RESPONSE TO QUESTIONS RELATED TO RADIOFREQUENCY ENERGY EXPOSURE

Background: A packet of information was handed to me during the Verizon Wireless Pt. Townsend meeting that identifies studies that show hazards or ill affects as a result of exposures. The following is a review of those studies in the order presented:


Response: This is not a "study" but a survey using a questionnaire. The survey volunteers were self selected with the questions focusing on symptoms such as nausea, loss of appetite, visual disturbances, loss of memory, dizziness, headaches, sleep disruption, skin problems, etc. At no time were measurements made of the various sources of radiofrequency (RF) and or magnetic fields (60 Hz sources). In short, the "study" is nothing more than a group of self selected individuals who attribute feelings of ill health to proximity to exposure to various RF sources. In a large city, small RF emitters such as those from cellular providers may not be the primary source of RF exposure as FM and TV stations as considerable distances from the individual can also significantly contribute to exposure.

Attachment 1 provides a summary of studies on Electromagnetic Hypersensitivity. Included in this attachment is a direct quote from the Health Council of the Netherlands on the subject as well as one from the World Health Organization fact sheet #296. In both instances of these reviews it is clear that there is a relationship between symptoms and the assumption of being exposed.


Response: In 2003, Zwamborn et al\(^3\) reported that exposure of human volunteers to base station RF energy caused decreased feelings of "well-being" and improvement on some cognitive function tests (e.g., reaction time and memory tests). The effect on "well-being" was found only for the UMTS (Universal Mobile Telecommunications Service) type of signal used by G3 (third generation) mobile phone systems; it was not found for GSM mobile phone signals (the system that now dominates Europe). The effects on cognitive function were found for both UMTS-like and GSM signals;

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\(^2\) http://www.milieuziektes.nl/Rapporten/TNO-FEL%20REPORT\_03148%20(Definitief).pdf Accessed 5/15/16

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the effects occurred in 8 of 30 tests, with no obvious pattern. In 2006, as a follow up to the Zwamborn study, Regel et al. studied 117 adults (33 reported sensitive, 84 non sensitive) at varying electric field strengths for a number of cognitive endpoints. The study was unable to confirm the results of the Zwamborn study.


Response: This is an interesting series of studies, first started by a preliminary study (Navarro) but based upon the same questionnaire used by Santini. The improvement made over the Santini study was that exposure measurements were made as opposed to simply basing results on the distance from the RF antennas. I was unable to locate any information as to how the individuals were selected for participation. Two important points to bring up. First, even if participants were randomly selected they would likely have known the nature of the study and it is clear from the World Health Organization and other studies that people who believe they are exposed to RF experience symptoms of ill health and attribute them to the energy from the RF antennas. Secondly, La Nora Spain is a small town with apparently few sources of RF energy. The author's segregation of "high" and "low" exposures is negligible. Meaning that even the "high" exposures are less than ~0.07 µW/cm² from all RF sources. This is an incredibly small exposure rate and we would be hard pressed to find any populated areas of the United States with exposures rate this low. So, the study found "effects" by segregating two very low background locations and then proceed to recommend based upon this study that exposures should remain less than 0.0001 µW/cm². Considering all of sources of FM, TV, WiFi, WiMax, and cellular signals in the environment there are virtually no locations in developed countries with total exposures rates near this level. Going back to Attachment 1 where in laboratory double blind studies (neither the study participants or the researchers know who is being exposed) are used, effects are not found in spite of repeated attempts.


Response: Attachment 2 is a summary of the Epidemiological studies performed to date. People (n=622) living in proximity to a mobile phone cell site in Netanya, Israel (began operation in July 1996) and attending a cancer clinic were compared

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4 Obtained from Dr. John Moulder’s website: http://www.mcw.edu/gcrc/cop/cell-phone-health-FAQ/toc.html#19C
with control populations registering in a neighboring clinic in Netanya as well as the entire population cancer rate in Netanya. Eight cases in the experimental area were diagnosed during the study period between July 1997-June 1998 - all different types of cancer (ovarian, breast lung, hodgkins, Osteoid osteoma, and hypernephroma). The authors report a statistically significant association between residential proximity to the mobile phone base station site and cancer incidence. The problems with this study are numerous. First, the cancers identified were of multiple types. The cellular base station was in operation for only a year prior to the start of the study meaning that the cancer latency period was less than 2 years. No adult cancers have a latency that short. The controls were not adequately matched nor was there adequate control for confounding variables. Cellular base stations are located throughout cities, were other radiofrequency exposures addressed and adequately controlled? How could the authors have not addressed the glaring issue of cancer latency which rules out the RF antennas as any possible source? No other studies in the past 50 years have identified the wide variety of cancers cited by these authors. Finally, the issue of dosimetry would have to be addressed if these RF exposures really were a possible causal source. Namely, cancers of the long bone and ovarian cancers sites in the body would receive a very small exposure from an external RF source. This paper should not have been published.


