DRAFT - INCOMPLETE

Electromagnetic Tables:

Studies of Chemical and Physical Effects

Aligned with Power Density & V/m

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Note:

Many studies are dated and most are super short – hours, days, months – not the years of exposure existing for many in 2020. Brief exposure reduces the chance of finding an effect.

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SEARCH: To search the document, usually you can hold the "CTRL" and "F" keys, and a search function will pop up. Enter your search term into the box.

Band No.	Metric Subdivision	Wavelength	Frequency Range	**Frequency Bands**		Common Names and Uses	Notes
-1	Gigametric		0.03-0.3 Hz	**ELF**	Extremely Low		
0	Hectomegametric		0.3-3 Hz			WIND TURBINES	
1	Decamegametric	100-10 Mm	3-30 Hz			**DIRTY ELECTRICITY**	
2	Megametric	10 Mm-1 Mm	30-300 Hz			Radio (30 Hz – 3 GHz) Electricity (50/60 Hz)	
3	Hectokilometric	1 Mm-100 km	300-3,000 Hz	ULF	Ultra Low		
4	Myriametric	100 km-10 km	3-30 kHz	VLF	Very Low	**DIRTY ELECTRICITY SPANS**	
5	Kilometric	10 km-1 km	30-300 kHz	LF	Low		
6	Hectometric	1 km-100 m	300-3,000 kHz	MF	Medium		
7	Decametric	100 m-10 m (building)	3-30 MHz	HF	High	Shortwave Radio	
8	Metric	10 m-1 m (adults)	30-300 MHz	VHF	Very High	Television	
9	Decimetric	1 m-1 dm (children)	300-3,000 MHz	UHF	Ultra High	Television (up to about 1 GHz) Cell Phones (about 800/900 MHz) Radar (1-40 GHz) Radio (up to 3 GHz)	**Legal Cellphone SAR**: 1.6 W/kg or *for appendages* like ears 4 W/kg averaged over 10 g (USA)
10	Centimetric	1 dm-1 cm (honeybee)	3-30 GHz	SHF	Ultra High	**Cell or Cordless Phones** (2.4-8 GHz) **Radar** (up to 40 GHz) **Microwaves** (3-300 GHz) **Wi-Fi** (2.4-5.875 GHz) Satellite TV (usually 4-8 GHz or 12-18 GHz)	
11	**Millimetric**	1 cm-1 mm	**30-300 GHz**	EHF	**Extremely High**		
12	Decimillimetric	1 mm- 100 µm	300-3,000	FIR	Far Infrared		

			GHz				
13	Centimillimetric	100-10 µm	3-30 THz	MIR	Mid Infrared		
14	Micrometric	10-1 µm	30-300 THz	NIR	Near Infrared		
15	Decimicrometric	1 µm-100 nm (10 µm is about size of human cells)	300-3,000 THz	NUV	Near Ultraviolet		
		100-10 nm		EUV	Extreme Ultraviolet		
	Nanometric	10-1 nm	>30 PHz-30 EHz	SX	Soft X-rays		
		1 nm-100 pm (atomic)		HX	Hard X-rays	Medical X-rays	
	Picometric	≤10 pm	≥30 EHz	Y	Gamma Rays		

Letter Symbols	Radar (GHz)	Space Radio Communications
L	1-2	1.5 GHz band
S	2-4	2.5 GHz band
C	4-8	4/6 GHz band
X	8-12	-----
Ku	12-18	11/14 GHz band 12/14 GHz band
K[1]	18-27	20 GHz band
Ka[1]	27-40	30 GHz band
V	-----	40 GHz band

Sources for the frequency chart information:

http://www.itu.int/dms_pubrec/itu-r/rec/v/R-REC-V.431-7-200005-I!!PDF-E.pdf

http://mynasadata.larc.nasa.gov/science-processes/electromagnetic-diagram/

http://www.hdtvprimer.com/ANTENNAS/TVfrequencies.html

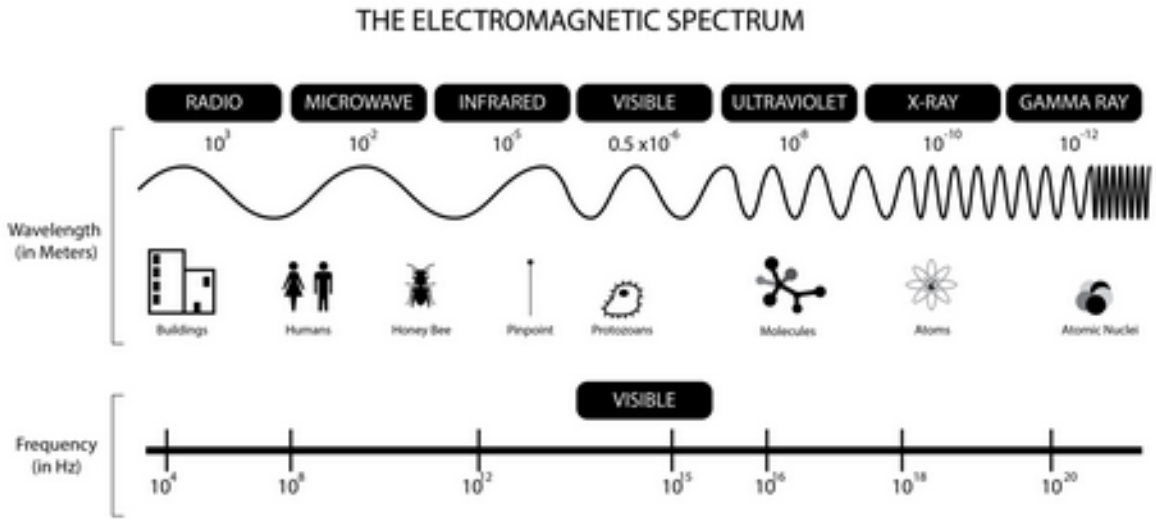
http://www.csgnetwork.com/tvfreqtable.html

https://en.wikipedia.org/wiki/Satellite_television The International Telecommunications Union

http://www.aewa.org/Library/rf_bands.html

Keys (incomplete)

- * Common ambient exposure in urban/residential areas from wireless, cell towers, use of electricity, common use of transformers, etc.
- ** Common exposure when *near* towers, routers, power lines, closely held Ipads/other electronic devices (Kindle, cell phone, etc.), heavy appliances, heavy use of electricity in a building, solar power inverters, etc.
- CAVEAT: An asterisk is only placed when known, but in some cases I don't know or it is not clear if the exposure is ambient (*) or near-exposure (**).



Epidemiological or Physical & Visible Effects of Electromagnetic Fields

Disease or Symptom	**Strength in µw/cm² (microwatts/ cm²) or as stated, transmitter distance, & reported frequencies**	**Supporting Epidemiological and Other Studies**
Electrical or magnetic sensitivity (EHS)	**1)** 60 Hz electric field of 300 V/m **2)** Self-reported EHS patients in Europe **3)** 100 MHz working at transmissions masts	**1)** Mcarty et al. 2012 *(EHS person was exposed to ELF (Extreme Low Frequency) Subject lacked knowledge of EMF in double blind study, but field transitions (off-on, on-off) caused muscle twitching, headache, temporal pain, and skipped heartbeats. The objective tests were done using EEG, MRI, heartbeat measurement, blood test and other physical methods.)* **2)** Hallberg & Oberfeld, 2006 *(Electrosensitivity rising from 0.06% of the total population in 1985 to 9-11% 2004-2005)* **3)** Schilling, 2000 *(Lassitude and malaise c. 1995 in 6 men, ongoing in 4 of the 6)* *4)*
Reproductive Troubles	**1)** More than 20 hours weekly in front of a VDT computer terminal. **2)** Use of radio- and microwave diathermy units by 42,403 physical therapists in 1989 **3)** 0.168 or 1.053 (antenna park)* **4)** 0.1-10; 0.168 or 1.053 µw/cm² (cell tower)* **5)** .327-1.022 V/m at 900 and 1800MHz* **6)** 0.1 V/m increments at 900 and 1800MHz * **7)** effects observed from 3-7 days exposure to 0.3 V/m or higher from EMF sources including: GSM 900/1800 MHz mobile phone, 1880-1900 MHz DECT wireless base, DECT wireless handset, mobile phone-DECT handset combination, 2.44 GHz wireless	****1)** Goldhaber, 1988 (100% increase in miscarriages)** ****2)** Oullet-Hellstrom, 1993 *("Pregnancies of mothers reporting microwave use 6 months prior to the pregnancy or during the first trimester were more likely to result in miscarriage (odds ratio (OR) = 1.28, 95% confidence interval (Cl) 1.02–1 59) The odds ratio increased with increasing level of exposure (x2 = 7 25, p < 0.005). The odds ratio in the highest exposure group (20 or more exposures/ month) was 1.59")* ***3)** Magras, 1997*(Mice newborn decreases & irreversible infertility fifth or third generation)*** ****4)** Balmori, 2005 *(40% of storks haven't chicks, frequent death of young)** ***5)** Everaert, J. and Bauwens, D., 2007 *(House sparrows decline as compared to lower ranges of 0.006 to 0.036 V/m)**

	network (Wi-Fi), 2.44 GHz blue tooth, 92.8 MHz FM generator, 27.15 MHz baby monitor, 900 MHz CW RF generator and microwave oven's 2.44 GHz RF and magnetic field components* **8)** EMF exposure – not defined **9)** ELF magnetic fields *on a typical day*; 913 pregnant woman	***6)** Balmori & Hallberg, 2007 *(Logarithmic decline of house sparrow at R=-0.87)* ****7)** Margaritas et al., 2014 *(Statistically significant effects on Drosophila reproductivity even at very low intensity)* **8)** Glaser, 1972[††] *(Down's Syndrome)* ****9)** Di-Kun Li et a 2017 [*Three-fold increase in miscarriage if exposed to higher magnetic fields (2.5 mG or higher)]*
Prenatal Impacts	**1)** 110 mothers of 3-7 year olds with speech trouble vs. 75 healthy kids; Cordless phone use or proximity to power lines (ionizing radiation did not correlate) **2)** 88,884 mother-child pairs from 5 countries sorted in to none, low, medium, high cell phone use by mothers; questionnaire on child behavior **3)** Median daily ELF magnetic field exposure	****1)** Zarei et al 2019 *(Speech problems correlated to mother's cordless phone use and power line proximity)* ****2)** Birks et al 2017 *(High prenatal cell phone use linked to hyperactivity/inattention problems in child, vs. no prenatal use linked to low risk for any behavioral problems in child)* ****3)** De-Kun Li et al 2011 *(Every 1-mG increase of magnetic field level during pregnancy associated with 15% increased rate of asthma in offspring; 3.5-fold increased rate of asthma for children whose mothers had high MF exposures, while children whose mothers had a medium MF level had a 74% increased rate of asthma)*
Cardiac & Abnormal Blood Pressure	**1)** "below thermal" **2)** non-ionizing radiation* **3)** 0.002 Shortwave **4)** Low-frequency *acoustic* noise -not electromagnetic but may have relation **5)** Radio & TV broadcast workers exposed to UHF-VHF radio frequency **6)** 5+ years microwave exposure in centimeter range (SHF) chronic exposure **7)** Below 1 mW/cm² and up to several mW/cm². **8)** 10 mW/m² work exposure **10)** **a.** microwaves, **b.** microwaves at 30-3,000 µw/cm² **c.** nonthermal 40-200 MHz **d.** High exposure over 200 mW/cm² and low	**1)** Adams & Williams, 1976[††] *(bradycardia, hypotension, EKG changes, etc.)* ***2)** Glaser, 1972[††] *(bradycardia, etc.)* **3)** Altpeter 1995, 1997 *(abnormal blood pressure)* **4)** Nuno et. al, 2002 *(chest pain)* ****5)** Bortkiewicz et. al, 2012 *(Higher heart rate in exposed groups)* ***6)** Glotova & Sadchikova, 1970 *(Of 105 exposed workers: "Some exhibit for only mild asthenic symptoms with sinus bradycardia and arterial hypotension with no signs of general or regional hemodynamic disturbances. Other develop autonomic-vascular dysfunction, often with symptoms of hypothalamic insufficiency and angiospasm which sometimes impair the cerebral and coronal circulation.")* **7)** Cleary, 1970 *(Review of numerous Soviet studies found disturbances including hypotension, dystonia (muscle*

	10-200 mW/cm² *[Multiple by 1000 for μW/cm²]* **e.** Increase in two groups exposed to microwaves of periodic high or chronic low intensities	*contractions leading to repetitive movements), vagotonic reactions)* **8)** Simonenko, 1998 *(chest pain & difficulty breathing)* **10)** NASA, 1981†† *(**a.** bradycardia, hypotension, pain in heart region in Dwyer;* ***b.** bradycardia, hypertension, cardiac pain, hypotension, systolic murmur in Sadicikova; **c.** cardiovascular changes in Kalyada;* ***d.** Complaints of bradycardia, 1.63% (high), 3.93% (low), 0.42 (none), in Lerner* ***e.** bradycardia, arterial hypotension, arterial hypertension, cardiac pain, dullness of heart sounds, systolic murmur, in Stuchly)*
Stroke, Abnormal Blood	**1)** Red blood cells 2.45 GHz (WiFi) exposure at densities from 25-10,0000 μW/cm² **2)** Red blood cell suspensions in vitro exposure to 902 MHz cell phone (2W output) 0, 10, 20, 30, 40, 50, 60 minutes.*	**1)** Savopol, Moraru, Dinu, Kovacs, 1995 *(Hemoglobin decreased in exposed erythrocytes but red blood cell count the same, indicating "membrane permeabilization")* ****2)** Kouzmanova, Atanasova, Atansoc, Mincheva-Tasheva, 2007 (*Hemoglobin plays an important role in maintaining shape of cells: irradiated suspensions had a decreased hemoglobin level)*
Amyotrophic lateral sclerosis (ALS), also known as Lou Gehrig's or Charcot disease. *(Muscle twitching, stiff muscles, gradual muscle wasting, and eventually loss speech, swallowing, life)*	**1)** comparing increasing ELF-MF exposure in Swedish engineering industry workers in 532,692 men and 180,529 women **2)** high levels of ELF-MF exposure **3)** comparison of low, medium, high ELF magnetic field exposure and electrical shocks in 2.2 million workers.	****1)** Håkansson, Gustavsson, Johansen, Floderus, 2003 *(With increasing exposure, odds of getting ALS increase)* ****2)** Zhou, Chen, Chen, Yu, Xu, 2012 *[Significant association of ALS found in meta-analysis of case-control studies that defined exposure by job title and defined ALS by clinical diagnosis (rather than by death certificate)]* ****3)** Huss et. al, 2015 *(Death from ALS significantly associated with medium- to high- long-term ELF magnetic field exposure)*
	Related: ALS is associated with protein denaturation (such as amyloid), apoptic cell death, DNA fragmentation, cellular changes (Golgi swelling and fragmentations), aneuploïdy (wrong no. of chromosomes), alterations in CA^{2+} homeostatis, and changes in voltage-gated calcium channel performance. These all are also caused by electromagnetic exposures.	

