New WHO-Funded Study Reports High Certainty of the Evidence Linking Cell Phone Radiation to Cancer in Animals

Scientific Experts Urge the FCC to Establish Science-Based Exposure Limits to Address Wireless Health Risks

https://icbe-emf.org/who-funded-study-reports-high-certainty-of-the-evidence-linking-cell-phone-radiation-to-cancer-in-animals/

Media Contact: communications@icbe-emf.org

Press Release April 27, 2025

Environment International has published a new systematic review, partially funded by the World Health Organization, concluding that there is high certainty of the evidence linking cell phone radiofrequency (RF) radiation to two types of cancer in animals. In response, leading scientists from the International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF) are calling for immediate policy action to protect public health and the environment, warning that further delay could have serious consequences amid the global surge in the use of wireless communication devices.

What the Review Found

A new systematic review of 52 animal studies, "Effects of Radiofrequency Electromagnetic Field Exposure on Cancer in Laboratory Animal Studies" by Mevissen et al. (2025), concluded there is high certainty of the evidence linking RF radiation exposure to two types of tumors: gliomas in the brain and malignant schwannomas in the heart. Notably, the same types of tumors have also been observed in human studies, adding significant confidence that the associations observed in human studies are real.

The review also found moderate certainty of evidence of an increased risk of rare tumors, such as pheochromocytomas in the adrenal glands and hepatoblastomas in the liver. Additionally, some studies indicated a possible association with lymphomas, although the findings were inconsistent.

ICBE-EMF highlights that in 2011, the World Health Organization's International Agency for Research on Cancer (IARC) classified radiofrequency radiation (RF-EMF) as a Group 2B "possible" human carcinogen, noting limited animal evidence. Since then, major animal studies — including those by the U.S. National Toxicology Program and the Ramazzini Institute — have found that RF radiation exposure causes cancer in rats.

The new WHO-funded review, concluding there is "high certainty" animal evidence of cancer causation, reinforces calls for IARC to urgently reevaluate the cancer classification of RF radiation.

Given this high level of certainty, government policymakers worldwide should immediately move to revise their RF radiation exposure limits to protect public health and the environment.

Statements by Experts of the International Commission on the Biological Effects of Electromagnetic Fields

"The evidence is now clear —cell phone radiation can cause cancer in animals in concordance with the tumor types identified in human studies of mobile phone users. As animal studies are essential for predicting cancer risk in humans, governments should develop science-based safety standards to protect human health. The conclusion of the study commissioned by the WHO shows that the long-standing assumption current government limits are based on — that cell phone RF radiation can only cause harm through tissue heating — is wrong" stated Ron Melnick, PhD, Chair of the ICBE-EMF and former senior toxicologist and Director of Special Programs at the National Toxicology Program and the National Institute of Environmental Health Sciences (NIEHS).

"The preponderance of the research published since 1996 finds adverse biologic and health effects from long-term exposure to low levels of modulated or pulsed wireless RF radiation. Given the widespread global usage of wireless among users of all ages, even a very small increase in the incidence of disease will have broad implications for public health," stated said Joel Moskowitz, PhD, Director of the Center for Family and Community Health at the School of Public Health, University of California, Berkeley, also an ICBE-EMF member.

"To protect public health and the environment, exposure to cell phone and wireless radiation must be significantly reduced," said Elizabeth Kelley, Managing Director of ICBE-EMF. She referenced the EMF Scientist Appeal now signed by 267 scientists from 45 nations. "Hundreds of scientists worldwide agree that current exposure limits are outdated and do not adequately protect against health risks."

ICBE-EMF emphasizes that governments must act immediately to strengthen regulatory limits on wireless radiation to protect public health. Wildlife exposures must be mitigated. Current exposure standards, based on outdated assumptions, do not reflect the scientific evidence linking RF radiation to cancer and other health effects.

