

Spotlight on EMF Research

Spotlight on “The effects of radiofrequency electromagnetic fields exposure on human self-reported symptoms: A systematic review of human experimental studies” by Bosch-Capblanch et al. in Environment International (2024)

Category [radiofrequency, review]

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Competence Centre Electromagnetic Fields (KEMF)

1 Putting the paper into context by the BfS

The World Health Organization (WHO) has initiated an ongoing project to systematically assess the potential health effects of exposure to radiofrequency electromagnetic fields (RF-EMF) in the general and occupational populations, including patients. To this end, in 2018, the WHO conducted a comprehensive international survey among RF-EMF experts to prioritize the potential health effects according to their importance [3]. Key topics were identified for which WHO has commissioned systematic reviews. More general information on the WHO systematic reviews can be found in a Spotlight (Apr/2024 no.2 [4]). Possible symptoms caused by RF-EMF and a sensitivity of some people to EMF have been discussed for many years. The current systematic review [1,2] addresses findings on the effects of RF-EMF exposure on self-reported non-specific symptoms and on the perception of RF-EMF, as reported in human experimental studies. A parallel systematic review assessed the effects of RF-EMF on symptoms in human observational studies [5].

2 Results and conclusions from the authors' perspective

The authors evaluated the relationship between short-term exposure to RF-EMF and symptoms, as well as the ability to perceive RF-EMF. Therefore, they considered experimental studies conducted on individuals of the general population and on individuals who attribute their symptoms to RF-EMF, a condition referred to as idiopathic environmental intolerance attributed to EMF (IEI-EMF). Note that some authors also refer to this phenomenon as electromagnetic hypersensitivity (EHS). The authors followed the recommendations for the conduct of systematic reviews in toxicology and environmental health research [6] and published the methods, including literature search strategy, eligibility criteria,

and the procedures of data extraction, synthesis, and analysis in a study protocol [7]. The quality of included studies was assessed taking into account risk of bias (RoB) criteria [8], and a three tier stratification system was employed to classify studies based on their susceptibility to bias. Studies categorized within tier 1 exhibited a low RoB, denoting high quality, whereas those categorized within tier 3 demonstrated a high RoB, reflecting low quality. For data analyses, the outcome measures of symptoms were converted to standardized mean differences (SMD). Data were analysed using random-effects meta-analyses. The relationship between exposure levels and outcomes was examined using meta-regression. Sensitivity and specificity of RF-EMF perception were calculated. The authors used the approach proposed by the “Grading of Recommendations Assessment, Development and Evaluation” (GRADE) working group [9] to assess the certainty of the evidence for each exposure-outcome combination.

A total of 8,908 publications were retrieved, of which 106 were considered relevant for full-text examination. Of these, 40 were included in the systematic review, while 66 were excluded, primarily due to inappropriate study design, inadequate exposure quantification or range, or lack of blinding. In terms of susceptibility to bias, 14 studies were classified as tier-1, 26 as tier-2 studies, and no tier-3 studies were identified.

The three primary outcomes – headache, sleeping disturbances, and composite symptoms – were analysed separately for the general population and IEI-EMF subjects, as well as for head and whole-body exposures. No studies on sleeping disturbances in IEI-EMF subjects were identified, resulting in a total of ten comparisons. In all of them, the effect sizes (SMD) were smaller than 0.2 and not statistically significant, indicating small or no effects. In terms of effect direction, six comparisons indicated that the RF exposure worsened the symptoms (positive SMD), while four comparisons indicated the opposite. The certainty of evidence was rated as “very low” in two comparisons, “low” in one, “moderate” in four and “high” in three comparisons. The reasons for downgrading the certainty of evidence were RoB in six comparisons, heterogeneity between studies in four comparisons and results based on a single study in two comparisons. The results are compiled in Table 1.

