10th December 2007

Updated Memorandum on WiFi Research

On the 12th October 2007, the HPA announced a new "systematic programme of research" into wireless local area networks. We welcome the extra money for research in this area. However, we believe that this programme needs a different focus in order for it to result in valuable new information for the required re-evaluation of the ICNIRP Guidelines. As the project is presently planned to ignore reported health effects, we question if this is appropriate expenditure by a public body responsible principally for the protection of public health.

We believe that, as announced, the research programme would be a misuse of almost a third of a million pounds of public money, addressing a question that has already been adequately answered by themselves and others. According to the press statement the programme is to:

> "… *measure exposures to radio signals from wireless computer networks. The results will be compared with established international exposure guidelines and also with exposures from other commonly used sources of radio signals, including mobile phones.*"
> www.hpa.org.uk/hpa/news/articles/press_releases/2007/071012_wifi.htm

The international exposure guidelines to which HPA refer are the 1998 ICNIRP guidelines. These guidelines are set at levels designed only to protect against exposure-induced thermal changes in tissue and biological processes, and to protect against direct peripheral nerve stimulation and electric shock.

Public microwave exposures due to emissions in a typical wireless local area network are orders of magnitude lower than the ICNIRP guidelines. There is already enough research documenting the predicted and measured exposures from these systems, some of which are listed below in Appendix A. As far as we are aware, these are not in any dispute.

> A senior HPA manager recently stated:
> *"The (existing) work appears as an excellent experimental investigation of both SARs produced in flat phantoms and field strengths around various items of radio equipment, including several WiFi access points and PC cards."*
> … *"We will also be considering the temporal patterns of transmitted data during the course of school lessons and thus the time-averaged output powers that occur from WiFi equipment in practice."*
>
> (in an email from Dr Jill Meara, Asst Director (Public Health), HPA CRCE, to Alasdair Philips, 28-Nov-07)

Although we have yet to receive a reply to our Memorandum, in a letter of 12 November 2007 to Dr Caroline Lucas (MEP), Dr Roger Cox (Director, HPA Centre for Radiation, Chemical and Environmental Health) states that the review will include a review of potential health effects with reference to ICNIRP guidelines. These state that they are based on:

> "… *short-term, immediate health effects such as stimulation of peripheral nerves and muscles, shocks and burns caused by touching conducting objects, and elevated tissue temperatures resulting from absorption of energy during exposure to EMF"*
> ICNIRP Guidelines, April 1998, v.74-4, p.496

The ICNIRP Guidelines specifically exclude any potential long-term effects such as those that we are concerned about. So, it is not surprising that Professor Pat Troop, Chief Executive of the HPA, was able to confidently state about this new research:

> "*We have good scientific reasons to expect the results to be re-assuring and we will publish our findings.*"
>
> Professor Pat Troop, CEO, HPA
>
> www.hpa.org.uk/hpa/news/articles/press_releases/2007/071012_wifi.htm

That re-assurance is already pre-determined by the study design limitations. It is clear from the above quotations that the study currently is only to examine time-averaged SAR exposures. That has virtually no meaningful relevance for the consideration of the various non-thermal signal characteristics (i.e. informational rather than heating effects) that are thought, by leading concerned scientists working in the field of bio-electromagnetics, to be most likely to be causing the asthenic problems being reported. At previous HPA EMF DG meetings we have discussed the real public concerns about the effects on their health from exposure to signals from WiFi and mobile phone base stations. This announced "programme of research", which is not to collect any reported health effects, does not in any way address our concerns and its findings will not re-assure the concerned scientists and general public.

Since the ICNIRP 1998 Guidelines were produced a considerable number of studies have been published pointing to health effects far below the ICNIRP levels (see below in Appendix B). Many of these effects are found at signal levels very similar to, and in some cases significantly below, typical exposures from a nearby wireless network.

The most commonly reported adverse effects to low-level electromagnetic signals are headaches, concentration difficulties, learning and memory problems, chronic fatigue, depression, and behavioural problems. These symptoms are present in many ADHD cases. Since 1997 there has been a four-fold rise in children diagnosed with ADHD - indeed the National Institute for Clinical Excellence now estimates that as many as 5% of children have this problem. The cause of this rise is, so far, unknown.

