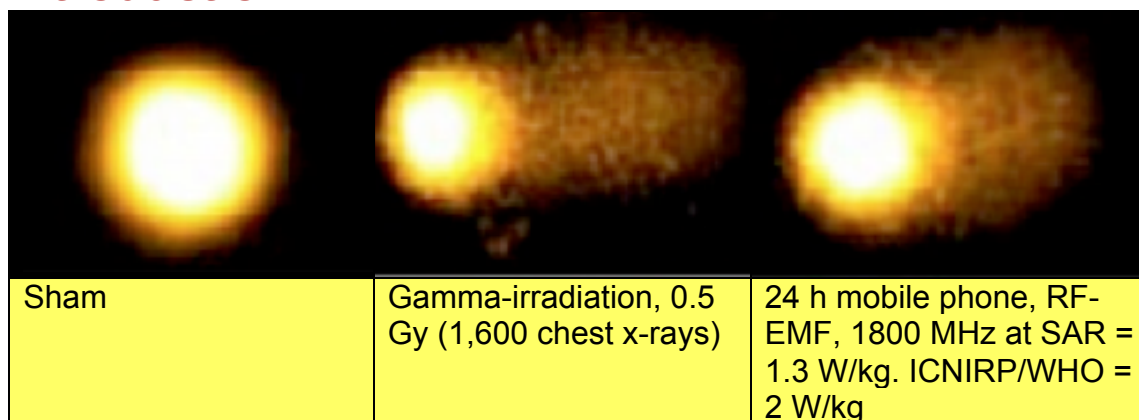


# Possible Health Risks

## Introduction



Comet Assay - a typical picture after RF-EMF-exposition of HL60 leukaemia cells  
Image source: Adlkofer (2004).

*“... children, the elderly, and some chronically ill people might have a lower tolerance for one or more forms of [non-ionising radiation] exposure than the rest of the population.”*  
International Commission on Non-Ionizing Radiation Protection (ICNIRP 2002).

The photos above show the effects of different types of radiation on gene expression of human HL60 cells. **The effects of radiation from the mobile phone, which is below current ICNIRP/WHO standards, creates a similar effect to the high dosage of gamma radiation (Adlkofer 2004).**

It would appear prudent to undertake similar tests with Smart Meters and smart appliances, particularly as RF/microwaves are now regarded as possibly carcinogenic to humans by the WHO/ International Agency for Research on Cancer (WHO/IARC 2011).

As no official data is available on the health effects of exposures to radiation from Smart Meters and related devices; reference is made to research undertaken on other devices emitting RF/microwave radiation at similar intensities.

Some tests which found “no effect” from exposure used methods 10-100 times less sensitive than those shown in the above (Morgan et al. 2009).

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## Autism



Image source: <http://www.dreamstime.com/royalty-free-stock-photography-autism-kid-looking-far-away-image20515227>

The lifetime costs for someone with high-functioning autism is £3.1 million and the lifetime costs for someone with low-functioning autism is £4.6 million (Knapp et al. 2007). The number of individuals diagnosed with autism is steadily increasing.

The present annual cost of autism to the UK economy is £27.7 billion (Knapp et al. 2009).

In 1978 it was estimated that approximately 0.04% of individuals exhibited classic autism. Around 1% of the UK population now exhibits autism-spectrum conditions (including classic autism), with approximately 1.57% of school children exhibiting autism-spectrum conditions. This may be due to, amongst other factors, improved detection and recognition (Baron-Cohen et al. 2009).

Kane (2004) suggests that an additional factor may also be at work – electromagnetic pollution. Whilst there are likely to be a number of potential factors that could in part be responsible for any increases that may actually have arisen; his hypothesis is worthy of further study, particularly if lower field regimes are shown to reduce the risk and severity of such conditions and their cost to national economies.

The reasoning behind his suggestion is “... *that human exposures to RF radiation have become pervasive during the past 20 years, whereas such exposures were uncommon prior to that time,*” and that the increased fetal or neo-natal exposures that could have occurred as a result of such variations may be a driver of increased incidence.

Lathe (2010) notes that, in the absence of firm data demonstrating that RF/microwave radiation cannot influence brain tissue, Kane’s hypothesis is plausible.

