WiFi Woes: The Rollout of 5G Re-awakens Wireless Fear

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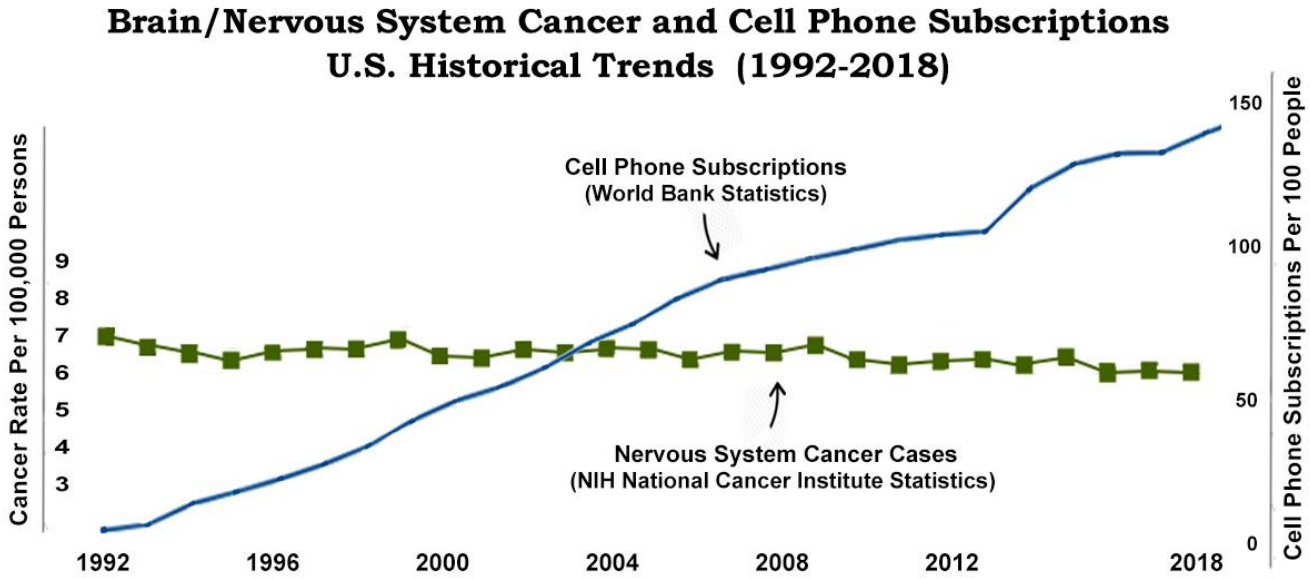
Introduction. Fifth generation (5G) wireless technology, inaugurated in 2019, connects us not only via computers and cell phones, as the four previous generations of wireless networking did, but also brings into our lives the so-called "Internet of things": devices that have been made "intelligent," ranging from household appliances and street lights to factory robots and self-guiding aircraft. At school and at work, in public and in private, electromagnetic waves will link people more efficiently and fruitfully than ever before, we are told.

There are critics, though, who warn about negative consequences of a 5G-dependent world in which human relationships are reduced to virtual dimensions. And there is an additional medical worry that this article will evaluate: a possible epidemic of

illness and death due to the increasingly dense blanket of electromagnetic radiation covering the earth. Does the use of mobile phone and other wireless technologies endanger human health?

This question has been scientifically studied, and we'll review the findings below. Although the safety of wireless devices, and of cell phones specifically, has certainly not been established beyond the shadow of a doubt, evidence from three independent sources points in the same direction:

1) *Historical Trend Statistics.* Although cell phone use has gone way up since the introduction of the devices in the 1980s, there has been no corresponding upward trend in illnesses such as brain cancer:[1]



2) *Biochemistry.* Unlike X-rays and radioactive emssions, which are ionizing (capable of stripping electrons from atoms or molecules) and therefore dangerous to a human body, the radiation of wireless devices is non-ionizing, and there is no other established biological mechanism whereby such radiation could cause harm.[2]

3) *Epidemiological Research.* Reputable scientific studies discern no causal relation between cell phone use and cancer or any other human illness.[3]

