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The 11th EMF Forum

The future of EMF Policy Harmonisation

Tuesday, 11 October 2022

#EMFFORUM

Download EMF Forum event guide

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Welcome and introduction

Daniel Pataki
Vice President, Policy and Regulation &
Head of Europe
GSMA

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Download 5G mmWave safety report

Status of the WHO RF-EMF risk assessment process

Dr Emilie van Deventer
Head, Radiation and Health Unit
World Health Organization

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Status of the WHO RF-EMF risk assessment process

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

11th GSMA EMF Forum, London, 11 October 2022

Outline

- Introduction
- The Radiofrequency Fields activity
- The WHO approach to assessing risks
- Discussion

The World Health Organization

- Established on **7 April 1948**
- **Function**: act as the UN directing and coordinating authority on international health work
- **Objective**: attainment by all peoples of the highest possible level of health
- **Health**: “A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” (WHO Constitution, 1948)

The WHO 3-level structure

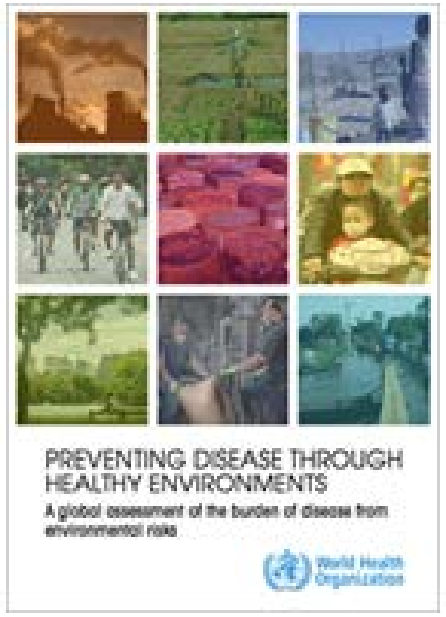
Over 7000 people work for WHO in

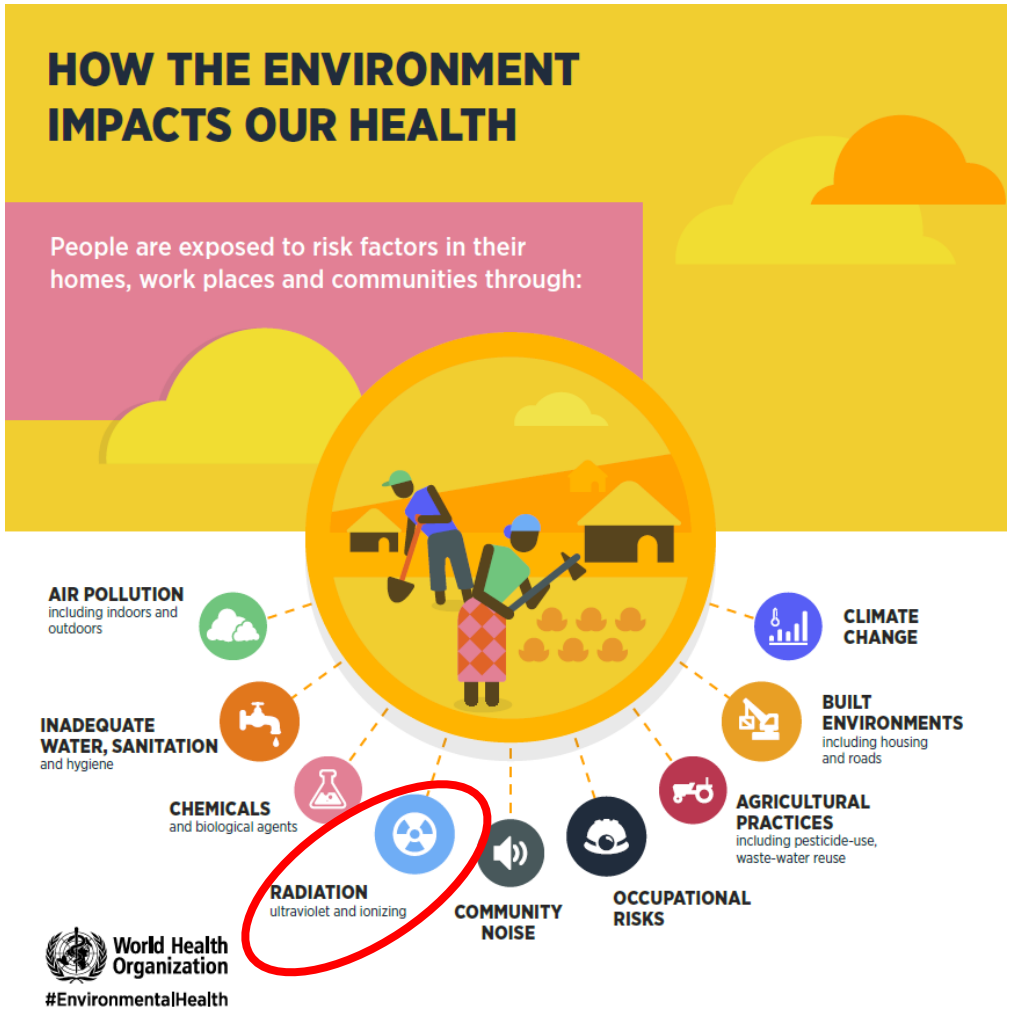
- Headquarters (Geneva)
- 6 Regional Offices
- 150 Offices in Countries, Territories and Areas
- International Agency for Research on Cancer (IARC)

WHO's core functions

- Articulate ethical and **evidence-based** policy positions
- Setting **norms and standards**, and promoting and monitoring their implementation
- Shaping the **research agenda**, and stimulating the generation, translation and dissemination of valuable knowledge
- Providing **technical support**, catalysing change and developing sustainable institutional capacity
- Monitoring the **health situation** and assessing health trends
- Providing leadership on matters critical to health and engaging in **partnerships** where joint action is needed

Public Health and Environment



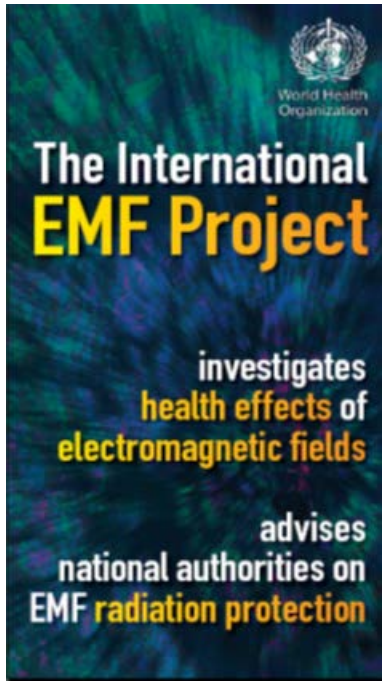


World Health Organization

Both **ionizing** and **non-ionizing radiation** are covered by the WHO Radiation and Health Unit

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



Outline

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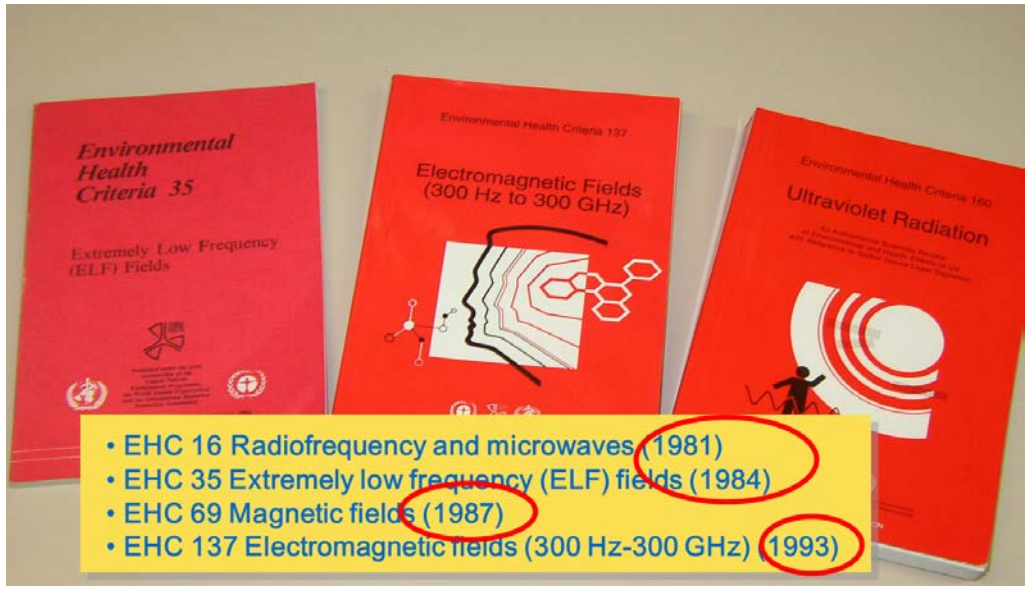
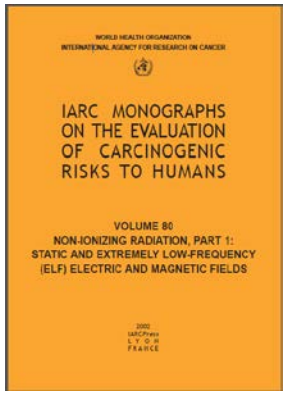
- **The Radiofrequency Fields activity**
- The WHO approach to assessing risks
- Discussion

WHO Monographs on EMF

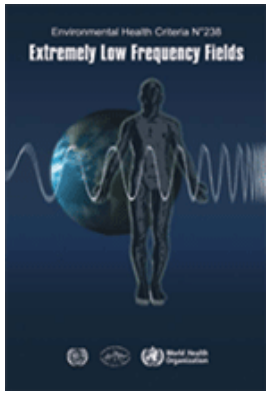


Health risk assessments

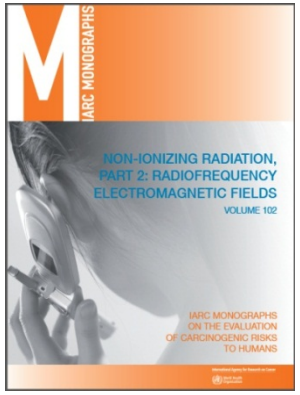


2002

2006



2007



2013

RF Fields

Health Risk Assessment

World Health Organization

Problem Formulation

Hazard Identification

Review key research to identify any potential health problems that an agent can cause

International Agency for Research on Cancer (IARC)

Centre International de Recherche sur le Cancer (CIRC)

Exposure-Response Assessment

Estimate how much of the agent it would take to cause varying degrees of health effects that could lead to illnesses

Exposure Assessment

Determine the amount, duration and pattern of exposure to the agent

Risk Characterization

Assess the risk for the agent to cause cancer or other illnesses in the general population