Presently anecdotal evidence as to why such a theory should be taken seriously, at least till it can be disproved or properly verified, is provided by an unpublished pilot study by Dr Dietrich Klinghardt MD, PhD. It intriguingly links higher levels of microwave radiation [ $0.011\text{-}0.171\text{ }\mu\text{W}/\text{cm}^2$ ], in the bedrooms of pregnant women to increased risk of autism and other neurological impairments in their children compared to low field bedrooms [ $0.0001\text{-}0.004\text{ }\mu\text{W}/\text{cm}^2$ ] (Klinghardt 2008).

Also of interest is a related study of 13,159 children by Divan et al. (2008), which found a 54% higher chance of children having emotional and social problems at school age if their mothers used mobile phones during pregnancy. Whether there is in fact a link remains open to conjecture.

It appears prudent to determine if raised EMF exposures do increase autism risk, and if so how new generations of 'bio-friendly' technology can mitigate, or even reverse, such risk.

Such precautions are in line with Resolution 1815 of the Council of Europe calls for all reasonable measures to be taken to reduce exposure to electromagnetic fields, particularly RF/microwaves (PACE 2011).

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## Alzheimer's disease



Image source: <http://www.dreamstime.com/stock-photo-elderly-woman-with-alzheimer-image21269060>

It has been suggested that the rise in Alzheimer's disease and other dementias may be the "*Most Significant Health Crisis of the 21st Century*." The number of people with dementia is predicted to double by 2030 and more than triple by 2050 (ADI 2010).

Research in Sweden and the USA have indicated a link between occupational exposures to EMFs and Alzheimer's disease (Davanipour et al. 2007, Feychting et al. 2003, Sobel et al. 1996).

It has also been indicated that there is a dose-response link between environmental exposures to EMFs and senile dementia and Alzheimer's disease (Davanipour & Sobel 2009, Huss et al. 2009).

It appears important to reduce ELF and RF/microwave magnetic field exposures "*through equipment design changes and [proper] environmental placement of electrical equipment ...*"  
Davanipour & Sobel (2009).

Very weak microwave radiation can change the shape of cellular proteins in the brain causing them to clump together into formations that resemble pathological fibrils associated with this disease (MWN 2003).

Earlier animal research by Dr Sam Koslov, who was the Director of the Applied Physics Laboratory at John Hopkins University in the US, led him to accidentally discover that exposing chimpanzees to repeated low-level nonthermal microwave exposures produced clinical Alzheimer's disease - lack of funding prevented his findings being followed up at that time (Becker 1990).

Increased risk of Alzheimer's disease and other neurodegenerative disorders is also linked to the increased production of peroxynitrite,

which can damage a wide variety of molecules in cells (including proteins and DNA). Its production can be increased by RF/microwave radiation that causes NADH-oxidase to create extra free electrons in a dose related manner that stimulate its production (Friedman et al. 2007).

Increased peroxynitrite production, as can be caused by exposure to RF/microwave radiation, is a pathogenic contributor to conditions such as: cancer, chronic heart failure, chronic inflammatory diseases, circulatory shock, diabetes, myocardial infarction, stroke, myocardial infarction and stroke (Pacher et al. 2007).

There are other electromagnetic factors that may affect the risk of succumbing to dementia. These, however, are out with the brief of this current document – *present author's comments*.

Interestingly, research by Arendash et al. (2010) indicates that unmodulated microwaves might be able to mitigate the effects of Alzheimer's. However, as the health effects of both these and modulated microwaves (as experienced when using mobile phones) have yet to be adequately researched, caution is required.

The cost of Alzheimer's and other dementias to the UK economy is presently £23 billion per year (ARUK 2011).

The number of individuals in the UK with dementia is presently predicted to rise as the population ages. Reducing RF/microwave exposure may be a novel way to help reduce the number of future sufferers. This may in part be achieved through optimising the design of Smart Meters, and related technologies, to help reduce/optimize individuals' exposures.

