# The 12th GSMA EMF Forum Event Guide

## Setting the stage for improved EMF policy harmonisation

**Tuesday 26 September**
**Brussels, Belgium**
**09:15-12:30 (online and in-person) and 14:00-17:30 (in-person only)**

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**#EMFFORUM**

# Download the EMF Forum Event Guide


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# Welcome and Introduction

**Laszlo Toth,**
**Head of Public Policy, GSMA Europe**

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FIRESIDE CHAT

# The Science Perspective

Prof Theo Samaras Aristotle University of Thessaloniki Member EU SCHEER

Prof Isabelle Lagroye, Ecole Pratique des Hautes Etudes, Paris, France

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# The European Commission's non-food Scientific Committees


**DG SANTE – (B) Public Health, Cancer and Health security**

# The SCHEER Opinion on RF EMF

Theodoros Samaras
Member of the SCHEER

Health and Consumers

# Scientific Committee on Health, Environmental and Emerging Risks

The SCHEER, on request of European Commission services, provides Opinions on questions concerning health, environmental and emerging risks. These risks concern

- broad, complex or multidisciplinary issues that require a comprehensive assessment of their impact on consumer safety, or
- public health and related issues not covered by other European Union risk assessment bodies.

# Weight of Evidence (WoE) approach

Following the rule of transparency, the SCHEER revised in 2018 its

Memorandum on Weight of Evidence and Uncertainties

https://ec.europa.eu/health/sites/health/files/scientific_committees/scheer/docs/scheer_o_014.pdf

which is focused on how to use the weight of evidence approach (WoE) to conduct a risk assessment for stressors to which humans and/or the environment may be exposed.

# WoE approach

- According to SCHEER, the WoE approach is an iterative process involving
  - Problem formulation
  - Identification, collection and selection of sources of evidence
  - Assessment and weighing of individual lines of evidence
  - Integration of lines of evidence
  - Description of uncertainties
  - Conclusion and reporting

# WoE approach

- Line of evidence: Set of evidence of similar type (EFSA, 2017)
  - e.g., *in vitro*, *in vivo* (animal/human), epidemiological
- Quality of evidence: It is the combined result of the judgement on
  - relevance
  - validity
  - reliability

# WoE approach – Integration

| Consistency | Quality: high | Quality: medium | Quality: low |
|---|---|---|---|
| high | strong | strong | moderate |
| medium | strong | moderate | weak/uncertain/ not possible |
| low | moderate | weak/uncertain/ not possible | weak/uncertain/ not possible |

European Commission

# Who legislates on EMF in the EU?



II

*(Acts whose publication is not obligatory)*

## COUNCIL

**COUNCIL RECOMMENDATION**
**of 12 July 1999**
**on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz)**

(1999/519/EC)

THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty establishing the European Community, and in particular Article 152(4), second subparagraph,

minimum requirements have been proposed for the protection of workers from physical agents (5) which include measures against non-ionising radiation; whereas, therefore, this recommendation does not address the protection of workers against occupational exposure to electromagnetic fields;

Health and Consumers

European Commission

# Who legislates on EMF in the EU?

29.6.2013 EN Official Journal of the European Union L 179/1

I

*(Legislative acts)*

## DIRECTIVES

**DIRECTIVE 2013/35/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL**

**of 26 June 2013**

**on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields) (20th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC) and repealing Directive 2004/40/EC**

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty on the Functioning of the European Union, and in particular Article 153(2) thereof,

(3) Following the entry into force of Directive 2004/40/EC of the European Parliament and of the Council of 29 April 2004 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields) (18th individual Directive within the meaning of

# Mandate to SCHEER

- Opinion I

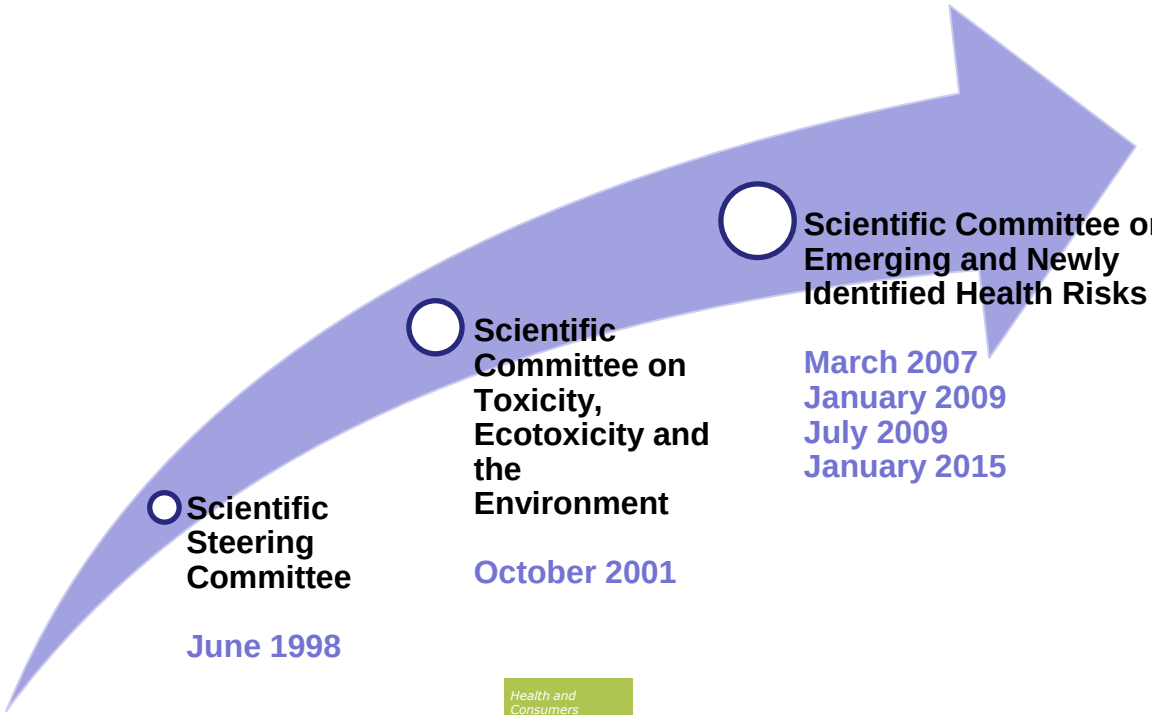
  To advise on the need of a (technical) revision of the Council Recommendation 1999/519/EC annexes and of the annexes of Directive 2013/35/EU in view of the latest scientific evidence available, in particular that of the ICNIRP guidelines updated in 2020, with regard to radio frequency 100 kHz to 300 GHz.

- Opinion II

  To update the SCENIHR Opinion of 2015 in the light of the latest scientific evidence with regard to frequencies between 1Hz and 100 kHz.

- Commission services: DG CNECT, DG SANTE, DG EMPL, DG RTD
- Date: June 2021

# Scientific Opinions on EMF



# Changes in methodology

- 2’700 articles on RF and health were published between 2009 and 2015
  3’270 articles on RF and health were published between 2015 and 2020
  It would be impossible to use each single article as a source of evidence in the requested timeline
- It was decided to address the mandate using mainly meta-analyses and systematic reviews, since they can efficiently handle the heterogeneity of individual studies resulting in an improved reliability of the level of evidence.
- Only in the lack of meta-analyses and/or systematic reviews on a specific biological/health effect, other reviews, like narrative reviews, were used. It was necessary for these reviews to have been performed with a methodology similar to the WoE approach of SCHEER.

# Timeline

- Preliminary Opinion adopted 16 August 2022
- Public consultation from 22 August to 25 September 2022
- 226 participants in the public consultation with more than 700 comments
- Final Opinion and answers to consultation adopted 18 April 2023

**https://health.ec.europa.eu/consultations/scheer-public-consultation-preliminary-opinion-scientific-evidence-radiofrequency_en**

# Opinion

- The SCHEER has considered meta-analyses, systematic reviews, and, when necessary, narrative or scope reviews and single research papers published after the (2015) SCENIHR Opinion on potential health effects of exposure to radiofrequency (RF) electromagnetic fields (EMF).

- The SCHEER notes that there is uncertain weight of evidence for interaction mechanisms in *in vitro* studies, involving oxidative balance, genetic and epigenetic effects, and calcium signalling, that can result in biological effects.

# Opinion

- The SCHEER could not identify moderate or strong level of evidence for adverse health effects resulting from chronic or acute RF EMF exposure from existing technology at levels below the limits set in the annexes of Council Recommendation 1999/519/EC and Directive 2013/35/EU.

- The SCHEER has noted the technical progress achieved since the ICNIRP (1998) exposure guidelines in the areas of computational and experimental exposure assessment and dosimetry, allowing for an increased accuracy of human exposure evaluation.

# Opinion

- The SCHEER has also noted that new and emerging wireless applications using RF EMF tend to use higher frequencies and lower emitted power in closer vicinity to the human body. However, there are situations where beam focusing or intense pulsed radiation can increase exposure for short times.

- The SCHEER acknowledges that the latest (2020) ICNIRP exposure guidelines respond to the developments in RF EMF and introduce new dosimetric quantities and limits to them, that can protect humans more effectively from emerging technological applications of RF EMF, and, therefore, advises positively on the need of a technical revision of the annexes in Council Recommendation 1999/519/EC and Directive 2013/35/EU with regard to radiofrequency electromagnetic fields (100 kHz to 300 GHz).

# Opinion - Clarification

- The SCHEER, by its Opinion, does not endorse the ICNIRP (2020) exposure guidelines
  - Microwave hearing, limits on contact currents, etc.

- The SCHEER, by its Opinion, acknowledges that the higher frequencies used by emerging technologies call for new dosimetric quantities/limits to warrant protection of the public and workers
  - Rapid surface heating, pulsed radiation, time-averaging, etc.