Response: This citation refers to a study by Eger et al\textsuperscript{8} in 2004. In this study, residential proximity to mobile phone base stations was correlated with total cancer incidence. The authors report that preliminary data (1000 individuals) suggests a correlation between general cancer onset and incidence and time living near a mobile phone base station tower. A radius of 400 meters was chosen as the cut-off for the high exposed group with an average distance to buildings within this circle of 266 meters. The average distance to buildings outside the circle was 1076 meters (low exposed group). The transmitter site used for the study has had one antenna operating since September 1993 at 32 watts per channel at a frequency of ~935 MHz (GSM signal), and in 1997 an additional transmitter was installed on the tower by another operator. Exposure was calculated assuming free space characteristics. The authors report that for the period of 1999 to 2004, a correlation between high exposure and general cancer incidence was observed (OR = 3.38; 95% CI = 1.39 - 8.25). No measurements were made for this study so no other sources of RF exposure were taken into consideration. Without measurements and relying solely on calculations, particularly in a city, greatly overestimates the actual exposure due to shielding, etc. The author's table 7 shows the comparison of tumors found (11 different cancer endpoints) to the expected number for a given population. With the exception of breast cancer, all results were equal to or less than expected. Further, when one reviews the trends over time, the overall cancer incidence rate remains unchanged.

\textsuperscript{8} Eger H et al. EINFLUSS DER RÄUMLICHEN NÄHE VON MOBILFUNKSENDEANLAGEN AUF DIE KREBSINZIDENZ. Umwelt-Medizin-Gesellschaft, 2004.
Finally, only rudimentary consideration for adequately matching of controls. This is simply another example of a poorly thought out study. See Attachment 2 for a summary of other epidemiological studies.

6. Austrian Study. Press release 1st May 2005

Response: Insufficient information was provided to identify the study and authors. There have been studies that have identified effects on EEG alpha waves. These are simply biological effects and are not indicative of a stress on the body or on adverse effects. Much like exposure to light causes pupil dilation, such biological effects mean nothing more than our body recognizing an external source.

A number of studies showing no effects on teenagers with exposure to GSM and UMTS signals (Haarala et al 2005, Preece et al 2005, and Riddervold et al 2008). Croft et al 2010 finds differences are associated with age. No effects on spontaneous EEG with GSM or CDMA signals in teenagers and older adults but does show an increase in resting alpha power (low frequency) in young adults with a GSM signal. Again, while this is an effect, there is no indication that this is an adverse effect or even could be an adverse effect.

7. Cell Phone Tower Proximity Impacts on House Prices:

Response: I can only address exposures and possible biological effects, this subject is outside of my area of expertise.

8. 22/07/2005 - German Doctors unite on RF health effects

Response: No study citation was provided but the subject area is related to Electromagnetic Hypersensitivity (EHS) to which I refer back to Attachment 1 which provides a substantial and well documented background on this subject.

9. Mobile phone and Mast Radiation - how dangerous are these (selected quotations only)

Response: This section refers to studies covered previously. Non published studies or appeals cannot be evaluated.

10. A few pages cover Asthma, Brain Tumors, Miscarriage, suicide, etc. This is all related to magnetic fields from 60 Hz power lines, not RF energy from base stations. Since this area is not germane to the issue of the proposed RF base station this subject will not be evaluated.

11. Maternal Exposure to Magnetic Fields During Pregnancy in Relation to the Risk of Asthma in Offspring. This is all related to magnetic fields from 60 Hz power lines, not RF energy from base stations. Since this area is not germane to the issue of the proposed RF base station this subject will not be evaluated.
12. New Research Links Cell Phones to Health Issues in Children. A. Yensi. This is not a published paper but an online article. In the article they quote D. Davis as stating two points, that the weight of evidence is clear that cell phones do cause brain cancer, and secondly, that the young brain absorbs twice as much radiation as an adult.