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*“The worldwide costs of dementia will exceed 1% of global GDP in 2010, at US\$604 billion. ... The costs of caring for people with dementia are likely to rise even faster than the prevalence...” ADI (2010).*

**Dementia is one of the World’s most costly illnesses. Interventive measures that reduce risk are likely to save Governments substantial outgoings.**

## Cancer



Image source: jscreationzs, [http://www.freedigitalphotos.net/images/view\\_photog.php?photogid=1152](http://www.freedigitalphotos.net/images/view_photog.php?photogid=1152)

Cancer rates are rising in the UK. The annual cost of cancer to England (not the whole UK – *present author's comment*) in terms of healthcare costs, lost productivity and costs to patients and families is £18.33 billion. These figures are set to rise to £24.72 billion over the next ten years. This figure is 6% higher than the European average (Featherstone & Whitham 2010).

The UK charity Macmillan Cancer Support claims 4 in 10 individuals in the UK may have cancer at some point in their lives (Brimelow 2011). In the USA, it is estimated that around 41 percent of citizens will be diagnosed with cancer at some time in their lives and approximately 21 percent die from it (US DHSS 2010).

*“Cancer is the world’s leading cause of death, followed by heart disease and stroke. ... cancer also has the greatest economic impact from premature death and disability of all causes of death worldwide. This data provides compelling evidence that balancing the world’s global health agenda to address cancer will not only save millions of lives, but also billions of dollars,” ACS (2010).*

As the International Agency for Research on Cancer (IARC) - which is part of the World Health Organization (WHO) - now classifies RF/microwave radiation as possibly carcinogenic to humans in recognition of growing concern over *“the possibility of adverse health effects resulting from exposure to radiofrequency electromagnetic fields, such as those emitted by wireless communication devices,”* (WHO/IARC 2011); it may be prudent to opt for Smart Meter options that avoid creating EMF regimes that may increase this risk.

Whilst there is growing anecdotal evidence on the effects of RF/microwave emissions from Smart Meters on health, no proper research appears to have been undertaken to date. As this is the case, examples are given of other studies assessing the possible effects of similar types of radiation on animals and individuals as related to cancers.



Whilst a large number of studies (such as those shown below) indicate a link between inappropriate exposures to some EMF regimes and negative health effects; it is important to recognise that not all studies do so, and that beneficial field regimes can also be created (Jamieson et al. 2010).

Eger et al. (2004) found increased risk of malignant tumours in individuals exposed to radiation from mobile phone base stations.

Their work, covering the period 1999-2004, indicated that after 5 years, risk of malignant blastoma for those in the vicinity of the phone mast was 3 times that of individuals living further away (Eger et al. 2004).

(Earlier animal tests by Repacholi et al (1997) found long-term (up to 18 months) intermittent exposure to pulsed 900 MHz fields resulted in significantly enhanced probability of cancer in cancer-prone mice).

Wolf & Wolf (2004) found relative cancer rates for females living adjacent to a base station were significantly higher ( $p < 0.0001$ ) than those living in a low field area and the rest of the city. They recorded 4.15 times more cases in the area adjacent the base station than for the entire population.

Dode et al. (2011) too found a strong association between increased exposures to RF/microwave emissions from base stations (as determined by distance from base stations) and human deaths from cancer in research undertaken in the city of Belo Horizonte in Brazil. Their findings led them to “*strongly suggest the adoption of the Precautionary Principle*” until satisfactory limits of human exposure can be determined.

An association has also been noted between increased incidences of childhood leukaemia & mortality through RF fields at power densities of  $8 \mu\text{W}/\text{cm}^2$  (Hocking et al. 1996); a power-density lower than that noted by PG&E (2011) as being created by a single wireless Smart Meter.

Additionally, RF/microwave exposure has been shown to cause DNA damage (De luliis et al. 2009). Changes in DNA can be a precursor of cancer and cause genetic mutations.

The above studies, whilst being in no way definitive, do provide good reason for lowering field emissions wherever practical as a precautionary measure.

The need for additional research particularly under field regimes individuals might receive in standard domestic environments when Smart Meters and smart appliances are installed appears necessary.

*“The influence of electrosmog on the human body is a known problem. ... The risk of damage to health through electrosmog has also become better understood as a result of more recent and improved studies. When for example, human blood cells are irradiated with electromagnetic fields, clear damage to hereditary material has been demonstrated and there have been indications of an increased cancer risk. ...”* Swisscom AG - major Swiss telecommunications provider (Swisscom AG 2003).