Weakness, Malaise, & Fatigue	**1)** 0.002 shortwave **2)** 0.1-0.11 (GSM and DCS bands)* **3)** 0.05-0.1 (cellular signals)* **4)** 2 at 0-500 Hz **5)** 100 MHz working at transmissions masts **6) a.** 750 KHz-200 MHz worker exposure **b.** radio frequency **c.** 30-3,000 µw/cm² **d.** to 1 mW/cm² **e.** Increase in two groups exposed to microwaves of periodic high or chronic at low intensities **7)** Initial level >2mG, which was reduced to less than 2 mG.	**1)** Alterpeter 1995, 1997 ****2)** Navarro, 2003**** ***3)** Kundi, 2009**** ****4)** Simonenko, 1998**** **5)** Schilling, 2000 *(Lassitude and malaise c. 1995 in 6 men, ongoing in 4 of the 6)* **6)** NASA, 1981†† ***a.** Weakness in 7% at ≤6 years to 12.3% at 7-16 years; fatigue in 12.3% ≤6 years to 17.8% in 7-16 years in Dwyer* ***b.** Tiredness and sleepiness in Dwyer* ***c.** Fatigue and sleepiness in Sadicikova* ***d.** Fatigue, drowsiness in Zalyubovskaya & Kiselev* ***e.** Tiredness in 46% (high) to 58% (low) contrasting with control at 6%, with sleepiness at 11% (high) and 8% (low) vs. 2% for control—percentages approximated from graph (Stuchly).* ****7)** Maisch, Podd, & Rapley, 2002 *(Improvement in sleep patterns and CFS symptoms with reduced magnetic field exposures from problematic sleep)***
Sleep Problems	**1)** 0.0076 µw/cm² at 900 MHz * **2)** 0.01-0.05 µw/cm² GSM * **3)** 0.05-0.01 µw/cm² (cellular signals) * **4) a.** radiofrequency **b.** 750 KHz-200 Mhz **5)** 0.1-0.11 µw/cm² (GSM and DCS bands) *	***1)** Buchner & Eger, 2011** ***2)** Hutter, 2006** ***3)** Kundi, 2009** **4)** NASA, 1981†† *(**a.** Dwyer, **b.** Dwyer)* ****5)** Navarro, 2003****
Impaired motor function or reaction time	**1)** radiofrequency **2)** 0.0076 µw/cm² at 900 MHz band * **3)** 0.3 µw/cm² **at** 900 or 1900 MHz * **4)** 0.1-10 µw/cm²; 0.168 or 1.053 µw/cm²; or .8 V/m – 3.2 V/m (cell tower signals)*[in schools, workplaces, by wireless wearables/devices]**	†† **1)** NASA, 1981†† *(Dwyer)* ***2)** Buchner & Eger, 2011** ***3)** Kolodynski & Kolodynska, 1996 (children)**** ****4)** Balmori, 2005 (Sticks fell to the ground when building nests, couples didn't advance the construction of the nest, and most affected nests were never built.)****

Dizziness or Vertigo	**5)** 2 μw/cm² at 0-500 Hz **6)** low-frequency noise – NOT actually an electromagnetic frequency, but some correlations possible?	****5)** Simonenko, 1998**** **6)** Nuno et. al, 2002 *(57% of 140 suffered dizziness or vertigo)*
Headache	**1)** 0.002 μw/cm² shortwave* **2)** 0.005-0.04 μw/cm² GSM* **3)** 0.01-0.05 μw/cm² GSM* **4)** 0.05-0.01 μw/cm² (cellular signals)* **5)** 0.1-0.11 μw/cm² (GSM and DCS bands)* **6)** 2 μw/cm² at 0-500 Hz **7) a.** radiofrequency **b.**microwave workers **c.** ≤1 mW/cm2 **d.** 2-1000 kHz at 3-5 V/m* **e.** 5-50 MHz **f.** 750 KHz-200 MHz **g.** microwave workers **8)** 100 MHz working at transmission mast.	**1)** Alterpeter 1995, 1997 **2)** Thomas, 2008* ***3)** Hutter, 2006* ***4)** Kundi, 2009 * ****5)** Navarro, 2003**** ****6)** Simonenko, 1998**** **7)** NASA, 1981†† *(**a.** Dwyer, **b.** periodic or constant in Dwyer, **c.** Zalyubovskaya & Kiselev, **d.** Katorgina, Semenova, et. Al, **e.** Alberti, **f.** 20% with ≤6 years and 32.9% with 7-16 years of work in Dwyer, **g.** Steady increases in repair workers of c. 28% to 60% from year one versus year ten in Tyler)* **8)** Schilling, 2000 *(Circa 1995 in 6 men, ongoing in 4 of the 6)*
Tingling, dysaesthesiae, or parasthesiae *or* loss of sensation.	**1)** Prolonged use of mobile phone **2)** Low-frequency acoustic noise – not electromagnetic but some correlations possible from kinetic effect? **3)** 100 Mhz exposed working on transmission masts (VHF)	****1)** Hocking & Westerman, 2000 *(Permanent unilateral dysaesthesiae of scalp, slight loss of sensation, abnormalities of cervical and trigeminal nerves with current perception threshold testing)**** **2)** Nuno et. al, 2002 *(Auditory-induced facial dyskinesia occurred in 4 patients, 37-44 years old)* **3)** Schilling, 2000 *(Parasthesiae c. 1995 in 6 men, ongoing in 4 of the 6)*
Learning (children) or memory & concentration (adults) troubles	**1)** 10^{-16}-10^{-13} W/cm² at 0.1-960 Mhz* **2)** 0.0076 μw/cm² at 900 MHz* **3)** 0.002 μw/cm² shortwave **4)** 0.005-0.04 μw/cm² mobile frequency **5)** 0.05-0.01 μw/cm² (cellular signals)*	***1)** NASA, 1981†† *(inability to concentrate in Bise, USA)* * ***2)** Buchner & Eger, 2011* ***3)** Alterpeter, 1995, 1997 *(Fewer children promoted)** ***4)** Thomas, 2008* ***5)** Kundi, 2009*

	6) 0.1-0.11 μw/cm² (GSM and DCS bands) **7)** 0.1-24[†] μw/cm² at 2.5-4.0 GHz, exposures over one year to a decade, with few exposed above 2 and fewer to 5 μw/cm²* **8)** 0.3 μw/cm² by radio tower* **9)** 1 V/m* **10)** 10 μw/cm² **11)** 916 MHz, 10 W/m² mobile phone electromagnetic field 6 h/day, 5 days a week.	**6)** Navarro, 2003** **7)** Liakouris, 1998** **8)** Kolodynski & Kolodynska, 1996 *(children)* **9)** Netherlands Ministries of Economic Affairs, Housing, Spatial Planning and the Environment, and Health, Welfare, and Sport, 2003 *(cognition and wellbeing impacted)*** **10)** Chiang et. al, 1989 *(Impaired short-term memory and visual reaction time in people living near transmitters)*** **11)** Hao, Yang, Chen, Tian, & Wu, 2012 *(Exposed rats showed irregular firing patterns in hippocampal neurons during experiment and decreased spiking activity 6-9 weeks compared with after 2-5 weeks. Long-term effects influence learning and memory)*
Memory loss	**1)** 0.1-24[†] μw/cm² at 2.5-4.0 GHz **2)** 0.3 μw/cm² radio tower **3)** 1.5 μw/cm² at 900 Mhz **4)** 2000 μw/cm² (1 hour) at 2.45 Mhz **5) a**. radiofrequency **b.** 30-30,000 μw/cm² **c.** to 1 mw/cm2 **d.** 10^{-16}-10^{-13} W/cm² at 0.1-960 Mhz** **6)** low-frequency noise – not electromagnetic but some correlations through kinetic effect?	**1)** Liakouris, 1998** **2)** Kolodynski & Kolodynska, 1996 *(children)*** **3)** Nittby, 2007 *(rats, significant impairment)*** **4)** Wang & Lai, 2000 *(rats, spatial)* **5)** NASA, 1981[††] ***a.*** *Dwyer, 1978* ***b.*** *Sadicikova* ***c.*** *Zalyubovskaya & Kiselev* ***d.*** *Bise, US*** **6)** Nuno, 2002
Alzheimer's Disease (AD) & Dementia	**2)** comparing increasing ELF-MF exposure in Swedish engineering industry workers in 532,692 men and 180,529 women **4)** ELF electromagnetic fields **1)** medium- and high-level exposure to ELF magnetic fields **3)** 50-60 Hz ELF magnetic field work exposure of 3050 Mexican Americans, aged 65+ **4)** Comparison for living within 50 m of a	**2)** Håkansson, Gustavsson, Johansen, Floderus, 2003 *(With increasing exposure, odds of getting AD increase)* **4)** García, Sisternas, & Hoyos, 2008 *(Meta-analysis of case-control and cohort studies showed moderate to high risk of AD from work exposure)* **1)** Andel et. al, 2010 *(Higher odds of dementia)* **3)** Davanipour, Tseng, Lee, Markides, Sobel, 2014 *(In subjects aged 75+, exposure increased risk of severe cognitive dysfunction significantly, and from 65+ when smoking)*

	220-380 kV power line vs. 600 m distant from 2000-2005 in 4.7 million persons from Swiss National Cohort database **5)** Hypothesis – ELF exposures medium to high	****4)** Huss et al 2009 *[Increased risk of death from neurodegenerative disease (senile dementia); years of residence had a dose response – 5 years 1.51 hazard ratio]* ****5)** Sobel et al 1996 *(Hypothesis: Previous research indicates medium-to-high exposure is likely to result in Alzheimer's Disease, hypothesis that EMFs increase amyloid beta pathogenesis)*
Neuropsychiatric Symptoms, Mental Illness & Behavioral	**1)** 0.002 µw/cm² Shortwave **2)** "non-thermal" EMF RF **3)** "leakage microwave" "low energy" 2.45 GHz **4)** low-frequency *acoustic* noise – not electromagnetic frequency but perhaps some correlation via kinetic effect? **5)** magnetic stimulation **6)** Radiofrequency – review of numerous studies	**1)** Alterpeter 1995, 1997 *(Nervousness, 280% more psychosis)* **2)** Grigoriev, Merkulov, & Lukyanova, 2012†† † *(Neurosis)* **3)** Sinha, 2008 *(Emotional reactiveness alters in animals)* **4)** Branco et. al, 2004 *(Increasing isolation)* **5)** Young, Camprodon, Hauser, Pascual-Leone, & Saxe, 2010 *(Reduced role of beliefs in moral judgments)* **8)** Pall 2016 *(Neuropsychiatric effects associated include obsessive compulsivity, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, psychoticism, irritability, sleeping disturbance, concentration troubles, tension, moodiness, total apathy, loss of empathy.)* NASA, 1981†† *Hypochondria, unsociable, fear*
Depression &, if noted, Suicide	**1)** 0.1-24† µw/cm² at 2.5-4.0 GHz **2)** Line of sight to power line EMFs **3)** low-frequency *acoustic* noise– not electromagnetic frequency but perhaps some correlation? **4)** Power lines **5)** Cumulative and increased magnetic field exposure	***1)** Liakouris, 1998† * ****2)** Poole et. al, 1993 *(2.8 times more)*** **3)** Nuno et. al, 2002; Branco et. al, 2004 ****4)** Reichmanis et. al, 1979 *(>Suicide)*** **5)** Perry et. al, 1989; van Wijngaarden et. al, 2000 *(>Suicide)*** NASA, 1981††
Irritability, Aggression	**1)** 0.002 µw/cm² Shortwave **2)** >0.01 through 10 µw/cm² at 900 or 1800 MHz **3)** 2 µw/cm² at 0-500 Hz **4)** low-frequency *acoustic* noise– not	**1** Alterpeter 1995, 1997 ****2)** Balmori, 2005 *(Storks frequently fought)*** **3)** Simonenko, 1998** **4)** Nuno et. al, 2002; Branco et. al, 2004 *(Irritability & aggression)*

	electromagnetic frequency but perhaps some correlation?	**5)** NASA, 1981[††]
Rheumatoid Arthritis, Fibromylagia,	**1.** pulsed 200 microT magnetic field (2000 mG)	**1.** Thomas, White, Drost, Cook, & Prato, 2001 *(Romberg Quotient (reduced balance) higher in fibromyalgia and rheumatoid arthritis patients with eyes closed in contrast to healthy control group)*
Endocrine (Thyroid, Adrenal)	**1)** Decimeter or UHF waves (microwaves) **2)** Bitemporal ultra-high frequency (UHF) electrical field and decimeter waves **3)** Leakage from microwave (2.45 Ghz) **4)** Below 1 mW/cm^2 (1000 $\mu W/cm^2$) and up to several mW/cm^2.	**1)** Pershin, 1989 *(UHF on thymus decreased glucocorticoid activity of adrenal cortex, simultaneously with pronounced immunostimulating effect, while UHF of adrenal glands increased immunosuppression simultaneously with enhanced glucocorticoid activity of adrenal cortex).* **2)** Sidorov, V.D., 1992 *(Activated hypothalamic-hypophyseal-thymic axis—"response achieved in RA seronegative variant with concomitant synovitis.")* ****3)** Sinha, 2008 *(Rats hyperactive and aggressive on 16th and 21st days, correlating with decreased T3 blood levels on 16th day and increased T4 on 21st day)* ****4)** Cleary, 1970 *(Increased thyroid gland activity and sometimes enlargement most commonly reported—adrenal changes reported.)*
Allergy & Skin Problems	**1)** Radiowaves sent from transmitter placed on the abdomen to implanted neurostimulator receiver **2)** 0.0076 $\mu w/cm^2$ in 900 Mhz band **3)** 0.1-24[†] at 2.5-4 Ghz **4)** Low-frequency noise – not electromagnetic but some correlation possible? **5)** Computer screen exposure **6)** Low-frequency *acoustic* noise – not electromagnetic but some correlation possible?	****1)** Strobos, 2001 *(dermatitis cleared between radiowave sessions)*** ***2)** Buchner & Eger, 2011 (*allergy*)* */****3)** Liakouris, 1998[†] (*allergic skin*)* */****3)** Elwood, 2012[†] (*psoriasis*)* **4)** Castro et. al, 1999 *(Elevation of skin and respiratory infections)* ****5)** Johannsson, Hilliges, Bjornhagen, & Hall, 1994 *(screen dermatitis with edema, pain, erhythema, itch)*** **6)** Nuno et. al, 2002 *[Stage II (4-10 years) Fungal, viral, parasitic skin infections; allergies]*
Also see for skin problems: histamine, bacteria, liver		

Epilepsy or Seizures	**1)** Low-frequency noise – not electromagnetic effect but some correlation possible? **2)** 2 hours 900 MHz at mobile phone intensity **3)** Television **4)** Videogame screens **5)** Flash at 3 Hz **6)** 900, 700, 500, 300, and 100 MHz for 20 hours, 12 hours and 2 hours. **7)** 30, 60, 90 minutes 900-950 MHz for 30 days **8)** Control and epileptic persons 30 minutes exposure to mobile phone and post-exposure extra 15 minutes with EEG recording	**1)** Nuno et. al, 2002 *(epilepsy occurs with advanced exposure)* ****2)** Lopez-Martin et. al, 2006 *(susceptible rats convulsed when irradiated—nonirradiated did not)* **3)** Harding, 2010 *(Peak sensitivity for photosensitive epilepsy between 16-20 flashes, or for 49% at 50 flashes)** **4)** Bureau, 2004 *(Recommend greater than 2 meters distance and "less provocative" 100 Hz screens)** **5)** Harding, 2005 (*Flash may be hazardous if transition to or from saturated red, or if 3 Hz, 10% of visual field, etc.*) ****6)** Cinar et al 2013 *(acute exposure to various frequencies for all tested time frames shortened time of epileptic seizure onset, appeared to facilitate seizures in susceptible and non-susceptible mice)* ****7)** Kouchaki et al 2016 *[chronic, rather than acute exposure, lowered threshold for (i.e. increased) tonic and clonic seizures]* *8) Azmy R eat al. 2020 (No changes in control. Epileptic persons with abnormal EEG (33%) showed increase in events, 1 going from interictal to ictal rhythm, & another with normal EEG developed temporal epileptiform.)*
	Also related to epilepsy: Calcium (the ion CA^{+2}), Nitric Oxide	
Digestive Troubles, Indigestion	**1)** 0.002 μw/cm² Shortwave **2)** 0.1-24† μw/cm² at 2.5 to 4 GHz **3)** 2 μw/cm² at 0-500 Hz **4)** 100 Mhz exposed working on transmission masts (VHF) **5)** Low-frequency *acoustic* noise – not electromagnetic but some correlation?	**1)** Alterpeter 1995, 1997 */****2)** Elwood, 2012† (*protozoal intestinal disease*)* ****3)** Simonenko, 1998**** **4)** Schilling, 2000 *(Diarrhea c. 1995 in 6 men, ongoing in 4 of the 6)* **5)** Nuno et. al, 2002 *(Stage III (> 10 yrs.) duodenal ulcers, spastic colitis)*
Diabetes or Promotion of Diabetes	**1)** 100-3300 μw/cm² tested at frequencies of 1-150 Mhz, 300-800 Mhz, & 3-30 Ghz—time not known **2)** 100-330 μw/cm² at 2.45 Ghz; 1 hour daily 21 days	**1)** NASA, 1981†† (*elevation of fasting blood glucose by Klimova-Deutschova*) **2)** Salah, 2013 *("diabetic-like status")*