# EC funded research on EMF and health: the research cluster CLUE-H

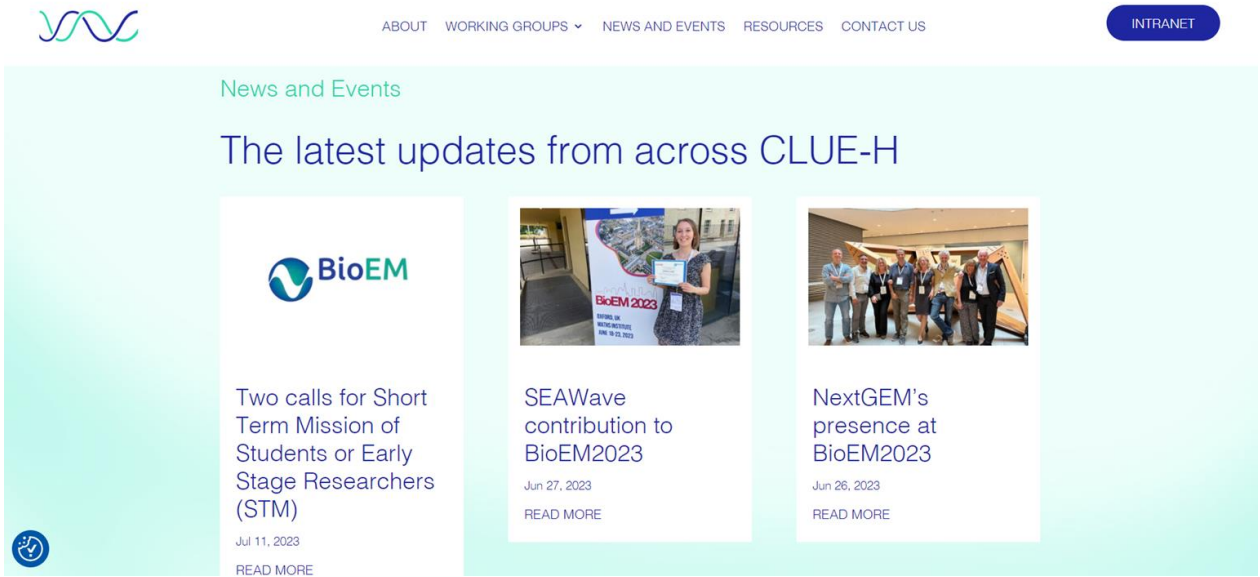

EUROPEAN
GREEN DEAL
URBAN HEALTH
Environment
& Health
OCCUPATIONAL
HEALTH &
SAFETY
PUBLIC HEALTH

CLUE – H

EUROPEAN CLUSTER
EMF AND HEALTH

clue-h.eu

www.emf-health-cluster.eu




ETAIN

GOLIAT
5G EXPOSURE, CAUSAL EFFECTS, AND RISK PERCEPTION THROUGH CITIZEN ENGAGEMENT

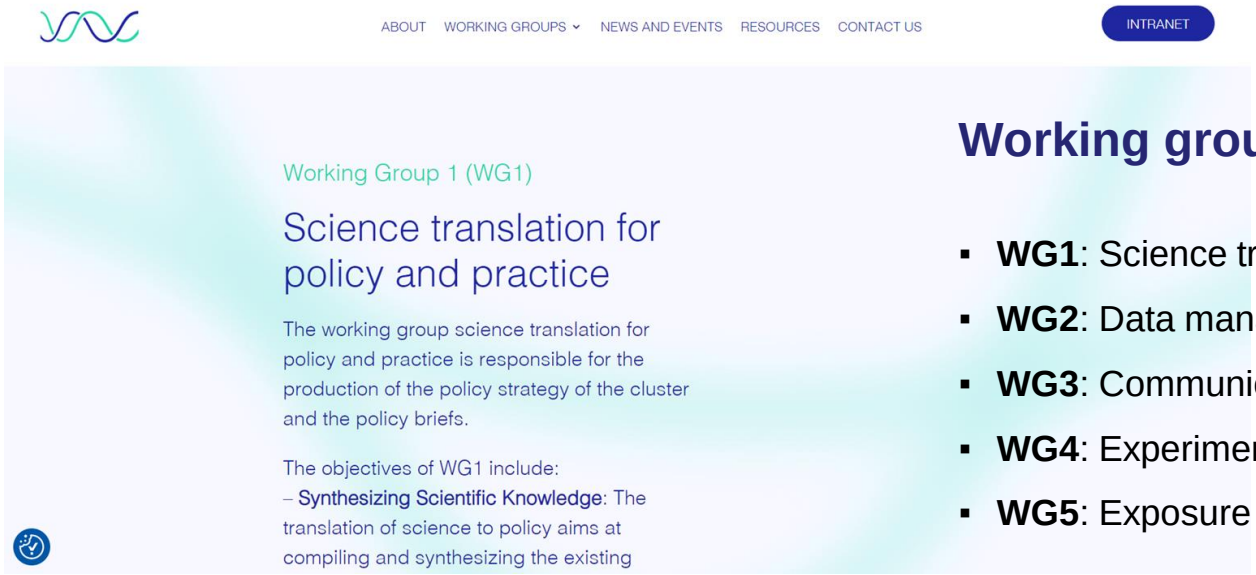
NextGEM

SEAWave

European Commission

www.emf-health-cluster.eu
clue-h.eu

CLUE – H
EUROPEAN CLUSTER
EMF AND HEALTH




## Working groups:

- **WG1**: Science translation for policy and practice;
- **WG2**: Data management and exchange;
- **WG3**: Communication and Dissemination;
- **WG4**: Experimental studies;
- **WG5**: Exposure assessment.

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5G EXPOSURE, CAUSAL EFFECTS, AND RISK PERCEPTION THROUGH CITIZEN ENGAGEMENT

NextGEM

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European Commission

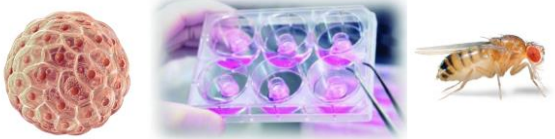

# Exposure To electromAgnetic fIelds and plaNetary health

Grant Agreement 101057216

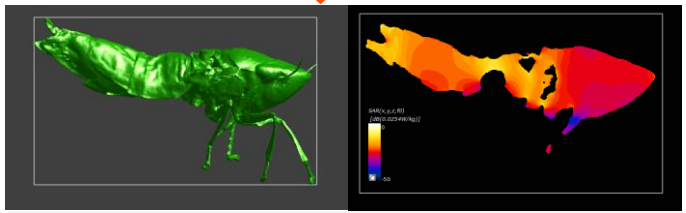
# Objectives ETAIN *(2022-2027)*

- **interacting with public** + stakeholders about exposure levels, possible associated risks/explore exposure reduction
- develop approach to assess impact of existing and novel technology from a **planetary health** perspective

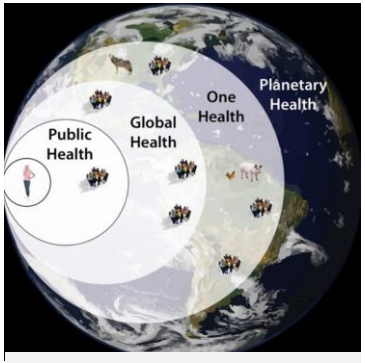
**App** collecting spatial and personal exposure/ dose

Lab research on skin, eyes, fruit flies, systems biology



Insect dosimetry/ **pollinator** health and biodiversity




**planetary** health



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Grant Agreement 101057216

| | Partners | Country |
|---|---|---|
| 1 | UNIVERSITEIT UTRECHT (UU) | The Netherlands |
| 2 | SCHWEIZERISCHES TROPEN- UND PUBLIC HEALTH-INSTITUT (SWISS TPH) | Switzerland |
| 3 | UNIVERSITEIT GENT (UGent) | Belgium |
| 4 | IDEAS FOR CHANGE (IFC) | Spain |
| 5 | FIELDS AT WORK, GMBH (FAW) | Switzerland |
| 6 | TECHNISCHE UNIVERSITIET EINDHOVEN (TU/e) | The Netherlands |
| 7 | GEOPONIKO PANEPISTIMION ATHINON (AUA) | Greece |
| 8 | CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE (CNRS) | France |
| 9 | TECHNOLOGIKO PANEPISTIMIO KYPROU (CUT) | Cyprus |
| 10 | GAME SOLUTIONS LAB B.V. (GSL) | The Netherlands |
| 11 | ELLINIKOS GEORGIKOS ORGANISMOS DIMITRA (ELGO) | Greece |
| 12 | UNIVERSITE DE MONTPELLIER (UM) | France |

# Consortium

**12 partners**

**5 years**

**6.6 million €**

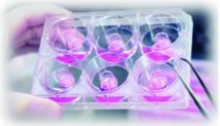
**(EU)**

ETAIN

Grant Agreement 101057216

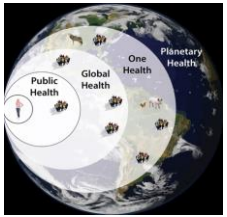
# Progress and next steps


- **App: (**validation) measurements started; engineering/ citizen science/ gamification/ GDPR/ mapping/ human dosimetry/ webportal underway (β~ end 2023)



- **Lab research**: Exposure set-ups, protocols etc under development (start 2023)

- **Insects**: dosimetry underway, exposure set-ups, protocols under development (start 2023/2024)




- **Planetary health**: not yet (start 2023/2024)

# Overarching aim

GOLiAT

5G EXPOSURE, CAUSAL EFFECTS, AND RISK PERCEPTION THROUGH CITIZEN ENGAGEMENT

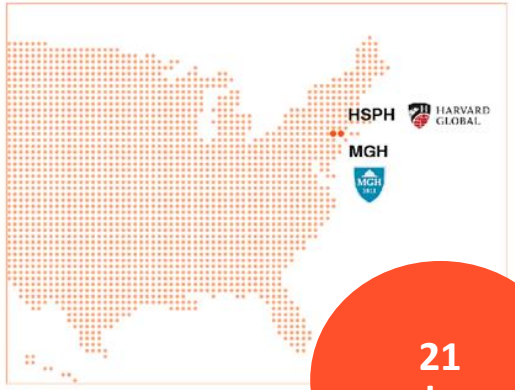
**To characterize and monitor RF-EMF exposure, in particular 5G**

**To understand risk perception and communication through citizen engagement**

**To provide novel insights into potential causal neuropsychological and biological effects**

**To use an integrative and transdisciplinary pan-European approach**

# Consortium






**21 partners**

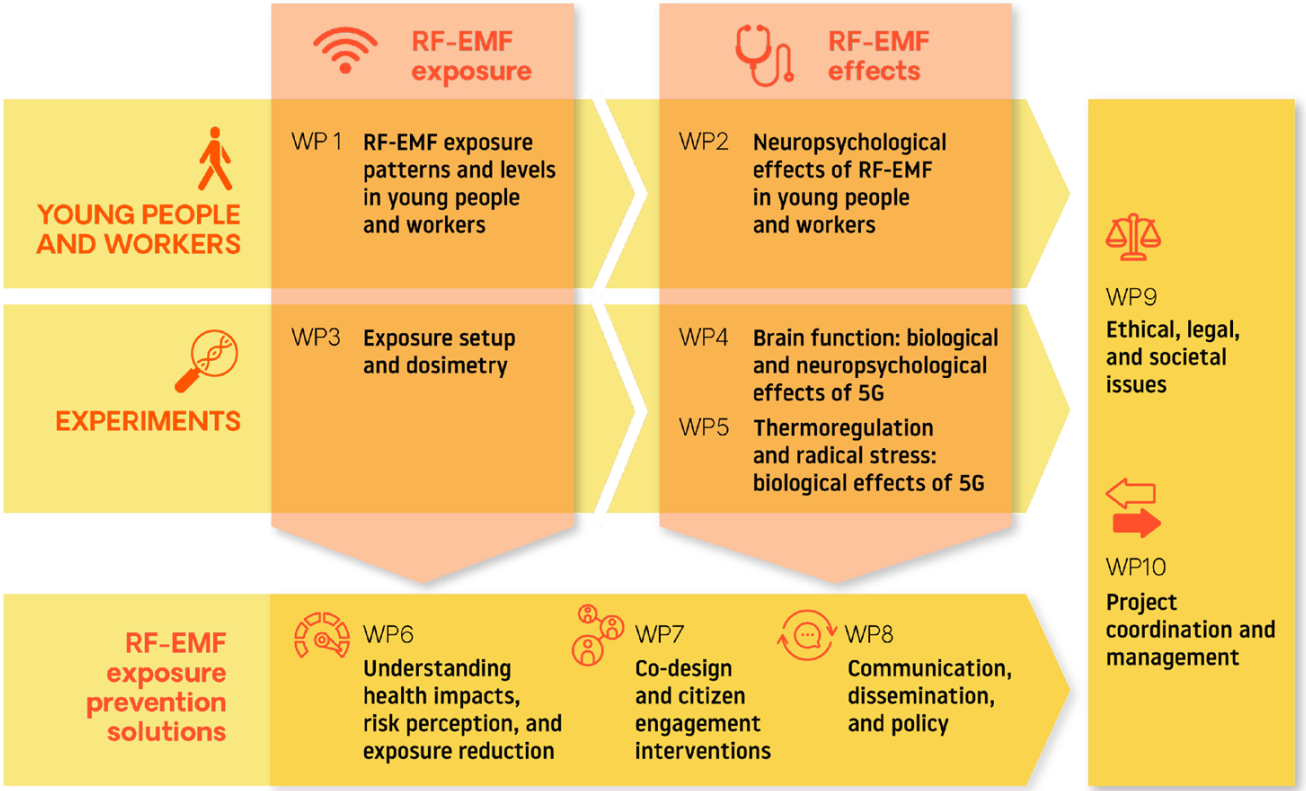
**5 years**

**9.2 million €**

**7.0 million € (EU)**

**1,348 PM**

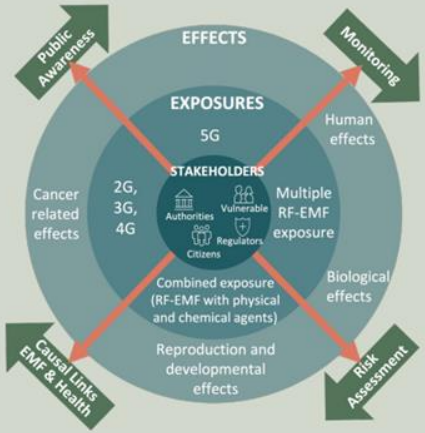
# PERT diagram



# NextGEM

# Next Generation Integrated Sensing and Analytical System for Monitoring and Assessing Radiofrequency EMF and Health

**NextGEM will ensure EU citizens' healthy living and a safer working environment when employing EMF-based telecommunication technologies.**