Outcome per population	No. of studies	Exposure	Effect measure, effect size (SMD) [95% CI]	Study quality	Certainty of the evidence
Headache					
General population	6	0.5 – 1.6 W/kg head	0.08 [-0.07; 0.24]	Tier 1: 1 study Tier 2: 5 studies	Moderate
General population	2	1.0 - 19.4 V/m whole body	0.09 [-0.35; 0.54]	Tier 1: 2 studies	High
IEI-EMF population	3	0.8 - 1.4 W/kg head	-0.16, [-0.38; 0.06]	Tier 1: 1 study Tier 2: 2 studies	Moderate
IEI-EMF population	1	19.4 V/m whole body*	0.11 [-0.29, 0.52]	Tier 1: 1 study	Moderate
Sleeping disturbances					
General population	8	1.0 - 6.0 W/kg head	-0.01 [-0.22; 0.20]	Tier 1: 2 studies Tier 2: 6 studies	Moderate
General population	1	NA whole body*	0.00 [-0.15; 0.15]	Tier 2: 1 study	Low
Composite symptoms					
General population	3	0.4 - 1.6 W/kg head	0.13 [-0.51; 0.76]	Tier 2: 3 studies	Very low
General population	4	1.9 - 19.4 V/m whole body	-0.05 [-0.17; 0.07]	Tier 1: 4 studies	High
IEI-EMF population	2	0.8 W/kg head	0.05 [-0.58; 0.68]	Tier 2: 2 studies	Very low
IEI-EMF population	3	1.9 - 19.4 V/m whole body	-0.19 [-0.46; 0.07]	Tier 1: 3 studies	High

CI – Confidence Interval, SMD – standardised mean difference, Tier 1: high quality, Tier 2: middle quality

* Results of a single study, no meta-analysis performed

In addition, meta-regression analyses across all primary outcomes separately for the general population and IEI-EMF individuals, as well as for head and whole-body exposure, showed that there was no statistically significant exposure-response relationship.

With regard to EMF perception, sensitivity and specificity differed statistically significantly between the IEI-EMF and general population samples, indicating according to the authors that IEI-EMF subjects were more likely to report the presence of exposure if true exposure was present, but less likely to report the absence of exposure when no exposure was present. As a result, the summarized ratio of correct to false estimates was similar for both samples and close to 1:1, indicating that the accuracy of the exposure detection corresponds to a chance hit rate. There were no significant differences in detection accuracy between the general population and the IEI-EMF subjects, no matter if analysis was restricted to head or whole body exposure.

In summary, estimated effects on the primary outcomes in both the general population and the IEI-EMF population were small and not statistically significant. The certainty of evidence varied mainly due to the RoB of the included studies in each meta-analysis. Study subjects were not able to perceive the exposure status in a way that would not be expected by chance. Limitations in the body of evidence refer to the methodology of included studies (exposure randomization and allocation concealment) and age group selection (focusing only on adults, young adults or adolescents).

The authors concluded that no evidence was found that would support an association between exposure to RF-EMF below regulatory limits and symptoms; neither did they find evidence that could suggest the capacity of individuals to detect the exposure to RF-EMF.

3 Comments by the BfS

After publishing the review [1], the authors recognized several errors and published a corrigendum [2]. The corrections are considered by the BfS.

The study was conducted according to the quality standards for systematic reviews [6], RoB assessment [8] and certainty of evidence assessment [9]. The restrictive eligibility criteria, especially with regard to exposure and blinding, resulted in a complete absence of studies with high risk of bias (Tier 3) in this systematic review and in the meta-analyses. Although this somewhat limits the database, the focus on studies that satisfy certain standards enhances confidence in the results.

Despite these quality standards, the authors themselves identified several limitations concerning the underlying database and the review process.

The selection of IEI-EMF subjects in all included studies was based on self-attribution. The group of self-attributed IEI-EMF subjects is heterogeneous, and only a small subgroup may actually be particularly susceptible to EMF. Thus, it cannot be excluded that a real EMF effect in some individuals in this group was masked by insensitive subjects.

One of the factors reducing the certainty of evidence is the selection of participants (e.g. young adults or only males). It cannot be excluded that individual reactions to EMF depend on age or gender.

For conducting the meta-analyses and meta regression, the authors had to perform many adjustments to the data, e.g., conversion of exposure metrics, conversion of the original outcome measures to SMDs, and selection of one single outcome parameter from each study. In several cases they were confronted with missing data. All these in part unavoidable aspects may introduce bias into the review process, but were all transparently documented.

This systematic review is the most recent compilation of the available data. It meets the necessary quality standards and is consistent with the results of a previous systematic review [10], suggesting that a causal association between non-specific symptoms and RF-EMF in both the general population and IEI-EMF subjects can be excluded with a high probability, and that weak RF-EMF cannot be perceived by humans.

In conclusion, the results of the systematic review show that in well-performed and blinded studies, no association between symptoms and RF-EMF exposure has been observed. If symptoms are perceived during acute HF-EMF exposure, there are indications that the placebo effect or false attribution are involved. In addition, despite many years of research, no reliable biophysical mechanism has been discovered that could explain a causal association between symptoms and weak HF-EMF exposure. Overall, these results support the position of the BfS that, according to the actual state of scientific knowledge, there is no evidence that weak RF-EMF can be perceived by humans or cause acute health-relevant, unspecific symptoms.

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