Bundesamt
für Strahlenschutz

**Spotlight on EMF Research**

# Spotlight on “The effect of exposure to radiofrequency fields on cancer risk in the general and working population: A systematic review of human observational studies - Part II: Less researched outcomes” by Karipidis et al. in Environment International (2025)

**Category [radiofrequency, review]**

Spotlight - Jul/2025 no.2 (Eng)

Competence Centre for 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). 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 [2]. Key topics were identified for which the WHO has commissioned systematic reviews. More information on the WHO systematic reviews in general can be found in this *Spotlight on EMF Research* article (Apr/2024 no.2 [3]).

The systematic review at hand by Karipidis et al. [1] is the second part of a two-paired systematic review on human observational studies that examine the effects of RF-EMF exposure on cancer risk in the general and working population and part of the WHO-commissioned series of systematic reviews. In this review, less researched cancer outcomes in this research field are reported, including, e.g., lymphohematopoietic system tumours, thyroid cancer, and oral cavity/pharynx cancer. In the first part [4], that was also addressed in the *Spotlight on EMF Research* series [5], the most researched cancer outcomes are reported, namely neoplasms of the central nervous system, the salivary gland, and leukaemia. Both systematic reviews are based on the same a priori published study protocol [6].

# 2 Results and conclusions from the perspective of Karipidis et al.

The objective of the systematic review and meta-analysis by Karipidis et al. [1] is the assessment of quality and strength of the evidence for an association between exposure to RF-EMF and the risk of cancer in human observational studies.

The authors published a protocol [6] before the start of the work on the systematic review. In the protocol, they outline all methods used throughout the systematic review and meta-analysis. In short, the authors followed the WHO approach to guideline development [7], followed the COSTER (conduct of systematic reviews in toxicology and environmental health research) [8] recommendation, and reported the findings in accordance with the PRISMA guidelines [9]. For assessing the Risk of Bias (RoB) they followed the method developed by the National Toxicology Program – Office of Health Assessment and Translation (OHAT) [10]. For this, the authors set up tailored bias rating instructions and answer options forms that were published alongside the paper and performed a pre-pilot among all assessors.

The RoB assessment was performed on exposure-outcome level by two assessors individually. Bias domains were confounding, selection bias, attrition/exclusion/missing data bias, confidence in the exposure characterization, confidence in the outcome assessment, selective reporting, and appropriateness of statistical assessment. For the OHAT's three-level tiering of the quality of individual studies, "selection/attrition bias", and "exposure/outcome information bias" were defined as the key domains. Tier-1 studies are studies with definitely or probably low risk of bias for all key domains and most of the other items, while tier-3 studies are studies with definitely or probably high risk of bias for all key domains and most of the other items. Tier-2 studies were those studies not meeting the above criteria for Tier-1 or Tier-3 studies.

The systematic review includes three **PECO (Population, Exposure, Comparator, Outcome)** statements used for defining the eligibility criteria. There is one PECO statement on RF-EMF **Exposure (E)** from wireless phone use, including mobile or cordless phones (SR-A), one on RF-EMF exposure from environmental sources, such as radio-television transmitters or base stations (SR-B) and one on occupational expo-sure to RF-EMF, such as professional use of hand-held transceivers or RF-emitting equipment in the workplace (SR-C). Regarding the **Population (P)** SR-A and SR-B include members of the general population, while SR-C is on workers. There were no restrictions on sex, age, or any other individual characteristic applied. The existence of a **Comparator (C)** group of unexposed or less exposed individuals was required to be included in the systematic review. While in the part 1 paper of this systematic review the most researched **Outcomes (O)**, such as glioma in relation to RF-EMF were investigated, in part 2 all other neoplasms were reported.

The authors included cohort studies, case-control studies, and nested case-control studies published in peer-reviewed journals, applying no restriction on publication date or language. Comparative studies such as ecological studies and cross-sectional studies were excluded.