For additional details on studies which indicate that long-term low intensity RF/microwave exposures may provoke cancer growth please refer to the review document by Yakymenko et al. (2011).

*“... just as there are many opportunities for harmful environmental exposures, ample opportunities also exist to intervene in, ameliorate, and prevent environmental health hazards. Governments, industry, the academic and medical communities, and individuals all have untapped power to protect the health of current and future generations ... and reduce the national burden of cancer.”* US President’s Cancer Panel (US DHSS 2010).

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In 2008 the total economic impact of premature death and disability from cancer worldwide was \$895 billion. This figure is equivalent to 1.5 % of the World's Gross Domestic Product (GDP) and does not incorporate direct medical costs (ACS 2010).

Tests assessing the potential biological effects of exposures to different types of 'smart' technology regimes to prove that they are safe may prove prudent, as this could lead to the development of safer RF/microwave technologies if risks are determined to be real.

## Diabetes



Image source: Ambro / FreeDigitalPhotos.net, [http://www.freedigitalphotos.net/images/view\\_photog.php?photogid=1499](http://www.freedigitalphotos.net/images/view_photog.php?photogid=1499)

Diabetes related care costs the UK upwards of £5 billion annually (Currie et al. 1997).

The cost of diabetes drugs and treatment have risen 40% in the last five years, and since 1996 the number of diagnosed individuals has increased from 1.4 million to 2.6 million.

It is predicted that, unless matters are taken in hand, over four million people will have diabetes by 2025 (Diabetes UK 2010).

'Dirty electricity' - high frequency transients created by a variety of electrical devices (including some Smart Meters) and sometimes carried on mains electricity - may be a contributory factor to diabetes and other health conditions (Milham 2011, Havas 2006).

The switching-mode power supply (SMPS) units in Smart Meters can often create such transients, and it has been suggested may in part be responsible for the detrimental health effects observed with Smart Meter installations even when wireless transmission is disabled (Brangan & Heddle 2011) – Refer also to the section '*PLC, Smart Meters and health*' elsewhere in this review.

The effects of exposure to RF/microwaves regimes from wireless Smart Meters on diabetics have yet to be assessed.

Havas (2006) determined that Type 1 diabetics required less insulin and Type 2 diabetics registered lower blood sugar levels when in electromagnetically clean environments.

Poor sleep is also a contributory factor to diabetes – see *related notes on Fatigue/sleep deprivation*:

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*"The prevalence of diabetes has reached epidemic proportions. ... Diabetes is one of the major causes of premature illness and death worldwide. Non-communicable diseases including diabetes account for 60% of all deaths worldwide."* World Diabetes Foundation (2010).

## Electrohypersensitivity



Source: <http://en.fotolia.com/id/25156314>

This is known by a variety of terms including 'Electrosensitivity' (ES), 'Electrohypersensitivity' (EHS), 'Electromagnetic Hypersensitivity' (EHS) and 'Idiopathic Environmental Intolerance with Attribution to Electromagnetic Fields' (IEI-EMF). The WHO began investigating it after Dr Gro Harlem Brundtland, their Director General (and former Prime Minister of Norway) announced she had EHS before she retired.

A variety of symptoms are reported by individuals who claim to be EHS. These include: depression, dizziness, fatigue, headaches, irregular heartbeat and palpitations, irritability, memory deficits, nausea, feeling stressed, sleep difficulties (including insomnia), skin rashes, whole-body skin symptoms, feeling of thirst (not quenched by drinking) and tinnitus.

Many of the above symptoms are reported by individuals exposed to radiation from wireless Smart Meters.

Peer-reviewed studies (not directly investigating EHS) indicate increased occurrence of a number of these symptoms in areas where raised exposures to RF/microwaves exist. A partial listing is given below:

**Depression:** Eger & Jahn (2010) found a highly significant dose-response relationship between the RF/microwave field strengths encountered at residential locations and depression ( $p < 0.001$ ). In their study, the mean radiation exposure level of the highest exposure group (1.2 V/m) was substantially higher than that recorded in other work.