Pitted against this scientific evidence is the case made by those who believe that the use of wireless technologies is dangerous. Among them is Joel Moskowitz,

faculty member of the Department of Public Health at the University of California at Berkeley and Director of the UC Berkeley Center for Family and Community Health, who warns that 5G specifically is not safe:

> The telecommunications industry and their experts have accused many scientists who have researched the effects of cell phone radiation of "fear mongering" over the advent of wireless technology's 5G…. it is our ethical responsibility to inform the public about what the peer-reviewed scientific literature tells us about the health risks from wireless radiation.[4]

Moskowitz's website entitled "Electromagnetic Radiation Safety" features research that claims to demonstrate the danger of smartphone use. The banner at the top of the home page announces that "This website has had more than two million page views," and indeed Moskowitz has over the past decade become a leader in the campaign to warn the public about wireless technology, including 5G. His article co-authored with four Korean investigators and published in November 2020, "Cellular Phone Use and Risk of Tumors: Systematic Review and Meta-Analysis,"[5] which alleges a causal relationship between smartphones and cancer, has been publicized by UC Berkeley and has received worldwide attention via Twitter and other social media.

Case-Control Research Design. Moskowitz's campaign represents itself as scientifically based, and the research studies upon which he relies do indeed employ a standard research model: the case-control study. Studies based on this model have commonly been relied upon in the past to investigate the health consequences of wireless technology and will certainly be used in the future to evaluate the safety of 5G upgrades to current telecommunications networks.[6]

Case-control scientific research looks backward in time to locate practices or exposures that might lead to a disease outcome. In this way we've learned, for example, that smoking is causally related to cancer, air pollution to asthma, contaminated water to malaria and other illnesses. Case-control studies are especially effective at tracing illnesses that typically take a long time to develop, such as cardiovascular disease and cancer, back to their first causes. For example, there has been in the past considerable uncertainty about risk factors for multiple sclerosis – might it be the case that certain types of vaccination make it more likely that a person will fall ill with MS? This question was addressed by a carefully designed case-control study published in 2019 that made use of a health insurance database containing detailed vaccination records for 223,035 Germans living in

Bavaria.[7] For each one of them, it was known with a high level of confidence which vaccinations they had received and whether or not they had contracted MS. So it was possible to use statistical analysis to detect a causal connection between vaccination and the disease. As it turns out, no such connection was found; the researchers concluded that for this population there is no evidence that vaccination is a risk factor for developing MS.

The study gave scientific support for this conclusion because the researchers observed two safeguards that are essential to case-control experimental design: the participants were not self-selecting—they were automatically enrolled in the study; and the evidence for their vaccination status came from factual historical records.

Selection Bias and Recall Bias in the Moskowitz Studies. These safeguards were not followed in the case-control studies that Professor Moskowitz cites in support of his claim that cell phone use is dangerous. First, patients with brain cancer decided for themselves whether or not to volunteer for these studies, and those decisions might have been motivated in part by their use of cell phones in the past. Second, instead of accessing historical records of cell phone use—information kept by phone companies for example—these studies relied entirely on the memories of these patients.

That the human subjects in an experimental study may be influenced in ways that invalidate the findings is universally acknowledged in the field of epidemiology. Every textbook introduction to the use of case-control design to study disease warns about "selection bias" (which inclines patients to participate in a study that they know in advance will inquire into whether their past has contributed to their present illness) and "recall bias" (which inclines the participants to misremember the past).[8] To rule out selection bias in the case-control studies that Moskowitz considers, the researchers would have needed to establish that the patients who volunteered to participate were not psychologically predisposed—by their illness and their knowledge of the purpose of the experiment—to volunteer and to exaggerate their prior cell phone use.

