

Mobile phones and health: Where do we stand?

SUMMARY

Mobile phones are an integral part of everyday life, and it is hard to imagine a world without them. There are nevertheless health concerns, and the debate is ongoing.

There is a vast body of research on the potential risks from exposure to radiofrequency electromagnetic fields such as those emitted by mobile phones. Yet scientific opinion remains split over the possibility of a link between mobile phone radiation and health problems. The results of research in this area have been interpreted in a variety of ways, and studies have been criticised for their methodological flaws, lack of statistical significance, and bias.

In 2011, the International Agency for Research on Cancer, a branch of the World Health Organization, classified radiofrequency electromagnetic fields as possibly carcinogenic (cancer-causing) to humans. The European Union defined basic restrictions for limiting exposure to electromagnetic fields in Council Recommendation 1999/519/EC, setting maximum values that should not to be exceeded. Moreover, in view of the scientific uncertainty, the European Environment Agency advises taking a precautionary approach.

Two sets of large-scale experimental studies involving laboratory animals, one from the United States National Toxicology Program and another from the Italian Ramazzini Institute, have recently brought the debate to the fore again. Both found varying levels of evidence of certain tumours in some of the animals tested. The results have nevertheless prompted diverging conclusions.



In this Briefing

- Mobile phones, a harmless fixture in our daily lives?
- Exposure to electromagnetic fields
- Research into mobile phones and health
- Major studies on the health effects of mobile phones
- Conclusions of international and European expert bodies
- European Union action
- Stakeholder views
- Going forward from here

Mobile phones, a harmless fixture in our daily lives?

Mobile phones are very widely used. In an April 2017 [Special Eurobarometer](#) survey, 93 % of European Union (EU) citizens interviewed owned a personal mobile phone. There are however concerns that exposure to radiofrequency electromagnetic fields, such as those emitted by mobile phones, could be bad for people's health. Numerous studies have been carried out, most notably on the potential risk of cancer, especially of the head and neck region. However, scientific opinion is split on the strength of the evidence and the conclusions to be drawn from it, and there is an ongoing debate over causality and whether any effects arise in humans. A case in point are the findings of two major animal-based studies – one from the United States and one from Italy – that have recently been published.

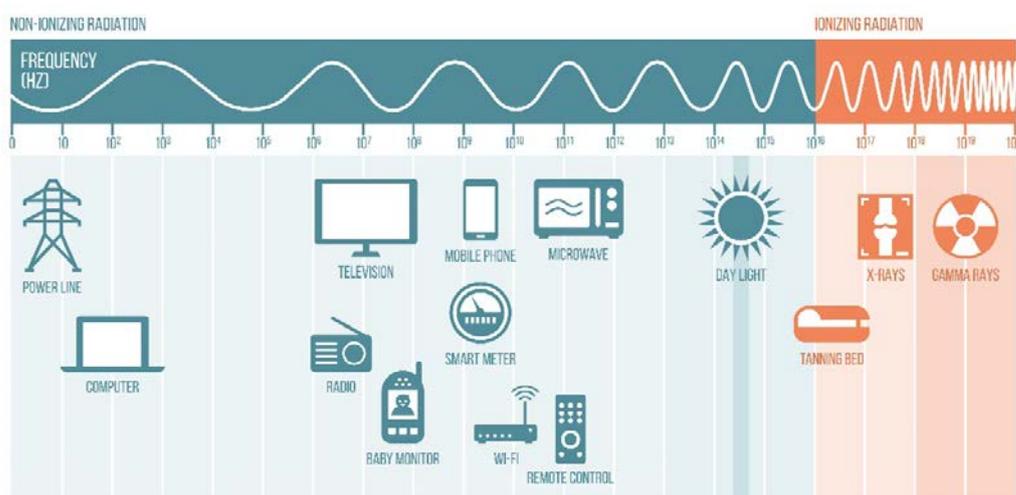
Exposure to electromagnetic fields

Non-ionising radiation and radiofrequency fields

Electromagnetic fields (EMFs) are invisible areas of energy, also referred to as waves or radiation. They are measured in hertz (Hz), and they are [typically characterised](#) by wavelength or frequency into two categories: ionising (mid to high-frequency, more powerful) and non-ionising (low-frequency, less powerful) radiation. The waves emitted from mobile phones are a type of non-ionising radiation referred to as radiofrequency fields, or radiofrequencies. Radiofrequencies are situated in the 30 kilohertz (kHz) to 300 gigahertz (GHz) range of the electromagnetic spectrum (see Figure 1).

