

Written evidence submitted by the International Commission on the Biological Effects of Electromagnetic Fields (NDC0026)

Response to Science, Innovation and Technology Committee Inquiry Neuroscience and Digital Childhoods.

How are digital devices and social media impacting children's brain development?

Who We Are

The International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF) is an international commission of distinguished scientists and researchers in engineering, medicine, biology, and public health, focused on the biological effects of non-ionizing electromagnetic fields.

ICBE-EMF has published several papers, including:

- A paper in *Environmental Health* documenting the scientific evidence indicating that current wireless radiation guidelines fail to protect public health.
- A paper in *Environmental Health* analysing the cancer data from the \$30 million U.S. National Toxicology Program (NTP) animal study which concludes that FCC/ICNIRP limits are at least 200 times too high to protect us from cancer risk with 8 hours per day of exposure.
- A paper in the *International Journal of Environmental Research and Public Health* outlining practical engineering solutions to reduce cell phone radiation emissions.

The following response is respectfully submitted by

John Frank MD
Chairperson, ICBE-EMF

Erica Mallery-Blythe BM
Special Expert, ICBE-EMF

Elizabeth Kelley, MA
Managing Director, ICBE-EMF

Alasdair Philips BSc, DAgE, MIEEE
Commissioner, ICBE-EMF

Ronald L. Melnick PhD
Senior Advisor, ICBE-EMF

Theodora Scarato MSW
Special Expert, ICBE-EMF

Joel Moskowitz PhD
Commissioner, ICBE-EMF

David Carpenter MD
Commissioner, ICBE-EMF

On Behalf of ICBE-EMF

Executive Summary

Wireless electromagnetic fields (EMFs) are not considered when assessing screen time risk

- Wireless radio-frequency (RF) radiation, a type of non-ionizing EMF, is currently regulated under exposure limits put forth by the ICNIRP, FCC, and IEEE. These limits are based on outdated science, inaccurate assumptions, and fail to reflect the growing body of evidence on human health and environmental risk.
- Daily exposures are increasing among all age groups and in all settings (home, school, workplace), and children are particularly vulnerable.
- Hundreds of scientists who are experts in the field are calling for stricter, evidence-based safety limits and policies to reduce exposure to protect public health and the environment.

Why do current human exposure guidelines for cell towers, cell phones, and wireless networks fail to protect the public?

- Current limits assume heat is the only harmful effect and are based on studies conducted in the 1980s involving 40–60-minute exposures in 5 monkeys and 8 rats.
- Significant scientific research has reported adverse effects at non-heating levels allowed by current regulations, including DNA damage, cancer, sperm damage, neurological effects, and oxidative stress.
- Current exposure limits do not adequately protect the vulnerable: children, medically sensitive individuals, and the developing foetus. Research has found that children can absorb higher amounts of radiation from wireless devices in their more sensitive developing brains and bodies.

Information for inquiry

Parliamentary guidance text is written in italics and our answers appear below each question

1. *What impact do digital devices have on the brain development of children and adolescents?*
 - *How does this affect physical and mental health, behaviour, and attainment?*

The healthy development of children is being profoundly compromised by their overuse of screens and unsupervised media consumption. Deliberately addictive pathways are engineered to maximize engagement and keep children online for as long as possible¹². This is achieved by stimulation of the brain's reward circuitry via pathways that are similar to those implicated in substance addiction^{3,4}. Gaming disorder is formally recognized by the WHO as a behavioural addiction⁵.

Crucial health factors such as sleep and exercise are negatively impacted by screen time and essential developmental activities, such as physical play and important face-to-face social interaction, are diminished⁶. Reduced grey/white matter volume and other structural and functional brain alterations (including of the prefrontal cortex, which can cause impaired executive function and reduced impulse control⁷), have also been associated with increased screen time^{8,9}.

A recent review¹⁰ indicates that children's mental and physical health, including sleep¹¹, cognition,^{12,13} academic performance¹⁴, social and emotional health^{15,16,17}, brain development,^{18,19} eye health²⁰ and cardio-metabolic function²¹ are all threatened by screen time, and risk of chronic disease^{22,23} including diabetes^{24,25} is elevated. Attention is often given to the roles of, for example, reduced exercise, overeating and social media content. However, a crucial factor that is typically overlooked, is the role of exposure to electromagnetic fields (EMFs).

