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Tom Butler Ph.D. MSc |**Professor**

A Review of the Health Risks of Radiofrequency Radiation Employed in 5G Technology and the Implications for UK Policymaking

This short critical review explores the findings of extant research on the health risks posed by 5G technologies that emit radiofrequency radiation (RFR)[1]. It also provides evidence that the processes by which policy decisions have been made concerning the protection of public health may be significantly flawed, as the overwhelming body of scientific evidence appears to have been ignored by relevant government departments and agencies in arriving at decisions about the introduction of 5G. This lacuna comes about due to the over-reliance on expert opinion from the International Commission on Non-Ionizing Radiation Protection (ICNIRP), an NGO whose members have traditionally had close ties to industry. It is significant that the UK government and its agencies neither sought nor obtained independent scientific advice on a matter of importance to public health. Consequently, it failed in its duty to identify, assess, and mitigate the risks posed by RFR-based technologies before their introduction, specifically 5G networking and related technologies, thereby protecting public health.

What does science have to say about the health risks of 5G Technology?

The World Health Organization (WHO) classifies non-ionizing radiofrequency radiation (RFR) as a possible human carcinogen. It is, therefore, incredible that not a single, peer-reviewed scientific study has been carried out on the health risks associated with 5G technologies that emit low frequency (700MHz), high frequency (3.4-3.8 GHz, centimetre (CM)) or extremely high-frequency millimeter (MM) (26 GHz and above) RFR. The overwhelming majority of published peer-reviewed scientific studies in biomedical research databases PubMed, Ovid Medline, EMBASE, Cochrane Library, and those listed in Google Scholar, indicate significant health risks with RFR of the type used in 5G technologies, both near field in the home and far-field in antennae, whether on access points or masts. This is the view of the majority of scientists across biomedical and related fields: However, the minority view is led by a group of 13 influential scientists from the International Commission on Non-Ionizing Radiation Protection (ICNIRP). Significantly, commission members have strong links with the telecommunications industry and hold key roles in the WHO, the International Agency for Research on Cancer (IARC), and the EU's Scientific Committee on Emerging and Newly Identified Health Risks

[1] Radiofrequency radiation (RFR) is a type of non-ionizing radiation (NIR), which is also referred to as radiofrequency (RF) electromagnetic fields (EMFs). RF EMFs are in the frequency range 100 KHz to 300 GHz, this includes all 2-5G, WiFi and Bluetooth technologies. In the UK, 5G technologies will emit RFR (RF EMF) in the frequency 700 MHz-28GHz. According to the latest ICNIRP Guidelines (2020, p. 3): *"Radiofrequency EMFs [i.e. RFR] consist of oscillating electric and magnetic fields; the number of oscillations per second is referred to as "frequency," and is described in units of hertz (Hz). As the field propagates away from a source, it transfers power from its source, described in units of watt (W), which is equivalent to joule (J, a measure of energy) per unit of time (t). When the field impacts upon material, it interacts with the atoms and molecules in that material. When a biological body is exposed to radiofrequency EMFs, some of the power is reflected away from the body, and some is absorbed by it. This results in complex patterns of electromagnetic fields inside the body that are heavily dependent on the EMF characteristics as well as the physical properties and dimensions of the body. The main component of the radiofrequency EMF that affects the body is the electric field. Electric fields inside the body are referred to as induced electric fields (Eind, measured in volt per meter; V m−1), and they can affect the body in different ways that are potentially relevant to health."* In keeping with relevant research papers, this report employs the term RFR, as opposed to RF EMF or simply EMF.

(SCENIHR). Thus, the minority view dominates through political influence, not the preponderance of scientific evidence. The majority view is represented in the findings of thousands of peer-reviewed empirical studies on microwave non-ionizing RFR focusing on the biomedical effects of 2-4G and WiFi technologies (see Di Ciaula, 2018; Miligi, 2019; Russell, 2018; and Kostof et al. 2020, for examples). There are also several reviews and general studies focusing on extremely high frequencies up to 100GHz that may be used in 5G (Neufeld and Kuster, 2018; Simkó and Mattsson, 2019). The overwhelming majority of studies conclude that there is a high risk of adverse biological effects on humans at low, high and extremely high frequencies. Recent research funded by DARPA (US Defense Advanced Research Projects Agency) finds that ICNIRP guidelines focus on short-term risks only, not long-term exposures to weak RFR: this despite *"a large and growing amount of evidence indicates that long-term exposure to weak fields can affect biological systems and might have effects on human health" with significant "public health issues"* (Barnes and Greenebaum, 2020. p. 1). Furthermore, research also finds biological effects at high frequencies may add to and compound those predicted at lower frequencies (Kostof et al., 2020).

What are the health risks of non-ionizing RFR?

