

Summaries and assessments of selected studies

Between mid of July and end of October 2024, 114 new publications were identified, five of which were discussed in depth by BERENIS. Of these, three were deemed most relevant based on the selection criteria. Their summaries and assessments are outlined below. In addition, one publication from an earlier screening period is discussed in this newsletter as well (Tahir *et al.* 2024).

1) *Experimental animal and cell studies*

Effects of 2.45 GHz RF-EMF on the inner ear - a histopathological study (Tahir et al. 2024)

In the study by Tahir *et al.* (2024), potential functional as well as structural effects of RF-EMF exposure (2.45 GHz, unmodulated wave) on the cochlea in the inner ear of pregnant rats were investigated. Pregnant rats were exposed to 2.45 GHz electric fields at intensities of 0.6, 1.9, 5, 10, and 15 V/m for 21 days during pregnancy, and the newborns were exposed until 45 days after birth. They were exposed in a circular cage with a centrally placed antenna. To detect and avoid fluctuations, daily measurements of the electric field strength were conducted. Field strength in the tissue was determined by computer simulations based on dielectric parameters. Ambient noise levels were measured in advance and should not exceed 50 dB in order to avoid any influence on the test outcome. Reaction tests to determine hearing threshold (sequential stimuli starting at 80 dB, decreasing by 10 dB) were conducted before and after RF-EMF exposure. Furthermore, the authors performed histopathological analyses of the cochlea as well as investigations of apoptosis. They report statistically significant and dose-dependent increase in hearing threshold for exposures above 5 V/m, while no differences in threshold values were measured in the control groups. Neuronal potentials in the brainstem represent an objective measurement of the function of the auditory pathway from the auditory nerve to the midbrain (mesencephalon). This allows for estimation of synchronous neuronal function and hearing threshold. At 10 and 15 V/m, a dose-dependent increase in apoptosis was found, based on measurements of caspase 3, 9 and the TUNEL method (an immunohistochemical technique for detecting dying cells). The authors concluded that apoptosis and immune activity in the cochlea depend on the power level of the electric field, and that damage to the inner ear was already measured at low doses.

Experiments on the molecular level and changes in microstructure using electron microscopy were not carried out. These kinds of investigations would be relevant to identifying specific target structures. Due to the insufficient dosimetry and exposure characterisation in this study, however, no recommendations for the use of wireless devices can be derived.

Effects of RF-EMF for wireless energy transfer on cell cultures (Chow et al. 2024)

The *in vitro* study by Chow *et al.* (2024) is presented here as it is foreseeable that wireless energy transfer will become increasingly important in the future. RF-EMF at a frequency of 6.78 MHz is anticipated to be used for this technology and therefore applied in this study to investigate effects of this exposure on cultured human cells (HUVEC, umbilical cord endothelial cells). The cells were continuously exposed at a magnetic flux density of 10 μ T for either 72 or 24 hours. Unfortunately, the exposure system was insufficiently described, and no dosimetry was documented, introducing some uncertainties regarding the exposure. The authors reported an increase in cell numbers and a decrease in the proportion of dead cells (apoptosis) after three days of RF-EMF exposure. To find a possible explanation for these observations, markers for oxidative stress were measured after 24 hours of

exposure. A reduction of ROS formation was observed for superoxide, whereas hydrogen peroxide formation remained unchanged. Furthermore, gene activity (transcriptomics) and protein levels (proteomics) were analysed and changes in 101 genes and 146 proteins were detected. Some of these belong to functional categories (such as cell proliferation, metabolic regulation and redox system) that are consistent with the above observations.

The observations by Chow *et al.* (2024) suggest a potential influence of a 6.78 MHz RF-EMF on cells at a relatively low magnetic flux density (10 μ T). However, no direct conclusions regarding possible health risks can yet be drawn. Further and better-controlled studies are needed, ideally including animal experiments. To date, there are only few studies for this frequency range available. As the use of wireless power transmission is expected to increase, more research on the biological effects is desirable.

2) Epidemiological studies

Regular mobile phone use and cardiovascular diseases (Zhang et al. 2024)

Zhang *et al.* (2024) investigated the possible association between mobile phone use and cardiovascular disease incidence, using data from the UK biobank, a large-scale health research endeavour which collects genetic, environmental, and health data. In the present study, data from 444,027 individuals who had no cardiovascular disease at the start of the study were analysed.

Exposure was assessed at the beginning of the study in two ways: (1) the number of years in which the mobile phone was used at least once a week, and (2) the total weekly duration of phone use during the past three months, categorized into six groups. Both are relatively coarse metrics, relying on the participants' personal memory, and their ability to estimate their average usage behaviour. Factors such as network type, connection quality and the position of the phone in relation to the body were not considered, making the exposure assessment in terms of RF-EMF dose very imprecise. Furthermore, mobile phone use was assessed only at the start of the study, raising the question of how representative this is for the entire follow-up period. While RF-EMF was not directly investigated, the authors imply in the introduction that "RF-EMF's [...] could affect various organs, such as heart and blood vessels."