In the light of Dr Havas' Canadian schools work on "dirty electricity" and improvements in children diagnosed with ADHD (see Appendix B), it is possible that background microwave exposure plays a role in this rise and we believe that it should be among the issues examined. It is important also to control for any placebo effect.

The various reports of adverse effects on well-being suggest that the adverse symptoms start to show in more sensitive people exposed to background peak signal levels above about 0.05 volts per metre. Typical signal levels in schools with WiFi are between 2 and 40 times higher than this. For further information, please see Appendix A.

We now urgently need ecological studies, monitoring the performance and well-being of children who are now exposed to these signals. Their health and performance details should be compared with those from relatively unexposed children and the data also examined to see if there are any temporal trends. As there are still some schools without WiFi, this may be the last opportunity to do some valuable work while we still have a chance to find relatively unexposed control children - although their home and mobile phone exposure also needs to be recorded. Much of the work could be done using questionnaires.

In June 2000 the UK Government advised people to consider preventing the 'beam of greatest intensity' from a base station's antenna from falling on school premises. The levels inside classrooms from internal WiFi / wLAN equipment will almost always significantly exceed the classroom levels from any nearby base station.

The 1998 ICNIRP Guidelines are overdue for revision in the light of evidence published since. In order to meaningfully re-assess the situation, information about the health, well-being and performance of users needs to be gathered.

We call on the HPA to fundamentally change the announced programme of work so that it primarily collects health and performance data on school pupil WiFi users.

Our initial suggestions for study include:

(1) To study secondary school children in the 12-15 year-old age-range as we have reports that this group is more affected than primary school children. This may be due to their longer exposure to environmental agents.

(2) School records should be used for health, behaviour and performance and some specific mental ability tests carried out.

(3) Schools with and without WiFi could be compared and also one or two schools with WiFi should also be equipped with wired networks and work 'half a term WiFi-on' and 'half a term WiFi-off' with suitable performance testing and well-being score at the end of each period for a couple of years.

(4) It would be important to also record, for these children, mobile-phone usage and home exposure to basestation, DECT and WiFi signals.

Some of this could be integrated with the forthcoming MTHR funded childhood illness research.

This programme of work could then result in some valuable information to feed into the necessary re-evaluation of the ICNIRP Guidelines.

This revised Memorandum has been signed by eight Members of the HPA-RPD EMF Discussion Group who are prepared to help with the study over-sight and planning.

http://www.hpa.org.uk/radiation/understand/radiation_topics/emf/emfdg/index.htm

From the Minutes of the HPA/RPD EMF DG meeting of 9th September 2007:
"Members were reminded of the Terms of Reference (ToR) of the EMF DG which are to:

To provide a forum for considering possible health concerns related to exposure to electromagnetic fields (EMFs) and to provide an input to the development of HPA advice.

The Chairman considered that this was an important remit which enabled the Members' concerns to be raised and taken forward in a structured way."

Ref [1] http://www.hpa.org.uk/hpa/news/articles/press_releases/2007/071012_wifi.htm

Appendix A - Exposure levels

The ICNIRP maximum public exposure Guidelines for the 2.4 GHz main current WiFi band are:

61 volts per metre (V/m) averaged over any 6 mins	10 W/m^2 averaged over any 6 minute period
>1 952 V/m is allowed in short peaks	10 000 W/m^2 averaged power of any short pulse

Signal levels from WiFi and similar equipment have been calculated and measured by industry during EMC compliance testing for over 10 years. The peak signals are up to about 6 volts per metre (V/m) and environmental signals that people are exposed to in rooms with WLAN hubs typically vary from about 0.1 to 3 V/m. Nobody seems to dispute this. The levels are lower in areas in the school without the Access Points and most wireless PCs can work down to reception levels well below 0.001 V/m, though the actual laptop PC transmitter will still be transmitting a signal of about 1 V/m or more to the user.

What is under dispute is whether signals as low as these can have effects on peoples' well-being.

The peak signal levels users are exposed to are generally in the range 0.2 to 2 V/m, with very short duty-cycles, resulting in low average power levels and tiny SAR absorbed power values. It is possible to have higher signals if sitting very close to the equipment, especially the Wireless Access Point.