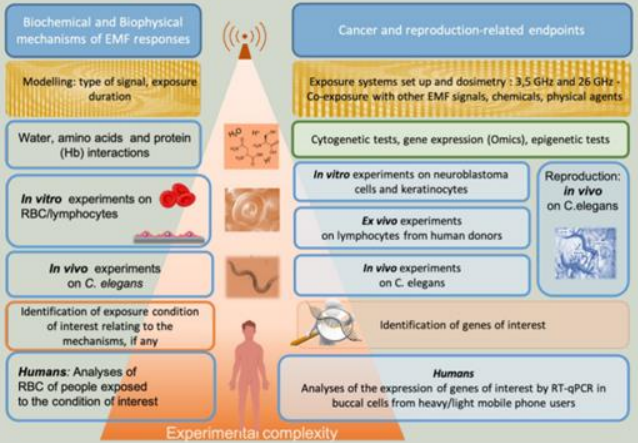



**NextGEM Overall Concept**

- **Objective 1:** Measurement and modelling of RF sources
- **Objective 2:** Experimental and human studies on health and EMF
- **Objective 3**: Causal links of EMF exposure and possible health effect
- **Objective 4**: Develop NextGEM Innovation Knowledge Hub
- **Objective 5**: Project's impact maximisation and clustering activities

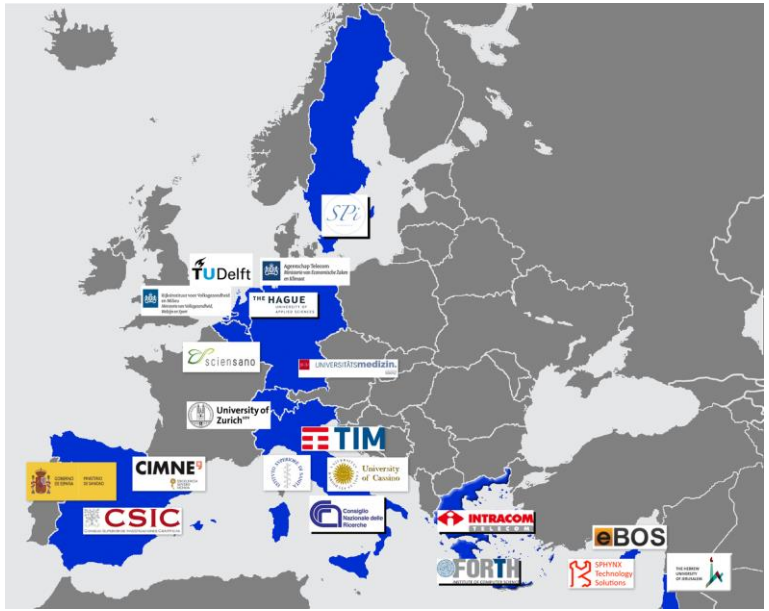

**EMF Exposure Modelling and Measurements**

**Experimentation and Human Studies**



# NextGEM

## Next Generation Integrated Sensing and Analytical System for Monitoring and Assessing Radiofrequency EMF and Health




**20 partners**

**4 years**

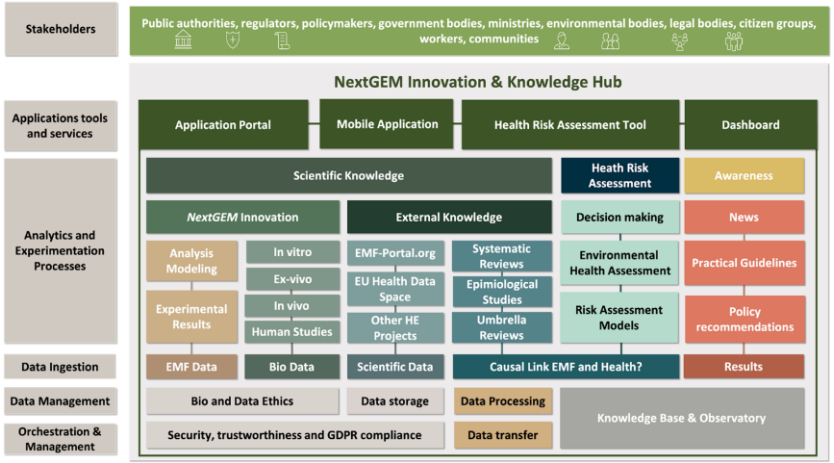
**7.6 million € (EU)**

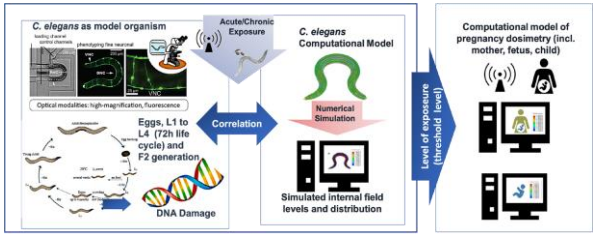
Duration: 1/7/22-30/6/26, Budget: 7.559.039 EU Funding, **Coordinator:** Dr Nikolaos Petroulakis (FORTH) www.nextgem.eu nextgem-project/ @NextGEM_eu

# NextGEM

# Next Generation Integrated Sensing and Analytical System for Monitoring and Assessing Radiofrequency EMF and Health

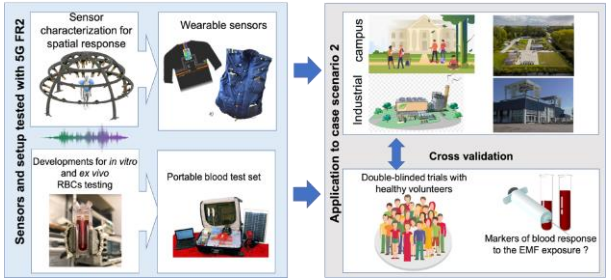
## Develop NextGEM Knowledge and Innovation Hub (NIKH) and validate it through real case studies



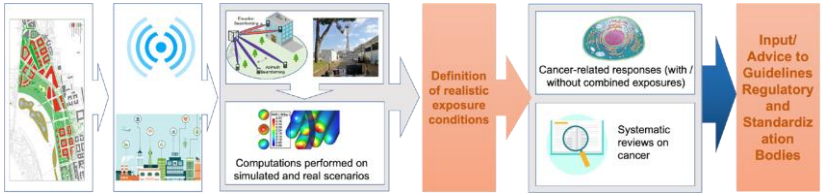




**Case Study 1** - Potential effects of indoor levels of RF exposure on reproduction and development

**Case Study 3** - Health effects of exposure to mmWave EMF in indoor & outdoor environments.




**Case Study 2** - Optimised outdoor urban planning and 5G design architecture and investigations for public awareness on cancer-related health-hazards



SEAWave

**S**cientific-based **E**xposure and risk **A**ssessment of radiofrequency and mm-**Wave** systems from children to elderly (5G and Beyond)

Contact person: Theodoros Samaras; theosama@auth.gr

This project has received funding from the Horizon Europe Research and Innovation programme under Grant Agreement No 101057622

# **S**cientific-based **E**xposure and risk **A**ssessment of radiofrequency and mm-**Wave** systems from children to elderly (5G and Beyond)

**15 partners**

**3 years**

**7.3 million €**

**(EU)**

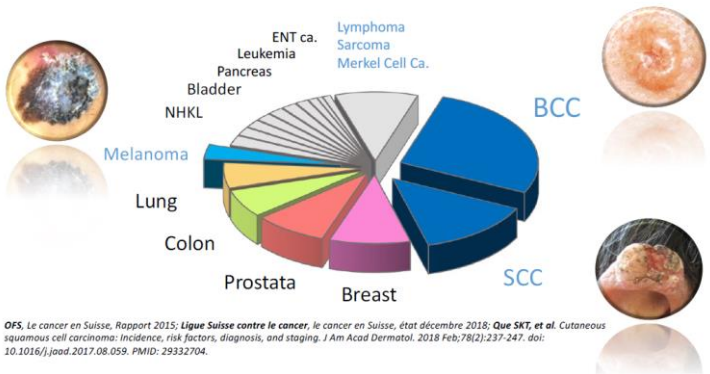

www.seawave-project.eu

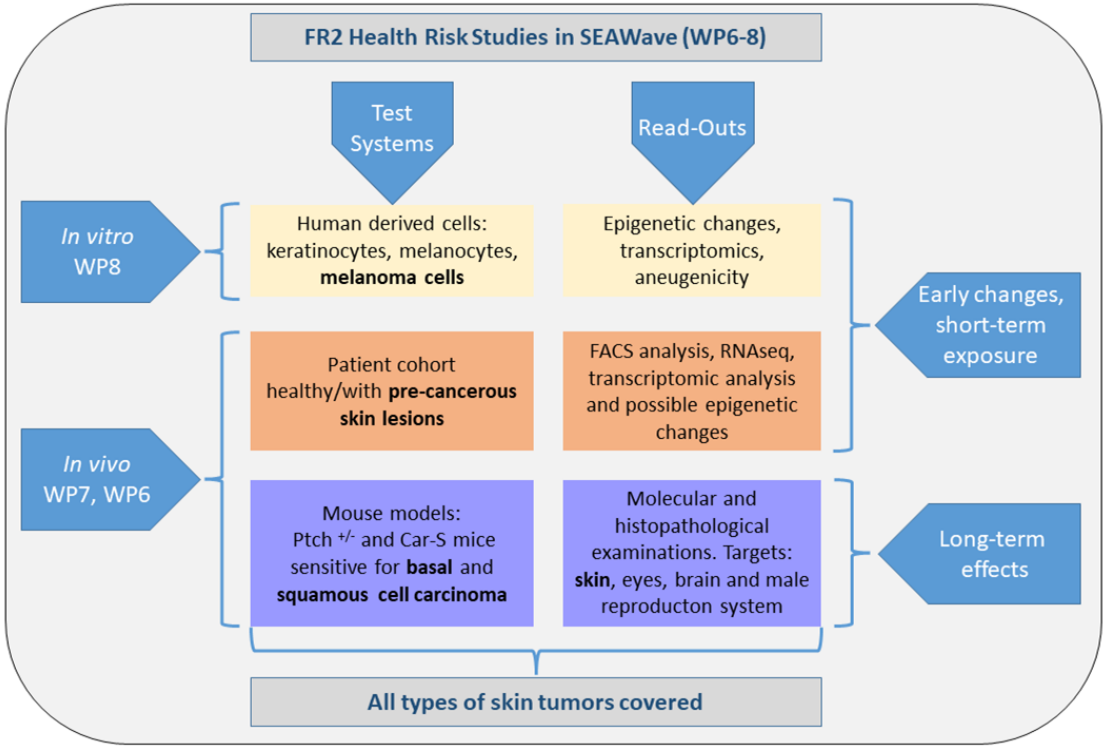
SEAWave

Grant Agreement 101057622

# **S**cientific-based **E**xposure and risk **A**ssessment of radiofrequency and mm-**Wave** systems from children to elderly (5G and Beyond)

