



Correspondence

Evidence on RF-EMF and cancer in animals misjudged: methodological and analytical flaws in the Mevissen et al. systematic review

To the Editors, *Environment International*

Re: Mevissen et al. *Effects of radiofrequency electromagnetic field exposure on cancer in laboratory animal studies, a systematic review.*

The systematic review by Mevissen et al. (2025) evaluated 52 studies for evidence of a relationship between radiofrequency electromagnetic field (RF-EMF) exposure and cancer incidence as reported in animal studies. The review found no evidence of cancer in most biological systems but reported moderate certainty evidence for an association with lymphoma, liver, lung, and adrenal gland tumours, and high certainty evidence for an association with brain cancer (glioma) and heart cancer (malignant schwannoma) only in male rats.

There are a number of serious flaws in the Mevissen et al. systematic review that relate specifically to the positive associations found with certain critical cancers and these flaws undermine their conclusions.

1. Inappropriate synthesis of results

The systematic review conducted a high-quality search and identified all the appropriate studies, collating a large evidence base. One of the most important parts of a systematic review is the synthesis of results from this evidence base. Unfortunately, the authors of this systematic review elected not to consider the evidence in its totality and instead focused on a small number of positive findings. The review considered RF-EMF to have an effect on cancer if at least one study showed a significant effect (on exposed versus not-exposed) or significant trend (across different exposure levels) regardless of other studies not finding an effect or trend. This is explicitly stated in section 2.7 of the systematic review. Further, a trend could be calculated as statistically significant even if it was based on individual non-significant results across different exposure levels. This issue is demonstrated repeatedly in the Mevissen et al. review, most prominently in the assessment of brain tumours, lymphoma, and heart schwannomas. It is particularly egregious for glioma, with the authors purporting a high certainty of an increased risk of brain tumours. This is despite there being no single significant result across all studies, with the review's reported outcome based on insignificant results from a single paper (NTP, 2018b) that have been interpreted as a significant trend. Furthermore, the very low actual numbers of glioma tumours reported in the NTP (2018b) study make this trend very tenuous, as a single tumour in the control group would have resulted in a non-significant trend. The review focused on this trend in their results and ignored the many non-significant outcomes reported by other studies. The approach taken by the authors to consider only positive outcomes fails to consider all the available evidence, ultimately defeating the purpose of conducting a systematic review.

Another point to consider with the synthesis is the absence of a meta-analysis. The authors reported that the studies were too heterogeneous

for a meta-analysis to be performed. In another recent systematic review on cancer in laboratory animals conducted by Pinto et al. (2023), that included much of the same evidence base, a meta-analysis was performed. The Pinto et al. systematic review found that there was low or inadequate evidence for an association between RF-EMF exposure and the onset of tumours of any type.

2. Unduly favourable risk of bias assessment of the main studies

There are several issues with the conduct of the risk of bias (RoB) assessment in the Mevissen et al. review which results in inappropriately generous characterisations of the included studies. Many of the limitations of the included studies, particularly those reporting positive findings for glioma and malignant heart schwannomas in male rats (Falcioni et al., 2018; NTP, 2018b), were not adequately considered. This is important as, due to the nature of evidence synthesis used in the review, the Mevissen et al. conclusions are primarily based on results from two studies: the National Toxicology Program NTP (2018a), NTP (2018b) study and the study by Falcioni et al. (2018). Both studies have been heavily criticised elsewhere (ICNIRP, 2019; FDA, 2020; ARPANSA, 2019) due to weaknesses in design or analysis. For instance, heart schwannomas were reported in the NTP study, when compared to historical controls rather than the actual controls; an approach that is highly prone to biased results (Angelos, 2000). In another example, neither the NTP nor Falcioni et al. studies were downgraded for the lack of appropriate blinding in the pathological assessment. These methodological weaknesses make it difficult to reconcile the weight Mevissen et al. placed on the conclusions regarding RF-EMFs and cancer risk from these studies.

The Mevissen et al. evaluation of statistical methods used by the included studies was also inadequate and particularly problematic for the key studies used to support their conclusions. In the NTP (2018a), NTP (2018b) studies, sharing of control groups amplified the likelihood of outcomes being found by chance and the lack of corrections for multiple comparisons was not adequately reflected as a confounding factor in the RoB assessment. For example, with 12,800 tests made in the NTP (2018a), NTP (2018b) studies, many hundreds would be expected to be significant due to chance alone (Li et al., 2017). The longer life-spans of exposed animals resulting in a higher chance for tumours to develop were also overlooked. Similarly, the issues with using significant trends in place of significant results were not adequately considered. When claiming that non-significant results can result in significant trends, the trend should be interpreted with caution (Nead et al., 2018). This is particularly true for the NTP study where the shared control groups and lack of control for multiple comparisons compound the issue, biasing toward a positive result. A more appropriate RoB assessment,

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where the RoB criteria were consistently applied for the same set of studies was presented in the systematic review by [Pinto et al. \(2023\)](#), where the authors rated the NTP studies at a higher RoB compared to the current systematic review.

