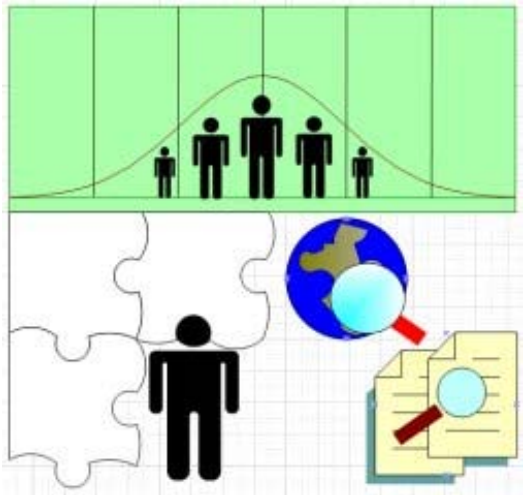
IEEE ICES Literature Review Report

NOVA SOUTHEASTERN UNIVERSITY

ATTACHMENT 8

- IEEE ICES EMF database
- Literature Review
- Issues to Consider



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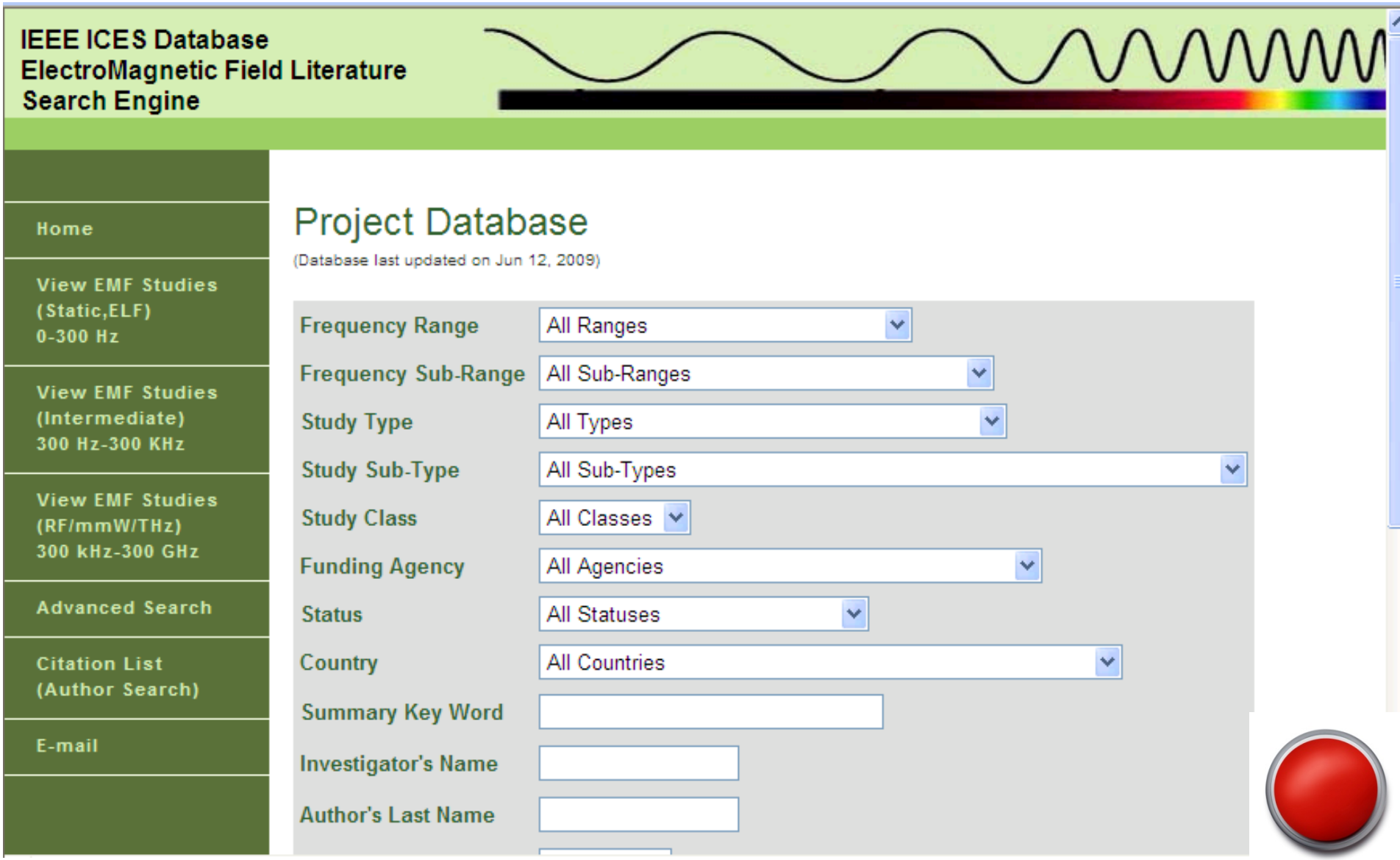
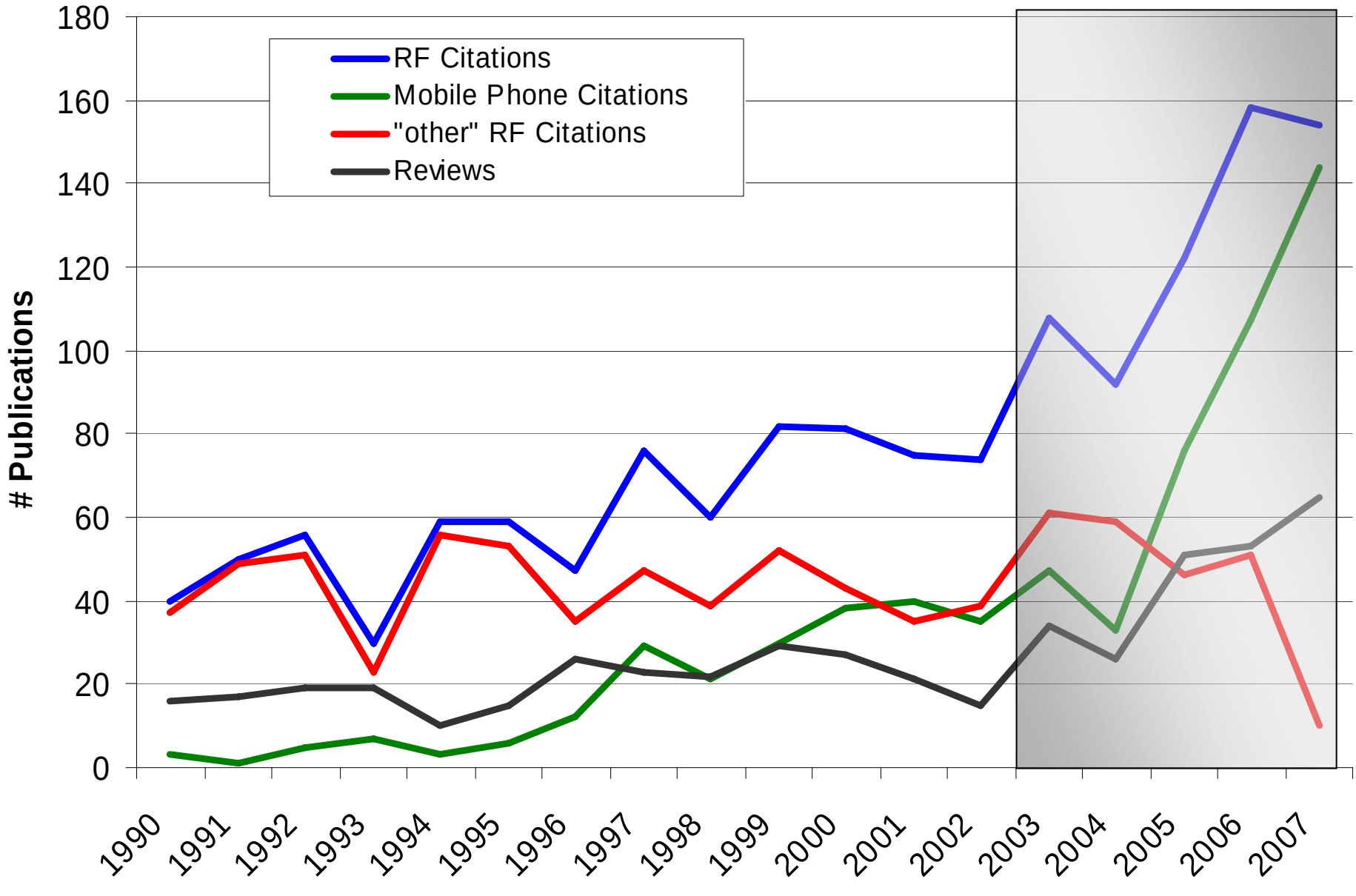