A recent research review on the health risks of RFR, involving independent verification based on 5,400 studies in the MedLine database, concludes that "*the literature shows there is much valid reason for concern about potential adverse health effects from both 4G and 5G technology"* and that extant research *"should be viewed as extremely conservative, substantially underestimating the adverse impacts of this new technology"* (Kostoff et al. 2020).

Kostoff et al. report that peer-reviewed studies show the following adverse health effects well below the safety limits set by the UK based on ICNIRP guidelines:

- *"carcinogenicity (brain tumors/glioma, breast cancer, acoustic neuromas, leukemia, parotid gland tumors),*
- *genotoxicity (DNA damage, DNA repair inhibition, chromatin structure), mutagenicity, teratogenicity,*
- *neurodegenerative diseases (Alzheimer's Disease, Amyotrophic Lateral Sclerosis),*
- *neurobehavioral problems, autism, reproductive problems, pregnancy outcomes, excessive reactive oxygen species/oxidative stress, inflammation, apoptosis, blood-brain barrier disruption, pineal gland/melatonin production, sleep disturbance, headache, irritability, fatigue, concentration difficulties, depression, dizziness, tinnitus, burning and flushed skin, digestive disturbance, tremor, cardiac irregularities,*
- *adverse impacts on the neural, circulatory, immune, endocrine, and skeletal systems."*

What is the scientific consensus on health risks?

It is significant that the vast majority of independent original experimental and epidemiological research studies and scientific review papers identify the health effects documented above (cf. Belpomme et al. 2018; Belyaev et al. 2016; Miller et al., 2018; Barnes and Greenebaum, 2020, for examples of the latter). In addition, following its own extensive empirical research on 2-3G radiation, which identifies clear evidence that RFR is carcinogenic (Lin, 2019), the US National Institute of Environmental Health Sciences' National Toxicology Program (NTP) is investigating whether 5G poses similar risks to human health (National Toxicology Program, 2018b). Inter alia, *"NTP scientists found that RFR exposure was associated with an increase in DNA damage. Specifically, they found RFR exposure was linked with significant increases in DNA damage in: the frontal cortex of the brain in male mice, the blood cells of female mice, and the hippocampus of male rats"* (NTP, 2018b). These concerns are echoed and amplified in the conclusions of other systematic reviews (see Di Ciaula, 2018; Russell, 2018), which argue that precautionary approaches need to be adopted by governments, given the known risks (Miligi,

2019). Significantly, Italian medical consultant and researcher Agostino Di Ciaula (2018) underlines concerns and concludes from his review of the scientific and medical literature that 5G technology is of great concern as the *"available findings seem sufficient to demonstrate the existence of biomedical effects, to invoke the precautionary principle, to define exposed subjects as potentially vulnerable and to revise existing limits."* Thus, the majority of peer-reviewed scientific studies conclude that 2-4G and WiFi, and by logical generalization, 5G, puts those exposed to RFR signals at significant health risks, even at exposure levels 100,000 times lower than Public Health England (PHE)/ICNIRP safety guidelines. However, the European Academy for Environmental Medicine (EUROPAEM) EMF Guidelines (Belyaev et al., 2016) indicates a non-thermal safety level of 1,000,000 to 100,000,000 times less than PHE and ICNIRP guidelines.

Is 5G RFR carcinogenic?

Few policymakers and healthcare professionals understand why in 2011 the WHO's IARC classified non-ionizing RFR as a Class 2B possible carcinogen. RFR's status as a major environmental toxin and probable carcinogen has been confirmed in numerous studies since. A recent scientific review of RFR studies and the links with cancer is unequivocal and states that *"[m]obile phone radiation causes brain tumors and should be classified as a probable human carcinogen (2A)"*. However, new experimental and epidemiological research has scientists conceding that it should be reclassified as a Class 1 human carcinogen. Accordingly, an IARC Advisory Group of 29 scientists from 18 countries recommended that non-ionizing radiation be prioritized by the WHO's International Agency for Research on Cancer (IARC) Monographs programme during 2020–24 (IARC Monographs Priorities Group,2019). It is significant that former ICNIRP members are now recognizing this and also calling on the IARC to review its classification (see Lin, 2019). It is therefore of concern that 5G RFR's status as a carcinogen is played down by the UK government and PHE: furthermore, it is clear that RFR's health risks as such are not understood, particularly by scientists and medical practitioners advising PHE.

What is the primary biological mechanism that leads to toxicogenic and carcinogenic effects?

Non-ionizing RFR is considered by the majority of independent scientists as a potent environmental toxin, due to its ability to cause oxidative stress in animal and human cells (Belpomme et al. 2018; Yakymenko et al., 2016). The relationship between non-ionizing RFR, the increase in free radicals/reactive oxygen species, the reduction in anti-oxidants, and oxidative stress in human cells of all types is significant (Kıvrak et al., 2017). The vast majority of studies identify oxidative stress as the mechanism through which cancer and a range of other more immediate health ill-effects, such as neurological and immunological effects, occur through exposure to most environmental toxins, including RFR (cf. Barnes and Greenebaum, 2020). Of particular concern here to many scientists are the effects on children's neurological and psychological development caused by RFR exposure (Belyaev et al. 2016).

