Wi-Fi as a Very Substantial Threat to Human Health.

Martin L. Pall, Professor Emeritus of Biochemistry and Basic Medical Sciences,
Washington State University; martin_pall@wsu.edu
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I have been asked to comment on the health and safety of Wi-Fi. I am happy to do so. Because this is a long document, I want to first outline what is in this document so you can see how it all fits together:

1. FCC and other safety guidelines are based on the **assumption that microwave frequency electromagnetic fields (EMFs) can only produce thermal (heating) effects**. In other words they claim that there cannot be any non-thermal effect on our bodies.
2. However there have been many thousands of studies in the scientific literature, published from the 1950's to the present, with **each of these showing the existence of one of more non-thermal EMF effects**.
3. There is a consensus among independent scientist, as shown by the 2015 Appeal to the United Nations signed by 220 independent research active scientist experts in this area, that there are non-thermal health effects produced by these EMFs and that the current safety guidelines are inadequate because they do not take these non-thermal effects into consideration.
4. I have listed 11 different health effects of such non-thermal exposures, seven of which have been found to be produced by Wi-Fi exposure. When one looks at these health impacts it is clear that non-thermal EMF exposures attack: our health; our brain function; the integrity of our genomes; and our ability to produce healthy offspring.
5. **Neither Wi-Fi apparatuses nor other devices putting out such EMFs are ever tested biologically for safety** – not even one of them, not even once, before they are put out to irradiate the unsuspecting public. Such biological safety testing is the only way to say anything about their biological impacts. All assurances of safety that you will see in industry propaganda are based on a theory (of only thermal effects) and that theory has been shown to be false and should have discarded, in my opinion, over 40 years ago.
6. I have found what appears to be the main mechanism of action by which low-intensity EMFs produce these non-thermal effects. This mechanism which is described below, is that these EMFs activate what are called voltage-gated calcium channels. Most if not all of these effects produced (see #4 above) can be understood as being caused by the excessive calcium levels in the cell produced though this activation
7. In Table1, I present 19 studies of health-related impacts of Wi-Fi exposure, each of which have found one or more health related impacts of Wi-Fi. 7 of these health effects have been replicated more than once in these Wi-Fi studies; these 7 have also been found to occur repeatedly following other low-intensity EMF exposures and should, therefore be considered established effect of Wi-

Fi. Industry propaganda claims that Wi-Fi has no health effects should be rejected out of hand.

8. There are some supposed Wi-Fi studies that have been claimed by industry to have found no effects. These studies are each tiny studies that have no statistical power to make any such a claim and they are also studies where the effects of simulated Wi-Fi were studied not real Wi-Fi.
9. There are four different types of studies, each of which provide evidence for cumulative effects of non-thermal EMF exposures. While none of these looked at Wi-Fi, they suggest that it is likely that biological impact of Wi-Fi will get much worse over time and therefore the short term studies described in #7 may only describe a small part of the long term effects.
10. Wi-Fi and other microwave frequency EMFs may be particularly active in producing biological damage in young people. It follows from this that placing Wi-Fi in schools may be particularly problematic.

The FCC guidelines as are many other such guidelines, are based on the assumption that only heating effects of microwave/lower frequency EMFs can have biological effects. However that assumption has been falsified by thousands of studies published from the 1950's to the present, each showing that non-thermal levels of exposure often produce biological effects. For example, in 1971, the U.S. Office of Naval Medical Research produced a document reporting over 100 different non-thermal effects [1], listing 40 apparent neuropsychiatric changes produce by non-thermal microwave frequency exposures, including 5 central/peripheral nervous system (NS) changes, 9 central NS effects, 4 autonomic system effects, 17 psychological disorders, 4 behavioral changes and 2 misc. effects [1]. It also listed cardiac effects including ECG changes and cardiac necrosis as well as both hypotension and hypertension, and also 8 different endocrine effects. Changes affecting fertility including tubular degeneration in the testis, decreased spermatogenesis, alterted sex ratio, altered menstrual activity, altered fetal development, programmed cell death (what is now known as apoptosis) and decreased lactation. Many other non-thermal changes where also listed for a total of over 100 non-thermal effects. They also provided [1] over 1000 citations documenting these various health effects. That was over 45 years ago and is only the beginning of the evidence for the existence of non-thermal effects. My own recent paper [2] shows that widespread neuropsychiatric effects are caused by non-thermal exposures to many different microwave frequency electromagnetic fields (EMFs).