For example, most WiFi units emit a background ~10 Hz beacon signal (a brain-wave frequency) pulsing at full power in 20 to 50 microsecond bursts even when not transferring files. In our opinion, it is quite inappropriate to time-average this by a reduction factor of 2 000 to 5 000-fold (as, for example, this HPA study will do and Foster (2007) did). If you take the peak SARs from the short pulse itself, then ICNIRP allows a 1 000-fold increase in power during this pulse (see top of this page), so this still does not address the relevant non-thermal issues.

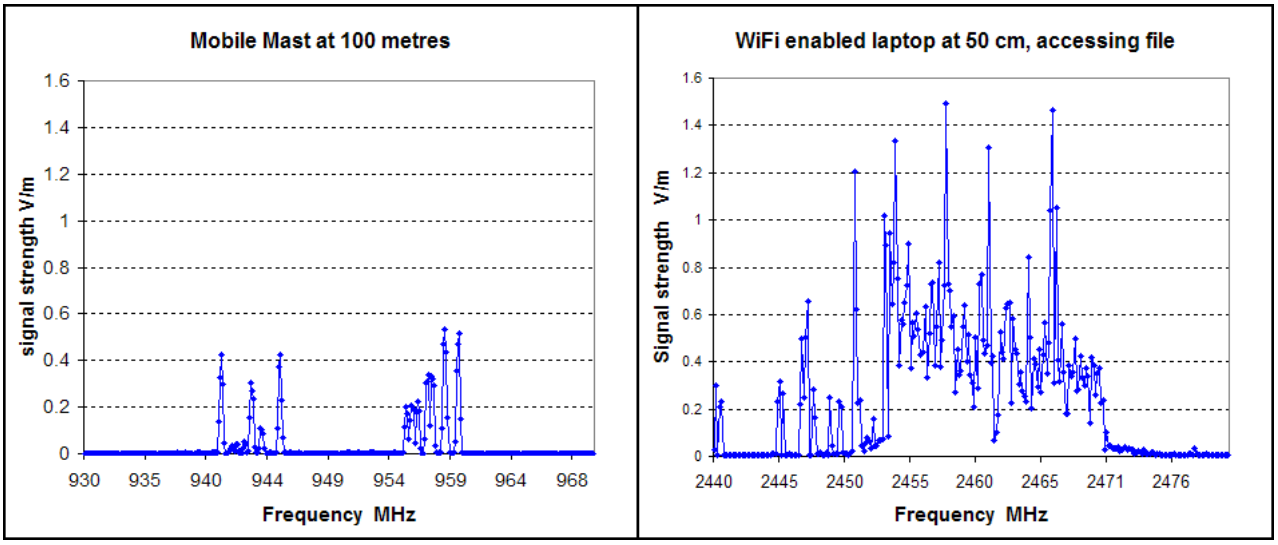
The HPA-RPD have assessed these and found average power density levels of 220 microwatts per square metre ($\mu W/m^2$) about 0.6 metres from a laptop PC and 330 $\mu W/m^2$ at 2 metres from a wireless Access Point. These translate into average signal strength levels of 0.3 and 0.4 V/m respectively, with peak levels probably in the order of 0.5 to 2.5 V/m. (December 2003, carried out by Adam Lowe, HPA-RPD, Leeds.)

In June 2005, SAEFL, the Swiss Agency for Environment, Forests and Landscape, published a report "Electrosmog in the Environment". This states signal strengths at one metre from both wireless PCs and normal strength Access Points to be in the range 0.7 to 2.8 V/m. These are in good agreement with the above figures. The report DIV 5801-E is downloadable from:
www.buwalshop.ch

An authoritative report was given by Neils Kuster, Foundation for Research on Information Technologies in Society (ITIS), Zurich, to a WHO Workshop meeting on "Base stations & wireless networks - Exposures & Health Consequences" in July 2005. ETH found that the typical peak signal strength at 1 m was about 1 V/m, rising to 2 V/m at a distance of 0.5 metres. This is in agreement with the above figures. The presentation is available at
http://www.who.int/peh-emf/meetings/archive/bsw_kuster.pdf

