Review

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The lack of international and national health policies to protect persons with self-declared electromagnetic hypersensitivity

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Abstract: Electromagnetic hypersensitivity (EHS), known also as an idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) or a microwave sickness, is not considered by the World Health Organization (WHO) as being caused by the exposures to electromagnetic fields (EMF). EHS is not recognized as a disease anywhere in the world. Some studies have roughly estimated that 1–10% of the population might experience some form of EHS. However, because of the lack of diagnostic criteria for EHS, these estimates might be either under- or over-estimates. Because the vast majority of human population is exposed to EMF, the possibility of developing EHS from the EMF is a substantial public health issue that should be dealt with globally, even if the individual risk of developing EHS might be small. The WHO recognizes that the symptoms experienced by the EHS persons might be severe and might significantly hamper everyday life. However, after a broad analysis of international and national documents, there seems to be currently no effort to develop health policies for the dealing with EHS, no matter what causes it. National governments, follow the opinions of the WHO and the EMF safety standards setting organizations, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the Institute of Electrical and Electronics Engineers – International Committee on Electromagnetic Safety (IEEE-ICES), are not developing any practical health policy advisories for self-declared EHS sufferers. However, symptoms experienced by the self-declared EHS persons affect their well-being and, according to the Constitution of the WHO, are a health problem. Hence, independently of what causes EHS symptoms, this admitted well-being-impairment should be dealt with globally by developing an uniform health policy. Furthermore, WHO, ICNIRP and IEEE-ICES should be advocating and supporting research that would generate a reliable scientific evidence on what are the possible cause(s) of EHS. Without such research there is not possible to develop diagnostic methods as well as any possible mitigation approaches. There is an urgent need for the WHO to advocate for the national governments to urgently develop a comprehensive and common EHS health policy.

Keywords: EHS; electromagnetic hypersensitivity; health policy; IEI-EMF; RF-EMF.

Introduction

Part of the population considers themselves as sensitive to radiofrequency electromagnetic radiation emitted by the wireless communication devices and networks (RF-EMF; radio-frequency electromagnetic fields). It has been indicated that up to 13.3% of the population might be experiencing RF-EMF sensitivity symptoms [1]. This ailment, called either by its historical name, the 'microwave sickness' [2], or electromagnetic hypersensitivity (EHS), or idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) [3], is currently not considered by the World Health Organization as being caused by the exposures to RF-EMF (https://www.who.int/teams/environment-climate-change-and-health/radiation-and-health/non-ionizing/el-hsensitivity). While the symptoms, experienced by persons self-declaring as having EHS, are acknowledged as health impairment, the cause of these symptoms is considered to be unknown.

Before the World Health Organization's conference on EHS in Prague in 2004, the EHS was considered as psychological and even psychiatric problem. In 2004, at the WHO's EHS conference in Prague it was formally acknowledged that the EHS symptoms are real and that they might severely impair the quality of life [3].

Experimental research on EHS was primarily done in provocation studies, performed by psychologists and using

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methods and approaches of psychology research. Based on the results of these provocation studies the EHS is currently considered to be a psychological ailment, not caused by exposures to RF-EMF or electromagnetic fields (EMF) in general. It is postulated that EHS is a result of a *nocebo* effect where a self-suggestion of harm makes person to think that the health symptoms of EHS are caused by RF-EMF or EMF exposures. The *nocebo*-consideration strongly influences on how the EHS persons are perceived within the society and how necessary the EHS health policies are being considered.

Nocebo-consideration alone might be an oversimplified look at EHS. Study by Wiedemann and Schütz [4] suggested that invoking the precautionary principle will not be advantageous for the communication of the uncertainties in RF-EMF and health research. According to the authors, implementing the precautionary measures may trigger concerns, amplify EMF-related risk perceptions and lower trust in public health protection. Wiedemann and Schütz suggested that informing people about the potential health risks may trigger the nocebo response. However, more recent study from some of the same scientists [5] has contradicted the considerations of Wiedemann and Schütz [4]. Contrary to the expectations, presentation of the precautionary information did not trigger *nocebo* response, even in persons with high anxiety (!). The practical reason for such result might be that volunteers, chosen for the experiments were considered as making their decisions based solely on the information provided by the scientists performing study. Scientists, erroneously, did not consider that every volunteer coming to experimental study has already an opinion on RF-EMF and health. These pre-existing pre-experimental opinions on RF-EMF and health, had impact on how the volunteers approached the opinions on EMF and health provided by scientists during the experiment.

The big picture and the full context of how the EHS should be considered and dealt with might not be that simple as the *nocebo*-consideration proponents suggest. The *nocebo*-approach to deal with EHS has its consequences – it is not known how to medically deal with the problem caused by *nocebo*. Hence, when reviewing the health policies of different organizations and countries on Due to *nocebo*-consideration, it appears that the self-declared EHS sufferers are not taken into account when EMF-related health policy decisions are made for the general public.

This article reviews the current, very limited, evidence of EHS health policies. In order to avoid re-interpretation bias during the compilation and writing process, the article contains numerous quotations from the official documents and websites. Inclusion of the quotations has been done on purpose. Most of the references are texts published by various international and national, governmental and non-governmental, organizations and are available on the internet in forms of publications/brochures/white books and websites. Most of these documents are not solely focused on the EHS itself but the focus is more generally on the EMF and health. The use of quotations is advantageous for several reasons:

- The quotes themselves can be considered as "form-of-data" in this study examining what EHS health policies are currently in existence.
- To make sure that the quotation is not misrepresented/misunderstood and that both, the author of the review and the reader of the review, use exactly the same quotation in their considerations.
- With the clearly and unmistakably available quotation, interested readers, may easily find in the referenced document the broader context in what the quotation was originally presented.
- The extensive use of quotations, considered as the "form-of-data", assures the readers that the EHS opinions of the originally referenced documents are not misrepresented by the author of the review.
- Finally, the use of quotations will also help the reader to find the quoted text within the often lengthy and multi-topical documents.

This article is not a review of the published EHS studies and it is not the aim of this article to argue whether EHS is caused by EMF exposures, or not.

This article reviews solely the currently existing international and national EHS health policies.

Individual sensitivity to radiation

Individual sensitivity to radiation is a well-known and an established phenomenon in science. Individual sensitivity means that, because of the genetic and the epigenetic differences between people, different persons may respond physiologically in different ways to exposure to the same physical and/or chemical agent, whether it is a natural one or man-made. The phenomenon of the individual sensitivity to radiation has been described for the ionizing radiation [6–8]. The recently published opinion/review [9] has concluded, in respect of the individual sensitivity phenomenon, that:

> *…Although theoretical and empirical considerations suggest that individuals differ in their response to radiation exposure, no strong and consistently validated biomarkers of either tissue or stochastic effects have been identified to date. Studies of functional assays and candidate SNPs have been largely inconclusive…*

Also, for the non-ionizing radiation, the existence of the individual sensitivity has been described for e.g. the ultraviolet radiation [10, 11] or for the ultrasound [12].

The practical problems of research on individual sensitivity, and biomarkers of response to ionizing radiation, that were specified by Rajamaran and co-workers [9], they very closely resemble the problems of the research on non-ionizing radiation emitted by the wireless communication devices reviewed in 'Radiation Proteomics' [13].

Rajamaran and co-workers [9] have pointed out several reasons for why ionizing radiation biomarker research is still inconclusive:

- *functional assays are not standardised and there has been little attempt to ensure transferability across laboratories. The studies involve different radiation doses, dose rates, parameters, and assay conditions;*
- *replication and validation studies are rarely carried out;*
- *patient cohorts are heterogeneous, and different scales are often used to quantify adverse tissue effects; and*
- *study designs vary considerably, and few involve power calculation and multivariate analysis…*

Interestingly and importantly, the ways to come out of this research impasse, pointed out by Rajamaran and co-workers [9], are very closely resembling the opinions on how to resolve problem of individual sensitivity to non-ionizing RF-EMF radiation presented in the recent review by Leszczynski [14].

- Rajaraman and co-workers [9] wrote:

> *…Developments in high-throughput molecular biology techniques make it possible to apply whole-genome sequencing to rapidly analyse thousands of genetic markers at relatively low cost, along with the mapping of linkage disequilibrium between common SNPs across the genome…*

…and that:

> *…In tandem with studying the role of biomarkers of sensitivity, better characterisation of the role of non-radiation risk factors, such as smoking and body mass index, may offer an opportunity to mitigate risk following radiation exposure…*

- Leszczynski [14] wrote:

> *…Patients' subjective description of symptoms combined with the biomarker objective information is considered the future for developing pain control. The same approach should be taken to resolve the problem of sensitivity to exposures from EMF. Physiological studies of responses to EMF exposures will generate data useful for developing diagnostic tools for the detection of EMF sensitive persons and to, potentially, develop methods to mitigate the physiological effects of EMF exposures without the necessity of avoidance of EMF exposures. This biochemical approach has been shown to be able to experimentally generate data on EMF-exposure affected proteins or genes…*

Individual sensitivity to RF-EMF (EHS or IEI-EMF)

Numerous review studies were executed to determine whether RF-EMF exposure causes EHS (for review see for example: [14–19]). Collectively, as pointed out in the reviews of EHS studies, majority of the research is of low quality and, while the studies have concluded/indicated a lack of causality link between the EHS (IEI-EMF) symptoms and exposures to EMF, the reliability of such conclusion is low because of the low scientific quality of the majority of the EHS studies.

Health impairment claims of the self-diagnosed EHS persons could and should be already now considered as relevant health impairment. The definition of health presented in the Constitution of the World Health Organization says (www.who.int/about/governance/constitution):

> *Health is a state of complete physical, mental and social well-being and not merely the absence of disease and infirmity*
>
> *The health of all peoples is fundamental to the attainment of peace and security and is dependent on the fullest co-operation of individuals and States*
>
> *Governments have a responsibility for the health of their peoples which can be fulfilled only by the provision of adequate health and social measures*

It means that already now, the symptoms of suffering by the self-declared EHS persons are '*health effects*' as per WHO Constitution. Furthermore, it means that the existing man-made RF-EMF emitting devices and exposures emitted by these, are causing health effects because the '*mental and social well-being*' of some persons is being affected, and this phenomenon is clearly recognized by the WHO [3].

World Health Organization's opinions on EHS

The World Health Organization's definition of EHS uses three criteria to characterize EHS, called also idiopathic environmental intolerance to electromagnetic fields (IEI-EMF):

(1) perception by the subjects of a variety of numerous non-specific functional symptoms (e.g. sleep disorders, headaches, dermatological symptoms)
(2) lack of clinical and biological evidence to explain these symptoms
(3) attribution of these symptoms, by the subjects themselves, to exposure to electromagnetic fields, which themselves are diverse.

The search of WHO website, as of March 2022, for the word 'hypersensitivity' results in 5 hits where two of them concern electromagnetic hypersensitivity and three others are dealing with allergies.

The WHO is keen on establishing a scientifically and socially reliable debate on RF-EMF impact on human lives. It has published an advisory brochure "Establishing a dialogue on risks from electromagnetic fields" [20]. This WHO brochure gives an established already example of what is in WHO opinion hazard and what is risk:

> *…Driving a car is a potential health hazard. Driving a car fast presents a risk. The higher the speed, the more risk is associated with the driving.*

In respect of RF-EMF exposures from mobile phones and base stations the question of hazard and risk might be expressed as follows, by paraphrasing from the WHO example of car driving hazard/risk: using mobile cell phone is a potential health hazard (e.g. IARC 2011 classified carcinogenicity of RF-EMF as possible). Using a mobile phone a lot (long periods of time and frequently and for tens of years) presents a risk. The more mobile phone is used the more risk is possibly associated with this activity.

While the hazard/risk of car usage has been already proven, the hazard/risk of mobile phone usage requires still more research. To stimulate the quality research, and on topics necessary for generation of better and more reliable human health policies, the WHO produces research agendas.

The last published WHO research agenda on RF-EMF was conceived and published a long time ago, in 2010. According to the WHO, this document is intended to provide guidance, for the scientists and for the research funding entities, on what are the research needs in the area of RF-EMF effects on human health. The link to this document, available on the WHO website, is listed with the date of June 9, 2020 even though the document was originally published on June 16, 2010.

In this WHO Research Agenda of 2010 there is only a single mention is of the EHS:

> *There have been several recent high-quality provocation studies of people reporting health symptoms that they attribute to RF EMF exposure. The results of these studies do not show any relation between the symptoms that these individuals experience and RF EMF exposure. Nevertheless, more research on the causes and treatment of this condition would be valuable in a broader socio-medical context and is recommended in the social sciences section below.*

Thus, for the 2010 WHO Research Agenda, the problem of the causality link between RF-EMF exposures and EHS appears to be settled. WHO doesn't see the need to continue research on whether RF-EMF causes EHS. Instead, WHO suggests that research should be performed to identify causes of the EHS symptoms and means to mitigate this health-related problem. This opinion is reflected in the list of Research Needs proposed by the WHO, in its 2010 Research Agenda, for the human studies:

High-priority research needs
- *Further RF EMF provocation studies on children of different ages*
- *Provocation studies to identify neurobiological mechanisms underlying possible effects of RF on brain function, including sleep and resting EEG*

Other research needs
- *No other research needs were identified.*

To recapitulate, for the WHO, it seems like there is no further need to continue research examining causality link between EHS and RF-EMF exposures.