Santini et al. (2002) found an increase in depression for people living within 100 m of a base station, as opposed to in lower field regimes. Women were particularly affected ( $p < 0.05$ ). Increased



incidence of depression also noted under similar circumstances by Bortkiewicz et al. (2004).

The cost to the UK economy of depression in terms of lost earning is now over £9bn a year. This represents an increase of £4bn since 1999, and a rise of half a billion over the last year (RSHCL 2010).

**Dizziness:** Eger & Jahn (2010) noted a highly significant dose-response relationship between the RF/microwave field strengths measured at residential locations and dizziness when comparing high field and low field exposure groups – *mean exposures levels of 1.17 V/m compared to 0.70 V/m* ( $p < 0.001$ ).

Santini et al. (2002) found an increase in individuals complaining of dizziness when they were living within 100 m of a base station, as opposed to living further away ( $p < 0.05$ ), whilst Simonenko et al., (1998) noted increased incidence of dizziness occurred in individuals at occupational exposures of  $1.0 \mu\text{W}/\text{cm}^2$ .

**Headaches:** Eger & Jahn (2010) recorded a highly significant dose-response relationship between residential locations and headaches when comparing high field and low field exposure groups – *mean exposures levels of 1.17 V/m compared to 0.70 V/m* ( $p < 0.001$ ).

Hutter et al. (2006) documented a significant link ( $p < 0.017$ ) between headaches and exposures to power densities  $>0.05 \mu\text{W}/\text{cm}^2$  (maximum  $0.41 \mu\text{W}/\text{cm}^2$ ) compared to  $\leq 0.01 \mu\text{W}/\text{cm}^2$ .

Simonenko et al. (1998) recorded increased incidence of headaches at  $1.0 \mu\text{W}/\text{cm}^2$ .

Santini et al. (2002) noted an increase in individuals, particularly women, complaining of headaches when living within 200 m of a base station as opposed to further away, or not exposed to radiation from a base station ( $p < 0.05$ ).

Bortkiewicz et al. (2004) also found incidence of headaches related to exposure and distance to base station. This was found for both those who associated their condition with being in proximity to the base station and those who did not.

Headache disorders cost the UK around £7 billion a year in absenteeism and reduced productivity (Thomas 2009).

**Irritability:** Santini et al. (2002) noted an increase in individuals complaining of irritability when living within 100 m of a base station, as opposed to further away or not exposed to radiation from a base station ( $p < 0.05$ ).

Bortkiewicz et al. (2004) also noted that increased complaints of irritability in individuals close to base stations. Simonenko et al., (1998) found occupational exposures of  $1.0 \mu\text{W}/\text{cm}^2$  were associated with increased irritability.

**Memory deficits:** Increased incidence of concentration difficulties was found in the vicinity of base stations by Bortkiewicz et al. ] could also be affected. Poorer memory retention was found by Santini et al. (2002) for individuals living within 100 m of a base station ( $p < 0.05$ ).

Simonenko et al. (1998) reported incidence of difficulty breathing, dizziness, chest pain, fatigue, headache, indigestion, insomnia, irritability & weakness) at occupational exposures of  $1.0 \mu\text{W}/\text{cm}^2$ .

### Incidence of EHS

A 2001 Swiss survey by Rösli et al. (2004), investigating symptoms of ill-health ascribed to EMF exposure, revealed that individuals most often related their symptoms to exposure to RF/microwave radiation from mobile phone base stations (74%), followed by use of mobile phones (36%), cordless phones (29%) and exposure to power lines (27%). **The most common mitigative measure taken by the respondents was to avoid exposures.**

Removing or disconnecting field sources indoors was judged to be particularly effective in reducing/preventing symptoms.

EHS symptoms often only become apparent in many individuals when exposed to higher field regimes. Whilst it is omm. nted that psychosomatic responses can occur, the extent to which biological effects (and differences in autonomic system regulation between individuals – *present author's comment*) may influence results has yet to be fully taken into account.

**National variations:** Figures on individuals who may be EHS vary greatly between countries. This may be in part due to differences in educational awareness, survey definitions, environmental factors and variations in the field regimes individuals are exposed to.

It is estimated by Schreier et al. (2006) that approximately 5% of the Swiss population may be EHS. If a similar fraction is affected in the UK, this would amount to approximately 3,090,000 individuals.