RF fields classified as
"*possibly carcinogenic to humans*"
(Group 2B)

Health Risk Assessment (cont'd)

World Health Organization

International EMF Project

Problem Formulation

Hazard Identification

Review key research to identify any potential health problems that an agent can cause

Exposure Assessment

Determine the amount, duration and pattern of exposure to the agent

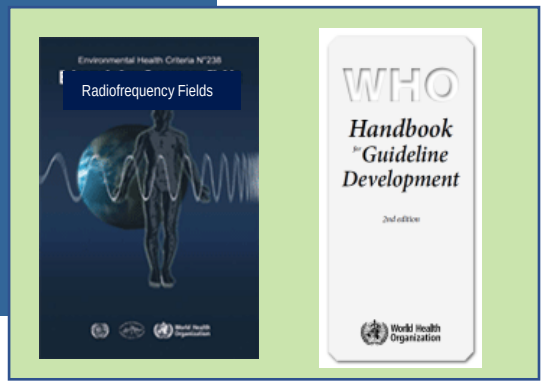
Exposure-Response Assessment

Estimate how much of the agent it would take to cause varying degrees of health effects that could lead to illnesses

Risk Characterization

Assess the risk for the agent to cause cancer or other illnesses in the general population

All studied outcomes



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

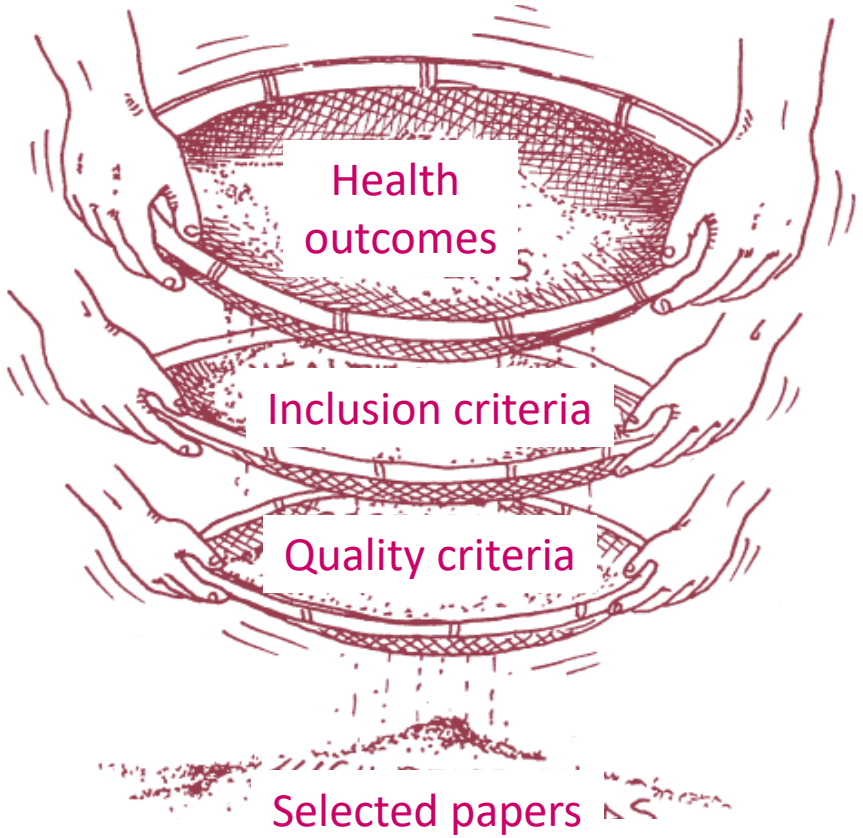
Amit Dhungel[1,*], Denis Zmirou-Navier[1,2] and Emilie van Deventer[3]
[1]Department of Environmental and Occupational Health, EHESP School of Public Health, Avenue du Professeur Léon Bernard CS 74312, 35043 Rennes, France
[2]Lorraine University School of Medicine, av. de la Forêt de Haye, 54505 Vandoeuvre-Les-Nancy,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

Scope and target audience

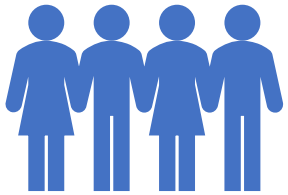
- Scope
  - Radiofrequency fields from 100 kHz to 300 GHz
  - Public and occupational exposures (not medical exposures)

- 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

Screening Process



Inclusion criteria



Epidemiological studies

Study base identified (to allow assessment of the representativity of the participants)

Exposed and unexposed groups considered

Relevant statistical analysis performed

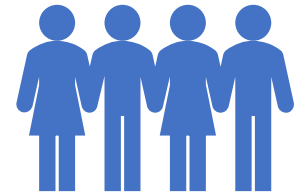
Laboratory studies

At least two exposure levels, whereof one could be a sham exposure under otherwise similar conditions

Exposure conditions blinded to the participants (human studies only)

Quality criteria

- **Epidemiological studies**
  - STROBE checklist, GRADE, Newcastle-Ottawa Scale



- **Experimental studies**
  - Volunteer studies
    - CONSORT statement and checklist, Gold Standard Publication Checklist
  - Animal studies
    - Gold Standard Publication Checklist
  - In-vitro studies
    - Dosimetry, statistical analysis, T control,…

Narrative review (2012-17)

World Health Organization

- Kickoff meeting of a Core Group of experts (2012)
- International survey of radiofrequency policies (2012)
- International stakeholders meeting, Paris, France (2013)
- Online first draft for comments (Fall 2014) – over 700 comments
- Incorporation of comments in the draft (2015)
- WHO request for systematic review process (2016)
  - *"although the types of questions that are being examined and the statements that will be issued are **not typical ones related to interventions**, they will have global impact and must be based on a systematic review of the evidence and transparent, explicit processes that minimize bias. Thus the **basic principles for guideline development** apply".*
  - Contracted a methodologist

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- **The WHO approach to assessing RF risks**
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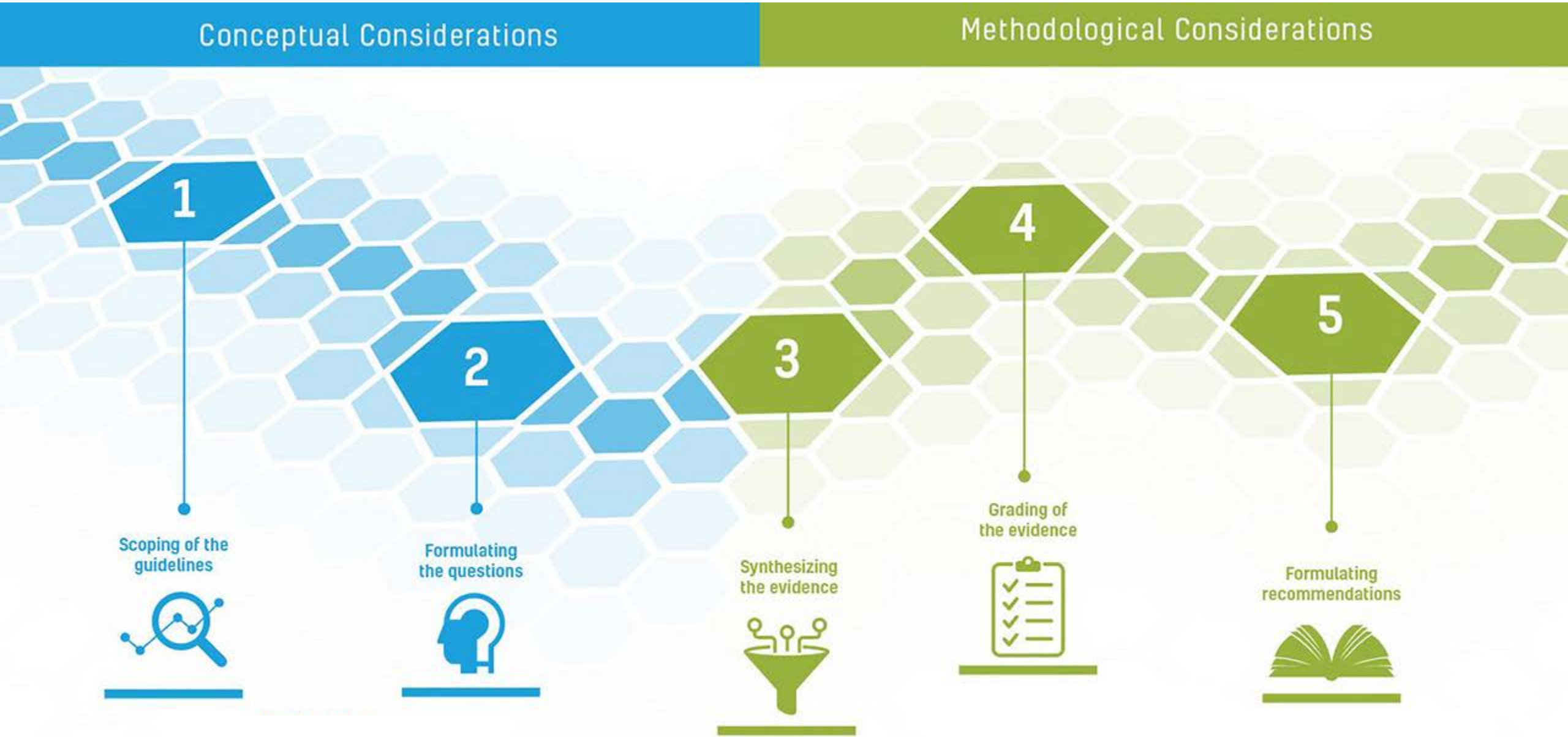
Systematic reviews

- A systematic review is a scientific investigation that focuses on a specific question and uses explicit, prespecified scientific methods to identify, select, assess, and summarize the findings of similar but separate studies.
- Objective is to summarize evidence from multiple studies using explicit methods
- Systematic reviews are designed to provide
  - methodological rigour
  - transparency
  - reproducibility

Source: WHO SR workshop, 2013, Doug Altman, Centre for Statistics in Medicine University of Oxford


Conceptual Considerations
Methodological Considerations
1
Scoping of the guidelines
2
Formulating the questions
3
Synthesizing the evidence
4
Grading of the evidence
5
Formulating recommendations

Relative importance of outcomes

- To prioritize health outcomes, WHO sought the opinion of experts on the topic of radiofrequency electromagnetic field exposures and health
- Online survey titled "Rating Potential Adverse Health Outcomes of Exposure to Radiofrequency Fields" (2018)
- Over 300 RF experts were invited, and 167 responses received.