Gaining information on how different countries deal with the issue of RF-EMF safety is not easy. Even inquiries form the WHO are not being thoroughly answered. In 2013 the WHO EMF Project send inquiries to all of the countries that are signatories of the WHO charter. Of the 194 inquiries, responses came only from 75 countries representing 6 WHO regions. The final published document claims to present information from 86 countries thanks to secondary inquiries and search of databases [21].

There seems to be a broad variety of approaches of different countries to the RF-EMF personal and environmental safety.

Of the 86 examined countries, 53 use ICNIRP international guidelines, 7 countries (Bolivia, Chile, Honduras, India, Republic of Korea, Trinidad and Tobago and the USA) follow the US Federal Communications Commission (FCC) limits, which is based on exposure limits recommended by IEEE-ICES. Canada and Russia follow their own evidence-based national limits, and Australia follows own evidence-based national limits that are very closely related to the ICNIRP guidelines.

As stated by the authors [21], environmental exposures of 86 countries evaluated, 78 had set public exposure limits for fixed installations. Of these, 57 countries followed the

ICNIRP Guidelines, five (Armenia, Canada, China, USA and Russia) had set their own standards and one (Trinidad and Tobago) followed the US FCC limits. There were 16 countries with exposure limits lower than the ICNIRP, of these 3 had used ALARA principle and 11 have used a precautionary approach. There are also countries that have no exposure limit for fixed installations, all except Syria also had not defined exposure limits for mobile devices.

Only 45 countries had provisions for advice on limiting RF-EMF exposure by mobile phone users, either addressed to the whole population or specifically to specific subgroups, including children (23 countries), pregnant women (9 countries) and people with implanted biomedical devices (14 countries).

No country had a complete ban on mobile phone use by children. However, 28 countries encouraged voluntary measures. Two countries (Russia and Zambia) declared that they have set advisory age limits for usage of mobile phones, whereas in France, a legal provision bans advertisements promoting the sale or use of mobile phones for people under 14 years of age.

Finally, what is of importance, the EHS as a phenomenon and as a sub-population that might potentially require extra protection form RF-EMF, were not mentioned at all in the WHO publication. This, yet again, suggests that for the WHO, the EHS is not considered anymore as a problem related to RF-EMF exposures.

Committees developing safety guidelines and their opinions on EHS

There are two major committees that review RF-EMF science and develop safety guidelines for exposures to RF-EMF. The International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the International Committee on Electromagnetic Safety of the Institute of Electrical and Electronics Engineers (IEEE-ICES).

There is a significant difference between the memberships of ICNIRP and IEEE-ICES. In ICNIRP, the 14 members of the ICNIRP's Main Commission do not include industry representatives. The following applies to how ICNIRP operates:

- ICNIRP is a group of currently 14 scientists who claim to represent solely themselves.
- There is only one medical doctor (physician) on ICNIRP (joined only after the safety guidelines of 2020 were published).
- Individually, ICNIRP members claim to be void of any lobbying influence from the industry and from the national radiation protection organizations.
- Retiring members of ICNIRP are replaced by new members who are selected and approved only by the ICNIRP members, solely at their discretion.
- Selection criteria and justifications for selecting particular new members, are not publicly available. Only ICNIRP members know why a person has been selected to join their group.
- ICNIRP is not responsible before any entity for the scientific decisions they make.
- No entity supervises how ICNIRP arrives at their recommended safety guidelines.
- There is no any administrative or scientific oversight of ICNIRP's activities by any entity.
- ICNIRP has no legal responsibility for their scientific opinions.

The lack of supervision over the ICNIRP activities is often considered as a factor that weakens reliability of ICNIRP's decisions. There are reasons for it. From the past, there are known cases of prominent scientists who claimed to be entirely void of any external influence but, documents, revealed after they have passed away, have shown a paid collaboration of these scientists with the industry. In 2006 it was revealed [22] that Sir Richard Doll, esteemed epidemiologist who demonstrated causal link between tobacco and lung cancer, was a consultant for the chemical industry company Monsanto, as shown by the documents discovered at the Wellcome Foundation library archive. Sir Doll, as paid consultant, wrote several opinions claiming lack of causality links between some chemicals and cancer, e.g. Agent Orange or vinyl chloride of plastics. Another high profile scientist with the undisclosed ties to the industry was Patricia Buffler. In her research, Buffler has determined a health hazard of wet led-paint but, simultaneously, she had testified as an expert in defense of the led-paint industry [23]. Thus, the self-assured independence of experts, like these of ICNIRP, working without any oversight, might not always be a sufficient assurance of the impartiality.

The IEEE-ICES operates differently from ICNIRP. IEEE-ICES operates under the rules and oversight of the IEEE Standards Association Standards Board and describes own procedures of developing safety standards as follows:

> *ICES follows an open consensus process, with a balance of disciplines and a balanced representation from the medical, scientific, engineering, industrial, government, and military communities. As of 24 November 2014, membership of the central governing and the*

technical committees (TC95 and TC34) stood at more than 209 professionals representing 27 countries. ICES strives to achieve consensus among all the stakeholders in the safe use of electromagnetic energy, thereby producing practical science-based standards that are readily accepted and applied.

IEEE-ICES safety guidelines are prepared largely by industry scientists and engineers and approved by the industry scientists and engineers who will later implement them in their own industries. This is because the majority of the ca. 130 members of IEEE-ICES are representatives employed by the industry or consultants to the industry. Only a small number of the IEEE-ICES members is from the academia but it is difficult to establish due to the confidentiality of the membership list. Some information on workings of IEEE-ICES is available in the yearly reports. However, publication of these reports has ended in 2016.

ICNIRP and IEEE-ICES have extensively influenced process of setting the safety limits around the world and their safety guidelines are used by the industry and by the governments, as stated in the 2013 study from the World Health Organization (WHO) [21]:

There are several notable, though not perhaps surprising findings from this study. One is that the existence of international exposure limits proposed by international bodies such as ICNIRP and IEEE/ICES has been fundamental in helping countries adopt these limits or adapt them into broadly similar national regulations to avoid the known risks of high RF EMF exposure. Another is that several countries, especially larger and wealthier ones, tend to develop their own policies, though usually referencing the same evidence base referenced in the published exposure limits. Hence, harmonization of policies, which can be helpful for saving costs and increase public confidence, is likely to remain incomplete.

ICNIRP, in their 2020 guidelines [24] discusses briefly issue of EHS where it dismisses any causality link with EMF exposures based on experimental (psychological provocation studies) and epidemiological evidence:

A number of human experimental studies testing for acute changes to wellbeing or symptoms are available, and these have failed to identify any substantiated effects of exposure.

A small portion of the population attributes non-specific symptoms to various types of radiofrequency EMF exposure; this is referred to as "Idiopathic Environmental Intolerance attributed to EMF (IEI-EMF)". "Double-blind experimental studies have consistently failed to identify a relation between radiofrequency EMF exposure and such symptoms in the IEI-EMF population, as well as in healthy population samples".

…experimental studies provide evidence that "belief about exposure" (e.g., the so-called "nocebo" effect), and not exposure itself, is the relevant symptom determinant…

Overall, the epidemiological research does not provide evidence of a causal effect of radiofrequency EMF exposure on symptoms or well-being.

In summary, no reports of adverse effects of radiofrequency EMF exposures on symptoms and wellbeing have been substantiated, except for pain, which is related to elevated temperature at high exposure levels (from both direct and indirect radiofrequency EMF exposure).

…and later on…

In summary, there is no evidence of effects of radiofrequency EMFs on physiological processes that impair human health.

Finally, in the frequently asked questions (FAQs) listing on ICNIRP website (https://www.icnirp.org/en/rf-faq/index.html) is presented consideration on whether EHS is accounted for in the ICNIRP 2020 Guidelines:

As there is no evidence that symptoms in EHS individuals are related to RF EMF exposure, there would be no benefit of applying RF EMF restrictions specifically to account for EHS. Accordingly, restrictions have not been set to separately account for EHS, and individuals who believe that they are adversely affected by RF EMF are treated as part of the general public in terms of RF EMF restrictions.

This means that every country that follows ICNIRP guidelines on exposure to RF-EMF is also likely considering that there is no need for any additional regulations to account for EHS because EHS is, according to ICNIRP FAQ, solely based on the belief that RF-EMF affects health.

Similar view of lack of causality link between EHS and RF-EMF exposures is held by the IEEE-ICES. In a review article published as part of IEEE-ICES sponsored issue of Bioelectromagnetics journal's Supplement, published in 2003, a very brief view of IEEE-ICES scientists on EHS [25] was as follows:

…the EHS individual is not better at detecting EMF and that EHS symptoms are not related to electric or magnetic field exposures

While EHS subjects fared no better at detecting EMF the report states that whatever its cause EHS is a real phenomenon which is a disabling problem for the affected individual.

One explanation, which seems quite plausible, […] EHS may be related to mycotoxins in the environment. Mycotoxins have shown, in animal studies, the same symptoms and effects as in EHS

…and the IEEE-ICES scientists concluded that:

There are individuals who report EHS and who believe they are influenced by electric and magnetic fields from a variety of sources. They report symptoms that are related to the nervous system such as fatigue, stress, and sleep disturbances. However, in controlled provocation experiments none of the test subjects could distinguish

a real RF exposure from sham exposures. Until other possible causes of the symptoms are ruled out, such as mycotoxins, it will be difficult to prove that low level RF is responsible.

Altogether, according to the opinions expressed by the ICNIRP and by the IEEE-ICES, EHS is not caused by the exposures to RF-EMF or EMF.

Reviews of EHS evidence by non-governmental organizations (NGOs) critical of ICNIRP and IEEE-ICES

There is a number of non-governmental groups of scientists and general population activists that disagree with the interpretation of scientific evidence proposed by the ICNIRP and by the IEEE-ICES.

EUROPAEM

The EMF working group of the European Academy for Environmental Medicine (EUROPAEM) in their review of EMF and health research [26] has briefly reviewed some selected studies on EHS and commented on the reliability of the evidence as follows:

The question, whether EHS is causally associated with EMF exposure is controversially discussed. On the one hand, physicians judge a causal association between EMF exposures as plausible based on case reports, on the other hand, national and international health risk assessments mostly claim that there is no such causal association, because provocation studies under controlled blinded conditions mostly failed to show effects. However, these studies have severe shortcomings that must be addressed: sequences of exposure conditions were often contiguous neglecting aftereffects of exposure; the exposure duration and the examined effects were short-term; the sham exposure was frequently under conditions that could provoke arousal in sensitive individuals; the time frame neglected the temporal conditions of symptom occurrence and disappearance, and/or the recruitment of persons with EHS was not medically assessed.

EUROPAEM's review [26] is critical of the WHO approach towards EHS and dismissal of causal approach while the scientific evidence is still not settled:

The WHO does not consider EHS as a diagnosis and recommends to medical doctors that the treatment of affected individuals should focus on the health symptoms and the clinical picture, and not on a person's perceived need for reducing or eliminating EMF in the workplace or at home […]. Based on the existing evidence and practical knowledge this view ignores a causal approach…

EUROPAEM has also proposed [26], still preliminary, recommendations for how to evaluate and diagnose self-declared EHS persons:

The recommended approach to diagnosis and treatment is intended as an aid and should, of course, be modified to meet the needs of each individual case […]. 1. History of health problems and EMF exposure, 2. Medical examinations and findings, 3. Measurement of EMF exposure, 4. Reduction and prevention of EMF exposure, 5. Diagnosis, 6. Treatment of the patient including the environment.

EUROPAEM review [26] admits the shortcomings of the knowledge on EHS that could be used for its diagnosis:

We do not have any clinical findings yet that are specific to EMF, which makes diagnosis and differential diagnosis a considerable challenge.

…but it proposes also a long list of biomedical tests that, potentially, could be helpful in diagnosis of EHS.

Large part of the EUROPAEM review [26] presents precautionary EMF exposure values, proposed by the EUROPAEM, that are lower than the safety guidelines recommended by ICNIRP and IEEE-ICES.

EUROPAEM review [26], on the contrary to the opinions of the WHO, ICNIRP and IEEE-ICES, proposes also classification of EHS as a disease:

Regarding the current International Classification of Diseases (ICD), ICD-10-WHO 2015, we recommend at the moment: (a) Electromagnetic hypersensitivity (EHS): to use the existing diagnostic codes for the different symptoms plus code R68.8 "Other specified general symptoms and signs" plus code Z58.4 "Exposure to radiation" and/or Z57.1 "Occupational exposure to radiation".

ICEMS

The International Commission for Electromagnetic Safety (ICEMS) was registered in Italy in 2003 as a non-profit organization of independent scientists who, similarly to ICNIRP, represent only themselves and their scientific opinions are their own (www.icems.eu/organization.htm).

In 2011 ICEMS has published its first, and so far the only, monograph: "Non-Thermal Effects and Mechanisms of Interaction Between Electromagnetic Fields and Living Matter", edited by Livio Giuliani and Morando Soffritti for the "European Journal of Oncology" – Library Vol. 5 of the National Institute for the Study and Control of Cancer and Environmental Diseases "Bernardo Ramazzini", Bologna, Italy, 2010, Part I and Part II (www.icems.eu/papers.htm).