ICBE-EMF also highlights practical steps the public can take to reduce exposure — such as using speakerphone or wired headsets, keeping devices away from the body, and limiting wireless use among children — but stresses that personal actions are not a substitute for government-enforced safety standards. Stronger, science-based regulations are urgently needed to address the widespread and increasing exposure to wireless radiation.

About the ICBE-EMF

ICBE-EMF is an international consortium of scientists, doctors and researchers with expertise and peer-reviewed publications on the biological and health effects of electromagnetic fields including wireless RF radiation. Wireless devices such as cell phones, cordless phones, Wi-Fi and cell towers emit radiofrequency (RF) radiation.

ICBE-EMF recently published major scientific papers concluding that current government safety limits for wireless radiation are not protective of public health and highlighting engineering solutions that could dramatically reduce radiation emissions from cell phones.

The Commission is committed to upholding the highest standards of scientific research and makes science-based recommendations to ensure the protection of the public and environment. icbe-emf.org

Video of Dr. Ronald Melnick on the Cell Phone Wireless Radiation Animal Cancer Study

Video of Elizabeth Kelley on the Cell Phone Radiation Animal Cancer Study

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Radiofrequencies and cancer: this WHO monograph reshuffles the deck

By : Phonegate Team • 29 Apr 2025

https://phonegatealert.org/en/radiofrequencies-cancer-who-monograph-reshuffles-the-deck/

For over twenty years, the World Health Organization (WHO) has been publishing monographs assessing the risk between radiofrequencies and cancer. This new monograph, the tenth of eleven planned, marks a notable break: whereas previous monographs concluded that the risk was limited or uncertain, this one points to more robust animal evidence and highlights worrying signals for public health.

In 2011, the **IARC** classified radiofrequencies as "possibly carcinogenic to humans" (Group 2B), on the basis of an increased risk of glioma in intensive users of cell phones. Since then, most monographs have downplayed the risks, despite the massive increase in worldwide exposure and the proliferation of scientific studies.

Enhanced animal evidence on several tumor types

Monograph 2025 is based on 52 animal studies, including 20 long-term bioassays, and concludes that there is a high level of evidence ("high certainty") for an increase in certain cancers in male rats exposed to radiofrequencies:

- **Cerebral gliomas**: significant increase in male rats exposed to high SAR (Specific Absorption Rate) levels (up to 6 W/kg).
- **Cardiac schwannomas**: increased risk in male rats, with dose-response effects observed in two independent long-term studies.
- **Hepatoblastomas and lung tumors**: significant increase in male mice exposed to CDMA (3G)-modulated radiofrequencies.

Consult the full monograph: Effects of radiofrequency electromagnetic field exposure on cancer in laboratory animal studies, a systematic review (Mevissen et al., 2025, Environment International)

SAR and dosimetry: persistent methodological limitations

The monograph highlights that the **Specific Absorption Rate (SAR)**, the main regulatory indicator of exposure to cell phones and connected objects, remains an imperfect measure for predicting long-term effects, particularly for non-thermal exposures. Uncertainty about the relevance of **SAR** for assessing actual risks is explicitly recognized, which weakens the scope of current health recommendations.

Extract: "The results of this systematic review provide high or moderate CoE for several cancer sites relevant to cancer hazard identification for humans. However, the type of exposure (whole body versus localized), intensity of exposure and duration of exposure must also be considered when translating the effect sizes to cancer risk in humans."

Conflicts of interest: WHO's scientific independence in question

Several authors of the **WHO** monographs declare links with organizations or groups (notably **ICNIRP**) historically close to the telecoms industry. This proximity – already denounced by the Karolinska Institute as early as 2008, and more recently by the Turin Court of Appeal in 2020 as a conflict of interest that must be systematically reported – has been ignored in the majority of previous monographs, and continues to provoke much justified criticism of the impartiality of the assessments.

The Italian ruling states:

"It is considered that less weight should be given to studies published by authors who have not declared conflicts of interest. In this case, situations of conflict of interest may arise in relation to the assessment of the effect of radiofrequencies on health, for example:

1. *cases where the author of the study has advised the telephone industry or has received funding for studies from the telephone industry*
2. *if the author himself is a member of ICNIRP."*

A scope minimized by the composition of the expert panel?