Peer Reviewed RF Bioeffects Publications



Primary Peer-Reviewed Biology Citations in the IEEE ICES EMF Literature Database

NSU NOVA SOUTHEASTERN UNIVERSITY

Study Type	RF ALL	RF 2003+
Epidemiology	332	149
Human	270	166
Animal	913	202
In Vitro	517	169
Total	**2032**	**686**

Agreed Approach

- Step 1: Literature Capture – ongoing through current database
- Step 2: Selection - ongoing / we agreed to all peer-reviewed citations
- Step 3: Division - specialty areas for review per existing database subcategories
- **Step 4: Critical Evaluation - ongoing**
- Step 5: Synoptic Review

Division: Study Subcategories

- **epidemiology**
  - case control
  - cohort
  - geographical correlation
  - etc
- **human studies**
  - EEG sleep
  - cognitive function
  - subjective symptoms
  - etc
- **in vitro studies**
  - DNA damage
  - gene expression
  - oxidative stress
  - proliferation / apoptosis
  - etc
- **In vivo studies**
  - animal cancer bioassays
    - 2yr bioassays
    - chemically initiated models
  - blood brain barrier
  - animal behavior brain biochem
  - auditory pathology
  - teratogenicity / reproduction
  - immune function
  - hormone changes
  - etc
- **time-temp thresholds**
  - adverse endpoints
  - summary from MMF contract

Status of Critical Reviews

- Linda Erdreich — **epidemiology**
- Myron Malanjyc — epidemiology exposure assessment
- Eric van Rongren — **human studies**
  — ***in vivo* studies**
- Joe Elder — animal cancer bioassays
- John D'Andrea — animal behavior and brain biochemistry
- CK Chou — auditory pathology / MW hearing
- Marv Ziskin — teratogenicity and reproduction (MMF contract)
- Joe Elder — blood brain barrier permeability
- (TBD) — **immune function**
- (TBD) — **hormone changes**
- Mark Dewhirst — time-temperature thresholds (MMF contract)
- Joe Morrissey — ***in vitro* studies**
- Lutz Haberland — membrane biochem, Ca++ signaling
- Lutz Haberland — theoretical mechanisms

Next Step:
Detailed Task Force Review

• **epidemiology**	Erdreich, Krewski, Elwood
• epi exposure assess	Malanjyc
• **human studies**	van Rongren, Croft, Black
***in vivo* studies**	
• animal cancer bioassays	Elder , Bushberg, McCormick
• animal behav brain bchm	D'Andrea
• aud path / MW hearing	Chou
• teratogenicity / reprod	Ziskin, Elder, McCormick
• time-temp thresholds	Dewhirst
• BBB	Elder
• Immune function	????
• Hormone changes	????
• ***in vitro* studies**	Morrissey, McNamee, *Leszczynski*
• membrane, Ca++ signaling	Haberland
• mechanisms	Haberland

Issues to Consider

Case Control Studies

Study	Exposure Assessment	**Findings**
Inskip [NCI] (2001,2003) n = 354 high grade glioma n = 135 low grade glioma n = 197 meningioma n = 96 acoustic neuroma	Personal interview	•OR = 0.9 ; 95% CI 0.5-1.6 - glioma (≥ 100 hrs) •OR = 0.7 ; 95% CI 0.3-1.7 - meningioma (≥ 100 hrs) •OR = 1.4 ; 95% CI 0.6-3.5 - acoustic neuroma (≥ 100 hrs) •**Ø ipsilateral association**
Muscat [ACF] (2000) n = 469 glioma	Personal interview	•OR = 0.7; 95% CI 0.3-1.4 - glioma (≥ 10 hrs/month) •**Ø ipsilateral association**
Lönn (2005); INTERPHONE Sweden n = 371 glioma n = 273 meningioma n = 148 acoustic neuroma n = 60 malignant salivary n = 112 benign salivary	Questionnaire or phone interview	•OR = 0.8; 95% CI 0.6-1.0 - glioma (**Ø ipsilateral**, **Ø** 10+ yr) •OR = 0.7; 95% CI 0.5-0.9 - meningioma (**Ø ipsilateral**, **Ø** 10+ yr) •OR = 1.0; 95% CI 0.6-1.5 - acoustic neuroma •**OR = 1.9; 95% CI 0.9-4.1**- 10+ yr acoustic neuroma •**OR = 3.9; 95% CI 1.6-9.5** - **ipsilateral** /10+ yr acoustic neuroma •OR = 0.7; 95% CI 0.4-1.3 - malignant salivary (Swedn + Denmk) •OR = 0.9; 95% CI 0.5-1.5 - benign salivary (Swedn + Denmk)
Christensen (2005) INTERPHONE Denmark n = 252 glioma n = 175 meningioma n = 106 acoustic neuroma	Personal interview	•OR = 0.58; 95% CI 0.37-0.90 - high-grade glioma •OR = 1.08; 95% CI 0.58-2.00 - low-grade glioma •OR = 1.00; 95% CI 0.54-1.28 – meningioma •OR = 0.90; 95% CI 0.51-1.57 - acoustic neuroma •**Ø ipsilateral association** * insufficient 10+ yr users for evaluation
Hepworth (2006) INTERPHONE UK n = 966 glioma	Personal interview	•OR = 0.94; 95% CI 0.78-1.13 - overall glioma •**OR = 1.24; 95% CI 1.02 -1.52** - **ipsilateral** glioma •OR = 0.75; 95% CI 0.61-0.93 - contralateral glioma
Schuz (2006) INTERPHONE Germany n = 366 glioma n = 381 meningioma n = 106 acoustic neuroma	Personal interview	•OR = 0.98; 95% CI 0.74-1.29 - glioma •OR = 0.84; 95% CI 0.62-1.13 - meningioma •**OR = 2.20; 95% CI 0.94-5.11** - 10+ yr glioma •OR = 1.09, 95% CI: 0.35-3.37 - 10+ yr meningioma •OR = 0.82; 95% CI 0.29 -2.33 - glioma (by subscriber list) •OR = 0.83; 95% CI 0.29-2.36 - meningioma (subscr list) •OR = 0.67; 95% CI 0.38-1.19 - acoustic neuroma •**Ø ipsilateral association**