ICEMS Monograph includes an experimental provocation study on EHS [27] that can be considered as an opinion of ICEMS on the existence of the EHS and on the causal link

between EHS and EMF. There are presented some general and critical comments on EHS research:

> *Most of the studies on humans, that did not show any effects of MW radiation in some of the studies mentioned above, were conducted with young, healthy subjects, giving rise to the question whether the experiments would have yielded different results with subjects with a "higher level of pathologic pre-load" and thus fewer possibilities to acutely compensate the possible stressor of radiation.*

…and pointed out difficulty of separating EHS from other kinds of stress:

> *Many of those claiming to have EHS also had food allergies, mold/pollen/dust allergies and were chemically sensitive. With so many other sensitivities it is difficult to determine whether the sensitivity to electromagnetic energy is a primary disorder attributable to high and/or prolonged EM exposures or a secondary disorder brought about by an impaired immune system attributable to other stressors.*

The authors of the study disagree with the re-naming of the EHS to become IEI-EMF as they consider that the causality link between EHS symptoms and EMF exposures exists:

> *The term EHS was deemed to imply that a causal relationship has been established between the reported symptoms and EMF exposure and for that reason the WHO has labeled EHS as Idiopathic Environmental Intolerance (IEI) to indicate that it is an acquired disorder with multiple recurrent symptoms, associated with diverse environmental factors tolerated by the majority of people, and not explained by any known medical, psychiatric or psychological disorder. We think this labeling needs to be changed especially in light of this study.*

However, the conclusions and statements on EHS published in the ICEMS Monograph by Havas and co-workers [27] are significantly weakened by the subsequent publications by Havas and Marrongelle of the replication study [28] and retraction of this replication study [29].

BioInitiative

BioInitiative (https://bioinitiative.org) considers biological effects as clearly established what is a far stronger statement than the statements of ICNIRP is or IEEE-ICES, although also these organizations recognize that some biological effects happen at non-thermal exposures. However, the most important distinction is that the BioInitiative assumes that these established biological effects will, over time, lead to health effects, whereas ICNIRP and IEEE-ICES disagree. On bioeffects and possibility of health effects the BioInitiative states (https://bioinitiative.org/conclusions):

> *Bioeffects are clearly established and occur at very low levels of exposure to electromagnetic fields and radiofrequency radiation. Bioeffects can occur in the first few minutes at levels associated with cell and cordless phone use. Bioeffects can also occur from just minutes of exposure to mobile phone masts (cell towers), WI-FI, and wireless utility 'smart' meters that produce whole-body exposure. Chronic base station level exposures can result in illness.*

In respect of chronic exposures the BioInitiative states (https://bioinitiative.org/conclusions):

> *Bioeffects with chronic exposures can reasonably be presumed to result in adverse health effects. Many of these bioeffects can reasonably be presumed to result in adverse health effects if the exposures are prolonged or chronic. This is because they interfere with normal body processes (disrupt homeostasis), prevent the body from healing damaged DNA, produce immune system imbalances, metabolic disruption and lower resilience to disease across multiple pathways. Essential body processes can eventually be disabled by incessant external stresses (from system-wide electrophysiological interference) and lead to pervasive impairment of metabolic and reproductive functions.*

Interestingly, while there is not much research altogether on the possibility of co-effects of EMF exposures and chemicals exposures, the BioInitiative states on this issue the following (https://bioinitiative.org/conclusions):

> *EMF and RFR make chemical toxins more harmful. EMF acts on the body like other environmental toxicants do (heavy metals, organic chemicals and pesticides). Both toxic chemicals and EMF may generate free radicals, produce stress proteins and cause indirect damage to DNA. Where there is combined exposure the damages may add or even synergistically interact, and result in worse damage to genes.*

BioInitiative asks for action on re-defining safe exposure levels (https://bioinitiative.org/conclusions):

> *New safety limits must be established – health agencies should act now. Existing public safety limits (FCC and ICNIRP public safety limits) do not sufficiently protect public health against chronic exposure from very low-intensity exposures. If no mid-course corrections are made to existing and outdated safety limits, such delay will magnify the public health impacts with even more applications of wireless-enabled technologies exposing even greater populations around the world in daily life.*

Finally, BioInitiative has the opinion that the sensitive populations, that include self-declared EHS and others vulnerable persons, need to be protected (https://bioinitiative.org/conclusions):

> *Sensitive populations must be protected. Safety standards for sensitive populations will more likely need to be set at lower levels than for healthy adult populations. Sensitive populations include the developing fetus, the infant, children, the elderly, those with*

pre-existing chronic diseases, and those with developed electrical sensitivity (EHS).

What also differentiates BioInitiative from ICNIRP and IEEE-ICES is the following statement (https://bioinitiative.org/conclusions):

Standard of evidence for judging the science. The standard of evidence for judging the scientific evidence should be based on good public health principles rather than demanding scientific certainty before actions are taken.

Reviews of the same scientific studies on EHS by different scientists may lead to entirely different conclusions

Reviews of to-date published EHS studies performed outside of the WHO, ICNIRP, IEEE-ICES, EUROPAEM, ICEMS BioInitiative, have also a very likely impact on how the issue of EHS is handled in the health policies developing international and national organizations.

Below are presented three examples of recent reviews of EHS studies. The omission of the multitude of EHS reviews and original studies was purposeful. This article is intended to present what kind of EHS health policies are currently in use by different international organizations and by national radiation regulatory agencies. This review was not intended to examine whether the EHS exists or whether the evidence obtained in the EHS studies is valid or of sufficient scientific quality. Hence, only few EHS studies are presented, with the clear intention to demonstrate that using exactly the same scientific database, of published EHS research, different scientists can come to different, even contradictory, conclusions. As examples of such were used studies of Schmiedchen et al. [18], Dieudonné [19] and Leszczynski [14]. One review was performed by a team of scientists that included an ICNIRP member – Gunhild Oftedal [18]. Two other reviews were performed by two committee-independent scientists: Maël Dieudonné [19] and Dariusz Leszczynski [14].

All three reviews have arrived at the very similar conclusion that the EHS research is of poor quality. However, this poor quality of research does not prevent the authors of two reviews [18, 19] from argument and justification that the causality of EHS symptoms by EMF exposures is not proven. However, this justification lacks logic. If, as the reviewers rightfully claim, the majority of EHS studies are of inadequate scientific quality then, this poor quality scientific evidence, should, logically, not be claimed to prove lack of causal link between EHS and EMF. Hence, the poor quality of the to-date executed EHS studies precludes scientific justification for the proof of the lack of causal link between EHS and EMF exposures.

It is not correct to claim that research is of poor quality and too few studies have been done and then, use the same claims, as evidence that causality link between EHS and EMF has not been proven. Inadequate research can't provide adequate proof.

Author of the third review, Leszczynski [14], disagreed with such interpretation and suggested that the low quality of EHS research precludes from making any far reaching conclusions on the causality of EHS.

Published in 2019 review [18] has analyzed methodological limitations of the to-date performed psychological provocation studies and, to demonstrate low quality of research, has presented a list of 13 biases and errors in psychological provocation studies. Hence, the authors of this review have shown how very imperfect is the research on EHS. Of the 845 EHS studies identified by data-base search, only 28 were selected as of eligible quality, after fulfilling the 13 bias criteria. Out of the 28 studies, 7 have shown and effect whereas 21 studies have shown lack of effect. However, since 25% of the "approved" studies have shown an effect, how the authors can justify that only the 21 no-effect studies are used as final proof of no link between EHS and EMF. Such extremely limited experimental evidence should be rather considered as insufficient to claim that EHS exists or that EHS does not exist. This is the problem of the "weight-of-evidence" logic used in evaluation of scientifically poor quality EMF research. Just plain number of studies with certain effect is used as sufficient argument to claim these studies are correct.

Dieudonné [19] agrees with Schmiedchen and co-workers [18] that the EHS research is scientifically of poor quality but he goes further in his logic of dismissal of causality link between EHS and EMF exposures.

He splits the EHS published studies into three possible hypotheses but, concludes that no hypothesis is totally satisfying:

(1) the electromagnetic hypothesis where EMF causes EHS;
(2) the cognitive hypothesis where *nocebo* causes EHS;
(3) the attributive hypothesis where self-diagnosed EHS is a coping strategy for pre-existing (non-EHS caused) conditions.

Dieudonné [19] makes several controversial statements. To dismiss the electromagnetic hypothesis, suggesting that EMF exposures cause EHS, Dieudonné claims that since only thermal effects of EMF exposures are proven and the

non-thermal effects are lacking scientific proof, this means that the electromagnetic hypothesis is not valid. Thus, by dismissing large body of scientific *in vivo* and *in vitro* evidence showing existence of non-thermal effects, Dieudonné dismisses possibility of causal link between EMF exposures and EHS. As evidence that non-thermal effects are likely false positives Dieudonné refers to a single study by a Motorola scientists, turned, consultant to telecom industry. As evidence that oxidative stress and free radicals are unlikely to be involved in EHS induction by EMF exposures, Dieudonné uses a single available reference where anti-oxidants were unsuccessfully used to counter the EMF exposure effects. As proof of lack of EMF impact on oxidative stress and free radicals generation Dieudonné uses a review co-authored by ICNIRP member. At the same time, Swiss committee examining EMF effects, with another ICNIRP member, has concluded [30] that the oxidative stress is caused by EMF exposures:

> *Most animal and many cell studies showed increased oxidative stress caused by RF-EMF and ELF-MF.*

The problem with Dieudonné's review [19] is the dismissal of any evidence that does not fit the thermal hypothesis of EMF effect only. Even when Dieudonné admits that we might not know enough:

> *…It remains possible to argue that yet undiscovered EMF health effects might appear below regulatory levels of exposure and explain EHS symptoms. Indeed, it is scientifically impossible to disprove the existence of a risk in absolute terms: this residual uncertainty arguably contributes to many controversies in environmental health, as it can always justify a precautionary approach […]. On the other hand, given the immense wealth of EMF research, and the incredibly widespread use of RF and LF EMF emitting technologies, it can be argued that any other biological effect than dielectric heating and electromagnetic induction would have been already discovered by serendipity…*

In his review of the EHS studies, Dieudonne [19] goes as far as to suggest that

> *EHS is explained analogically to hypochondria*

…from what opinion is a straight way to claim that EHS is hypochondriac and mental problem.

In paragraph speaking of dubious evaluation of results, Dieudonne makes itself dubious evaluation [19]. Namely:

> *…First limitation: a dubious interpretation of experimental results*
>
> *However, such an analysis rests on a disputable interpretation of experimental results. The observation that subjects believing in the harmfulness of EMF, whether because they regard themselves as EHS or have just received alarmist information, react adversely to perceived EMF exposure, actually demonstrates two things: that nocebo responses can be induced experimentally, and that EHS persons are susceptible to them…*

This opinion is dubious because *nocebo* effect is well known to be possible to induce experimentally and there is nothing exceptional that self-diagnosed persons are susceptible to *nocebo*.

Dieudonné [19] proposes three kinds of studies to resolve EHS and EMF enigma:

(1) to study systematically the symptoms, attributions, *and behaviors* of EHS persons to determine whether all three are connected
(2) to conduct clinical trials of cognitive and behavioral therapies aimed at symptom reattribution, which offers the best opportunity to alleviate EHS symptoms if the cognitive hypothesis is correct
(3) the rigorous comparison of experience and trajectories of people with EHS and other functional somatic syndromes.

Dieudonné [19] concludes that EHS might exist but unlikely:

> *…It remains possible that only a few EHS persons are actually sensitive to EMF, whose reactions are unobservable at a collective level, especially given the few positive results of environmental studies using an individual approach. However, these results are likely to reflect residual confounding or false positives…*

Schmiedchen and co-workers [18] propose similar approach to this of Dieudonné [19]:

> *…Overall, the evidence points towards no effect of exposure. If physical effects exist, previous findings suggest that they must be very weak or affect only few individuals with IEI-EMF. Given the evidence that the nocebo effect or medical/mental disorders may explain the symptoms in many individuals with IEI-EMF, additional research is required to identify the various factors that may be important for developing IEI-EMF and for provoking the symptoms. We recommend the identification of subgroups and exploring IEI-EMF in the context of other idiopathic environmental intolerances. If further experimental studies are conducted, they should preferably be performed at the individual level. In particular, to increase the likelihood of detecting hypersensitive individuals, if they exist, we encourage researchers to achieve a high credibility of the results by minimizing sources of risk of bias and imprecision…*

The third of the recent reviews, authored by Leszczynski [14], arrives at different conclusions. Leszczynski considers that the poor quality of research studies and insufficient number of them indicates that the causality link between EHS and EMF exposures has neither been proven nor disproven. Leszczynski concludes:

It is logical to consider that the sensitivity to EMF exists but the scientific methodology used to find it is of insufficient quality. It is time to drop out psychology driven provocation studies that ask about feelings-based non-specific symptoms experienced by volunteers under EMF exposure. Such research approach produces only subjective and therefore highly unreliable data that is insufficient to prove, or to disprove, causality link between EHS and EMF.

A very important aspect is that the reviews by Schmiedchen and co-workers [18], Dieudonné [19] and Leszczynski [14] have analyzed the same available scientific evidence. However, the three reviews arrived at significantly different conclusions.

This variability of opinions reflects a broader problem of EMF research. When results of the experimental studies are difficult to interpret and outcomes are mostly ambiguous, it is up to individual scientists and groups of scientists to determine the significance of the results of such studies. Scientists more cautious of the possible health effects will provide different final evaluation of the ambiguous science than the scientists who are less cautious of the possible effects.

