Bundesamt
für Strahlenschutz

Spotlight on EMF Research

Spotlight on “Reduced subjective sleep quality in people rating themselves as electro-hypersensitive” by Eicher et al. in Sleep Medicine (2024)

Category [radiofrequency, human study]

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Competence Centre Electromagnetic Fields (KEMF)

1 Putting the paper into context by the BfS

In Germany, about 1% of the population consider themselves electro-hypersensitive (EHS). They attribute several unspecific symptoms like headache, insomnia, dizziness or lack of concentration to everyday electromagnetic fields (EMF). A causal relationship between symptoms and EMF exposure is not scientifically established. In human experimental studies, EHS persons are neither able to perceive EMF nor do they develop symptoms if the exposure is applied in a blinded manner. On the other hand, the health complaints of EHS persons are real, and those affected are suffering a lot. Therefore, there is a need to better understand the nature and origin of the symptoms.

2 Results and conclusions from the authors’ perspective

The present study [1] examines the relationship between self-reported EHS, subjective sleep quality, and genetic background, which could contribute to sleep disturbances. For a cross-sectional study, 2040 participants aged 18–30 were recruited in Switzerland in 2017 and 2018. Sociodemographic data, health status and the use of a mobile phone with and without headphones were collected using questionnaires. Participants that reported considering themselves EHS or to attribute symptoms to EMF were assigned to the EHS/attributers-group, while the remaining participants were assigned to the non-EHS group. Sleep quality [2], daytime sleepiness [3], and innate diurnal preference [4] were assessed using validated questionnaires.

Acute effects of RF-EMF on sleep EEG were found in several laboratory studies. These effects were characterized by inter-individual variability, but they showed a certain intra-individual stability [5], pointing to a possible contribution of genetic factors. There are hypotheses suggesting an effect of RF-EMF in voltage-gated calcium channels [6]. The gene CACNA1C is encoding such a channel, and its genetic variants are associated with sleep quality [7]. The authors hypothesized that there might be a relationship between this gene and the sleep problems of EHS persons and performed an analysis of CACNA1C allelic variants in

the saliva of study participants. Allelic variants are gene variants where the DNA sequence differs between two or more variants at a particular position on a chromosome.

Shift-workers, participants taking sleep medications or illegal drugs, and persons for whom the determination of allelic variants failed were excluded. Complete data was collected from 1765 participants who were included in the analysis. The authors used multiple regression analyses to assess the associations between EHS status, sleep quality and CACNA1C genotype. The covariates age, sex and RF-EMF exposure (assessed by time spent on phone calls without headphones) were predefined. The "Benjamini-Hochberg False Discovery Rate" method was applied to correct for multiple testing [8].

The EHS and non-EHS groups were similar concerning age, consumption of alcohol, nicotine and caffeine, and reported phone call duration without headphones. The EHS group included more women, had a slightly lower body mass index, lower education and reported more phone calls using headphones. They had a higher prevalence of both sleep disturbances and comorbidities (e.g., neurological, psychiatric or internal diseases).

According to linear regression analyses, there was a statistically significant association between EHS and a longer self-rated sleep onset latency, poorer subjective sleep quality, increased daytime sleepiness and enhanced mentation (e.g., very vivid dreams) during sleep. These results did not change if persons considering themselves EHS and persons attributing symptoms to EMF were pooled in the statistical analyses or if the two groups were analysed separately, except for self-rated sleep latency that remained significant only in the attributers. Exposure to RF-EMF measured by the reported duration of phone calls without headphones was in the multiple regression analyses not associated with sleep onset latency and subjective sleep quality, but it was statistically significantly associated with increased mentation during sleep, increased daytime sleepiness, and later diurnal preference. In addition to the subjective reported duration of mobile phone calls without headphones, gender, existing sleep disorders and education were included in the multiple regression models. There was a statistically significant association between the T-allele variant rs2302729 of the CACNA1C gene and both self-reported EMF sensitivity and reduced subjective sleep quality. A mediation analysis revealed that the association between EHS and poor sleep quality was not mediated by the allelic variant rs2302729.

The authors mention several study limitations. The study population consisted of people of young age and high education level, with a higher proportion of women than men, and is not representative of the general population. As the aim of the study was known to potential participants, selection bias can be expected. The prevalence of 7% EHS in the study population is higher than in the general population [8], supporting this hypothesis.

The authors conclude that the results suggest a poorer sleep quality in EHS individuals have, irrespective of reported EMF exposure by mobile phones. The T-allele of CACNA1C variant rs2302729 was associated with impaired sleep quality as well as with self-rated EMF sensitivity. The authors recommend controlled interventional studies with standardized RF-EMF exposure and genetically characterized individuals to investigate the role of the CACNA1C gene in the biological effects of RF-EMF on sleep.

3 Comments by the BfS

This well documented observational study suggests a complex interaction between self-reported electromagnetic hypersensitivity, subjective sleep quality and genetic factors. The large dataset includes a fairly high number of EHS persons and the results indicate that those affected are more likely to experience sleep disturbances than those not affected. However, self-assignment to EHS status was relatively imprecise based on a single criterion. An additional enquiry as to whether people regularly attribute symptoms to EMF and experience a reduction in their level of functioning is recommended by some researchers for a more precise assignment to EHS status. [9].

In accordance with the current state of knowledge, no relationship could be demonstrated between the EHS status and the exposure to RF-EMF from mobile phones. In a cross-sectional study, it is not possible to estimate the causality of a relationship. Causality presupposes that the cause precedes the effect in time. In a cross-sectional study, however, all variables are measured simultaneously, making it impossible to clearly determine the sequence of cause and effect.

The exposure to RF-EMF was assessed using a questionnaire, the time spent on phone calls with and without headphones was estimated. It is known that such an assessment and estimation is subject to recall bias and leads to an underestimation of number of calls and overestimation of call duration [10, 11]. Further, it must be noted that for modern mobile networks (3G, 4G, 5G) questionnaire data regarding usage duration do not provide reliable information on the actual exposure of individuals to the physical agent RF-EMF [12]. In addition to the typical biases in the accuracy of responses to questionnaire surveys, there are significant unaccounted factors influencing exposure, such as the very efficient output power control mechanisms of modern mobile phones. Therefore, the fact that no association was observed needs to be treated with care, especially if the phones operated in 3G, 4G or 5G networks. In fact, the potential mechanisms for the activation of cation channels by RF-EMF that the authors reference to justify investigating possible effects of RF-EMF on sleep or associations with allelic variants of a voltage-gated calcium channel subunit do not apply to the intensity and frequency range used in mobile telephony and are not scientifically substantiated [13].

From a radiation protection point of view, there is currently not enough evidence to motivate further investigations of a potential role of genes encoding voltage gated ion channels as a mechanism of a potential individual sensitivity to RF-EMF exposure. The evidence that EHS persons tend to experience poorer sleep is an important finding and deserves further attention, including investigation of genetic factors involved in sleep disorders and further symptoms reported by persons considering themselves EHS, independently of a real RF-EMF exposure.

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