In total, 5,060 articles were identified. Throughout the deduplication process, title/abstract screening and the full-text screening, non-relevant articles were excluded, leaving 26 articles published between 1988 and 2019 for inclusion in the systematic review on less researched outcomes reporting on 143 exposure-outcome pairs (studies). In SR-A, 71 studies investigated 45 neoplasms in relation to mobile phone use. Among these neoplasms were mainly lymphohematopoietic system tumours, such as lymphomas. For SR-B, no study on broadcast transmitters was identified. However, one article comprising 4 exposure-outcomes pairs in relation to RF exposure from mobile phone base stations was included. Reported tumours in this study were risks of all lymphomas combined, two lymphoma subtypes, and chronic lymphatic leukaemia in adults. For SR-C, there were 41 studies, mainly in military personnel. These studies investigated 26 neoplasms, with the majority being lymphohematopoietic system tumours.

Out of the 143 studies, 19 met the criteria for meta-analyses based on sufficiently homogenous datasets regarding exposure type and metric and type of neoplasm. For SR-A, meta-analyses on mobile phone use and risk of leukaemia, non-Hodgkin's lymphoma and thyroid cancer were feasible. For SR-B, no meta-analysis was carried out because only one article was identified. For SR-C, meta-analyses on the risk of lymphohematopoietic system tumours and risk of oral cavity/pharynx cancer in exposed workers vs. not exposed workers were carried out.

Regarding the RoB assessment, the most critical issues were exposure characterization, especially for occupational studies. Furthermore, outcome information bias in mortality-based occupational studies and confounding were an issue. Selective reporting and statistical methods were considered at low risk of bias in all included studies. Overall, 13 (68%) of the studies were classified as moderate risk of bias (tier-2), and the remaining 6 studies as low risk of bias (tier-1, 32%).

The main findings of the meta-analyses are summarized in Table 1. Overall, all meta-relative risk estimates were close to unity, indicating no increased risk – that is, the risk was similar for users and non-users, as well as for long-term users and non-users.

tIn short, there was low certainty of evidence that mobile phone use does not increase the risk of leukaemia, non-Hodgkin's lymphoma or thyroid cancer (SR-A). Further, there was very low certainty evidence that occupational RF-EMF exposure does not increase the risk of lymphohematopoietic system tumours or oral cavity/pharynx cancer (SR C). There were insufficient data for a meta-analysis on the effect of whole-body far-field RF-EMF exposure from fixed-site transmitters (SR-B). Overall, exposure information bias and small numbers of exposed cases limited the confidence in the results. In conclusion, the study found no statistically significant increased risk for any of the analysed cancer outcomes associated with RF-EMF exposure.

# 3 Comments by the BfS

For the publication presented here, BfS employees have participated as authors. As a result, we are refraining from providing a detailed evaluation and commentary on the content and significance of this publication.

| Outcome<br>Cancer subtype | No. of studies /<br>Exposed cases (n) | Exposure metric | Effect, meta Relative Risk (mRR) (95 % KI) | Statistically significant effects | Certainty of the evidence |
|---|---|---|---|---|---|
| **Results of SR-A of studies on RF-EMF exposure from wireless phone use**<br>(Near-field personal exposure to the head) | | | | | |
| Leukaemia | 2 Cohort, 2 Case-control<br>n = 1,538 | Ever vs.<br>never use | 0.99 (0.91-1.07) | No | Low |
| | 2 Cohort, 1 Case-control<br>n = 260 | Long-term use<br>(10+ years) | 1.03 (0.85-1.24) | No | Low |
| Non-Hodgkin's lymphoma | 2 Cohort, 3 Case-control<br>n = 2,179 | Ever vs.<br>never use | 0.99 (0.92-1.06) | No | Low |
| | 1 Cohort, 3 Case-control<br>n = 295 | Long-term use<br>(10+ years) | 0.99 (0.86-1.15) | No | Low |
| Thyroid | 2 Cohort, 1 Case-control<br>n = 1,040 | Ever vs.<br>never use | 1.05 (0.88-1.26) | No | Low |
| **Results of SR-C of studies on occupational exposure to RF-EMF**<br>(Near-field/Far-field exposure) | | | | | |
| Lymphohematopoietic system | 4 Cohort<br>n = 215 | Exposed vs.<br>unexposed | 1.05 (0.87-1.28) | No | Very low |
| Oral cavity/pharynx | 3 Cohort<br>n = 34 | Exposed vs.<br>unexposed | 0.68 (0.42-1.11) | No | Very low |

**Table 1:** Summary of the results.

# References


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