Bone Growth or Loss	**1)** PEMF 15 Hz, 0.6 mT 15 days [a very strong field] **2)** PEMFs (pulsed electromagnetic fields) **3)** 0, 400, or 2800 pulses at 400 kV/m PEMFs **4)** WiFi (2.45 GHz) at SAR 9 mW/kg; 2h/day WiFi in pregnancy (21 days) and lactation (21 days). On 7^{th}, 14^{th}, 21^{st} days after birth, 8 male offspring were decapitated and jaws examined. **5)** 2 hours at 900 MHz (cellphone frequency) averaging at center of cage 0.0252 mW/cm² for 10 months *(cellphone exposure)* **6)** 2.45 GHz 2 h per day during gestation (21 days) and up to 21 after birth at SAR: 9 mW/kg *(levels below cellphone SAR limits)*	**1)** Diniz, 2002 *(Increase in nitric oxide synthesis which mediated proliferation and differentiation of osteoblasts, cells which make bone)* **2)** Ongaro, 2014 *(PEMFs induced osteogenic differentiation, by increasing ALP activity, osteocalcin, and matrix mineralization in human mesenchymal stem cells obtained from bone marrow and adipose tissue)* **3)** Li et. al, 2014 *(Alkaline phosphatase growth curve did not stop at 400 pulses, but decreased after 2800 pulses, suppressing proliferation, differentiation, and mineralization of MC3T3-E1 cells)* ***4)** Zülfikar et al 2015 *(Composition of teeth altered from exposure: iron and strontium concentrations rose in WiFi group, while boron, copper, zinc fell suggesting imbalance in oxidative stress condition of teeth)* ****5)** Adiguzel et al 2008 *[Significantly race elements of magnesium dropped and zinc rose in rat's teeth (note this influences oral health as for example seen in Meisel et al 2005)* ****6)** Ciftci et al 2013 *(Significantly trace elements of strontium and iron rose and boron, copper, and zinc decreased in rat teeth]*
Benign & Malignant Tumors	**1)** 0.1-24† µw/cm² 2.5-4.0 GHz **2)** 900 hours of cell phone use **3)** 900/1800 Mhz wireless phones	†*/****1)** Liakouris, 1998† ****2)** Coureau et. al, 2014 *(>odds ratio (2.89, 2.57) for glioma & meningioma-study left out cordless phones in calculations thus odds may be higher)*** ****3)** Hardell & Carlberg, 2014 (*3-fold, or 400%, increase for deadly glioma with 25 years use, & even greater risk if beginning before age of 20; using 3G mobile phone with a latency period of >5-10 years; with use on one side only; and with 100 h cumulative use for all phone types)***
Leukemia, some overlap with other cancers	**1)** Distance of 2 km vs. 20 km from AM radio transmitters with ≥20 kW **2)** 0.1-24† µw/cm² (2.5-4.0 GHz) **3)** 0.2-8 µw/cm² television towers	***1)** Ha et. al., 2007 *(Risks of 2.15: 1.0 for children inside 2 km. with 1928 leukemia patients and 3082 controls)** */****2)** Liakouris, 1998† *(leukemia)** ****3)** Dolk, 1997 *(200%)***

	4) 1.3-5.7 μw/cm² on television and FM radio transmitter **5)** 3.5 km from radio tower **6)** 60 Hz "excess electrical configurations" with high current use **7)** a. 10 years, or b. 1 year, ≥2000 G/S exposure at school workplace; units are high frequency voltage surges between 2-100 KHz, one unit is 24 volts per second and all from electrical lines in building **8)** Prenatal and childhood exposure to high voltage powerlines with minimal other electric exposures **9)** Inside of 50 m (vs. >400 m) of a lower voltage line or in a home with >3 mG **10)** Ten sites with AM radio towers at ≥100 kW (one site 250 kW, one 500 kW) vs. control areas at least 2 km away without a radio tower. **11)** Meta-analysis of magnetic field exposures based on over 11,000 leukemias and over 13,000 controls.	****4)** Hocking, 2003 *(200% more leukemia; decreased survival)* ** ***5)** Michelozzi, Ancona,Fusco, Forastiere, & Perucci, 1998 *(>leukemia)** */****6)** NASA, 1981†† *(childhood, Wertheimer & Leeper)**/** ***7)** Milham & Morgan, 2008 *(**a.** accumulating 700% greater cancer risk, including leukemia **b.** 21% greater)*** ****8)** Tabrizi & Bidgoli, 2015 *(Powerline exposure greatest risk factor)*** ****9)** Marcillo et. al, 2011 *(increased risk from lower voltage lines, and of mortality in homes with high magnetic fields)*** ****10)** Park, Ha, & Im, 2004 *(Increased mortality risk of leukemia, brain, and total cancer with increasing power, highest among young 15-29 years with MRR = 2.44, secondly among 0-14 years with MRR =2.29)*** ****11)** Zhao, 2014 *(≥0.4 uT or 4 mG increased leukemia risk)*
Mixed Cancers and Tumors (melanoma, Non-Hodgkins Lymphoma, as promoter of other cancer-causing agents, etc.)	**1)** Removal of UV (sunlight) exposure **2)** a. 10 years, or b. 1 year, ≥2000 G/S exposure at school workplace; units are high frequency voltage surges between 2-100 KHz, one unit is 24 volts per second **3)** Sprague-Dawley rats formaldehyde exposure with exposed to 50 Hz 1 mT (10,000 mG) exposure from 6 weeks of age until death (max 104 weeks). **4)** Sprague-Dawley rats ionizing radiation exposure and from 19th day until death 19 hours daily 2 groups exposedto 50 Hz at 20 uT (200 mG) or 1000 uT **5)** Meta-analysis of populations exposed to low frequency magnetic fields	**1)** Mitra et. al, 2012 *(Absent sunlight, mice developed melanoma. Red hair/freckle gene found to increase melanoma development—absence of pheomelanin synthesis in albinos was found protective)* **2)** Milham & Morgan, 2008 *(**a.** accumulating 700% greater cancer risk, including melanoma, **b.** 21% greater)*** **3)** Soffriti et al, 2016 *(>malignant tumors, thyroid C-cell carcinomas, lymphomas/leukemias)* **4)** Soffriti et al, 2016 *(>mammary adenocarcinomas, atypical precursor cells, and in males >malignant schwannomas of the heart, lymphomas/leukemias)* **5)** Zhang et al, 2016 (>cancer risk found in North America, especially USA, and from appliances or residential exposures)

	---Frequency modulation (FM) broadcasting towers. **6)** Frequency modulation (FM) broadcasting towers **7)** **8)** Mobile or cordless phone use comparison of 1498 patients and 3530 controls. **9)** >10 V/m or >40 V/m at 60 Hz **10)** Traffic radar work exposure **11)** 0.3-0.5 μw/cm² at distance of 350 meter radius from 850 MHz from 10 meter 1500 Watt tower **12)** <10 mW/cm² VHF **13)** Military radar workers	**--** Hallberg & Johansson, 2002 *(Melanoma incidence correlated with the number of FM transmitters)* **6)** Hallberg, Johannsson, & Eger, 2014 *(Continuing exponential melanoma increase in correlation with increasing FM radiation near 100 MHz—strongly indicates causality of melanoma from signals resonant with length of the body)* **7)** **8)** Hardell & Carlberg, 2015 [*Survey of patients with brain cancer aged 20-80 and 18-75. Mobile phone use increased risk of glioma, esp. in temporal lobe: OR= 1.3, increasing to OR= 3.0 at >25 years. Cordless phone use risk increased OR= 1.4 and in the 15-20 year group OR- 1.7 Ipsilateral use yielded OR 1.8 (mobile) or 1.7 (cordless). Use before age 20 gave higher OR for glioma than other groups.]*** **9)** Villeneuve et. al, 2000 *(study included only electrical workers and noted Non-Hodgkins Lymphoma odds ratios increased to 3.05 and 3.57 respectively above 10 and 40 V/m)*** **10)** Finkelstein, 1998 *(Increased incidence of testicular cancer and melanoma in police officers, who "might absorb energy from radar units.")* **11)** Wolf & Wolf, 2004 *(women 10,000% more)* **12)** NASA, 1981†† *(promotion of cancer referencing Holt, Australia)* **13)** Richter et. al, 2002 *(Brain cancer within 10 years of initial occupational exposure, in 5 young patients, four less than 30 years of age at diagnosis)*
Limb or Joint Pain	**1)** 0.002 shortwave	**1)** Alterpeter 1995, 1997
Nosebleeds, hemorrhoids, blood in urine	**1)** Low-frequency *acoustic* noise– not electromagnetic frequency but perhaps some correlation?	**1)** Nuno et. al, 2002 *[Stage II (4-10 years) Inflammation of stomach lining, pain and blood in urine; Stage III (> 10 yrs.) Haemorrhages of nasal, digestive, and conjunctive*

		mucosa (small nose bleeds), varicose veins and hemorrhoids]
Light or Noise Sensitivity; Hearing loss	**1)** low-frequency *acoustic* noise– not electromagnetic frequency but perhaps some correlation – reports of lots of nosebleeds? 2) Avg. electrical exposure 21-38 KV/m for impacted workers	**1)** Branco, Pimenta, Ferreira, & Alves-Pereira, 2002 *(At 4 years, individuals with vibroacoustic disease (VAD) note discomfort with noises, possibly due to cilia fusion or findings of wilted, sheared, shaggy cilia that could not remain upright)* **2)** Zhao J, Sun J, Jia Z, Diao M, Liu Y, Tian F 2013 *(Impaired hair cells for hearing and sensation correlated with electromagnetic exposure and length of service, daily exposure time)*
Eye problems	**1)** 0.1-24[†] µw/cm² 2.5-4 GHz **2)** 1-2 hours of exposure to down-powered mobile transmitter at 150-600 **3)** Eye lens exposed to near continuous (50 min. each hour) microwave radiation (1.1 GHz) at a either 89-220 µW/cm² for up to 15 days	**1)** Elwood, 2012[†] *(frequent refractive errors-impacts focusing ability)** **2)** Hocking 2001 *(unilateral left blurred vision and pupil constriction, abnormalities of current perception thresholds on testing left trigeminal ophthalmic nerve)* **3)** Dovrat et al. 2005 *(Significant macro-degeneration (deteriorated focusing ability) and micro-degeneration (formation of microscopic bubbles within the lens) evident after 48 hours and progressing to its saturation level after 6-8 days. Macro-degeneration was reversible within days after radiation ceased, but micro-degeneration (within 15-day period of study) remained. Effects were also evident at less than half the intensity (.89 vs. 2.2 mW/cm2) only with the period needed to reach specified stages of degeneration doubled. In addition, pulsed radiation caused 4.7 times more damage)* Nasa

Other Effects or Symptoms Based on Laboratory Studies - Mixed

Effects or Symptom	**Strength in microwatts/cm2 or as defined, Transmitter**	**Supporting Epidemiological Studies with (list one) and without (list two) Power or Distance Measurements**

	Distance, &Frequencies	
Anti-biotic Resistant Bacteria; Bacteria Population Changes; Activation of Dormant Viruses	**1)** 50 Hz EMF (magnetic field) **2)** 1 mT, 50 Hz sine waves, applied 24-72 hours (magnetic field) **3)** WiFi router used and cells exposed 24 and 48 hours **4)** Non-thermal exposure in soil around cell towers **5)** Review **6)** Millimeter waves (60-70 Ghz) and wine **7)** *Klebsiella pneumonia* irradiated with WiFi (2.45 Ghz) for 3, 4.5, and 8 hours	**1)** Grimaldi, Pasquali, Barbartano, Lisi, Santoro, Serafino, Pozzi, 1997 *(Activated latent Epstein-Barr virus genome, showing DNA can be modulated by magnetic field.)* **2)** Pica, Serafino, Divizia, Donia, Fraschetti, Sinibaldi-Salimei, Giganti, Volpi, 2006 *(Kaposi's sarcoma-associated herpes virus DNA found higher in exposed cells at 72 hours, but not earlier—viral progeny consisted of many viral defects).* **3)** Said-Salman, Jebaii FA, Yusef HH, Mousafa ME, 2019 (*Increased antibiotic resistance, motility, and ability to form biofilm of Escherichia coli*) **4)** Adebayo, Adeeyo, Omomowo 2014 *(Statistical analysis indicates RF increases antibiotic resistance and reduces nitrogen-producing bacteria in the soil – loss of nitrogen in the soil can be predicted to reduce fertility)* **5)** Torgomyan & Trchounian 2012 *(Low power EMF is used in telecommunications and as bactericide in medical and food industries – may have impacts on cell membrane, water, and genome, increase chemical activity, alter transport and energy, sensitivity to chemicals)* **6)** Seo DH, Kim MS, Park CS, et al. 2016 *(Lactic acid bacteria and yeasts changed, increasing alcohol content of wine)* **7)** Taheri M, Mortazavi SM, Moradi M, et al. 2015 *(Initial antibiotic sensitivity falls 8 hours after exposure to wifi)*
Electrical or magnetic sensitivity (ES or EMS)	**1)** Self-reported EHS patients **2)**153 ES vs. 132 control Italians tested for 12 blood redox parameters and gene polymorphisms **3)** Self-reported EHS patients: 727 evaluated of 839 cases in published 2015 study, with a mean age of 47 and 521 with EHS, 52 with MCS, and 154 with EHS and MCS (multiple chemical sensitivities).	**1)** Dhamen, 2009 *(Laboratory signs of thyroid dysfunction, liver dysfunction, chronic inflammation seen in EHS, especially females. Thyroid TSH results were below 0.3 mU/L (6.1% vs. 0.9%). Elevated ALT (ALT ≥ 35 U/L) 20.9% (P¼0.045) and elevated AST (AST ≥35 U/L) in 12.4% (P¼0.042) of individuals with EHS.)* **2)** De Luca C et al, 2014 *[9.7-fold increased risk of electromagnetic sensitivity if genetic haplotype (null) GSTT1 + (null) GSTM1 variants. Proinflammatory alterations Ided in sensitivity including increased plasma coenzyme-Q_{10} ratio.]* **3)** Belpomme, D., Campagnac, C, & Irrigaray, P., 2015 (*Findings of EHS patients indicate risk of chronic neurodegenerative disease and a mechanistic link with multiple chemical sensitivity—in 70%-80% histamine, protein S100B, and/or nitrotyrosin were altered, and in the*