## Skin

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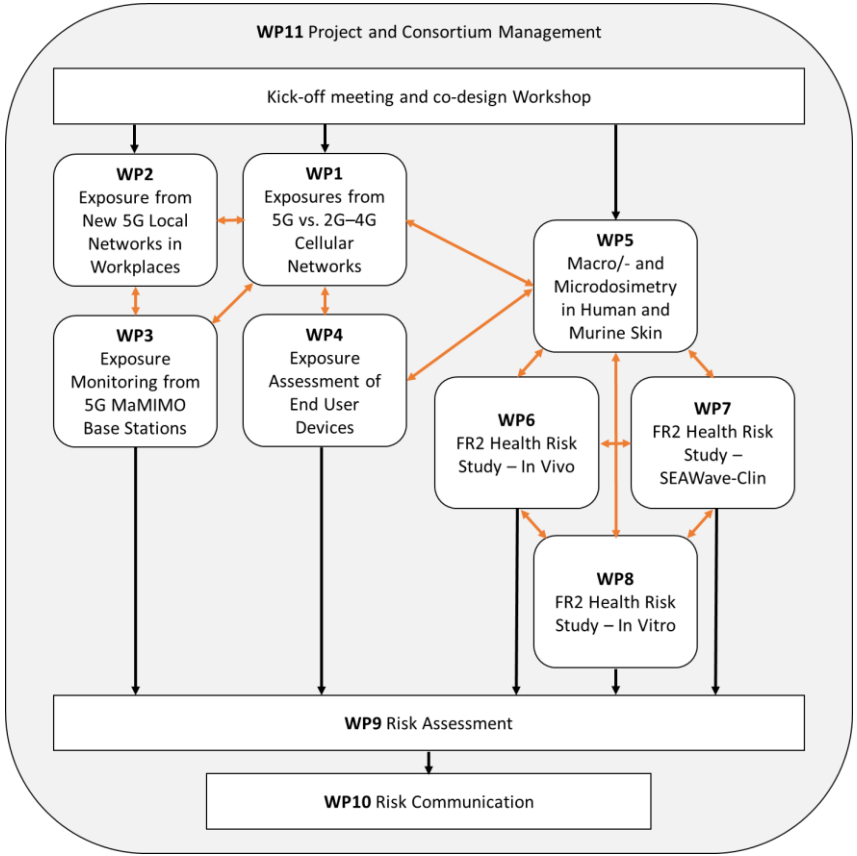
SEAWave

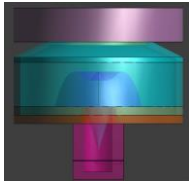
Grant Agreement 101057622

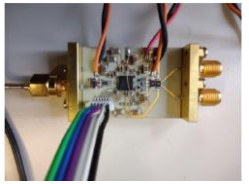
# **S**cientific-based **E**xposure and risk **A**ssessment of radiofrequency and mm-**Wave** systems from children to elderly (5G and Beyond)



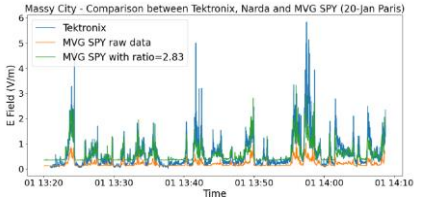

## Examples of progress achieved:

- Exposure setups (designed and manufactured)





- Exposure measurement campaigns in four countries


www.seawave-project.eu

SEAWave

Grant Agreement 101057622

European Commission

# Thank you for your attention!

theosama@auth.gr

# Science Perspective
# 5G and health

**Isabelle Lagroye**

Directrice d'études Ecole Pratique des Hautes Etudes

PharmD, PhD

**The GSMA 12th EMF Forum 2023. - Brussels, September 26th 2023**

# Overview of recent RF-EMF scientific developments

- Before 5G:

What did we learn?

- 5G:

What do we expect?

# Before 5G: What did we learn?


- Mobile communications
- Radiofrequency fields < 6 GHz

- **Non-ionising** radiations
- Established effects relate to tissue heating
- **Exposure limits** developed

# Before 5G: What did we learn?

- **25 years of research on mobile communications**

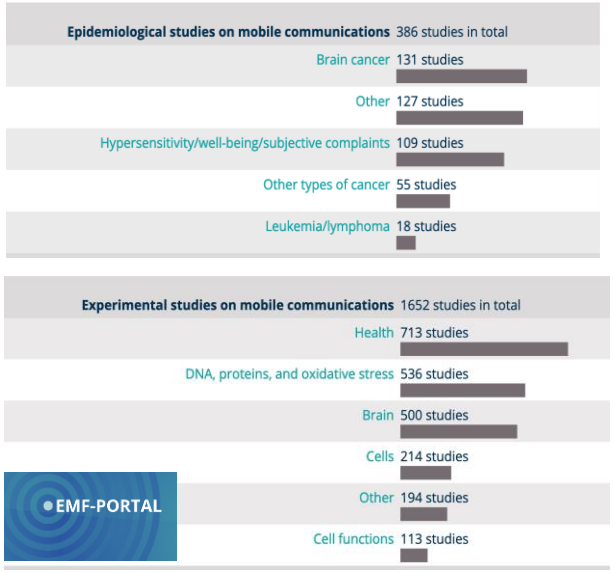

> 150 M€ funds

European Commission

(About 50 M€)

NTP National Toxicology Program

(About 30 M$)




- Significant increase in scientific knowledge about health risks related to the use of mobile communications


- > 200 expert reports

# Before 5G: What did we learn?

- **Central Nervous system**

Effects of RF emitted by mobile phones on the ElectroEncephaloGramme (EEG)

- GSM, Tetra, LTE
- Effects reported not always consistent


➢ So far, no related health effect evidenced

# Before 5G: What did we learn?

- **Electromagnetic Hyper Sensibility (EHS)**

**Idiopathic Environmental Intolerance attributed to EMF**


ANSES Report and Opinion - 2018

- **No association** between RF exposures and symptoms reported by self-declared EHS persons
- Need for appropriate care and dedicated research

# Before 5G: What did we learn?

- **Cancer**

International Agency for Research on Cancer

World Health Organization

PRESS RELEASE
N° 208

31 May 2011

**IARC CLASSIFIES RADIOFREQUENCY ELECTROMAGNETIC FIELDS AS POSSIBLY CARCINOGENIC TO HUMANS**

- Association of increased risk for glioma and acoustic neuroma with RF emitted by mobile phones : **2B carcinogen**
- Possible bias and lack of experimental support **prevented causality**

- Interphone, Hardell showed an association with glioma
- > 1640 h of mobile phone use or > 5-10 years of use

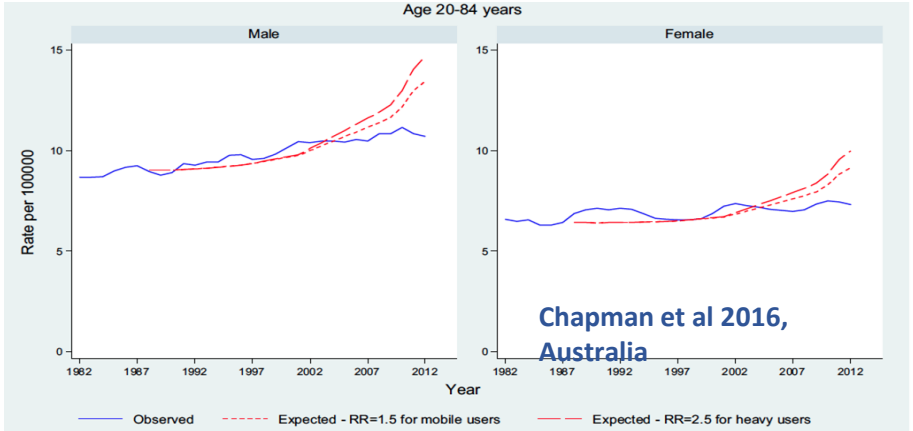
- 40 animal studies (Baan et al. 2011)
- No cancer induction
- Tumour promotion : 10% studies, not independently confirmed

# Before 5G: What did we learn?

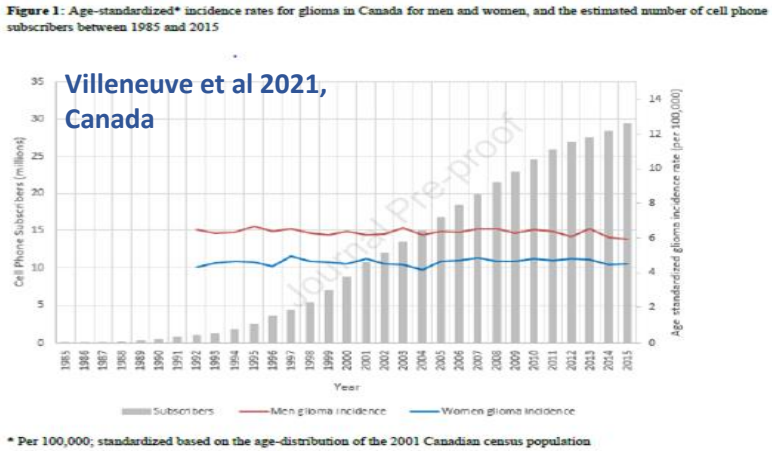
- **Cancer**

Current trends for brain tumors and/or glioma incidences **do not fit** with Interphone and Hardell's data

Schüz et al 2022 (UK) ; Elwood et al 2022 (New Zealand) ; Deltour et al 2022 (Nordic countries) ; Villeneuve et al 2021 (Canada) ; Choi et al 2021 (Korea) ; Karipidis et al, 2019 (Australia) ; Philips A et al, 2018 (USA) ; Chapman et al 2016 (Australia) ; Sato Y. et al 2016 (Japan); Kim et al 2015 (New Zealand) ; Inskip et al 2010 (USA), Deltour et al 2009 (Sweden) ; etc




Observed and expected brain cancer incidence rate in Australia (age standardised, World)



# Before 5G: What did we learn?

- **Well-being**

- Children and adolescents' well-being can be impacted
- Association with fatigue, probably due to use/overuse of screens rather than to RF exposure
- « Addiction » behaviour

# Before 5G: What did we learn?

- **Controversies**

Independent confirmation of primarily significant published effects **consistently failed**

Salford et al 2003, 1994;
Diem et al 2005;
Maes et al 1996;
Lai et al, 1995 ;
Lai et al 1994
Litovitz et al. 1993, 1997

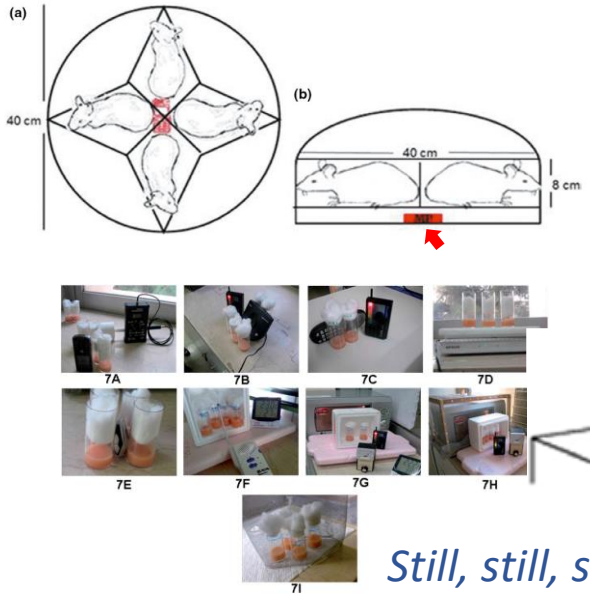
# Before 5G: What did we learn?

- **Controversies**

Exposure setups and dosimetry

➢ What is OK: Dosimetry


➢ What is not OK: No dosimetry




*Still, still, still in 2023…*

# Before 5G: What did we learn?

- **Conclusion**

Below current exposure limits

- ➢ No demonstrated health effects
- ➢ No biophysical mechanism identified

However, some open questions remain

- ➢ Oxidative stress; male fertility ; cognitive functions (children/adolescents)
- ➢ Ongoing WHO systematic reviews

*(+ heat-related effects, cancer, symptoms)*

World Health Organization

# 5G: What do we expect?


- Mobile communications
- Radiofrequency fields < 6 GHz
  - 2G, 3G & 4G frequencies + 3.5 GHz
- Radiofrequency fields > 6 GHz
  - 26 GHz; 40.5 – 43.5 GHz; 66-71 GHz

- **2G; 3G; 4G frequencies of 5G**

All above should be true for 5G

Similar mechanisms, similar degree of health protection

- **New frequencies of 5G ?**

# 5G: What do we expect?

- 5G will include new frequency ranges
  - Frequency < 6 GHz : 3.5 GHz
  - Frequency > 6 GHz : 26 GHz (then 40.5 – 43.5 GHz & 66-71 GHz?)