The researchers did not establish that. For example, in his publication, "Case-control study of the association between malignant brain tumours diagnosed between 2007 and 2009 and mobile and cordless phone use," published in 2013, researcher Lennart Hardell gives a detailed, statistics-rich, account of the conduct

of the study. But he provides no information about precautions taken to avoid selection bias. Patients were recruited as follows: the "attending physician was contacted for permission to include the case in the study." If that permission was granted, then patients were sent "an introduction letter and ... asked if they were willing to participate and answer the included questionnaire." In their conversations with prospective patient volunteers, did physicians discuss the nature and aims of the study? What information about the study was provided in the invitation that the volunteers received? The questionnaire asked detailed questions about patients' past cell phone use and about other possible risk factors, including occupational history, smoking habits, etc. Upon reading the questionnaire, patients might easily have figured out that the study was looking for past behaviors and conditions that could have led to their cancer. Might that understanding have influenced their interest in the study and their answers to the questions? There is no indication in this study, or in any other published by Hardell, that selection bias of this kind was controlled for as a possible confounding factor.[9]

As well, recall bias received scant attention in these studies. Researchers relied entirely on patients' memories to measure their past use of cell phones. How trustworthy are such memories? Not very. Quite often, people afflicted with a serious, debilitating illness search in the past for things they themselves did that might have led to their present predicament. Malignant brain cancer is no exception to this generalization. As cell phones have become increasingly popular since their introduction to the public in the 1980s, more and more people have at least heard of the idea that the devices, held close to the head, may cause cancer. "Cell phones cause brain cancer" sounds as plausible to some people as "tobacco causes lung cancer" or "clouds cause rain." And this conjecture may very well enter into a patient's accounting for their own condition.

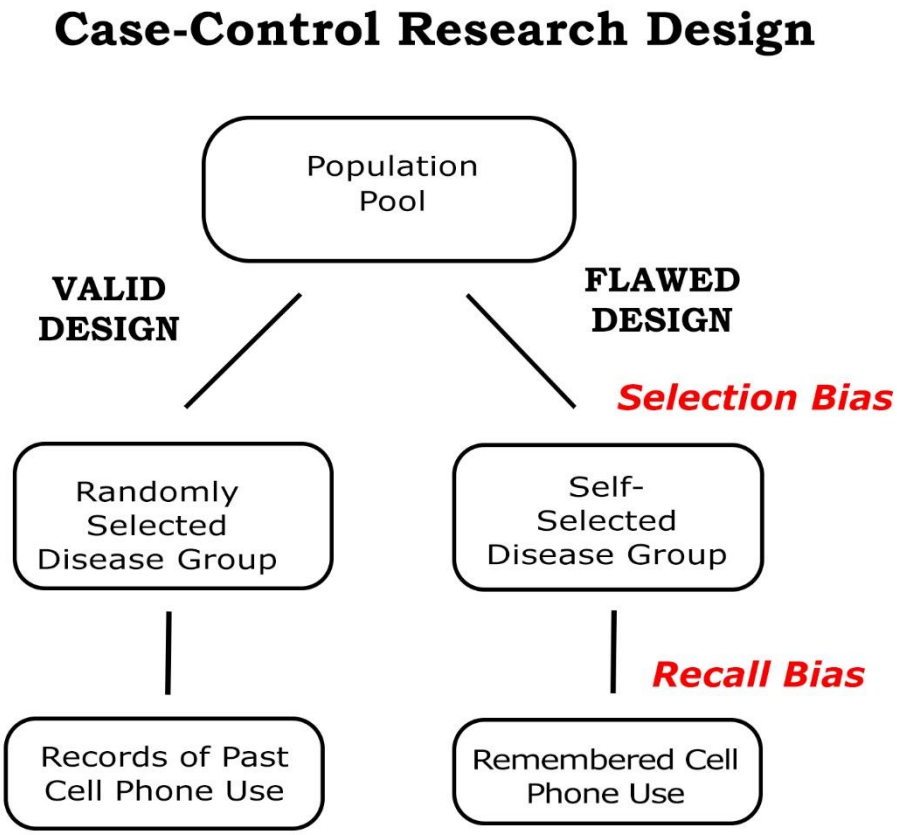
There is a tendency in the mind, Michael Shermer explains,

> to reconstruct the past to fit with present knowledge. Once an event has occurred, we look back and reconstruct how it happened, why it had to happen that way and not some other way, and why we should have seen it coming all along.[10]

To cancer patients the thought may occur, "I have brain cancer. Of course. I spent all those years of my life holding my ear to a cell phone. Why would I have expected anything else?" And that idea may very well motivate them first to

volunteer as experimental subjects in a study that hypothesizes this connection, and second to overestimate the frequency and/or duration of their past cell phone conversations.