In its 2014 [fact sheet](#) on electromagnetic fields and health, the World Health Organization (WHO) defines mobile phones as low-powered radiofrequency transmitters that operate at frequencies between 450 and 2 700 megahertz (MHz), with peak powers in the range of 0.1 to 2 watts (W).

Figure 1 – Electromagnetic spectrum diagram with frequencies, waves and examples



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Specific absorption rate

Handsets only transmit power when they are turned on. During phone calls, the user's exposure to radiofrequency fields is mostly confined to the part of the head that is closest to the phone's antenna. With increasing distance from the handset, the power – and so the user's exposure – tails off. A person using a mobile phone 30 to 40 cm away from their body (for example, when text

messaging, accessing the internet, or using a hands-free kit) would be subject to much lower exposure than someone holding the handset against their head. Mobile phones nevertheless [emit radiation constantly](#) while turned on, even if not in active use, and many people carry their phones in standby mode close to their bodies (in trouser, shirt or jacket pockets, or handbags, for instance).

Radiofrequency radiation exposure levels are quantified in terms of the rate of energy absorbed by the body (specific absorption rate, SAR), expressed as watts per kilogram (W/kg). SARs vary throughout the body. Mobile phones do not typically make use of the entire permissible exposure range; depending on the model, the test-SAR values might range [between 10 and 80 %](#) of the limit.

The EU has set safety limits for the energy absorbed by the body from exposure to a mobile phone. [Council Recommendation 1999/519/EC](#) sets a safety limit for a localised SAR of 2 W/kg, averaged over any 10 g of body tissue in a person's head and trunk, and of 4 W/kg in a person's limbs.¹ In practice, standards for limiting the exposure of the public to electromagnetic waves are based on the guidelines of the International Commission on Non-Ionizing Radiation Protection ([ICNIRP](#)) (see also [below](#)). Mobile phones sold in Europe must also undergo standardised tests to demonstrate compliance in accordance with the specifications of the European Committee for Electrotechnical Standardisation ([CENELEC](#)) (more in the [section](#) on European and EU-level committees).

Research into mobile phones and health

Potential risks of mobile phone radiation

Ionising radiation, such as X rays, has the potential to harm because it can transfer sufficient energy to [ionise](#) molecules. With prolonged exposure, this can lead to chemical changes, including cellular and/or DNA damage. Repeated DNA damage over time [can cause cancer](#). Conversely, non-ionising radiation, including the radiofrequencies emitted by mobile phones, is generally perceived as harmless due to its lack of potency. It is traditionally believed to have just one [known biological effect](#): tissue heating (thermal effects). At high exposure levels, local tissue heating can damage [temperature-sensitive biological structures and processes](#).

It is not currently known whether extended radiofrequency exposure at levels below those that cause tissue heating (that is, non-thermal effects) could impact human health. Numerous studies have investigated the potential long-term risks. Research has mainly looked at mobile phone use in relation to cancers of the head and neck region (in particular, [glioma](#), [meningioma](#) and [acoustic neuroma](#)) because these are the tissues primarily exposed.

Other health implications that have been investigated include: other malignant diseases (including childhood cancer); brain electrical activity; cognitive, psychomotor and memory functions; sleep; heart rate and blood pressure; fertility (especially in males) and reproduction; and child development and behavioural problems.

Do mobile phones increase the risk of brain tumours?

A November 2018 [article](#) on the United States explanatory news site Vox delves into the potential health effects of radiofrequency radiation, focusing on cancers of the head and neck. For their research, the journalists looked at [PubMed](#) studies published over the previous 10 years, of which they selected 102 to make 12 systematic reviews. They sum up the complexity of the issue as follows: 'We think it's fair to argue two things based on the best available research: that they don't cause tumors, or that the data is too poor to know that for sure'.

Bias and scientific uncertainty

Scientific opinion remains divided over the possibility of an association between mobile phone radiation and health, and the results from research into the health effects have been interpreted differently by different sides. A number of studies have been accused of having methodological flaws, lacking in statistical significance, or being biased,² and in particular, fraught with [funding and](#)

[study quality](#) bias,³ while much of the scientific evidence has been disparaged as insufficient, not convincing or too weak to draw reliable conclusions for or against any (adverse) effects.