Environment International 146 (2021) 106300

Contents lists available at ScienceDirect

Environment International

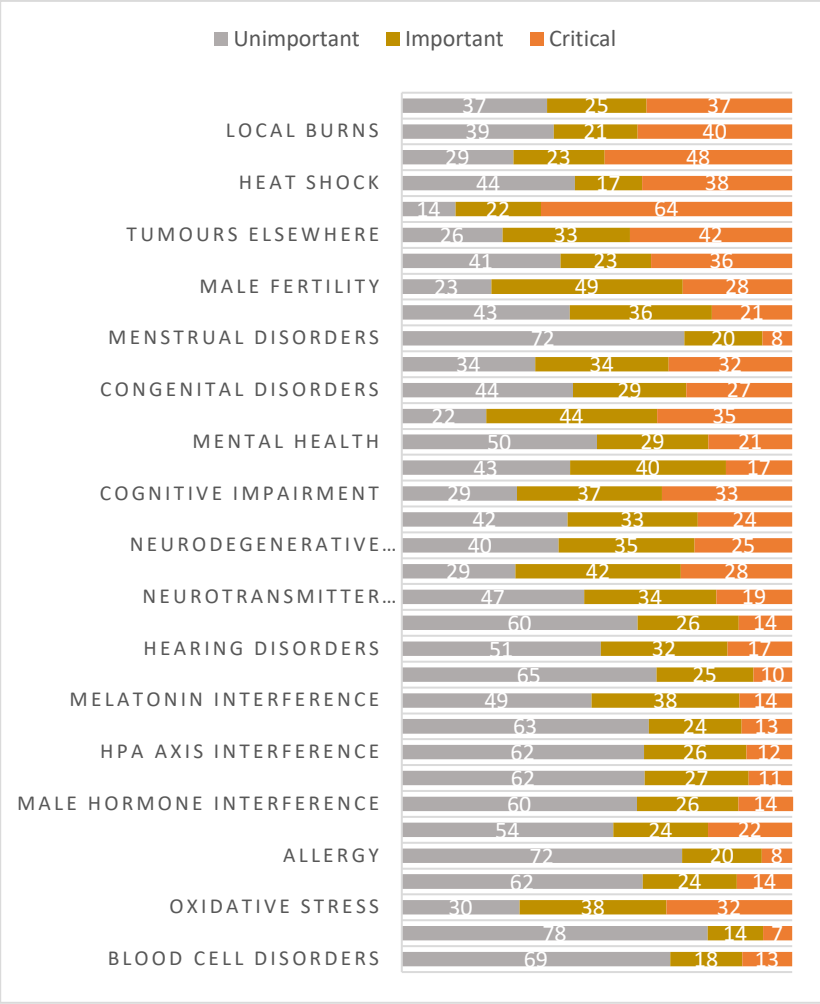
journal homepage: www.elsevier.com/locate/envint

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

Jos Verbeek [a,*], Gunnhild Oftedal [b], Maria Feychting [c], Eric van Rongen [d], Maria Rosaria Scarfì [e], Simon Mann [f], Rachel Wong [g], Emilie van Deventer [h]

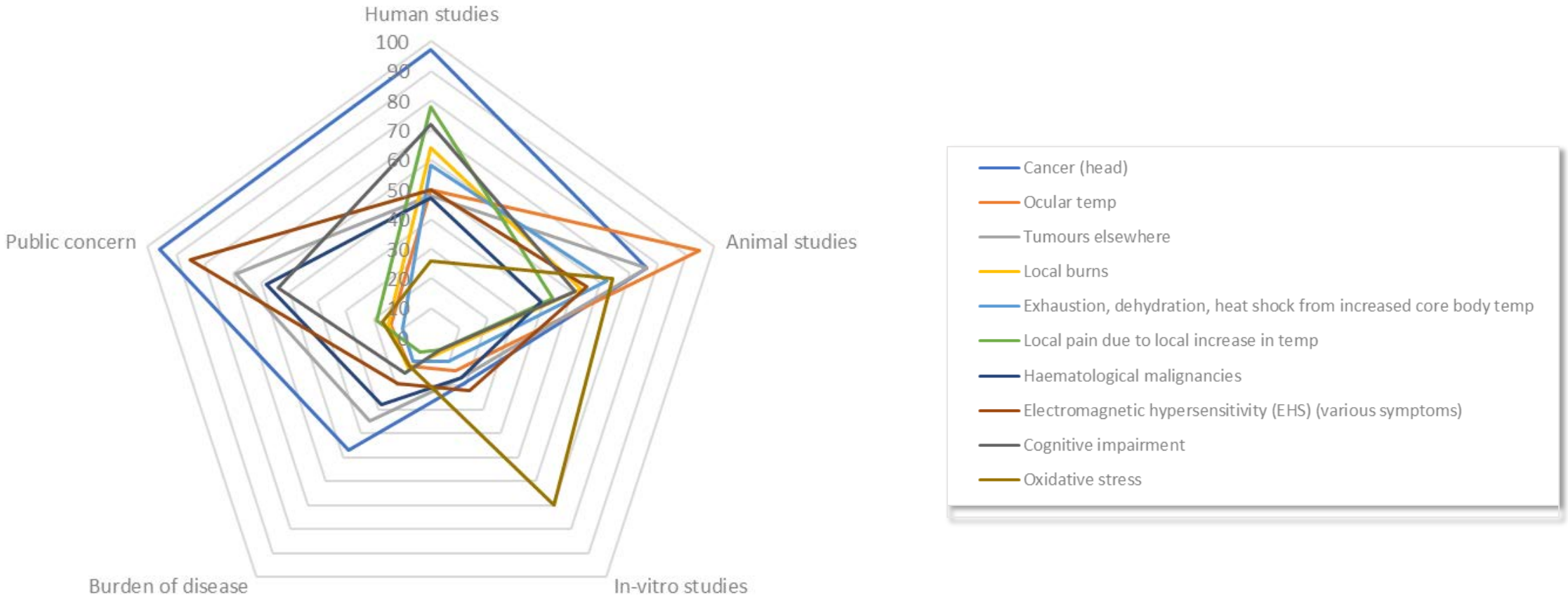
[a] Amsterdam University Medical Center, Cochrane Work Review Group, Amsterdam, the Netherlands
[b] Department of Electronic Systems, Norwegian University of Science and Technology - NTNU, Trondheim, Norway
[c] Unit of Epidemiology, Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden
[d] Health Council of the Netherlands, Den Haag, the Netherlands
[e] National Research Council, Institute for Electromagnetic Sensing of the Environment, Naples, Italy
[f] Public Health England, Chilton, Didcot, United Kingdom
[g] University of Toronto, Toronto, Canada
[h] Department of Environment, Climate Change and Health, World Health Organization, Geneva, Switzerland

International survey of priority outcomes



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

Priority outcomes
Rationale



Systematic reviews

Observational and experimental studies

Observational studies	Human volunteer studies	Animal studies	In-vitro studies
SR1 - Cancer		SR2 - Cancer	
SR3 - Adverse reproductive outcomes		SR4 - Adverse reproductive outcomes	SR4 - Adverse reproductive outcomes
SR5 - Cognitive impairment	SR6 - Cognitive impairment		
SR7 - Symptoms	SR8 - Symptoms		
		SR9 - Oxidative stress	SR9 - Oxidative stress
SR10 – Heat and pain, burns, cataract, etc.	SR10 – Heat and pain, burns, cataract, etc.		

Systematic reviews:
Deliverables

1. **Protocol** submission to *Environment International*
2. **Registration** of the protocol in Prospero (or other appropriate protocol database)
3. **Systematic review** submission to *Environment International*

Environment International

Peer-reviewed journal

Environment International is a peer-reviewed scientific journal covering environmental science and health. It was established in 1978 and is published eight times per year by Elsevier. The co-editors-in-chief are Adrian Covaci, Mark Nieuwenhuijsen, Zhen He, and Yongguan Zhu. Wikipedia

Impact factor: 7.943 (2018)

History: 1978-present

ISO 4: Environ. Int

LCCN: 81649513

People also search for: Environmental Research, MORE

Editors: Adrian Covaci, Mark Nieuwenhuijsen, Zhen (Jason) He, Zhu Yongguan

Disciplines: Environmental science, Environmental health

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9.621

Impact Factor

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WHO assessment of health effects of exposure to radiofrequency electromagnetic fields: systematic reviews

Edited by Sharea Ijaz, Jean-François Doré, Sarah Drießen, Paul Whaley

FEEDBACK

Nine out of the 10 systematic review **protocols** have been published

Technical outputs

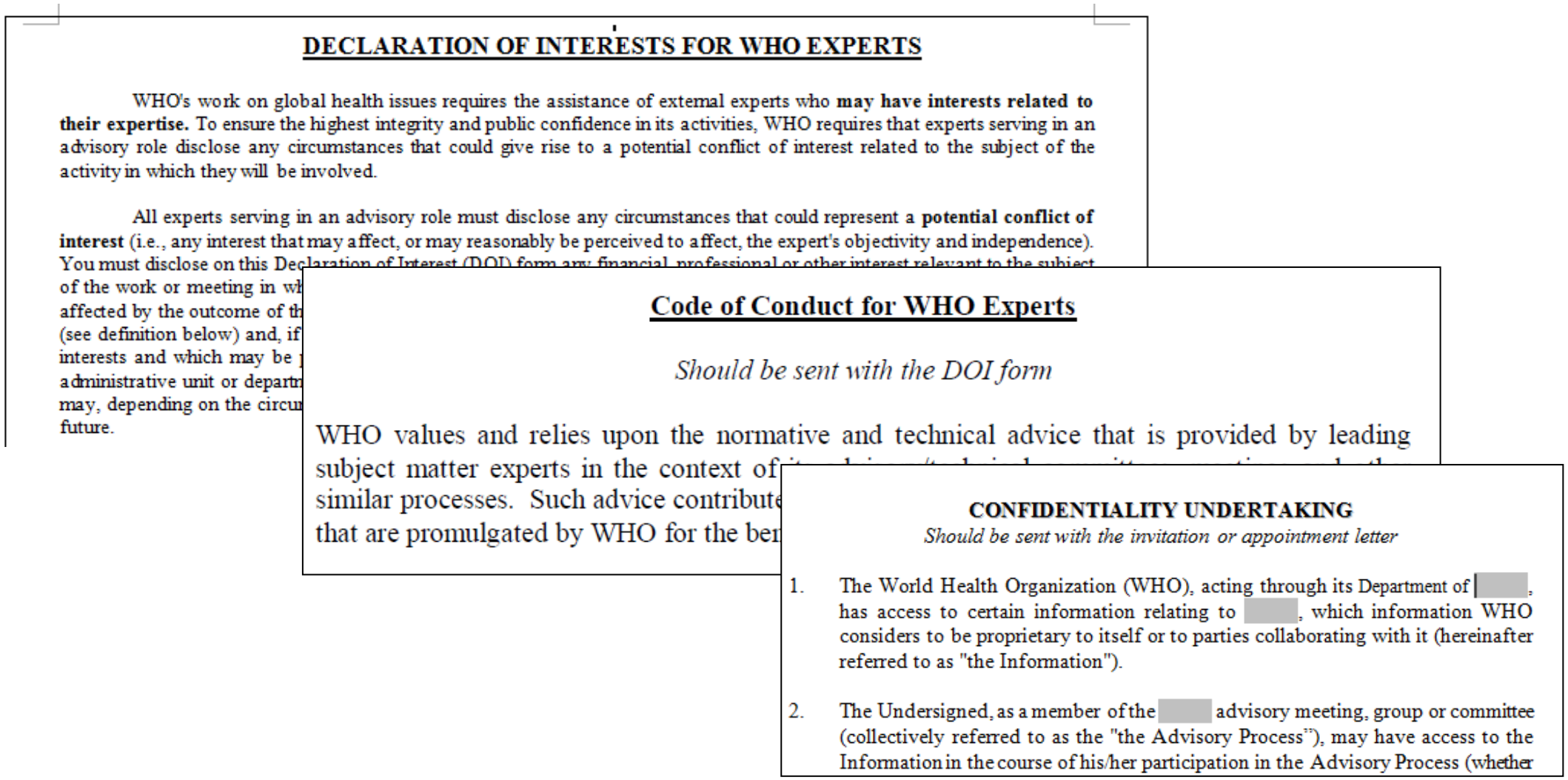
The appraisal of the evidence for health risks associated with exposure to RF fields to result in