Why are the health risks of exposure to RFR significant?

As with any environmental toxin, the risks related to RFR exposures increase with the frequency and duration of such exposures over time, even at low levels of exposure: put simply, it is the extent of the exposure to all sources of RFR that poses the greatest risk to individuals and society (Barnes and Greenebaum, 2020). Unlike other toxins and carcinogens, RFR is truly ubiquitous: it radiates from multiple personal and WiFi devices, routers, access points—these radiate 3-5G telecommunications and data signals, 2.4 and 5G Wifi signals and Bluetooth RFR—in the home, public spaces, hospitals, cars, in schools, and a web of antennae across the built environment. Thus, exposure to this carcinogen and toxin is of high frequency and long, if not continuous, duration. This continuous exposure maximizes the risk of persistent and continuous oxidative stress and, consequently, makes humans vulnerable to

ALL the health risks listed earlier. Children are particularly at risk. Hence, scientists and medical practitioners globally believe that ubiquitous 5G sources present high levels of risk to human health and well-being (5G Appeal, 2019). Just how significant are the health risks? What follows is a precis of the major health risks.

On the Elevated Risk of Cancers from RFR

A recent study by US economists demonstrates *"that mobile phone subscription rates are positively and statistically significantly associated with death rates from brain cancer 15-20 years later*" (Mialon, and Nesson, 2019). This 25-year cross country analysis provides solid evidence of the link between mobile phone use and cancer of the central nervous system (CNS) when positioned alongside epidemiological studies. Brain tumours and other cancers of the CNS have long been linked with RFR exposure: the challenge for scientists is to prove the link.

On November 1st 2018, the final report of a 10-year $30m comprehensive study by US National Institute of Environmental Health Sciences' National Toxicology Program (NTP) confirmed that radiofrequency radiation from 2G and 3G cell phones caused cancer in animals exposed in the near field (National Toxicology Programme 2018a). That study refutes the long-held theory that non-ionizing radiation, such as RFR, cannot cause DNA damage and related cancers or lead to other effects on the health and well-being of the animals studied, and human beings by extrapolation (National Toxicology Programme, 2018b). In their peer-reviewed publication on the NTP study in 2020, 11 distinguished scientists concluded *"that exposure to RFR is associated with an increase in DNA damage"* (Smith-Roe., et al. 2020, p. 220).

In a separate ground-breaking study at the world-renowned Ramazzini Institute study involving 17 world-class scientists, Falcioni et al. (2018, p. 496) found that *"far field exposure to RFR [that] are consistent with and reinforce the results of the NTP study on near field exposure, as both reported an increase in the incidence of tumors of the brain and heart in RFR-exposed Sprague-Dawley rats. These tumors are of the same histotype of those observed in some epidemiological studies on cell phone users. These experimental studies provide sufficient evidence to call for the re-evaluation of IARC conclusions regarding the carcinogenic potential of RFR in humans."* Again to emphasize, this study is notable as it focused on the health implications of far-field RFR sources on humans living or working in the proximity of mobile phone base stations, as opposed to operating 2 & 3 G handsets near field.

In his critical review of both the above studies, former ICNIRP commissioner James Lin (2019, p. 19) concluded that: *"The time is right for the IARC to upgrade its previous epidemiology based classification of RF exposure to higher levels in terms of the carcinogenicity of RF radiation for humans."* This is clear and unambiguous as the findings of both the NTP and Ramazzini Institute studies that provided "clear evidence," the highest burden of scientific proof possible of the carcinogenicity of RFR.

After more than 25 years of widespread cell phone use, one would expect to see a rise in cancers, particularly brain tumours. The evidence here is mounting: take for example new studies in the US note a disturbing rise in cancers of the Central Nervous System, particularly in adolescents. There is also a marked increase in other cancers. Nevertheless, while recent research has provided "clear evidence" of a link between RFR and cancers in animals, epidemiological studies have yet to provide conclusive evidence of an increase in the incidence, prevalence, and mortality rates directly linked with RFR in 2-4G and wireless devices. Michaels (2008) points out that poorly conducted or biased studies are more likely to produce negative evidence and show no effect, than robust rigorous studies which tend to show positive links between environmental toxins and health risks and demonstrate the existence of effects. Thus Miller et al. (2018, p. 689) argue that extant epidemiological studies have significant flaws, indicating the need for additional *"epidemiological studies of brain cancer to be carried out [that] should include validated measures of exposure and/or biomarkers of possible impact of RFR on*

biological processes." Nonetheless, a recent review of 24 epidemiological case-controlled studies illustrated an increased risk of gliomas and other brain tumours with long-term exposure to RFR from mobile phones (Bortkiewicz, Gadzicka, and Szymczak, 2017). Nevertheless, a short review of recent epidemiological evidence is instructive and heightens the need for a precautionary approach by policymakers to protect public health (Miller et al. 2018).