Such ambiguity can be seen as an expression of scientific uncertainty, which is [broadly defined](#) as 'the expression of lack/limitation of scientific knowledge that could be reduced by additional data or information'. Scientific uncertainty has many reasons, including insufficient data, statistical variability, or conflicting evidence; yet defining, identifying and conveying scientific uncertainty is considered to be important for transparency and essential in scientific communication, especially when [communicating environmental and health risks](#), where public action is expected despite uncertain knowledge.

Scientists do, however, generally agree on the need for additional high-quality research, for instance on questions such as long-term exposure or mobile phone usage in children and adolescents.

Human, animal and *in vitro* studies and systematic reviews

While [randomised controlled trials](#) are usually considered the gold standard for generating evidence in health research, these are not a viable option for mobile phone research.⁴ Instead, research into the effects of electromagnetic fields on health relies on [observational](#) methods tracking real-world mobile phone use and disease incidence. As explained on the internet information platform of RWTH Aachen University ([EMF-Portal](#)),⁵ these include: epidemiological studies involving people (human studies); experimental studies in laboratory animals (animal studies); and studies of biological properties – on cell cultures, for example – in test tubes (*in vitro* studies).

Human studies, such as case-control or cohort studies,⁶ have the advantage of being carried out directly on humans; however, their sample sizes are in many cases too small, and they often provide insufficient retrospective data (on patients' recall of their mobile phone usage, for example) and lack statistical power. This makes it difficult to prove an actual link between a possible cause (for instance, magnetic field) and an observed effect (such as a disease). To confirm results or test hypotheses, additional *in vitro* and animal studies are carried out. Because of their larger sample sizes and standardised procedure protocols, their results are deemed more reliable than those of human studies, but their disadvantage lies in the difficulty of transposing the results to humans. According to the EMF-Portal, clear evidence of an effect can be only shown by collating and comparing the results of all types of studies.

In addition, [systematic reviews](#) critically appraise relevant research, analyse data from the studies included in the review, and summarise the results of the studies included, with or without the help of statistical methods ([meta-analyses](#)).

Major studies on the health effects of mobile phones

National Toxicology Program studies and the Ramazzini study

In recent months, two large-scale animal studies – from the United States and Italy – have released their results. The studies, here referred to as the 'NTP studies' and the 'Ramazzini study', are outlined below.

NTP studies: in the United States, the National Toxicology Program (NTP)⁷ conducted a series of toxicology [studies](#) in rats and mice to examine the potential health hazards, including cancer, from exposure to radiofrequency radiation used in 2G and 3G mobile phone technologies. The NTP studies tested around 3 000 animals for two years in a situation of near-field exposure, which approximates how humans are dosed while using mobiles phones. The studies took nearly 10 years to complete; the final conclusions were released in November 2018 (see also the study [fact sheet](#)). Based on the NTP's four categories of evidence that a substance may cause cancer ('clear', 'some', 'equivocal', 'no' evidence), the study found that there is: clear evidence of tumours (malignant [schwannomas](#)) in the hearts of male rats; some evidence of tumours (malignant gliomas) in the brains of male rats; and some evidence of tumours ([pheochromocytomas](#)) in the adrenal glands of

male rats. For female rats, as well as for male and female mice, there was equivocal evidence, meaning that it was unclear if the tumours observed were linked with mobile phone radiation. The researchers also reported cancers occurring in several other organs of the exposed animals, but were unable to clearly determine whether these resulted from exposure. These include: tumours of the prostate, [pituitary gland](#), pancreas and liver (in [rats](#)), as well as higher incidences of [lymphomas](#) and skin, lung and liver tumours (in [mice](#)).

The NTP studies, qualified by some as [potentially game-changing](#), are nevertheless thought to have limitations. The researchers themselves acknowledged that the exposures studied in animals '[cannot be compared directly](#)' to the exposure humans encounter (the lab rodents received radiofrequency radiation across their whole bodies), and that exposure levels and durations were greater than what mobile phone users typically experience. According to some commentators, the study examined the effects of a radiofrequency associated with an [early generation of mobile phone technology](#), so that any concerns arising from the study would seem to apply mainly to users of those models, not of current ones. The NTP researchers however argue that '2G and 3G networks were standard when the studies were designed and are still used for phone calls and texting', and that the results of the studies remain relevant.