		remaining abnormal findings from brain pulsed ultrasound computed tomosphygmography indicated EHS. Findings include: ** Women are at higher risk: two thirds were EHS patients & three fourths were EHS-MCS patients* ** With reference to melatonin, all patients show decreased 24 h urine 6-hydroxymelatonin sulfate (6-OHMS)/creatinin ratio (<0.8, suggesting reduced anti-oxidant defenses, risk of chronic disease, and sleep disturbance)* **Using pulsed cerebral ultrasound computed tomosphygmography, both EHS and MCS disorders were associated with hypoperfusion in the capsulothalamic area, suggesting that the inflammatory process involve the limbic system and the thalamus.* ** 40% hyper histaminic: histaminemia.* ** 33% of patients have increased Hsp27 and/or Hsp70—which is important to body systems for regulation of cell development, cell death, sending messages, and cell protection.* ** 28% of patients show increase of nitrotyrosin, a marker of both peroxynitrite and blood barrier opening.* ** 15% of patients show increase in protein S100B (marker of the opening of the brain blood barrier)* ** In 23%, proteins against O-myelin circulate in the blood, suggesting EHS is associated with autoimmunity.)* ** 22% (EHS) and 24.7% (EHS-MCS) show increase of IgE levels which appears separate from histamine* ** 23% (EHS) and 33%% (EHS-MCS) show severe deficiency in vitamin D.* **14.7% and 14.3% show increase in hs-CRP levels indicating systemic inflammation, for which no other cause could be found, and which is considered a biomarker of Alzheimer's Disease and dementia.*
Computer Sensitivity	**1)** 1 kHz frequency and 150 V/m and 220 V/m intensity for 30 and 60 minutes (LCD monitors) **2)** More than 20 hours weekly in front of a VDT computer	****1)** Buczyńska et al 2015 *(Decrease in antioxidant defense, worse with greater intensity and length, and increase in oxidation even at just 30 minutes)* *****2)** Goldhaber, 1988 *(Children had 40% more genetic defects than the "normal" average of the control group)***

	terminal.	
Elements of Reproductive Troubles	**1)** More than 20 hours weekly in front of a VDT computer terminal. **2)** 0.00034-0.07 μw/cm² ("cell phone radiation") **3)** 0.1-24† μw/cm² at 2.45 GHz, averaged at low levels **4)** effects observed from 3-7 days exposure to 0.3 V/m or higher from EMF sources including: GSM 900/1800 MHz mobile phone, 1880-1900 MHz DECT wireless base, DECT wireless handset, mobile phone-DECT handset combination, 2.44 GHz wireless network (Wi-Fi), 2.44 GHz blue tooth, 92.8 MHz FM generator, 27.15 MHz baby monitor, 900 MHz CW RF generator and microwave oven's 2.44 GHz RF and magnetic field components **5)** EMF exposure on abdomen of rats for 15 min/day for 15 days	****1)** Goldhaber, 1988 (Children had 40% more genetic defects than the "normal" average of the control group)** **2)** Sage & Carpenter, 2012 *(Sperm damage)** **3)** Liakouris, 1998† [*43 workers examined in 1967 (37 exposed and 7 not exposed) finding 20 of the 37 were above range for chromosomal abnormalities. In 1969, a follow-up indicated chromosomal changes warranting reproductive cessation]** **4)** Margaritas et al., 2014 *(Statistically significant effects on cell death (apoptosis) of ovarian follicles during oogenesis even at very low intensity)* **5)** Bakacak et. al, 2015 *(Significant decrease in ovarian follicles of exposed rats—reduced by less than half the amount compared to control)***
Prenatal Exposure	**1)** 2.45 GHz WiFi signal 2h/day; 10 Wistar albino pregnant rats divided into 2 groups.	**1)** Othman et al 2017 *(Prenatal WiFi impaired offspring neurodevelopment, cerebral stress equilibrium, and cholinesterase activity)*
Cardiac & Abnormal Blood, Stroke, Raynaud's	**1)** 4 and 7 mG at 150 and 155 kHz via a primary coil, ferrite ring, and secondary coil	**1)** Shuvy et. al, 2014 (In rats with reduced kidney function, promotes severe aortic root calcification, with unique pattern of circular rings)** **2)** Havas, 2010 – not peer reviewed *(Healthy baseline, but after*

Syndrome	similar to a transformer. **2)** Live blood analysis - exposure 10 min.s on cordless phone and 70 min.s on computer **3)** Humans fasted 5+ hours & from cell phones 4+ hours then 45 min.s carrying & 45 min.s using cell phones. **4 + 5)** *None – just effects of RBC coagulation.*	*computer or cell phone use, red blood cell coagulation including rouleax formations – like long stacks of coins. Notes coagulation reduces oxygen levels, waste removal, circulation, and increases headaches, numbness, cold extremities)* **3)** Weston Price Foundation Funded Study – Authors request anonymity, not peer-reviewed, summary by B. Rubik, 2011 *(Blood in fingers & toes showed gross RBC coagulation & rouleaux formations from carrying or using cell phones – see ensuing citations from study relevant to stroke & Raynaud's)* **4)** McHedlishvili, Varazashvili, Gobejishvili, 2002 (Microscopic video reveals RBC aggregation in individual capillaries slows blood flow & can bring to full stop in microvessels, grow from influx of new cells, interfering with capillary blood flow. RBC can move gradually to larger veins, accelerating at arrival) **5)** Reinhart, Chien, 1986 *[Deformed RBC could impair passage through microcirculation (stick together - filter poorly) and larger vessels (viscosity)]*
Stroke Risk (Aggregation of Blood)	**1)** 24 μW/cm² at 650-800 MHz occupational exposure divided into exposure groups ranging from 5 to over 25 years, the 5 year group having highest daily exposure at up to 6 hours daily.	**1)** Khamidova, 2014 ***(****Blood hyperaggregation increases, while hypoaggregation and normoaggregation decrease with exposure at work, creating a "sludge" which interferes with bodily functions: "The heart generates electrical oscillations with frequencies from 30 to 700Hz and the brain from 200 to 500Hz. If the frequency of bio-currents coincides with the frequency of the EMF, the bio-currents are distorted, which leads to disruption of normal functioning of the body. Microcirculatory disorders and hyperactivity of platelets further exacerbate this situation")***
Allergy & Skin Problems (Bacteria, histamine, IgE increase)	**1)** "mobile phone use" **2)** microwave frequencies (Dwyer); up to 1 mW/cm² (Zalyubovskaya & Kiselev)	**1)** Kimata, 2002, 2003, 2005, 2003 (*increased IgE, allergic skin wheal responses*)** **2)** NASA, 1981†† (*histamine increase in Dwyer, 1978; decrease in bactericidal action of skin and oral cavity in Zalyubovskaya & Kiselev*)
	Also see histamine, bacteria, liver	
Liver, Gall Bladder	**1. a)** single exposure at 80 mW/cm² for 30 minutes at 2.45 GHz, continuous wave	**1.** Lange, D'Antuono, Timm, Ishii, &Fujimoto, 1993 ***(A)*** *Reversible increased bile flow rate and decreased permeability of rat canalicular membrane to sucrose, resulting in recovery of sugar in bile;* ***B)***

	1. b) 4 exposures as above.	*Irreversibly decreased bile flow rate and decreased membrane permeability).*
Behavior Modification	**1)** 10 V/m <30 Hz	**1)** Adey, 1979 *(Behavior modification: "if the animal is trained in the presence of a radiofrequency signal modulated at the frequency of the particular brain signature [EEG], the number of correct responses goes much higher, to over 90% . . . [and]. . . the animal keeps on performing at a level significantly above chance for almost two months in the absence of any punishment").*
Mechanisms for Action & Confounders	**1)** 27, 35 GHz; pulses 100 & 600 ns, peak power 20 kW)	**1)** Gapeeva et al 2007 *(High peak-power radiation of high frequency excited acoustic waves in objects containing water and muscular tissue)* **2)** Blank, Goodman 2005 *(Since weak fields accelerate electron transfer reactions, weak fields could stimulate transcription by interacting with electrons in DNA to destabilize the hydrogen bond holding DNA strands together)* **3)** Pall M 2013 *(Some cell membranes open with voltage changes. Of these, voltage-gated calcium channels are influenced by non-thermal radiofrequencies to open or close. The downstream effect can include therapeutic stimulation of the nitric oxide-cGMP-protein kinase G pathway or pathogenic stimulation of the nitric oxide-peroxynitrite-oxidative stress pathway, leading to DNA breaks)* **4)** Goodman, Blank 2002 *"Biological studies with in vitro model systems have focused, in general, on the nature of the signal transduction pathways involved in response to EM fields. It is likely, however, that EM fields also interact directly with electrons in DNA to stimulate biosynthesis."* **5)** Bawin, Adey 1976 *Discusses how weak fields may cause neuronal excitation, referencing windows of action. The "Adey window" which describes conditions for physiological effects from a very weak electromagnetic signal; as microwaves pulsed in an exact frequency released calcium ions from the nerve cells. Release of calcium ions from nerve cells occurred in a microwave field modulated as 16 Hz. The microwave alone (unmodulated) had no such effect – pulsed and amplitude modulation is biologically important.* **6)** Halgamuge et al, 2009 *Discusses different models for interactions with biological effects at low power levels and low frequencies, noting many epidemiological studies show associations with different cancers*

		from extremely weak, low-frequency magnetic fields. For example, the hydrogen nuclear polarization model provides a mechanism for biological effects from the combination of a static magnetic field, an oscillating magnetic fields above one milligauss (0.1 microtesla), and frequencies beginning at a few hundred hertz. The Ion Parametric Resonance model provides a mechanism for effects from the combination of specific resonant frequencies, a static magnetic field, and oscillating magnetic fields of about 100 milligauss (10 microtesla) when the earth's magnetic field serves as the static field. *Both of these models suggest that oscillating magnetic fields stimulate the biological effects, in addition to electromagnetic frequencies.* **6)** Blackman et al 1985 *Dr. Robert Becker in Cross Currents wrote: n 1985, Dr. Carl Blackman of the EPA and Dr. Abraham Liboff of Oakland University, working independently, . . . concluded that the strength of the local steady-state magnetic field of the Earth at the site of each of the laboratories was the hidden variable that determined the different frequencies reported. Both . . . suggested that the mechanism involved was a specific type of resonance, cyclotron resonance. . . . When they applied the mathematical equations for cyclotron resonance to the different frequencies reported by the different laboratories, along with the respective strengths of the local magnetic fields they found the same result. The Ca++ efflux was the result of cyclotron resonance between the frequency of the applied electric field and the strength of the Earth's local magnetic field at each separate laboratory.* **7) From Dr. Livio Guiliani CHE-EMF email communication on 4/19/2020** *X ray is ionizing in empty space while electromagnetic fields under 10^15 Hz are not.* ***But in condensed matter it is another tale.*** *Ionization depends on the interaction of the electromagnetic fields with the structure of the matter. Liquid water shows a peculiar condition: it is a biphase liquid, partially coherent. The effect is the ionization (mediated by water) of a neutral molecule as Glutamic Acid, in aqueous solution at PH 3 and room conditions, shown in the experiment of Mikhail Zhadi (Biofizik 1994), replicated with Frank S. Barnes, Viktor V Novikov and Pergola at University of Colorado (Bioelectrom. 1998). As Abe Liboff observed some years ago (2015) the effect has been observed in many labs by now. . .*

		Furthermore there is a solid theory supporting the Zhadin effect . . . : it is developed in the frame of QED (Preparata G. QED Coherence in Matter. Chapt. 3. World Scientific London - New Jersey 1995; Del Giudice et al. On the 'unreasonable' effects of.ELF magnetic fields upon a system of ions. Bioelectromagnetics 2002 Oct 23(7) PMID: 12224056; Zhadin MN, Giiliani L. Some problems in modern bioelectromagnetics. Electrom Biol Med 2006 25(4)). The peculiar structure of water had an indipendent experimental confirmation in 2009 (Huang C et al.. The inhomogeneous structure of water at ambient conditions. PNAS September 8, 2009 106 (36) 15214-15218; https://doi.org/10.1073/pnas.0904743106), in Dec 2010 (Deprotonation of glutamic acid induced by weak magnetic fields : an FTIR-ATR study. Bioelectromagnetics 2011 32(3)), in 2013 (Taschin A et al. Evidence of two distinct local structures of water from ambient to super cooled conditions. Nature Communications 2013 4, 2401). Also experiments of Gerard Pollack, from Washington University support a biphase character of liquid water, even if his theoretical basics are not all shareable. . . . the definition of ionizing radiation used only for FUV, X and Gamma rays is erroneous if it is not joint to the words "in empty space". Moreover the definition of NIR related to electromagnetic fields (< 10^15 Hz) is misleading. *7)* Portelli et al, 2013 *Ambient static and time-varying fields in incubators are large and can differ by a factor of a hundred or more between incubators. This could be a confounder in cell culture studies (not mentioned but may have an impact on pre-natal infants).*

Chemical or Hidden Physical Findings

Disease or Symptom	**Strength in microwatts/cm2 or as defined, Transmitter Distance, &Frequencies**	**Supporting Epidemiological Studies with (list one) and without (list two) Power or Distance Measurements**

Abnormal EEG *Continuing research indicates that initially an excitatory reaction occurs, which eventually reverses and can eventually lead to a "flat" EEG.*	**1)** 0.000000001 μw/cm² at 0.1 to 960 MHz and 8.5 to 9.6 GHz pulse-modulated waves, with effects produced between 130 and 960 MHz **2)** Healthy males exposed to 900 MHz 30 min.s while awake **3)** GSM mobile phone at distance 40 cm **4)** GSM mobile phone **5) 0.15 mW/cm-2** at 450 MHz **6)** 880-890 MHz at 10 W **7)** weak DC magnetic field (GSM) 7) 0.3 mW/cm² average at 915 MHz 10 minutes (1 min. on & off) 3 times a day for 5 days **8)** 900/1800 MHz at 80 meters from cell towers **9)** 900 MHz pulsed-EMF irradiation 6 h/day **10)** 916 MHz, 10 W/m² mobile phone electromagnetic field 6 h/day, 5 days a week.	*__1)__ Bise, 1978 *(Altered EEG in human subjects)** **2)** Huber et. al, 2000 (*>spectral power in non-rapid eye movement, with max> in 9.75-11.25 Hz and 12.5-13.25 Hz in initial sleep*) **3)** Mann & Röschke, 1996 (*Suppression of REM phases*)** **4)** Kramarenko & Tan, 2003 (*Slow-wave activity (2.5-6.0 Hz or, in kids, 1.0-2.5 Hz, in contralateral frontal and temporal areas after 20-40 mins., increased median frequency decreased and disappeared after 15-20 min.s. In children, higher amplitude occurred earlier.)*** **5)** Bachman et. al, 2005 *(increasing EEG variability)* **6)** Barcal et. al, 2004 (*shift to lower frequency components, hippocampal activity changes to higher frequencies, theta rhythmicity changes*) **7)** Dobson et. al, 2000 **8)** Vorobyov et. al, 2010 *(>beta wave₂ activity (17.8-30.5 Hz) in cortical and hypothalamic EEG; cumulative effect)* **9)** Oberfeld, 2005 *[blind trials show EEG significantly altered in alpha 1 (8-10 Hz), alpha 2 (10-12 Hz), and beta (13-20 Hz) in sensitive individuals]*** **10)** Razavinasab, Moazzami, & Shabani, 2014 *(Babies of exposed mother rats showed decrease in neuronal excitability, decrease in action potentials fired in spontaneous activity, increase in amplitude of afterhyperpolarization (AHP), with significantly altered learning acquisition and memory retention compared to controls.)* **11)** Hao, Yang, Chen, Tian, & Wu, 2012 *(Exposed rats showed irregular firing patterns in hippocampal neurons during experiment and decreased spiking activity 6-9 weeks compared with after 2-5 weeks. Long-term effects are not obvious, but have influences on learning and memory)* *http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2869.2012.01025.x/abstract* *http://onlinelibrary.wiley.com/doi/10.1002/bem.20010/abstract* *http://www.kirj.ee/public/Engineering/2008/issue_2/eng-2008-2-124-137.pdf*
Abnormal EKG	**1)** 60 Hz magnetic fields **2)** Below 1 mW/cm² and up to	**1)** Sastre et. al, 2000 *(Reduced power in low band of HRV frequency; decreased mean heart rate)*