Over the follow-up period of 12.3 years, 56,181 study participants developed cardiovascular diseases, including coronary heart disease, atrial fibrillation and stroke. The study found that mobile phone use at least once per week was associated with a 4% increased risk of cardiovascular disease. Each increase in cumulative call time beyond 5 minutes was associated with a further increased risk of cardiovascular disease. The most intensive users (more than 6 hours per week) had a 19% increased risk compared to those using their mobile phones less than 5 minutes per week.

The study's strengths include its large sample size, and its prospective design¹. However, limitations of the study are the uncertainty in exposure assessment (see above) and the risk of bias due to factors that were not taken into account. While the investigators corrected for some confounders (including age, sex, urban residence, education, body mass index), the results suggest that the selection of confounders played a significant role, and that some may have been overlooked. For example, the authors did not consider any markers of stress as confounders. Instead, they assessed how the effect of phone use was mediated through sleep disturbance and psychological distress, although these have

¹ In a prospective study, exposure is assessed well before the health-related 'endpoints' (in this case cardiovascular disease), which rules out a systematic bias in the results due to differences in the participants' memory.

been shown to be significant risk factors for cardiovascular disease themselves. Since sleep disturbance and psychological distress have other causes than just phone calls, it seems likely that these factors were not only influenced by phone calls and therefore may have been incorrectly treated as mediators. Considering these markers as confounders instead might have reduced the associations found.

The authors do not address the counterintuitive observation that people who use hands-free devices/speakerphones are at higher risk than those who do not. The researchers also further found a rough doubling of the risk for diabetic individuals and smokers, but do not discuss why these populations would be more vulnerable. The same research group has previously reported an increased risk for new-onset hypertension (see [BERENIS newsletter 36](#)) and several types of cancer based on crude self-reported phone use (at least one call per week)². Since mobile phone use patterns have changed substantially since the start of the study, the impact on public health would be substantial if these associations were causal and attributable to mobile phone use. This seems unlikely considering the very crude exposure metrics. Although the authors acknowledge that their study cannot establish causality, their language suggests causality and is at times contradictory.

3) Human experimental studies

Responses of the autonomic nervous system to 5G exposure (3.5 GHz) in healthy volunteers (Jamal et al. 2024)

Forty-four participants (24 males, 20 females) were exposed to an RF-EMF (pulse modulated 3.5 GHz signal; field strength 2 V/m head; 1.5 V/m torso) and a control condition (no field). A total of seven runs were measured: Runs 1 and 2 before exposure (baseline); Runs 3 to 5 with exposure; Runs 6 and 7 after exposure. The focus was on the autonomic nervous system, operationalised by measuring temperature (head, neck: infrared camera; hand: temperature probe) and electrodermal activity on the finger (response to acoustic stimulation). Effects on brain activity (EEG) have been published previously (Jamal et al. 2023; no effect observed; [BERENIS newsletter 37](#)). No temperature effects were observed at the finger. Head temperature increased slightly after RF-EMF exposure (by less than 0.1°C), neck temperature increased slightly both during and after exposure (about 0.1°C). Subtle changes in certain electrodermal parameters were observed after exposure, mainly in Run 7. These effects could indicate a potentially faster physiological response to auditory stimuli.

The observed effects are within the normal physiological range and could also be influenced by uncontrolled factors, as the authors themselves point out. The differences fall within the range of measurement uncertainty. Furthermore, temperature measurement using an infrared camera is not suitable for series of measurements. Lastly, it should be noted that the intensity of the field was low (SAR 0.037 mW/kg; base station) and that hardly any effects are to be expected at these intensities.

4) Further information

Monitoring of non-ionising radiation in Switzerland

The SwissNIS project consortium has published its third annual report (in German). The report describes the measurements carried out as part of the Swiss exposure monitoring programme with

² <https://doi.org/10.1093/ehjdh/ztad024>, <https://doi.org/10.1158/1055-9965.epi-23-0766>

regard to non-ionising radiation in 2023.³

Reviews commissioned by the WHO

With the publication of the review by Mevissen *et al.* (2025)⁴ on carcinogenicity in laboratory animals, all systematic reviews commissioned by the WHO on the health effects of RF-EMF exposure have now been published.

References

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Zhang Y, Ye Z, Zhang Y, Yang S, Liu M, Wu Q, Zhou C, He P, Gan X, Qin X. **Regular Mobile Phone Use and Incident Cardiovascular Diseases: Mediating Effects of Sleep Patterns, Psychological Distress, and Neuroticism.** Can J Cardiol. 2024 Jul 22:S0828-282X(24)00437-9. <https://doi.org/10.1016/j.cjca.2024.06.006>

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³ SwissNIS (2024): Expositionsmessungen nichtionisierende Strahlung: Jahresbericht 2023 - Projektkonsortium SwissNIS. 20. August 2024. Bundesamt für Umwelt (BAFU).

<https://www.news.admin.ch/news/message/attachments/89990.pdf>

⁴ <https://doi.org/10.1016/j.envint.2025.109482>

[BERENIS - Swiss expert group on electromagnetic fields and non-ionising radiation](#)

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[List of abbreviations \(pdf\)](#)