Ramazzini study: in Italy, the non-profit [Ramazzini Institute](#) carried out an experimental study to evaluate the carcinogenic effects of exposure to radiofrequency radiation generated by base stations of mobile phones on rats. The [Ramazzini study](#) included around 2 500 animals and looked at far-field exposures, which approximate the radiofrequency radiation emitted from

various sources, including wireless devices such as tablet and laptop computers, with whole-body exposure for 19 hours a day. At the highest dose (50 V/m), the researchers found a statistically significant increase in the incidence of heart schwannomas in male rats. Moreover, they observed elevated rates of heart Schwann cell [hyperplasia](#) in male and female rats, as well as of malignant gliomas in female rats, although neither of these findings were statistically significant. The researchers concluded that the experiment provided 'sufficient evidence' to call for the re-evaluation of the IARC's conclusions as to the carcinogenic potential of radiofrequency radiation in humans.

NTP studies versus Ramazzini study: different set-up, similar results

As a March 2018 [article](#) in the Scientific American sets out, the two studies differ in size and method of evaluation (3 000 rats and mice, followed for two years in near-field exposure, versus 2 500 rats, followed throughout their lifetime in far-field exposure), but generate comparable results. The article quotes Jon Samet, a professor of preventive medicine and Dean of the Colorado School of Public Health, as saying that, taken together, the findings of the studies confirm that radiofrequency radiation exposure has biological effects in rats, some of them relevant to carcinogenesis (cancer formation).

Other recent studies

[INTERPHONE](#) was an international collaboration of researchers at 16 institutions in 13 countries,⁸ coordinated by the International Agency for Research on Cancer (IARC). The multicentre, [case-control study](#) was designed to determine whether mobile phone use increases the risk of head and neck cancers, mainly tumours of the brain (glioma and meningioma) and acoustic nerve (schwannoma), and specifically, whether the radiofrequency energy emitted by mobile phones is carcinogenic. According to the 2011 [final report](#), no increase in risk of glioma or meningioma was observed with mobile phone use of more than 10 years. There were some indications of an increased glioma risk at the highest exposure levels, but the researchers concluded that biases and errors prevented a causal interpretation. No increased risk of acoustic neuroma was found. However, the researchers mentioned that, as neuroma is a slow-growing tumour, the time period between the introduction of mobile phones and the occurrence of the tumour (latency period) might have been too short to observe an effect, if there is one.

The EU-funded [MOBI-KIDS](#) project (2010-2015) looked at the risk of brain cancer from exposure to radiofrequency and extremely low-frequency fields from mobile phones in children and adolescents. The large-scale project was conducted in 14 countries⁹ using a case-control study design. The main study has been completed and a publication is underway; the results have not been made public pending their publication in a peer-reviewed scientific journal.

Conclusions of international and European expert bodies

World Health Organization

In its 2014 fact sheet mentioned above, the World Health Organization (WHO) looks at the short- and long-term effects of exposure to radiofrequency fields. Short-term effects include tissue heating, or 'negligible temperature rise', in the brain or any other organ due to radiofrequency energy being absorbed by the skin and other superficial tissues. According to the WHO, 'research does not suggest any consistent evidence of adverse health effects from exposure to radiofrequency fields at levels below those that cause tissue heating'. As for the potential long-term effects, especially the association between brain tumours and mobile phone use, the WHO argues that 'results of animal studies consistently show no increased cancer risk for long-term exposure to radiofrequency fields' and concludes that, despite the many studies performed over the last two decades, 'no adverse health effects have been established as being caused by mobile phone use'. However, given the increasing use of mobile phones and the lack of data for mobile phone use exceeding 15 years, the WHO considers it warranted to conduct further research on a potential cancer risk, in particular among young people. Moreover, the WHO has announced its intention to conduct a formal risk assessment of all studied health outcomes from radiofrequency field exposure by 2016 (this assessment is not yet available).