Case Control Studies

Study	Exposure Assessment	Findings
Klaeboe (2007) INTERPHONE Norway n = 289 glioma n = 207 meningioma	Questionnaire or phone interview	•OR = 0.6; 95% CI 0.4-0.9 - glioma •OR = 0.8; 95% CI 0.5-1.1 - meningiomas •OR = 0.5; 95% CI 0.2-1.0 - acoustic neuroma •**Ø 6+ yr association** •**Ø ipsilateral association**
Lahkola (2007) Hartikka (2009) INTERPHONE Finland n = 1521 glioma	Questionnaire or phone interview	•OR = 0.78; 95% CI 0.7-0.9 - glioma •**OR = 1.39; 95% CI 1.01-1.92** - 10+ yr glioma •OR = 1.96; 95% CI 0.38-10.2 – MRI co-localized > 5 yrs use •OR = 1.34; 95% CI 0.29-6.20 – MRI co-localized **ipsilateral** glioma •**OR = 4.93; 95% CI 0.83-13.76** – MRI co-localized **contralatrl** glioma •**Ø ipsilateral association** * insufficient 10+ yr users for evaluation
Hours (2007) INTERPHONE France n = 96 glioma n = 145 meningioma n = 109 acoustic neuroma	Personal interview	•OR = 1.15; 95% CI 0.65-2.05 - glioma •OR = 0.74; 95% CI 0.43-1.28 - ***m***eningioma •OR = 0.92; 95% CI 0.53-1.59 - acoustic neuroma •**Ø ipsilateral association** * insufficient 10+ yr users for evaluation
Sadetzki (2008) INTERPHONE Israel n = 402 benign salivary n = 58 malignant salivary	Personal interview	•OR = 0.87; 95% CI 0.68-1.13 - salivary overall •**OR = 1.58; 95% CI 1.11- 2.24** - **ipsilateral** + highest number of calls •**OR = 1.49; 95% CI 1.05- 2.13** - **ipsilateral** + highest call time
Takebayshi (2008) INTERPHONE Japan n = 88 glioma n = 132 meningioma n = 102 pituitary adenoma n = 51 acoustic neuroma	Personal interview	•OR = 1.22; 95% CI 0.63-2.37 - glioma •OR = 0.70; 95% CI 0.42-1.16 - meningioma •**OR = 5.84; 95% CI 0.96-35.60** - highest estimated SAR category •OR = 0.73; 95% CI 0.43-1.23 - acoustic neuroma •**Ø ipsilateral association** •**Ø 10+ yr association**
Schoemaker (2005) Lahkola (2007, 2008) INTERPHONE Nordic + UK n = 1522 glioma n = 1209 meningioma n = 678 acoustic neuroma	Personal interview	•OR = 0.78; 95% CI 0.68-0.95 - glioma •**OR=1.39; 95% CI 1.01-1.92** - 10+ yr / **ipsilateral** glioma •OR = 0.76; 95% CI 0.65-0.89 - meningioma •OR = 0.9; 95% CI 0.7-1.1 - acoustic neuroma overall •**OR = 1.8; 95% CI 1.1-3.1** - 10+ yr / **ipsilateral** acoustic neuroma

Hardell et al. Studies
(Regional Hospital, Orebro, Sweden)

Study	Exposure Assessment	**Findings**
Hardell (2004, 2005, 2006) n = 1429 brain tumors n = 359 brian tumors n = 905 brian tumors	Questionnaire + phone interview	•<u>Overall glioma</u> **- OR = 2.6; 95% CI 1.5-4.3** - analog **- OR = 1.9; 95% CI 1.3-2.7** - digital **- OR = 2.1; 95% CI 1.4-3.0** - cordless •<u>Residential location glioma</u> - OR = 1.4; 95% CI 0.98-2.0 - rural overall **- OR = 8.4; 95% CI 1.02-69** - 5+ yr rural - OR = 0.9; 95% CI 0.8-1.2 - 5+ yr urban •<u>2000+ hrs use glioma</u> **- OR = 5.9; 95% CI 2.5-14** - analog **- OR = 3.7; 95% CI 1.7-7.7** - digital **- OR = 2.3; 95% CI 1.5-3.6** - cordless •<u>Ipsilateral glioma</u> **- OR = 2.1; 95% CI=1.5-2.9** - ipsilateral analog **- OR = 1.8; 95% CI 1.4-2.4** - ipsilateral digital **- OR = 1.7; 95% CI 1.3-2.2** - ipsilateral cordless •<u>10+ yr use glioma</u> **- OR = 2.7; 95% CI 1.8-4.2** - 10+ yr analog **- OR = 3.8; 95% CI 1.8-8.1** - 10+ yr digital **- OR = 2.2; 95% CI 1.3-3.9** - 10+ yr cordless
Hardell (2004) n = 293 salivary gland	Questionnaire + phone interview	•OR = 0.92; 95% CI 0.58-1.44 - analog •OR = 1.01; 95% CI 0.68-1.50 - digital •OR = 0.99; 95% CI 0.68-1.43 - cordless
Hardell (2005) n = 84 acoustic neuroma	Questionnaire + phone interview	•OR = 2.0; 95% CI 1.1-3.8 - analog •OR = 1.4; 95% CI 0.8-2.4 - digital •**OR = 4.2; 95% CI 1.8-10** - 10+ yr analog •**OR = 2.0; 95% CI 1.05-3.8** - 10+ yr digital
Hardell (2005) n = 305 meningioma	Questionnaire + phone interview	•OR = 1.7 ; 95% CI 0.97 – 3.0 - analog •OR = 1.3 ; 95% CI 0.9-1.9 - digital •**OR = 2.1; 95% CI = 1.1-4.3** - 10+ yr analog