Response: Let's address one item at a time. First, do children's brains absorb twice as much radiation as an adult. The short answer, no. While it may be possible that the energy distribution of a child's head versus an adult is different, to date, recent studies using realistic models of child versus an adult do not show significant differences between the two.

Second, do cell phones cause brain cancer? Not based upon the evidence we have to date. Without getting into all of the supporting studies let's look at this from a big picture perspective. We as a world have been using cell phones since the early 1990s. If cell phone exposure causes an increase in brain cancers then due to the overwhelming use of the phones the increase in incidence rates would readily be observed. The chart below clearly shows that the incidence rate is not increasing for any age group other than those over 75, but the increase from the over 75 age group is not RF exposure related but age alone. The data to date cannot rule out any possible future association but it is clear that the risk, if it exists in the future, would be very small. But I emphasize that to date, no data shows a risk of brain cancer from RF exposure as the work by Hardell et al in Sweden has been shown to not match the available incidence rates so his work is ruled out.

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Third. A related article in the Baltimore Sun was published on the same day so it appears to be the study to which the article refers. In this article they cite a study by a Dr. Taylor of Yale putting cell phones on top of cages containing pregnant mice and noting behavioral changes in the offspring. I could not locate this paper but they provide sufficient information to make it clear that such a study contains no controls on dosimetry (the RF exposure) as cell phones on cages may look appealing to a researcher but result in a completely unknown exposure to the animals. The second portion of Attachment 1 provides a review of cognitive studies that include children and notes no indication of replicated adverse effects.

13. 10 out of 14 peer reviewed studies on base stations found significant increases in symptoms and conform to WHO standards of scientific quality

Response: I'll not go through every one of these studies as this overall response has taken a large amount of time and hopefully an individual reading this will recognize that every study that has been identified so far has had serious shortcoming in the study design. So, briefly, the first two are papers by Santini and are nothing more than questionnaires. The 3rd and 7th paper are in German (which I cannot read). The 4th is a paper by Navarro and was a precursor to the Oberfeld et al study and already discussed. The 5th paper by Hutter in 2006 is a precursor to the 2009 paper by Kundi and Hutter and used by the Bio Initiative Report as the basis for their recommended exposure limit. Unfortunately, as hopefully conveyed in Attachment 1, in order to obtain meaningful results in well being studies the studies must be double blind such that neither the researchers or the test subjects know who is being exposed. The Hutter paper is not a double blind paper and DOES NOT meet the WHO standards of


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scientific quality. The 46 double blind studies performed to date (mentioned in Attachment 1) clearly show that no adverse effects occur as a result of RF exposure.

The 6th paper by Abdel-Rassoul in 2006 appears to be a reasonably well designed study that used prior power density measurements as a guide to exposure rates of the participants. Unfortunately, without adequate knowledge of the actual exposure to the study participants one can have no idea as to whether the exposure correlates to the symptoms. I say this for the simple reason that RF energy is significantly attenuated through the building walls and particularly the glass if tinted (a reasonable assumption in Egypt). Interior workers or workers on the other sides of the building may experience exposures several orders of magnitude lower than those of the existing building and without verification one would have no way of knowing the level of exposure. I refer the reader again back to the second part of Attachment 1 that reviews a number of cognitive studies and clearly shows no trends in the results.

Papers 10, 11 and 12 have already been reviewed. The paper by Regel (the 13th paper) in 2006 failed to confirm the results of Zwamborn as is discussed in Attachment 1.

Finally, paper 14 is interesting. Eltiti et al in 2007 tried to determine whether short term exposure to mobile phone base station signals increase symptoms in individuals who report sensitivity to electromagnetic fields. Eltiti's results show that none of the volunteers are able to detect a signal and the study found no evidence of any physiological effects from the RF energy exposure. The author's correctly point out that "the number of symptoms experienced by the sensitive individuals was not, however, related to the presence of an EMF signal". In short, this study did NOT find effects but supports the conclusion in Attachment 1 that individuals are not sensitive to RF exposures but to the "thought" of being exposed.

14. The final paper is by Eger and was discussed in Attachment 2.

Regards,

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ATTACHMENT 1: EHS and Child Cognition Studies

Electromagnetic Hypersensitivity

The most comprehensive review on the subject of Electromagnetic Hypersensitivity (EHS) has been performed by Dr. James Rubin and colleagues. In 2005, Rubin, Munshi and Wessely11 reviewed the published studies related to Electromagnetic Hypersensitivity (EHS). Overall, 31 double blind12 experiments were identified which tested 725 participants. 24 studies found no difference between the exposure and sham conditions. Of the remaining seven, two of the groups failed to replicate their own results while two other groups found opposite effects (better/worse mood). The other three results appeared to be statistical artifacts.