Scientists warn of potential health effects of exposure to electromagnetic fields

In their [appeal](#) to the United Nations and its sub-organisations, the World Health Organization and the United Nations Environmental Programme, as well as all Member States, scientists engaged in the study of the biological and health effects of non-ionising electromagnetic fields express serious concerns and call for greater health protection from exposure to mobile phones and other sources of electromagnetic radiation, including the development of more protective guidelines, encouraging precautionary measures, and educating the public about health risks. The appeal, initially submitted in May 2015, is ongoing, and has so far been signed by over 240 scientists from across the world.

In another [appeal](#) from 2017, so far more than 200 scientists worldwide recommend a moratorium on the roll-out of the fifth generation wireless technology (5G) until potential hazards for human health and the environment have been fully investigated.

International Agency for Research on Cancer

In 2011, the International Agency for Research on Cancer (IARC), a WHO specialised agency, classified radiofrequency electromagnetic fields as 'possibly carcinogenic to humans' (Group 2B carcinogen). The IARC investigated the potential for an increased cancer hazard among people exposed to radiofrequency radiation. It did not focus specifically or exclusively on mobile phones, but on the type of radiation emitted by wireless phones and other sources, and it did not quantify the risk.¹⁰ The [bulk of the evidence](#) came from the INTERPHONE study and the Swedish case-control studies (Hardell *et al.*) on gliomas, meningiomas and acoustic neuromas. The evidence was [overall evaluated](#) as being 'limited' among users of wireless phones for glioma and acoustic neuroma, as well as in experimental animals, and as 'inadequate' to draw conclusions for other types of cancers.¹¹ An IARC spokesperson was quoted as saying that [a re-evaluation](#) of the classification might occur after the NTP delivered its final report (the NTP studies were ongoing at the time).

European Code against Cancer

The European Code against Cancer is a set of 12 recommendations that provide EU citizens with advice on cancer prevention. It is co-funded by the EU and the IARC and is currently at its [4th edition](#). Its section on [ionising and non-ionising radiation and cancer](#) explains that non-ionising types of radiation 'are not an established cause of cancer and are therefore not addressed in the recommendations to reduce cancer risk'.

International Commission on Non-Ionizing Radiation Protection

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) is an independent non-profit organisation that provides scientific advice on the health and environmental effects of non-ionising radiation, including to the European Commission. The ICNIRP's radiofrequency exposure guidelines, currently [under review](#), feed into the framing of EU standards. According to a September 2018 [note](#), while the two animal carcinogenesis studies (NTP and Ramazzini) have been taken into account, they 'do not provide a reliable basis' for revising the existing guidelines.

French Agency for Food, Environment and Occupational Health and Safety

The French Agency for Food, Environment and Occupational Health and Safety ([ANSES](#)) has undertaken expert appraisals concerning the health effects of radiofrequency radiation, and issued opinions on them. According to its [2013 opinion](#) on 'radiofrequency electromagnetic fields and health', the appraisal has demonstrated various effects with limited evidence in animal models and humans. ANSES also notes that it is not possible to reach conclusions on certain studied effects in the absence of data in humans, and that it would appear unfounded to propose new exposure limit values for the general public with regard to health. In its [2016 opinion](#) on 'exposure of children to radiofrequencies', ANSES states that children are a particularly vulnerable population, mainly because of their ongoing development, but also on account of the fact that they may use radiofrequency devices from an early age. ANSES makes a series of recommendations aimed at adapting the regulatory limit values to reduce children's exposure, and reiterates its call for a reduction in exposure of children by advocating moderate use and favouring the use of hands-free kits.

United States Food and Drug Administration and National Cancer Institute

According to the United States (US) Food and Drug Administration ([FDA](#)), the results of most studies indicate that there is no connection between health problems and exposure to radiofrequency fields via mobile phone use. It acknowledges, however, that [additional research](#) is warranted to address gaps in knowledge, such as mobile phone use over the long-term and among children. In a February 2018 [statement](#) on the NTP studies' draft report, the FDA notes that 'based on this current information, we believe the current safety limits for cell phones are acceptable for protecting the public health'. In a [statement](#) on the NTP studies' final findings, the FDA stresses that, since the studies were not designed to test the safety of mobile phones in humans, 'we cannot draw conclusions' about the risks of mobile phone use from them. The FDA concludes that the available scientific evidence 'continues to not support adverse health effects in humans caused by exposures at or under the current radiofrequency energy exposure limits'.