CNS Cancers

In 2019, The Lancet Neurology observed that *"CNS cancer is responsible for substantial morbidity and mortality worldwide, and the incidence increased between 1990 and 2016"* (Patel et al., 2019). This is just one of several recent epidemiological studies that note such increases (see Ostrom et al. 2016: Khanna et al. 2017; Withrow et al. 2018, for others). In the UK context, Philips et al. (2018) studied the incidence of glioblastoma multiforme brain tumours in England during 1995–2015 and found *"a sustained and highly statistically significant ASR [(incidence rate)] rise in glioblastoma multiforme (GBM) across all ages. The ASR for GBM more than doubled from 2.4 to 5.0, with annual case numbers rising from 983 to 2531. Overall, this rise is mostly hidden in the overall data by a reduced incidence of lower-grade tumours."* In the UK in 1995, 553 frontal lobe tumours were diagnosed in patients, while 1231 were found in 2015. Likewise, 334 temporal lobe tumours were reported in 1995, while 994 were diagnosed in 2015. The increase in these cancers of the CNS is clear and unambiguous. The authors of this study argue that: *"The rise cannot be fully accounted for by promotion of lower–grade tumours, random chance or improvement in diagnostic techniques as it affects specific areas of the brain and only one type of brain tumour. Despite the large variation in case numbers by age, the percentage rise is similar across the age groups, which suggests widespread environmental or lifestyle factors may be responsible."* Scientists are have concluded there is strong evidence that RFR is the environmental factor responsible. Indeed, the Turin Court of Appeal came to the same conclusion in 2019.

Colorectal Cancer

We have all witnessed how adolescents and young adults predominantly carry their smartphones in trouser pockets. If the theory that RFR causes cancer is correct then we should see an uptick in local cancers in that region of the body as the radio units in smartphones are active, even in standby. In 2019, the journal Cancer described a rising incidence of colorectal cancer among young Americans, with rectal cancers being slightly higher than colon cancers (Virostko et al., 2019). Another contemporary study found significant increases in colorectal cancer among people under 50 in Denmark, New Zealand, and the UK since 2009 (Araghi, 2019). Yet another study of colorectal cancer in young adults in 20 European countries over the last 25 years found that over the last 10 years, the incidence of colorectal cancer increased 8% per year among people in their 20s, by 5% for people in their 30s, and by 1.6% for those in their 40s (Vuik et al., 2019). Dr. De-Kun Li [2] maintains that *"When placed in trouser pockets, the phones are in the vicinity of the rectum and the distal colon and these are the sites of the largest increases in cancer."* He concludes that there is a link between how people carry, as well as use, their phones, and the rising incidences of various cancers and other health risks. Take for example that researchers found that RFR from cell phones may be triggering breast cancer in young women who carry their devices on or near their breasts (West et al., 2013)

Skin Cancers

5G systems present a perfect storm where the above health risks are concerned. Not only will they expose adults and children to near and far field 3-5G RFR signals, 5G technologies expose them with low frequency, high frequency and extremely high frequency RFR simultaneously. The aforementioned health risks are linked with low frequency 5G RFR which penetrates deep into the body, high frequency, which penetrates sufficiently deep to be of significant concern, permeating as it does the brain, and

[2] De-Kun Li, MD, PhD, MPH, is a Senior Research Scientist at the Division of Research, Kaiser Permanente Northern California. https://microwavenews.com/news-center/de-kun-li-crc

extremely high frequency, which chiefly affects the skin and eyes. Scientists at the ICNIRP have questionable competencies to deal with this from a biomedical perspective, as they dismiss any significant thermal or non-thermal risks in light of the cumulative body of evidence.

Extremely high-frequency RFR penetrates and is absorbed into the skin, i.e. epidermis, dermis, and subcutaneous fat, and also into the eyes (Feldman et al., 2009). Research on the biological effects of extremely high-frequency RFR is mature (Zalyubovskaya, 1977)–there are, therefore, significant concerns on the biological effects of this type of RFR in relation to their use in 5G (Di Ciaula, 2018). In medical and scientific terms the skin does not form a barrier to extremely high-frequency RFR, it is permeable, it is a biological organ that protects the body, but is itself prone to infections and environmental influence. It contains capillaries and nerve endings and is both an input and output from the CNS (Duck, 1990)—it is in medical terms a vital organ. Significantly, therefore, researchers point out that *"More than 90% of the transmitted power [of extremely high frequency RFR] is absorbed by the skin"* (Zhadobov et al., 2011). This is significant, as this energy is not harmlessly dissipated, as the ICNIRP hold: with regular exposure, studies have demonstrated that skin cells go into oxidative stress with significant health implications and risks (Neufeld and Kuster, 2018).