Tolgskaya and Gordon [3] in 1973 published a long and detailed review of effects of microwave and lower frequency EMFs on experimental animals, mostly rodents. They report that non-thermal exposures impact many tissues, with the nervous system being the most sensitive organ in the body, based on histological studies, followed by the heart and the testis. They also report effects of non-thermal exposures on liver, kidney, endocrine and many other organs. The nervous system effects are very extensive and include many changes in cell structure, dysfunction of synaptic connections between neurons and programmed cell death and are discussed in Refs. [2,3]; more modern studies reporting extensive effects of such non-thermal EMF

exposures on the brain are also cited in [2]. There are also many modern studies showing effects of non-thermal exposures on fertility of animals.

The Raines 1981 National Aeronautics and Space Administration (NASA) report [4] reviewed an extensive literature based on occupational exposures to non-thermal microwave EMFs. Based on multiple studies, Raines [4] reports that 19 neuropsychiatric effects are associated with occupational microwave / radio frequency EMFs, as well as cardiac effects, endocrine including neuroendocrine effects and several other effects.

I reviewed many other scientific reviews on this topic, each of which clearly supports the view that there are various non-thermal health impacts of these EMFs [5]. In 2015, 220 international scientist signed a statement sent to the United Nations Secretary General and to member states, stating that international safety guidelines and standards are inadequate to protect human health [6]. Each of these 220 scientists from 41 countries had scientific publications on biological effects of such EMFs for a total of over 2000 peer reviewed publications; therefore each is well qualified to judge this. **It can be seen from this statement to the UN, that there is a strong scientific consensus that current safety guidelines and standards are inadequate because they do not take into consideration any of the non-thermal health effects produced by various EMF exposures. That scientific consensus also rejects, therefore, the FCC EMF guidelines, guidelines that are not supported by most independent scientists.**

It can be seen from the previous paragraphs, that the following non-thermal effects of EMF exposures are well documented:

- Widespread neuropsychiatric effects
- Several types of endocrine (that is hormonal) effects
- Cardiac effects impacting the electrocardiogram (Note: these are often associated with occurrences of sudden cardiac death)
- Male infertility

However, there are many additional types of biological changes produced by non-thermal EMF exposures (reviewed 5,7) including:

- Oxidative stress
- Changes in calcium fluxes and calcium signaling
- Several types of DNA damage to the cells of the body, including single strand and double strand DNA breaks and 8-OH-deoxyguanosine (8-OHdG) in DNA
- Cancer (which is undoubtedly caused, in part, by such DNA damage)
- Female infertility
- Lowered melatonin; sleep disruption
- Therapeutic effects of EMFs when they are highly controlled and focused on a specific part of the body

It can be seen from the above, that each of things that we most value as individuals and as a species are being attacked by non-thermal microwave frequency EMFs [5.7]:

- **Our Health**
- **Our brain function**

- **The integrity of our genomes**
- **Our ability to produce healthy offspring**

I want to emphasize that the specific health effects listed above are **not** the only things that are likely to be impacted by non-thermal EMF exposures, they are however the best documented such effects.

While it has been clear for many years that there are many non-thermal health effects of microwave frequency EMFs, it has not been clear until about 4 years ago, how these effects are produced by such exposures. I found evidence for the mechanism in the scientific literature in 2012 and published on it in mid-2013. This 2013 paper [8] was honored by being placed on the Global Medical Discovery website as one of the most important medical papers of 2013. At this writing, it has been cited 112 times according to the Google Scholar database, with approximately 2/3rds of those citations occurring over the past year. So clearly it is having a substantial and rapidly increasing impact on the scientific literature. I have given 32 invited professional talks, in part or in whole on EMFs and their effects, in 9 different countries over the last 3 1/2 years. So it is clear that there has been a tremendous of interest in this research.

What the 2013 study showed [8], was that 24 different studies (and there are now 2 more that can be added [2,7]), effects of low-intensity EMFs, both microwave frequency and lower frequency EMFs could be blocked by calcium channel blockers, drugs that block what are called voltage-gated calcium channels (VGCCs). There were a total of 5 different types of calcium channel blocker drugs used in these studies, with each type acting on a different site on the VGCCs and each thought to be highly specific for blocking VGCCs. What these studies tell us is that these EMFs act to produce non-thermal effects by activation the VGCCs. Where several effects were measured in a single study, when one of them was blocked or greatly lowered, each other effects studied was also blocked or greatly lowered. This tells us that the role of VGCC activation is quite wide-many effects go through that mechanism, possibly even all non-thermal effects in mammals. There are a number of other types of evidence confirming this mechanism of action of microwave frequency EMFs [2]. Each of the 11 health impacts caused by non-thermal EMF exposures can be explained as being produced by indirect effects of VGCC activation [5,7].