Electromagnetic Fields (EMFs) – a neglected but crucial aspect of screen time

Many of the health effects documented to be associated with screen time overlap with those found to be related to EMF exposure. Problems with memory, attention, sleep, and headaches, for example are common to both. Thus, the reported health effects of “screen time” may arise from both direct, physical EMF exposures (e.g., light, radiofrequency radiation and extremely low frequency emissions) and also behavioural changes arising from excessive use of the device (e.g. prolonged inactivity, altered sleep patterns, repetitive muscle use or awkward positioning). The mechanisms of action of these two types of effects are entirely different and yet all are bundled under the term ‘screen time’ as though they were created via the same pathway.

Children are exposed to numerous types of non-ionising EMF from screens

Screens have become a primary source of non-ionising EMF exposure for children because they emit multiple different types of EMFs and are often held very close to the body – sometimes at zero distance. Smartphones, tablets, laptops, smart watches, ear buds, smart speakers, tracker fobs and gaming systems can all emit radiofrequency (RF) radiation while also producing extremely low frequency (ELF) electric and magnetic fields from their internal electric circuitry and charging systems^{26,27}.

Additionally, artificial blue light is emitted by LED backlighting in screens. This is another type of non-ionising radiation with well-documented biological effects. Blue light at night has been associated with health impacts, including increased breast, prostate, and colorectal cancer risk in several epidemiology studies^{28,29,30,31}. Exposure to artificial light and RF radiation can suppress melatonin production, a naturally occurring hormone that plays a crucial role in our immune system and regulates the body's circadian rhythm, the internal 24-hour biological clock that governs sleep–wake cycles and neuroendocrine processes^{32,33}. Disruption of circadian rhythm can interfere with restorative sleep, affect brain development, and alter metabolic, endocrine, and immune function, contributing to chronic disease^{34,35,36}.

In the presence of multiple wireless devices, additive exposures are produced that are not considered within the current exposure guidelines. Combined RF, ELF and artificial LED light exposures occur in proximity to the body, often just inches from a child's face or lap, substantially increasing the absorbed dose of non-ionising EMFs^{37,38}. Furthermore, EMF exposures have been shown to have synergistic effects when combined with some other environmental toxicants (such as heavy metals like lead, air contaminants like carbon black, formaldehyde, and water contaminants like hexavalent chromium^{39,40,41,42,43}), and this is also not considered within current exposure limits.

Escalating EMF exposures from modern technology are unsafe

The rapid expansion of cell towers, 4G/5G and soon 6G wireless networks, wearables, and constantly connected “smart” devices is dramatically increasing continuous background RF radiation exposure in homes and schools. At the same time, the rise of artificial intelligence is driving massive growth in energy-hungry data centres and new electric power lines, further increasing environmental exposure to ELF-EMF, long linked to an increased risk of childhood leukaemia^{44,45,46,47}.

There are biological effects from exposure to EMFs at levels well below current exposure limits

The International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF) has outlined 14 false assumptions which invalidate the currently used exposure limits to RF radiation⁴⁸. Additionally, the outdated limits have been criticised on many different levels by many different groups^{49,118-148}. Studies in adults have reported numerous adverse effects, including oxidative stress,^{50,51} genetic impacts,^{52,53} blood-brain barrier permeability,^{54,55} sperm damage,^{56,57,58,59} structural and functional changes of the reproductive system,^{60,61} sleep impacts,^{62,63,64} EEG alterations,^{65,66} and other neurological effects,⁶⁷ as well as multi-systemic acute symptoms, including electromagnetic hypersensitivity.^{68,69}

Further, animal and human studies have reported impairments in behaviour, cognition, learning, and memory, critical for academic performance and learning.^{70,71,72,73,74 75} Animal studies are useful for demonstrating that these effects cannot have been created via any psychological mechanisms relating to fear of exposures, nor are they induced purely by screen usage behaviours.

Cancer is associated with EMF exposure

In 2001, the International Agency for Research on Cancer (IARC) of the World Health Organization categorized ELF-EMF magnetic fields as a Group 2B “possible” human carcinogen due to the associations of residential exposure with childhood leukaemia. In 2011, IARC classified wireless RF radiation as a Group 2B carcinogen, i.e., ‘possibly’ carcinogenic to humans, largely due to studies associating heavy cell phone use with brain cancer. Since then, credible evidence reporting an association between wireless radiation and cancer has increased^{76,77,78,79,80}. Multiple case-control epidemiological studies have found increased risks for tumours associated with long-term cell phone use.^{81,82} Furthermore, the human epidemiology studies are now corroborated by large-scale animal studies, including the Ramazzini Institute and U.S. National Toxicology Program, which concluded there was “clear evidence” of cancer and DNA damage.^{83,84,85,86 87}. Although human studies have focussed on adult populations, these findings are relevant to children as they could indicate increased risk of tumour development later in life, and risk from early exposures could be greater given children’s immature physiology and greater cumulative exposures. Relevant cancers such as glioblastoma multiforme have been shown to have increased in relatively young populations in the UK⁸⁸.