The excitatory to flattening pattern applies to the EKG as well.	several mW/cm². **3)** Workers exposed to UHF-VHF radio frequency **5)** Below 1 mW/cm² and up to several mW/cm². **6)** **a.** SHF from 1 to several mW/cm²; UHF <1 mW/cm2; short-wave HF 10s-100s V/m; medium-wave HF 100s-1000 V/m **b.** High exposure over 200 mW/cm² and low 10-200 mW/cm² **c.** Increase in two groups exposed to microwaves of periodic high or chronic low intensities	**2)** Adams & Williams, 1976[††] *(EKG changes)* **3)** Bortkiewicz et. al, 2012 *(Higher heart rate characterized by dominance of sympathetic system, with significantly higher VLF and LF values)* **5)** Cleary, 1970 *(EKGs reporting bradycardia, arrhythmia, and esp. sinus arrhythmias; depressed intracardial conduction (esp. intraventricular) & lowered EKG waves, esp. T-waves)* **6)** NASA, 1981[††] *(**a.** 3% bradycardia cases, 14% arterial hypotonia, 2% with QRS interval in ECG increased to 0.1 sec (reduced ventricular conductivity)—the latter excepting short- & medium wave HF in Presman* ***b.** Bradycardia with abnormal cardiac ST waves: 11.8 (high), 11.2 (low), 5.6 (none) in Lerner* ***c.** ECG bradycardia, ECG lowering of deflections T I and T*
Changes in Mineral Access: Calcium, (& CA^{2+}) Zinc, Magnesium	**1)** 700-1100 MHz, SAR 0.5-5W/kg **2)** 500 uT ELF-MF 2h/day 10 months	**1)** Rao et. al, 2008 *[>Ca^{++} spikes to 15.7 (P<0.05) based on frequency, not power] (** possibly)* **2)** Ulku et. al, 2010 *(statistically significant <Ca, <Zn, & <Mg in rats; would impact bone metabolism and chemical structure)* **3)** Ghazizadeh & Naziroglu, 2014 *(Wi-Fi exposure induced CA(2+) influx and oxidative stress-induced hippocampal & DRG death through activation of TRPV1 channels with epilepsy)*
Proteins Break up into: Nitric oxide (further below) Blocking calcium (move up to section above)	**1)** EM Pulses less than lifetime of Ca^{2+} bound to CaM **2)** 30 min. pulsed electric field **3)** 750 and 300 MHz: *21 dbm [100 milliwatts=.1 V/m] and *27 dBm [500 mW=.5 V/m] *24 dBm [251 mW=.251 V/m]	**1)** Pilla et. al, 2011 *(Pulses were configured to modulate calmodulin-dependent signaling, and found to increase NO & cGMP in neuronal cultures—calmodulain antagonists and downstream blockers annihilated these effects—strongly supports Ca/CaM/NO as EMF pathway useful beyond wound or tissue repair)* **2)** Fitzsimmons et. al, 2008 *(Increased DNA content of chondrocyte monolayer 150% at 72 h poststimulus, increased NO and cGMP during exposure. Adding calcium increased NO, while inhibitor W7, blocking calcium/calmodulin, prevented PEF increase in NO and cGMP.)* **3)** Daniells et. al, 1998 *(Protein damage in nematodes: "greater*

Protein damage		*response at 21 than at 27 dBm, although extremely variable responses were observed at 24 dBm and 750 MHz")***
Brain Damage or Alterations to Brain Structures, Cells, Dendrites, Proteins, etc. *(Also see Brain Membrane)*	**a)** Co-exposure of H_2O_2 (hydrogen peroxide) and 50 Hz at 1 mT (10,000 mG) on human neuroblastoma cell line for 1-26 hours **b)** Co-exposure of human neuroblastoma cells to Parkinson's toxin MPP^+ with exposures 24 hours of 50 Hz at 1 mT (10,000 mG) and 0.5 mV/m **c)** 50 Hz, 100 uT (1000 mG), 2 hrs/day for 3 months, Wistar albino rats, with stimulation of 400 Hz **----** **1)** 900 MHz, SAR 1.15 with peak power of 146.6 microwatts for 1 h/day for 28 days **2)** 2 hours of exposure to GSM mobile phone electromagnetic fields of different strengths **3)** A real GSM programmable mobile phone in 900 MHz band, with 2-hour exposure at 0.12, 1.2, 12, 120 mW/kg or sham exposures. **4)** 10 mW/cm^2 at 2.45 GHz for 7 hours daily for 5 consecutive days exposure of one- and six-day old rats. **5)** 12.45 exposures 24h/day for 12 mo.s; 16 Wistar rats divided	**a)** Reale et al, 2014 *(oxidative stress could impact human neuroblastoma cells)* **b)** Benassi et al, 2016 *(>toxicity of **Parkinson's** toxin MPP^+ and >ROS. apoptic cells, and carbonyl proteins, while antioxidans acetylcystine and glutathione reduced ROS and apoptosis)* **c)** Komaki et al, 2014 *(>excitatory postsynaptic potential slope and the compound action potential; conclude synaptic plasticity altered in the hippocampus)* **---** **1)** Narayanan, SN, Kumar, RS, Karun, KM, Nayak, SB, & Bhat, PB, 2015 *(In addition to **cognitive difficulties**, viable cell count in dorsal hippocampal CA3 region & dendritic arborization pattern of apical and basal dendritic trees impacted by RF-EMR in prepubescent rats).* **2)** Salford, Brun, Eberhardt, Malmgren, & Persson, 2003 *(Highly significant evidence of neuronal damage in the cortext, hippocampus, and basal ganglia in exposed rats).*** ***3)*** Eberhardt, Persson, Brun, Salford, & Malmgren, 2008 *(Blood-brain barrier increasingly permeable, or broken, as seen by enhanced uptake of albumin after 14 days exposure, which was not seen after a 28 day recovery period. However, signs of damage, occurrence of dark neurons, remained after 28 days and were significantly related to uptake of albumin.)*** **4)** Albert & Sherif, 1988 *(Significant cerebellum morphological changes: number of pydnotic cells nearly twice controls & Nissle bodies in Purkinje cells finely dispersed. Some exposed showed mononuclear cellular infiltration. Pyknotic cells presented: electron dense nuclei with clumped chromatin, extrusion or disintegration of the nucleus, ruptured nuclear membrane, and the vacuolization of the cytoplasm. These cells became phagocytosed by surrounding EGL cells. Most Purkinje cells showed small, disorganized rough endoplasmic reticulum (RER) instead of order, parallel arrays. This suggests microwaves may interfere with cellular microneurons and metabolic status of Purkinje cells.)* **5)** Dasdag S et al 2015 *(Exposure altered expression of some miRNAs,*

	into 2 groups (sham, exposed) **6)** 900 MHz, SAR 8.47 x 10(-5) W/kg ("low level") for 30 days; 12 Fischer rats divided in 2 groups **7)** 900, 1800, 2450 MHz; SARs 0.59, 0.58, 0.66 mW/kg; 24 male Fisher rats divided into 4 groups; exposed 2h/day, 5 days/week for 60 days; sacrificed for hippocampus **8)** Male Wistar rats 2 groups 6 each; 2100 MHz 4/h day, 5 days/week for 3 months **9)** Control vs. male rats exposed to 3 & 60 Hz 2 h/day exposure for 4 days separated with a 2-day interval and again.	*with mir 107 expression 3.3 times lower and miR106b-5p expression 3.65 times lower – may lead to neurodegenerative disease)* **6)** Deshmukh PS et al 2013 *(Significant cognitive impairment evidenced by increased MDA levels (marker of lipid peroxidation) and protein carbonyl (marker of protein oxidation) and unaltered GSH content in blood.* **7)** Megha K et al 2015 *(Compared to sham, significant increase in oxidative stress markers viz. Malondialdehyde (MDA), protein carbonyl (PCO), and catalase (CAT); levels of reduced glutathione (GSH) and superoxide dismutase (SOD) decreased in exposed group; significant increase in levels of pro-inflammatory cytokines (IL-2, IL06, TNF-α, and IFN-γ); DNA damage)* **8)** Sharma A et al 2019 *(Significant changes in cholinesterase activity, muscular strength, learning ability and **anxiety**, oxidative defense; hippocampus degeneration – impacts on nervous system **may lead to many severe illnesses**)* **9)** Rostami et al 2016 *(A significant reduction in firing rate of locus coeruleus (LC) was found after 2 hours of both 3 Hz and 60 Hz exposures. LC 'can influence the activity of many brain areas and modulate different basic behavioral and physiological processes, such as sleep, waking, and arousal.' Locomotor activity decreased. Proteome analysis also revealed global changes in whole brain proteome after treatment: 'one should consider that proteins widely define the functions of an organism, so any change in proteome caused by EMFs can alter the cell or organism's behavior.' Stated that LC and proteome effects may vary. Cites other studies stating depressant effects may be caused by brain changes as well, such as a study noting an increase in opioid receptors.*
Brain Glucose Uptake *[Increased: diabetes & neurodegeneration ; reduced: w/ neurodegeneration]*	**1)** Transient and steady-state magnetic fields **2)** Mice to 1950 MHz at 5 W/kg for 2h/day and 5 days/week 8 months of "5xFAD mice" **3)** Meaning of excess glucose uptake	**1)** Frilot et. al, 2011 *(Increased fluorodexyglucose uptake in rats' hindbrain)* **2)** Son Y et al 2018 *(Glucose metabolism in the hippocampus and amygdala regions of the brain of 5xFAD mice was significantly increased compared to sham-exposed)* **3)** Ashraf A 2014 *(Hypermetabolism found in mild cognitive impairment in 5 of 10; may be compensation for failure of neurons before deposits of amyloid in Alzheimer's)*

Myelin Damage	**1)** Low-intensity 2.45 GHz **2)** 3 GHz	**1)** Switzer et. al, 1977 *(myelin figures in cortical dendrites)* **2)** Baranski et. al, 1972 *(degeneration and glial cell proliferation)*
Brain Membrane Unusual Risk to Brain from Broken Blood-Brain Barrier (Allowing Inside Drugs, Viruses, & Toxins Normally Blocked)	**1)** 0.9 and 1.8 GHz continuous-wave (CW) for 20 min at SARs of 4.26 mW/kg and 1.46 mW/kg **2)** 1.8 GHz exposure "conforming to the GSM1800-standard used in mobile telephones" **3)** Transient and steady-state magnetic fields **4)** 2 hours of GSM-900 mobile phone **5)** Magnetic resonance imaging for 23 minutes	**1)** Sirav & Seyhan, 2011 *(A significant increase in albumin was found in male rat brains, showing blood-brain permeability in male rats as compared to sham-exposed rats. Female rats did not show albumin leakage into the brain.)*** **2)** Shirmacher et. al, 2000 *(1.8 GHz increased permeability of the blood-brain barrier in vitro, based on effects on co-culture of rat astrocytes and porcine brain capillary endothelial cells)*** **3)** Frilot et. al, 2011 *(Increased fluorodexyglucose uptake in rats' hindbrain)* **4)** Nittby et. al, 2009 *(Permeability in mammalian brain 7 days after exposure)*** **5)** Prato et. al, 1990 *(Permeability found increased in rats 1 hour after the last exposure)*
Melatonin	**1)** 300 m from German cell tower	**1)** Blanz et. al, 2007 *(84% nocturnal decrease or increase, 100% paradoxical daytime increase)*** **2)** Singh et al, 2015 *(<plasma melatonin in 12.5-18 GHz group, with greater than 10 years increasing effect)*
Serotonin	**1)** 300 m from German cell tower **2)** Military personnel 8-12 GHz or 12.5-18 GHz range exposure, either more or less than 10 years.	**1)** Blanz et. al, 2007 *(84% reduced daytime, 50% with decrease of 68%)*** **2)** Singh et al, 2015 *(Highly significant >plasma serotonin in 12.5-18 GHz group, with greater than 10 years increasing effect)*
Prolactin	**1)** Cell tower signal over 6 yrs.	**1)** Eskander et. al, 2011 *(significantly reduced ages 14-22, versus rose ages 25-60)**
Testosterone	**1)** Males with high EMF electrical power plant exposure and in some cases walkie talkie	**1)** Wang et al, 2016 *(<testosterone and testosterone/estradiol ratios, with increased impact from extended employment and/or mobile phone use)*

	use. 2) Cell tower signal over 6 yrs.	2) Eskander et. al, 2011 *(serum T significantly decreased)**
Cortisol	**1)** Cell tower signal over 6 yrs.	***1)** Eskander et. al, 2011 *(significant decrease)**
Protein denaturation and aggregation *Amyloid peptides and proteins* *Prion Diseases*	**1)** Review of diseases associated with protein aggregation & causes of aggregation. **2)** Wireless mobile communication frequencies (GSM) effects on human neuroblastoma cells; SAR = 0.23 W/kg; 10.51 V/m; Time: 3 times, 10 minutes, 2 days **3)** 1-5 GHz; Varying strength	**1)** Meredith 2005 *(Protein aggregation is prominent in many neurodegenerative or protein misfolding diseases: Alzheimer's, Huntington's, and Parkinson's, prion disorders, Creutzfeldt-Jacob, spongiform encephalopathies, systemic amyloidoses, ALS. Aggregates are believed from disrupted cell membranes & functions; inactivation of normal proteins, and binding or inactivating components)* **2)** Stefi et al 2019 *(Changes in monomeric α-syn accumulation and multimerization, as well as induction of oxidative stress and cell death require further investigation to check links into Parkinson's and Alzheimer's Diseases & indicate changes in APP processing and cellular topology)* **3)** Todorova et al 2020 *(Field frequency and strength each altered the shape of amyloid peptides for specific conformations)*
Thyroid & Thyroid Hormones	**1)** Cell tower signal over 6 yrs. **2)** Bitemporal ultra-high frequency (UHF) electrical field and decimeter waves **3)** In non-users, moderate users, and heavy mobile phone users (with lower levels) **4)** 2.45 GHz at 0, 1.5, 3.0, or 12.0 W power) for 4 groups of rats	***1)** Eskander et. al, 2011 *(significantly lower T3 & T4, & reduction in release)* * **2)** *Activated hypothalamic-hypophyseal-thymic axis—"response achieved in RA seronegative variant with concomitant synovitis."* (Sidorov, V.D., 1992) ****3)** Mortavazi et. al 2009 *(Levels of thyroid hormones were statistically significant (P<0.05)—increasing use showing low levels of mean T4 and normal T3 and a compensatory higher than normal TSH level. Levels of severe users were 1.18±0.30 ng/ml (T3); 7.76±1.14 µg/dl (T4), and 4.25±2.12 µu/l (TSH) vs. levels from non-users which were 1.15±0.27 ng/ml (T3); 8.42±2.72 µg/dl (T4), and 2.70±1.75 µu/l (TSH). Microwaves show deleterious effects on hypothalamic-pituitary-thyroid axis.)* ***4)** Misa-Agustiño et. al, 2015 *(Non-ionizing radiation sub-thermal radiation causes changes in the endothelial permeability and vascularization of thymus, and is a tissue-modulating agent for Hsp90 (decreased at 12 W) and glucocorticoid receptors, the latter of which showed greater immunemarking on thymic cortex in exposed animals. All but one exposed group recovered after 24 hours.)*