Because selection bias and recall bias can erroneously confirm an association of an illness (cancer, for instance) with an origin (cell phone use), studies that fail to take these distorting factors into account are fundamentally flawed.

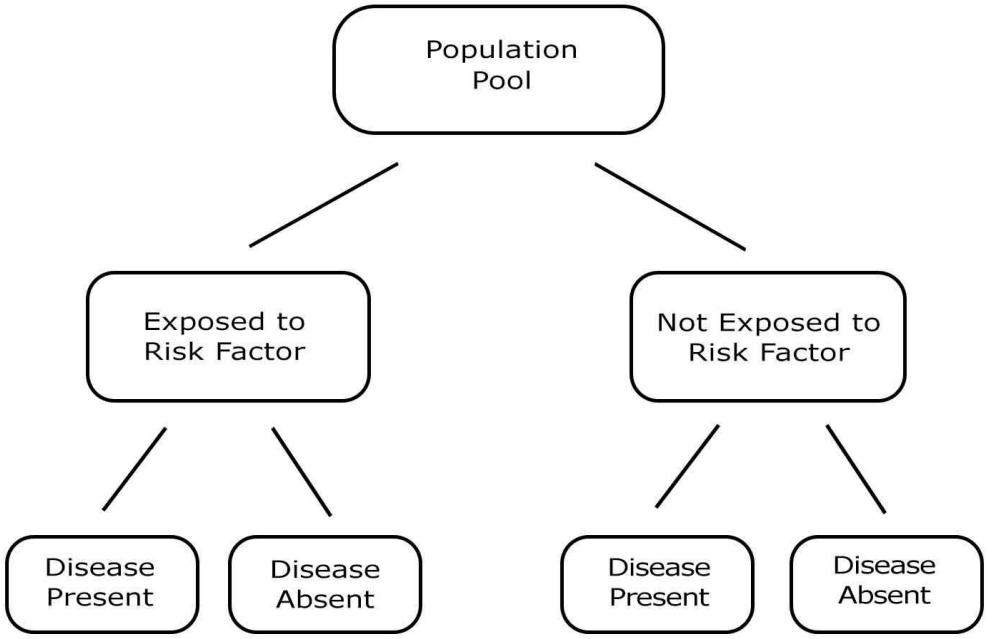


Summarizing, in the case-control studies reviewed in Moskowitz's meta-analysis, the researchers disregarded the randomness requirement for subject selection (selection bias) and relied on cancer patients' verbal reports of their past cell phone use (recall bias).[11] Additional design flaws in this research have been pointed out by peer reviewers.[12] Hence the findings of these studies do not support the hypothesis that cell phone use leads to cancer.

Cohort Research Design. There exists an epidemiological research model that is more capable of yielding scientifically reliable information about the danger of cell

phone use: the prospective, cohort study. Unlike the case-control model, which gathers human subjects with a condition such as brain cancer and then reaches back in time to find a possible cause, prospective cohort research design is forward-looking: it tracks initially healthy individuals "longitudinally" (typically for years, or even decades) to determine whether those with a documented higher level of exposure to a certain risk factor, such as cell phone radiation, are more likely to contract a disease, such as cancer.

Cohort Research Design



Two strengths of cohort research methodology are that research participants are selected prior to occurrence of the disease being studied, and the research does not rely on the accuracy of the memories of those participants.

In past large-scale epidemiological studies that deploy a cohort design, thereby eliminating selection bias and recall bias, the correlation of cell phone use with subsequent disease fell to zero.[13] This was first shown in a cohort study conducted in Denmark and has been confirmed as well in subsequent research elsewhere. In 1968 a national registry was set up in Denmark that tracks health and other kinds of information for all residents of the country. Based on that information, epidemiological research followed 358,000 subscribers to cell phone services to see whether their incidence of cancer or other illnesses was higher than that for non-

subscribers. During the twenty-five years between 1982, when cell phones were introduced in Denmark, and 2007, these studies found no increase in rates of nervous system tumours among subscribers.[14] Great Britain's "Million Women Study," which also used a prospective cohort research model to track the incidence of brain cancer among nearly 800,000 middle-aged women, similarly found no association of disease with cell phone use.[15]