Conflicts of interest declared by the authors of this monograph may have limited the scope of the conclusions and explained the report's caution, despite animal evidence that is now difficult to ignore. Indeed, several of the monograph's authors declare links with industry or industry-funded organizations: leading a research group with employees of a telecommunications company, government financial support, participation in advisory committees (including the industry-linked **ETHz Swiss Research Foundation for Electricity and Mobile Communication (FSM)**, or consulting activities in cell phone safety.

Phonegate Alert calls for action

Following this new scientific evidence in animals, our NGO calls for:

1. An immediate revision of exposure standards, based also on non-thermal effects and vulnerable populations (children, pregnant women).
2. The exclusion of experts linked to **ICNIRP** or industry from evaluation panels.
3. Official recognition of **Phonegate** – the overexposure of users due to biased SAR tests.

For Dr Marc Arazi, President of Phonegate Alert:

*"This tenth **WHO** monograph marks a turning point, but its impact is limited by the persistence of conflicts of interest and an outdated dosimetric approach. As long as **WHO** continues to rely on industry-related experts, public health will remain insufficiently protected from the risks of radiofrequencies."*

Summary of this WHO monograph

- **The 10th WHO monograph is based on solid animal evidence for several cancers, but the scope of its conclusions remains attenuated by the composition of the expert panel and the maintenance of the SAR paradigm.**
- **Previous monographs, which were mostly reassuring, failed to take into account the growing importance of recent studies and worrying epidemiological signals.**
- **Recurrent conflicts of interest among the authors raise questions about the true independence of international expertise, at a time when the question of dosimetry and SAR remains a weak point in health assessment.**

Download the monograph: https://doi.org/10.1016/j.envint.2025.109482

WHO Review Finds Cancer Risk in RF-Exposed Animals

At Odds with ICNIRP, Most Health Agencies

April 27, 2025
Last updated
April 28, 2025

https://microwavenews.com/news-center/who-review-sees-rf-cancer-risk-animals

A major review of animal studies has found reliable evidence that RF radiation increases the risk of cancer.

The new systematic review was commissioned by the World Health Organization (WHO) EMF office in Geneva as part of its ongoing assessment of RF health effects (more here).

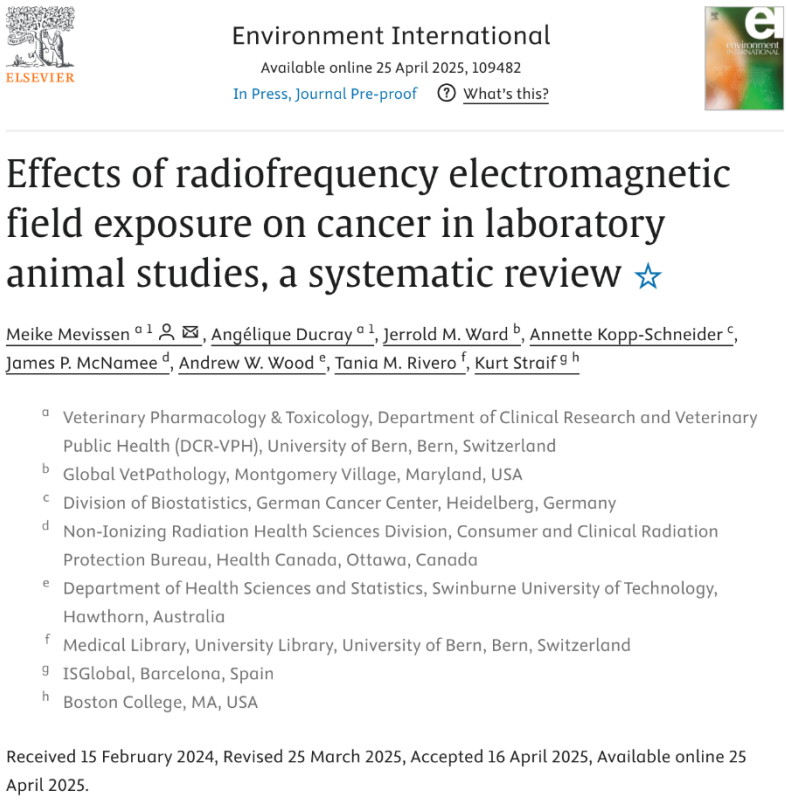
It concludes: "[T]here is evidence that RF EMF exposure increases the incidence of cancer in experimental animals with the [certainty of evidence] being strongest for malignant heart schwannomas and gliomas" (brain tumors).