The umbrella organizations of the industry

The important players in the area of EMF health are umbrella organizations of telecommunication industry, makers of hardware and providers of network services. These organizations lobby and pressure governments to make administrative regulations easier for the telecommunication businesses.

There are two major umbrella-organizations of the telecommunication industry, one for the networks operators, the GSM Association (GSMA) (www.gsma.com) and the other for the hardware manufacturers the Mobile & Wireless Forum (MWF; formerly Mobile Manufacturers Forum, MMF) (www.mwfai.org).

GSMA is an organization representing the interests of mobile network operators. More than 750 mobile operators are full GSMA members and a further 400 companies, in the broader mobile ecosystem, are associate members. GSMA calls for:

Government policies for electromagnetic fields should be evidence-based, harmonized internationally and draw on the recommendations by expert bodies such as the World Health Organization (WHO) and the International Telecommunication Union (ITU). Both these organizations recommend the human exposure guidelines developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). The ICNIRP guidelines are designed to provide protection to all people (including children) against all established health hazards.

For the GSMA, one of the means of lobbying for regulations better suiting the industry needs is presentation of excellence awards to governments and their organizations. One of such Awards is the GSMA's Government Leadership Award that recognizes world-class leadership in the establishment of 'sound regulatory policies for mobile connectivity'. These should be based on clear principles that encourage private investment, such as transparency, free and fair competition, and regulatory independence. Any government can freely enter the competition. Awardees are presented yearly at the Barcelona MWC organized by the GSMA (www.mwcbarcelona.com/ministerial/government-award). The Award is presented since 2005.

GSMA in its opinions relies predominantly on ICNIRP evaluation of science but it also quotes number of international and national expert evaluations of EMF science (www.gsma.com/publicpolicy/emf-and-health/expert-reports). However, the evaluations that are not considered by GSMA at all are the evaluations prepared by groups of scientists like EUROPAEM, ICEMS or BioInitiative, who, in conclusions, disagree with ICNIRP opinion and support the notion that exposures to EMF radiation emitted by wireless communication devices and networks might be, or are, hazardous to health and call for lowering the exposure guidelines recommended by ICNIRP.

Opinion of GSMA on EHS directly follows the opinion of the WHO (www.gsma.com/publicpolicy/wp-content/uploads/2012/03/gsma_electromagnetic_hypersensitivity.pdf), formulated at the 2004 conference in Prague:

GSMA Position: The WHO has concluded that there is no scientific basis to link symptoms to exposure to electromagnetic fields.

GSMA agrees with the WHO opinion that EHS sufferers need help:

GSMA supports the WHO recommendation that treatment of affected individuals should have the aim of helping them to develop strategies for coping and to encourage them to lead a normal social life. Importantly, this should be distinguished from the person's perceived need to reduce or eliminate electromagnetic fields in the workplace or home.

What is important to GSMA is that the EHS is not only not causally linked with EHS exposures but also that it is not recognized as a disease as stated in the above mentioned GSMA document. Importance of it is such that the EMF exposures not only don't cause disease but also any suspicious effects are not classified as disease.

MWF advocates for safety regulations that are harmonized around the world. MWF describes itself, its goals and its input into regulatory matters as follows:

> *The MWF is an international association of companies with an interest in mobile and wireless communications including the evolution to 5G and the Internet of Things.*
>
> *The MWF's goal in standards is to have a globally harmonised and consistent approach to conformance and compliance tests and that all safety standards be based on the best available scientific data…*
>
> *The MWF's regulatory activities are focused on developing and presenting the views of the mobile industry to regulatory agencies and authorities in a globally coordinated manner…*

On its web page dealing with EMF and health (https://www.emfhealth.info/research-expert-opinions.cfm), the MWF prominently displays excerpt from the WHO:

> *WHO: A large number of studies have been performed over the last two decades to assess whether mobile phones pose a potential health risk. To date, no adverse health effects have been established for mobile phone use.*

Below this WHO statement is a link to expert opinions coming from national and international expert groups. In all of the quoted excerpts the opinion of lack of health effects from EMF exposures is clearly pointed out.

As a general rule, MWF does not present own opinions on EMF and health. It presents excerpts from the opinions of national and international experts groups. An example of how MWF is dealing with EHS issue is in the brochure published by MWF to celebrate achievements of 20 years of research on mobile phone radiation and health (http://www.mwfai.org/docs/eng/2018_05_MWF_20YearsofResearch.pdf). EHS is mentioned in this MWF brochure in the same way as WHO does it since the 2004 EHS conference in Prague:

> *While no accepted bioelectromagnetic mechanisms exist to explain this correlation, health experts accept that the symptoms felt by suffers are real. This report recommended clinicians and researchers should pay greater attention to electromagnetic hypersensitivity sufferers.*

Health policies on EHS in various countries

The majority of the world countries follows the WHO recommended ICNIRP safety guidelines for exposures to RF-EMF and few countries, besides USA, follow IEEE-ICES recommendations. While information about safety guidelines used in various countries is available, information on health policies on EHS is difficult to find and in most cases countries do not have official EHS policy and recommendations of how to deal with the health symptoms and problems of the EHS persons. Few examples of how different countries (European Union, Nordic Countries, and selected 17 countries in alphabetical order) deal with EHS: European Union, Australia, Belgium, Canada, Finland, France, Germany, Iceland, India, Italy, Japan, Netherlands, New Zealand, Poland, Russia, Switzerland, UK, and USA.

European Union

Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), in its opinion on 'Potential health effects of exposure to electromagnetic fields (EMF)' (https://op.europa.eu/en/publication-detail/-/publication/a67fe808-06bb-11e6-b713-01aa75ed71a1/language-en), concluded on EHS (IEI-EMF) as follows:

> *The symptoms that are attributed by people to RF EMF exposure can sometimes cause serious impairments to a person's wellbeing. However, research […] adds weight to the conclusion that RF EMF exposure is not the cause of these symptoms. This applies to the general public, children and adolescents, and to people with IEI-EMF. Recent meta-analyses of observational and provocation data support this conclusion. For symptoms triggered by short-term exposure to RF fields (measured in minutes to hours), the consistent results from multiple double-blind experiments lead to a strong overall weight of evidence that RF EMFs do not cause such effects. For symptoms associated with longer-term exposures (days to months), the evidence from observational studies is broadly consistent but has gaps, most notably in terms of the objective monitoring of exposure. Current evidence weighs towards an absence of effects due to RF EMF exposure.*

Also published in 2015, 'Opinion of the European Economic and Social Committee on "Electromagnetic hypersensitivity"' (own-initiative opinion) (2015/C 242/05) (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014IE5117&from=PL):

> *The EESC [European Economic and Social Committee] acknowledges and is concerned about the prevalence of EHS. It is encouraged to note that further substantial research is ongoing to understand the problem and its causes.*
>
> *However, to allay continuing public concern and to uphold the precautionary principle the EESC urges the Commission to continue its work in this area particularly as further research is still needed to accumulate evidence concerning any potential health impact from long-term exposure, for example using a mobile phone for more than 20 years.*

> *There remains the issue of public perception. For some individuals the prevalence of EMF is seen as a threat – in the workplace, to their families and in public spaces. Similar groups are equally concerned over multiple chemical exposure, widespread food intolerance or exposure to particles, fibres or bacteria in the environment. Such individuals need support, not only in dealing with actual illness symptoms but with the concerns they express about modern society.*
>
> *The Committee notes that EHS sufferers experience real symptoms. Efforts should be made to improve their health conditions with a focus on reducing disability.*
>
> *Unfortunately, from their point of view, the overwhelming medical and scientific opinion is that there is no conclusive evidence to link the wide range of symptoms described as EHS to electromagnetic or radiofrequency exposure (EMF).*
>
> *EHS sufferers continue to argue that action on their problem, both by Member States and the EU, falls far short of what they believe is necessary. Most public health authorities, however, do not agree.*
>
> *However, this is not to deny the reality of EHS-attributed symptoms; clearly many people self-diagnose as suffering from a range of disconnected health problems which they link with electromagnetic fields. The proportion of the population claiming this diagnosis varies considerably between Member States. The World Health Organisation notes that 'EHS has no clear diagnostic criteria and there is no scientific basis to link EHS symptoms to EMF exposure. Further, EHS is not a medical diagnosis, nor is it clear that it represents a single medical problem.*

And finally the EESC opinion/conclusion on safety limits and lowering exposures is as follows:

> *The EESC has stated its concerns regarding these issues and expressed its support for reducing exposure to non- ionising radiation in opinions published on these rules while they were being prepared. However, sufferers from EHS are characterised by attributing their symptoms to EMF at intensities well below the limits permitted.*

Nordic countries

In Nordic countries EHS is recognized as a handicap but not as disease. Hence, there are no diagnostic criteria for EHS. Nordic Countries, Denmark, Iceland, Finland, Norway and Sweden, have together developed a Nordic co-operative project called "The Nordic Adaptation of Classification of Occupationally Related Disorders (diseases and symptoms) to ICD-10", financed by the Nordic Council of Ministers (Nordisk Ministerråd) and completed from 1996 to 2000 (https://eloverkanslig.org/wp-content/uploads/2019/09/the-nordic-adaptation-of-classification-of-occupationally-related-disorders-icd-10.pdf). The aim of the project was to provide a "Nordic list of occupational disorders" with advice on how to code them in accordance with the WHO International Statistical Classification of Diseases and Related Health Problems (ICD) version 10. EHS is defined as follows:

> *Electromagnetic intolerance, El-allergy. Usually general symptoms (tiredness, nausea, memory- and concentration difficulties etc.) related to use of TV/PC/data-screens, electrical transformers or fluorescent lamps. Symptoms disappear in 'non-electrical environments'.*

In the table listing ICD-10 codes for the most frequently encountered occupational disorders in the Nordic countries, EHS is listed as follows:

> *R68.8 Other specified general symptoms and signs (suggested/recommended for multisymptomatic 'idiopathic/environmental intolerance' (IEI), including 'multiple chemical sensitivity' (MCS); "electromagnetic intolerance" ('el-allergy') etc. if the patient has not one major symptom which should preferably be coded).*
>
> *T78.8 Other adverse effects, not elsewhere classified ('Other specified general symptoms and signs' (R68.8) is recommended for conditions like 'idiopathic environmental intolerance' (IEI), incl. MCS; electromagnetic intolerance ('el-allergy') etc.).*

Australia

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) is the Australian Government's primary authority on radiation protection and nuclear safety, what includes exposures to radiation emitted by the wireless communication devices and networks.

ARPANSA develops own radiofrequency safety standard based on the ICNIRP standard and on the own, ARPANSA's, review of scientific evidence. To develop the new standard, ARPANSA reviewed the 2020 ICNIRP guidelines and other relevant scientific literature and performed also public consultation. The updated ICNIRP 2020 guidelines were considered by ARPANSA as an international best practice. Australia was the first country that adopted ICNIRP 2020 guidelines in their own safety guidelines.

ARPANSA (https://www.arpansa.gov.au/understanding-radiation/radiation-sources/more-radiation-sources/electromagnetic-hypersensitivity) considers that the current scientific evidence does not establish that electromagnetic hypersensitivity symptoms are caused by exposure to low-level electromagnetic fields. According to ARPANSA website, some individuals report a wide range of non-specific health problems that they self-attribute to low-level exposure of electromagnetic fields (EMF). The most commonly reported symptoms are headaches, body pain, lethargy,

tinnitus, nausea, burning sensation, heart arrhythmia and anxiety. The collection of these symptoms is not part of any medically recognized syndrome. Finally, ARPANSA advises that on the basis of current scientific information, there is no established evidence that EHS is caused by EMF at levels below exposure guidelines. ARPANSA acknowledges that the health symptoms experienced by the affected individuals are real and can be a disabling problem, and advise those affected to seek medical advice from a qualified medical specialist. As useful link ARPANSA provides link to World Health Organization (WHO) fact sheet on Electromagnetic Hypersensitivity (https://www.who.int/teams/environment-climate-change-and-health/radiation-and-health/non-ionizing/el-hsensitivity).