Work Exposure	**1)** ELF exposure in subjects working at 132 kV high-voltages substations	**1)** Tiwari, Lakshmi, Bhargava, & Ahuja, 2015 (ELF exposure with altered epinephrine concentrations, DNA damage, and significant oxidative stress)
Plasma ACTH *(relevant to energy)*	**1)** Cell tower signal over 6 yrs.	**1)** Eskander et. al, 2011 *(significantly reduced)**
Nitric Oxide (NO); Superoxide (SOD) *(NO relevant to seizures; both to chronic disease)*	**1)** 10 MHz pulse and 10 kHz at 5 V **2)** 900 MHz mobile phone **3)** PEMF (pulsed electromagnetic field) **4)** 900 MHz 1-7 minutes. **5)** 0.1 mT, 60 Hz **6)** Co-exposure of H_2O_2 (hydrogen peroxide) and 50 Hz at 1 mT (10,000 mG) on human neuroblastoma cell line for 1-26 hours	**1)** Miura et. al, 1993 *(>GMP & >NO cerebellum: RF activated NO synthase & induced vasolidation—radiation effect abolished by NO synthase inhibitor)* **2)** Irmak et. al, 2002 *(>serum SOD, <serum NO)** **3)** Kim et. al, 2002 *(>nNOS &PLC-gamma1)* **4)** Stopczyk et. al, 2002 *(<SOD-1 in 1, 5, 7 min. and > after 3 min)* **5)** Yoshikawa et. al, 2000 *(>NO)* **6)** Reale et al, 2014 *(<SOD and <enzyme activity of the nitric oxide synthase after 1 hour; >enzyme activity of catalase after 6 hours and changed enzymatic kinetic parameters of the catalase and the cytochrome P450; >gene expression levels of the transforming growth factor beta-1 and the interleukin-18-binding protein; in* H_2O_2 treated cultures, <catalase enzyme activity.)
Stress Markers (serum HSP70, Adrenaline and Noradrenaline)	**1)** Greater use of wireless technology **2)** 900 MHz 35 μW/m² (peak) of 58 persons, excepting two with 320 μW/m² (peak)	**1)** Balakrishnan et. al, 2014 *(>HSP70)*** **2)** Buchner & Eger, 2011 *(Significant increase in stress hormones adrenaline and noradrenalin)***
Phenylethylamine (PEA) & dopamine	**1)** 35 μW/m² (peak) of 58 persons, excepting two with 320 μW/m² (peak) at 900 MHz	**1)** Buchner & Eger, 2011 *(Significant decrease in PEA, dramatic drop in precursor dopamine)***
Acetyl cholinesterase	**1)** 100 MHz	**1)** Smialowicz, 1981* *(significant < in 22-day & 44 day-old, but not 97-day old, rats)*

	Related to temporal epilepsy, see Green et. al, 1989, & sleep regulator	
Blood & Lymphocytes	**1)** Electromagnetic radiation **2)** Low-frequency noise – not electromagnetic, but may relate? **3)** 2 millitesla at 50 Hz (4h/day) 30 days, lead acetate 1 & 5 mg/kg (mice). **4)** PEMF with generator at 75 Hz, 200 V, 0.2 to 3.5 mT, and induced electrical field of 0.04 mV/cm^{-1} in air over span of 30 to 120 minutes **5)** 50 nM PMA for 3 hours (LF) **6)** 10 GHz 2 hours/day for 30 consecutive days; one of the groups received 500 mg extract per kg/body weight 1 hour before exposure daily.	**1)** Lisiewicz, 1993 *(Causes imbalance in lymphocyte T3, T4, and T8, decreasing T8 cell count. Marked neutropenia (abnormally low count of white blood cells, neutrophils) after exposure).* **2)** Castro et. al, 1999 *(Statistically significant elevation in the number of circulating CD8+ and CD4+ T lymphocytes)* **3)** Hashem & El-sharkawy, 2009 *(EMF exposure increased RBCs, WBCs, & platelets; increased serum total protein levels, gamma, and total globulins; significantly increased phagocytosis and phagocytic index; & dissection showed focal centrolobular necrosis of hepatic cells surrounded by severe hydropic degeneneration, congestion of renal blood vessels in kidneys, contracted glomerular tufts of some flomeruli & focal leukocyte aggregation, etc. EMF & lead exposure significantly aggravated findings, with leucopenia, neutropenia, lymphopenia, monocytopenia, thrombocytopenia, higher levels of serum enzymes ALT, AST, creatinine & urea—the latter may be due to renal dysfunction as supported by dissection).* **4)** Varani et. al, 2002 *(Significant alterations in the functionality of adenosine A_{2A} receptors in human neutrophil receptors with upregulation; increase in adenylyl cyclase activity, reduction of superoxide anion production; may be useful in clinical applications).* **5)** Golbach et. al, 2015 *(Enhanced extracellular trap formation by human neutrophils through NADPH pathway: NETs "can lead to autoimmune diseases like systematic lupus erythematosus [23] and arthritis [24]. Furthermore, collateral damage to the host's own endothelial and ephithelial cells was also described. Our data support this report . . . "; cell flattening, cell adherence, & massive vacuolization occurred within 30 minutes after PMA stimulation.)* **6)** Sisodia, Rifat, Sharma, Srivastava, Sharma, 2013 *(Hemoglobin, monocytes, packed cell volume, red blood cells, mean corpuscular hemoglobin concentration declinded significantly, whereas white blood celss, lymphocytes, erythrocyte sedimentation rate, and mean corpuscular volume increased significantly, along with cholesterol, alkaline phosphatase, and lipid peroxidation. Depletion in blood sugar, total protein, acid phosphatase, and gluatathione leves was noted. Histopathological alterations in blood cells was seen. A second exposed*

		group given Prunus avium fruit extract before exposure showed improvements in the hematological, biochemical, and hisopathological parameters.)
IgG Immune	**1)** Electro oxidation **2)** Electro oxidation of blood from donors	**1)** Bozic, Cucnik, Kveder, & Rozman, 2007 *(Electro-oxidation of IgG significantly changes immunoreactivity and specificity of igG fractions, even in healthy persons. ELISA measurements showed increased reactivity of anti-β2-glycoprotein I antibodies at the beginning and various, fluctuating results after prolonged exposure. Individual differences in chemical stability of immunoglobulins, antioxidative status, and altered proteins likely influence outcomes.)* **2)** Omersel et. al, 2008 *(IgGs bound after electro-oxidation to β2-glycoprotein I, cardiolipin, citrullinated cyclic peptide, and protein 3; alterations in IgG depend on electric current, time of exposure, and presence of antioxidants; HUVEC treatment with oxidized IgGs changes cell morphology and increased released interleukin-6.*
Induced electrical current (determines permeability of all membranes)	**Still to do—**	1) Induced electrical field—risk higher from magnetic field: http://www.researchgate.net/publication/224593568_Study_and_evaluation_of_induced_currents_in_human_body_from_exposure_to_electromagnetic_fields_at_low_frequencies **2)** In review, internally, transmembrane voltage of 30 mV closes, or gates electrosensitive channels. Lednev's (2003) proposition polarization of proton spins of water by weak time-varying fields indicates biological responses depend on the ratio of the amplitude of magnetic field and its frequency, so that a 50 Hz magnetic field with amplitude equivalent to 1 μT (10 mG) would "elicit biological response." http://www.ncbi.nlm.nih.gov/pubmed/9125234 Combination of electric and magnetic induces current in child quicker than power density readings at same level: http://www.ncbi.nlm.nih.gov/pubmed/17526911 **laptop induced current journal article in measurement binder**
Mitochondria	**1.** ELF magnetic fields at	**1.** Li & Héroux, 2014; Li, 2012 *(Exposed cancer cell lines lost*

Mitochondria's adenosine triphosphate synthase (ATPS) and redox metabolism mitochondrial DNA (mtDNA)	0.025-5 μT (0.25 mG-50 mG). **2.** 10 μW /cm² microwaves **3)** 80 mW/cm² 2.45 GHz continuous wave 30 minutes daily for 4 days, with radiant heat control. **4)** Pulsed RF at 1800 MHz modulated by 217 Hz at average absorption rate (SAR) of 2 W/kg. **5)** comparison of 900, 1800, 2450 MHz every day 1/h for 28 consecutive days; male rats; Y-maze behavior 1/h after exposure	*chromosomes—cell lines showing flat dose response excepting erythroleukemia cells which had progressive rise up to 0.4 μT (4 mG). Constant exposure led to rising return to baseline, then small increases or decreases triggered "karyotype" contractions (KCs). Data suggests, as seen with inhibitors such as oligomycin, that interference with mitochondrial ATPS causes KCs, compensated by adenosine monophosphate-activated protein kinase (AMPK))*** **2)** Belokrinitskiy, 1982 *(Damaged mitochondria, nucleus of cells in hippocampus of brain)* **3)** Phelan, Neubauer, Timm, Neirenberg, & Lange, 1994 *(Mg(++)-ATPase activity (Vmax) decreased by 48.5% in group exposed to GHz only, with partial compensatory increase in Na+/K(+)-ATPase activity (170% increase in Vmax over control); these alterations are associated with large decreases in ratio of saturated to unsaturated fats).*** **4)** Xu, Zhou, Zhang, Yu, Zhang et. al, 2010 *[In cortical neurons levels of mitochondrial RNA (mtRNA) transcripts and copy number of mtDNA were clearly reduced and oxidative damage significantly increased as measured by increase in levels of 8-hydroxyguanine (8-OHdG). mtDNA defects are closely associated with various nervous system diseases]*** **5)** Gupta SK et al 2018 *(Severe* ***cognitive deficits*** *exhibited in rats exposed to 2450 MHz: loss of mitochondrial function & integrity, increase in amyloid beta expression, release of cytochrome-c, activation of apoptic factors like caspase-9 and -3 in hippocampus, decrease in acetylcholine, increase in acetyl cholinesterase indicating impairment of cholinergic system)*
DNA & Cells	**3)** Low power 8.1 mW/cm² and higher power 40 mW/cm² at 835 MHz exposed 20 minutes, 3 times per day, 7 days **4)** 6 with radiofrequency radiation **5)** 8.75 at 900 MHz for 2-12 hours **6)** 10-4 V/ m, corresponding to a power density of 0.0026	**3)** French PW, Donnellan M, McKenzie DR, 1997 *(At the low power density in human astrocytoma cell line, the rate of DNA synthesis decreased, cells flattened and spread out in comparison to unexposed culture. At the higher power, cells spread, but there were no effects seen on DNA synthesis rate and there was the addition of actin-containing blebs at localized sites on the membrane. 835 MHz low power density may affect a signal transduction pathway involved in cell proliferation.)* **4)** Phillips, 1998 as reported by Sage & Carpenter, 2012 *(DNA damage in cells)***

	pW /cm² (0.0000000026 µW/cm²), at approximately 30 MHz **7)** 3.68 V/m (± 0.36) at 2.45 GHz 1 hour daily for 30 consecutive days; one group received 500 mg/kg garlic	**5)** Marinelli, 2004, reported in Sage & Carpenter, 2012 *(DNA breaks in leukemia cells)*** **6)** Marha, 1969 *("It is known from reports in the literature that the velocity of **cell division** with Vicius fabus [a bean] **is accelerated** at field intensities of 10-4 V/ m at frequencies of approximately 30 MHz and the velocity **decreases** at values above 0.1 V / m" (p. 189). 10-4 V /m corresponds to a power density of 0.0026 pW /cm² (0.0000000026 µW/cm²). This is less than what we receive on earth from satellites. These experimental results, and those from Skrunda, and those of Kondra with chickens, above, prove that **satellite signals are biologically active**.")* **7)** Gűrler, Bilgici, Akar, Tomak, & Bedir, 2014 *(DNA damage in brain tissues and plasma of rats and protein oxidation in plasma. Garlic helped reduce some of the effects)** *Changes in morphology of cells* *https://www.ncbi.nlm.nih.gov/pubmed/22395787* *Investigations on DNA damage and frequency of micronuclei in occupational exposure to electromagnetic fields (EMFs) emitted from video display terminals (VDTs).* http://www.ncbi.nlm.nih.gov/pubmed/21637620
cAMP and PKA or MAPK signaling pathways	**1)** EMFs not intentionally applied—UV exposure intentionally absent **2)** EMFs	**1)** Mitra et. al, 2012 *(MC1R gene encodes cAMP-stimulating G-protein-coupled receptor that controls pigment production with red hair/freckles was found to increase **melanoma** development absent UV exposure—whereas absence of pheomelanin synthesis in albinos was found protective)* **2)** Yong et. al, 2014 *(EMF-induced cAMP level increase causing protein kinase A (PKA) and extracellular signal-regulated kinase (ERK) ½ phosphorlation, promoting osteogenesis (**bone growth**) mediated by PKA and MAPK signaling pathways.)*

Adenosine monophosphate-activated protein kinase (AMPK)	**1)** Magnetic fields	**1.** "MFs interfere with redox in a novel way that the cell has no means of controlling. We think that over time, this will erode the precision of **glucose control**. In our article we have confirmed that MFs influenced AMPK. AMPK is central to **diabetes** research." (Héroux, 2014)
Distribution of metals, pharmaceuticals	**1)** 10 μw/cm²	1) Shutenko, 1981, as reported by Firstenberg, 2001 *(Redistribution of metals in the lungs, brain, heart, liver, kidney, muscles, spleen, bones, skin, blood)***
Rheumatoid Factor	**1)** High & low intensities of laser irradiation vs. heat at 63° C for 15 minutes.	1) Cohen, Klein, & Fein, 1967 *(Laser reduced or destroyed capacity of globulins to precipitate RF; heat caused aggregation & more precipitation; laser shifted position of precipitin curve peaks.)*
Skin damage from changes in: Histamine Peptide Protein Cells Fibroblasts	**1)** Video-display terminals (VDT) **2)** Computer screens **3)** 250-500 V/m, 100 nA, and >10,000 uT from a room in on position with 5 computer screens, attached to monitors, and 2 televisions. **4)** Computer screens	**1)** Johannsson, Hilliges, Bjornhagen, & Hall, 1994 *(high somatostatin-immunoreactive dendritic cells and histamine-positive mast cells in skin biopsies before exposure, after which somatostatin-positive cells seemed to disappear)*** **2)** Johansson, Hilliges, & Han, 1996 *(Individuals with screen dermatitis identifiable from differences in calcitonin generelated peptide (CGRP), somatostatin (SOM), vasoactive intestinal polypeptide (VIP), peptide histidine isoleucine amide (PHI), neuropeptide tyrosine (NPY). protein S-100 (S-100). neuron-specific enolase (NSR), protein gene product (PGP) 9.5 and phenyl-ethanolamine N-methyltransferase (PNMT))* **3)** Johansson, Gangi, Liang, Yoshimura, Jing, & Liu, 2001 *(Healthy volunteers free of skin dermatitis showed mast cells increased in papillary and reticular dermis in 5 of 13 subjects after exposure, with some cells losing granular content and cytoplasm shrinking. Two of 13 cases showed decrease in mast cell number, but a shift to dermis was still visible. 24 hours after exposure the cellular no. and location normalized.)*

		4) Kimata, 2003 *(computer-induced stress enhanced plasma levels of substance P (SP), vasoactive intestinal peptide (VIP), and allergen-specific IgE production in patients with atopic dermatitis, but not patients with allergic rhinitus.)***
Voltage-Gated Calcium Channels (VGGCs)	**1)** Radiofrequency – numerous studies	**1)** Pall 2016 *(Review of numerous studies shows microwaves activate voltage-gated Ca2+ channels (VGCCs) concentrated in the brain and activate neuropsychiactric effects. Based on prior knowledge from genetic studies, VGCC activity causes widespread neuropsychiatric effects in humans.)*

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Measurement Overview of Holyoke Home

Holyoke, Massachusetts is an urban community with a municipally-owned utility and dam. February 9, 2015, Antennasearch.com listed in a radius of 4 miles my Holyoke residence, on Mt.Tom and less than a mile from the 2,161 acre Mt. Tom reservation, as surrounded by 26 towers starting one mile away, a pending new tower, and 434 antennas (starting at 0.84 mile equivalent to 70 towers). Transmissions of radio (93.1 and 102.1 Ghz), television (340 Mhz), and radar (1.21 Ghz) were especially strong.