The US [National Cancer Institute](#) states that, although a few studies have shown some evidence of statistical association of mobile phone use and brain tumour risk in humans, most studies have found no association. The reasons for such discrepancies include: recall bias; inaccurate reporting; participation bias; and changing technology and methods of use (today's mobile phones operate at a different frequency and a lower power than older, analogue phones).

European Union action

Regulatory framework

The EU rules on electromagnetic fields are laid down in [Council Recommendation 1999/519/EC](#), which is based on guidelines issued by the ICNIRP (see above). The recommendation encourages Member States to establish a common protective framework; inform the public on the health impact of electromagnetic fields and the measures taken to address them; and increase consistency between national approaches. It also calls upon the European Commission to keep the possible health effects under review (see 'Scientific Committees' below). In particular, the recommendation defines the [basic restrictions and reference levels](#) for limiting exposure to electromagnetic fields by setting maximum SAR values that should not to be exceeded. These exposure limits are non-binding for EU Member States. However, some Member States have adopted [more stringent limits](#) than those recommended at EU level.

Furthermore, two directives apply to mobile phones. [Directive 2014/35/EU](#) establishes uniform conditions throughout the EU for the sale of electrical equipment designed for use within certain voltage limits. For instance, all equipment on sale in the EU has to bear the CE conformity marking to show that it meets the safety requirements, and before obtaining the marking, manufacturers have to perform a safety and conformity assessment. [Directive 2014/53/EU](#) (the Radio Equipment Directive) sets out essential requirements for radio equipment devices, including mobile phones, to be placed on the market. Manufacturers have to ascertain, among other things, that the radio equipment has been constructed in such a way as to ensure the protection of health and safety of persons, including the safety requirements set out in Directive 2014/35/EU. Moreover, the radio equipment has to be accompanied by instructions and safety information that can be easily understood.

European and EU-level committees

European Committee for Electrotechnical Standardisation

To demonstrate compliance with essential requirements, mobile phones sold in Europe have to undergo standardised tests. European standards to facilitate compliance are developed through one of the three not-for-profit [European standardisation organisations](#) that have been officially recognised by [Regulation \(EU\) No 1025/2012](#).¹² Of these, the European Committee for Electrotechnical Standardisation ([CENELEC](#)) is the one that typically informs standard-setting as regards human exposure to electromagnetic fields. According to CENELEC, European [standards](#) are

European Environment Agency recommends precautionary approach

On the question of whether mobile phones increase the risk of cancer, the [European Environment Agency](#) (EEA) advises policy makers to take preventive action, and recommends using the [precautionary principle](#), for three main reasons:

- The mechanisms by which mobile phone radiation could cause cancer are not yet fully understood, but waiting for that knowledge could take many years.
- The design of animal studies investigating the potential association of mobile phone radiation and cancer is an area of uncertainty, as some studies suggest a correlation and many others do not. Yet even if all animal studies failed to show a link, this would not necessarily indicate the absence of a link in humans.
- Studies in humans may be inconclusive for several reasons, one of them being the time it could take for any brain cancer effects of prolonged mobile phone use to develop.

The EEA advocates doing more to inform citizens about the risks of mobile phone use, especially among children. It advises users not to place the handset against their heads, given that text messaging or hands-free kits lead to much lower radiation levels than when the phone is pressed to the head. The EEA also suggests that mobile handsets could be labelled as a 'possible carcinogen', in line with the IARC classification decision. Lastly, the EEA solicits more independent research.

driven by business and drafted by technical experts in the field, based on a consensus reflecting the economic and social interests of its member countries.

Scientific Committees

The Scientific Committee on Health, Environmental and Emerging Risks ([SCHEER](#)) was formed in 2017 from the [merger](#) between the Scientific Committee on Health and Environmental Risks (SCHER) and the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR). SCHEER provides opinions on complex issues requiring a comprehensive assessment of risks to consumer safety or public health at the request of Commission services.¹³ SCENIHR had a standing mandate to evaluate the risks from electromagnetic fields, including those from mobile phones, and periodically reviewed the scientific evidence available to assess whether it still supports the exposure limits as proposed in Council Recommendation 1999/519.