Risk assessments using EPA-developed methodologies have further concluded that current UK exposure limits, based on guidelines created by ICNIRP (the International Commission on Non-ionising Radiation Protection), may be substantially higher than would be required to protect against cancer, i.e. at least 200-fold based on NTP findings and up to 4,200-fold when Ramazzini Institute data are considered⁸⁹.

- *How does this vary with characteristics including age, sex, socioeconomic background, ethnicity, and others?*

Children Are More Vulnerable to Wireless and Non-Ionising Radiation Exposure.

Children, whose nervous systems are still developing and have rapidly dividing cells, are especially susceptible to environmental stressors. Even low-level exposures can result in long-lasting and irreversible effects⁹⁰.

Because of their thinner skulls, higher water content, and unique physiology, children absorb proportionally more radiation than adults^{91,92,93,94,95}. Research has found cell phone radiation exposures up to 30 times greater in the hippocampus and 10 times greater in the bone marrow of the skull compared to adults⁹⁶.

Intra-uterine development may also be a period of heightened sensitivity, as foetal development involves complex and rapidly growing cellular systems that are particularly vulnerable, and studies investigating prenatal exposure have reported increased miscarriage,⁹⁷ impacts to the brain,⁹⁸ cognition,⁹⁹ behaviour,¹⁰⁰ development,¹⁰¹ reproductive system,¹⁰² and higher rates of ADHD,¹⁰³

- *How does this vary for different types of use – including passive or active engagement across activities such as gaming, phones, televisions, and others – and different types of devices – whether handheld, wearable, or fixed?*

Radiation is emitted even when devices are not in use

Parents are generally unaware that devices emit RF radiation even when they are not in use. It is important to understand that if a wireless device is powered on and has wireless networking activated, it is potentially still both receiving and transmitting RF radiation. Increasing distance from a cell phone or wireless device can significantly reduce exposure.

Type of device and distance from the emission (handheld / wearable / fixed) are important

Mobile phones classically produce the highest intensity exposures to children. This is in part because they are capable of high intensity emissions, and because they are often used directly against the head, abdomen or pelvis. Although head tumours have been a subject of particular debate, evidence regarding the impact on fertility^{104,105,106,107,108,109,110} suggests that moving devices nearer to reproductive organs cannot be considered improved practice. Tablets can have similarly high outputs, and are also used very close to, or against, the body. Compounding the issue, these devices often do not have adaptive power control in which case, they will continuously emit full power (unlike mobile phones). Newer devices such as smart watches and even wearables (in some cases for babies) may employ lower intensity emissions, but since these have zero distance to the body in practice, they are still capable of affecting the user.

While a true biological 'no effect level' has not yet been demonstrated, the intensity of exposure to the child does dissipate in keeping with the inverse square law, so keeping wireless devices as physically far away from children as possible is sensible.

2. What are the short-, medium- and long-term effects on the brain of using digital devices in childhood and adolescence?

Short term effects: Some children have electromagnetic hypersensitivity (EHS). Although this is a controversial issue, some individuals have demonstrated a truly physical (rather than psychological) symptomatic reaction to EMF exposure¹¹¹ even under double-blinded conditions¹¹². Classical symptoms include, but are not limited to headaches, insomnia, dizziness, tinnitus, skin rashes, mood disturbance and palpitations. Some have suggested a 'nocebo response' (symptoms induced by fear of exposure) as the mechanism behind the reaction. This explanation does not withstand scientific scrutiny and is based primarily on the outcomes of some very poorly conducted studies. Biomarkers are being identified,¹¹³ and mechanisms that may explain the reaction are evolving¹¹⁴⁻¹¹⁷.

Advice from multiple international medical groups,¹¹⁸⁻¹²⁷ scientific panels¹²⁸⁻¹³⁹ and governmental bodies¹⁴⁰⁻¹⁵⁰ is to decrease exposures to relieve symptoms. Additionally, guidelines for EHS diagnosis and management have been peer-reviewed and published which make it clear that the mainstay of medical management is avoidance of anthropogenic non-ionizing radiation (NIR)¹⁵¹⁻¹⁵³. EHS has been recognised as disabling in some cases by the WHO¹⁵⁴. Disability and compensation cases for those with EHS have been won internationally as well as here in the UK¹⁵⁵, and a child in the UK has received an Education Health Care Plan (EHCP) which requires that the child is accommodated in a low EMF school environment¹⁵⁶.