In 2010, Rubin and colleagues updated their 2005 review13. Fifteen new double blind studies were reviewed bringing the total to 46 double blind provocation studies with a total of 1175 participants. These studies directly analyzed whether RF fields are responsible for triggering various symptoms. Despite the conviction of the participants that RF/EMF exposure cause the acute symptoms, the studies were not able to replicate the findings. In short, the participant’s symptoms occurred whether they were exposed or not. Many studies have identified the possibility that an adverse effect is caused by the belief that the exposure is harmful14.

The Health Council of the Netherlands15 has this to say on the symptoms experienced by individuals:

Both in the living environment and in the laboratory, studies have been performed into a possible link between exposure to electromagnetic fields and the occurrence of symptoms. Several of these studies were not properly designed and cannot be used for the analysis. From the good quality scientific data emerges the picture that there is no causal relationship between exposure to radiofrequency electromagnetic fields and the occurrence of symptoms. However, there is a relationship between symptoms and the assumption of being exposed and therefore most likely with the risk perception. Nevertheless, the symptoms do exist and require a solution.

The World Health Organization (WHO) has issued a fact sheet on this subject. The overall conclusion is that while there is little doubt that the individuals are experiencing symptoms, 60 Hz power frequency fields or RF energies are not the cause. WHO fact sheet #296 is on EHS.

12 Double blind experiments are superior to single blind experiments as neither the participant nor the researcher knows who is being exposed and thereby avoids the introduction of bias from an expectation of the results due to the exposure.

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Child and Adult Cognitive Studies

Cognition studies applied to human volunteers are an attempt to identify direct effects as a result of exposures, mostly from cell phones (not the lower base station exposures). This is perhaps more meaningful than electroencephalogram (EEG) studies where an EEG influenced by cell phone signals might be an example of a biological effect but would be limited in terms of determining a potential health effect. In the cognitive studies included below, initial effects by an author or often unreplicated by the same or other researchers. The only conclusion one might make is that the cellular phones tend to improve performance on tests but such improved performance could certainly be a statistical artifact.

- In 2006, Chang Nam et al. studied the effects of cellular phone exposure on both teenagers and adults. 21 adults and 21 teenagers were exposed to 300 mW CDMA phones for 30 minutes. No changes in all physiological parameters measured occurred with the exception of a non statistical transient decrease in skin resistance for teenage males.

- In 2005, Haarala et al. investigated the cognitive function of 10-14 year old children from mobile phone function. The study concludes that mobile phones have no effect on children’s cognitive function as measured by response speed and accuracy.

- In 2005, Preece et al. examined cognitive function on 18 children 10-12 years old. Exposures were 0.25W from a mobile phone. Study results shows that reaction times were shorter (but not significantly so) for exposure conditions than for sham exposure. This study failed to replicate the results from Preece’s earlier work in 1999. Preece’s 1999 study showed that individuals reacted faster during exposure conditions.

- In 2003, Haarala et al. reported that they could not replicate their earlier findings on human reaction times. The testing was performed by two independent laboratories on 64 adults (32 at each lab).

- In 2004, Hamblin et al. reported that 1 hour of exposure of human volunteers to mobile phone RF energy resulted in decreased reaction times.

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• In 2003, Lee et al\textsuperscript{23} reported that exposure of human volunteers to mobile phone RF energy resulted in better performance in one of two measures of attention. This is in contrast to Lee’s earlier findings from 2001\textsuperscript{24}.

• In 2004, Krause et al\textsuperscript{25} in a study of 24 adults analyzed 902 MHz mobile phone effects on auditory memory. This double blind study also failed to replicate the finding of earlier work by the study group\textsuperscript{26}. In their previous study, the group identified eight significant changes but in the double blind testing configuration (i.e. steps made to ensure that the adults tested could not know whether they were exposed or not) the significant changes were not present. In the 2004 study, a decrease in the number of incorrect answers was observed as a result of exposure to RF field.

• In 2005, Besset et al\textsuperscript{27} studied a group of 55 adults for 45 days to examine motor function following mobile phone exposure. The study concluded that mobile phone use has no effect on cognitive function following a 13 hour rest period.