Case Control Meta Analysis

Study	Exposure Assessment	**Findings**
Kan (2008) META ANALYSIS n = 5259 brain tumors (glioma, meningioma, AN)	Mixed	•OR = 0.86; 95% CI 0.7-1.05 - high grade glioma •OR = 1.14; 95% CI 0.91-1.43 - low grade glioma •OR = 0.64; 95% CI 0.56-0.74 - meningioma •OR = 0.96; 95% CI 0.83-1.10 - acoustic neuroma •OR = 0.90; 95% CI 0.81-0.99 - pooled all brain tumors •**OR = 1.25; 95% CI 1.01-1.54** - 10+ yr all brain tumors •**OR = 1.22; 95% CI 1.06-1.41** - analog vs digital, all brain tumors
Hardell (2007, 2008) META ANALYSIS n = 2946 brain tumors (glioma, meningioma, AN)	Mixed	•OR = 0.9; 95% CI 0.8-1.1 - overall glioma •OR = 1.2; 95% CI 0.8-1.9 - 10+yr glioma •**OR = 2.0; 95% CI 1.2-3.4** - 10+yr / **ipsilateral** glioma (4 studies total) •OR = 0.9; 95% CI 0.7-1.1 - overall acoustic neuroma •OR = 1.3; 95% CI 0.6-2.8 - 10+ yr acoustic neuroma •OR = 2.4; 95% CI 1.1-5.3 - 10+ yr / **ipsilateral** acoustic neuroma
Kelsh (submitted - 2009) META ANALYSIS n = 8,272 brain tumors (glioma, meningioma, AN)	Mixed	•OR = 0.87; 95% CI 0.77-0.99 - glioma •OR = 0.78; 95% CI 0.68-0.91 - meningioma •OR = 0.86; 95% CI 0.74-1.01 - acoustic neuroma •OR = 1.07; 95%CI: 0.83-1.37 – 10+yr all brain tumors

Geographical Correlations

Study	Exposure Assessment	Findings
Cook (2003) – New Zealand	Geographical Correlation	• No correlation: MP technology (~1987) and brain, head, neck tumors • *"we found no evidence of an increase in brain malignancies in the years following the introduction of cellular telephones. This suggests that if there is an increase in tumour rates with cellular telephone use it is relatively weak, or is manifest after a longer latency period"*
Inskip [NCI] (2003) - USA	Geographical Correlation	• No correlation: mobile phone subcriptions and ocular melanoma • *"The dramatic increase in use ofcell ular telephones has not been accompanied by an increase in the incidence ofocu lar melanoma"*
Hallberg (2002-7) - Sweden	Geographical Correlation	• Correlation: MP, BTS, FM towers and multiple cancers and illness
Muscat [ACF] (2006) - USA	Geographical Correlation	• No correlation: MP technology (1973-2002) and brain, CNS tumors • *"these results indicate that mobile phone use is unrelated to therisk of neuronal cancers"*
Deorah [U Iowa] (2006)-USA	Geographical Correlation	• No correlation: MP technology (1973-2001) and brain tumors • *"Despite raised concerns related to the risk of brain cancer from using cellular phones, our study fails to find support for this hypothesis at the population level"*
Roosli (2007) – Switzerland	Geographical Correlation	• No correlation: MP technology (1969-2002) and brain tumors • *"…after the introduction of mobile phone technology in Switzerland, brain tumour mortality rates remained stable in all age groups. Our results suggest that mobile phone use is not a strong risk factor in the short term for mortality from brain tumours."*
Nelson (2006) - UK	Geographical Correlation	• No correlation: MP technology (1979-2001) and acoustic neuroma • *"The trends in acoustic neuroma are most likely explained by changes in reporting and diagnosis" and "as this study illustrates, co-existing trends may be apparent for other reasons"*
Klaeboe (2005) Scandinavia	Incidence	• No correlation: MP technology (1979-2001) and meningioma • *"…little evidence that RF exposure has any effect on meningioma"*
WHO/IARC World Cancer Report (2008)		• "After 1983 and more recently during the period of increasing prevalence of mobile phone users, the incidence has remained relatively stable for both men and women." (p. 461)

Cohort Studies

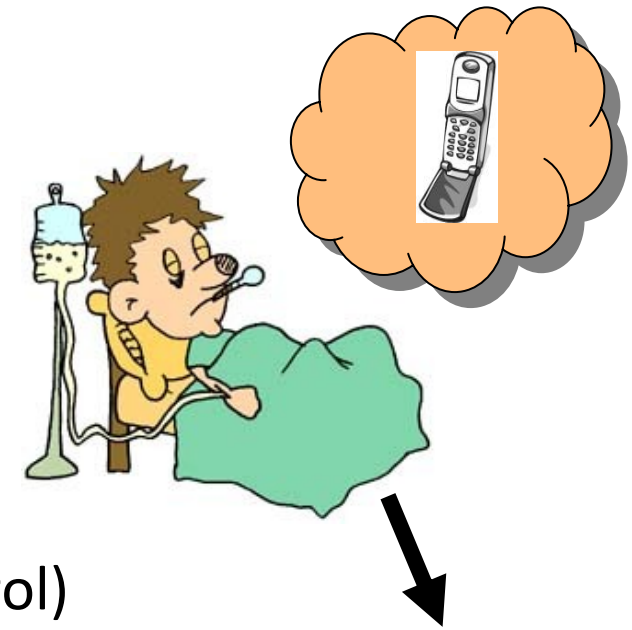
Study	Exposure Assessment	Findings
Johansen (2001) n = 420,000 / 3391 cancers	Subscribers (1982-1995) (TeleDanmark / Sonofon)	• OR = 0.95; 95% CI 0.81-1.12 – brain and CNS cancer • OR = 0.72; 95% CI 0.29-1.49 – salivary gland • OR = 0.97; 95% CI 0.78-1.21 - leukemia • OR = 0.66, 95% CI = 0.44-0.95 – 10+ yr all cancers (28 cases)
COSMOS (ongoing) UK, Sweden, Denmark, and Finland (n = ~200,000)	Questionnaire + some network data	malignant tumors, heart disease, neuro-degenerative disease (Parkinson's disease, MS, ALS), eye and skin disease, tinnitus, etc

Children Studies

Study	Exposure Assessment	
Mobi-Kids (n = ~235, France, Australia, ?)	Personal interview	• INTERPHONE spin-off
CEFALO (n = 530, Denmark, Sweden, Switzerland, UK)	Personal interview	• Case control study of children

Sources of Error in Exposure Assessment

- Selection bias
- Recall bias
- Over-estimation bias
- Technology variables
  - Frequency band / channel
  - Signal modulation
  - Transmit pwr (DTx, dynamic control)
  - Form factor
  - Antenna position
  - Evolving use cases

