are related to adverse health outcomes.

2 Results and conclusions from the perspective of van der Meer et al.

The present study [1] aimed to investigate the effect of RF-EMF from mobile phones on the resting state EEG and to improve the study protocol and the statistical evaluation of the results. A randomized double-blind counterbalanced crossover design was used, in which each participant is his own control.

The experiments were performed in a room with a low background RF-EMF exposure. The exposure set-up consisted of four GSM antennas placed in a rectangular configuration, facilitating a homogeneous delivery of RF-EMF in the area of the volunteer’s head. A carrier frequency of 900 MHz with a pulse modulation of 217 Hz was used. In order to assess the effects of the exposure on the EEG system and to exclude possible artefacts in the EEG electrodes due to the pulsed RF-EMF exposure, validation measurements using a phantom (watermelon) were conducted.

Thirty-two healthy volunteers (eleven males) participated in the study. Every volunteer underwent two sessions of 15 minutes duration each, one under sham and the other under real RF-EMF exposure. The sessions were separated by a 15-minute washout period. Before the sessions, a 15-min adaptation period was included. Half of the volunteers (group 1) were exposed to RF-EMF in the first session (session A), the other half (group 2) in the second session (session B). During both experimental sessions, resting EEG was recorded under the conditions “eyes closed (EC)” and “eyes opened (EO)”, both lasting 1.5 minutes and repeated alternately five times. EEG war recorded using a system with 63 electrodes. After removing artefacts, the power spectral density (PSD) was calculated for each recording channel and participant for the four conditions EO and RF on, EO and RF off, EC and RF on, EC and RF off. Then, PSD was averaged over six cranial regions: left and right temporal, frontal, central, parietal and occipital. The PSD-contrast, i.e. the difference between session A and B, was calculated for each participant for the frequency range 6-10 Hz under EO and EC conditions. Five different hypotheses were modelled considering changes in PSD between groups and brain areas, and the model most likely to explain the observed data was identified.

There was no difference in the PSD under EC condition, independently on session or RF-EMF exposure. Under EO condition, solely when the RF-EMF exposure occurred in session B the PSD differed between the sessions, suggesting an increased power in the alpha band of the EEG under RF-EMF exposure. When exposure occurred in session A (i.e. prior to the sham exposure session), no such difference could be observed. The statistical analyses indicated that the difference in the PSD contrast between the groups was most compatible with the predictions of a model that assumes, that RF-EMF have an effect on the EEG in the alpha band, but there is no difference between the brain areas.

3 Comments by the BfS

The authors investigated the effects of 2G mobile phone-like RF-EMF exposure on the EEG while controlling for environmental and experimental confounders commonly present in older studies. The study followed a double-blind crossover counterbalanced design, which is the gold standard for this kind of human experimental studies. However, it remains unclear to what extent the volunteers were actually exposed, due to the absence of a precise characterisation of exposure and a lack of assessment of the spatial distribution of the specific absorption rate (in the brain.

When RF-EMF exposure followed sham exposure, the PSD showed a clearly elevated alpha power under exposure in the condition with open eyes. When sham exposure followed real exposure, the PSD contrast was close to zero. This might indicate that the increase of alpha power caused by RF-EMF exposure had not disappeared yet. As the authors discuss themselves it cannot be ruled out that the washout period was too short. The applied 15-minute separation between sham exposure and RF-EMF exposure condition is much shorter that the washout period of one day that is recommended to avoid carry-over effects [4].

There are possible individual differences which were not considered and could possibly dilute the weak effect of RF-EMF on the EEG. From the supplementary material it is apparent, that the increase in alpha power under exposure by RF-EMF could only be observed in volunteers showing a spontaneous alpha rhythm. About 85% of individuals have a basic alpha type rhythm. Other authors recommended to consider the basic EEG rhythm of subjects included in the study [3]. The lack of baseline EEG data from before the initial session complicates any further interpretation of the results.

Despite the described shortcomings, using sophisticated statistical methods the study confirmed results of several earlier studies showing a weak but significant increase of alpha power under RF-EMF exposure. A health relevance of this subtle effect has not been demonstrated.

References

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