The UK Radiocommunications Agency commissioned a useful report (AY-4434, 2.4 GHz Monitoring Exercise) carried out by Mass Consultants Ltd in 2003. This looks in some considerable detail at microwave signals in the 2.4 GHz band and is available on the internet.
www.ofcom.org.uk/static/archive/ra/topics/research/topics/other/2-4ghzbandmonitoring.pdf

The BBC1 Panorama programme asked Powerwatch to make measurements for a programme on WiFi in schools, broadcast in May 2007. Values of between 0.2 and 1.5 V/m were measured 0.5 metres in front of a laptop downloading a file over the WiFi / wLAN wireless link. This is in good agreement with the above figures. The graphs below can be found at:
www.powerwatch.org.uk/news/20070529_panorama_extra.asp



The rationale behind these measurements was questioned by some people and a formal complaint made to the BBC about the Panorama programme. The BBC Editorial Complaints Unit has looked into this and has backed the programme's radiation experiment, saying *"The programme made clear that its measurements of wi-fi and mobile phone mast radiation were taken at the points where schoolchildren were likely to be exposed to the respective signals, thus avoiding the false impression that the level of radiation from wi-fi was higher at source."*
http://www.bbc.co.uk/complaints/news/2007/11/30/51156.shtml

The consistency of the measurements (typically in the range 0.1 to 2 V/m peak signal strength) made by many competent people using good quality equipment, that are orders of magnitude below the ICNIRP compliance levels, means that a new programme of work concentrating on making further measurements is not needed at present.

The error budgets on these measurements mean that all present-day WiFi signals will be ICNIRP compliant. That does not in any way address, or even help to address, the low-level exposure adverse health questions that are currently being asked.

Appendix B - Some Relevant References (post ICNIRP 1998)

This is not intended to be a comprehensive listing

2007

Abdel-Rassoul G, El-Fateh OA, et al, (March 2007) *Neurobehavioral effects among inhabitants around mobile phone base stations*. Neurotoxicology. 28(2):434-40 - PMID: 16962663 [View Abstract]

Carpenter D. and C. Sage (2007) *BioInitiative Report.* www.bioinitiative.org

Eltiti S, Wallace D, et al. (2007) *Development and evaluation of the electromagnetic hypersensitivity questionnaire*. Bioelectromagnetics 28: 137-151, PMID: 17013888 [View Abstract]

Eltiti S, Wallace D, et al.(2007) *Does Short-Term Exposure to Mobile Phone Base Station Signals Increase Symptoms in Individuals who Report Sensitivity to Electromagnetic Fields? A Double-Blind Randomised Provocation Study*. doi:10.1289/ehp.10286, PMID: 18007992 [View Abstract]

Foster KR, (March 2007) *Radiofrequency Exposure from Wireless LANs utilizing Wi-Fi Technology*, Health Physics, 92:1, 280-289, PMID: 17293700 [View Abstract]

Kuhn S, Lott U, Kramer A, Kuster N, (Aug 2007) *Assessment Methods for Demonstrating Compliance With Safety Limits of Wireless Devices Used in Home and Office Environments*, IEEE Transactions on Electromagnetic Compatibility, 49(3) 519-525 [View Abstract]

Mortazavi SM, Ahmadi J, Shariati M, (2007) *Prevalence of subjective poor health symptoms associated with exposure to electromagnetic fields among university students*, Bioelectromagnetics. 2007 May;28(4):326-30, PMID: 17330851 [View Abstract]

Preece AW, Georgiou AG, et al, (2007) *Health response of two communities to military antennae in Cyprus*. Occ and Env Med; 64:402-408, PMID 17259164 [View Abstract]

Schröttner J, Leitgeb N, Hillert L,(2007), *Investigation of electric current perception thresholds of different EHS groups*, Bioelectromagnetics, Apr;28(3):208-13, PMID: 17080457, [View Abstract]

2006

Aalto S, Haarala C, et al, (July 2006) *"Mobile phone affects cerebral blood flow in humans"*. J Cereb Blood Flow Metab. 26(7):885-90 PMID 16495939 [View Abstract]