Furthermore, it is important to note also that *"the cumulative body of research and scientific evidence demonstrates beyond a reasonable doubt that* [extremely high-frequency RFR] *not only penetrate the skin of humans but present a heightened risk of ill-effects on all biological systems including cells, bacteria, yeast, animals and humans"* (Zhadobov et al., 2011). This evidence refutes the ICNIRP assertion that 5G RFR produces thermal effects only. An example of the implications of ubiquitous extremely high-frequency RFR will illustrate. Research on ultraviolet radiation indicates that UVB is ionizing radiation and directly damages DNA, which may lead to melanoma. UVA, on the other hand, is non-ionizing. Both are on the electromagnetic spectrum along with non-ionizing RFR. UVA, which accounts for 95% of incident UV radiation, causes oxidative DNA damage through how it creates reactive oxygen species (ROS) (Brem et al. 2017). *"DNA damage caused by UVA-induced ROS is a potential contributor to sun-induced mutation and cancer"* (McAdam, Brem, and Karran, 2016, p. 612). Scientists acknowledge that "the growing incidence of melanoma is a serious public health issue…[and] UVA-associated DNA damage responses may contribute to melanoma development (Khan, Travers, and Kemp, 2018). Any exogenous agent that increases ROS can either directly or indirectly cause skin cancers such as melanoma. Research has demonstrated unequivocally that RFR increases ROS and decreases vital anti-oxidants. Thus, it is axiomatic that extremely high-frequency RFR poses a significant threat to human health as people are increasingly vulnerable to skin cancers—both melanoma and non-melanoma.

On the risks to pregnant women and their offspring

A prospective cohort study of 913 pregnant women conducted by Dr. De-Kun Li and his team at US healthcare provider Kaiser Permanente examined the association between exposure to RFR and the risk of miscarriage. After controlling for multiple other factors, women who were exposed to higher RFR levels had 2.72 times the risk of miscarriage (hazard ratio = 2.72, 95% CI: 1.42–5.19) than those with lower exposures. The increased risk of miscarriage was consistently observed regardless of the RFR sources (Li et al., 2017). However, follow-up studies on children born to mothers with the same high levels of exposure found that in-utero exposure was related to increased risk in children of the following conditions:

- Asthma 2.7 times;
- Obesity 5 times;
- ADHD 2.9 times. (Li et al. 2011, 2012)

Research conducted at Professor Hugh Taylor's research laboratory at Yale comments on the significant increase in the incidence of ADHD. Taylor and his team posit that one or more environmental factors

are involved. The paper showed that prenatal in-utero exposure of pregnant mice to real cell phone RFR produced three highly statistically significant changes observed in mice exposed in-utero. These are: (1) a decrease in memory function; (2) hyperactivity; and (3) an increase in anxiety. The researchers conclude "that these behavioral changes were due to altered neuronal developmental programming." (Aldad et al., 2012). These results have been replicated in several subsequent experimental studies on rodents (Othman et al., 2017a,b; Kumari et al., 2017). However, there are also several epidemiological studies that identify similar outcomes in children (Divan et al., 2008, 2012). More recently, Birks et al. (2017) used data from studies in five different countries involving 83,884 children which concluded that mobile phone use by mothers during pregnancy increased the risk of hyperactivity and attention issues with children. These studies provide evidence for an association between prenatal exposure to cell phone RFR and neurological development. This should stimulate a reassessment of the risks concerning all RFR use, particularly children, as *"[t]he level of proof required to justify action for health protection should be less than that required to constitute causality as a scientific principle"* (Frentzel-Beyme, 1994). We are far beyond that level of proof where RFR is concerned.

Neurological and Neurodegenerative Risks from RFR

The research cited above indicates a significant risk to the neurological development of children in utero from RFR. There are numerous studies on the abnormal behaviour and learning of mice and rats exposed to RFR. A recent research review investigated the mechanisms by which RFR causes neurophysiological and behavioral dysfunctions (Sharma et al. 2017). The review indicated that impaired cognitive and memory functions. The impact and severity of effects identified are linked to the duration of exposure, and level of exposure. Other recent research includes a study by Deshmukh et al. (2015), who examined the effects of chronic, low-level RFR exposure on learning capacity and memory. The researchers observed that spatial orientation, as well as learning and memory, were impaired. In another recent study, Hassanshahi et al. (2017) divided 80 male rats into control and experimental groups and exposed them to Wifi signals 12 hours a day: the researchers observed that the experimental rats displayed impaired cognitive performance.