- *How does the dopamine and any other hormones released by the use of certain devices impact brain development?*

Whilst the stimulation of dopamine is important, it should also be considered that EMF exposures from wireless devices can potentially interfere with multiple different hormones including, importantly, melatonin. Melatonin is a powerful endogenous antioxidant and sleep-related hormone. Sleep disorders have become extremely prevalent and have been related to screen time, but again, it is presumed that behavioural factors and screen light are solely to blame, despite evidence that RF can impact melatonin production in isolation from those other factors^{157,158}.

- *Is there evidence of a link between use of digital devices in childhood and adolescence and any neurological and behavioural conditions?*

Animal and human studies have reported impairments in behaviour, cognition, learning, and memory, critical for academic performance and learning^{159,160,161,162,163,164}. Some scientists expect a link between EMF exposure and Autistic Spectrum Disorders to be eventually proven^{165,166}. Electromagnetic Hypersensitivity is multisystemic but symptoms are often concentrated within the neurological system^{167,168}.

- *Does the use of digital devices in childhood and adolescence have physical effects that impact the brain – for example on brain function, the eyes, or elsewhere in the body?*

In addition to eye strain and myopia associated with long term use of close screens¹⁶⁹, radiation doses to the eyes of a child when using RF-emitting devices are substantially higher than the dose absorbed by the eyes of an adult and exposures in the hippocampus of the brain could be 30x higher¹⁷⁰. References above explain some of the potential impacts of this ranging from brain cancer to brain development issues impacting behaviour.

3. How do children and adolescents view the impact of digital devices, and how far are their views taken into account in policy?

Whilst some children are probably aware that too much screen time may negatively impact their health, it is unlikely that they will have been warned to also limit their exposure to radiofrequency radiation. This is despite the current warning from the UK chief medical officers that, “Children and young people under 16 should be encouraged to use mobile phones for essential purposes only”¹⁷¹. This advice is also underpinned by a medical doctors’ appeal¹²⁴ (signed by more than 1,000 physicians) stating “Children below the age of 8 should not use cell phones and cordless phones; children and adolescents between the ages 8 and 16 should also not use cell phones or only use them in the case of an emergency”.

However, this advice has never been effectively communicated to the public, and children are still encouraged to use RF-emitting tablets, computers and numerous other wireless devices (sometimes including mobile phones) in school. The same caution should apply for tablets and other similar RF sources as their maximum Specific Absorption Rates (SARs) are comparable and in some cases higher. Many children, especially those in higher age groups have the capability to self-regulate potentially harmful practices and take simple steps to reduce their EMF exposures. Reducing exposures is recommended by the UK Government which currently states, ‘excessive use of mobile phones by children should be discouraged’ followed by a list of measures which can be taken to reduce RF exposures such as distancing the phone, using hands-free kits and choosing phones with lower specific absorption rates (SARs)¹⁷², but this important advice has never been communicated to children or to the adults who care for them.

4. Is there adequate evidence around the impact of digital devices on the development of children and adolescents?

- *Where is more research needed on their impact?*

There is adequate evidence now to support the urgent need to reduce exposures and educate children, their parents and the other adults who care for them regarding ways to reduce their exposure. Further research is always desirable and it is important to understand the impacts of EMF excluding the other components of screen time. Animal studies where EMF exposures have been used in isolation from the other factors have given us reason to have serious concerns, and further evidence is not necessary to justify steps to immediately better protect children, e.g. by using hardwired networks.

5. What are the wider social and economic implications of the impacts of use of digital devices in childhood and adolescence on brain development?

- *What is the government doing to measure, regulate or respond to these, and what more should it be doing?*

In other countries phones have been tested to check compliance with radiation emissions, and this has revealed that a large proportion (8/10 mobile phones tested in one case) of phones exceed even the invalid tissue-heating ICNIRP exposure levels^{173,174}. Following these compliance checks, multiple mobile phone models were withdrawn from the market or updated with software 'fixes' to reduce radiation emissions. This has not happened in the UK because compliance has not been tested. The Government needs to implement these basic safety checks and additionally set up a truly independent expert team to review the science regarding biological damage from EMFs. The last UK review was undertaken in 2012 by the Advisory Group on Non-Ionising Radiation (AGNIR). Their report, which was used to construct current UK policy, is not only severely out of date, but it has also been found to be "inaccurate", "biased" and "misleading".¹⁷⁵ That group has been disbanded but, nonetheless, their report is still being used to inform current policy. Conflicts of interest were noted within the group that must be avoided when future reviews take place. A new review must include experts who have expressed concerns regarding the laxity of current exposure limits such as those who have signed the EMF Scientists' Appeal which comprises over two hundred scientists, all of whom have published within this field.