This finding runs counter to the stated views of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the WHO itself, as well those of most national health agencies.

The open access paper, which runs more than 75 manuscript pages in the journal *Environment International*, was published on April 25.

The new review will most likely reopen —yet again— the decades-long controversy over the cancer risk associated with cell phones and other RF and microwave devices that many thought had been put to rest.

The review team was led by Meike Mevissen of the University of Bern and Kurt Straif, the former head of the IARC Monographs section in Lyon who now has appointments at Boston College and at ISGlobal in Barcelona. Other members include James McNamee of Health Canada in Toronto and Andrew Wood of Australia's Swinburne University of Technology.



Environment International
Available online 25 April 2025, 109482
In Press, Journal Pre-proof What's this?

Effects of radiofrequency electromagnetic field exposure on cancer in laboratory animal studies, a systematic review ☆

Meike Mevissen [a 1], Angélique Ducray [a 1], Jerrold M. Ward [b], Annette Kopp-Schneider [c], James P. McNamee [d], Andrew W. Wood [e], Tania M. Rivero [f], Kurt Straif [g h]

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The peer review process for the systematic review took a full 14 months. The protocol for the analysis was published in 2022.

Animal and Human Studies Point to Same Tumor Types

April 28, 2025

In a statement on the new WHO systematic review, Ron Melnick, the chair of the International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF), says:

"The evidence is now clear —cell phone radiation can cause cancer in animals in concordance with the tumor types identified in human studies of mobile phone users. As animal studies are essential for predicting cancer risk in humans, governments should develop science-based safety standards to protect human health."

He goes on to add:

"The conclusion of the study commissioned by the WHO shows that the long-standing assumption current government limits are based on — that cell phone RF radiation can only cause harm through tissue heating — is wrong."

The full statement of the ICBE-EMF on the WHO review is here.

New WHO-Funded Study Reports High Certainty Of The Evidence Linking Cell Phone Radiation To Cancer In Animals

Scientific Experts Urge the FCC to Establish Science-Based Exposure Limits to Address Wireless Health Risks

Media Contact: communications@icbe-emf.org

Press Release April 27, 2025

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'High Certainty' Cellphone Radiation Linked to Cancer in Animals, WHO Study Finds

https://childrenshealthdefense.org/defender/high-certainty-cellphone-radiation-cancer-animals-who-study/

Experts say it's time for the World Health Organization to classify wireless radiation as a "known human carcinogen," after a review commissioned by the organization concluded there is "high certainty" evidence that cellphone radiation exposure causes two types of cancer in animals.

by Suzanne Burdick, Ph.D.

April 28, 2025

A systematic review commissioned by the World Health Organization (WHO) concluded there is "high certainty" evidence that cellphone radiation exposure causes two types of cancer in animals.

The WHO-backed review, published online April 25 in Environmental International, determined radiofrequency-electromagnetic fields (RF-EMF) emitted by cellphones and other wireless devices were linked to an increased risk of malignant gliomas in the brain and malignant schwannomas, or nerve tumors, in the heart in studies on animals. The review noted that both tumor types had previously been found in studies on humans.

The WHO's review also concluded there is "moderate certainty" evidence that cellphone radiation exposure causes an increased risk of rare liver and adrenal gland tumors.