Lai, (2018) reviewed summarized research from 2007-2017 on the neurobiological effects of RFR. Lai reports deficits in short-term memory in human subjects exposed to RFR, with one study reporting significant changes in cognitive functions in adolescents that impoverished the accuracy of their working memory. While these studies focused on the effects near-field RFR, a study by Meo et al. (2019) reported that high-level far-field RFR negatively affected the fine and gross motor skills, spatial working memory, and attention in school-going adolescents, as opposed to those exposed to very weak levels of RFR. Thus, near-field and far-field RFR poses significant risks to children's neurobiological health (Markov, 2018; Elhence, Chamola, and Guizani, 2020). This is underpinned by a significant cumulative body of research in Russia, with one longitudinal study from 2006 to 2017 indicating the risks that RFR sources present to children (Grigoriev and Khorseva, 2018). These researchers find that chronic exposure to RFR may negatively affect the central nervous systems of the children.

Electrohypersensitivity (EHS) is a medically recognised condition that affects people who have developed an intolerance to EMFs. EHS describes a clinical condition first coined experts for the European Commission (Bergqvist and Vogel, 1997). The relationship of EHS with RFR was identified in Sweden with research indicating a relatively high incidence among those living near mobile phone base stations (Santini et al., 2003). The global increase in people reporting EHS, prompted the WHO to organise an international workshop in Prague: The Prague working group report clearly defined EHS as "a phenomenon where individuals experience adverse health effects while using or being in the vicinity of devices emanating electric, magnetic or electromagnetic fields" (Belpomme et al. 2018): subsequently the WHO acknowledged EHS as an adverse health condition (WHO, 2005). Research reveals that it remains on the increase, with occurances having a strong link with oxidative stress: Take for example that in one study *"80% of EHS patients presented with an increase in oxidative/nitrosative*

stress-related biomarkers" (Belpomme and Irigaray, 2020, p. 1): they (ibid., p. 6) indicate that *"in addition to low-grade inflammation and an anti-white matter autoimmune response, EHS can also be diagnosed by the presence of oxidative/nitrosative stress."* This finding indicates that EHS is a very real phenomenon that has significant public health consequences as RFR becomes ubiquitous and physicians recognise "*that EHS is a neurologic pathological disorder which can be diagnosed, treated, and prevented. Because EHS is becoming a new insidious worldwide plague involving millions of people"* (ibid., p. 1).

The most troubling neurodegenerative condition facing modern society is Alzheimer's Disease. Stefi et al. (2019) find evidence that RFR promotes molecular pathogenic mechanisms associated with Alzheimer's Disease. A possible link between electromagnetic fields and the occurrence of Alzheimer's Disease has long been noted (Sobel et al., 1995). However, there is a concern as to the increasing incidence of and deaths from this neurodegenerative disease (Vieira et al. 2013), particularly the increasing trend since the 1990s (Niu et al., 2017). Figure 1 illustrates the trend in mortality from the disease comparing males and females. Note the growth in the incidence of mortality in the UK which far outstrips age at which the population is aging. Given the growth in RFR sources across society, researchers are concerned that it may be one of the environmental factors responsible for the dramatic increase in the incidence, aging population aside (Hallberg and Johansson, 2005; Hallberg, 2015). Hallberg and Johansson (2005) investigate the correlation between the increase in RFR from mobile cellular networks in Sweden and the dramatic increase in the incidence in Alzheimer's Disease and find a direct correlation. We can see from Figure 1 that Sweden, one of the first economies to adopt mobile telephony, has a significant increase in mortality rates that is in lockstep with the growth of RFR sources. The question facing epidemiologists is what are the causal mechanisms that have RFR exposure increase the risk of Alzheimer's Disease? One common cause of neurodegenerative diseases is oxidative stress CNS cells (Paloczi et al. 2018), and this condition is strongly linked with Alzheimer's Disease (Butterfield, Howard and LaFontain, 2001; Tönnies and Trushina, 2017).

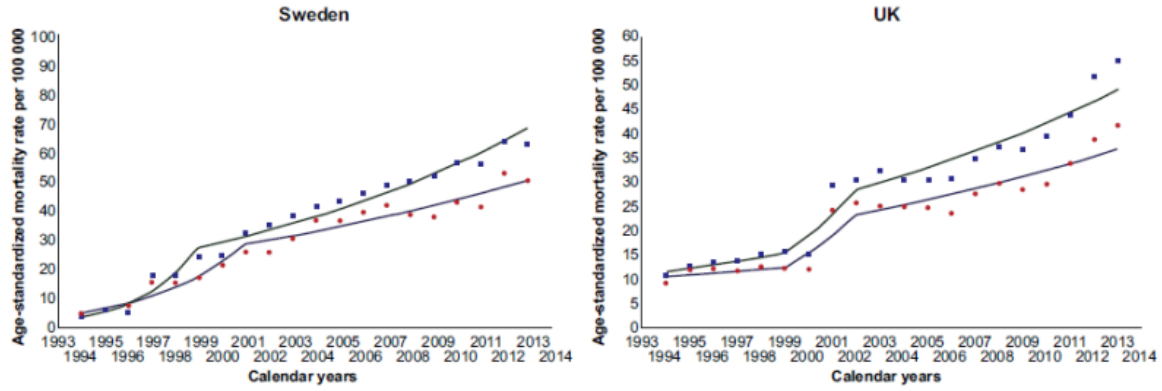

Figure 1 Trends in mortality from Alzheimer's disease in the European Union, 1994–2013.