- A **Technical Report** (scoping review of the scientific literature of studied health outcomes)
- A series of **Systematic Reviews** on priority health outcomes to be published in a special issue of *Environment International*
- An **EHC Monograph** that will elaborate on the health outcomes highlighted in the review process, using procedures for guideline development as recently required by WHO
- A RF **Research Agenda**
- Journal publications

Contributors

- Core Group (6 members) and expert working group members (~ 20-30)
- Systematic review teams
- Task Group members
  - Individual scientists, not representatives of their organizations
  - Composition dictated by range of expertise and views, gender and geographical distribution
- Observers
- Secretariat

Declaration of Interests



DECLARATION OF INTERESTS FOR WHO EXPERTS

WHO's work on global health issues requires the assistance of external experts who **may have interests related to their expertise.** To ensure the highest integrity and public confidence in its activities, WHO requires that experts serving in an advisory role disclose any circumstances that could give rise to a potential conflict of interest related to the subject of the activity in which they will be involved.

All experts serving in an advisory role must disclose any circumstances that could represent a **potential conflict of interest** (i.e., any interest that may affect, or may reasonably be perceived to affect, the expert's objectivity and independence). You must disclose on this Declaration of Interest (DOI) form any financial, professional or other interest relevant to the subject of the work or meeting in wh
affected by the outcome of th
(see definition below) and, if
interests and which may be
administrative unit or departm
may, depending on the circu
future.

Code of Conduct for WHO Experts

Should be sent with the DOI form

WHO values and relies upon the normative and technical advice that is provided by leading subject matter experts in the context of
similar processes. Such advice contribute
that are promulgated by WHO for the ben

CONFIDENTIALITY UNDERTAKING

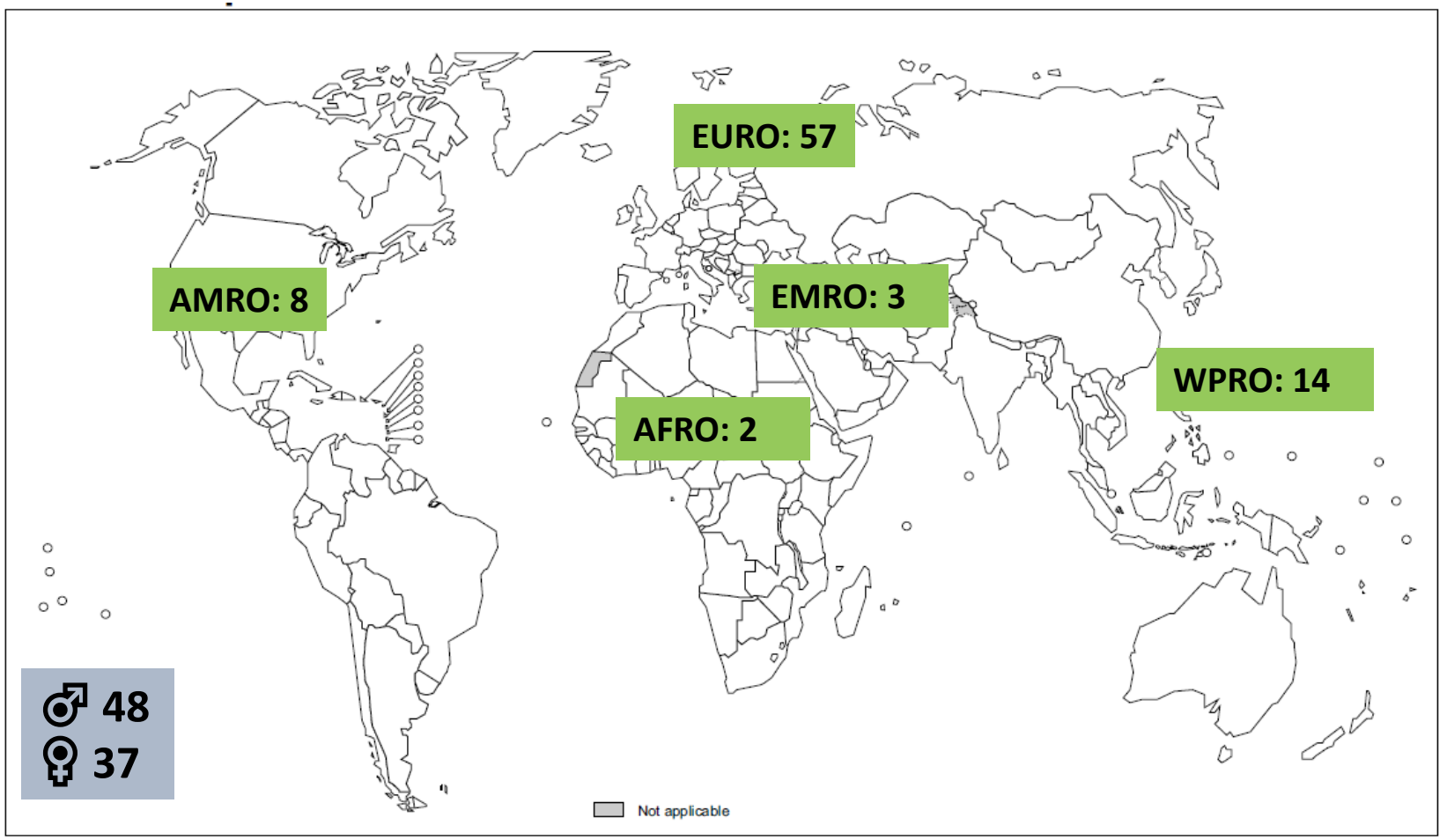
Should be sent with the invitation or appointment letter

1. The World Health Organization (WHO), acting through its Department of [redacted], has access to certain information relating to [redacted], which information WHO considers to be proprietary to itself or to parties collaborating with it (hereinafter referred to as "the Information").

2. The Undersigned, as a member of the [redacted] advisory meeting, group or committee (collectively referred to as the "the Advisory Process"), may have access to the Information in the course of his/her participation in the Advisory Process (whether

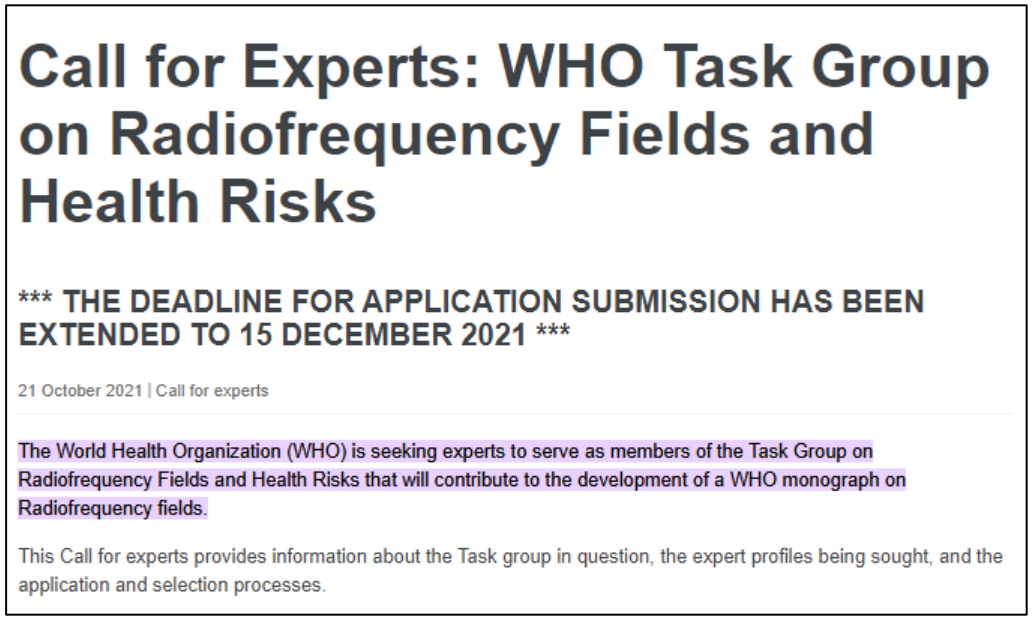
Systematic Review Teams

Experts



Data Source: **World Health Organization**
Map Production: **WHO Graphics**

Task Group of Experts



Call for Experts: WHO Task Group on Radiofrequency Fields and Health Risks

***** THE DEADLINE FOR APPLICATION SUBMISSION HAS BEEN EXTENDED TO 15 DECEMBER 2021 *****

21 October 2021 | Call for experts

The World Health Organization (WHO) is seeking experts to serve as members of the Task Group on Radiofrequency Fields and Health Risks that will contribute to the development of a WHO monograph on Radiofrequency fields.