In its [most recent opinion](#)¹⁴ of January 2015, SCENIHR did not suggest a review of the recommendation. SCENIHR concluded that, overall, the epidemiological studies on mobile phone use neither showed an increased risk of brain tumours nor indicated increased risk of other cancers of the head and neck. Some studies suggested increased risk of glioma and acoustic neuroma in heavy users of mobile phones, but other studies did not support this finding as regards glioma; the possibility of a link with acoustic neuroma remains open. According to SCENIHR, there is no evidence for other cancer types in adults and children, and a lack of evidence that the radiation emitted by mobile phones affects cognitive functions in humans. Studies on neurological symptoms show no clear effect, but the evidence is limited. SCENIHR confirms the conclusion reached in its [previous opinion](#) (2009) that there were no adverse effects on reproduction and development at non-thermal exposure levels, and that the evidence of an effect on child development and behavioural problems was weak. Moreover, SCENIHR states that the effects of exposure of foetuses arising from mothers' mobile phone use during pregnancy are not plausible, and that studies on male fertility are of poor quality and provide little evidence. The animal studies are considered to provide strong evidence for the absence of an effect (the NTP studies were still ongoing at the time).¹⁵

Stakeholder views

The [GSMA](#), which represents mobile operators worldwide, [states](#) that 'expert groups and public health agencies broadly agree that no health risks have been established from exposure to the low-level radio signals used for mobile communications'. In its [booklet](#) on mobile communications and health, GSMA explains that the consensus view of expert public health bodies, including the WHO, is that 'there are no adverse health effects associated with the radio signals used by mobile phones and base stations'. Moreover, it argues that 'international safety guidelines are protective of all persons, including children and pregnant women'.

A May 2016 article in the [Wall Street Journal](#) on whether mobile phones should carry warning labels illustrates the scientific split over the issue by interviewing two experts with divergent views. According to the article, opponents say that the risk, if any, is not great enough to warrant a warning, given that most expert bodies, such as the WHO, 'find no convincing evidence' of the risk of brain tumours or other harm. They contend that there is no known scientific mechanism by which mobile phones might cause brain tumours. Moreover, opponents argue that numerous epidemiological studies do not conclusively show increased risk of brain tumours associated with mobile phone use, and most studies show no association at all; while a number of studies do suggest an increase in risk, some of these depend on patients' recall of their mobile phone use and thus are susceptible to bias. Supporters of a warning say that, 'while the research is not conclusive, higher-quality studies show that mobile phone use is associated with brain-tumor risk and reproductive harm'. Countering the argument that overall increases in brain cancer were not seen after the introduction of mobile phones, supporters argue that this merely shows that 'there can be a considerable lag between exposure to a carcinogen and the cancer's diagnosis'. Supporters also state that mobile phone risk sceptics often cite studies that are flawed.

Two July 2018 articles, published in *The Guardian*, are another case in point. The authors of an [article from 14 July](#) condemn the lack of media coverage on the results of the NTP studies. They claim that it is in the industry's interest to keep the scientific argument going by casting into doubt studies that show a link to cancer, and making it appear that not all scientists agree. Reacting to these claims, the author of an [article from 21 July](#) argues that those authors misrepresented the research, given that 'scientific consensus to date is that there is no evidence linking cancer to mobile phones'. He levels criticism at the authors for only using evidence that supported the story they wanted to tell and stresses that it is important 'that we hone our scientific scepticism rather than succumb to baseless panics'.

Going forward from here

It is evident that consensus is far from being reached on the issue, and that studies continue to be carried out to increase the knowledge base. For instance, the ongoing EU-funded research project [GERoNiMO](#) uses novel methods to improve understanding of the mechanisms underlying the potential health effects of electromagnetic fields, with a focus on radiofrequency and intermediate frequency fields. Among other things, it will evaluate the possible effects (such as cognitive and behavioural development, cancer risk and reproductive effects) of exposure in children and adults; and is aimed at achieving a better understanding the mechanisms of biological effects (behavioural and reproductive effects, cancer, ageing and Alzheimer's disease) linked to exposure to these fields. In the [COSMOS](#) study, launched in 2007, a consortium of six European countries¹⁶ will follow approximately 300 000 adult mobile phone users for 20 to 30 years, to determine if there are any health issues linked with long-term exposure to radiofrequency energy from mobile phone use.