Ron Melnick, Ph.D, chair of the International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF) and a former senior toxicologist in the National Toxicology Program (NTP), said in a statement:

"The evidence is now clear — cell phone radiation can cause cancer in animals in concordance with the tumor types identified in human studies of mobile phone users. As animal studies are essential for predicting cancer risk in humans, governments should develop science-based safety standards to protect human health."

The WHO review prompted leading scientists with the ICBE-EMF on April 27 to call for "immediate policy action" to protect people from possible harm from wireless radiation exposure.

"Given this high level of certainty," ICBE-EMF said in a press release, "government policymakers worldwide should immediately move to revise their RF radiation exposure limits to protect public health and the environment."

ICBE-EMF is a "consortium of scientists, doctors and related professionals" who study RF-EMF and make recommendations for RF-EMF exposure guidelines "based on the best peer-reviewed scientific research publications."

The group warned that delaying such revisions "could have serious consequences amid the global surge in the use of wireless communication devices."

WHO researchers analyzed 52 studies

The review, partially funded by the WHO, sought to systematically evaluate the effect of wireless radiation exposure on cancer in experimental animals.

For the review, the authors systematically analyzed 52 studies. They concluded there is "moderate certainty" evidence of an increased risk of some rare tumors, such as pheochromocytomas in the adrenal glands and hepatoblastomas in the liver.

They found "no or minimal" evidence of increased cancer risk in the kidney and mammary gland.

They also found "no or minimal" evidence of increased cancer risk in some body systems, including the gastrointestinal/digestive, endocrine, musculoskeletal, urinary, reproductive and auditory systems.

In their report, the authors of the WHO study acknowledged that animal studies are commonly used when assessing whether something might be carcinogenic to people. However, it's "complex" to extrapolate human cancer risk from animal studies when the thing being studied is wireless radiation, they said.

One of the 52 studies reviewed by the WHO researchers was the NTP's $30 million study on cellphone radiation that found "clear evidence" of malignant heart tumors in male rats, "some evidence" of malignant brain tumors in male rats, and "some evidence" of benign, malignant and complex combined adrenal gland tumors in male rats.

The NTP is an "interagency program composed of, and supported by" the U.S. Food and Drug Administration, the Centers for Disease Control and Prevention and the National Institutes of Health (NIH), according to the agency's website.

As The Defender reported, the NIH refuses to reveal nearly 2,500 pages of records related to the NTP's decision to shut down its research on how wireless radiation affects human health.

'You know we're in trouble' when industry-friendly WHO says there's a problem

The WHO report is part of a WHO-commissioned series of scientific reviews of the possible health risks of wireless radiation. So far, most of the other studies in the series have found no increased health risk from wireless radiation.

For instance, a review on the plausible link between wireless radiation and brain cancer in humans claimed it found no link. ICBE-EMF posted a rebuttal and called for its retraction.

Critics, including ICBE-EMF member Joel Moskowitz, Ph.D., and Mona Nilsson, have said this is likely because some of the studies' authors are biased against finding health risks linked to wireless radiation exposure.

Nilsson, co-founder and director of the Swedish Radiation Protection Foundation, said she found it surprising that the latest WHO review recognized wireless radiation's harmful effects.

"On the contrary, the WHO has a history of downplaying them and promoting industry-friendly opinions," Nilsson said.

In a March 7 post on his Electromagnetic Radiation Safety website, Moskowitz noted that all of the WHO's scientific review teams have one or more members from the International Commission on Non-Ionizing Radiation Protection (ICNIRP).

Moskowitz directs the Center for Family and Community Health at the School of Public Health, University of California, Berkeley.

ICNIRP, which Moskowitz called a "cartel," is a German nonprofit that issues RF radiation exposure limits "produced by its own members, their former students and close colleagues."

The wireless industry favors the ICNIRP limits because they're designed to protect people only from radiation levels high enough to generate heat — meaning the limits turn a blind eye to the possible health effects from radiation levels lower than those needed to heat human tissue.