A German study involving 30,047 participants, found that 10.3% attributed personal adverse health effects they had to exposure to RF/microwave emissions from mobile phone base stations (Blettner et al. 2009).

EHS has become officially fully documented as a functional impairment in Sweden since 2007. It is not regarded as a disease (Johansson 2010).

Survey studies indicate that around 230,000 – 290,000 Swedish adults (out of a population of 9,000,000) report a variety of symptoms when in contact with manmade sources of EMFs (Miljöhälsorapport 2001). The work of Eger & Jahn (2010) also indicates a highly significant dose-response relationship between the RF/microwave field exposures and symptoms reported by some EHS individuals.

Rea et al. (1991), found that EHS is a real phenomenon in some environmentally sensitive patients (under special test conditions), as they exhibited consistent reactions while none of the controls did.

A similar deduction was recently reached by McCarty et al. (2011) who concluded, “*EMF hypersensitivity can occur as a bona fide environmentally-inducible neurological syndrome.*”

In 2011, the Labour Court in Madrid, Spain declared that hypersensitivity, caused in part by exposure to RF/microwaves, can cause permanent disability. The ruling is unique in this regard and sets a precedent for future conditions related to EHS. The verdict issued on 23<sup>rd</sup> May awarded the college professor, who has been permanently incapacitated, a permanent disability pension at 100% of his base salary rate.

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Refer also to Appendix 8 – Seletun Resolution

## Fatigue/sleep deprivation



Image source: Michal Marcol, [http://www.freedigitalphotos.net/images/view\\_photog.php?photogid=371](http://www.freedigitalphotos.net/images/view_photog.php?photogid=371)

Exposure to some RF/microwave radiation regimes are linked with fatigue and insomnia (Eger & Jahn 2010, Hutter et al. 2006, Bortkiewicz et al. 2004).

Simonenko et al. (1998) noted occupational exposures of  $0.1 \mu\text{W}/\text{cm}^2$  could cause both fatigue and insomnia in humans, whilst Santini et al. (2002) found a significant increase in individuals complaining of fatigue within 300 m of a base station and sleep disturbances within 200 m of a base station ( $p < 0.05$ ).

Lack of sleep may be a causal factor in premature ageing, high blood pressure, diabetes, obesity, depression and other mental health problems, and can also tax the immune system.

The present annual cost to the UK economy of chronic sleep deprivation is estimated at £1.6 billion (Bupa 2010).

27% of UK workers regularly go to work tired and unrefreshed from sleep. Over 50% arrive at work fatigued more than 20 times a year. Those with sleep debt take on average three days a year more sick leave (at an average cost of £93.50 per employee day lost).

When tired, workers are 23% less satisfied with their jobs. As noted by Dinges et al. (1997), individuals with less than 8 hours sleep exhibit reduced decision making abilities, dramatic attention lapses and distinct physiological and cognitive deficits, (including impaired memory). The effects of these deficits increase as sleep debt continues.

**Fatigue/sleep deprivation and accidents:** Long-term sleep deprivation increases the likelihood of motor vehicle accidents. At present, driver fatigue is responsible for almost 20% of traffic accidents on main roads in the UK (DfT 2011).

*"The only real cure for sleepiness is proper sleep."*  
UK Department for Transport (DfT 2005).

The extent to which EMF emissions by some types of Smart Meters and related technologies may result in increased fatigue and insomnia has yet to be fully determined. One survey indicated that 49.1% of their respondents reported sleep problems in either themselves or members of their household after the installation of wireless Smart Meters (SDA 2011). *Refer also to Appendix 1.*

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## Infertility



### Animals

Research by Magras & Zenos (1997) recorded irreversible infertility in mice after 3 generations at exposures of  $1.053 \mu\text{W}/\text{cm}^2$  from a RF tower – measurements were taken in the 80–900 MHz range. Lower exposures of  $0.168 \mu\text{W}/\text{cm}^2$  (further away from the tower) were linked with total infertility in mice after 5 generations.