• In 2003, Zwamborn et al\textsuperscript{28} reported that exposure of human volunteers to base station RF energy caused decreased feelings of "well-being" and improvement on some cognitive function tests (e.g., reaction time and memory tests). The effect on "well-being" was found only for the UMTS (Universal Mobile Telecommunications Service) type of signal used by G3 (third generation) mobile phone systems; it was not found for GSM mobile phone signals (the system that now dominates Europe). The effects on cognitive function were found for both UMTS-like and GSM signals; the effects occurred in 8 of 30 tests, with no obvious pattern\textsuperscript{29}. In 2006, as a follow up to the Zwamborn study, Regel et al\textsuperscript{30} studied 117 adults (33 reported sensitive, 84 non sensitive) at varying electric field strengths for a number of cognitive endpoints. The study was unable to confirm the results of the Zwamborn study.

• Eliyahu et al (2006) examined, in 36 young, right-handed male subjects, the effects of GSM RF exposure of the right or left side of the head on four cognitive tasks selected for high cerebral hemisphere specificity. The authors’ intention was to examine the effect of RF exposure of a specific part of the brain on associated cognitive functions. These were

\begin{itemize}
  \item Lee TMC, Ho SMY, Tsang LYH, Yang SYC, Li LSW, and Chan CCH. Effect on human attention of exposure to the electromagnetic field emitted by mobile phones. NeuroReport 12:729-731. 2001.
  \item Obtained from Dr. John Moulder’s website: http://www.mcw.edu/gcrc/cop/cell-phone-health-FAQ/toe.html#19C
\end{itemize}
a spatial item recognition task (activating the right premotor cortex), a verbal item recognition task (activating the left posterior parietal cortex and supplementary motor and premotor cortex), and two spatial compatibility tasks (a visual stimulus on the left side of the test screen activating the left posterior parietal cortex, and on the right side activating the right posterior parietal cortex). Each task required right- and left-handed responses. The subjects performed 3 series of tests, with exposure to the right or the left hemisphere or with sham exposure, in either of two 1-h sessions, separated by 5 minutes. The study was conducted under single-blinded conditions, and the exposure regime and task sequence were counterbalanced. The authors analyzed the reaction times for correct responses to each task, comparing the exposure condition (left, right or sham) for left hand or for right hand responses. Generally, right-hand responses were faster than left-hand responses (the subjects were right-handed subjects) and strong training effects (reaction times faster in the second session) were present in most sham responses. The authors reported that exposure of the left hemisphere of the brain resulted in slower left-hand responses in the second session compared to the first.

- Haarala et al (2007) also compared responses of exposure of the left and right hemisphere. They exposed 36 healthy male volunteers to a continuous or GSM signal operating at 0.25 W. In a double blind, crossover design, subjects were exposed in 90 min sessions at 1 week intervals. Different cognitive functions tasks were performed: simple reaction time, 10-choice reaction time, subtraction, verification, vigilance, and memory (n-back test). No difference on response was observed for any task for both continuous wave and GSM exposure between exposure to either the left or right hemisphere and sham exposure. The absence of a difference in response with a control group tested without the exposure equipment indicated that the presence of the exposure equipment also was of no influence. The authors comment that they used fairly simple and hemisphere-aspecific behavioral tasks and that it cannot be excluded that more complex or hemisphere-specific cognitive tasks could be more sensitive to effects of RF exposure.

- Terao et al (2006) exposed 16 healthy volunteers for 30 min to an 800 MHz mobile phone signal in a double-blind crossover study. Immediately before and after actual or sham exposure a precued choice reaction time test was performed. Exposure did not have any effect on reaction time or accuracy.

- Schmid et al (2005) exposed 58 healthy volunteers to UMTS signals resulting in SAR values of 0.37 or 0.037 W kg-1, thus simulating a UMTS phone in transmitting or receiving mode. A double-blind crossover design was used. Four visual perception tests were applied: the Critical Flicker Fusion Frequency test, a visual pursuit test, the Tachistoscopic Traffic test Mannheim, and a contrast sensitivity threshold test. The duration of exposure is not given, but was most likely the time it took to perform the tests. Since for all subjects the test procedures were applied on one single day, carry-over effects might be present. However, in none of the tests was an effect of either level of exposure observed.

- Regel et al (2007a) investigated reaction time and memory in 20 subjects exposed to either a 900 MHz continuous or GSM-type signal for 30 min. In this double-blind, randomized, counterbalanced cross-over study no effects were observed in single or 2-choice reaction time tests. An improvement in accuracy in the 3-back memory test was found after GSM-type (pulsed field) exposure, but not after CW exposure.