Belgium

Belgium follows the opinion of the WHO. The Federal Public Service Health, Food Chain Safety and Environment website (https://www.health.belgium.be/en/electromagnetic-hypersensitivity) provides information about EHS is as follows:

> *Although the name suggests a connection between the complaints and the exposure to electromagnetic fields, this connection is not confirmed by scientific research. That is why electromagnetic hypersensitivity is considered as a case of "idiopathic environmental intolerance". "Idiopathic" refers to symptoms that remain unexplained, the cause of which is unknown. There is a hypothesis that the cause of electromagnetic hypersensitivity (at least partially) can be found in a strong negative affectation (strong influenceability due to a negative expectation). Yet, additional research is necessary before further conclusions can be drawn.*

There is also offered full info about EHS as a downloadable document (https://www.health.belgium.be/sites/default/files/uploads/fields/fpshealth_theme_file/19104345/Electromagnetic%20hypersensitivity%20EN_fiches.pdf). This document informs also that EHS is not classified as a disease due to lack of diagnostic criteria:

> *Due to the fact that no methods have been found to objectify the symptoms and describe these as separate pathology, "electrohypersensitivity" is not included in the internationally recognised list of diseases (International Classification of Diseases and Related Health Problems) of the World Health Organisation.*

Also here it is stressed and advised to provide help and to treat EHS sufferers with consideration and respect:

> *Even if no causal connection to electromagnetic fields is found, the symptoms themselves are very real and we need to pay attention to that.*

…and further the following advice is provided on how to help EHS persons, but in very general terms that are of little help to persons providing assistance to EHS sufferers:

> *After the medical, psychosocial and environmental conditions have been investigated, it is necessary to treat an electromagnetically sensitive person in a personal, multidisciplinary and global manner.*
>
> *There are various therapeutic techniques suggested, of which cognitive behavioural therapy (CBT) has proved to be the most efficient. In cognitive behavioural therapy, patients are encouraged to question their assumptions and to look for other causes and interpretations of their symptoms. They look for ways to deal with their symptoms and if necessary, learn techniques to deal with psychosocial stress. The best results are achieved when the treatment is started in a timely fashion.*

However, it is strongly discouraged to advise avoidance of EMF exposures as it might:

> *Reducing the exposure is often seen by the affected people as a solution. This, however, brings the person reporting electromagnetic sensitivity into a vicious circle, in which the existence of symptoms, the attribution of them to one source of electromagnetic fields or another and avoidance follow and support one another.*

Finally, the document ends with general advice of the importance of good personal relationship between EHS person and physician, as helping factor in recovery of EHS person:

> *Although there is currently no clearly outlined therapeutic treatment, it is certain that a good relationship between doctor and patient and the emotional support of people in their environment are important.*

Canada

Health Canada Safety Code 6 is a document that sets out recommended safety limits for human exposure to radiofrequency electromagnetic fields (EMF) in the frequency range from 3 kHz to 300 GHz. The recommendations were published in 2009 and updated in 2015 (https://www.canada.ca/content/dam/hc-sc/migration/hc-sc/ewh-semt/alt_formats/pdf/consult/_2014/safety_code_6-code_securite_6/final-finale-eng.pdf).

Safety Code 6 uses weight-of-evidence approach that takes into account both the quantity of studies and the quality of those studies. Properly conducted studies receive more weight when they have appropriate statistics applied, all of the necessary controls included, and have complete evaluation of the radiofrequency source and exposure level. Poorly conducted studies receive little weight when they

have limitations such as inadequate statistical analysis, lack of appropriate control samples, and inadequate evaluation of the radiofrequency source and exposure level.

According to Health Canada Safety Code 6 updated in 2015 (excerpts):

> *…the only established adverse health effects associated with RF field exposures in the frequency range from 3 kHz to 300 GHz relate to the occurrence of tissue heating and nerve stimulation (NS) from short-term (acute) exposures.*

> *…there is no scientific basis for the occurrence of acute, chronic and/or cumulative adverse health risks from RF field exposure at levels below the limits outlined in Safety Code 6.*

> *The hypotheses of other proposed adverse health effects occurring at levels below the exposure limits outlined in Safety Code 6 suffer from a lack of evidence of causality, biological plausibility and reproducibility and do not provide a credible foundation for making science-based recommendations for limiting human exposures to low-intensity RF fields.*

Health Canada also states that the exposure limits in Safety Code 6 are consistent with the standards used in other parts of the world, including: Japan, Australia, New Zealand, USA and European Union.

Finland

In general, the stance of Finland's STUK – Radiation and Nuclear Safety Authority is that there are no proven health effects of radiation emitted by wireless communication devices and networks (www.stuk.fi/web/en/topics/mobile-telephones-and-base-stations/no-evidence-of-health-hazards).

STUK follows closely opinions and recommendations of the WHO and ICNIRP. Hence, STUK considers that the only proven effect of EMF exposures are thermal effects and does not recognize non-thermal effects as scientifically established when it states:

> *Various theories have been offered according to which radio frequency radiation has other negative effects not attributable to excessive warming. However, such theories have not been verified by scientifically valid research reports. Insofar as other negative effects exist, they are caused by as yet unknown mechanisms.*

In respect of health effects STUK states:

> *The conclusions […] can be summarized in the statement that any exposure falling below the current exposure limits has no verified health effects.*

…but STUK also recognizes that there remains uncertainty about effects of low-level EMF exposures on humans:

> *However, additional research is required on exposure that approaches the limits before final conclusions can be drawn. Exposure to this kind of radiation occurs practically only when people talk on their mobile phones. The most significant gap in the information related to mobile phones is the fact that no data exist on the health effects of mobile phone use that today spans more than 15 years. Because of this, an increase in the number of slowly developing cancer forms, for example, is not yet detectable in statistics.*

In respect of EHS, STUK does not recognize EHS as being caused by EMF exposures and has a very brief and very vague statement on EHS, mentioning also other, potentially harmful, agents (www.stuk.fi/web/en/topics/mobile-telephones-and-base-stations/electromagnetic-hypersensitivity):

> *Some people experience symptoms detrimental to health in certain working and living environments, although the same environment or exposure does not cause symptoms to the majority of people. The factors related to such symptoms include moulds, various chemicals and fragrances as well as electromagnetic fields.*

> *The Radiation and Nuclear Safety Authority follows advances in the research data concerning electrical sensitivity and, when necessary, makes statements on electrical sensitivity issues in terms of radiation protection.*

Finally, as many other radiation protection authorities and organizations, also STUK, while claiming lack of proof of health effects, advises general public how to reduce exposures to wireless radiation emitted by handsets, because STUK considers effects of radiation emitted by base stations as settled (www.stuk.fi/web/en/topics/mobile-telephones-and-base-stations/how-to-reduce-your-exposure):

> *Health effects of mobile phones are marked by a number of uncertainties. For this reason; STUK recommends that unnecessary exposure to radiation from mobile phones be avoided. In particular, children's unnecessary exposure should be avoided as their life-long exposure will be longer than that of those who begin using mobile phone as adults and as only scant research exists on health effects to children. This recommendation does not apply to weak exposure generated by base stations, as scientifically valid data on the health effects of such radiation is unavailable at the present time.*

France

The 2018 Opinion of the French Agency for Food, Environmental and Occupational Health & Safety (https://www.anses.fr/en/system/files/AP2011SA0150EN.pdf) regarding the expert appraisal on 'electromagnetic hypersensitivity (EHS) or idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF)'.

ANSES report has found that while the pain and suffering reported by the EHS sufferers is real, there is no clear diagnostic criteria for the ailment and studies have

shown that the development of symptoms is unrelated to exposure (*nocebo* effect).

> *Currently, the only way to define EHS is on the basis of self-reporting by people. This can cause a lack of sensitivity in all the studies on the topic, since very different EHS individuals can be recruited without distinction.*

Considering uncertainties of science and the need for further research to resolve current gaps in the knowledge the ANSES recommends that:

> *Considering the current or future deployment of new mobile communication technologies […], in parallel with the existing services, and the uncertainties concerning the long-term effects of exposure to radiofrequencies, the Agency emphasizes the need for these technological developments to go hand in hand with limitation of individual exposure, whether exposure is environmental or related to devices.*

Specific recommendation for how to care for EHS persons before the science provides better evidence of the ailment's causes:

> *develop training for doctors on the health effects of radiofrequencies and provide them with information enabling them to meet the expectations of EHS individuals*
>
> *ask the French Society for Occupational Medicine to examine the feasibility of a good practice guide on the care of EHS individuals in the workplace*
>
> *ask the French National Authority for Health (HAS) to examine, as with the recommendations it formulated on fibromyalgia, the relevance of formulating care recommendations tailored to EHS individuals*
>
> *foster closer ties and promote collaboration among professionals involved in the care of EHS individuals (doctors, occupational and environmental disease clinics – CCPPs, departmental homes for disabled persons – MDPHs, etc.)*

Germany

In Germany, issue of health effects of RF-EMF exposures is guided by The Federal Office for Radiation Protection (BfS) (www.bfs.de) that is described as an organizationally independent, scientific-technical higher federal authority supervised by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

German BfS opinion on possibility of health effects caused by RF-EMF exposures at the levels below ICNIRP safety guidelines is completely negative. According to BfS there is no proof and no evidence to support existence of non-thermal biological effects and health effects caused by non-thermal RF-EMF exposures. The only open question for the BfS, where it indicates the need for further research is the possibility of long-term effects, when exposures to RF-EMF last for tens of years.

BfS clearly and unequivocally states on its website (see: BfS. Electromagnetic Fields) that Deutsches Mobilfunk Forschungsprogramm (www.emf-forschungsprogramm.de) has concluded:

- *The existence of health effects below the limit values was neither confirmed by the results of the DMF (Deutsches Mobilfunk Forschungsprogramm), nor by other up-to-date studies conducted on national or international levels.*
  - *No evidence of non-thermal biological effects below the limits*
  - *No impairment of general health and cognitive performance*
  - *No proven increased cancer risk*
  - *No acute effects in embryos or children*
- *Long-term effects for periods of use exceeding a decade remain an open issue. Therefore, further research is conducted into this question.*

However, in another place on the BfS website (https://www.bfs.de/EN/topics/emf/lff/effect/discussed/discussed.html) the following information concerning EHS is published:

> *…Electromagnetic hypersensitivity*
>
> *Studies conducted by the BfS have shown that just under two per cent of the German population consider themselves to be electromagnetically hypersensitive. They attribute various complaints, such as headaches, sleep disturbance, fatigue and concentration problems to the presence of electric and magnetic fields in their environment.*
>
> *For a long time, science has been trying to understand the phenomenon of electromagnetic hypersensitivity. The common conclusion of the numerous studies conducted to date, is that a causal relationship between electric and magnetic fields and the complaints of electromagnetically hypersensitive individuals is highly unlikely. This view is also held, among others, by the World Health Organization (WHO)…*

Thus the information presented on the BfS site oscillates between forceful statement of no evidence for non-thermal effects and more ambiguous statement of EMF as cause of EHS as highly unlikely. According to BfS non-existence of non-thermal effects means there is no mechanism for EMF exposures below safety limits to cause EHS. However, BfS refrains from stating such unequivocally and, instead, claims that it is highly unlikely for the EHS to be caused by EMF.

At the same time, when advising that there are no biological or health problems associated/caused by RF-EMF

exposures below levels approved as safe by ICNIRP, the BfS advises users how to reduce exposures and BfS advises to purchase cell phone models with low levels of emitted radiation (SAR) (https://www.bfs.de/EN/topics/emf/mobile-communication/protection/smartphone-tablet/smartphone-tablet.html):

> *A device is considered to be low-radiation up to a SAR value of 0.5 watts per kilogram for the use case "holding the phone right next to the ear during a call". 41 per cent of currently available smartphones can be classified as "low-radiation" regarding this use case.*

Such advice, of buying phones with lower SAR to lower RF-EMF exposures, is in disagreement with what umbrella organization of wireless networks providers, the GSMA advises on understanding SAR (https://www.gsma.com/iot/wp-content/uploads/2012/03/mmfgsmasarflyer-2.pdf) as follows:

> *Does a lower SAR mean that a phone is safer? No. Variations in SAR do not mean that there are variations in safety. While there may be differences in SAR levels among phone models, all mobile phones must meet RF exposure guidelines.*

Iceland

Icelandic Radiation Safety Authority follows directly opinion of the WHO and writes the following opinion on EHS (https://gr.is/rafsgulothol):

> *Electromagnetic intolerance: with the increased utilization of electronic communications technology that utilizes electromagnetic fields on radio frequencies, the Radiation Protection Authority has received inquiries and complaints from people who have health problems that they associate with intolerance to electromagnetic fields. The World Health Organization (WHO) website has some detailed information and advice on electromagnetic tolerance, see* https://www.who.int/peh-emf/publications/facts/fs296/en/.

In respect of the specific question: Are there people with electromagnetic intolerance? The answer of the Icelandic Radiation Safety Authority is that to date, it has not been possible to demonstrate, by scientific methods, that electromagnetic fields cause electromagnetic resistance.

India

Ministry of Communications' Department of Telecommunications' website (https://dot.gov.in/journey-emf) provides information concerning safety guidelines and possible health effects.

Safety guidelines recommended by the WHO are strictly followed by the Government of India that states:

> *WHO has recommended adoption of international standards, namely International Commission for Non Ionizing Radiation Protection (ICNIRP)/Institute of Electrical and Electronics Engineers (IEEE). The main conclusion from the WHO reviews is that EMF exposures below the limits recommended in the ICNIRP international guidelines do not appear to have any known consequence on health. The WHO says – "All reviews conducted so far have indicated that exposures below the limits recommended in the International Commission for Non Ionizing Radiation Protection (ICNIRP) 1998 EMF guidelines, covering the full frequency range from 0–300 GHz, do not produce any known adverse health effect". However, there are gaps in knowledge still needing to be filled before better health risk assessments can be made.*

However, the limits for emissions from base stations were reduced to 10% of ICNIRP recommended guidelines:

> *Keeping the precautionary EMF safe exposure limits for the Radio Frequency Field (Base Station Emissions) as 1/10th of the safe limits prescribed by ICNIRP for all areas in India, eliminates the need for fixing lower limits for specific areas like schools, hospitals, residential premises, children playgrounds; a segregation of which is impractical in densely populated localities.*

In line with the precautionary approach and in order to provide citizens with the detailed information about location and workings of base stations, the Government of India own EMF Portal (www.tarangsanchar.gov.in) has been set up and it provides the general public with information on location of base stations in vicinity of any locality.