As mentioned elsewhere in this document, PG&E (2011) have recorded a power-density of  $8.8 \mu\text{W}/\text{cm}^2$  (in the 902-928 MHz range) 30.5 cm from a single wireless Smart Meter. Wireless Smart Meters can also operate in the 450-470 MHz and 2.4 GHz range.

Mailankot et al. (2009) reported that exposing male Wistar rats to active mobile phone radiation at frequencies of between 900 MHz to 1.8 GHz for 1 hour per day for 28 days significantly decreased sperm motility. They also suggested that exposure to RF/microwave radiation may impair fertility. The review by Desai et al. (2009) further covers the effects of RF/microwave radiation on animal fertility and also discusses possible mechanisms that might lead to the RF/microwave related infertility in human males.

### Humans

Falzone et al. 2011 found that 1 hour exposure to 900 MHz radiation (from mobile phones) caused significant reduction in sperm head areas ( $9.2 \pm 0.7 \mu\text{m}^2$  versus controls  $18.8 \pm 1.4 \mu\text{m}^2$ ), and noted a significant decrease in sperm binding compared to controls – *their results indicated that RF/microwaves could have a significant effect on sperm fertilisation potential.*

A pilot study by Agarwal et al. (2009) also revealed a significant reduction in sperm motility and sperm vitality as a result of exposure to such radiation. Additionally, Santini et al. (2002) found a significant loss in libido for subjects within 100 m of a base station ( $p < 0.05$ ).

Davoudi et al. (2002) tested men who had normal spermiogramms ( $n = 13$ ). They were tested 5 days after not carrying or using mobile phones, then tested 4 weeks later (after carrying mobile phones on their belts and using them 6 hours per day for the 5 days before their final test). Increased exposure to RF/microwaves (through mobile phone use) was indicated as possibly reducing sperm motility by 32.3% ( $p = 0.01$ ).

In research by De Iuliis et al. (2009), purified human spermatozoa exposed to raised levels of RF/microwave radiation exhibited significantly reduced sperm motility and vitality. Significantly elevated DNA fragmentation and mitochondrial generation of reactive oxygen species were found to occur after exposure ( $p < 0.001$ ).

De Iuliis et al. (2009) concluded that their own research indicated that there were “*clear implications for the safety of ... [increased RF/microwave exposures to] males of reproductive age, potentially affecting both their fertility and the health and wellbeing of their offspring.*”

Dramatically reduced birth rates would cause a declining labour force, crucially undermining individual countries' economic viability and increasing the burden of supporting the ill and elderly.

At present exposure to many types of Smart Meter and smart appliance would increase RF/microwave radiation indoors 24/7. Research urgently needs to be undertaken to determine suitable solutions so that smart metering regimes do not impact negatively on health.

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It has also been indicated that RF/microwave radiation at levels encountered in the environment may affect fertility of insects, birds and amphibians – Refer to section on '*Environmental Concerns*'.

## Learning ability



### The hippocampus

The brain's hippocampus plays a vital role in consolidating information from short-term memory to the long-term memory and in matters related to spatial navigation. Some RF/microwave regimes have been indicated as damaging it and also compromising its development.

Animal research by Odaci et al. (2008) has shown that exposing pregnant rats to 900 MHz RF/microwave radiation (created by a mobile phone in talk mode for 1 hour daily) for the duration of the pregnancy resulted in far fewer nerve cells being present in this part of the brain in offspring ( $p < 0.01$ ). This will have effects on learning and memory.

Some wireless electric Smart Meters operate in the 902-928 MHz range.

Salford et al. (2003) additionally reported that exposing rats to 915 MHz RF/microwave regimes from mobile phones for 2 hours produced highly significant ( $p < 0.002$ ) evidence of neuronal damage in the hippocampus and other parts of the brain.

### Memory function

A number of animal tests have been undertaken to help determine the possible effects of RF/microwave exposures on learning abilities. To date none have been undertaken related to emissions from various types of Smart Meters and related technologies.

### 900 – 1800 MHz exposures

Nittby et al. (2008) investigated the possible effects of exposure to 900 MHz radiation on rats' cognitive functioning. 32 out of 56 rats (*the rest being either sham exposed or controls*) were exposed for 2 hours every week for 55 weeks to RF/microwave mobile phone

radiation. After this protracted exposure, they were compared to sham exposed controls.