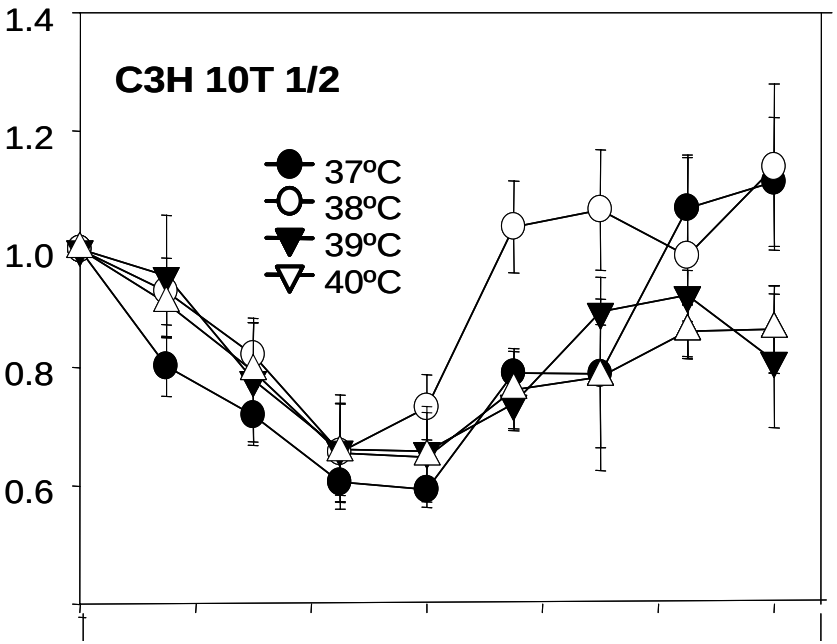


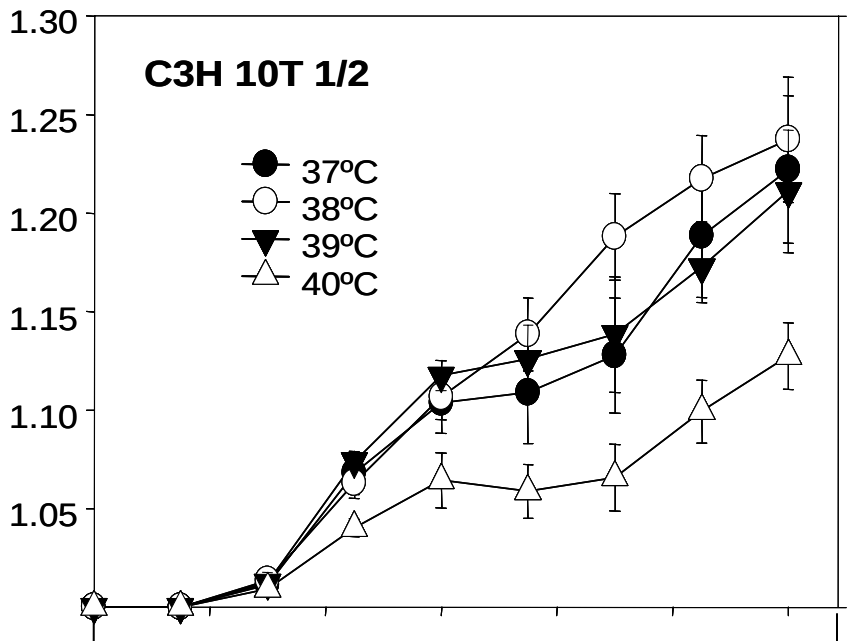
MOST / ALL PRIOR BEHAVIORAL AND ANIMAL STUDIES IN RODENTS DONE UNDER COLD STRESS

Species	Core Temperature (°C)	Thermoneutral Zone	
		LCT (°C)	UCT (°C)
Human	37	24	31
Rat	36.6–37.5	28	34
Hamster	36.0–37.8	28	34
Mouse	36.0–37.6	26	34
Guinea pig	38.1–38.6	30	31
Rabbit	39	13	20
Dog	38–39	18	25
Cat	39	24	27
Cattle, dairy	38–39	5	16
Goat	38–39	20	26
Sheep	39	13	31
Horse	38		
Swine	37–38	0	20
Chicken	41–42	19	29
Pigeon	43	20	30

- Dawe et al., Bioelectromagnetics (2006, 2008): 0.2°C increase induces hsp reporter ~ 20% and shifts temperature sensitive mutant phenotypes

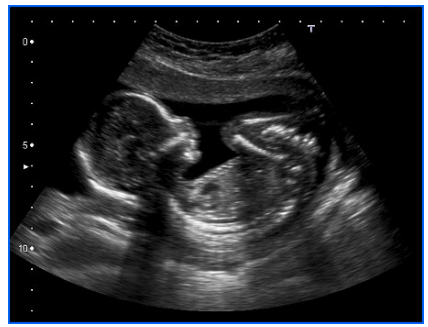
- Morrissey et al., J Drug Targeting (2009): 1°C increase sufficient to increase progression through the cell cycle

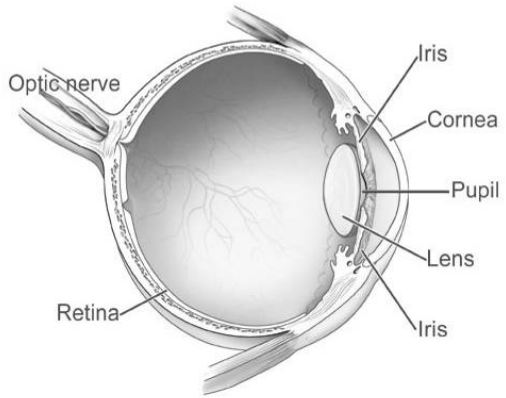




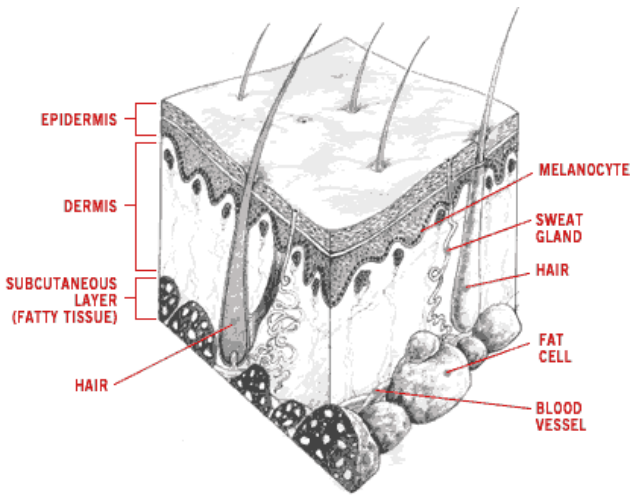
Tissue Specific Time-Temperature Thresholds