Esen F, Esen H (March 2006) *"Effect of electromagnetic fields emitted by cellular phones on the latency of evoked electrodermal activity"*. Int J Neurosci. 116(3):321-9, PMID 16484058 [View Abstract]

Hardell L, et al, (2006) *Tumour risk associated with use of cellular telephones or cordless desktop telephones.*, World J Surg Oncol 2006 Oct 11;4:74, PMID 17034627 [View Abstract]

Havas M, (2006) *Electromagnetic Hypersensitivity: Biological Effects of Dirty Electricity with Emphasis on Diabetes and Multiple Sclerosis*, Electromagnetic Biology and Medicine, 25: 259–268 PMID 17178585 [View Abstract]

Huss A, Röösli M, (2006) *Consultations in primary care for symptoms attributed to electromagnetic fields--a survey among general practitioners*, BMC Public Health. 2006 Oct 30;6:267, PMID: 17074080 [View Abstract]

Hutter H-P, Kundi M, et al, (2006) *Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations*, Occup Environ Med 2006;63:307–313, PMID 16621850 [View Abstract]

Johansson O. (2006). *Electrohypersensitivity: State-of-the-art of a fundamental impairment.* Electromagnetic Biol. Med. 25: 235-258, PMID: 17178584 [View Abstract]

Kuhn S, Kuster N, (July 2006) *Development of Procedures for the EMF Exposure Evaluation of Wireless Devices in Home and Office Environments Supplement 1: Close-to-Body and Base Station Wireless Data Communication Devices, ITIS Foundation, ETH Zurich, 8092 Zurich.* www.bag.admin.ch/suchen/index.html?keywords=kuster&lang=en

Nylund R, Leszcynski D, (2006) *Mobile phone radiation causes changes in gene and protein expression in human endothelial cell lines and the response seems to be genome- and proteome-dependent,* Proteomics Sep;6(17):4769-80, PMID 16878295 [View Abstract]

Panagopoulos DJ, et al, (2006) *Cell death induced by GSM 900-MHz and DCS 1800-MHz mobile telephony radiation*, Mutat Res 2006 Oct 10, PMID 17045516 [View Abstract]

Schreier N, Huss A, Röösli M. (2006) *The prevalence of symptoms attributed to electromagnetic field exposure: a cross-sectional representative survey in Switzerland*, Soz Praventivmed. 51(4):202-9, PMID: 17193782 [View Abstract]

Yurekli AI, (2006) *GSM base station electromagnetic radiation and oxidative stress in rats*, Electromagn Biol Med 25(3):177-88, PMID 16954120 [View Abstract]

2005

Balmori A (2005) *Possible Effects of Electromagnetic Fields from Phone Masts on a Population of White Stork*, Electromagnetic Biology and Medicine, 24:109–119. A copy of the paper is available from: www.powerwatch.org.uk/news/20051006_storks.pdf

Bamberg Report (July 2005), Open letter to Edmund Stoiber, president of the federal state of Bavaria, from a group of general medical doctors regarding 357 patients, with supporting details of symptoms and microwave exposure levels. www.powerwatch.org.uk/news/20050722_bamberg.asp

Belyaev IY, Hillert L, et al, (April 2005) *"915 MHz microwaves and 50 Hz magnetic field affect chromatin conformation and 53BP1 foci in human lymphocytes from hypersensitive and healthy persons"*. Bioelectromagnetics. 26(3):173-84 - PMID 15768430 [View Abstract]

Huber R, Treyer V, et al, (Feb2005) *"Exposure to pulse-modulated radio frequency electromagnetic fields affects regional cerebral blood flow"*. Eur J Neurosci. 21(4):1000-6 - PMID 15787706 [View Abstract]

Kramer A, Kuhn S, Lott U, Kuster N; (Feb 2005) *Development of Procedures for the Assessment of Human Exposure to EMF from Wireless Devices in Home and Office Environments*. Technical report, ETH / ITIS Foundation, Zurich. www.bag.admin.ch/suchen/index.html?keywords=kuster&lang=en

Preece AW, Georgiou AG,et al, 2005, *The Akrotiri Military Antennae Survey Report*, a study for the Ministry of Health of the Republic of Cyprus by Bristol University. Available from: www.sba.mod.uk/environment_forms/Antennae%20Health%20survey.pdf