- 30-300 GHz : Millimeter wave – MMW
  - ➢ RF energy absorption is **superficial**
  - ➢ **Power density** is accurate
  - ➢ **Above 250 W/m² : skin** heating

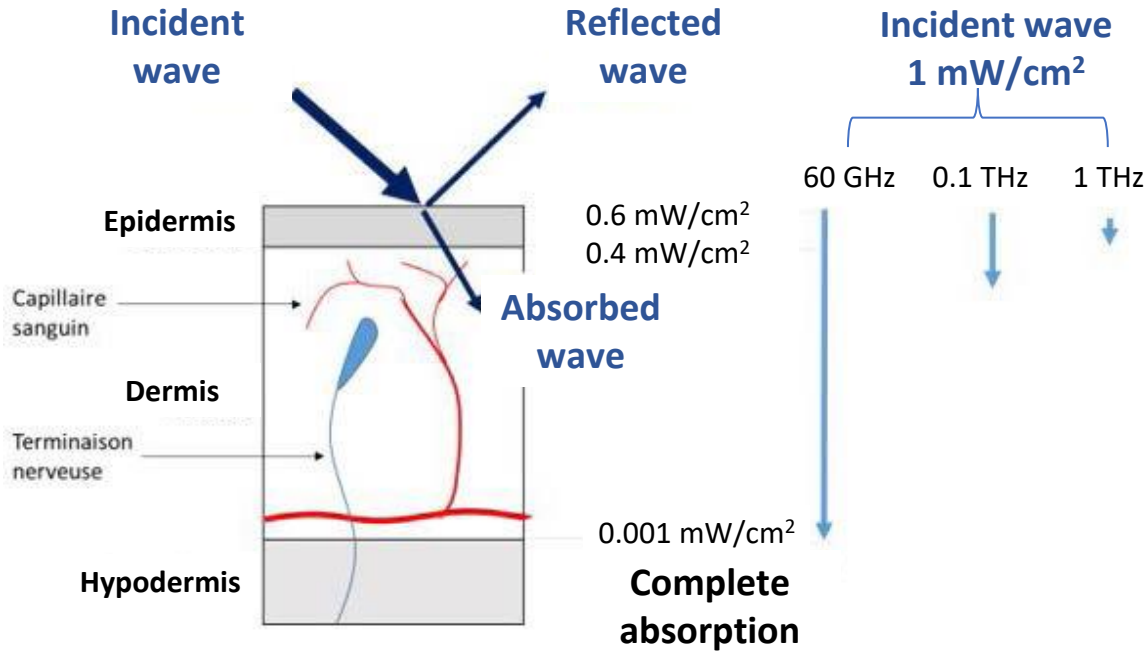
- Related exposure limits

ICNIRP
INTERNATIONAL COMMISSION ON NON-IONIZING RADIATION PROTECTION

IEEE
Advancing Technology for Humanity

# 5G: What do we expect?

- Biological « target » of MMW : **skin,** eyes
- **Brain tissues won't be exposed**



# 5G: What do we expect?

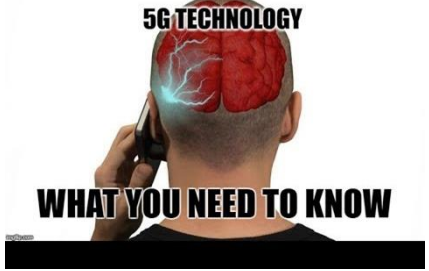
- Scientific research


On going !

QUALITY PLEASE!

- Risk perception






On going !

# 5G: What do we expect?

## Scientific research

Int. J. Environ. Res. Public Health **2019**, 16, 3406;
doi:10.3390/ijerph16183406

*Review*

**5G Wireless Communication and Health Effects—A Pragmatic Review Based on Available Studies Regarding 6 to 100 GHz**

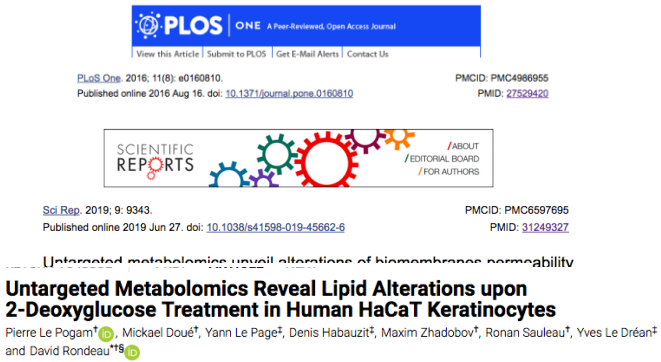
Myrtill Simkó * and Mats-Olof Mattsson

« The available studies do not provide adequate and sufficient information for a meaningful safety assessment, or for the question about non-thermal effects. »

# 5G: What do we expect?

## Scientific research

- Le Dréan & Zhadobov
  60 GHz




No evidence for deleterious effect

- Investigations at 3.5 GHz

Bektas et al 2022; Dasgupta et al 2022, 2020; Wang et al 2022, 2021; Yang et al 2022 ; Joushomme et al 2023; Canovi et al, 2023; Chou et al 2023

- ➢ Only one group used a 5G modulation
- ➢ Mixed models , mixed results

- ➢ No conclusion can be made at this stage

# 5G: What do we expect?

## Scientific research

- HORIZON-HLTH-2021-ENVHLTH-02-01
  EMG & health


ETAIN GOLiAT NextGEM SEAWave

CLUE – H

**Deliverable**

**“Scientific strategy of the cluster”**

- identify key scientific topics that will potentiate synergies across the four CLUE-H projects

# 5G: What do we expect?

## Scientific research

➢ In vitro & small animals

**Transcriptomics metabolomics**

| | Endpoint | Frequency (GHz) | Bandwidth | SAR/$S_{abs}$ | Exposure Time / On-Off cycles | Project |
|---|---|---|---|---|---|---|
| **Skin cells / keratinocytes** | Transcriptomics and gene expression of selected genes | 3.5 | 100 MHz | 10 mW/kg - 100 W/kg | 1-24h, 3 weeks | NextGEM |
| | | 26.5 | 100 MHz | 0.4, 1 W/kg | 1-24h, 3 weeks | NextGEM |
| **Skin cells / keratinocytes** | Transcriptomics | 27.5 | 100 MHz | 0, 3.3, 10 W/m$^2$ (uncertainty TBD) | Up to 7 days<br><br>10 min On / 10 min Off | SEAWave |
| **3D reconstructed model** | Transcriptomics and metabolomics | 26 | 100 MHz | Optimal $S_{abs}$ | Optimal exposure conditions | ETAIN |
| **Drosophila melanogaster** | Transcriptomics, metabolomics | 26 | 100 MHz | Optimal $S_{abs}$ | At first and after 5 and 10 generations, during whole life cycle | ETAIN |
| **Caenorhabditis elegans** | Transcriptomics | 26.5 | 100 MHz | TBD | 72h, during whole worm development | NextGEM |

# 5G: What do we expect?

## Scientific research

➢ In vitro & small animals

**Oxidative stress**

| | Endpoint | Frequency (GHz) | Bandwidth | SAR/$S_{abs}$ | Exposure Time / On-Off cycles | Project |
|---|---|---|---|---|---|---|
| Skin cells / fibroblasts / keratinocytes / reconstituted skin cell sheets | ROS production and induced gene expression / Mitochondrial function | 3.5 | 100 MHz | 0.08, 0.4, 4 W/kg | Up to 1h | GOLIAT |
| | | 26 | 100 MHz | 0.3, 3, 30 W/m$^2$ | Up to 1h | |
| Skin cells / keratinocytes | ROS production | 3.5 | 100 MHz | 10 mW/kg - 100 W/kg (exact SAR TBD) | 1-24h | NextGEM |
| | | 26.5 | 100 MHz | 0.3-1.25 W/kg | 1-24h | NextGEM |
| Skin cells / fibroblasts | ROS production | 3.5 | 100 MHz | 0.08, 0.4, 4 W/kg | Real time | ETAIN |
| | | 26 | 100 MHz | 0.3, 3, 30 W/m$^2$ | Real time | |
| 3D commercial epiderm model | Antioxidant defense | 3.5 | 100 MHz | 0.08, 0.4, 4 W/kg | 1-2h to 1-2 days | |
| | | 26 | 100 MHz | 0.3, 3, 30 W/m$^2$ | 1-2h to 1-2 days | ETAIN |
| Caenorhabditis elegans | ROS production | 26.5 | 100 MHz | TBD | 72h, during whole worm development | NextGEM |

# 5G: What do we expect?


- **Conclusion**

➢ Up to now : health risk seemed unlikely unless exposure exceeds the current limits

➢ Coordinated research at the EU level is ongoing

CLUE – H

➢ Main questions adressed

- Children, young people, occupationally-exposed people
- Co/multi-exposures
- Integrative research on skin (*from in silico to human*)
- Thermoregulation, cancer, oxidative stress, epigenetics, omics
- Biodiversity


Thank you
for your attention

PANEL DISCUSSION

# Q&A with science speakers

Facilitator: DI Manfred Ruttner,
A1 Telekom Austria – Deputy
Chair GSMA EMF and Health

© GSMA 2023

# Coffee break

© GSMA 2023

FIRESIDE CHAT

# Update on WHO RF-EMF activities

Jos Verbeek, MD, PhD
Senior Researcher, consultant to WHO as guideline methodologist

Facilitator: Dr Jack Rowley,
Senior Director Research & Sustainability, GSMA

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World Health Organization

# Status of the WHO RF-EMF risk assessment process

J.H. Verbeek
Consultant to WHO

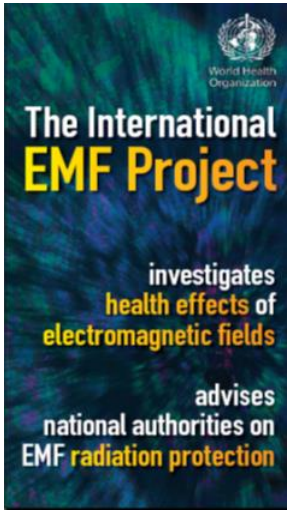
E. van Deventer
Radiation and Health Unit
World Health Organization
Geneva, Switzerland

12th GSMA EMF Forum, Bruxels, 26 September 2023

# Outline

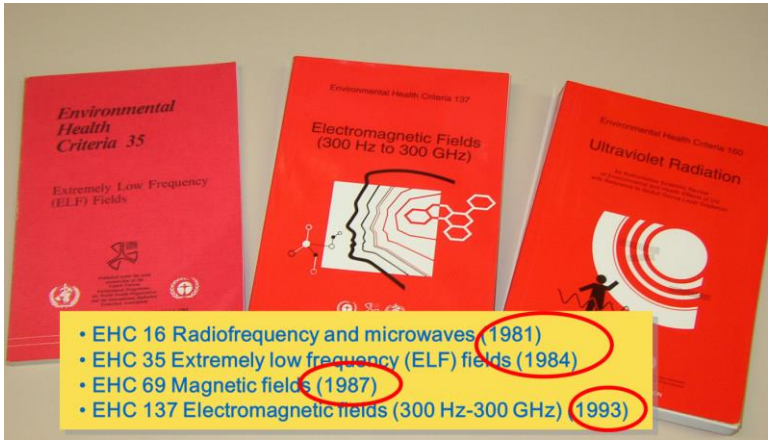
- Introduction
- The Radiofrequency Fields activity
- Where are we in the process?
- What does the published evidence look like?