The comparative strengths of the two design models discussed above, as well as the challenges that beset them, have been carefully examined in a number of epidemiological publications.[16] These models have also been evaluated in a report on the causal association of cellular frequency radiation with cancer that was issued by the U.S. Food and Drug Administration (FDA) in 2020. The report concludes that "Based on the studies that are described in detail in this report, there is insufficient evidence to support a causal association between RFR exposure and tumorigenesis."[17]

Public Monitoring of the Safety of Cell Phone Use. Professor Moskowitz claims that the FDA and other federal health agencies tasked with monitoring the health effects of electromagnetic radiation are keeping the public in the dark about smartphone danger because they are influenced by the telecommunications industry. In his view, these government agencies

> have failed to monitor the vast and growing body of peer-reviewed research that documents adverse health effects from low-intensity exposure to radiofrequency radiation. Rather, the Federal government has increasingly relied upon advice from engineers and scientists with conflicts of interest and industry lobbyists.[18]

In fact, public health experts and scientists in the Food and Drug Administration (FDA), the National Cancer Institute (NCI), and other federal agencies examine and provide to the public regular, detailed reports on research bearing on the health consequences of human interactions with wireless devices. Data drawn from the U.S. Surveillance, Epidemiology and End Results (SEER) database and other international registries contribute to FDA evaluation of the quality and policy implications of research studies. Objectivity of these reports is further supported – although not guaranteed, to be sure—by exacting regulation of conflict of interest on FDA advisory committees. In their discussion of the Moskowitz meta-analysis, epidemiologists Frank de Vocht and Martin Röösli point out that the researchers for

the studies cited by Moskowitz that found an association between cell phone use and disease were actually less insulated from the influence of interest groups than were the reserchers whose studies found no association.[19]

Moskowitz is right to point out that government regulatory agencies, the FDA included, sometimes abet private interests at the expense of the common good. For example, in June 2021 the FDA officially approved an Alzheimer's drug, Aduhelm, without providing the oversight that many scientists inside and outside of the agency believed was needed. The approval may have been influenced by close collaboration with Biogen, the company that developed the drug.

It is crucial to remember, though, that while a government scientist's belief in the safety of, say, wireless technology may be industry-influenced, those who attest to the danger of this technology may rest their case on beliefs that are no less biased, even if they are not economically driven. On both sides of this issue, the strength of invested opinion may drive the search for evidence that supports it. In *The Believing Brain* Michael Shermer points out that

> We form our beliefs for a variety of subjective, personal, emotional, and psychological reasons in the context of environments created by family, friends, colleagues, culture, and society at large; after forming our beliefs we then defend, justify, and rationalize them with a host of intellectual reasons, cogent arguments, and rational explanations. Beliefs come first, explanations for beliefs follow.[20]

Critics who have a reputation for "speaking truth to power," like people who exercise that power, may fall vulnerable to irrational "subjective, personal, emotional, and psychological" motivations that, even in the absence of any material incentive, shape their convictions.

Conclusion. The willingness of academics to reach beyond the halls of ivy to voice their opinions on controversial issues serves the public interest, provided that their views are well-informed. But this enterprise can go very wrong; researchers and public intellectuals sometimes promote policies that are not evidence-based and may even be detrimental to the humanitarian aims they claim to champion. Professor Moskowitz's website that warns about the life-destroying effects of smartphone radiation is publicized by the University of California at Berkeley as "a valuable resource for scientists, journalists, and the public." However, the

defectively designed studies featured on the site not only communicate misinformation to the public but also undermine the credibility of legitimate scientific authority.[21]

That does not mean that all of the consequences of using fifth generation (5G) wireless networks are benign. Study of possible health effects should continue. Also warranted is concern about misuse, ranging from injurious messaging on Instagram to social media disinformation and repressive state surveillance. Translating that concern into medical fear of the technological instruments themselves, though, will not help us deal effectively with their impact on our daily lives.