This Call for experts provides information about the Task group in question, the expert profiles being sought, and the application and selection processes.

https://www.who.int/news-room/articles-detail/call-for-experts-who-task-group-on-radiofrequency-fields-and-health-risks#:~:text=The%20World%20Health%20Organization%20(WHO,WHO%20monograph%20on%20Radiofrequency%20fields

- Call for experts (Fall 2021)
- Over 60 candidates
- 20 experts have been short-listed

- Main tasks
  - review the draft of the scoping report
  - draw conclusions for each health outcome in the EHC monograph based on the scoping report and the systematic reviews

The Word Health Organization

"Health is a complete state of physical, mental and social well-being, and not merely the absence of disease or infirmity“

WHO's Constitution (1948)

Is there a health risk from Wi-Fi – results of a systematic review

Professor Martin Röösli
Head of Environmental Exposures and Health Unit
Swiss Tropical and Public Health Institute

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Swiss TPH

The 11th GSMA EMF Forum, London
11 October 2022

Is there a health risk from Wi-Fi: results of a systematic review

Martin Röösli, Swiss Tropical and Public Health Institute, Allschwil (Basel)

CRITICAL REVIEWS IN ENVIRONMENTAL SCIENCE AND TECHNOLOGY
https://doi.org/10.1080/10643389.2021.1951549

Taylor & Francis
Taylor & Francis Group

Health effects of WiFi radiation: a review based on systematic quality evaluation

Stefan Dongus[a,b], Hamed Jalilian[c], David Schürmann[d], and Martin Röösli[a,b]

[a]Department of Epidemiology and Public Health, Swiss Tropical and Public Health Institute, Basel, Switzerland; [b]University of Basel, Basel, Switzerland; [c]Department of Occupational Health Engineering, Research Center for Environmental Pollutants, Faculty of Health, Qom University of Medical Sciences, Qom, Iran; [d]Department of Biomedicine, University of Basel, Basel, Switzerland

https://www.tandfonline.com/doi/full/10.1080/10643389.2021.1951549

Exposure vs. distance from laptop

Measurements during maximum data transmission (Peak = average)

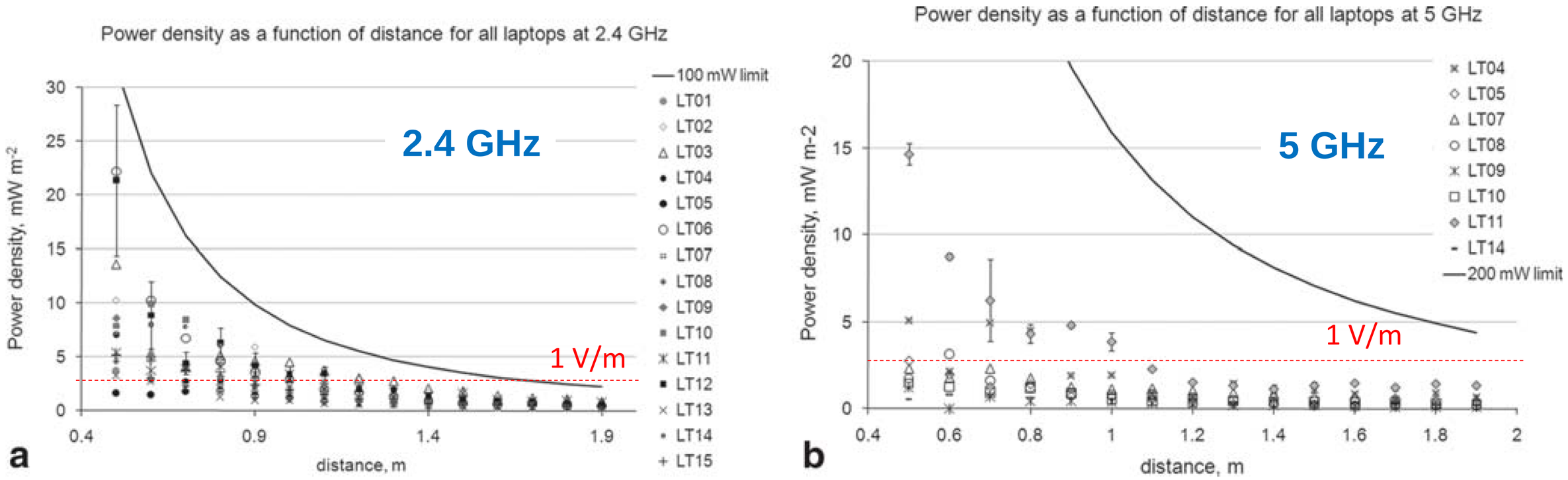

Fig. 8. Variation of power density as a function of distance for laptops operating at (a) 2.4 GHz and (b) 5 GHz band. The power density calculated from an EIRP equal to 100 mW and 200 mW limits are shown for comparison. The error bars represent the standard deviation of a given set of samples recorded by the signal analyzer at that position. For clarity, only the largest set of error bars is shown.

Peyman et al., Health Phys, 2011

Personal measurements of 148 adolescents from Greater London (2015-2018)

Environmental Research 212 (2022) 113252

Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres

Check for updates

Personal radiofrequency electromagnetic field exposure of adolescents in the Greater London area in the SCAMP cohort and the association with restrictions on permitted use of mobile communication technologies at school and at home

Claudia Schmutz [a,b], Alexandra Bürgler [a,b], Narain Ashta [a,b], Jana Soenksen [a,b], Yasmin Bou Karim [c,d], Chen Shen [c,d], Rachel B. Smith [c,d,e], Rosemary H. Jenkins [c,d,f], Michael O. Mireku [c,g], Julian Mutz [c,d,h], Mikaël J.A. Maes [c,i,j], Rosi Hirst [c], Irene Chang [c], Charlotte Fleming [c], Aamirah Mussa [c], Daphna Kesary [c], Darren Addison [k], Myron Maslanyj [k], Mireille B. Toledano [c,d,e], Martin Röösli [a,b], Marloes Eeftens [a,b,*]

https://www.sciencedirect.com/science/article/pii/S0013935122005795

Personal measurements of 148 adolescents from Greater London (2015-2018)

Median Total EMF:

100 µW/m² (0.19 V/m)

Median WiFi:

7.7 µW/m² (0.05 V/m)

ICNIRP limit: 10 W/m²

(i.e. >1 million higher than median WiFi level)

Environmental Research 212 (2022) 113252

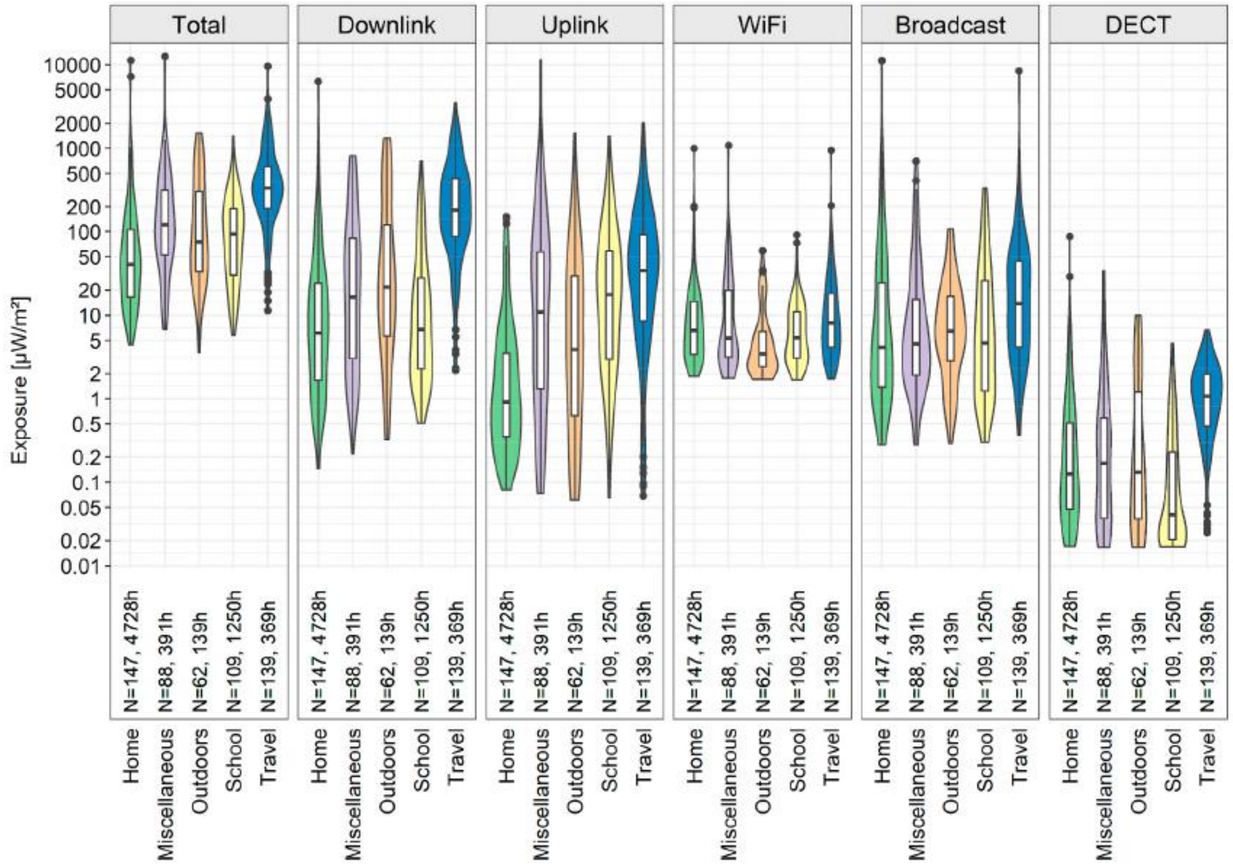

Fig. 2. Violin and boxplot of individual mean RF-EMF exposure by activity, for total exposure, downlink, uplink, WiFi, broadcast and DECT. Violins show the kernel probability density of the data at different values, where the width of the curve corresponds with the approximate frequency of occurrence of data points. Boxplots show the median as a thick line and the interquartile range (IQR) as a box. The whiskers extend to the 25th percentile – 1.5 * IQR (lower) and the 75th percentile + 1.5 * IQR (higher). Dots portray any observations for a single adolescent beyond the whiskers' range.

