Summaries and assessments of selected studies

Between mid of April and end of July 2025, 137 new publications were identified, four of which were discussed in depth by BERENIS. Two of these were deemed particularly relevant based on the selection criteria. Their summary and assessment are outlined below.

1) Experimental animal and cell studies

Are there molecular patterns associated with EHS? (Sonzogni et al. *2025)*

The authors of this study (Sonzogni *et al.* 2025) investigated a group of volunteers, which are affected by electromagnetic hypersensitivity (EHS; DEMETER cohort, n=26: 20 females, 6 males, aged 39–70) and were recruited from a French EHS association. Based on this small cohort, the authors aimed to find commonalities regarding molecular and symptomatic patterns. The study comprised two parts: Firstly, the symptoms of EHS were characterised in relation to their EMF sources and the organ systems affected. Secondly, the researchers investigated at a molecular level the ability of skin fibroblasts, obtained from skin biopsies taken from the participants' inner side of the arms, to cope with DNA damage.

The impact of various sources of non-ionising radiation on well-being was assessed using a questionnaire. This led to the identification of two subgroups: 14 of the volunteers reacted strongly to RF-EMF in the 300 MHz to 5 GHz range, but felt hardly affected by LF-MF exposure (LBHR group; 'low background, high responsiveness', EHS with low background sensitivity but strong reaction to RF-EMF), whereas the others reported symptoms triggered by sources across all frequency ranges (HBLR group; 'high background, low responsiveness', general EHS, fewer RF-EMF-dependent symptoms). It was also found that the second group (HBLR) more frequently reported symptoms and discomfort triggered by other environmental factors, and that in many cases they had a notable medical history or pre-existing condition, or were currently undergoing treatment. Based on the analyses of symptom intensities and the involvement of organ systems, the authors postulated that there is a tendency that HBLR-EHS correlates with sleep disturbances, fatigue and reduced cognitive activity, while LBHR-EHS often manifests with skin-related, cardiovascular and digestive problems as well as headaches. However, this classification into groups only partially overlapped with the previous classification based on sensitivity to certain frequency ranges.

In the second part of the study, cells from the participants' skin biopsies were examined regarding the integrity of their genetic information (DNA damage). Based on analyses of spontaneously occurring DNA double-strand breaks (γH2AX foci) and micronuclei, the cell samples could be divided into two groups. The first group showed normal background levels of DNA damage, similar to the control samples from another cohort (COPERNIC study on X-rays/radiosensitivity). The second group, in contrast, showed significantly increased DNA damage, comparable to the values seen in radiosensitive patients with genetic predispositions, yet these increases manifested only in a subpopulation of the cells. However, there was no clear correlation between the groups based on the classification by DNA damage and by EHS symptoms (LBHR/HBLR). Furthermore, the authors analysed the intracellular distribution of a key signalling protein for DNA double-strand breaks ('ATM crowns') and reported signs of accelerated cellular ageing in some of the samples with high levels of DNA damage. The researchers also investigated systematically the repair capacity of X-ray-induced DNA damage in DEMETER cells. It was found that, compared to the skin cells of the control cohort, all DEMETER fibroblasts exhibited altered repair dynamics, with reduced detection of strand breaks and increased persistence of DNA

damage. However, these analyses showed hardly any correlations or consistent differences with regard to the previous classifications of the cohort. An exception to this was the observation that cells with a high background level of DNA damage also reacted particularly sensitively to the administration of a strong oxidant, hydrogen peroxide. The authors conclude from their experiments that EHS may be linked to an altered response to DNA damage, although its causality and mechanism requires further investigation.

Although the research by Sonzogni *et al.* (2025) is based on a small number of volunteers and few analyses, it is nonetheless noteworthy, as it is one of the few studies specifically looking for molecular patterns in cells of people affected by EHS. This approach is of central importance when it comes to the scientific and medical understanding of EHS symptoms, which are likely to have complex and multifactorial causes. A causal link between EMF exposure and EHS cannot be inferred from this study; however, it provides interesting clues for further research.

2) Human experimental studies

Effects of 5G RF-EMF on human sleep EEG: study in a genetic context (Sousouri et al. *2025)*

L-type voltage-gated calcium channels (LTCC) are important for many brain functions. RF-EMF can activate these channels, which have been linked to sleep quality and EEG oscillatory activity (e.g. sleep spindles) in a genetic context. The genetic variant (allele rs7304986) is associated with LTCC. Enhanced spindle or 'sigma' activity (~11–16 Hz) in the non-rapid-eye-movement (NREM) sleep EEG is among the most consistent effects of 2G–4G RF-EMF exposure. The aim of this study was thus to investigate the influence of 5G RF-EMF on sleep and EEG spindle activity, with a particular focus on a possible association with the genetic variant rs7304986.

Thirty-four participants with these genetic variants for rs7304986 (15 T/C and 19 matched T/T carriers) took part in this double-blind, randomised study. Before going to sleep, they were exposed for 30 minutes either to standardised left-hemispheric exposure to two 5G HF EMF signals (3.6 GHz and 700 MHz) or to a control condition without radiation.

The T/C carriers reported a longer subjective sleep latency than the T/T subjects. Exposure to 3.6 GHz (but not 700 MHz) accelerated sleep spindles (higher frequency) in T/C subjects over widespread cortical areas. However, the simulated SAR distribution in the brain revealed a deeper penetration of the 700 MHz signal. It remains unclear why the more pronounced effects on sleep spindles occurred following exposure to the 3.6 GHz signal (with only superficial penetration).

The study showed that voltage-gated calcium channels of the LTCC type might be involved in the physiological response to RF-EMF. Further research is needed to explore genetic and biophysical mechanisms underlying effects of RF-EMF on sleep.

References

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BERENIS - Swiss expert group on electromagnetic fields and non-ionising radiation

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List of abbreviations (pdf)