Sample of Measurements in Suburban/Urban Home	Circa 2015 ~ *No WiFi, No Smart Meter*	2022 ~ *No Smart Meter, Cordless Phone, WiFi*
Ambient Magnetic Field	**<0.5 mG**	
Magnet on an Ipad Cover	**15-20 mG**	-----
Cordless phone handset *(between 200 MHz-8GHz)*:	**0.4 microwatts/cm²** (µW/cm²)	-----
Radar signal, possibly for traffic surveillance *(1.21 Ghz)*:	**2.5 microwatts/cm²** every few seconds	
Iphone 6 (1.6 is the FCC legal limit for SAR):	**19 µW/cm²** or microwatts/cm² Iphone peak average	
Near Ipad wireless signal:	**88.8 microwatts/cm²** peak downloading [A] **30 microwatts/cm²** periodic bursts [A]	-----
Electrical Field over Keyboard	**100 V/m** directly above Dell computer keyboard, by Optiquest LCD monitor and Brother printer	not measured
Sunday Dirty Electricity Frequencies 10-100 kHz (<51 G/S recommended):	**800-1300 G/S** or Graham Stetzer units (new kitchen) **200-300 G/S** by computer	
Cellphones (1.6 is the FCC legal limit for SAR, but testing is faulty):	**Industry says 1.28 W/kg SAR** or specific absorption rate, 824.2-1909.8 MHz (older Samsung model SGH-T219) **Industry says 1.59 W/kg SAR** (Iphone 6 plus)	

Measurement Key

Unless otherwise identified by references, measurements occurred with the following devices:

A = Author measured with Acoustimeter, Model AM-10, Frequency Response 200 Mhz to 8 Ghz, with a maximum peak measurement of >6 V/m and an average measurement utilizing microwatts per meter squared. Device limited by peak measurement of 6 V/m and 100,000 μW/m².

S= Spectran HF-60105, a professional level meter, able to identify and zero in on strength of frequencies or frequency ranges, measured by individual with bachelor's degree in physics.

AE= Aaronia electrodetektor Profi 2, a professional level multi detector (both electric and magnetic fields) with a sensitivity of 0.1 V/m and 0.01 mG for magnetic.

MISSING OTHER MAGNETIC FIELD MEASUREMENT TOOLS

Conversion Charts:

Volts/meter to Milliwatts/cm² Available at Powerwatch UK at this link: https://www.powerwatch.org.uk/science/unitconversion.asp
Convert milliwatts to microwatts by multiplying by 1000.

Magnetic Field Readings in Milligaus (mG)

Magnetic fields are produced by current, existing always with a corresponding electric field. The magnetic field only exists when the object, such as a lamp, is switched on. Magnetic fields can fluctuate greatly as current can change in response to load. "Alternating magnetic fields produced by AC electricity can induce the flow of weak electric currents in the body" (NIEHS, 2002).

1 milligauss (mG)= 0.1 microTesla (μT) *and* ***1 Amp/meter = 0.1257 mG***

0.5 40 inches from a LCD laptop computer monitor, and 20 inches from a LCD desktop computer monitor (Felix, Chizurumoke, Emmanuel, 2013)

0.6 Median exposure for teacher in a school, with 3.3 mG the peak for the top fifth percentile, with similar measurements for patients in a hospital, and for office building support staff, with information provided by OSHA. (NIEHS, 2002)

≤0.6 50% of 922 US homes measured by the Electric Power Research Institute (EPRI) had these fields. Another 25% had fields of 1.1 mG or less. EMF Research and Public Information Dissemination (EMF RAPID) (NIEHS, 2002).

1.7 Mean level 100 feet from a 115 kV powerline. (NIEHS, 2002)

≤2 Average exposure for 86% of the US population at home and 80% at work in the USA, as per EMF Research and Public Information Dissemination study commissioned by US government. (NIEHS, 2002)

2.2 Gas oven: directly before stove.

2.45 Average for school with students with working memory significantly worse than control with 1.64 mG. (Ghadamgahi et al, 2016)

4 House outlet: 1 inch away (July 14, 2014).

9 Breville toaster oven: reading 10 inches away at counter (July 14, 2014).

10 Highest reading 10 inches from five different LCD laptop computer monitor, in contrast to a highest reading of 2.8 mG 10 inches from five different LCD desktop computer monitors, and, at 15 inches, 7 mG and 1.40 mG respectively (Felix, Chizurumoke, Emmanuel, 2013)

12.6 Mean level 100 feet from a 500 kV powerline (NIEHS, 2002)

13.7 Ice-cream shoppe in Easthampton, MA. July 26, 2014

14 Median level in 1992 for old visual display terminals for PCs at 6 inches away, vs. 2 mG when 2 feet away (NIEHS, 2002)

15-20 Ipad Magnetic Fields: "Look at the top line of the Tri-Field Meter, it shows that the magnetic fields of the iPad2 was at 15-20 milligauss even with Wi-Fi turned off and the unit is on Airplane Mode (no cellphone reception/connection). The "safe" level of magnetic fields is below 3 milligauss (the dotted line) [at a minimum]" (SafeinSchool, January 2012).[1]

20 Small CD player: directly in front, 2 mG when two feet away (July 14, 2014).

20 Median level of dishwasher, 6 inches away, and 4 mG when 2 feet away (NIEHS, 2002)

0.3 – 45 Cashier's seat in Europe, which uses 50 Hz (ELF) (Roivainen et al, 2014) *Note: If all other factors are the same, 60 Hz will give a higher field*

40 Median level of fluorescent Lights, 6 inches away, and 6 mG when 2 feet away (NIEHS, 2002)

82 Breville toaster oven: 1-2 inches away (July 14, 2014)

80 Median level of garbage disposals, 6 inches away, and 10 mG when 2 feet away (NIEHS, 2002)

90 Median level of copy machine, 6 inches away, and 20 mG when 2 feet away (NIEHS, 2002)

187 Credit/debit card reader: 6 inches from credit/debit card reader at retail store (July 24, 2014).

300 Median level of vacuum cleaner, 6 inches away, and 60 mG when 2 feet away (NIEHS, 2002)

476 Conair hair dryer: readings fluctuated every second, this was the highest reading after less than a minute about 1 inch below dryer—not in heated area (July 24, 2014).

700+ Vitamix: Readings fluctuated quickly over a half minute (July 25, 2012)

833 Limit for the general public set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). Keep in mind studies show damaging effects at much lower levels.

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[1]SafeinSchool. (January 16, 2012) Apple iPad2 high magnetic fields: Do NOT put iPad on your lap! *Is Wi-Fi Safe for Children? Beware of Health Risks.* Retrieved July 8, 2014 at http://www.safeinschool.org/2012/01/ipad-iphone-wi-fi-radiation-and.html

>833	Leakage magnetic fields around a transformer (inverter) in apartment building – the transformer station was on bottom floor of 3-floor building and "many people living in this building reported health complaints such as immunological problems of their children."(Sirav et al, 2014)
1890 o	Electronic surveillance gate exposure maximum measured in Europe – authors remark cashiers "an exceptional group f workers with respect to exposure to electromagnetic fields"(Roivainen et al, 2014)
21450	MacBook Pro, Mac OS X (10.6.5) 2010: User states right hand rest of Mac exceeded any Gauss meter, while other laptops would be below 1000 mG (Gerhapsody, 2011).[2]

[2] Gerhapsody. (2011, January 5, 2:49 PM). MacBook Pro Electromagnetic Radiation – EMF. Retrieved from https://discussions.apple.com/thread/2708984?start=0&tstart=0

Power Density Readings and Limits (in microwatts or μW/cm²)

0.0003 - 0.0006

Current precautionary level offered by the Bioinitiative 2012, with the *caveat* that a safe level is not known.

.0006 Inside Holyoke, MA, home—no other wireless devices in home and 1+ miles from towers. (July 8, 2014)[A]

.0094 Ice-cream shop in Easthampton, MA. (July 25, 2014)[A]

.015 In line of site of cellular tower in Hampden, MA, at town swimming pond and park. (Summer 2014) [A]

.016 1 Mile from a cellular tower—note measurements can vary (Firstenberg, 2001).[3]

.044 Quarter mile (400 meters) from cell tower with single antenna in Springfield, MA—measured less than 2 minutes. (Fall 2014) [A]

.05 10 feet from a wireless computer (Firstenberg, 2001)[4]

>.1-10 200 to 50 meters away from cell tower in Spain at 900 or 1800 MHz (Balmori, 2005)

.3 3 feet away from d-link router at South Hadley Public Library (June 25, 2014) [A]

1.1 6 inches from wi-fi router at South Hadley Public Library (June 25, 2014) [A]

1.2 Next to automated electrical meter outside Holyoke home for 10 minutes—transmitted every minute (October 17, 2014) [A]

1.7 6 inches from router in Holyoke home. July 26, 2014 [A]

2.0 "Microwave hearing" clicking, buzzing, chirping, hissing, or high-pitched tones or "Frey" effect (Firstenberg, 2001)

4.3 Cellphone when signal is strong. (Wall et al, 2019)

[3]Firstenberg, A. (September 2001). *Radio Wave Packet*. Cellular Phone Task Force. Retrieved from http://www.cellphonetaskforce.org/?page_id=32

[4]Firstenberg, A. (September 2001). *Radio Wave Packet*. Cellular Phone Task Force. Retrieved from http://www.cellphonetaskforce.org/?page_id=32

19	iPhone peak average, with most measurements between 4-11 (SafeinSchool, April 2014).[5]
58.5	Radiation from a school WiFi router was 50 times higher than 100 feet from a cell tower, which was 1.139 microwatts per meter squared (SafeinSchool, July 2014)[6]
88.8	Next to iPAD connecting wirelessly on June 26, 2014, in Holyoke home.[A]
200	**US general population exposure limit** set by FCC for 30-300 MHz frequencies, with a 6 minute measurement time and calculation an average of all peaks.
360	Cellphone when signal is weak. (Wall et al, 2019)
1000	**US occupational exposure limit** set by FCC for 30-300 MHz frequencies with a six-minute average; limit only applicable when with full agreement and awareness of employee.
17,500	Cisco 4410N WAP router in a classroom EXCLUDING radiation from wireless devices in use in the classroom as measured on August 22, 2013 (Classroom RF/EMF Counter, 2014).[7]

[5]SafeinSchool. (2014, April 30). Radiation from iPhone on talking mode. *Safe in School* Retrieved on July 8, 2014 at http://www.youtube.com/watch?v=n097VN7KB_A
[6]WiFi router radiation 50 times higher than 100 ft from celltower. *Is Wi-Fi Safe for Children? Beware of Health Risks* Retrieved on July 8, 2014 at http://www.safeinschool.org/2012/01/ipad-iphone-wi-fi-radiation-and.html
[7]Classroom RF/EMF Counter. Retrieved on July 4, 2014 at http://www.rfemf.com/counter.html

Volts/Meter (Electrical Field) Studies & Measurements

An electric field is produced by voltage, and so exists with or without a magnetic field. A plugged in lamp continuously produces an electric field, whether or not it is switched on. "AC electric power produces electric and magnetic fields that create weak electric currents in humans. These are called 'induced currents'" (NIEHS, 2002). *"A person standing directly under a high-voltage transmission line may feel a mild shock when touching something that conducts electricity. These sensations are caused by the strong electric fields from the high-voltage electricity in the lines"* (NIEHS, 2002).

0.59 V/m	Holyoke public pool (July 25, 2014) [A]
1.942 V/m	Cell phone in car measured 2500 millivolts per meter. (Harvey, 2011)[8]
1.08 V/m	West Springfield, MA, movie theater, 8 minutes of measurement (July 2, 2014) [A]
2	Laptop on connected with wi-fi measured 2000 millivolts per meter (Harvey, 2011).[9]
0.6-4 V/m	Ambient dining room (Winter 2014)
4.7 V/m	Front of laptop at Calais School, Plainfield, VT, in a school room set up with transmitting wireless laptops (Trackingcandles, 2011).[10]
5 V/m	Itron Automated Meter Reader measured for a few minutes (May 2014) [A]
5.36 V/m	**Hospital:** Peak reading after 15 minutes at Holyoke Hospital, Holyoke, MA (Fall 2014) [A]
6 V/m	By router at Calais School, Plainfield, VT, in room set up with transmitting wireless laptops as shown in video (WiFi in Schools, 2011).[11]

[8]Peter Harvey [Trackingcandles]. (2011, November 10). WiFi laptop emits more microwave radiation than cell phone. Retrieved from http://www.youtube.com/watch?v=hVS37zUMwYQ&feature=youtu.be
[9]Peter Harvey [Trackingcandles]. (November 10, 2011). WiFi laptop emits more microwave radiation than cell phone. Retrieved from http://www.youtube.com/watch?v=hVS37zUMwYQ&feature=youtu.be
[10]Trackingcandles. (September 21, 2011) Wi-Fi in schools: Testing for microwave radiation dangers in the classroom. Uploaded September 21, 2011 by Wifiinschools.com. Retrieved on July 8, 2014, at http://www.youtube.com/watch?v=FO0AnNHz8vI
[11]Trackingcandles. (September 21, 2011) Wi-Fi in schools: Testing for microwave radiation dangers in the classroom. Uploaded September 21, 2011 by Wifiinschools.com. Retrieved on July 8, 2014, at http://www.youtube.com/watch?v=FO0AnNHz8vI

> 6 V/m	WiFi router 3 feet away with meter at front of desk (June 25, 2014) [A]
> 6 V/m	IPAD, 1 foot away. Maxed out meter—no WiFi router on at this time (June 26, 2014) [A]
> 6 V/m	South Hadley public library, 3 feet from d-link router in children's section (Fall 2014) [A]
> 6 V/m	Itron Automated Meter Reader measured five minutes in Holyoke, MA (October 17, 2014) [A]
7-10 V/m	Kitchen island in room with Romex (unshielded) wiring and recently remodeled, new outlets and low-power lights (Winter 2014—ELF)[AE]
8 V/m	Radiated all across "shielding" cloth laid on bed, and when removed measurements range from 7 V/m at foot to 10 V/m at head (Winter 2014—ELF)[AE]
20 V/m	Top of bed when light plugged into outlet near foot of bed with extension cord. (Winter 2014—ELF)[AE]
40 V/m	Foot of bed when light plugged into outlet near foot of bed with extension cord. (Winter 2014--ELF)[AE]
100 V/m	Above computer keyboard & at computer monitor (Winter 2014—ELF)[AE]
100 V/m	Few centimeters from energy-saving light on bedroom ceiling (Winter 2014—ELF)[AE]
112 V/m	-6 dBm at frequency of 1.210 Ghz, or radar (-6 dBm), emitting every few seconds in Holyoke home. [S]

Historical Health and Timelines for Electromagnetic Technologies

Several forces united to raise life expectancy in the USA: improved birthing care, public sanitation, hospital cleanliness, surgical skills, and, since 1940, antibiotic use—even if microorganisms and bacteria are increasingly antibiotic resistant today. However, life expectancy is a term quite different from life span and good health. In the past, provided one survived birthing, war, and accidents requiring surgery, lives could be long and simultaneously healthy based upon living conditions and opportunities. A recent study of US presidents found that most exceeded average life expectancy of the times with a mean of 78.1 years (Olshansky, 2011).[i] *John Quincy Adams, for example, died at the age of 80 in 1848, while revolutionary Samuel Adams died at 81 in 1803 and suffragist Sojourner Truth at 86 in 1883.*

Improvement in ***birthing procedures has had a significant impact on "life expectancy" calculations****. From 1960 to 1988, the infant mortality rate declined 60 percent, from 26 to 10 infant deaths per 1,000 births (MacDorman & Rosenberg, 1993).*[ii] *In 1960, high percentages of mortality occurred primarily from birthing issues, such as from postnatal asphyxia and atelectasis (17.6%), birth labor injuries (9.2%), influenza and pneumonia (8.9%), pneumonia of newborns (3.2%), or incompatible blood types (1.2%).* ***Today, infant mortality issues appears primarily caused by environmental toxins and mother's health:*** *US National Center on Vital Statistics shows leading causes of infant mortality in 1988 as firstly congenital abnormalities (20.9%), then Sudden Infant Death Syndrome (14.1%), disorders of short gestation or unspecified low birth weight (8.4), respiratory distress (8.2%), and maternal complications (3.6%) (MacDorman & Rosenberg, 1993).*[iii] *In 1960, congenital abnormalities are significantly lower at 13.9%, while SIDs and maternal complications are not included within the statistics.*

Despite advances in understanding human health or in medical technology, degenerative diseases and ill health at all ages appears to be increasing. By 2005, projections for greater longevity needed revision based upon increasing obesity (Olshansky et. al, 2005).[iv] *By 1986, deaths from degenerative disease had replaced deaths from infection in the USA (Olshansky & Ault, 1986).*[v] *Meanwhile, infant mortality at birth is increasing . . .*

Environmental causes contribute to increasing ill health. Continued investment into the creation and sale of chemicals for war, agriculture, and other uses has led to long-term contamination as evidenced by SuperFund sites in the USA. Of course, electromagnetic exposures have increased as well for industry and military purposes.