One of the latest WHO study authors, Andrew Wood, has been affiliated with ICNIRP since 2013.

Given that the WHO review authors may be biased, it's especially noteworthy that this latest review found "high certainty" evidence of increased cancer risk from wireless radiation, said Miriam Eckenfels, director of Children's Health Defense's (CHD) Electromagnetic Radiation (EMR) & Wireless Program.

"When even the WHO panel designed to whitewash the issue says there is a problem, you know we're in trouble," she said.

Eckenfels added:

"It's ridiculous that, despite these clear health risks, residents cannot choose where cell towers are placed based on concerns that the radiation from a cell tower near their kids' school might impact their kids' health.

"That's why our 704 No More initiative is so important."

CHD's initiative is raising money to legally challenge Section 704 of the Telecommunications Act (TCA) of 1996. The section states:

"No State or local government or instrumentality thereof may regulate the placement, construction, and modification of personal wireless service facilities on the basis of the environmental effects of radio frequency emissions to the extent that such facilities comply with the Commission's regulations concerning such emissions."

Time for WHO to classify wireless radiation as 'known human carcinogen'

Lennart Hardell, M.D., Ph.D., a leading scientist with ICBE-EMF, said he thinks there's now enough evidence for the WHO's International Agency for Research on Cancer (IARC) to reclassify RF-EMF as a Group 1 human carcinogen.

In 2011, IARC classified RF-EMF as a Group 2B hazard that is "possibly carcinogenic to humans."

Hardell said that the latest WHO review reinforces experts' claims that enough scientific evidence has accumulated for IARC to classify RF-EMF as a "known human carcinogen."

"We have now similar findings of increased risk for glioma and acoustic neuroma in human epidemiology, laboratory studies on animals and mechanistic studies such as on reactive oxidative species with DNA damage," he said. "These results fulfill the criteria for a human carcinogen."

Nilsson agreed. She estimated there are now "several hundred" studies that outline the mechanisms by which wireless radiation increases a person's risk of cancer, such as causing DNA damage and oxidative stress.

Elizabeth Kelley, managing director of ICBE-EMF, pointed out that 267 scientists from 45 nations have signed the EMF Scientist Appeal, which calls for greater health protection from EMF exposure.

"Hundreds of scientists worldwide agree that current exposure limits are outdated and do not adequately protect against health risks," Kelley said.

The Federal Communications Commission (FCC) has not revised its human exposure to RF radiation limits in nearly 30 years.

Although the FCC sets the legal limit on human wireless radiation exposure, the commission is not under the U.S. Department of Health and Human Services. The FCC is an independent U.S. agency overseen by Congress.

The FCC continues to defy a 2021 court mandate to explain how its current limits adequately protect humans, especially children, and the environment from harm.

The agency needs to act now if it's going to protect public health, according to Moskowitz. He said in a statement:

"The preponderance of the research published since 1996 finds adverse biologic and health effects from long-term exposure to low levels of modulated or pulsed wireless RF radiation.

"Given the widespread global usage of wireless among users of all ages, even a very small increase in the incidence of disease will have broad implications for public health."

The Defender asked the FCC when it will comply with the 2021 court mandate and if it has plans to revise its wireless radiation exposure limits. The agency did not respond by the deadline.

Environment International

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In Press, Journal Pre-proof

Effects of radiofrequency electromagnetic field exposure on cancer in laboratory animal studies, a systematic review☆

Meike Mevissen [a 1]

, Angélique Ducray [a 1], Jerrold M. Ward [b], Annette Kopp-Schneider [c], James P. McNamee [d], Andrew W. Wood [e], Tania M. Rivero [f], Kurt Straif [g h]

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https://www.sciencedirect.com/science/article/pii/S0160412025002338?via%3Dihub

Abstract

Background

More than ten years ago, the World Health Organization's (WHO) International Agency for Research on Cancer (IARC) published a monograph concluding there was limited evidence in experimental animals for carcinogenicity of Radio Frequency Electromagnetic Field (RF EMF).