It is now apparent [7] that these EMFs act directly on the voltage sensor of the VGCCs, the part of VGCC protein that detects electrical changes and can open the channel in response to electrical changes. The voltage sensor (and this is shown on pp. 102-104 in [7]) is predicted, because of its structure and its location in the plasma membrane of the cell, to be extraordinarily sensitive to electrical forces produced by these EMFs, about 7.2 million times more sensitive that are singly charged groups elsewhere in the living cells. What this means is that the industry argument that EMFs produced by particular devices are too weak to produce biological effects, are immediately highly suspect because of the actual target, the voltage sensor of the VGCCs is extremely sensitive to these EMFs. **Because heating is mostly produced**

by forces on these singly charge groups elsewhere in the cell, limiting safety guidelines to heating effects means that these guidelines allow exposures that are something like 7.2 million times too high.

Why then does the FCC stick with these totally unscientific safety guidelines? That is the 64 billion dollar question. The FCC has been shown, in a long detailed document published by Harvard University Center for Ethics, to be a 'captured agency", that is captured by the telecommunications industry that the FCC is supposed to regulating [9; can be obtained full text from web site listed in 9]. So perhaps the failure to the FCC to follow the extensive science in this important area can be understood. Of course, what that means is that the FCC is completely failing in its role of protecting the public and it is a major blunder, therefore for either you or any organizations to depend on the FCC guidelines as a reliable predictor of impact of EMFs in humans.

So what is known about health impacts of Wi-Fi EMFs?

Table 1. The following Table summarizes various health impacts of Wi-Fi EMF exposures:

Citation(s)	Health Effects
[10-17]	Sperm/testicular damage, male infertility
[10,15,18-23]	Oxidative stress
[21,22]	Calcium overload
[11,12,21]	Apoptosis (programmed cell death)
[18]	Melatonin lowering; sleep disruption
[10,13,17]	Cellular DNA damage
[24]	MicroRNA expression (brain)
[19]	Disrupts development of teeth
[25]	Cardiac changes, blood pressure disruption; erythrocyte damage
[26,27]	Neuropsych changes including EEG
[28]	Growth stimulation of adipose stem cells (role in obesity?)
[23,25]	Hormone changes incl.: Catecholamine, prolactin, progesterone and estrogen

Each of the effects reported above in from 2 to 8 studies have an extensive literature for their occurring in response to various other non-thermal microwave frequency EMFs so it should be clear that these observations on Wi-Fi exposures are highly probable to be correct. These include (see Table 1) findings that Wi-Fi exposures produce impact on the testis leading to lowered male fertility; oxidative stress; apoptosis (a process that has an important causal role in neurodegenerative disease); cellular DNA damage (a process causing cancer and germ line mutations); neuropsychiatric changes including EEG changes; hormonal changes. Each of these are very serious: Oxidative stress has causal roles in many different human diseases;

cellular DNA damage can cause cancer and produce mutation that impact future generations (if there are any; see below [29]); apoptosis has central roles in neurodegenerative diseases; the neuropsychiatric effects are almost certainly caused by the impact of EMFs on brain structure which is, in my opinion, horrendous [2]. We are, of course, seeing major lowering of sperm counts and sperm quality in many countries around the world; given the major impact of EMF exposures on sperm count and quality in human and in animal studies, the pattern of evidence is very worrying.

Two studies cited here [20,21] report raises in TRPV1 activity following EMF exposures which lead in turn to increased intracellular calcium. Does this conflict with the finding that EMF activation of the VGCCs may control many, perhaps even all EMF effects? No it does not. It is well established the the TRPV1 receptors become activated or more sensitive to activation when exposed to oxidants, such that oxidative stress produced by VGCC activation may be predicted to lead to increased TRPV1 activity.

One issue that has been raised about the effects of these low-intensity EMFs producing biological effects is are they cumulative? I am aware of 4 different types of evidence for cumulative effects, over different time periods. Three of the human occupational exposure studies from the 1970's reviewed in [4], showed that effects increased substantially with increasing time of exposure to a particular type and intensity of EMF.

The impacts of such EMFs on animal brains reviewed in [3] and discussed in [2], initially over period of 1 to 2 months showed relatively modest change in structure of the brain and the neurons and when exposures ceased, most of the structural changes disappeared – that is the changes were reversible. However more months of exposure produced much more severe impacts on brain and neuronal structure and these were irreversible.

Studies of headaches during or immediately after cell phone usage showed the following: Headaches usually only occurred after cells of over one hour in duration and when they occurred, headaches were on the side of the head where the cell phone was held. The headache studies also suggest cumulative effects, in this case over periods of over one hour.