Epidemiological studies and health trends may provide insight on the impact of electromagnetic forces upon health. Thomas Edison began wiring New York City in the 1880s and by 1956, the electric grid had finally reached US farms (Milham, 2009).[vi] *Epidemiologist Samuel Milham, examining rates of initial and continuing electrification alongside government statistics, found*

significant correlations to "cardiovascular disease, malignant disease, diabetes, and suicide" (2009)[vii] and "obesity" (2014)[viii]. Milham emphasized poor power quality or "dirty electricity," as the primary villain. This is worrisome because the USA does not monitor home power quality, which is worsening dramatically based on new technologies such as energy-saving lights and digital devices.

Wireless exposures are dramatically increasing. Cellular devices such as cell phones or GPS often transmit in close proximity to the human body, and require transmissions to and from transmitting antennas, towers, or satellites. Satellites, cellular towers, and distributed antenna systems, can connect with a variety of wireless devices ranging from GPS, microchip pills, identify theft devices, credit cards, manufacturing labels, dental RFID implants, Zigbee or Z-wave appliances antennas, burglar alarms, phones, etc. All increase power output when connecting to transmitters, with many devices connecting continuously even when "off." Wireless transmissions continue to morph from WiFi in 2001 to increasingly pervasive, new options, with evolving names or alternative systems such as WiMax, LVX System (utilizing LED lights), or a laser wireless network. In 2011, IEEE reported Wireless Regional Area Networks (WRANs) would transmit over 100 kilometers, or 62 miles, from the transmitters utilizing a previously unused frequency (white space) of 802.22.[ix]

In 2011, Arthur Firstenberg described a rise in illness and death corresponding to data of satellite launches beginning since 1998 and increasing in intensity with 4G launches into space in 2010.[x] With the launch of digital cellular service in 19 US cities between 1996 and 1997, Firstenberg calculated a 10 to 25% increase in mortality lasting three months "as if an epidemic had swept through."[xi]

Wireless meters are a hidden, very strong source of electromagnetic radiation. Automated meter readers (AMR) may contain a single antenna transmitting power use data once a month or every few minutes, sometimes with a powerful signal, to the power utility. New designs include expensive, stronger 'AMI' meters with multiple transmitters and frequencies, which require the erection of new towers for transmissions and collect data from wireless appliances inside the home.

Olle Johansson and ?, recently showed that the rate of cancer followed the periodic increases in wireless transmission. Radio in the 1920s, TV in the 50s(?), Colour TV in the late 60s(?) etc. Would be interesting to include, along with dates of wireless onset.

Health Statistics

6th Mass Extinction: 45% mean decline in monitored invertebrates and 25% average decline of other monitored species (Dirzo, Young, Galetti, Ceballos, Isaac,& Collen, 2014).[xii] Stanford University biology professor Dirzo worked with researchers across the world to assess human impacts on animal biodiversity, noting humans are altering habitat favorably towards rodents, which carry human infectious diseases, and defaunation and species loss indirectly impacts soil and water quality. Strong declines in pollinators, needed for 75% of the world's crops, are further reducing populations of plant species dependent on these pollinators.

Epilepsy: Figures in a national database in the UK show rates of epilepsy increasing 15.6% over a period of five years (Fleming, 2007)[xiii]. Since 2001, veterans returning from warfare suffer high rates of epilepsy and other neurological diseases, and have demonstrated an alternative algorithm for epilepsy diagnosis, with comorbidity of 15.9% for TBI and 24.1% for PTSD, versus Operation Iraqi Freedom veterans with percentages of 52.6% and 70.4%. (Mooney, 2014)[xiv]. High levels of electromagnetic radiation exposure occur from military surveillance and communications. Less well known is exposure resulting from deployment of new electromagnetic weapons, such as of Project Sheriff, an active denial system, which was deployed from Humvees as the "Silent Guardian System" in Iraq (Phillips, 2006)[xv].

Multiple Sclerosis: In Kuwait from 2003 to 2011, incidence increased 3.22 times (men) and 2.54 (women) times (??), with a peak in prevalence among patients aged 30-39 years (Alroughani et. al, 2014).[xvi] In the Veneto region of Italy, incidence increased significantly with an overall rate of 5.5 (women) and 3.5 (men) over the years from 2000 to 2009, ending with an overall incidence of 139.5/100,000 in December 2009 (Puthenparampil et. al, 2013)[xvii] Similarly, a study in Vestford, Norway demonstrated prevalence of MS increased from 61.6/100,000 in 1963 to 166.8/100,000 in 2003, and 7.9% of MS patients in 2003 had epilepsy, in contrast with 2.9% in 1963 (Lund, Nakken, Edland, & Celius, 2014)[xviii]. An old national study in the United States found a rate of 4.2 per 100,000 from 1970-1975 and of 58 per 100,000 in 1976 (Baum & Rothschild, 1981)[xix]. Despite lack of mandated MS reporting, a 2002 study estimated a prevalence of 85/100,000, noting a 50% increase of reported MS from periods within the early 1980s to early 1990s.

Two cases of MS entered remission after electrical lines were filtered to remove microsurges (Havas, 2006)[xx]. In an interview, French scientist Dominique Belpomme similiarly reports two cases of multiple sclerosis arising from prolonged use of cellphones, and highlights electromagnetic links (Fauteux, 2011)[xxi].

Crohn's Disease: 300% rise in Crohn's Disease among 16 to 29-year-olds between 2003/4 and 2012/13, jumping from 4,937 to 19,405 in *one decade* as provided by statistics from the United Kingdom Health and Social Care Information Centre. (Goldsworthy, 2014).[xxii] Similarly, rates of ulcerative colitis and Crohn's Disease are increasing all over the world. Lower levels of membrane fluidity

and abnormalities in the lipid bilayer exist in CD patients (Aozaki, 1989)[xxiii]. Numerous studies, even if not specific to CD, reveal membrane alterations initiated by electromagnetic forces.

Inflammatory Bowel Disease: In Finland from 1987 to 2003, pediatric inflammatory bowel disease increased 6.5% each year, while coincidentally Crohn's disease increased 2-5 per 100,000 and ulcerative colitis from 4-9 per 100,000 (Lehtinen et. al, 2011).[xxiv]

Celiac Disease in Children and Adults: In the UK from 1990 to 2011, incidence rates increased fourfold (West, Fleming, Tata, Card, Crooks, 2014).[xxv] In the Netherlands from 1995 to 2010, the incidence of biopsy-proven CD increased almost threefold (Burger, Roovers, Drenth, Meijer, & Wahab, 2014).[xxvi] In Scotland from 1990 to 2009, pediatric CD increased 6.4 fold (White et. al, 2013).[xxvii] A study of healthy active-duty US military demonstrated a five-fold CD increase, with the highest rates of increase among those over 34 years of age (Riddle, Murray, Porter, 2012).[xxviii] In Estonia from 1976 to 2010, children up to 19 years of age showed a more than 30-fold increase in incidence (Ress, Luts, Rägo, Pisarev, Uibo, 2012).[xxix]

Autism & Learning Disability: Globally, autism increased 2500-3000% "since the earliest epidemiologic studies conducted in the late 1960s and early 1970s;" then, rates were 1 in 2,500 children (Baio, 2010).[xxx] In 2010, autism rates in CDC monitored populations soared to 1 in 68 in 2010—with 1 in 48 for boys. Diagnosis was 30% higher in non-Hispanic white populations. Intellectually, 31% were identified with IQ scores ≤70 (disability) and another 23% in the border range (71-85). Permeability of the cell membrane in the brain, due to electromagnetic forces, may cause autism (Goldsworthy, 2011)[xxxi]. Clinical observations of autistic patients removed from excessive electromagnetic exposure have shown improved social skills, in addition to excretion of toxic metals (Mariea & Carlo, 2007)[xxxii].

ADHD: The 2013 Trend Report by ExpressScripts, a pharmaceutical company with more than 90 million clients, reports adult prescription use of Attention Deficit Hyperactivity Disorder (ADHD) prescription drugs rose 53 percent from 2008 to 2012, or from 1.7 million to 2.6 million. A similar doubling occurring among youth, such that 7.8 percent of boys and 3.5% of girls were taking prescription drugs for ADHD in 2012, with rates of for adolescents ages 12 to 18 of 9.3% in adolescent boys and 4.4%. This report confirms reports by the Center for Disease Control (CDC) of epidemic ADHD rates (Schwarz, 2014).[xxxiii]

Anxiety: From 2001- 2003, an estimated 31.9% of adolescents in the USA had an anxiety disorder, and 8.9% had a severe anxiety disorder.[xxxiv] Adolscent suicide rates increased from 2000 – 2017, e.g. 67% for ages 10 – 14.[xxxv]

Prescription Trends for Diabetes: The 2013 Trend Report reported increases in utilization of popularly utilized drugs from 2012 to 2013 as follows: diabetes (2.4%), ulcer (.9%), asthma (1%), attention disorders (5.3%), and depression (1.5%).[xxxvi]

Diabetes: More than 29 million people, or 9.3% of the population, have diabetes in the USA, in contrast with 26 million in 2010. (Centers for Disease Control and Prevention, National Diabetes Statistics Report, 2014).[xxxvii]

Obesity: Between 1980 and 2008, the rate of obesity has doubled, with nearly 50% of women overweight in Europe, the Eastern Mediterranean, and the Americas, and the highest increases occurring in China & the USA, followed by Brazil and Mexico—childhood obesity rates are highest in Spain with one in three overweight. (Pérez Rodrigo, 2013).[xxxviii] Prevalence of severe obesity among children and adolescents ages 7-17 in Beijing increased from 1.86% in 2004 to 4.17% in 2003, with an annual increase rate of 0.26%, with clinical examination showing cardiometabolic risk factors (Yan et. al, 2014).[xxxix]

Cancer: 70% rise in cancers predicted by World Health Organization (WHO): cancers expected to grow yearly from 14 million in 2012 to 25 million in 2033 (Boseley, 2014)[xl] The President's U.S. Cancer Panel Report states at onset, "The Panel was particularly concerned to find that the true burden of environmentally induced cancer has been grossly underestimated" (Lefall& Kripke, 2010).[xli] Electromagnetic forces can increase absorption and reduce release of toxins, as has been described by multiple research studies.

Thyroid, melanoma, and uterine cancer rates: Based on trends in the USA, thyroid cancer will be the fourth leading, melanoma the fifth, and uterine cancer the sixth most common cancer diagnoses by 2030. Lung cancer is projected to be the first, pancreas the second, and liver the third leading causes of cancer-related death by 2030 (Rihab et. al, 2014).[xlii]

Youth Thyroid Cancer Increase: A significant increase of thyroid cancer and of increasingly large tumors from 1990 to 2009 in the USA, with cancer rates of 2.77 to 9.63 (male) and 18.35 to 50.99 (female) for children, adolescents, and young adults. The increasing trends for large tumors rules out diagnostic scrutiny as the only explanation (Vegamini, Frazier, Abrantes, Ribeiro, Rodriguez-Galindo, 2014).[xliii]

Worldwide, thyroid cancer rates are rising: For example, thyroid cancer rates have risen exponentially between 2000 and 2010 in Saudi Arabia, being the second most common cancer among young Saudi women (Hussain et. al, 2013)[xliv] National statistics in Korea show a 24.8 % (men) and 24.2% (women) annual increase in thyroid cancers from 1999 to 2010. (Hardell, 2013) [xlv]

Thyroid Cancer Increases and Malignant Neoplasm in Adolescents: In Italy between 1988 and 2008, a significant annual percent increase (APC) of +6.1% for thyroid cancer and +8.1% for melanoma in adolescents (ages 15-19), as well as an increase in malignant neoplasms (+2.0%), in particular Hodgkin lymphoma (+3.6%). Most recent trends (1998-2008) confirm increasing thyroid cancer (7.9% APC) and malignant neoplasm rates (AIRTUM Working Group, CCM, AIEOP Working Group, 2013).[xlvi]

Tumors: Cases of pheochromocytomata, a tumor, rose from 1,927 to 3,344 between 1997 and 2006 in Washington state, coinciding with wireless communications growth (Ossiander, 2010).[xlvii] Animal experiments show microwave radiation (used for wireless) develops pheochromocytomata (Guy, Chou, Kunz, Crowley, Krupp, 1985).[xlviii]

Cancer: Increased cancer rise in Germany of 90% among men and 40% among women over two decades, according to the Berliner Robert-Koch-Instituts; 1.45 million tumor patients exist in Germany as of 2010 (Viel mehr Krebskrake in Deutschland, 2010).[xlix]

Depression: In Italy from 2000 to 2011, antidepressant consumption increased from 8.18 to 36.12 per 1,000, jumping significantly in 2002 (Gualano, Bert, Mannocci, La Torre, Zeppegno, & Siliquini, 2014).[l]

Suicide: Youth in Ireland have double the average suicide rate of the European Union, with girls at 2.09 per 100,000 and boys at 5.12 per 100,000 (Shanahan, 2014).[li] In Galway the third level counselors' association says there is a "tsunami of students presenting with mental health problems" at NUI Galway and GMIT, having gone from 500 five years ago to over 1000. "Every second day we have students presenting with suicidal thoughts. Ten years ago that was unheard of—now it is every second day." (Bradley, 2014)[lii]

Suicide: The World Health Organization marks the increase of suicide per 100,000 from 1950 to 2002 as from approximately 17 to 28 in males and from 5 to 7 in women.[liii]

Vision: In Germany between 1993 and 2009, overall prevalence of blindness and low vision increased by 12.3%. (Wolfram & Pfeiffer, 2012)[liv] National and international government statistics, as well as multiple studies, find increasing rates of myopia (Bloom, Friedman, Chuck, 2010).[lv]

Chronic Pain: At least 100 million adult Americans in 2010 had common chronic pain conditions, which does not include acute pain (Institute of Medicine Report from the Committee on Advancing Pain Research, 2011). [lvi] This number is approximately a third of 308 million adults in 2010 as estimated by the U.S. Census Bureau.

Chronic Pain: Recent Center for Disease Control and Prevention (CDC) and National Center for Health Statistics (NCHS) data suggest substantial rates of pain from the various causes and that most people in chronic pain have multiple sites of pain. For U.S. adults reporting pain, causes include: severe headache or migraine (16.1%), low back pain (28.1%), neck pain (15.1%), knee pain (19.5%), shoulder pain (9.0%), finger pain (7.6%), and hip pain (7.1%) (Institute of Medicine Report from the Committee on Advancing Pain Research, 2011).[lvii]

Headaches and Migraine in Children: 17 percent of U.S. children, aged 4-18, experience frequent or severe headaches, including migraine, over the course of a year, according to the National Health and Nutrition Examination Survey (NHANES) (Institute of

Medicine Report from the Committee on Advancing Pain Research, 2011).[lviii] Before puberty, boys and girls have headaches at approximately the same rate, but after 12, the rate of recurrent and severe headaches rises among girls.

Tuberculosis: Rates of tuberculosis have doubled in the past decade in the United Kingdom. (Mobile TB detector deals with soaring UK infection rate, 2013).[lix]

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