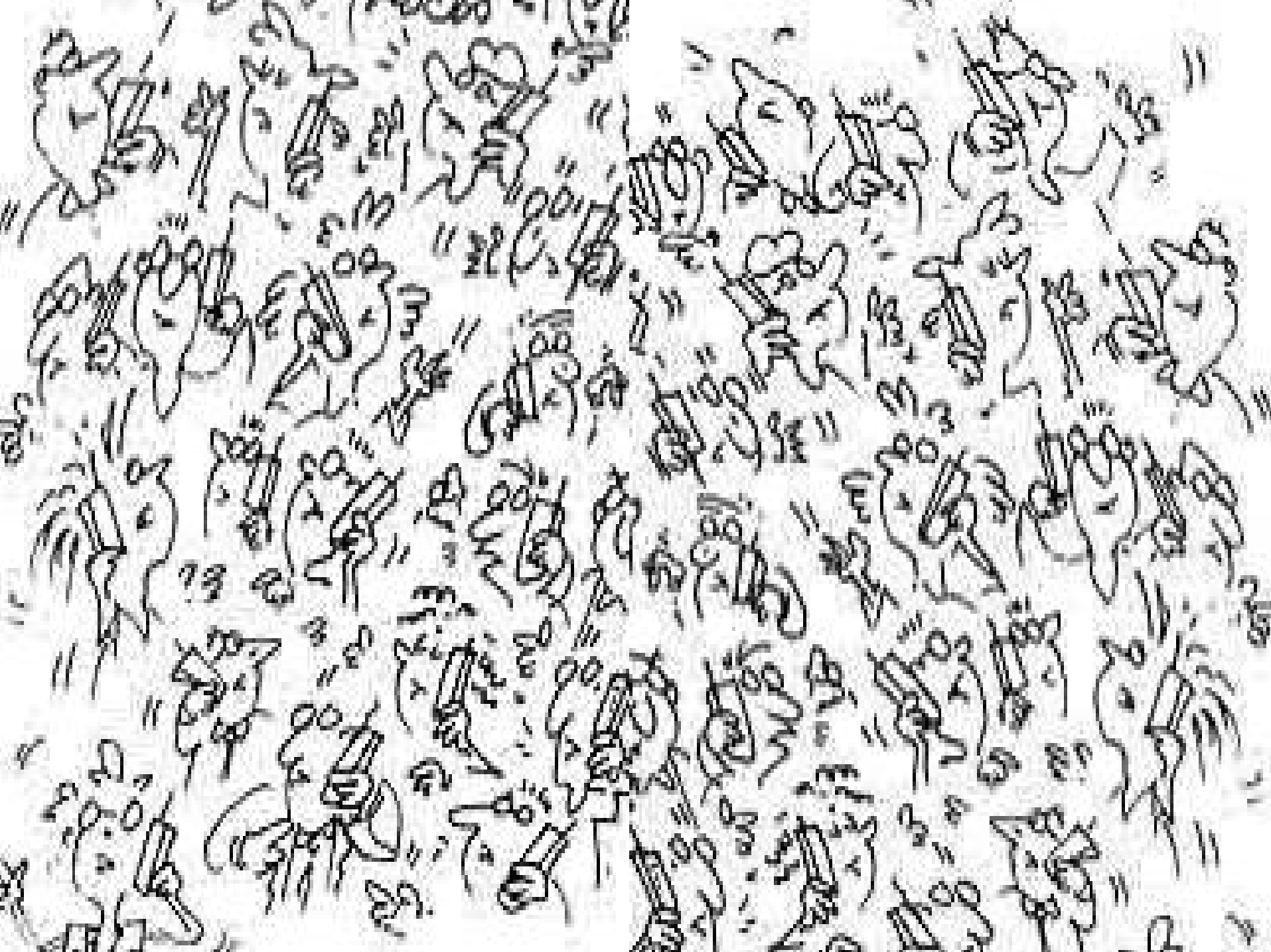
- Several numerical studies suggest 10 W/kg can result in increases ~1°C (10g avg)





- **Wang, Fujiwara et al (1999)**
  - 0.55°C / 10 W/kg (brain)
- **Ghandi et al (2001)**
  - 0.5°C / 10 W/kg (brain)
- **Yioultsis et al (2002)**
  - 1.6°C / 10 W/kg (brain)
- **Van Leeuwen, Lagendijk (1999, 2007)**
  - 1.35°C / 10 W/kg (eye)
  - 0.68°C / 10 W/kg (brain)
- **Hirata et al (2003, 2005)**
  - 1.75°C / 10 W/kg (eye)
  - 1.0 - 1.5°C / 10 W/kg (head)
- **Buccella et al (2007)**
  - 1.5°C / 10 W/kg (eye)
- **Bernardi et al(2001, 2007)**
  - 0.5°C / 10 W/kg (brain)
- **Samaras et al (2007)**
  - 1-2°C / 10 W/kg (eye)





1°C Temperature Increase

- From ICNIRP-1998: "*Established biological and health effects in the frequency range from 10 MHz to a few GHz are consistent with responses to a body temperature rise of more than 1°C.* This level of temperature increase results from exposure of individuals under moderate environmental conditions to a whole-body SAR of approximately 4 W/kg for about 30 min. A whole-body average SAR of 0.4W/kg has therefore been chosen as the restriction that provides adequate protection for occupational exposure. An additional safety factor of 5 is introduced for exposure of the public, giving an average whole-body SAR limit of 0.08 W/kg"

- From IEEE C95.1-2005: "For localized exposure, this standard uses recent scientific information to protect against adverse effects in the tissues most sensitive to thermal effects. Recent modeling studies show that at 10 W/kg per 10 g it may be possible to exceed a 1 °C rise in tissue, which had been suggested earlier as the upper temperature increase that has no detrimental health effects (UNEP/WHO/IRPA) (ICNIRP-1998) (WHO EHC 137-1993). ***More recent WHO information (Int J Hyperthermia,19:215–390, 2003 – from WHO workshop) indicates that a 1 °C rise in temperature, even in the most sensitive tissues and organs, is not adverse***"

L. S. GOLDSTEIN, M. W. DEWHIRST, REPACHOLI and L. KHEIFETS. Summary, conclusions and recommendations: adverse temperature levels in the human body. Int J Hyperthermia,19:215–390, 2003

- “However, exposure of rats at 38^{o}C for 4h results in cellular damage in several different parts of the brain”
- “It is not clear from these studies which best apply to the small change in temperature and the long exposure times that might be encountered in the environment”
- “Most healthy people can tolerate body core temperature excursions up to 40"C when adequately hydrated. However, heat-related disorders are quite common, especially in people unaccustomed to heat. Many organizations concerned with limiting the risk of heat-related disorders during work in hot environments place an upper limit on body core temperature of 38^{o}C”
- “The only tissue in humans for which there is carefully documented data on damage from local heating is skin”

From: Wiart J, Hadjem A, Wong MF, Bloch I.
Phys Med Biol 53 (2008) 3681–3695

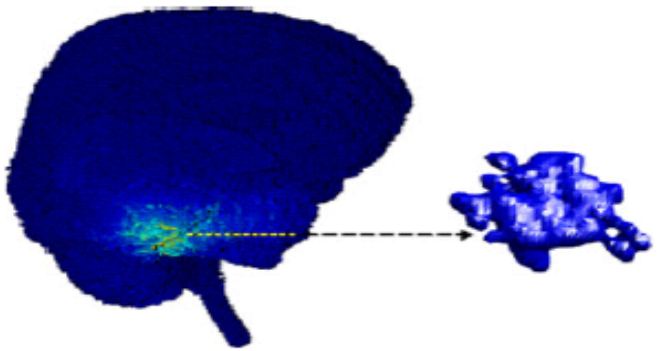


Figure 7. SAR distribution in the brain (left) of a 15 year old child and the shape of the 1 g volume having maximum SAR (source: CMP operating at 1800 MHz).