Rubin GJ, Das Munshi J, Wessely S. (2005), *Electromagnetic hypersensitivity: a systematic review of provocation studies*, Psychosom Med. 2005 Mar-Apr;67(2):224-32, PMID: 15784787 [View Abstract]

Seitz H, Stinner D, et al, (2005) *Electromagnetic hypersensitivity (EHS) and subjective health complaints associated with electromagnetic fields of mobile phone communication--a literature review published between 2000 and 2004*, Sci Total Environ. Oct 15;349(1-3):45-55, PMID: 15975631 [View Abstract]

2004

Al-Khlaiwi T, Meo SA (June 2004) *"Association of mobile phone radiation with fatigue, headache, dizziness, tension and sleep disturbance in Saudi population"*. Saudi Med J. 25(6):732-6 - [View Abstract]

Bortkiewicz A et al 2004 – *Subjective symptoms reported by people living in the vicinity of cellular phone base stations: review* Med Pr 55(4):345-51 15620045 [View Abstract]

Caraglia M, Marra M, et al, (June 2004) *"Electromagnetic fields at mobile phone frequency induce apoptosis and inactivation of the multi-chaperone complex in human epidermoid cancer cells"*. J Cell Physiol. 204(2):539-48 - PMID 15754340 [View Abstract]

Czyz J, Guan K, et al, (May 2004) *"High frequency electromagnetic fields (GSM signals) affect gene expression levels in tumor suppressor p53-deficient embryonic stem cells"*. Bioelectromagnetics. 25(4):296-307 - PMID 15114639 [View Abstract]

Eger H et al 2004 – *The influence of being physically near to a cell phone transmission mast on the incidence of Cancer* Umwelt Medizin Gesellschaft 17.4.2004 [View pdf file]

IEC TC106; (Jan 2004), *Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30MHz to 6 GHz* (draft).

Nikolova T, Czyz J, et al, (October 2004) *"Electromagnetic fields affect transcript levels of apoptosis-related genes in embryonic stem cell-derived neural progenitor cells"*. Bioelectromagnetics. 19(12):1686-8 - PMID 16116041 [View Abstract]

Oberfeld G, Navarro A E, et al, (August 2004). *"The Microwave Syndrome - Further aspects of a Spanish Study"*. Conference Proceedings - [View Summary and Download Report]

Röösli M, Moser M, et al, (2004) *Symptoms of ill health ascribed to electromagnetic field exposure--a questionnaire survey*, Int J Hyg Environ Health. Feb;207(2):141-50, PMID: 15031956 [View Abstract]

Sarimov R, Malmgren LOG, et al, (2004) *"Nonthermal GSM Microwaves Affect Chromatin Conformation in Human Lymphocytes Similar to Heat Shock"*. IEEE Trans Plasma Sci 32:1600-1608 [View Abstract]

Wolf R & Wolf D 2004 – *Increased incidence of cancer near a cell-phone transmitter station* Int J of Cancer Prevention 1(2) [View pdf file]

2003

Huber R, Schuderer J, et al, (May 2003) *"Radio frequency electromagnetic field exposure in humans: Estimation of SAR distribution in the brain, effects on sleep and heart rate"*. Bioelectromagnetics. 24(4):262-76 - PMID 12696086 [View Abstract]

Kramarenko AV, Tan U (July 2003) *"Effects of high-frequency electromagnetic fields on human EEG: a brain mapping study"*. Int J Neurosci. 113(7):1007-19 - PMID 12881192 [View Abstract]

Leitgeb N, Schröttner J, (2003), *Electrosensibility and electromagnetic hypersensitivity*, Bioelectromagnetics, Sep;24(6):387-94, PMID: 12929157 [View Abstract]

Navarro E A, et al, (2003) *The microwave syndrome: a preliminary study in Spain*, Electromagnetic Biology & Medicine 22 (2 & 3) 161-169 [View Abstract]

Santini R, Santini P, et al (September 2003). *"Symptoms experienced by people in vicinity of base stations: II/ Incidences of age, duration of exposure, location of subjects in relation to the antennas and other electromagnetic factors"*. Pathol Biol (Paris). 51(7):412-5, PMID 12948762 [View Abstract]