# WHO International EMF Project

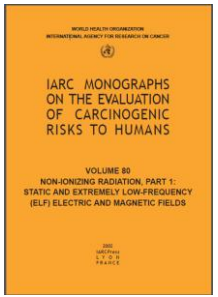



- Established in 1996
- Coordinated by WHO HQ
- Objectives
  - Review the scientific literature on health effects of EMF exposure and formally assess health risks;
  - Promote a focused agenda of high-quality EMF research;
  - Encourage internationally acceptable harmonized standards;
  - Provide information on risk perception, risk communication, risk management

# WHO Monographs on EMF

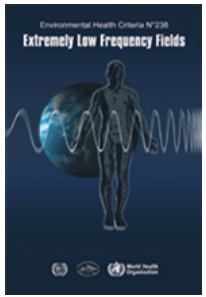



Health risk assessments

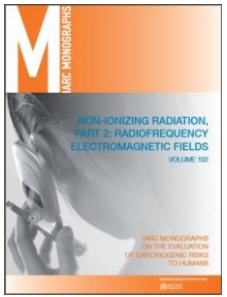



2002


2006




2007




2013

RF Fields

# RF Environmental Health Criteria
## Objectives

- To review the scientific literature regarding **adverse health effects** from exposure to radiofrequency fields
- To perform a **health risk assessment** of all studied health endpoints, as far as the evidence can offer
- To compile a **summary of national policies** around the world (based on a survey performed in Fall 2012 and now being updated)
- To identify gaps in knowledge

Radiation Protection Dosimetry (2014), pp. 1–6 doi:10.1093/rpd/ncu324

**RISK MANAGEMENT POLICIES AND PRACTICES REGARDING RADIO FREQUENCY ELECTROMAGNETIC FIELDS: RESULTS FROM A WHO SURVEY**

Amit Dhungel[1,*], Denis Zmirou-Navier[1,2] and Emilie van Deventer[3]
[1]Department of Environmental and Occupational Health, EHESP School of Public Health, Avenue du Professeur Léon Bernard CS 74312, 35043 Rennes, France
[2]Lorraine University School of Medicine, av. de la Forêt de Haye, 54505 Vandoeuvre-Les-Nancy, France
[3]Radiation Programme, Department of Public Health, Environmental and Social Determinants of Health, World Health Organization, Geneva, Switzerland

# Scope and target audience

- Scope
  - Radiofrequency fields from 100 kHz to 300 GHz
  - Public and occupational exposures (not medical exposures)

- Target audience
  - Policy-makers in Ministries of Health, and Ministries of Labour, Environment, Telecommunications, ..
  - Bodies involved in developing exposure guidelines for RF EMF, such as non-governmental organizations
  - Professional societies and academics studying the health effects of RF EMF

# Process

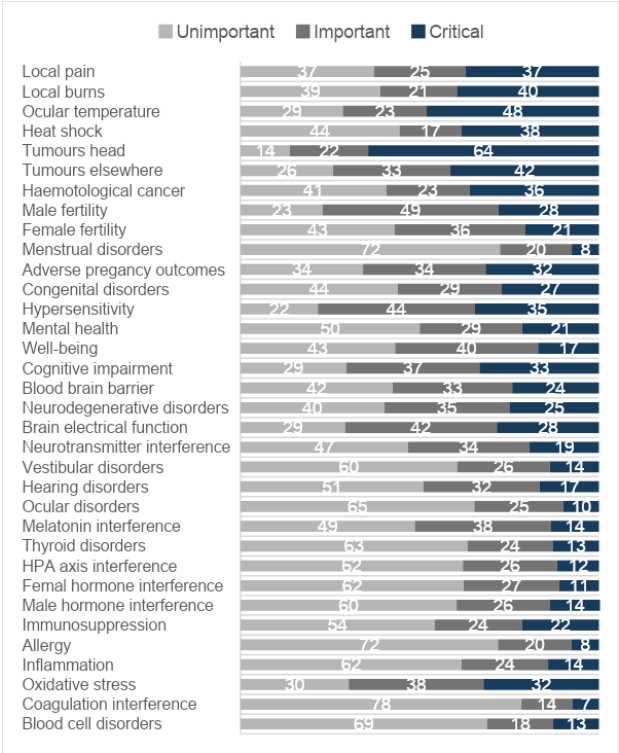
1. Scoping report of all available evidence in
   - Human observational studies
   - Human experimental studies
   - Experimental animal studies
   - Experimental cell studies
2. Study on priority health outcomes
3. Systematic reviews of effects of RF EMF on priority health outcomes
4. Independent Task Group will…
   - ..formulate conclusions on effects of RF EMF
   - ..conduct a health risk assessment
   - ..report conclusions and HRA in EHC monograph

# Where are we? Scoping report

- Scoping report
  - Project started in 2012, WHO methodology changed, Methodologist attracted

- Scoping report finalized for use by Task Group with chapters on
  - Heat-related illnesses, ocular function, circulatory diseases, cancer, immune response, haematological response, fertility, auditory function, neuroendocrine response, symptoms, autonomic nervous response, cognitive function, brain physiological response, other biological responses

# Where are we? Priority outcomes




1. Cancer
2. Heat related
3. Fertility
4. Symptoms
5. Cognitive performance
6. Oxidative stress

Environment International
Volume 146, January 2021, 106300

Prioritizing health outcomes when assessing the effects of exposure to radiofrequency electromagnetic fields: A survey among experts

Jos Verbeek, Gunnhild Oftedal, Maria Feychting, Eric van Rongen, Maria Rosaria Scarfi, Simon Mann, Rachel Wong, Emilie van Deventer

# Where are we? Systematic Reviews

- **Protocols** published in Environment International
  - Cancer: in humans (2 SRs), cancer in animals (1 SR)
  - Fertility: in humans (2 SRs), fertility in animals (2 SRs)
  - Symptoms: in human observational (1 SR) and in experimental studies (1 SR)
  - Cognitive function: in human observational (1 SR) and in experimental studies (1 SR)
  - Biomarkers of oxidative stress (1 SR)
  - Heat-related outcomes: not yet published (1 SR)

- **Systematic reviews**
  - Published in Environment International: 1 SR
  - Submitted and under review: 4 SRs
  - In final stage of writing: 6 SRs
  - In progress: 2 SRs

# Where are we? Task Group

- Has been set up consisting of 20 experts..
  - …in epidemiology, experimental studies, animal studies, cell studies, public health
  - ..from all WHO regions

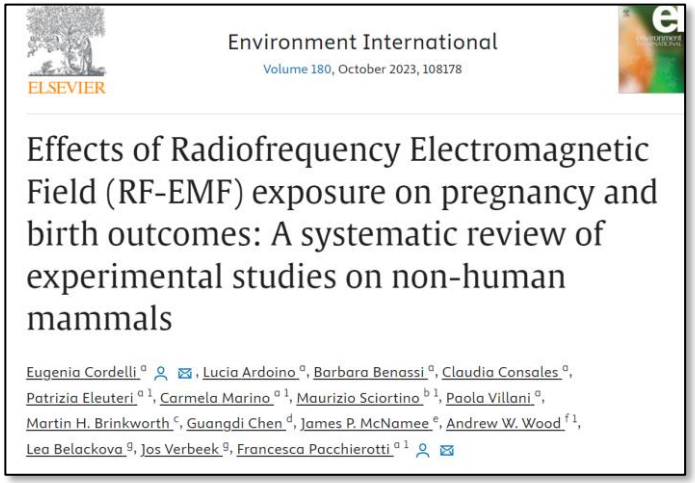
- Convened in person in Geneva in March 2023
  - Consensus..
    - ..methods for drawing conclusions from scoping report and systematic reviews
    - ..methods for how to assess if RF EMF is a hazard for a specific adverse health outcome
    - ..about exposure levels

- Currently working very hard to review the available evidence

- Will meet in October 2023 and have a final meeting in February 2024

# What does the evidence look like?

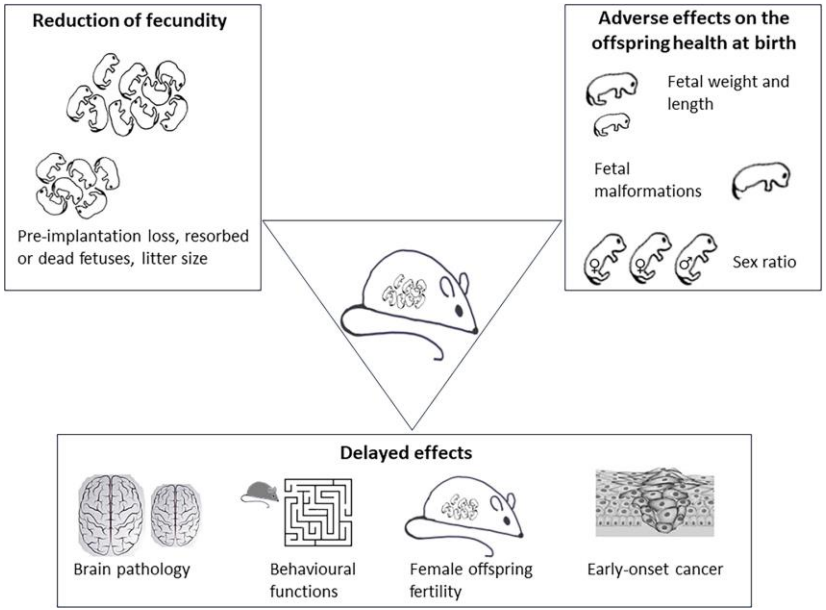
- What are the effects of RF EMF on pregnancy and birth outcomes in animals



Environment International
Volume 180, October 2023, 108178

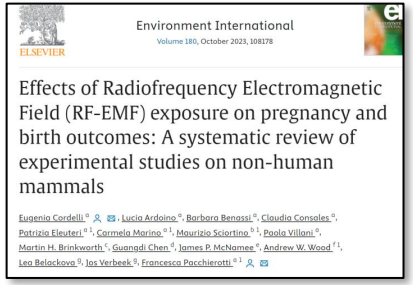
Effects of Radiofrequency Electromagnetic Field (RF-EMF) exposure on pregnancy and birth outcomes: A systematic review of experimental studies on non-human mammals

Eugenia Cordelli [a], Lucia Ardoino [a], Barbara Benassi [a], Claudia Consales [a], Patrizia Eleuteri [a 1], Carmela Marino [a 1], Maurizio Sciortino [b 1], Paola Villani [a], Martin H. Brinkworth [c], Guangdi Chen [d], James P. McNamee [e], Andrew W. Wood [f 1], Lea Belackova [g], Jos Verbeek [g], Francesca Pacchierotti [a 1]