Health concerns are being recognized but generally dismissed as unlikely and the advice of the WHO seems to be strictly followed:

> *There is a public concern over possible health effects from Electromagnetic Field Radiation (EMR) exposure from diverse EMR sources especially Mobile BTS antennae and mobile. In this regard, several studies have been conducted in different countries, under the aegis of World Health Organization (WHO). WHO has referred to approximately 25,000 articles published around the world over past 30 years, and based on an in-depth review of scientific literature, has concluded: "current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic field". Since the effects on human beings are to be studied over a long period of time, further studies are going on around the world.*

…and further in respect to radiation emitted by the base stations:

> *With reference to Electromagnetic Radiation emanating from cellular mobile towers, World Health Organization (WHO) in its Fact Sheet No. 304, May 2006 on Electromagnetic Fields and Public Health (Base Stations and Wireless Technologies) has concluded that "considering the very low exposure levels and*

research results collected to date, there is no convincing scientific evidence that the weak Radio Frequency (RF) Signals from base stations and wireless networks caused adverse health effects". From all evidence accumulated so far, no adverse short or long term health effects have been shown to occur from the RF Signals produced by based stations.

Furthermore, in respect to base stations in India the Department of Communications wrote the following on base stations' radiation and health:

EMF radiations from a mobile tower, which are below the safe limits prescribed by ICNIRP and recommended by WHO, have no convincing scientific evidence of causing adverse health effects. Department of Telecommunications have prescribed stricter precautionary norms for exposure limit for the Radio Frequency Field (Base Station Emissions) which is 1/10th of the existing limits prescribed by ICNIRP and recommended by WHO. Further, Government of India has taken adequate steps to ensure that Telecommunications Service Providers strictly adhere to these prescribed norms.

The website of the Ministry of Communications of India does not mention EHS. However, EHS is presented by the Telecom Regulatory Authority of India in their Information paper 'On Effects of Electromagnetic Field Radiation from Mobile Towers and Handsets' published on July 30, 2014 (https://www.trai.gov.in/sites/default/files/EMF_Information_Paper_30.07.2014.pdf):

…a study conducted by the WHO concluded that EHS is characterized by a variety of non-specific symptoms that differ from individual to individual. The symptoms are certainly real and can vary widely in their severity. Whatever its cause, EHS can be a disabling problem for the affected individual. However, EHS has no clear diagnostic criteria and there is no scientific basis to link EHS symptoms to EM radiation. Furthermore, EHS is not a medical diagnosis, nor is it clear that it represents a single medical problem…

Italy

In Italy, there are no official government and public health materials on EHS available. There is a draft law document on the initiative of Senator Scipoliti, of March 15, 2013, on the rules for the protection of people with environmental disabilities, including electromagnetic sensitivity (https://www.senato.it/service/PDF/PDFServer/BGT/00699527.pdf). This document proposes the list of the measures that need to be taken in order to protect environmentally sensitive persons, including those with electromagnetic hypersensitivity:

(1) *In order to protect the right to work of subjects suffering from environmental disease or disability, the following measures are envisaged:*
   a. *adoption of adequate aids in the workplace, including, in particular, those listed in article 5, paragraph 3;*
   b. *use of detergents with low emission of volatile organic compounds and free of fragrances for cleaning the premises used for work and for the relative toilets in the case of chemical sensitivity;*
   c. *use of furnishings that do not exhale volatile chemicals in the case of chemical sensitivity;*
   d. *allocation in environments equipped with purifiers and with air exchange of the equipment that release ink fragrances and volatile chemicals;*
   e. *possibility of changing duties if incompatible with the condition of a person suffering from disease or environmental disability;*
   f. *ban on the use of wireless communication systems in offices where there is a person affected by electrosensitivity or by disease or environmental disability incompatible with biologically active electromagnetic fields;*
   g. *maintenance of the professional category for those who have contracted an illness or an environmental disability due to work-related reasons;*
   h. *incentives for teleworking in all cases in which it is of advantage to a person suffering from disease or environmental disability.*

(2) *In order to protect the right to study of subjects suffering from disease or environmental disability, adequate accommodation solutions are provided in a reclaimed school environment, both as regards the building materials and those necessary for teaching, as well as the prohibition of use of fragrances and chemical detergents, in the case of chemical sensitivity and the ban on the use of wireless fidelity systems and mobile telephones, resorting, in the most serious cases, to remote learning and verification.*

However, while very interesting this document was not enacted.

Two communities in Italy have taken unilateral actions on electromagnetic sensitivity and/or 5G deployment. Basilicata region of Italy recognizes electrosensitivity as a rare disease. Document 'deliberazione no. 1296', dated October 15, 2013 of the Regione Basilicata, Dipartimento Salute, Sicurezza e Solidarietà Sociale, Servizi alla Persona e alla Comunità (Department of Health, Safety and Social Solidarity, Personal and Community Services) has recognized pathology of electrosensitivity (given code: RQG020) and stated the following on the subject of the implementation of the Ministerial Decree of 18 May 2001, number 279, dealing with the recognition of rare diseases, including electrosensitivity:

> *…the recognition of the right to exemption for subjects affected by these diseases, it takes place on the part of Local Health Companies of residence, upon presentation of certification/diagnosis of disease, prepared by medical specialists of recognized public reference centers from regions and autonomous provinces for the treatment of rare diseases.*
>
> *to transmit, to the extent of subsequent competence, this act to the Healthcare companies ASP and ASM, at the San Carlo Hospital Potenza and IRCCS CROB of Rionero in Vulture.*

It means that in region of Basilicata, electrosensitivity is considered as rare disease, it can be diagnosed by physicians and diagnosed persons can receive hospital care as needed.

In another region of Italy – Comune di Avolasca, Provincia di Alessandria – on June 12, 2019, was implemented moratorium on deployment of the 5G. One of the reasons justifying moratorium was electrosensitivity. Moratorium was set in place for a limited period of time, until the forthcoming new evaluation of the carcinogenicity of EMF will be performed by IARC:

> *…the Mayor and the Town Council THEY UNDERTAKE – to adopt a contingent and urgent ordinance to suspend the testing of 5G in the administered territory pending the new classification of carcinogenesis announced by the International Agency for Research on Cancer, applying the precautionary principle sanctioned by the European Union, pending the data by reference more up-to-date scientific studies, independent from links with industry and already available on the effects of radio frequencies, which are extremely dangerous for human health…*

The document of the moratorium on deployment of the 5G was sent, among others, to the President and to the Prime Minister of the Italy as well as Ministers of Health and of Internal Affairs.

Japan

Japan EMF Information Center (JEIC) website (https://www.jeic-emf.jp/english/topics/4991.html) informs that the Ministry of Internal Affairs and Communications (MIC) of Japan has set out the Radio Radiation Protection Guidelines for Human Exposure to Electromagnetic Fields that serves as a standard in the use of mobile phone, radio and TV waves. Under the Radio Law, Regulations for Enforcement of Radio Law and Radio Equipment Regulations of Japan, MIC has defined the standards for the frequency and strength of the radio waves that will prevent occurrence of harmful to human health effects.

Japanese government recognizes only thermal effects of exposure as hazardous to health. Japanese EMF Information Center states that:

> *…when exposed to the high frequency electromagnetic field (EMF), the human body or some part of it's received an energy which could be converted to heat. As a result, the temperature of specific body parts could be elevated in case of exposure to a very strong high frequency EMF or radio wave. Fortunately, the body's thermoregulatory system prevents the elevation of temperature above the safety levels at exposure to an EMF at or below a certain strength of the acting factor. The human body has a system that maintains the body temperature within certain boundaries by regulation of perspiration and blood circulation…*

Further, the JEIC informs that the health effects are unlikely when following current safety guidelines:

> *…Since the mobile phones operate at low level of energy (relying mostly on modulation) there is no possibility that in common living or working environment for exposure to strong EMF that can raise the body's temperature. Therefore, high frequency EMFs and radio waves used in mobile phones and other types of wireless telecommunications are thought to have no adverse health effects…*

Safety guidelines enforced in Japan are directly based on the ICNIRP guidelines (https://www.tele.soumu.go.jp/e/sys/ele/body/index.htm) as it appears from the following statement:

> *…Based on scientific knowledge accumulated by these studies, we formulated the "Radio Radiation Protection Guidelines for Human Exposure to Electromagnetic Fields" (hereinafter referred to as RRPG) taking various safety factors into consideration. The standard values set out in these guidelines are on a par with the values released by ICNIRP (International Commission on Non-Ionizing Radiation Protection), and are used not only in Japan, but in every country of the world. If these standard values are satisfied, there is no influence on the human health according to WHO (World Health Organization), ICNIRP etc…*

…and further:

> *…There is no indication that radio waves emissions from cellular phones or their base stations will cause or promote cancer, there are also no other effects on the human body which adversely affect health…*

MIC website does not have information on EHS and JEIC website informs that the web page dealing with EHS is under construction (as of Jan. 12, 2022).

The Ministry of Internal Affairs and Communications of Japan has published a brochure (in Japanese), 'Radio Waves and Safe Living Environments' (https://www.tele.soumu.go.jp/resource/j/ele/body/emf_pamphlet.pdf) on health effects and safety of EMF exposures where it mentions EHS. Information concerning EHS, extracted from the brochure shows that it follows opinions of the WHO Fact sheet 296 published in December 2005. It states that:

- EHS has a broad variety of nonspecific symptoms.

- Symptoms severity can be very broad, and EHS symptoms can interfere with everyday life for those affected, regardless of whether it causes symptoms.
- EHS has no clear diagnostic criteria.
- There is no scientific basis for EHS symptoms to be associated with electromagnetic field exposure.
- EHS is not a medical diagnosis, nor is it clear whether it represents a single medical problem.
- The WHO urges governments to: "Governments should be aware of the potential risks of electromagnetic fields to people, health professionals, and employers in EHS."
- Properly targeted and balanced information about health hazards should be provided.

However, as per the MIC and JEIC websites, the EHS is not formally recognized in Japanese safety regulations.

The Netherlands

In the Netherlands, the National Institute for Public Health (RIVM) and the Environment of the Ministry of Health, Welfare and Sport very briefly presents EHS. Webpage presenting electromagnetic fields in daily life (https://www.rivm.nl/en/electromagnetic-fields/emf-dailylife) states the following:

> *There is ongoing research on possible non-specific health effects such as fatigue, loss of concentration, sleep disturbance, headache and 'electrohypersensitivity'. However, a causal relationship with EMF exposure has not been established.*

New Zealand

The Ministry of Health of New Zealand has the RF-EMF exposure safety limits that (https://www.health.govt.nz/our-work/environmental-health/non-ionising-radiation/radiofrequency-field-exposure-standard):

> *are based on a careful review of the research into the health effects of exposure to radiofrequency radiation, and include wide margins for safety*

New Zealand standard NZS 2772.1:1999 Radiofrequency fields – Maximum exposure levels – 3 kHz to 300 GHz recommends limits for controlling exposures to radiofrequency fields. It is in full agreement with the ICNIRP recommendations of 1998 and 2020. The Ministry of Health states that it has reviewed the ICNIRP 2020 Guidelines and advises that compliance would provide protection at least equivalent to that offered by NZS 2772.1:1999.

Biomedical research on RF-EMF and health is reviewed by the Interagency Committee on the Health Effects of Non-Ionising Fields. The membership includes representatives from government, industry, academic and consumer groups. The Committee meets every 6 months and considers papers on key research topics, and research reviews published by national and international health bodies. The Committee prepares occasional reports to Ministers to provide them with background information and a current summary of research findings. The most recent was published in 2018 (https://www.health.govt.nz/publication/interagency-committee-health-effects-non-ionising-fields-report-ministers-2018).

Report states on EHS:

> *Electrohypersensitivity (EHS) is the name given to a range of symptoms such as headaches, tiredness, dizziness, sleep disturbances and aching muscles, which some people attribute to EMF exposures.*
>
> *Although both ELF and RF fields have been suggested as a cause of the symptoms, most of the concern and research have focused on RF fields.*
>
> *Recent reviews of these studies continue to conclude that people who consider themselves unusually sensitive to EMFs are, in fact, unable to detect EMFs, and the occurrence of symptoms appears unrelated to exposures.*
>
> *Experimental evidence suggests a nocebo effect…*

Poland

Government of Poland has recently (in 2020/21) approved ICNIRP safety guidelines as legally binding. In respect of health effects of EMF, Government of Poland firmly states that there is no proven link between EMF exposures from wireless devices and networks and any health problems, including cancer. The most recent statement (https://www.gov.pl/web/5g/przeczytaj-siec-5g-powoduje-nowotwory-fake-news), published on Nov. 4, 2021 states (excerpts; translated from Polish language):

> *5G causes cancer? Fake news! 11/04/2021. The results of scientific research do not support this thesis. For several years there have been disseminated numerous myths about the harmfulness of the 5G network. From time to time, materials posted on social media appear suggesting the harmful effects of this technology on human health. […] So far, however, no studies have been published that would be positively assessed by experts and confirm the relationship between cancer formation and the GSM network.*

EHS is not considered as valid medical diagnosis. The "White Book" on EMF quoted by the Government of Poland

(https://www.gov.pl/web/5g/biala-ksiega1) states on EHS (translated from Polish language):

> *A few percent of people with ailments such as severe exhaustion, headache, tinnitus or insomnia are considers them as the effects of electromagnetic fields (EMF) on the body. Research shows that symptoms occur when a person subjectively believes they are particularly vulnerable to EMF, and not when measurements show that they are, so the severity of symptoms is related to perceived, not real, EMF exposure. Attempts are being made to define a medical condition called "electromagnetic hypersensitivity" (EHS). The unresolved problem, however, remains to define the causes and the precise set of electrosensitivity symptoms.*

Russia

The Russian National Committee on Non-Ionizing Radiation Protection (RNCNIRP) was created in 1997 at the Russian Academy of Medical Science (RAMS) within the framework of the Russian Scientific Commission on Radiation Protection (RSCRP). The RSCRP acts as the overseer of the RNCNIRP. The RNCNIRP is an independent scientific organization which does not accept financial sponsorship. Its decisions are thought of as recommendations, and are considered by the Ministry of Health of the Russian Federation when it is setting standards. Mandatory compliance is required with regard to the Sanitary Provisions and Ecological Norms (SanPiN) guidelines set by the Ministry of Health of the Russian Federation. The latest RF-EMF SanPiN 2.1.8/2.2.4.1190-03 (safety standard) on mobile communications was issued by the Ministry of Health of the Russian Federation in 2003 (http://apekspro.ru/files/SanPiN%202.1.8_2.2.4.1190-03.pdf). This decreed that the maximum permissible exposure level for RF-EMF over the frequency range of 300 MHz–300 GHz in the Russian Federation is 10 μW/cm2 (0.1 W/m2). SanPiN 2003 also recommended that:

> *Use of mobile telecommunication devices should be restricted for those under 18 years of age and pregnant women*

Currently, the Health Ministry of Russian Federation, the State Sanitary Serwis, and the RNCNIRP don't have any official policy on EHS. Exposure limits in Russia have are claimed to have sufficiently large safety factor, and take into account possible knowledge uncertainties, including sensitivity to EMF. Therefore, there are no EHS complaints from the general population. It is considered that for the public health system the EMF sensitivity is irrelevant.