Table 1 Results of personal exposure to radiofrequency electromagnetic fields from the Wi-Fi band in schools or universities (indoor/classroom or outside environment)

Author	Country	Source	E (V/m)	Power density (μW/m²)
Khalid et al. 2011 (3)	United Kingdom / 3 primary, 3 secondary schools	access points*/ 0.5	5.70[b]	86200[b]
Pyman et al. 2011 (4)		Laptops / 0.5	2.90[b]	22300[b]
Joseph et al. 2010 (5)	Hungary / 31 primary school teacher	Wi-Fi devices*	2.00–5.00[a]	10600–66300[a]
Vermeeren et al. 2013 (6)	Belgium (10 school area)	various Wi-Fi devices*#	0.0500[a], 0.240[b]	6.63[a], 153[b]
	Greece (5 school area)		0.0900[a], 0.200[b]	21.5[a], 106[b]
Verloock et al. 2014 (7)	Belgium / 5 primary and secondary schools	access points, various Wi-Fi clients*#	0.340[a], 2.52[b]	307[a], 16800[b]
Gledhill 2014 (8)	New Zealand / 2 schools	access points# / 2 laptops / <0.5	0.971[a], 2.746[b] 0.868[a], 3.36[b]	2500[a], 20000[b] 2000[a], 30000[b]
Karipidis et al. 2017 (9)	Australia / 7 primary 16 secondary schools	access points*# / 1.9	0.388[a], 3.88[b]	400[a], 40000[b]
Prlić et al. (1)	Croatia /151 primary & secondary schools	access points*# / across whole classroom (grid 1×1 m)	<0.661[b]	<1160[b]
Roser et al. 2017 (10)	Switzerland / at school	using WLAN band	0.0351[a]	3.27[a]
Kurnaz et al. 2018 (11, 12)	Turkey / inside classroom	WLAN band	0.0220[a]	1.28[a]
Fernandez 2020 (13)	Spain / inside university	Wi-Fi band	0.0310[a]	2.55[a]
Vermeeren et al. 2013 (6)	Belgium / inside schools	Wi-Fi band	0.0500[a]	6.64[a]
Hardell et al. 2017 (14)	Sweden / schools	Wi-Fi band	0.0354[a]	3.32[a]
Bhatt et al. 2016 (15)	Greece / school area	Wi-Fi band	0.0635[a]	10.7[a]
Hamiti et al. 2022 (16)	Kosovo / school area	Wi-Fi band	0.0835[a]	18.5[a]
Vermeeren et al. 2013 (6)	Greece / inside schools	2G Wi-Fi band	0.0898[a]	21.4[a]
Ramirez-Vazquez et al. 2020 (17)	Jordanian / total exposure in university area	Wi-Fi band (2G and 5G bands)	0.0931[a]	23.0[a]
Ramirez-Vazquez et al. 2020 (18)	Spain / inside school buildings	Wi-Fi band (2G and 5G bands)	0.0977[a]	25.3[a]
Ramirez-Vazquez et al. 2020 (17)	Jordanian / university area	Wi-Fi band (2G and 5G bands)	0.104[a]	28.8[a]
Hedendahl et al. 2017 (19)	Sweden / in seven schools	Wi-Fi band connection	0.158[a]	66.1[a]
Ibrani et al. 2016 and Hamiti et al. 2018 (20, 21)	Kosovo / different offices	Wi-Fi band	0.163[a]	70.2[a]
Bhatt et al. 2016 (15)	Australia / kindergarten area	Wi-Fi band	0.179[a]	85.0[a]
Verloock et al. 2014 (7)	Belgium / inside schools	Wi-Fi band	0.200[a]	106[a]
Gallastegi et al. 2018 (22)	Spain / inside classroom	different sources including Wi-Fi band	0.213[a]	120[a]
Lahham et al. 2017 (23)	Palestine / inside schools	WLAN band	0.005[a]	0.0600[a]
Lahham et al. 2017 (23)	Palestine / inside universities area)	WLAN band	0.008[a]	0.180[a]
Relevant ICNIRP reference levels[§]			61 V/m	10 W/m²

*2.4–2.5 GHz; #5.15–5.85 GHz. [a] average value; [b] maximum value; [§] reference levels for general public exposure to time-varying electric and magnetic fields: electric field strength and equivalent plane wave power density refer to the 2–300 GHz frequency range (24)

Typical levels: <0.2 V/m

Arribas, AHRT, 2022
https://arhiv.imi.hr/index.php/arhiv/article/view/1531

Motivation

- WLAN devices transmit short pulses (bursts), depending on the actual data traffic in the network
  (in stand-by a duty cycle of 10 Hz).
- In the absence of data traffic, peak to average ratio (crest factor) is about 100
- To be speculated that this type of exposure is particularly biologically relevant.
- Complaints: sleep problems, headache and other non-specific symptoms

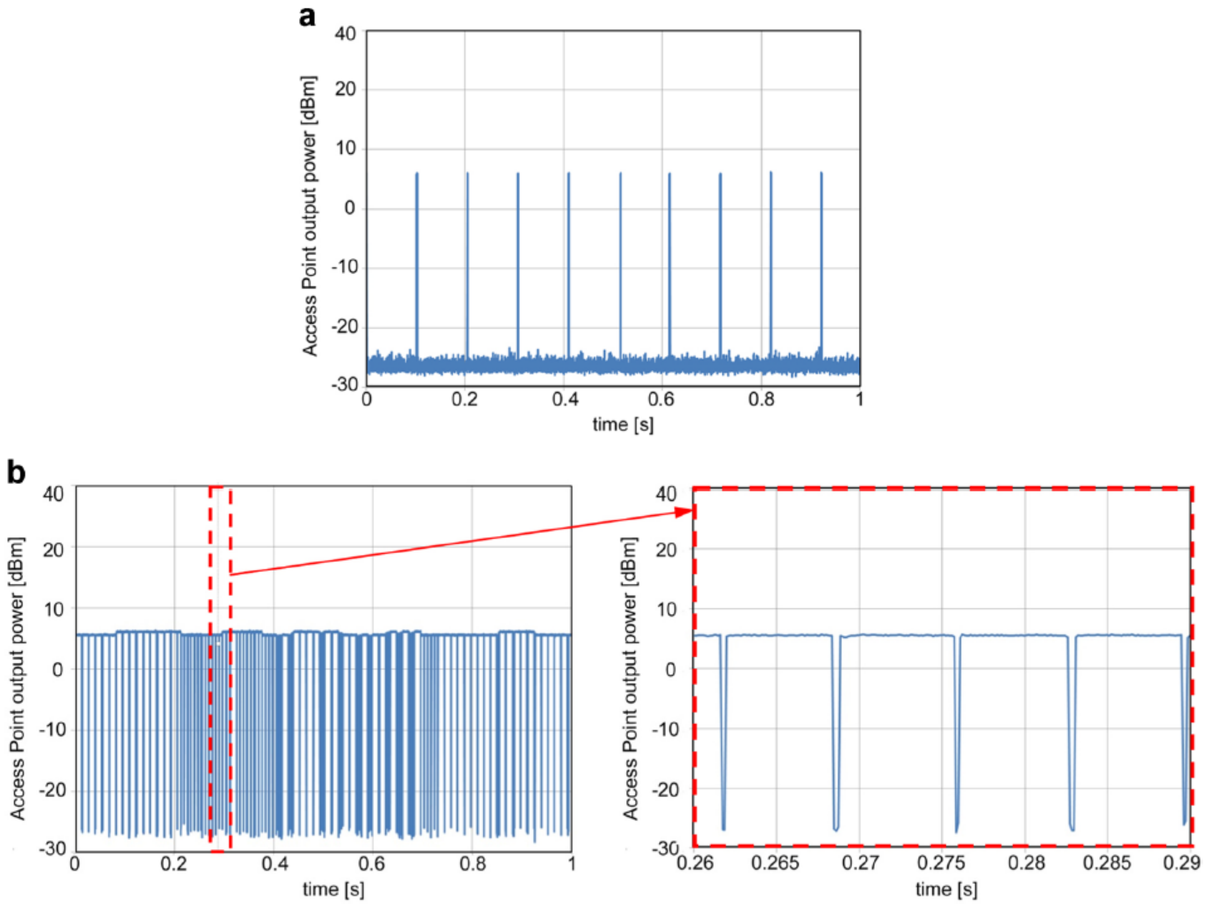

Fig. 1. Time domain characteristics of a typical wireless local area network (WLAN) signal according to IEEE 802.11-2007 during “beacon only” transmission (**a**) and maximum data transmission rate (**b**), measured at the radiofrequency (RF) output of the access point.

Schmid et al., BioEM, 2020

Existing reviews

- **Foster & Moulder (2013):**
  - Few studies included due to stringent inclusion criteria
  - “Several studies observed biological effects due to WiFi-type exposures, but technical limitations prevent drawing conclusions about possible health risks”
- **Wilke (2018):**
  - Not peer-reviewed; > 100 studies included
  - “damage to the reproductive system, impacts on the EEG and brain functions, as well as effects on the heart, liver, thyroid, gene expression, cell cycle, cell membranes, bacteria, and plants.”


THE RADIATION SAFETY JOURNAL
HEALTH PHYSICS

Wi-Fi and Health

Review of Current Status of Research

Foster, Kenneth R.*; Moulder, John E.†

Author Information

Health Physics: December 2013 - Volume 105 - Issue 6 - p 561-575
doi: 10.1097/HP.0b013e31829b49bb


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Review

Biological and pathological effects of 2.45 GHz radiation on cells, fertility, brain, and behavior