The authors failed to acknowledge the well-documented flaws of these two studies that have previously been extensively addressed ([ARPANSA, 2019](#); [ICNIRP, 2019](#)) and have consequently under-represented the RoB in the conclusions of these studies. These choices in the RoB assessment are crucial as these two studies overwhelmingly informed the conclusions of the present review.

3. Cascading consequences for the certainty in evidence

A consequence of inappropriate RoB assessment discussed above is that the RoB has an undue influence on the certainty of evidence (CoE), which ultimately brings into question the higher certainties presented in the Mevissen et al. review. When examining the robustness of their CoE assessment in the other domains, further problems also arise. For example, inconsistency is a major issue across the evidence base that is downplayed by the systematic review. This problem first arises in the way the authors have chosen to synthesise their conclusions but is repeated in the CoE evaluation where different results across the study base are largely ignored. Even internal inconsistencies within the NTP study are not judged as cause for a downgrade; for example, schwannomas, can occur in a few organs (e.g. salivary gland schwannomas, metastatic, trigeminal ganglion) but were only positively associated with RF-EMF in the heart. Similarly, unexplained differences in cancer incidence between male and female animals were overlooked. A related issue is the authors commentary on the variance of animal models when evaluating inconsistency for CoE. If the evidence base used different animal models, the authors stated that this did not warrant a downgrade in the CoE for inconsistency. However, they also listed this as a reason not to do a *meta-analysis*, and these two justifications contradict each other.

The CoE assessment downplays the indirectness of the animal models and exposure magnitudes in relation to human health outcomes. RF-EMF interacts differently with smaller animals. While the higher frequency RF-EMF such as used in the [NTP \(2018b\)](#) study can reach the heart or liver of a rat or mouse, it cannot do so in humans ([Basandraia and Dhami, 2016](#); [ICNIRP, 2020](#)). This reduces the direct applicability of certain cancer outcomes in animals, particularly the schwannomas reported in the hearts of rats, to humans. Further, much of the RF-EMF exposure employed in the NTP studies (e.g., 6 W kg⁻¹) was higher than the international whole-body exposure limits ([ICNIRP, 2020](#)). Such high exposures are not encountered by people in the everyday environment and cannot be realistically associated with human cancer studies.

The CoE assessment also wrongly upgraded the CoE for brain cancer based on a supposed dose–response relationship with RF-EMF exposure. As mentioned earlier a dose–response is reported only in the NTP (2018) study based on non-significant individual results across different exposure levels. In contrast, the [Pinto et al \(2023\)](#) systematic review did not find a dose–response relationship for brain cancer or any other tumour and therefore did not upgrade the CoE.

It is important to note that a CoE assessment should consider the scientific evidence in its totality. However, the manner in which Mevissen et al. have chosen to synthesise results causes the CoE assessment to inappropriately draw from all studies to support an assessment of certainty in singular results from singular studies, regardless of the number and quality of other studies or if they have incongruent results. The ultimate consequence of the author's systematic failings in both the CoE and RoB assessments is that results are given a higher certainty rating that is not supported by the scientific evidence.

4. Further minor flaws question the rigour of the systematic review

In addition to the above major flaws there are numerous minor issues scattered throughout the document that degrade the overall article quality. These include undocumented deviations from the published protocol (e.g. section 3.7.3.1.1), incoherent supplementary information and improper comparison of exposure levels between studies (e.g. section 3.8.3.1.1). While the prominent issues discussed at length above have a greater impact on the interpretation of the review, the extent of additional issues complicates this interpretation and introduces serious doubt surrounding the rigour in which the substantive parts of the article have been conducted.

5. Conclusion

In light of the methodological shortcomings, flawed synthesis of results, and inappropriate risk of bias and certainty assessments, the conclusions drawn in the [Mevissen et al. \(2025\)](#) systematic review appear overstated and insufficiently supported by the broader evidence base. The disproportionate emphasis on a narrow set of studies—despite clear and well-documented limitations—undermines confidence in the reported associations between RF-EMF exposure and a number of critical cancer risks in animals. Taken together, these concerns call for a more appropriate reassessment of the available data.

The Mevissen et al. review is one of several systematic reviews commissioned by the World Health Organization ([WHO, 2019.](#)), the overall aim of which is to assess the possible implications of RF-EMF exposure on human health. We share the authors' commitment to this cause, however, that goal can only be achieved through accurate and rigorous science.

CRediT authorship contribution statement

Ken Karipidis: Writing – review & editing, Conceptualization. **Sean Hewson:** Writing – original draft. **Rohan Mate:** Writing – original draft. **Chhavi Bhatt:** Writing – original draft. **Stuart Henderson:** Writing – review & editing. **Azadeh Peyman:** Writing – review & editing, Conceptualization. **Sarah Loughran:** Writing – review & editing, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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