Switzerland

There is no official position on EHS in Switzerland. Also in Switzerland it is considered that the causality link between EMF exposures and EHS symptoms is not yet established. However, the opinion of lack of causality is not considered to be proven sufficiently and it is considered that the non-specific symptoms of EHS are probably caused by EMF exposures and more research is needed to establish it.

The document 'Electrosmog in the environment' (https://www.bafu.admin.ch/bafu/en/home/topics/electrosmog/publications-studies/publications/electrosmog-in-the-environment.html) published by the Swiss Agency for the Environment, Forests and Landscape (SAEFL) states the following:

> *Some people have the ability to consciously perceive weak electromagnetic radiation, which can be established in experimental arrangements and tests. Test subjects have to be able to tell the difference between a real and a sham exposure.*
>
> *…it is difficult to precisely determine the causes of these [EHS] symptoms […] other factors come into question, such as stress, noise, flickering light, chemicals, and physical or mental disorders.*
>
> *…there are no generally acknowledged criteria for an objective diagnosis of electrosensitivity, and it also appears that ability to perceive weak fields and electrosensitivity exist independently of one another.*

The document admits that to-date published research is insufficient to give reliable answers on EMF and EHS:

> *Many questions still need to be answered regarding these two phenomena, and therefore a great deal of research is still required.*

The document lists also EMF exposure effects that are established, probable, possible and improbable. Effects such as:

> *non-specific symptoms (headaches, fatigue, problems of concentration, disquiet, burning skin, etc.)*

…are listed as probable effects of EMF exposure.

The document states also that:

> *Every year, the data volume transmitted over mobile communication networks doubles. […] Overall, the population's exposure to electrosmog is likely to rise further.*
>
> *It has not been conclusively determined whether non-ionising radiation below the limit value harms health in the long term. […] … electrosensitive people feel that their health or well-being is harmed by electrosmog. To date, there are no recognised medical diagnostic criteria.*

The document lists several actions needed to be done by the Federal Government. These call for adoption of the Precautionary Principle, for minimizing radiation emissions, for continuation of research and for following changes in exposure of population:

> *The federal government adopts the precautionary principle as regards the limit values in the Ordinance on Protection against Non-Ionising Radiation (NISV)…*
>
> *…Network operators and installation owners should ensure that their mobile communication services and power grid infrastructures emit as little radiation as possible.*
>
> *…Targeted research needs to be conducted in order to fill in the knowledge gaps about the long-term effects.*
>
> *The population's exposure level must be better known…*

Report 'Mobile Radio and Radiation' by the working group on Mobile Radio and Radiation on behalf of the Federal Department of the Environment, Transport, Energy and Communications (DETEC) presents two important opinions concerning the existence of EHS are presented [excerpts]:

> *In medical practice there are cases in which patients plausibly attribute their complaints to high NIR exposures in their everyday life.*
>
> *It cannot, however, be excluded that the effects manifest themselves only under certain conditions or exposure situations which are not yet understood. Owing to methodical difficulties with investigation of electromagnetic hypersensitivity, additional research activities are therefore urgently required.*

Finally, electrosmog is presented briefly on website of the Federal Office for the Environment (FOEN) (https://www.bafu.admin.ch/bafu/en/home/topics/electrosmog/in-brief.html) with the following opinions on EMF and health, including EHS:

> *Various studies present evidence of biological effects, however, including in the case of weak radiation exposure below these limit values. For example, weak high-frequency radiation can alter electric brain activity and influence brain metabolism and blood flow. Whether these effects have an impact on health is still unclear*
>
> *…some people firmly believe that they suffer from impaired well-being and health impacts due to very weak radiation. Ways of helping so-called electrosensitive persons are only beginning to emerge.*

United Kingdom

Advisory Group on Non-Ionising Radiation (AGNIR) was an independent scientific advisory group that reported to Public Health England (PHE). AGNIR report published in 2012 (https://www.gov.uk/government/publications/radiofrequency-electromagnetic-fields-health-effects) states the following on the responses of humans to EMF exposures concerning acute exposures/effects:

> *The overall evidence from the numerous experimental studies that have been conducted suggests that no causal link exists for short-term exposures.*
>
> *These studies also suggest that people are unable to detect the presence of RF fields.*
>
> *These findings apply to both healthy participants and to people who report being sensitive to various types of electromagnetic field.*
>
> *This does not undermine the importance of the symptoms that are experienced, but it does suggest that causes other than those related to RF fields should be considered.*

…and on the chronic/delayed exposures/effects:

> *…RF field exposures over the longer term, early observational studies concerning the effects of RF fields from mobile phone handsets or base stations suffered from several methodological flaws which limit the conclusions that can be drawn from them.*
>
> *…insufficient good quality evidence is available to draw conclusions as to the role of long-term exposure to RF fields in causing symptoms.*

In 2017 AGNIR was dissolved (https://www.gov.uk/government/groups/advisory-group-on-non-ionising-radiation-agnir). Following dissolution of AGNIR, the Committee on Medical Aspects of Radiation in the Environment (COMARE) (https://www.gov.uk/government/groups/committee-on-medical-aspects-of-radiation-in-the-environment-comare), and expert group at the Department of Health will continue to watch over the non-ionising radiation. However, as of end of 2020, COMARE has not yet established non-ionizing radiation group and is still in process of acquiring expertise in this area.

USA

Radiofrequency safety limits are set in place by the US Federal Communications Commission (FCC) (https://www.fcc.gov/general/radio-frequency-safety-0) whereas the US Food and Drug Administration reviews the biomedical evidence concerning effects of RF-EMF exposures.

Currently, US FDA considers that the scientific evidence does not demonstrate that exposures to RF-EMF would be hazardous to health (https://www.fda.gov/radiation-emitting-products/cell-phones/scientific-evidence-

cell-phone-safety). Hence, Head of the US FDA has provided in 2019 FCC with a letter confirming the validity of the FCC safety standards (https://www.fda.gov/media/135022/download).

In respect of the EHS, the US FDA states the following:

> *…the scientific evidence indicates symptoms experienced by people who self-identify as having electromagnetic hypersensitivity occur when the individual believes they are being exposed to radio frequency energy.*
>
> *…very real symptoms [of EHS] are not the result of radio frequency exposures.*
>
> *…people cannot sense when they are being exposed to RF.*
>
> *The World Health Organization has a fact sheet on this subject: Electromagnetic Hypersensitivity […]. The FDA continues to monitor all scientific publications in this area.*

Court cases on EMF and health

Self-declared EHS persons consider themselves as left out of the health system because while it is acknowledged that the symptoms cause suffering and affect wellness, there is still (i) non-recognition of EHS as disease, (ii) lack of diagnostic tools to identify EHS, (iii) lack of treatments to relieve symptoms of EHS, (iv) hesitance of physicians to even attempt to diagnose EHS. Hence, some of the self-declared EHS attempt to resolve their health problem and get help by going to courts of law (https://physicstoday.scitation.org/do/10.1063/pt.5.8136/full/).

In some cases, the decisions or opinions are of significance for all EHS sufferers.

California Appellate Court Rules That Electromagnetic Hypersensitivity May Qualify as a Disability Under FEHA 05.27.2021 (https://www.aalrr.com/newsroom-alerts-3850):

> *Employers should be aware that California courts will construe FEHA broadly when determining whether an individual has a qualifying "disability." Plaintiffs need only plead they have a mental or physical disability that affects a major life activity to proceed to trial, regardless of whether they have a condition formally recognized by the medical community or the ADA (such as EHS).*

Two articles by David McRobert, published on the website of the Ontario Bar Association of Canada [31, 32] state the following considerations that apply to EHS:

> *Importance of Experts*
>
> *Experts are absolutely key to the success of proceedings in the Canadian courts and at administrative tribunals. Law societies in Canada provide very detailed rules for lawyers on competence and their requirements to retain and work with qualified experts on behalf of their clients and the courts. Experts must be viewed as credible and have a duty of loyalty to the courts "to provide opinion evidence that is fair, objective and non-partisan".*
>
> *Courts and tribunals have struggled with medical evidence on EHS and other sensitivities for the past 15 years. Currently, lawyers representing EHS clients and clients with other environmental sensitivities often are unable to identify experts who can be properly qualified by the courts.*

In the USA, an article by Paul A. Scrudato [33] has presented a specific case of EHS lawsuit. Case of EHS in New Mexico, USA, Firstenberg v. Monribot, has been dismissed because of lack of credible evidence of causality:

> *…the District Court in Firstenberg v. Monribot reviewed the evidence provided by Mr. Firstenberg and dismissed the case partially due to a lack of scientific support for the claimed correlation between the symptoms of EHS and exposure to electromagnetic fields. On March 5, 2015, the Court of Appeals affirmed that decision finding that the district court did not abuse its discretion in excluding scientific evidence or dismissing the case. Although Mr. Firstenberg could not get past summary judgment he has been collecting social security disability benefits for his claimed disease since 1992.*

Court has used as evidence to dismiss the case study by Eltiti and co-workers [34] and WHO opinion:

> *The World Health Organization, has similarly concluded that, though individuals claiming EHS exhibit real symptoms, there is no scientific basis to link EHS symptoms to EMF exposure.*

Some court cases, e.g. in Italy, France or Australia were won by the persons claiming to have health symptoms caused by EMF exposures. Some other court cases were lost and dismissed. Nevertheless, it is likely that "in human desperation" self-declared EHS persons will more and more turn to courts of law to get assistance with their health problems and suffering. The only way to avoid it is to conduct further EHS research to get scientifically irrefutable, as much as possible, evidence on what is EHS, what causes it and how to remedy the symptoms that affect the quality of life.

Concluding opinions

As far as the author is aware, it is the first, so comprehensive collection of information about EHS health policies of different organizations and countries. Hence, it is hoped and expected to bring attention to the EHS health policy issue.

It appears that the self-declared EHS persons are currently left alone and not taken care of in the WHO's, ICNIRP's, IEEE-ICES's and governmental health policy considerations. There are also no indications, by the WHO, ICNIRP or IEEE-ICES and governments, of the willingness to pursue molecular level research on EHS in particular and on the individual sensitivity to RF-EMF in general.

Interestingly, there is a lack/scarcity of medical professionals, physicians, in organizations crucial to developing EMF radiation safety limits to protect health of the population. The WHO EMF Project that world-widely recommends use of ICNIRP safety guidelines, is an office consisting of the Head of the EMF Project and an assistant. The head of the WHO EMF Project is an electrical engineer. On the ICNIRP Main Commission there is currently one medical doctor (physicians) but this person has joined ICNIRP only after the 2020 guidelines were developed. On the IEEE-ICES membership there is only one medical doctor (physician).

Unfortunately, just an admission that the symptoms are real and might hamper every-day life is not sufficient.

The return to claims that the symptoms are '*just in the heads of sufferers*', as *nocebo*-hypothesis suggests, is a mistake because the evidence for *nocebo*-hypothesis as the major cause of EHS is scientifically weak and inconclusive. The apparent return to consider self-declared EHS persons as psychological/psychiatric cases is wrong when the scientific evidence is inadequate to do so.

While the research on RF-EMF and health has been conducted for a long time, there are still significant gaps in the knowledge. Especially, there is lack of studies where, as far as it is ethically possible, the discovered biological effects in *in vitro* and in animal studies would be examined whether they occur also in humans. Without such confirmation studies it is difficult to claim that human health is affected or is not affected by RF-EMF exposures, and no matter whether the exposures meet, or not, the current safety guidelines.

The majority of the studies are of poor quality and of small sample size and providing *in vitro*/animal evidence that has not been shown to occur in living humans. There is a strong and urgent need for a better research [35–37].

However, despite the general agreement that the currently available scientific evidence is, in general, of poor quality, it is common that this current inadequate evidence is incorrectly used to state that there is no evidence of harm or harm is unlikely. Such statements lack logic. If we do not have sufficient quality scientific evidence to back-up claims of safety then any claims of presumed safety are unreliable, because they lack quality scientific basis.