Isabel Wilke

Existing reviews

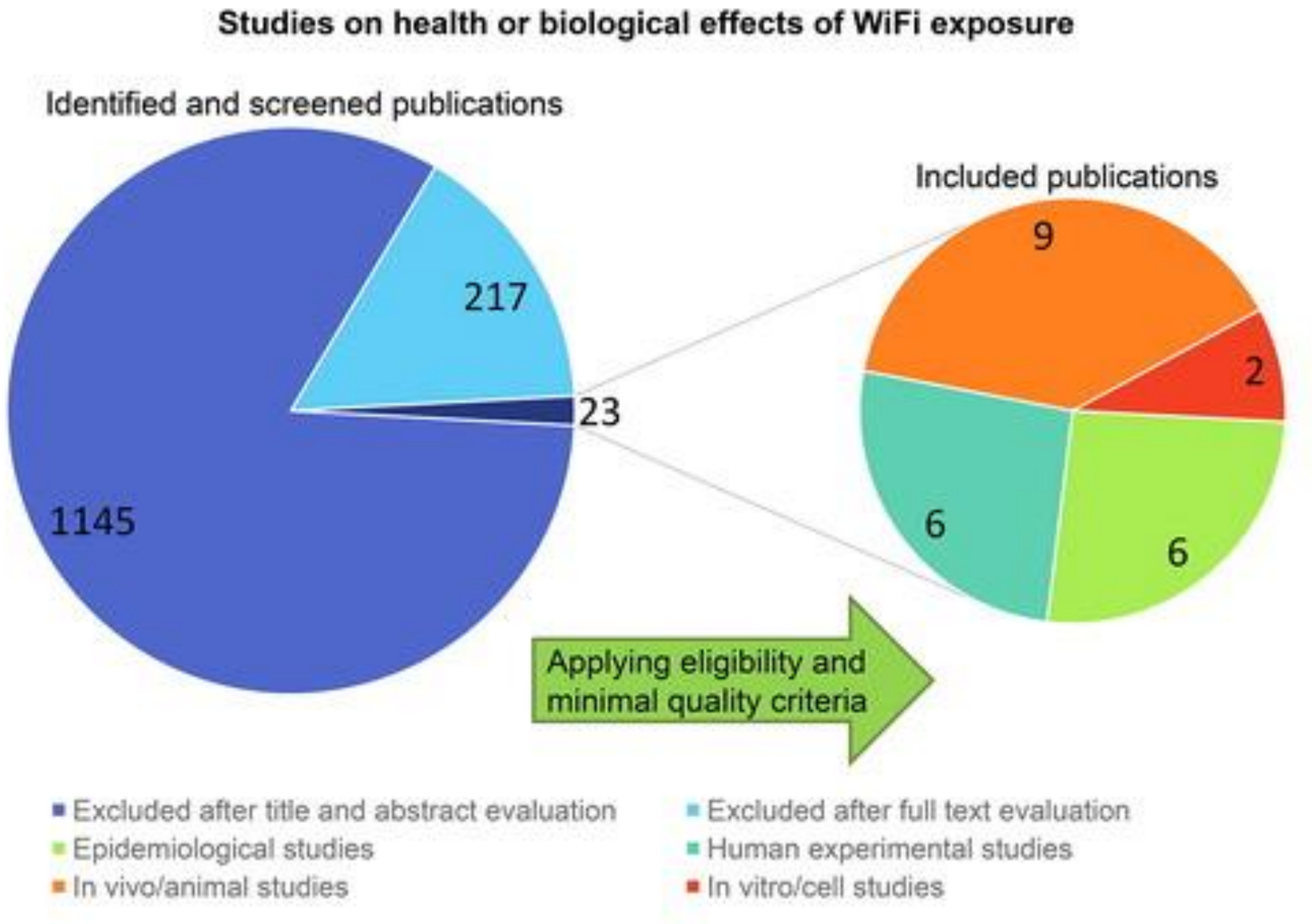
- **Pall (2018):**
  - oxidative stress, sperm/testicular damage, neuropsychiatric effects including changes in the encephalogram (EEG), apoptosis, cellular DNA damage, endocrine changes, and calcium overload are established effects of WiFi exposure.

→ Quality?

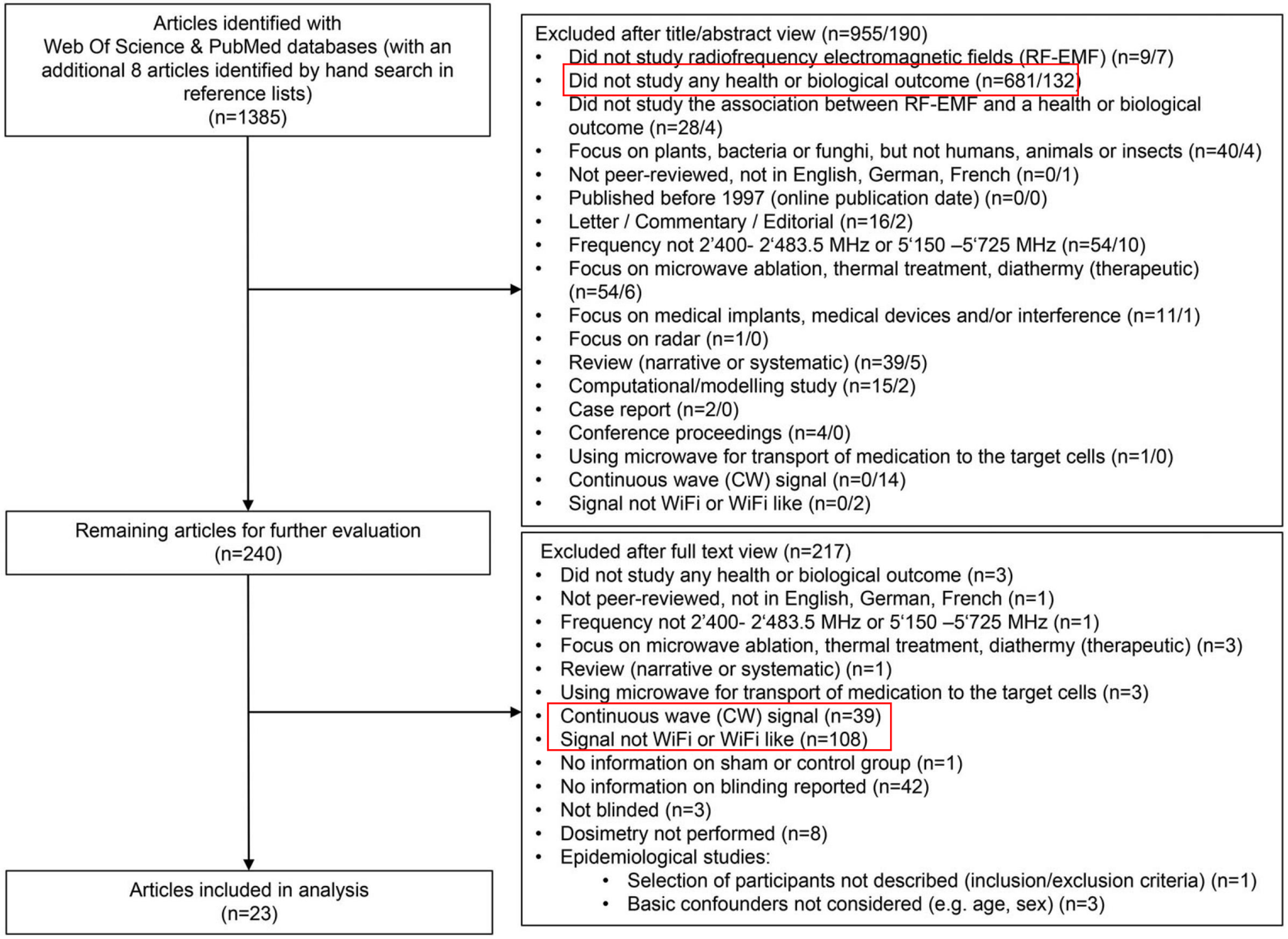
Methods

- Systematic literature screening (Pubmed, EMF-Portal etc.)
- Main inclusion criteria:
  - *In vivo*, *in vitro*, human experimental, epidemiology
  - Real WiFi signal
- Systematic quality evaluation
  - Experiment: with sham condition
    ≥ single blinded
    exposure contrast characterized
  - *In vivo*, *in vitro*: dosimetry conducted
  - Epidemiology: selection of study participants
    basic confounders (age, gender, sociodemographic factors)

Literature search



Literature search



Included publications

Study type	Reference
Epidemiological	Bektas et al. (2020)
	Bolte et al. (2019), including Bogers et al. (2018) (pilot study)
	Guxens et al. (2019)
	Huss et al. (2015)
	Redmayne et al. (2013)
Human experimental	Andrianome et al. (2017)
	Andrianome et al. (2019)
	Danker-Hopfe et al. (2020)
	Hosseini et al. (2019)
	Papageorgiou et al. (2011)
	Zentai et al. (2015)

Study type	Reference
In vivo	Ait-Aissa et al. (2010)
	Ait-Aissa et al. (2012)
	Ait-Aissa et al. (2013)
	Dasdag et al. (2015)
	de Gannes et al. (2012)
	de Gannes et al. (2013)
	Laudisi et al. (2012)
	Sambucci et al. (2010)
	Sambucci et al. (2011)
In vitro	Kuzniar et al. (2017)
	Schuermann et al. (2020)

Summary findings in vivo / in vitro studies

- High exposure levels
- Mostly no association between WiFi exposure and the assessed readouts in respect to neuro- and genotoxicology, reproduction and immunological parameters
  - Eg. Sambucci et al. (2010), 3 groups of mice exposed after mating, newborn analysed after 5 and 26 weeks.
    + Higher body weight in male week 5
    - Mating success, number of newborns/mother, body weight (female at week 5 and 26, male at week 26), spleen cell number, B cell frequency, antibody serum levels (IgM, IgG), ex vivo antibody production (IgM, IgG), B cell proliferation

Summary findings: epidemiology and human experiments

- Epidemiological studies:
  - Weak exposure assessment
  - Low exposure levels
  - Risk of exposure misclassification due to low contribution of WiFi exposure to total RF-EMF exposure

- Human experimental studies
  - More informative than epidemiological studies
    - e.g. because of realistic exposure scenarios, control of confounder
  - Acute effects found unlikely, even in sensitive (EHS) individuals

Human experimental study

- Whole night Wi-Fi exposure: high quality exposure set up, mimicking an extreme, but still realistic situation close to the head during sleep (max psSAR10g: 6.4 mW/kg).
- Double-blind, sham-controlled, randomized, fully counterbalanced cross-over study (n=34 young male adults), five nights per individual.
- No effect: recorded sleep macrostructure, and sleep microstructure (24 out of 25 EEG parameters).
- Effect: Reduced alpha band during NREM sleep.

Fig. 2. Structure containing the antennas. Six commercially available Wi-Fi patch antennas were positioned every 60° along a circle of 0.6 m radius in order to meet the requirement of an almost uniform exposure of the head regardless of the subject's position.

Danker-Hopfe et al, IJHEH, 2020

- Post review: No effect on emotional and procedural memory but overnight improvement in the declarative task, most likely chance as not supported by corresponding EEG measurements (Bueno-Lopez et al, J. Sleep Res, 2021).

Conclusions: quality matters

- Little evidence that WiFi exposure is a health risk in the everyday environment, where exposure levels are typically low.
- No evidence that WiFi exposure may be more problematic than other types of RF-EMF.
- Number of studies limited.
- More systematic experiments needed to clarify the role of the signal characteristics. This would also be useful for any new technology to be implemented such as 5G.
- Low quality studies are more likely to report effects (in line with other reviews).
- Reporting needs to be improved.
- Review was used for BAG fact sheet on WiFi: https://www.bag.admin.ch/bag/en/home/gesund-leben/umwelt-und-gesundheit/strahlung-radioaktivitaet-schall/elektromagnetische-felder-emf-uv-laser-licht/emf.html

Swiss TPH

Thank you for your attention

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Bundesamt für Gesundheit BAG

Contributors: Stefan Dongus, Hamed Jalilian, David Schürmann

Panel discussion

Is there a consensus among scientific reviews of RF EMF health risks?