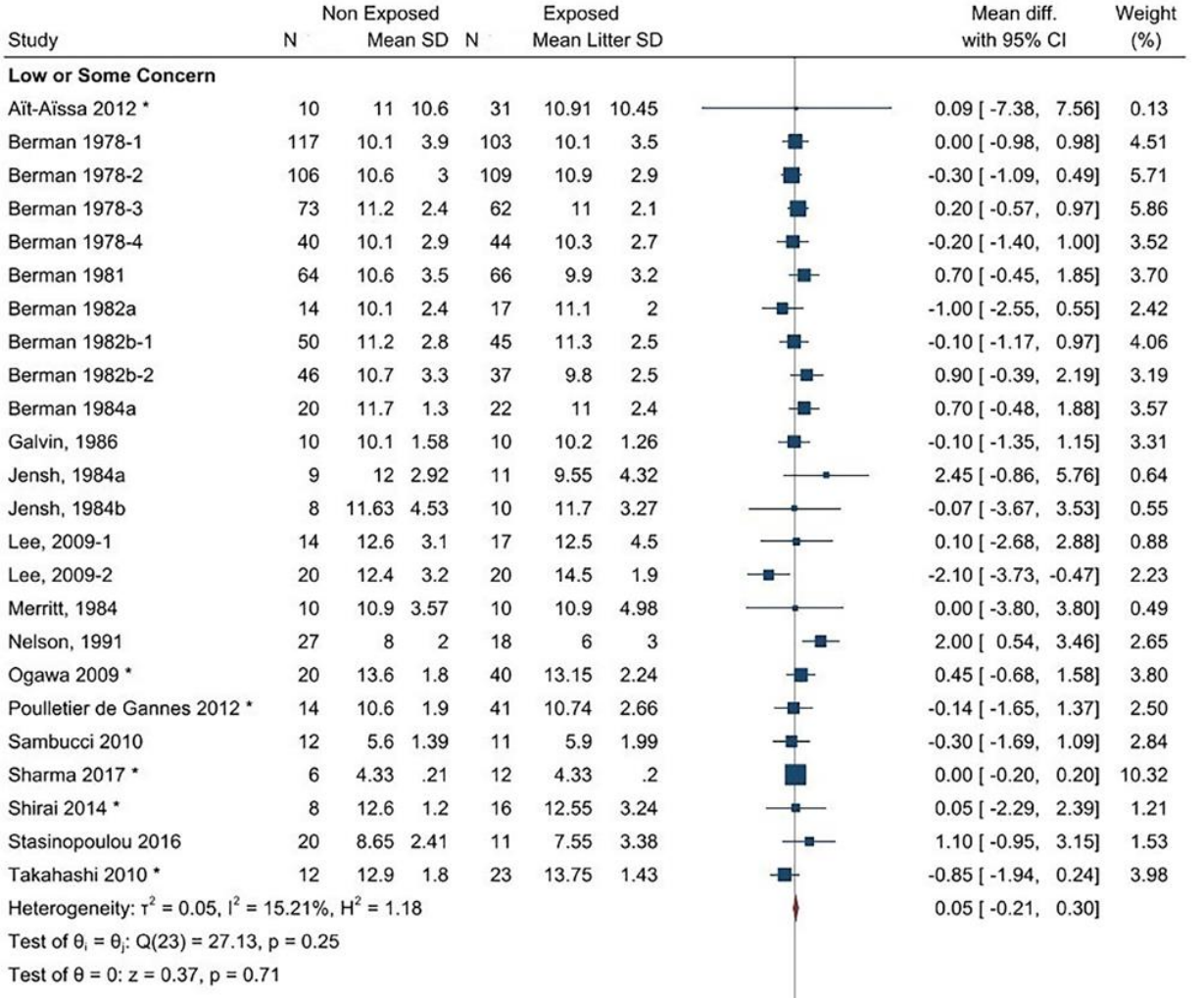
# Studies and outcomes

- 88 (!) papers included
- Three major outcome categories:
  - Fecundity
    - Pregnancy rate
    - Litter size
    - Dead foetuses
  - Adverse effects at birth
    - Birth defects
    - Weight, length
  - Delayed effects after birth
    - Behavioural
    - Learning and memory



# Meta-analysis

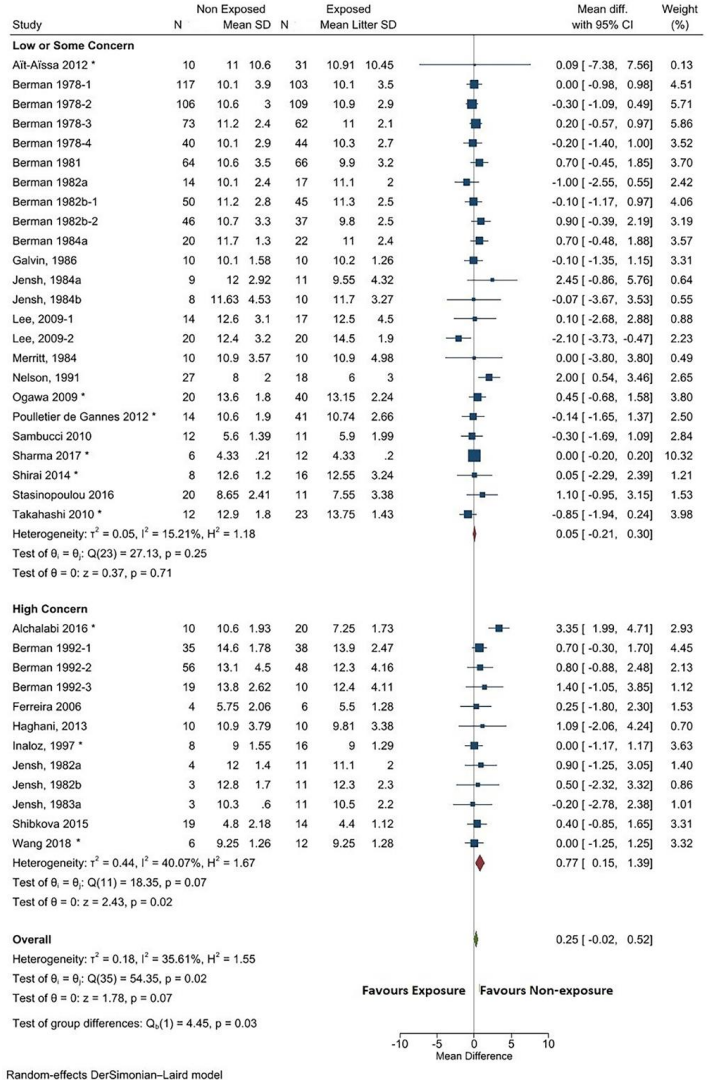
- Meta-analysis
  - Weighted average of the results across studies
- Forest plot of individual studies
- Summary effect: diamond at the bottom



| Study | Non Exposed N | Non Exposed Mean | Non Exposed SD | Exposed N | Exposed Mean Litter | Exposed SD | Mean diff. with 95% CI | Weight (%) |
|---|---|---|---|---|---|---|---|---|
| **Low or Some Concern** | | | | | | | | |
| Aït-Aïssa 2012 * | 10 | 11 | 10.6 | 31 | 10.91 | 10.45 | 0.09 [ -7.38, 7.56] | 0.13 |
| Berman 1978-1 | 117 | 10.1 | 3.9 | 103 | 10.1 | 3.5 | 0.00 [ -0.98, 0.98] | 4.51 |
| Berman 1978-2 | 106 | 10.6 | 3 | 109 | 10.9 | 2.9 | -0.30 [ -1.09, 0.49] | 5.71 |
| Berman 1978-3 | 73 | 11.2 | 2.4 | 62 | 11 | 2.1 | 0.20 [ -0.57, 0.97] | 5.86 |
| Berman 1978-4 | 40 | 10.1 | 2.9 | 44 | 10.3 | 2.7 | -0.20 [ -1.40, 1.00] | 3.52 |
| Berman 1981 | 64 | 10.6 | 3.5 | 66 | 9.9 | 3.2 | 0.70 [ -0.45, 1.85] | 3.70 |
| Berman 1982a | 14 | 10.1 | 2.4 | 17 | 11.1 | 2 | -1.00 [ -2.55, 0.55] | 2.42 |
| Berman 1982b-1 | 50 | 11.2 | 2.8 | 45 | 11.3 | 2.5 | -0.10 [ -1.17, 0.97] | 4.06 |
| Berman 1982b-2 | 46 | 10.7 | 3.3 | 37 | 9.8 | 2.5 | 0.90 [ -0.39, 2.19] | 3.19 |
| Berman 1984a | 20 | 11.7 | 1.3 | 22 | 11 | 2.4 | 0.70 [ -0.48, 1.88] | 3.57 |
| Galvin, 1986 | 10 | 10.1 | 1.58 | 10 | 10.2 | 1.26 | -0.10 [ -1.35, 1.15] | 3.31 |
| Jensh, 1984a | 9 | 12 | 2.92 | 11 | 9.55 | 4.32 | 2.45 [ -0.86, 5.76] | 0.64 |
| Jensh, 1984b | 8 | 11.63 | 4.53 | 10 | 11.7 | 3.27 | -0.07 [ -3.67, 3.53] | 0.55 |
| Lee, 2009-1 | 14 | 12.6 | 3.1 | 17 | 12.5 | 4.5 | 0.10 [ -2.68, 2.88] | 0.88 |
| Lee, 2009-2 | 20 | 12.4 | 3.2 | 20 | 14.5 | 1.9 | -2.10 [ -3.73, -0.47] | 2.23 |
| Merritt, 1984 | 10 | 10.9 | 3.57 | 10 | 10.9 | 4.98 | 0.00 [ -3.80, 3.80] | 0.49 |
| Nelson, 1991 | 27 | 8 | 2 | 18 | 6 | 3 | 2.00 [ 0.54, 3.46] | 2.65 |
| Ogawa 2009 * | 20 | 13.6 | 1.8 | 40 | 13.15 | 2.24 | 0.45 [ -0.68, 1.58] | 3.80 |
| Poulletier de Gannes 2012 * | 14 | 10.6 | 1.9 | 41 | 10.74 | 2.66 | -0.14 [ -1.65, 1.37] | 2.50 |
| Sambucci 2010 | 12 | 5.6 | 1.39 | 11 | 5.9 | 1.99 | -0.30 [ -1.69, 1.09] | 2.84 |
| Sharma 2017 * | 6 | 4.33 | .21 | 12 | 4.33 | .2 | 0.00 [ -0.20, 0.20] | 10.32 |
| Shirai 2014 * | 8 | 12.6 | 1.2 | 16 | 12.55 | 3.24 | 0.05 [ -2.29, 2.39] | 1.21 |
| Stasinopoulou 2016 | 20 | 8.65 | 2.41 | 11 | 7.55 | 3.38 | 1.10 [ -0.95, 3.15] | 1.53 |
| Takahashi 2010 * | 12 | 12.9 | 1.8 | 23 | 13.75 | 1.43 | -0.85 [ -1.94, 0.24] | 3.98 |
| Heterogeneity: $\tau^2$ = 0.05, $I^2$ = 15.21%, $H^2$ = 1.18 | | | | | | | 0.05 [ -0.21, 0.30] | |
| Test of $\theta_i = \theta_j$: Q(23) = 27.13, p = 0.25 | | | | | | | | |
| Test of $\theta$ = 0: z = 0.37, p = 0.71 | | | | | | | | |

# Litter size

- Litter size by Risk of Bias (Low or Some versus High)