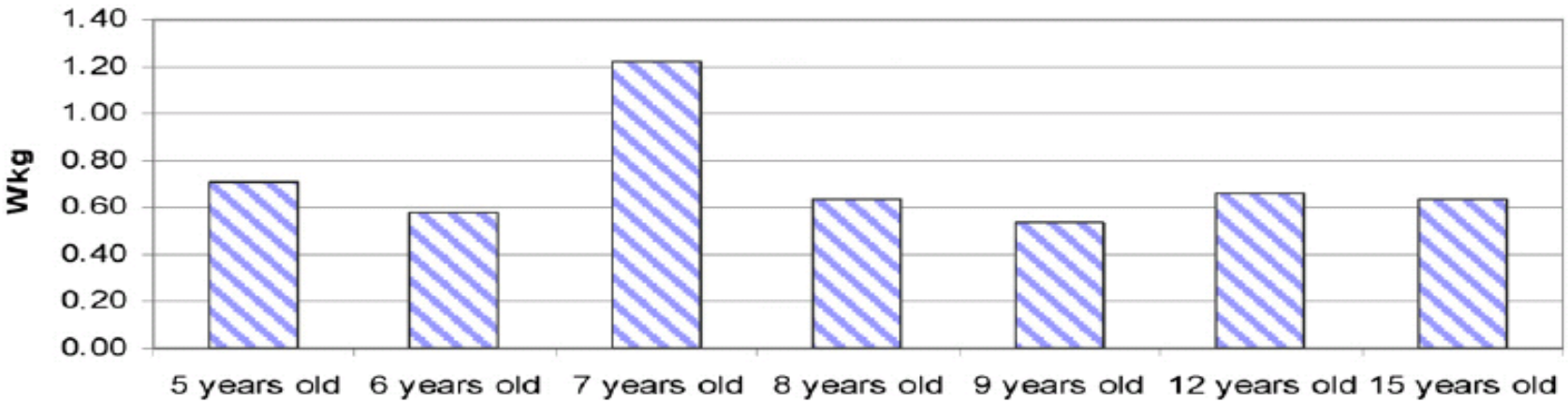


Figure 8. MSAR10g induced by CMP operating at 900 MHz in the different child head models (power emitted by the handset corresponding to an MSAR10g of 1 W kg^{-1} in VH).

From: Wiart J, Hadjem A, Wong MF, Bloch I.
Phys Med Biol 53 (2008) 3681–3695

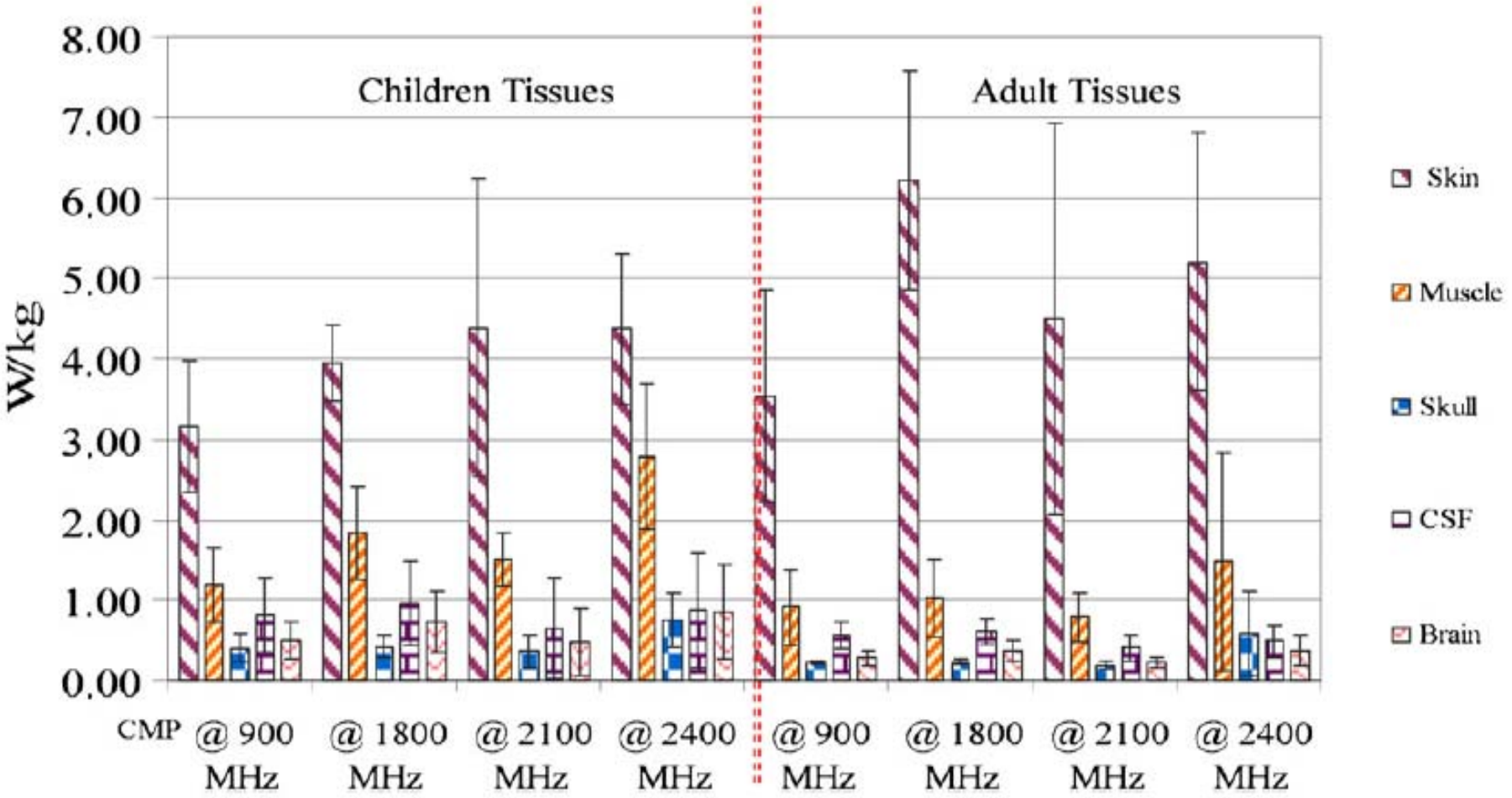


Figure 11. Mean MSAR 1g of tissues induced by the CMP in child and adult head models tissues (input power set up to induce an MSAR10g of 1 W kg^{-1} in VH).