Members of the European Parliament have addressed many [parliamentary questions](#) to the European Commission on mobile phones and electromagnetic radiation. In a [June 2015 answer](#), the Commission stated that, taking into account the conclusions of the latest SCENIHR opinion and ongoing studies, it believes that for the time being there is no need to consider additional action on the possibility of a link between mobile phone use and brain cancer. In a [September 2018 answer](#), the Commission noted that the committee may reassess the situation depending on the outcome of the review of the ICNIRP guidelines.

MAIN REFERENCES

[A comprehensive guide to the messy, frustrating science of cellphones and health](#), Vox, updated 2 November 2018.

[EMF-Portal](#), RWTH Aachen University.

[Fact sheet – Electromagnetic fields and public health: mobile phones](#), World Health Organization, October 2014.

[Non-ionizing Radiation, Part 2: Radiofrequency Electromagnetic Fields](#), IARC Monographs, Volume 102, International Agency for Research on Cancer, 2013.

[Potential health effects of exposure to electromagnetic fields](#), European Commission, 2015.

ENDNOTES

- ¹ See Annex II, [Table 1](#) of the recommendation.
- ² Bias is the effect of factors in the design or execution of a study that lead erroneously to a stronger or weaker association than actually exists between an agent and disease (IARC Monographs, Volume 102, p. 17).
- ³ For instance, in its 2018 [evaluation](#) of recent research on electromagnetic fields and health risk, the Swedish Radiation Safety Authority noted that it had to exclude studies owing to poor quality and missing information, and found it 'very unfortunate that investigators are not adhering to international standards concerning the reporting of their studies, and that journals often do not have an adequate peer-review system that corrects such omissions'. Moreover, a 2017 [systematic review](#) of the association between study quality, source of funding, and research outcomes found that funding source was not associated with risk estimates, but study quality was, whereby studies of higher quality showed a trend towards a high risk of brain tumour, while lower-quality studies showed a trend towards lower risk.
- ⁴ Test subjects are randomly assigned to one of two groups, whereby one groups receives a treatment and the other a placebo. In theory, this type of study could also be used to investigate whether mobile phone radiation can cause disease; in practice, it would likely prove too difficult and too expensive to conduct, and all but impossible to find volunteers.
- ⁵ The EMF-Portal inventories and systematically summarises available research data in its scientific literature database.
- ⁶ A [case-control study](#) is a type of retrospective study in which people with the disease under study ('cases') are compared with those who do not have the disease ('controls'). A [cohort study](#) is a type of prospective study that compares an outcome (such as the incidence of disease) in groups of people who are alike in many ways, but differ by certain characteristics.
- ⁷ NTP is a federal, interagency programme headquartered at the National Institute of Environmental Health Sciences. Its goal is to safeguard the public by identifying substances in the environment that may affect human health.
- ⁸ Australia, Canada, Denmark, Finland, France, Germany, Israel, Italy, Japan, New Zealand, Norway, Sweden and the United Kingdom.
- ⁹ Australia, Austria, Canada, France, Germany, Greece, India, Israel, Italy, Japan, Korea, Netherlands, New Zealand and Spain.
- ¹⁰ The working group tasked with the assessment consisted of 31 scientists from 14 countries. It published its findings in the IARC Monographs, Volume 102.
- ¹¹ For the definition of 'limited' and 'inadequate' evidence for carcinogenicity, see IARC Monographs Volume 102, p. 27.
- ¹² These are: the European Committee for Standardisation ([CEN](#)), the European Committee for Electrotechnical Standardisation ([CENELEC](#)) and the European Telecommunications Standards Institute ([ETSI](#)). The CEN and the CENELEC have been cooperating since 2010 under [joint governance](#).
- ¹³ See also the infographic on the committee's approach to determining the [weight of evidence](#).
- ¹⁴ See also the [easy-to-read summary](#) drafted by Green Facts for the Commission. It contains a glossary of technical terms.
- ¹⁵ SCENIHR has been criticised for its composition and reports. In 2015, 20 organisations sent a [complaint](#) to the Commission concerning the 2015 SCENIHR opinion, bemoaning '[conflicts of interest](#)' among SCENIHR members and their '[biased assessment](#)'. Attached was also an [open letter](#) from 2011 to then Commissioner John Dalli, in which public interest stakeholders called for a 'transparent, impartial and pluralist' expert assessment of the health risks of non-ionising electromagnetic fields.
- ¹⁶ Denmark, Finland, Sweden, Netherlands, France and the United Kingdom.

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