| Study | Non Exposed N | Non Exposed Mean | Non Exposed SD | Exposed N | Exposed Mean Litter | Exposed SD | Mean diff. with 95% CI | Weight (%) |
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| Berman 1978-2 | 106 | 10.6 | 3 | 109 | 10.9 | 2.9 | -0.30 [ -1.09, 0.49] | 5.71 |
| Berman 1978-3 | 73 | 11.2 | 2.4 | 62 | 11 | 2.1 | 0.20 [ -0.57, 0.97] | 5.86 |
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| Berman 1982a | 14 | 10.1 | 2.4 | 17 | 11.1 | 2 | -1.00 [ -2.55, 0.55] | 2.42 |
| Berman 1982b-1 | 50 | 11.2 | 2.8 | 45 | 11.3 | 2.5 | -0.10 [ -1.17, 0.97] | 4.06 |
| Berman 1982b-2 | 46 | 10.7 | 3.3 | 37 | 9.8 | 2.5 | 0.90 [ -0.39, 2.19] | 3.19 |
| Berman 1984a | 20 | 11.7 | 1.3 | 22 | 11 | 2.4 | 0.70 [ -0.48, 1.88] | 3.57 |
| Galvin, 1986 | 10 | 10.1 | 1.58 | 10 | 10.2 | 1.26 | -0.10 [ -1.35, 1.15] | 3.31 |
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| Lee, 2009-2 | 20 | 12.4 | 3.2 | 20 | 14.5 | 1.9 | -2.10 [ -3.73, -0.47] | 2.23 |
| Merritt, 1984 | 10 | 10.9 | 3.57 | 10 | 10.9 | 4.98 | 0.00 [ -3.80, 3.80] | 0.49 |
| Nelson, 1991 | 27 | 8 | 2 | 18 | 6 | 3 | 2.00 [ 0.54, 3.46] | 2.65 |
| Ogawa 2009 * | 20 | 13.6 | 1.8 | 40 | 13.15 | 2.24 | 0.45 [ -0.68, 1.58] | 3.80 |
| Poulletier de Gannes 2012 * | 14 | 10.6 | 1.9 | 41 | 10.74 | 2.66 | -0.14 [ -1.65, 1.37] | 2.50 |
| Sambucci 2010 | 12 | 5.6 | 1.39 | 11 | 5.9 | 1.99 | -0.30 [ -1.69, 1.09] | 2.84 |
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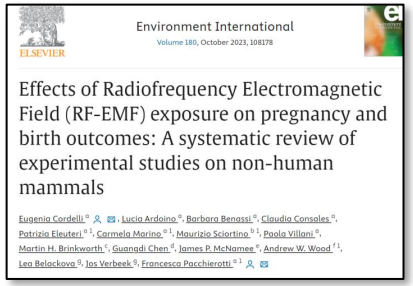
| Shirai 2014 * | 8 | 12.6 | 1.2 | 16 | 12.55 | 3.24 | 0.05 [ -2.29, 2.39] | 1.21 |
| Stasinopoulou 2016 | 20 | 8.65 | 2.41 | 11 | 7.55 | 3.38 | 1.10 [ -0.95, 3.15] | 1.53 |
| Takahashi 2010 * | 12 | 12.9 | 1.8 | 23 | 13.75 | 1.43 | -0.85 [ -1.94, 0.24] | 3.98 |
| Heterogeneity: $\tau^2$ = 0.05, $I^2$ = 15.21%, $H^2$ = 1.18 | | | | | | | 0.05 [ -0.21, 0.30] | |
| Test of $\theta_i = \theta_j$: Q(23) = 27.13, p = 0.25 | | | | | | | | |
| Test of $\theta$ = 0: z = 0.37, p = 0.71 | | | | | | | | |
| **High Concern** | | | | | | | | |
| Alchalabi 2016 * | 10 | 10.6 | 1.93 | 20 | 7.25 | 1.73 | 3.35 [ 1.99, 4.71] | 2.93 |
| Berman 1992-1 | 35 | 14.6 | 1.78 | 38 | 13.9 | 2.47 | 0.70 [ -0.30, 1.70] | 4.45 |
| Berman 1992-2 | 56 | 13.1 | 4.5 | 48 | 12.3 | 4.16 | 0.80 [ -0.88, 2.48] | 2.13 |
| Berman 1992-3 | 19 | 13.8 | 2.62 | 10 | 12.4 | 4.11 | 1.40 [ -1.05, 3.85] | 1.12 |
| Ferreira 2006 | 4 | 5.75 | 2.06 | 6 | 5.5 | 1.28 | 0.25 [ -1.80, 2.30] | 1.53 |
| Haghani, 2013 | 10 | 10.9 | 3.79 | 10 | 9.81 | 3.38 | 1.09 [ -2.06, 4.24] | 0.70 |
| Inaloz, 1997 * | 8 | 9 | 1.55 | 16 | 9 | 1.29 | 0.00 [ -1.17, 1.17] | 3.63 |
| Jensh, 1982a | 4 | 12 | 1.4 | 11 | 11.1 | 2 | 0.90 [ -1.25, 3.05] | 1.40 |
| Jensh, 1982b | 3 | 12.8 | 1.7 | 11 | 12.3 | 2.3 | 0.50 [ -2.32, 3.32] | 0.86 |
| Jensh, 1983a | 3 | 10.3 | .6 | 11 | 10.5 | 2.2 | -0.20 [ -2.78, 2.38] | 1.01 |
| Shibkova 2015 | 19 | 4.8 | 2.18 | 14 | 4.4 | 1.12 | 0.40 [ -0.85, 1.65] | 3.31 |
| Wang 2018 * | 6 | 9.25 | 1.26 | 12 | 9.25 | 1.28 | 0.00 [ -1.25, 1.25] | 3.32 |
| Heterogeneity: $\tau^2$ = 0.44, $I^2$ = 40.07%, $H^2$ = 1.67 | | | | | | | 0.77 [ 0.15, 1.39] | |
| Test of $\theta_i = \theta_j$: Q(11) = 18.35, p = 0.07 | | | | | | | | |
| Test of $\theta$ = 0: z = 2.43, p = 0.02 | | | | | | | | |
| **Overall** | | | | | | | 0.25 [ -0.02, 0.52] | |
| Heterogeneity: $\tau^2$ = 0.18, $I^2$ = 35.61%, $H^2$ = 1.55 | | | | | | | | |
| Test of $\theta_i = \theta_j$: Q(35) = 54.35, p = 0.02 | | | | | | | | |
| Test of $\theta$ = 0: z = 1.78, p = 0.07 | | | | | | | | |
| Test of group differences: $Q_b(1)$ = 4.45, p = 0.03 | | | | | | | | |



Random-effects DerSimonian–Laird model

World Health Organization



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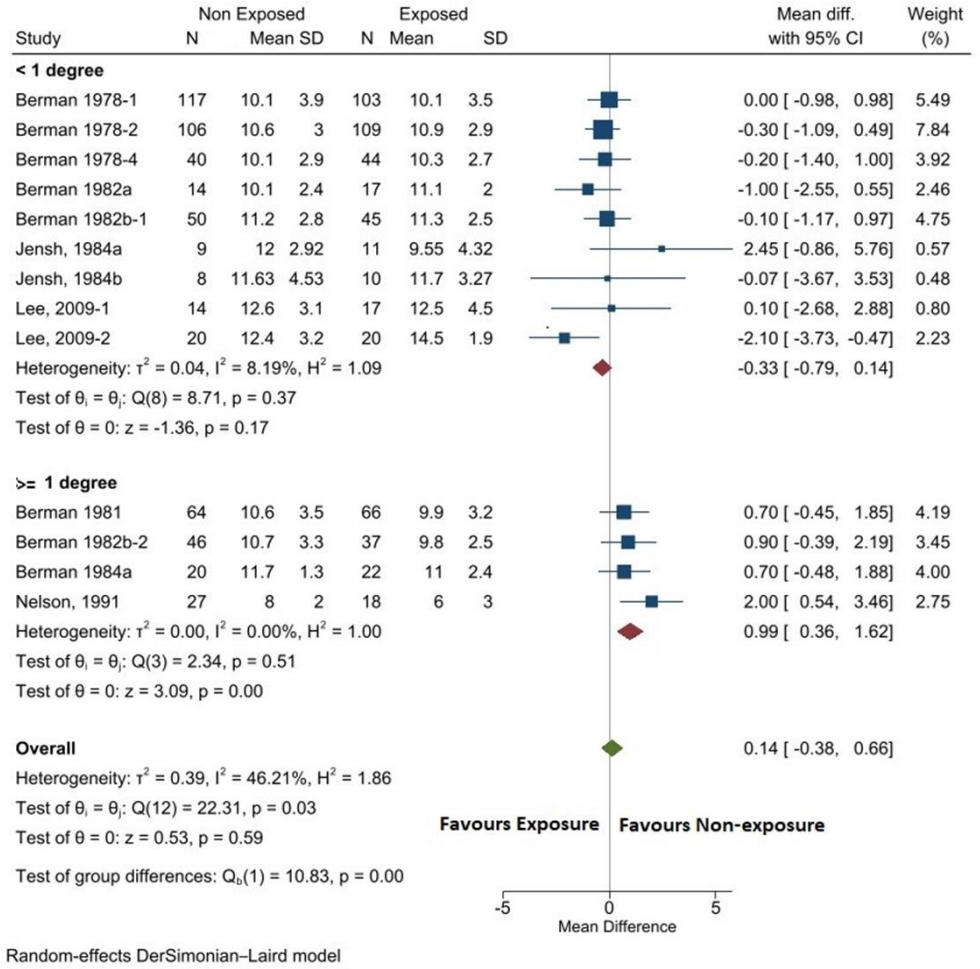
Effects of Radiofrequency Electromagnetic Field (RF-EMF) exposure on pregnancy and birth outcomes: A systematic review of experimental studies on non-human mammals

Eugenia Cordelli [a], Lucia Ardoino [a], Barbara Benassi [a], Claudia Consales [a], Patrizia Eleuteri [a, 1], Carmela Marino [a, 1], Maurizio Sciortino [a, 1], Paola Villani [a], Martin H. Brinkworth [c], Guangdi Chen [d], James P. McNamee [e], Andrew W. Wood [f, 1], Lea Belackova [g], Jos Verbeek [g], Francesca Pacchierotti [a, 1]

# Litter size

- Litter size by temperature increase

**Litter size: subgrouping by animal temperature**



# Certainty of effect or of lack of an effect

- Assessment of reasons to downgrade the certainty..
  1. Risk of bias
  2. Indirectness of the measure
  3. Inconsistency across studies
  4. Imprecision of the results
  5. Publication bias

- Resulting in
  - High certainty (no downgrade reasons)
  - Moderate certainty (some concern)
  - Low certainty (serious concern)
  - Very low certainty (very serious concern)

# Certainty of lack of effect on litter size

- Certainty of the evidence on litter size
  - Risk of bias: low
  - Indirectness: no, very direct measure
  - Inconsistency: no, similar results across studies
  - Imprecision: no narrow confidence interval
  - Publication bias: not observed

- Resulting in high certainty evidence

# More research

- Given possible delayed effects more research needed
- Improved quality of studies needed:
  - Standardized outcomes
  - Better exposure generation
  - Several exposure levels
  - Assessment of the outcome blinded for exposure status

# RF EMF hazard for fertility

- Task group will assess
  - Results systematic review animal studies: effect sizes and certainty
  - Results systematic review of human observational studies: effect sizes and certainty
  - Results of cell studies in scoping review

- Together this will result in a conclusion about the hazard of RF EMF for fertility (with and) under exposure without temperature increases

# RF EMF risk at given exposure

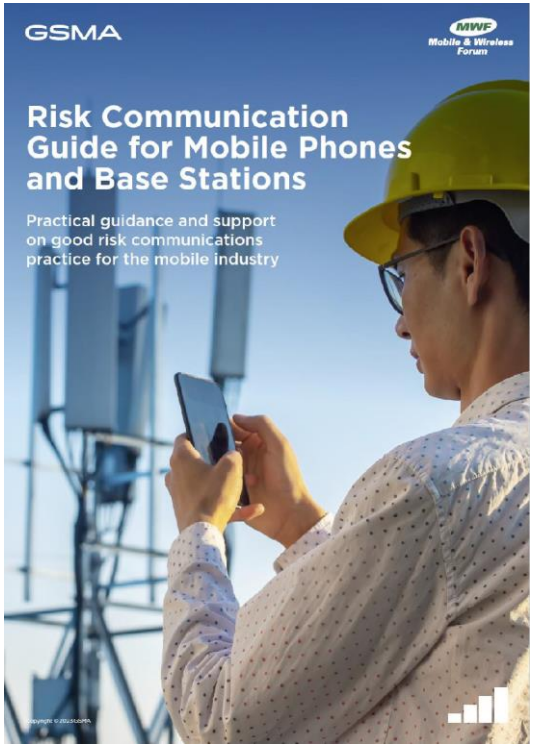
- Task Group will..
  - compare current exposure level against evidence of effects at various exposure levels
  - resulting in an indication of the number of persons that might be affected

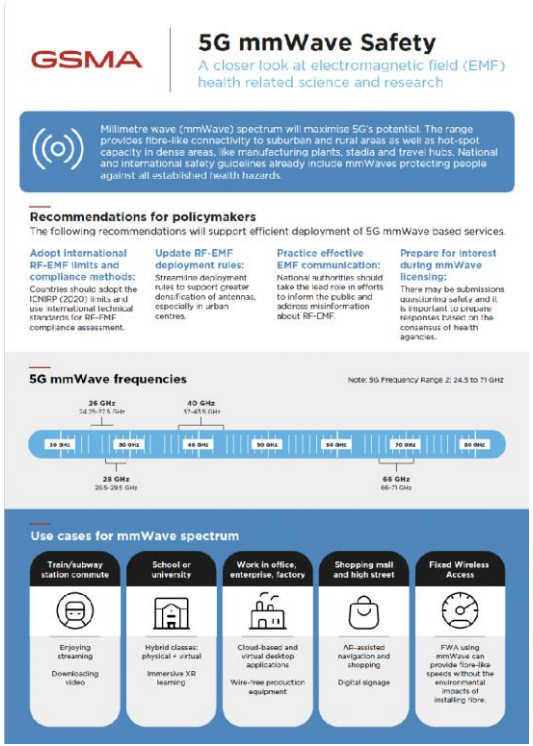
- If there is no hazard, then there will be no risk.

# Outlook

- October 2023 preliminary conclusions about RF EMF hazard for various adverse health outcomes
- February 2024 finalisation of EHC monograph and scoping report
- Publication summer 2024

# Focus on Risk Communication, IoT, and mmWaves





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PANEL DISCUSSION

# Evaluating the effectiveness of RF-EMF policies

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FIRESIDE CHAT

# Summary and Conclusions

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