Dr Emilie van Deventer
Head, Radiation and Health Unit
WHO

Sarah Loughran
Associate Professor
ARPANSA, Australia

Prof Martin Röösli
Head of Environmental Exposures and Health Unit
Swiss Tropical and Public Health Institute

Prof Theo Samaras
Aristotle University of Thessaloniki
Member EU SCHEER

Moderator:
Dr Concha Muro Lupori
EMF & Health Expert
Telefónica

Coffee Break

Fireside chat

Assessing EMF compliance of 5G network equipment

Mike Wood
Technology Leader, EME Strandards, Governance and Risk Management
GSMA EMF and Health Vice Chair
Telstra

Dr Nicola Pasquino
Professor
Chair of Technical Committee CEI CT 106
University of Naples

Assessing EMF compliance of 5G network equipment

Mike Wood
Chair IEC TC106

GSMA EMF Forum
11 Oct 2022

IEC 62232 ED3 – Key Changes

Edition 3 Approved – publication November 2022

Key changes include:

- **Increased frequency range from 100MHz to 300GHz**
- **5G Beam forming assessment methods**
- **Actual or ‘realistic’ power assessments for 5G base stations**
- **Case studies from live 5G networks illustrating power monitoring and controls**
- **Methods valid for assessing compliance to ICNIRP 2020**

More Information - IEC Blog
https://www.iec.ch/blog/iec-approves-new-5g-emf-exposure-assessment-methods-standard-base-stations

Thank you

Assessing EMF compliance of 5G network equipment

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Chair CT106 "Human Exposure to Electromagnetic Fields"
Italian Electrotechnical Committee

COMITATO
ELETTROTECNICO
ITALIANO

11th GSMA EMF forum, October 11, 2022 - London

What we will focus on:

- Measurements on live (commercial) 5G network
  - 5G is here and it can be measured.

- Power Monitoring & Control (PMC) systems (see IEC 62232) case study
  - How do they work? Are they effective?

Three different scenarios to test PMC feature

S. Adda et al., "A Methodology to Characterize Power Control Systems for Limiting Exposure to Electromagnetic Fields Generated by Massive MIMO Antennas," in *IEEE Access*, vol. 8, pp. 171956-171967, 2020
doi: ***10.1109/ACCESS.2020.3024764***

Measurement Site

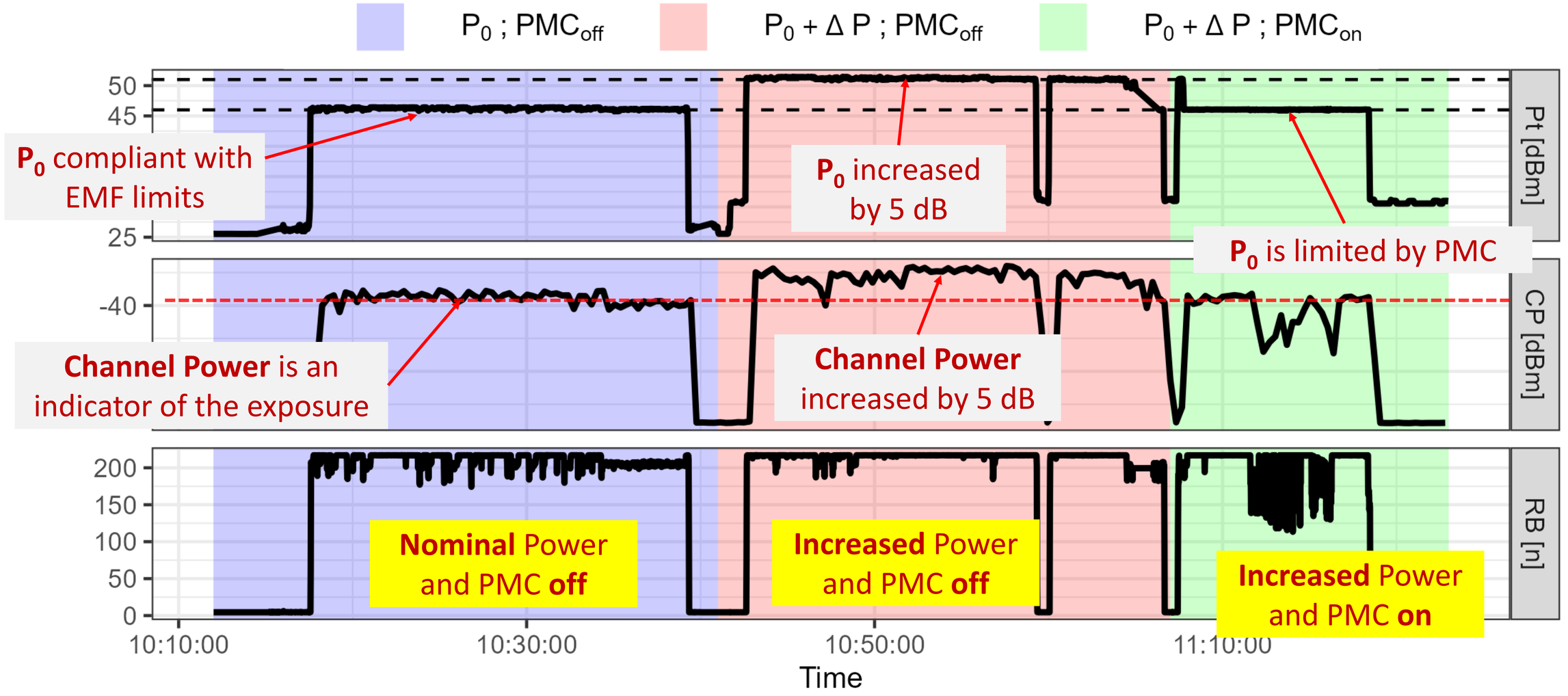
5G base station (source of EMF): Starting from initial compliance (1) at nominal power, we increased power (2) and switched the Power Monitoring and Control on (3).

We monitored power and resource blocks.

Measurement point:
We used a cell phone with UDP transmission to activate a beam.

Exposure monitored during transmission.

Power Monitoring and Control on **antenna**'s input power

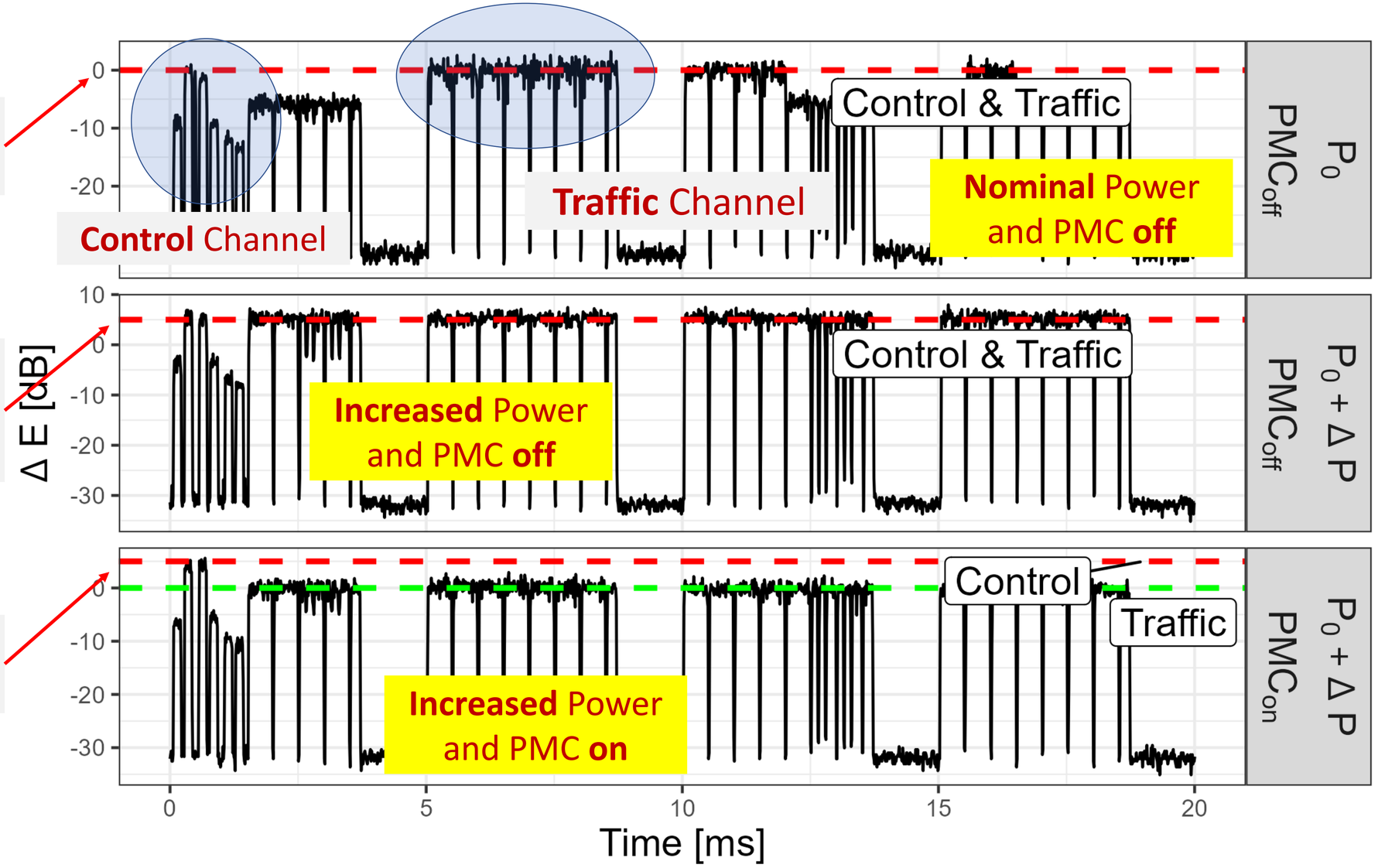


Exposure is limited - Coverage is preserved

Control and Traffic at the same level

Control and Traffic at the same level, increased by 5 dB

Control increased by 5 dB, traffic limited



Conclusions:

- Power Monitoring and Control (PMC) system does the job:
  - It limits exposure without limiting coverage

- PMC helps to ensure compliance to exposure limits:
  - Once activated, it takes care of limiting exposure without any further action

- Future inclusion of IEC 62232 in Italian national standards
  - CEI 211-7/Annex E about measurements of EMF generated by base stations

Mandating of public EMF limits in the UK and mmWave spectrum for 5G

Martin Fenton
Director of Spectrum Analysis
Ofcom

GSMA™

Panel discussion

Priorities for EMF Policy and Communication

Dr Alberto Nájera
Professor and Member
CCARS, Spain

Josette Gallant
Senior Director, Terrestrial and Standards Engineering
ISED, Canada

Sarah Wylie
EMF Manager
Global EMF & Health Chair, GSMA
Vodafone Group

Martin Fenton
Director of Spectrum Analysis
Ofcom, UK

Moderator:
Martin Busch
Vice-Chair EMF and Health, GSMA
Deutsche Telekom

Please take the event survey

Summary and conclusions

Sarah Wylie
EMF Manager
Global EMF & Health Chair, GSMA
Vodafone Group

Dr Jack Rowley
Senior Director, Research and Sustainability
GSMA

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Event survey