The CNS appears to be the most vulnerable human biological system, with neurodegenerative diseases, neurobehavioral (including problems with learning and development in children), and immunological problems the source of greatest concern to scientists (s Barnes and Greenebaum, 2020; Belpomme et al. 2018; Belyaev et al. 2016; Di Ciaula, 2018; Miller et al., 2018; Russell, 2018, among many others). There is a unanimous agreement that the property of RFR to place human cells into oxidative stress lies at the core of almost all health risks (Yakymenko et al., 2016). The generation of reactive oxygen species (ROS) contributes greatly to this. Because PHE and other government agencies look to the

ICNIRP[3], and because it ignores the majority of scientific evidence demonstrating harmful non-thermal exposures, UK citizens and their children are exposed to RFR that generates high levels of oxidative stress in their bodies, and which neutralizes the body's antioxidant defence system (Kıvrak et al., 2017). Recent studies of people living in proximity to mobile base stations found evidence for elevated levels of ROS in their blood, which is a biochemical indicator of oxidative stress, indicating that they are exposed to greater risks of ill-health (Zothansiama et al., 2017). Scientists and medical practitioners are concerned about the significant risks all this places on the most vulnerable in society, such as children, pregnant women, those with existing health issues, and senior citizens.

Why hasn't the UK Government and its agencies acted to protect public health?

UK policymakers look to Public Health England (PHE) to assess the safety of non-ionising RFR. The PHE's position on this draws heavily upon two reports by the Advisory Group on Non-ionising Radiation (AGNIR). These were published in 2012 and 2017. The Department of Health's Committee on Medical Aspects of Radiation in the Environment (COMARE) also looks to the AGNIR reports for guidance. It is therefore incredible that when it issued its last report, ICNIRP members, from the NGO based in Munich, constituted 30% of the 18 member UK committee. Note that AGNIR's primary role was to assess the ICNIRP's safety guidelines, which reflect industry interests not those of public health. In no other regulated sector or area of business activity would this be acceptable from a conflict of interest or corporate governance perspective. ICNIRP scientists were not going to judge their own guidelines unsafe. Thus, they had a significant conflict of interest which compromised the entire decision-making process on UK policy towards RFR and public health, specifically, the introduction of 5G.

The ICNIRP's 2020 guidelines published in March of this year, updated those published in 1998. These include only minor changes to the 1998 guidelines in order to accommodate 5G's extremely high-frequency millimeter RFR signals (Barnes and Greenebaum, 2020). It must be remembered the guidelines focus on technical issues and present safety recommendations for the thermal effects of non-ionizing RFR at high-levels of exposure over the short-term measured in minutes. They effectively ignore or deny the existence of non-thermal effects on adults and children and long-term exposure to RFR at low levels. The ICNIRP 2020 Guidelines ignore or dismiss on scientifically spurious grounds the significant body of scientific research since 1998. The majority of independent scientists consider the ICNIRP and the related EU SCENIHR as 'captured' organisations—that is they are heavily influenced by industry-funded researchers and industry itself.

Scientists from the ICNIRP, who are also, as indicated, members of SCENHIR and WHO, are accused of conflicts of interest due to their close ties with industry. An Italian court judgment recently recognised this. In December 2019, Turin Court of Appeal president Dr. Rita Mancuso ruled that research reviews carried out by ICNIRP and its members were biased and could not be trusted in determining whether there was a causal link between wireless cell phone use and brain cancer.[4] The court decided that there was such a link, and its judgment was based on extant independent scientific studies, such as those cited herein.

How does Industry influence UK Policy and Public Opinion?