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31 Copied with permission from Section II.5.1.4 of the ICNIRP 16/2009 report.
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Regel et al (2007b)\textsuperscript{34} exposed healthy volunteers for 30 min to a GSM 900 signal immediately before sleep while performing cognitive tasks. Exposure and sham were double-blind, randomized and given at 1 week interval, and importantly they looked for a dose-response relation using 0.2 and 5 W kg\textsuperscript{-1} peak spatial SAR. They observed a dose-related reduction of reaction time with increasing field strength for the 1-back task, and similar relations at trend level for the 2-back task and the choice reaction time task, but no effect on the simple reaction time or 3-back task.

There are a few other studies that have been performed (Tahvanainen et al Bioelectromagnetics 2004; Maier et al, Acta Neurol Scand 2004; Curcio et al NeuroReport 2004; Hinrichs et al NeuroReport 2004; Edelstyn and Oldershaw NeuroReport 2001) showing no effect (2), improved performance (1), and impaired performance (2).

Movvahedi et al 2014\textsuperscript{35} using 60 elementary school children ages 8 to 10 year old in a 10 min real/sham exposure setting. Short term exposure leads to better performance of their short term memory.

Loughran et al 2013\textsuperscript{36} examined potential sensitivity of adolescents to RF exposures using a double blind, randomized crossover design with 22 youth aged 11-13 years. No clear significant effects of RF exposure on the waking EEG or cognitive performance was found. This follow up study was unable to demonstrate a effect found in adults in a similar study.

Thomas et al 2010\textsuperscript{37} in Australia with 236 students participating middle school students. No overall trends.

Abramson et al 2009 in Australia. 317 7th grade students in a cross sectional study examining cognitive function using a questionnaire based upon the Interphone study. Overall, mobile phone use was associated with faster and less accurate responding to higher level cognitive tasks.

\textsuperscript{34} Copied with permission from Section II.5.1.4 of the ICNIRP 16/2009 report.  
ATTACHMENT 2:
Epidemiological Studies and RF Base Stations

A summary of related studies to this subject is as follows:

- 1992: Selvin and colleagues\(^{38}\) investigated the occurrence of cases of leukemia, brain cancer, and lymphatic cancer in children under 21 years of age in an area around a large microwave tower located to the southwest of the center of San Francisco. They used three analytical approaches to investigate a possible association between the electromagnetic radiation from the tower and the occurrence of cancer. Their results showed that cancer occurrence was random. In other words, no pattern emerged that suggested an association between the tower and the occurrence of cancer. The weaknesses of this study were that no measurements of exposure were taken, and other factors that could influence the occurrence of cancer were not considered\(^{39}\).

- 1994: Maskarinec, G, and colleagues\(^{40}\) report a cluster of twelve cases of leukemia occurring in children in Waianae Coast in Oahu, Hawaii in the years 1979-1990. The population had expressed concerns about radio towers from a nearby military installation. The radio waves were transmitted at 23.4KHz. In a case control study, each case was matched with 4 controls for age and sex. Risk factors examined included parents' occupations, x-ray exposure, domestic smoking, family and medical histories, and distance of the children's residence locations to the radio towers. The odds ratio found was 2.0 for having lived within 2.6 miles of the installation but this OR was not statistically significant due to the low numbers used in the study. Exposure to radiofrequencies was not adequately assessed, and other possible risk factors, e.g. chemical exposure, were not included in the investigation. The authors state that since 1985 the incidence of leukaemia in the area has returned to an expected pattern of approximately one case every 2 years. This paper demonstrates the difficulty of interpreting a cluster of cases of a disease\(^{41}\).

- 1996 and 2004: Hocking\(^{42}\) and colleagues compared municipalities "near TV towers" to those further away. No RF energy exposures were actually measured, no other sources of exposure to RF are taken into account, and the study is based on only a single metropolitan area. The authors reported an elevated incidence of total leukemia and childhood leukemia, but no increase in total brain tumor incidence or childhood brain tumor incidence. In 2003, they also reported decreased survival in these childhood leukemia cases\(^{43}\).