Objective

The objective of this review was to systematically evaluate the effects of RF EMF exposure on cancer in experimental animals.

Methods

Eligibility criteria: Based on pre-established Populations, Exposures, Comparators, Outcomes, and Study Type (PECOS) criteria, studies in experimental animals of the following study types were included: chronic cancer bioassays, initiation-(co–)promotion studies, and studies with tumor-prone animals.

Information sources: MEDLINE (PubMed), Science Citation Index Expanded and Emerging Sources Citation Index (Web of Science), and the EMF Portal.

Data abstraction and synthesis: Data are publicly available online as interactive visuals with downloadable metadata. *W*e adapted the risk-of-bias (RoB*)* tool developed by Office of Health Assessment and Translation (OHAT) to include considerations pertinent to the evaluation of RF EMF exposure and cancer bioassays. Study sensitivity was assessed with a tool adopted from the Report on Carcinogens (RoC). We synthesized studies using a narrative approach. Effect size was calculated

as the 1% Bayesian Average benchmark dose (BMD) of a respective study when dose–response or a trend was identified (see BMDAnalysisSupplementaryMaterial) (Supplement 1).

Evidence Assessment: Certainty of the evidence (CoE) was assessed using the Grading of Recommendations, Assessment, Developing and Evaluations (GRADE) approach, as refined by OHAT. Evidence from chronic cancer bioassays was considered the most directly applicable to evaluation of carcinogenicity.

Results

We included 52 studies with 20 chronic bioassays No studies were excluded based on risk of bias concerns. Studies were not considered suitable for *meta*-analysis due to heterogeneity in study design, species, strain, sex, exposure characteristics, and cancer outcome. No or minimal evidence of RF EMF exposure-related cancer outcomes was found in most systems or organs in any study (these included gastrointestinal/digestive, kidney, mammary gland, urinary, endocrine, musculoskeletal, reproductive, and auditory).

For lymphoma (18 studies), with 6 chronic bioassays (1,120 mice, 1,780 rats) inconsistency between two chronic bioassays was not plausibly explainable, and the CoE for lymphoma was rated 'moderate'.

For brain tumors (20 studies), including 5 chronic bioassays (1,902 mice, 6,011 rats), an increase in glial cell-derived neoplasms was reported in two chronic bioassays in male rats. The CoE for an increased risk in glioma was judged as high. The BMD analysis was statistically significant for only one study and the BMD was 4.25 (95% CI 2.70, 10.24).

For neoplasms of the heart (4 chronic bioassays with 6 experiments), 3 studies were performed in rats (∼2,165 animals), and 1 in mice (∼720 animals). Based on 2 bioassays, statistically significant increases in malignant schwannomas was judged as high CoE for an increase in heart schwannomas in male rats. The BMDs from the two positive studies were 1.92 (95 %CI 0.71, 4.15) and 0.177 (95 %CI 0.125, 0.241), respectively.

Twelve studies reported neoplasms in the adrenal gland (5 chronic bioassays). The CoE for an increased risk in pheochromocytoma was judged as moderate. None of these findings were dose-dependent when compared to the sham controls.

Sixteen studies investigated tumors of the liver with 5 of these being chronic bioassays. The CoE was evaluated as moderate for hepatoblastomas.

For neoplasms of the lung (3 chronic bioassays), 8 studies were conducted in rats (∼1,296 animals) and 23 studies in mice (∼2,800 animals). In one chronic bioassay, a statistically significant positive trend was reported for bronchoalveolar adenoma or carcinoma (combined), which was rated as moderate CoE for an increase in lung neoplasms with some evidence from 2 initiation-(co–)promotion studies.