Industry sectors responsible for harming the environment and human health adopt well-articulated pseudoscientific strategies to undermine independent rigorous research aimed at uncovering scientific truth (McGarity and Wagner, 2008). Michaels (2008) illustrates graphically how the tobacco industry

[3] https://www.gov.uk/government/publications/mobile-phone-base-stations-radio-waves-and-health/mobile-phone-base-stations-radio-waves-and-health

[4] https://www.radiationresearch.org/wp-content/uploads/2020/01/Turin-Verdict-ICNIRP_Judgment-SUMMARY-of-the-Turin-Court-of-Appeal-9042019_EN-min.pdf Original Italian https://www.diritto24.ilsole24ore.com/_Allegati/Free/Ca_torino_vers_1.pdf

hired scientists and commissioned papers to cast doubt on epidemiological and laboratory evidence on the risks to human health of smoking. Micheals illustrates how that industry sows doubt about science and medical fact *"since it is the best means of competing with the 'body of fact' that exists in the minds of the general public."* This approach has been adopted across industry sectors, including the telecommunications industry and its approach to neutralising concerns about the health risks of RFR. Thus, through lobbyists, law firms, consulting scientists, targeted scientific research funding and the co-optation of pseudo-independent organisations such as the ICNIRP, the health risks of RFR have been disputed and scientific findings undermined using what Michaels terms *"junk science."* This involved the perverse and biased application of epidemiological approaches and statistical methods to reinterpret valid scientific data in order to arrive at conclusions that support the industry view of no harm or effect. In the current context, that view of no harm held by industry and the ICNIRP holds that easily controlled thermal effects matter and that non-thermal effects do not exist.

The ICNIRP in concert with industry-sponsored scientists in physics, toxicology, epidemiology, and risk assessment systematically discredit research suggesting that exposure to RFR causes health risks. This is easily achieved as Michaels argues that epidemiology is *"a sitting duck for uncertainty campaigns."* In considering RFR health risks, exposures must be estimated and risks to humans extrapolated from animal studies *in vivo* or cellular studies *in vitro.* Persistent exposure to RFR may cause diseases such as brain cancer or neurodegenerative conditions, but these diseases could also be triggered by other environmental or genetic vectors. As with those from the tobacco, petrochemical, and drug industries, the ICNIRP and industry scientists can easily cast doubt on the assumptions, methods, and findings of independent public health-minded scientists.

The telecom's industry strategy for countering public health concerns is proving more successful than its predecessors as indicated by the findings of research from Harvard Law School. In *Captured Agency*, Harvard Research Fellow Norm Alster (2015) illustrates how the telecommunications industry captured the Federal Communications Commission—the US regulator. Research adduced here indicates the same may apply where it comes to the ICNIRP and its influence over the WHO, AGNIR and PHE (Starkey, 2016; Pockett, 2019)

Implications for Policymaking

Independent peer-reviewed research continues to identify significant research deficiencies, omissions, inaccuracies, and distortions in ICNIRP research reviews and guidelines: they also question SCENIHR reports, due to the significant participation of ICNIRP commissioners (Starkey, 2016; Belpomme et al. 2018). It is also significant that five of the six core group members responsible for drafting the WHO's Monograph on RF fields were directly affiliated with the ICNIRP NGO (Hardell, 2017). Similarly, the chapter on RFR in the WHO's World Cancer Report 2020 was chiefly authored by ICNIRP member Professor Martin Röösli (see Laurier and Röösli, 2020). Research has demonstrated that the WHO is deficient in managing conflicts of interest (Wang et al., 2019). This is compounded by what many consider the blatant disregard of the ICNIRP for basic ethical principles and its management of conflicts of interest: Take for example that Pockett (2019, p. 4) finds the *"ICNIRP is a self-selected, private (non-governmental) organization, populated exclusively by members invited by existing members. The organization is very concerned to project the image that it is composed of disinterested scientists—indeed all ICNIRP members are required to post on the organization's website detailed declarations of interest (DOIs). However, a closer inspection of these DOIs reveals that a good many of the sections of a good many of the forms remain unfilled, and a detailed list of undeclared conflicts of interest among ICNIRP members has been published by a group of concerned citizens. The relevant section of WHO is essentially identical to ICNIRP… in spite of their stated rules and protestations to the contrary, there have been persistent allegations that both ICNIRP and the relevant section of WHO are riddled with undeclared conflicts of interest."* These points echo Starkey's (2016) separate critical analysis of conflicts of interest involving the WHO, ICNIRP and AGNIR.

Former ICNIRP members now recognise that RFR is a significant risk to human health (see Lin, 2019). Because of the over-reliance on what many scientists consider deeply flawed and biased ICNIRP guidelines, PHE and UK policymakers possess a fundamental ignorance of the large body of extant research on the significant non-thermal health effects of RFR (cf. Starkey, 2016). There is an increasing body of evidence in peer-reviewed academic research that confirms governments and policy-makers (1) may be misled by the ICNIRP (Pockett, 2019); (2) are succumbing to pressures from industry and lobbyists (Michaels, 2008); or (3) are turning a blind eye to scientific and public concerns for economic reasons (Alster, 2015)—which in the UK relate its to digital transformation strategy, lucrative industry licenses, and significant tax revenues. Thus, it may be argued that the decision-making process on the introduction of 5G and its implications for public health are flawed and open to judicial review.

Yours Sincerely,

Professor Tom Butler
University College Cork
e: tbutler@ucc.ie
m: 0879865629

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