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\(^{39}\) Summary provided by the University of Ottawa. http://www.rfcom.ca/epi/pop.shtml


\(^{41}\) Summary provided by the University of Ottawa. http://www.rfcom.ca/epi/pop.shtml


\(^{43}\) Summary provided by Dr. John Moulder, Medical College of Wisconsin.
• 1998: McKenzie and colleagues repeated the Hocking study. They looked at the same area, and at the same time period; but they made more precise estimates of the exposure to RF energy that people got in various areas. They found increased childhood leukemia in one area near the TV antennas, but not in other similar areas near the same TV antennas, and they found no significant correlation between RF exposure and the rate of childhood leukemia. The increased incidence reported by Hocking et al was found to have been based on data from a single area, and to have resulted largely from cases diagnosed before 24-hr TV transmission was introduced at most of the stations.

• 1997: Dolk and colleagues investigated a reported leukemia and lymphoma cluster near a high-power FM/TV broadcast antenna at Sutton Coldfield in the UK. They found that the incidence of adult leukemia and skin cancer was elevated within 2 km of the antenna, and that the incidence of these cancers decreased with distance. No associations at all were seen for brain cancer, male or female breast cancer, lymphoma or any other type of cancer.

• 1997: Because of the above finding, Dolk and colleagues extended their study to 20 other high-power FM/TV broadcast antennas in the UK. Cancers examined were adult leukemia, skin melanoma and bladder cancer, and childhood leukemia and brain cancer. No elevations of cancer incidence were found near the antennas, and no declines in cancer incidence with distance were seen. This large study does not support the results found in the much smaller studies by the same authors at Sutton Coldfield or by Hocking et al in Australia.

• 2001: In a follow-up to the first 1997 Dolk et al study, Cooper et al reported that more recent cancer incidence data did not support the association of distance and adult leukemia incidence reported at Sutton Coldfield.

• 2002: Michelozzi et al reported that the incidence of childhood leukemia was elevated within 6 km of Vatican Radio (31 transmitters at 4-44 kHz and 0.5-1.6 MHz, with power of up to 600,000 W). The authors also report elevated leukemia in adult men residing near the transmitters, but not in adult women. Interpretation of this reported cancer cluster is limited by the small numbers and by the use of distance as a surrogate of exposure (i.e. no direct exposure measurements). For example, only 8 childhood leukemia cases occurred during a 12 year period.

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45 Summary provided by Dr. John Moulder, Medical College of Wisconsin.
2004: Park\textsuperscript{50} et al reported that overall cancer death rates were slightly elevated among people who died in "administrative units" that contained AM radio broadcast antennas. The overall association is weak and is seen only in males. No specific types of cancer are elevated, and there is no trend toward increased cancer death rates with increasing broadcast power. The authors note that "In the Korean culture, most people tend to return to their hometown when they die"; so that the "administrative units" where people die will frequently not reflect where they lived (and what they were exposed to) before they developed cancer.

This significant statement by Park et al of the Korean culture would serve to limit the potential benefit of ecological studies as no direct exposure relationship could easily be determined for individuals without extensive retrospective follow-up.

2003: Ha\textsuperscript{51} et al compares the cancer incidence of groups exposed to low power versus high power RF fields. The control in this instance (50 kW and less) are the exposures we are (in the U.S. and Europe) interested in. The authors do call for an individual study (case control or nested case control study) to further analyze the association between exposure and cancer.

2007: Ha\textsuperscript{52} et al analyzed cancer incidence from AM broadcast towers in adults and children living in Korea (those living within 1.2 miles). Tower transmitted power was between 100 to 500 kW. The initial studies (2003) reported one area with a significant increase in leukemia and another area showing a significant increase in brain tumor as compared to the control areas. However, when all 10 areas were analyzed together there was no overall increase in leukemia or brain tumor incidence. Collectively, the overall cancer mortality was significantly higher and this is similar to the results of Park and the possible complication of Korean culture.

On a follow up study by Ha of children and leukemia, the group first found a correlation with all types of leukemia. However, when re-analyzed with predicted field strength instead of distance, no association found (OR = 0.83).

2004. Wolf et al\textsuperscript{53}. People (n=622) living in proximity to a mobile phone cell site in Netanya, Isreal (began operation in July 1996) and attending a cancer clinic were compared with control populations registering in a neighboring clinic in Netanya as well as the entire population cancer rate in Netanya. Eight cases in the experimental area were diagnosed during the study period between July 1997-June 1998 - all different types of cancer (ovarian, breast lung, hodgkins, Osteoid osteoma, and hypernephroma). The authors report a statistically significant association between residential proximity to the mobile phone base station site and cancer incidence. The problems with this study are numerous. First, the cancers identified were of multiple types. The cellular base station


was in operation for only a year prior to the start of the study meaning that the cancer latency period was less than 2 years, no adult cancers have a latency that short. The controls were not adequately matched nor was there adequate control for confounding variables. Cellular base stations are located throughout cities, were other radiofrequency exposures addressed and adequately controlled?