http://www.microwavenews.com/

Statements have been made in the medical and general Press that the electric waves used in wireless telegraphy are injurious to the operators and produce various diseases, such as conjunctivitis, corneal ulceration, and leukoma. Mr. Marconi writes to the *Times* to deny these suggestions, for which, he says, there is no evidence whatever. He adds:— "During the twelve years or so of our operations we have had to deal with no single case of compensation for any injury of this origin, nor, so far as I can ascertain, has any such injury been suffered. Speaking for myself, I may remark that my own good health has never been better than during the often extended periods when I have been exposed for many hours daily to the conditions now challenged, and in the constant neighbourhood of electrical discharges at our Transatlantic stations, which I believe are the most powerful in the world."

From *Nature* 6 May 1909

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- (1) the purpose and character of the use, including whether such use is of a commercial nature or is for nonprofit educational purposes;
- (2) the nature of the copyrighted work;
- (3) the amount and substantiality of the portion used in relation to the copyrighted work as a whole; and
- (4) the effect of the use upon the potential market for or value of the copyrighted work.

US LIMITS:

Occupational = 0.4 W/kg (WB) and 8 W/kg (local)

General Public = 0.08 W/kg (WB) and 1.6 W/kg (local)

- Whole-Body SAR exposure limits derived 70's and 80's research:
  - Brooks AF Base a leader in this research
  - Behavioral endpoints in rodents and some primates
  - SAR of ~4 W/kg determined as a threshold for work stoppage
  - Safety factor of 10x (occupational) + additional 5x (general public) applied to give limits of 0.4 W/kg and 0.08 W/kg, respectively

- Local SAR exposure limits have different origins:
  - **ICNIRP** used rabbit studies showing ~100 W/kg threshold for cataracts. A safety factor of 10x (**occupational**) + additional 5 x (**general public**) over a tissue volume of 10 g (~eye) gives **10 W/kg** and **2 W/kg**, respectively†
  - **IEEE** initially (C95.1-1982, 1995) extrapolated from whole body values using an approximate 20x peak-to-average factor for SAR resulting in **8 W/kg** and **1.6 W/kg**, respectively (per1 gram tissue‡ , per 30 minutes).
  - **IEEE** has since (C95.1-2005) been revised upward§ to **10 W/kg** and **2 W/kg** over10 grams‡ (with **20 W/kg** and **4 W/kg** allowed in extremities and the pinna).

† Averaged over a *contiguous tissue* volume

‡ Averaged over a *cube* volume

§ based upon increased peak / average SAR data and desire to harmonize with ICNIRP

** body worn devices measured with a 2.5cm spacer

Mobile Phone & Wi-Fi Communication

Criteria: Freq Range=300 kHz - 300 GHz (RF/mmW/THz),Freq Subrange=Mobile Phone & Wi-Fi Communication,Study Type=Epidemiology,Status=All

Study Type/Subtype	Ongoing	Effect	Effect (Thermal Only)	No Effect	Total
Epidemiology					
Behavior, Neurochemistry, Neuropathology	1	0	0	0	1
Blood Brain Barrier, Brain Circulation	0	1	0	0	1
Case Control Epi Study	10	12	0	15	37
Case Study of a Patient(s)	0	2	0	0	2
Cognitive Function & Memory	0	2	0	0	2
Cohort Epi (Geographical Correlation)	0	1	0	8	9
Cohort Epi Study	7	2	0	5	14
EEG, Event Related Potentials, Sleep Disturbances	1	0	0	0	1
Experimental Dosimetry in Humans	2	0	0	0	2
Eye Pathology	1	1	0	1	3
Subjective Symptoms (e.g., Headaches, Hypersensitivity, Fatigue)	2	15	0	1	18
Teratogenicity, Reproduction, & Development	0	1	0	0	1
Vehicular Accident Study	0	1	0	0	1
Total	24	38	0	30	92

Mobile Phone & Wi-Fi Communication

Criteria: Freq Range=300 kHz - 300 GHz (RF/mmW/THz),Freq Subrange=Mobile Phone & Wi-Fi Communication,Study Type=In Vivo,Status=All

Study Type/Subtype	Ongoing	Effect	Effect (Thermal Only)	No Effect	Total
In Vivo					
Auditory Pathology & RF Hearing	0	1	0	4	5
Behavior, Neurochemistry, Neuropathology	3	8	1	7	19
Blood Brain Barrier, Brain Circulation	2	5	0	7	14
Chemical-Radiation-Genetically Initiated Tumor Bioassay	0	1	0	18	19
Cognitive Function & Memory	0	1	0	0	1
DNA Breaks, Repair, & Mutation	0	1	0	3	4
EEG, Event Related Potentials, Sleep Disturbances	2	5	0	0	7
Experimental Dosimetry in Animals	0	0	0	0	0
Eye Pathology	0	1	0	0	1
Gene Expression, Protein Activity	1	6	1	9	17
Growth Rate, Cell Cycle, Apoptosis	0	0	1	1	2
Hematology & Immune Function	0	2	0	3	5
Hormone Changes	1	1	0	8	10
Long Term Animal Bioassay	2	2	0	10	14
Micronuclei & Chromosome Aberrations	1	2	0	5	8

Mobile Phone & Wi-Fi Communication

Criteria: Freq Range=300 kHz - 300 GHz (RF/mmW/THz),Freq Subrange=Mobile Phone & Wi-Fi Communication,Study Type=In Vitro,Status=All

Study Type/Subtype	Ongoing	Effect	Effect (Thermal Only)	No Effect	Total
In Vitro					
Behavior, Neurochemistry, Neuropathology	0	2	0	0	2
Blood Brain Barrier, Brain Circulation	1	1	0	1	3
DNA Breaks, Repair, & Mutation	3	8	1	8	20
Eye Pathology	0	0	1	0	1
Gene Expression, Protein Activity	10	18	1	17	46
Growth Rate, Cell Cycle, Apoptosis	3	10	1	13	27
Hematology & Immune Function	2	3	0	0	5
Hormone Changes	0	1	0	0	1
Membrane Biochemistry, Fluidity, Electroporation	2	2	0	0	4
Micronuclei & Chromosome Aberrations	2	6	0	10	18
Oxidative Stress	4	2	0	2	8
Signaling (Ca++/Ion Efflux, Neuron Conduction, Muscle Contraction)	4	5	1	5	15
Teratogenicity, Reproduction, & Development	1	2	0	1	4
Thermal Analysis & Regulation	0	0	0	0	0
Transformation	2	0	1	2	5