Finally Magras and Xenos [29] put pairs of young mice into cages on the ground at two locations each with two somewhat different exposures within an antenna park. The exposure levels at both sites were well within safety guidelines, so if the safety guidelines have any biological relevance, there should be no effects It takes about one month for mice to go through gestation. At the higher level exposure, the pairs produced one litter of approximately normal size, and a second litter with lowered numbers of progeny; after that they were completely sterile [29]. At the other site, the mating pairs produced four litters, with decreasing numbers of progeny over time followed by completely sterility. It should be noted that [15] shows that Wi-Fi

exposure impacts animal reproduction and that [10-14,16,17] suggest this as well from the Wi-Fi impact on male fertility.

It can be seen from these four examples, each shows evidence for cumulative effects over somewhat different time periods. One thing that should tell us is that the short-term Wi-Fi studies shown in Table 1 may greatly underestimate the damage Wi-Fi may do over much longer time periods. Given the fact that Wi-Fi has been placed in most schools, hotels, restaurants, coffee shops, commercial aircraft and airports, and that Wi-Fi hot spots are becoming increasingly common in cities around the world, we should expect massive cumulative Wi-Fi effects in many people.

Wi-Fi May Be Particularly Damaging to Young People:

Most arguments that have been made that microwave frequency EMFs may be much more damaging to young children have centered on the much smaller skulls and skull thickness in young children, increasing the exposure of their brains to EMFs. However here a second such argument to be made. EMFs have been shown to be particularly active in producing effects on embryonic stem cells [28, 30-40]. Because such stem cells are much more common in children, with stem cell densities the highest in the fetus and decreasing with increasing age [30,31], impacts on young children are likely to be much higher than in adults. The decreased DNA repair and increased DNA damage following EMF exposure strongly suggest that young children may be increasingly susceptible to cancer following such exposures [30-34]. EMF action on stem cells may also cause young children to be particularly susceptible to disruption of brain development [32-36]. These are both very problematic issues and we cannot rule out the possibility that there are other problematic issues as well. Redmayne and Johansson [41] reviewed the literature showing that there are age-related effects, such that young people are more sensitive to EMF effects. It follows from these various findings that the placement of Wi-Fi into schools around the country may well be a high level threat the health of our children as well being a threat to teachers and any fetuses teachers may be carrying, as well.

Summary:

1. 19 studies have each shown health effects of Wi-Fi, most of which have also been shown to occur in response to low intensity exposures to other types of microwave frequency EMFs. These are likely to have massive health effects by producing male infertility (female infertility has not been studied in response to Wi-Fi), oxidative stress (involved in dozens of human diseases), cellular DNA damage (possibly leading to both cancer and mutations in future generations), life threatening cardiac effects, cellular apoptosis and also intracellular calcium overload (with both of these possibly leading to neurodegenerative diseases), various neuropsychiatric changes and many hormonal changes. The high level sensitivity of stem cells to such EMFs may put children, particularly young children at special risk of Wi-Fi exposure. It follows that placing Wi-Fi in schools may well be especially damaging.

2. The FCC has been shown, in a detailed Harvard's University report, to be a "Captured Agency", captured by the industry that it is supposed to be regulating. This provides an additional reason to be very highly skeptical about all FCC safety guidelines.
3. The EMF safety guidelines supported by the FCC and others assume that only heating need be of concern. These assumptions have been known to be false for over 40 years and there is a scientific consensus on this, that has lead to the 2015 Appeal by 220 highly qualified international scientist to the UN stating that current safety guidelines are inadequate because they do not take into consideration non-thermal effects of EMFs.
4. The voltage sensor of the VGCCs, the main target of EMFs in the cells of our bodies, is stunningly sensitive to such low intensity EMFs, about 7.2 million times more sensitive than are singly charged groups elsewhere in our cells. The consequences of this is that safety guidelines allow exposures that are approximately 7.2 million times too high.
5. We know now that low intensity non-thermal exposures work via VGCC activation and that indirect effects of such VGCC activations can produce each of the health effects that have been widely reported to occur in response to such EMF exposures for something like 60 years. Low intensity EMFs attack:
    a. **Our health**
    b. **Our brain function**
    c. **The integrity of our genomes**
    d. **Our ability to produce healthy offspring**
6. It is essential that Wi-Fi and other devices that expose us to microwave frequency EMFs be tested biologically for safety. Assuring people of safety based on a theory that has been known to be wrong for over 40 years, as industry currently does, is completely unacceptable.

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Martin L. Pall, Professor Emeritus of Biochemistry and Basic Medical Sciences, Washington State University (see contact information at the beginning of this document).