- 2004. Eger et al\textsuperscript{54}. Residential proximity to mobile phone base stations was correlated with total cancer incidence. The authors report that preliminary data (1000 individuals) suggests a correlation between general cancer onset and incidence and time living near a mobile phone base station tower. A radius of 400 meters was chosen as the cut-off for the high exposed group with an average distance to buildings within this circle of 266 meters. The average distance to buildings outside the circle was 1076 meters (low exposed group). The transmitter site used for the study has had one antenna operating since September 1993 at 32 watts per channel at a frequency of ~935 MHz (GSM signal), and in 1997 an additional transmitter was installed on the tower by another operator. Exposure was calculated assuming free space characteristics. The authors report that for the period of 1999 to 2004, a correlation between high exposure and general cancer incidence was observed (OR = 3.38; 95% CI = 1.39 - 8.25). Absolutely zero measurements were made for this study so no other sources of RF exposure were taken into consideration. Without measurements, relying solely on calculations, particularly in a city, greatly overestimates the actual exposure due to shielding, etc. The author's table 7 shows the comparison of tumors found (11 different cancer endpoints) to the expected number for a given population. With the exception of breast cancer, all results were equal to or less than expected. Further, when one reviews the trends over time, the overall cancer incidence rate remains unchanged. Finally, only rudimentary consideration for adequately matching of controls.

- 2008: Merzenich\textsuperscript{55} et al conducted a case control study of electromagnetic fields and childhood leukemia in West Germany. Total towers were 16 AM and 8 FM transmitters. Cases were ages 0 to 14 diagnosed between 1984 and 2003. The analysis included 1,959 cases and 5,848 controls. Considering total RF-EMF, the OR for all types of leukemia was 0.86 (0.67-1.11). The OR for all types of leukemia was 1.04 (0.65, 1.67) among children living within 2 km of a transmitter compared with those living at a distance.

- 2010: Elliott et al\textsuperscript{56} conducted a case control study of mother’s exposure to radiofrequency from proximity to mobile phone base stations during pregnancy. 1397 cases and 5588 controls in Great Britain. Outcome measures included cancers of the brain and central nervous system, leukemia, lymphomas (non Hodgkins) and all cancers combined. There was no association between risk of early childhood cancers and estimates of the mother’s exposure to mobile phone base stations during pregnancy. In this study distance was used as a surrogate for exposure and as the exposure would vary greatly within a fixed distance. Distance is a poor indicator of actual exposure.


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• 2012: Li et al. Population based case control study in Taiwan considered child ages 15 years or less admitted from 2003 to 2007 for all neoplasms (including leukemia and brain neoplasm cases). Annual summarized power for each of 71,185 mobile phone base stations in service from 1988 to 2007 then computed the annual power density per mobile phone base station per township. A slightly elevated but not statistically significant risk was observed for leukemia and brain neoplasms (RR = 1.13, RR = 1.23).

• 2014: Hauri et al. A time to event analysis including children under age 16 living in Switzerland in year 2000. Follow-up lasted until 2008. RF exposure from broadcast transmitters was modeled. Based on 997 cancer cases, adjusted hazard ratios were 1.03 (95% CI: 0.75, 1.43) for all cancers, 0.55 (95% CI: 0.26, 1.19), and 1.68 (95% CI: 0.98, 2.91) for childhood central nervous system tumors. Results of the incidence density analysis based on 4,246 cancers were similar for all types of cancer and leukemia but did not indicate a CNS tumor risk (incidence rate ratio 1.03 (95% CI: 0.73, 1.46). This large census based cohort study did not suggest an association between predicted RF exposure from broadcasting and childhood leukemia. The results for CNS tumors were less consistent but did not suggest an association.

A second analysis by the same group was an incidence density cohort analysis with 4,246 cancer cases obtained from the Swiss Childhood Cancer Registry from 1998 to 2008. The analysis showed a somewhat higher risk for CNS-tumors for the time period 1985-1995 with a Hazard ratio (HR) of 1.6 (95% CI 0.98-2.61). However, for the later period of 1996-2008 the CNS-tumors showed a reduced risk of 0.75 (95% CI 0.45-1.23). The HR over the entire time period was 1.03, indicating no effect.

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