Santini R, Santini P, et al, (2003) *Survey Study of people living in vicinity of cellular phone base stations*, Biol.Med., 1:41-49 [View Abstract]

2002

Edelstyn N, Oldershaw A, (January 2002) *"The acute effects of exposure to the electromagnetic field emitted by mobile phones on human attention"*. Neuroreport. 13(1):119-21 PMID 11924872 [View Abstract]

Freiburger Appell, (October 2002) A signed document by about 200 medical practitioners regarding symptoms in people living near to mobile phone base stations etc was published by IGUMED ü Interdisziplina re Gesellschaft fur Umweltmedizin e.V. www.igumed.de

Huber R, Treyer V, et al, (December 2002) *"Electromagnetic fields, such as those from mobile phones, alter regional cerebral blood flow and sleep and waking EEG"*. J Sleep Res. 11(4):289-95 PMID 12464096 [View Abstract]

Hillert LN, Berglind BB. et al, (2002). *Prevalence of selfreported hypersensitivity to electric or magnetic fields in a population-based questionnaire survey*, Scand J Work Environ Health. 2002 Feb;28(1):33-41, PMID: 11871850 [View Abstract]

Leszczynski D, Joenväärä S, Reivinen J, Kuokka R (May 2002) *"Non-thermal activation of the hsp27/p38MAPK stress pathway by mobile phone radiation in human endothelial cells: molecular mechanism for cancer- and blood-brain barrier-related effects"*. Differentiation. 70(2-3):120-9 PMID 12076339 [View Abstract]

Levallois P. (2002) *Hypersensitivity of human subjects to environmental electric and magnetic field exposure: a review of the literature*, Environ Health Perspect. 2002 Aug;110 Suppl 4:613-8, PMID: 12194895

Levallois P, Neutra R, et al, (2002), *Study of self-reported hypersensitivity to electromagnetic fields in California*, Environ Health Perspect. 2002 Aug;110 Sup 4:619-23, PMID: 12194896 [View Abstract]

Santini R, Santini P, et al, (July 2002). *"Investigation on the health of people living near mobile telephone relay stations: I/Incidence according to distance and sex"*. Pathol Biol (Paris). 50(6):369-373 PMID 12168254 [View Abstract]

2000

Hillert L. (2001) *Hypersensitivity to electricity; Symptoms, risk factors and therapeutic interventions*. Thesis, Karolinska Institute, Stockholm. 56 pp.

Huber R, Graf T, et al, (October 2000) *"Exposure to pulsed high-frequency electromagnetic field during waking affects human sleep EEG"*. Neuroreport. 11(15):3321-5 PMID 11059895 [View Abstract]

Krause CM, Sillanmäki L, et al, (December 2000) *"Effects of electromagnetic fields emitted by cellular phones on the electroencephalogram during a visual working memory task"*. Int J Radiat Biol. 76(12):1659-67 PMID 11133048 [View Abstract]

Koivisto M, Krause CM, et al, (June 2000) *"The effects of electromagnetic field emitted by GSM phones on working memory"*. Neuroreport. 11(8):1641-3 PMID 10852216 [View Abstract]

Krause CM, Sillanmäki L, et al, (March 2000)*"Effects of electromagnetic field emitted by cellular phones on the EEG during a memory task"*. Neuroreport. 11(4):761-4 PMID 10757515 [View Abstract]

UK Parent-Teacher study (2000) www.powerwatch.org.uk/news/20001202_school.asp

1998

Eulitz C, Ullsperger P, et al, (October 1998) *"Mobile phones modulate response patterns of human brain activity"*. Neuroreport. 9(14):3229-32 PMID 9831456 [View Abstract]

Freude G, Ullsperger P, et al, (1998) *"Effects of microwaves emitted by cellular phones on human slow brain potentials"*. Bioelectromagnetics. 19(6):384-7 PMID 9738529 [View Abstract]

Plus one very relevant older paper:

Lai H, Carino MA, et al, 1989 – *Low-level microwave irradiation and central cholinergic systems*, Pharmacol Biochem Behav 33(1):131-8, PMID 2675124 [View Abstract]