The RF/microwave exposed rats exhibited impaired memory for objects and temporal order of presentation compared to the sham exposed controls ( $p = 0.02$ ). Their results indicated significantly reduced memory functions in rats after 900 MHz RF/microwave exposures ( $p = 0.02$ ) (Nittby et al. 2008).

Research by Fragopoulou et al. (2009) demonstrated that exposing mice for approximately 2 hours per day to 900 MHz RF/microwave radiation from a mobile for four days caused cognitive deficits in spatial learning and memory. In that study, the exposed mice were shown to be less proficient in transferring learned information to the following day, and exhibited deficits in consolidation and/or retrieval of learned information.

Narayanan et al. (2009), undertaking tests on 10-12 week old male rats, found exposing them to the 900/1800 MHz RF/microwave radiation of 50 missed calls a day from a mobile phone daily for 4 weeks induced behavioural changes though the exact cause of these undetermined.

The rats exposed to RF/microwave radiation took longer to undertake tasks, had poorer spatial navigation and exhibited poorer memory function than those unexposed. (Narayanan et al. (2009).

## 2.4 GHz exposures

Some wireless Smart Meters operate in the 2.4 GHz range. Again tests have not yet been undertaken to determine the biological effects of their operation 24/7 on leaning ability or other biological functions.

Research undertaken by Wang & Lai & (2000) indicated that exposure to some 2.45 GHz RF/microwave regimes may affect memory.

In that work, the long-term memory and navigational skills of rats appeared negatively influenced by one hour of exposure to 2.45 GHz radiation (pulse width 2ms, 500 pulses/s, average power density of  $2,000 \mu\text{W}/\text{cm}^2$ ) as compared to the unexposed control group. Whilst some studies by others failed to replicate this work (MMF 2005), the need for caution is indicated.

A later study by Li et al. (2008), found exposing rats to a 2.45 GHz pulsed RF/microwave field at an average power density of 1,000  $\mu\text{W}/\text{cm}^2$  for 3 hours daily for up to 30 days resulted in significant deficits in spatial learning and memory performance in the exposed rats.

### Concentration, memory or learning problems

Though no official human testing has been undertaken related to Smart Meters, a survey on their impacts found that for 34.6% of recipients (n = 318), either they or individuals in their homes experienced worsened concentration, memory or learning problems since Smart Meter installations (SDA 2011). Refer also to Appendices 3 and 4 related to '*Health promotion*' and '*Educational buildings and Smart Meters*'.

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## Obesity



Image source: Michelle Meiklejohn, [http://www.freedigitalphotos.net/images/view\\_photog.php?photogid=901](http://www.freedigitalphotos.net/images/view_photog.php?photogid=901)

Obesity is on the rise worldwide. It is estimated that the annual cost of obesity in the USA may be over \$75 billion (Finkelstein et al. 2004).

In 1980, 36% of the UK population was categorised as being overweight or obese. By 2004 this figure had risen to 63%, with a third being categorised as obese. Almost two of every three individuals in the UK are overweight or obese (WHO 2005). If this is not addressed, 60% of men, 50% of women and 25% of children in the UK could be obese by 2050 (DH 2011).

Obesity increases risk of many serious ailments:  
Cardiovascular disease, Cancer, Diabetes, High blood pressure, Osteoarthritis, Psychological problems / Mental Disorders, Urinary incontinence & Sleep disorders (NIH 2011).

Obesity places a significant burden on health services worldwide. At present it is estimated that the UK's National Health Service (NHS) has direct costs of £4.2 billion annually caused by obesity, and that this figure is likely to double by 2050. Reducing obesity is a priority of the UK Government (DH 2011).

Poor quality sleep, as can be created by exposure to inappropriate RF/microwave regimes – *Refer to related item on 'Fatigue/sleep deprivation' in current document* – is a contributory factor to obesity.

Sleep debt can increase fatigue levels making individuals less prone to exercise. It can also increase levels of the hormone grehlin thereby stimulating appetite (Taheri et al. 2004).

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The EMF Safety Network Smart Meter survey (SDA 2011) indicated 49.1% of respondents (n = 318) experienced sleep problems after Smart meter installations. The need to replicate that study appears evident.