In spite of these shortcomings in science, the WHO, the ICNIRP, the IEEE-ICES continuously claim that the current RF-EMF safety guidelines protect everyone and forever. These claims are misleading as they lack sufficiently robust scientific basis.

There is a hesitance to study EHS on molecular level, instead of, *ad nauseam*, continuation of provocation studies. The reason might be that if ever EHS would be recognized as a disease caused by exposures to RF-EMF, it would have profound impact on the whole wireless communication and telecom industry. If EHS is proven to be caused by RF-EMF then it will require a complete revision of safety guidelines and introduction of technical and technological modifications in wireless devices and networks. Continuation of examining EHS with provocation studies is futile because such studies generate highly unreliable subjective data, and not the necessary evidence of objective biomarker/bioeffects data. Only research using molecular level examinations of physiology might prove, or disprove, the existence of a causality link between EHS and RF-EMF exposures [14, 38, 39].

The claims, by the WHO, the ICNIRP and the IEEE-ICES, of unlikeness of causal link between EHS and RF-EMF exposures, are influencing opinions of the national radiation regulatory agencies. Statement as this, by ICNIRP in its FAQs page (https://www.icnirp.org/en/rf-faq/index.html), that:

> *As there is no evidence that symptoms in EHS individuals are related to RF EMF exposure, there would be no benefit of applying RF EMF restrictions specifically to account for EHS. Accordingly, restrictions have not been set to separately account for EHS, and individuals who believe that they are adversely affected by RF EMF are treated as part of the general public in terms of RF EMF restrictions.*

…causes that governments use it as a reason and an excuse to avoid any discussion on inclusion of EHS in any health policies.

Out of numerous science evaluations by numerous groups of scientists, the industry and the WHO have chosen to rely solely on the opinions prepared by ICNIRP and by IEEE-ICES. Considering the opinions of the ICNIRP unrelated groups as EUROPAEM, ICEMS or BioInitiative, would cause a need to redesign the wireless appliances and networks to work using lower radiation emission levels.

This favoring of the opinions of ICNIRP and IEEE-ICES and disregarding the opinions of EUROPAEM, BioInitiative and ICEMS takes place in scientific situation when there is no certainty that the opinions of ICNIRP or IEEE-ICES are the correct ones. There is no consensus on RF-EMF science and the opinions of all above presented groups of scientists should be validated at a common get-together round table conference.

From the above presented evidence, surprisingly and importantly, none of the examined countries (European

Union as a whole, Nordic Countries and the examples from the 17 separate countries) had in place any official and formal opinion on EHS as health impairment (potentially a disease) and none had a health policy related to EHS. It is likely that all of the countries, by following the WHO, ICNIRP and IEEE-ICES opinion on EHS, felt that there is no specific need to address problem of EHS in their own health policies.

The only recognition of EHS is as handicap in Nordic Countries. However, there are no diagnostic criteria for identifying EHS and it is not considered as a disease *per se*.

Self-declared EHS persons, claiming to experience various health symptoms from the exposures to RF-EMF are themselves trying to find the ways to mitigate the occurrence and the severity of the symptoms. They organize in a self-help groups where they are prone to misinformation. However, knowing the risks, they do so because they were left out of the health policies by their own governments at the advice of the WHO, ICNIRP and IEEE-ICES.

On the one hand, scientists, radiation safety agencies and governments are admitting that the health suffering of self-declared EHS persons is real and might be very severe in some cases, but at the same time, these entities do not provide sufficiently reliable science and do not provide means to diagnose EHS and a practical ways to mitigate it. Simply, claims that suffering is due to *nocebo* effect and, therefore, mostly imagined by the self-diagnosed EHS persons, is not trustworthy and reliable when the scientific evidence to back it up is either still lacking or is of poor scientific quality.

When personally discussing with the self-declared EHS persons it comes out their deep disappointment in science and scientists, in safety standard setting bodies and in governmental radiation protection agencies and health care organizations. The research examining link between EHS symptoms and RF-EMF exposures is not of sufficient quality to prove, or to disprove, causality link between EHS and RF-EMF exposures. Better quality research is needed but, scientists of ICNIRP and IEEE-ICES use this currently available low quality science as an argument to dismiss the need for further, more in-depth research on what kind of molecular level biochemical changes are caused in human body during acute or chronic exposures to RF-EMF.

RF-EMF exposures are going to affect us for tens of years, the whole life-time of persons born in this century. Molecular level research on RF-EMF effects in humans is needed not only to find out whether causality link between EHS and RF-EMF exists but to find out what other health effects might be caused by exposures lasting the life time.

Molecular level research of RF-EMF effects in humans is urgently needed because the life of every person is currently being closely dependent on the ability to use wireless communication devices. Mobile phones are no just phones anymore. These are palm-held computers that contain more and more information that is essential to function in the society. For the self-declared EHS persons the life in such RF-EMF-saturated society is, already now very challenging, and it will be more and more difficult in the future.

Scientists and research funding organizations should continue research on EHS and facilitate research that would provide scientifically high quality evidence to reliably prove, or reliably disprove, the existence of causality link between EHS and EMF exposures [14].

In conclusion, it seems clear that the opinion of ICNIRP:

> *As there is no evidence that symptoms in EHS individuals are related to RF EMF exposure, there would be no benefit of applying RF EMF restrictions specifically to account for EHS.*

…had a strong bearing on why individual countries did not consider it worthy to develop health policies for dealing with self-declared EHS persons, admittedly suffering of real symptoms. Hence, claims that EHS does not exist lead to decisions that there is no need for health policies to deal with EHS.

This is a mistake. The self-declared EHS persons are left alone and, for now, there seems to be no help in sight.

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References

1. Tseng MCM, Yi-Ping Lin YP, Cheng TJ. Prevalence and psychiatric comorbidity of self-reported electromagnetic field sensitivity in Taiwan: a population-based study. J Formos Med Assoc 2011;110: 634–41.
2. Carpenter DO. The microwave syndrome or electro-hypersensitivity: historical background. Rev Environ Health 2015; 30:217–22.
3. Mild KH, Repacholi M, van Deventer E, Ravazzani P. Electromagnetic hypersensitivity. In: Proceedings international workshop on EMF hypersensitivity. Prague, Czech Republic; 2004. Available from: https://www.who.int/publications/i/item/9789241594127.

4. Wiedemann PM, Schütz H. The precautionary principle and risk perception: experimental studies in the EMF area. Environ Health Perspect 2005;113:402–5.
5. Boehmert C, Verrender A, Pauli M, Wiedemann P. Does precautionary information about electromagnetic fields trigger nocebo responses? An experimental risk communication study. Environ Health 2018;17:36.
6. Foray N, Colin C, Bourguignon M. 100 years of individual radiosensitivity: how we have forgotten the evidence. Radiology 2012;264:627–31.
7. Bourguignon MH, Gisone PA, Perez MR, Michelin S, Dubner D, Di Giorgio M, et al. Genetic and epigenetic features in radiation sensitivity. Part I: cell signalling in radiation response. Eur J Nucl Med Mol Imaging 2005;32:229–46.
8. Bourguignon MH, Gisone PA, Perez MR, Michelin S, Dubner D, Di Giorgio M, et al. Genetic and epigenetic features in radiation sensitivity. Part II: implications for clinical practice and radiation protection. Eur J Nucl Med Mol Imaging 2005;32: 351–68.
9. Rajaraman P, Hauptmann M, Bouffler S, Wojcik A. Human individual radiation sensitivity and prospects for prediction. Ann ICRP 2018;47:126–41.
10. Rees JL. The genetics of sun sensitivity in humans. Am J Hum Genet 2004;75:739–51.
11. Kelly DA, Young AR, McGregor JM, Seed PT, Potten CS, Walker SL. Sensitivity to sunburn is associated with susceptibility to ultraviolet radiation–induced suppression of cutaneous cell–mediated immunity. J Exp Med 2000;191: 561–6.
12. Barnett SB, Rott HD, ter Haar GR, Ziskin MC, Maeda K. The sensitivity of biological tissue to ultrasound. Ultrasound Med Biol 1997;23:805–12.
13. Leszczynski D, editor. Radiation Proteomics. The effects of ionizing and non-ionizing radiation on cells and tissues. In: Adv in Exp Med Biol, Dordrecht, Springer; 2013, vol 990.
14. Leszczynski D. Review of the scientific evidence on the individual sensitivity to electromagnetic fields (EHS). Rev Environ Health 2022;37:423–50.
15. Röösli M. Radiofrequency electromagnetic field exposure and non-specific symptoms of ill health: a systematic review. Environ Res 2008;107:277–87.
16. Baliatsas C, Van Kamp I, Lebret E, Rubin GJ. Idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF): a systematic review of identifying criteria. BMC Public Health 2012;12:643.
17. Belpomme D, Irigaray P. Electrohypersensitivity as a newly identified and characterized neurologic pathological disorder: how to diagnose, treat, and prevent it. Int J Mol Sci 2020;21: 1915.
18. Schmiedchen K, Driessen S, Oftedal G. Methodological limitations in experimental studies on symptom development in individuals with idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) – a systematic review. Environ Health 2019;18:88.
19. Dieudonné M. Electromagnetic hypersensitivity: a critical review of explanatory hypotheses. Environ Health 2020; 19:48.
20. Bonner P, Kemp R, Kheifets L, Portier C, Repacholi M, Sahl J, et al, WHO. Establishing a dialogue on risks from electromagnetic fields. 2002. Available from: https://www.who.int/publications/i/item/9241545712.
21. Dhungel A, Zmirou-Navier D, van Deventer E. Risk management policies and practices regarding radio frequency electromagnetic fields: results from a WHO survey. Radiat Prot Dosim 2015;164: 22–7.
22. The Guardian. Renowned cancer scientist was paid by chemical firm for 20 years. 2006. Available from: https://www.theguardian.com/science/2006/dec/08/smoking.frontpagenews.
23. Heath D. Lauded public health researcher also worked for industry, revealing entanglements of science. The Center for Public Integrity; 2013. Available from: https://publicintegrity.org/environment/lauded-public-health-researcher-also-worked-for-industry-revealing-entanglements-of-science/.
24. ICNIRP. Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). Health Phys 2020;118:483–524.
25. D'Andrea JA, Chou CK, Johnston SA, Adair ER. Microwave effects on the nervous system. Bioelectromagnetics 2003;6:107–47.
26. Belyaev I, Dean A, Eger H, Hubmann G, Jandrisovits R, Kern M, et al. EUROPAEM EMF Guideline 2016 for the prevention, diagnosis and treatment of EMF-related health problems and illnesses. Rev Environ Health 2016;31:363–97.
27. Havas M, Marrongelle J, Pollner B, Kelley E, Rees CRG, Tully L. Provocation study using heart rate variability shows microwave radiation from 2.4 GHz cordless phone affects autonomic nervous system. Eur J Oncol Library 2010;5:273–300.
28. Havas M, Marrongelle J. Replication of heart rate variability provocation study with 2.4-GHz cordless phone confirms original findings. Electromagn Biol Med 2013;32:253–66.
29. Havas M, Marrongelle J. Statement of retraction "Replication of heart rate variability provocation study with 2.4-GHz cordless phone confirms original findings". Electromagn Biol Med 2014; 33:335.
30. Schuermann D, Mevissen M. Manmade electromagnetic fields and oxidative stress – biological effects and consequences for health. Int J Mol Sci 2021;22:3772.
31. McRobert D. Using law and advocacy to win accommodations for clients with electromagnetic hypersensitivity (EHS): part 1. 2021. Available from: https://www.oba.org/Sections/Environmental-Law/Articles/Articles-2021/February-2021/Using-Law-and-Advocacy-to-win-Accommodations-for-C.
32. McRobert D. Using law and advocacy to win accommodations for clients with electromagnetic hypersensitivity (EHS): part 2. 2021. Available from: https://www.oba.org/Sections/Environmental-Law/Articles/Articles-2021/March-2021/Using-Law-and-Advocacy-to-win-Accommodations-for-C#_edn1.
33. Scrudato PA. Suffer from electromagnetic hypersensitivity? Better call…. Natl Law Rev 2015;5:2015. Available from: https://www.natlawreview.com/article/suffer-electromagnetic-hypersensitivity-better-call.
34. Eltiti S, Wallace D, Russo R, Fox E. Aggregated data from two double-blind base station provocation studies comparing individuals with idiopathic environmental intolerance with attribution to electromagnetic fields and controls. Bioelectromagnetics 2015;36:96–107.
35. Foster KR, Vijayalaxmi. Needed: more reliable bioeffects studies at "high band" 5G frequencies. Front Comms Net 2021; 2:721925.

36. Vijayalaxmi. Biological and health effects of radiofrequency fields: good study design and quality publications. Mutat Res Genet Toxicol Environ Mutagen 2016;810:6–12.
37. Szucs D, Ioannidis JPA. When null hypothesis significance testing is unsuitable for research: a reassessment. Front Hum Neurosci 2017;11:390.
38. Leszczynski D. The grand challenge: use of a new approach in developing policies in the area of radiation and health. Front Public Health 2014;2:50.
39. Belpomme D, Carlo GL, Irigaray P, Carpenter DO, Hardell L, Kundi M, et al. The critical importance of molecular biomarkers and imaging in the study of electrohypersensitivity. A scientific consensus international report. Int J Mol Sci 2021;22:7321.

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