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[1] The two historical trends shown on the graph are based on these sources: National Cancer Institute Surveillance, Epidemiology, and End Results (SEER) Program. 2021. And World Bank statistics: https://data.worldbank.org/indicator/IT.CEL.SETS.P2?locations=US
Incidence trends for individual types of brain cancer is reported here: Li, K and Lu, D. 2018. "Trends and patterns of incidence of diffuse glioma in adults in the United States, 1973-2014." Cancer Medicine, Table 1 and Fig. 1.

In some countries other than the U.S., a rise in rates of nervous system tumors has been observed over the past thirty years. Partially accounting for this increase are: 1) rising life expectancies – since nervous system cancer is mainly a disease of the elderly, larger numbers of elderly result in more cases; 2) Improvement in diagnostic tools, including advanced imaging methods, has increased the detection rate of nervous system tumors.

[2] Electromagnetic radiation that strikes a copper wire can align the wire's free electrons and make them flow along a certain path, as in a cell phone. There doesn't seem to be any analogous mechanism in a biological cell. The effects of electromagnetic radiation on the body are complex, however, and still being studied. "Oxidative stress," for example, may result from non-ionizing radiation. See this discussion: International Commission on Non-Ionizing Radiation Protection (ICNIRP). 2020. "Guidelines for Limiting Exposure to Electromagnetic Fields (100 kHz to 300 GHz)." *Health Physics*. May. Such effects are being investigated through experiments on animals. The U.S. National Toxicology Program has published the results of two studies done on rats and mice, which are evaluated in ICNIRP. 2020.

"Critical Evaluation of Two Radiofrequency Electromagnetic Field Animal Carcinogenicity Studies Published in 2018." *Health Physics*. May.

[3] Dongus, S. et al. 2021. "Health effects of WiFi radiation: a review based on systematic quality evaluation." *Critical Reviews in Environmental Science and Technology.*

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[5] Choi, Y-J, Moskowitz J., et al. 2020. "Cellular Phone Use and Risk of Tumors: Systematic Review and Meta-Analysis." *International Journal of Environmental Research and Public Health*. Nov. 2020.

[6] The International Commission on Non-Ionizing Radiation Protection (ICNIRP) compared 5G with earlier generations of wireless in a communication published in May 2021.

[7] Hapfelmeier, A. et al. 2019. "A large case-control study on vaccination as risk factor for multiple sclerosis." *Neurology*. Aug 27: pp. e908-e916.

[8] Röösli, M. et al. 2019. "Brain and Salivary Gland Tumors and Mobile Phone Use: Evaluating the Evidence from Various Epidemiological Study Designs." *Annual Review of Public Health*. April 40:221-238.

[9] Research epidemiologists Frank de Vocht and Martin Röösli point out in their critique of Moskowitz's meta-analysis that he draws on Hardell's studies to support the claim that empirical research demonstrates that cell phone use is carcinogenic; eleven of the studies reviewed by Moskowitz list Hardell as a principal investigator. Vocht F., Röösli M. 2020. "Comment on Choi, Y.-J., et al. Cellular Phone Use and

Risk of Tumors: Systematic Review and Meta-Analysis." *International Journal of Environmental Research and Public Health.* March, 8079.

[10] Shermer, Michael. 2011.*The Believing Brain: From Ghosts and Goods to Politics and Conspiracies*. Holt & Co. p. 275.

[11] Recall bias is most evident in memories of cell phone use that occurred many years in the past: In the multinational Interphone study of the health effects of wireless communication, "the ratio of self-reported to recorded phone use [among participants from Australia, Canada and Italy] increased with increasing time before the interview in cases but not in controls." Repacholi, M.H. et al. 2012, "Systematic Review of Wireless Phone Use and Brain Cancerand Other Head Tumors." *Bioelectromagnetics.* April.33(3). p. 200.

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Röösli, M. (ed.). 2014. *Epidemiology of Electromagnetic Fields*, CRC Press, especially chapters 2, 4, and 5.

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[18] Moskowitz, J. 2021. *Blog: Electromagnetic Radiation Safety*. August 15.

[19] Vocht and Röösli, cited above in note 10.

[20] Shermer, cited in note 11 above, p. 11.

[21] Although Moskowitz bases his warning about smartphone danger on flawed case-control studies, not everything he has to say on this subject can be dismissed as ill-considered or groundless. Conclusive demonstration of the safety of wireless devices will require further investigation.