Discussion

Meta-analysis was considered inappropriate due to the heterogeneity in study methods. The GRADE/OHAT CoE framework has not been frequently applied to animal studies and experience to date suggests refinements are needed. We deferred to standard methods in environmental health where CoE is framed in the context of strength of the evidence providing positive support for carcinogenicity. High CoE can be interpreted as the true effect is highly likely to be reflected in the apparent relationship. Moderate CoE indicates the true effect may be reflected in the apparent relationship. Cancer bioassays conducted in experimental animals are commonly used to identify

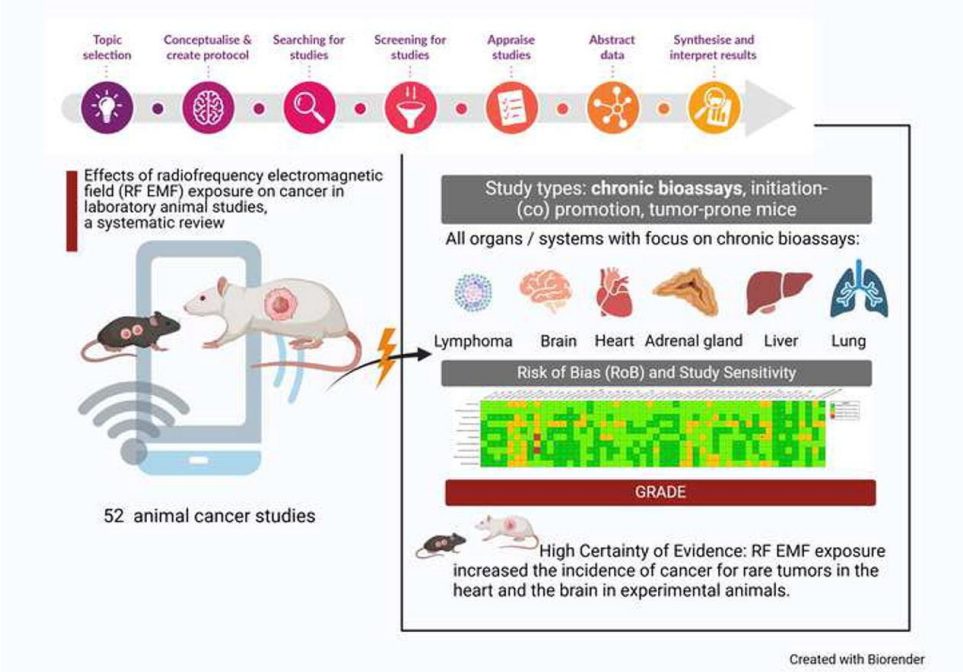
potential human carcinogens. We note that the two tumor types with high CoE in animals in this systematic review are the same as those identified with limited evidence in humans by the IARC Working Group. However, even in cases where the animal evidence demonstrates high CoE, the extrapolation of risk from cancer bioassays to humans is particularly complex for RF EMF. Without a better understanding of the mechanism of the carcinogenicity of RF-EMF, the choice of exposure metric for risk extrapolation (whole body versus localized), intensity or cumulative exposure, whether or not a monotonic dose–response holds for carcinogenic effects, and whether SAR is the appropriate dose metric for adverse effects induced by RF-EMF may be critical.

Other

This review was partially funded by the WHO radioprotection programme.

The protocol for this review was registered in Prospero reg. no. CRD42021265563 and published in Environment International 2022 (Mevissen et al. 2022).

Graphical abstract



2.2.2. Final conclusions

The findings of this systematic review indicate that there is evidence that RF EMF exposure increases the incidence of cancer in experimental animals with the CoE being strongest for malignant heart schwannomas and gliomas.

Despite the high level of certainty that evidence of carcinogenicity in experimental animals may predict a carcinogenic hazard to humans, extrapolation of risk from cancer bioassays to humans is particularly complex for RF EMF. Without an understanding of the mechanism of the carcinogenicity of RF-EMF the choice of exposure metric for risk extrapolation (whole body versus localized), intensity or cumulative exposure whether or not a monotonic dose-response holds for carcinogenic effects, and whether SAR is the appropriate dose metric for adverse effects induced by RF-EMF may be critical.