- *How could the government future-proof its interventions in this area against developments in technology and its use?*

Ensure that new technology is compliant with exposure limits that are truly evidence-based and designed to prevent biological damage. Far lower limits have been proposed by multiple expert groups including the Bioinitiative Working Group, Institute of Building Biologists, and EUROPAEM 2016 EMF Guidelines.

Children today will face lifelong exposure to non-ionising radiation from multiple sources, beginning before birth and lasting far longer than any generation before them. Today's 5G-dense, heterogeneous networks, constantly-on wearable devices, and smart city infrastructures, etc., mean that children are exposed to multiple RF sources simultaneously. Although not every study reports effects, the preponderance of peer-reviewed research provides sufficient evidence to warrant policy action.

Government Safety Limits Do Not Protect Children.

Government limits for allowable human exposures to wireless RF radiation, such as those of the International Commission on Non-Ionising Radiation Protection (ICNIRP), and the Institute of Electrical and Electronics Engineers (IEEE) do not assure safety¹⁷⁶. These limits were set decades ago, based on inaccurate assumptions, including that they:

- Are based solely on preventing tissue heating during short-term exposure
- Do not address biological effects from low-intensity, cumulative, or long-term exposure.
- Do not address the synergistic effects when combined with other environmental toxins or additive cumulative exposures from multiple EMF sources.

- Are not based on research reporting cancer and other biological impacts, including effects on the brain, nervous system, reproductive system, immune system and increased oxidative stress reported in scientific research.
- Were derived from animal studies applied to adult males, not children.
- Lack adequate safety factors that account for children's unique vulnerabilities.

The situation is equally inadequate when it comes to limits for powerline ELF-EMF frequencies, because ICNIRP limits, used by numerous governments, are based only on acute impacts such as neurostimulation from short-term high exposures rather than chronic disease risk. Increased risk of childhood leukaemia is documented at levels well below these limits. While several countries have various policies¹⁷⁷ in place to reduce children's exposure below the levels linked to cancer, the UK has agreed a 3.6-fold higher magnetic fields limit (360 μ T instead of 100 μ T) than the ICNIRP general public guidelines for ELF-EMF^{178,179} based on mathematical modelling by one person. In contrast, Switzerland (in 2000) set a 1 μ T limit as the maximum permissible ELF EMF from new or modified stationary installations (such as high-voltage power lines and transformers). This limit applies in or around spaces where people spend significant amounts of time, such as homes, schools, hospitals, and children's playgrounds^{180,181}.

The failure to reduce exposure limits for non-ionising EMFs in the face of mounting scientific evidence constitutes a public health crisis, endangering children, families, and the future

Recommendations for immediate lowering of children's EMF exposures:

- Replace wireless school networks with hardwired computer networks
- Ensure all devices in school have wireless signals disabled
- Collect mobile phones and other wireless devices at the beginning of the school day and store them in Faraday boxes
- Provide staff Faraday boxes also for their phones and other emitting devices.
- Ensure electrical infrastructure is distanced from desks so that ELF levels are low
- Ensure computer workstations are low ELF by ensuring good grounding
- Favour human-to-human teaching practices over screens wherever possible
- Forbid RF-emitting antenna installations (e.g., mobile phone masts) and ELF-creating infrastructure (e.g., high voltage power lines) near schools
- Encourage parents to consider lowering EMF exposures where possible at home
- Deploy education programmes to improve awareness and understanding of current risk and mitigation techniques

General Recommendations for Policymakers

- Ensure a robust, independent scientific review of the research
- Adopt exposure limits that are science-based and protective of public health and the environment
- Adopt a risk mitigation approach with policies that reduce exposures, especially for children, such as distancing cell towers from homes, and installing safer Ethernet connections in schools

- Strengthen transparency and oversight
- Fund independent bioeffects research
- Expand public awareness on why and how to reduce exposure
- Promote industry research and design for safer technology

10 May 2026

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