



A Systemic Review on CNS Effect of Electromagnetic Radiation 1800/900Mhz

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ABSTRACT

As per today's global scenario use of mobile phone is increasing day by day for communication. Due to its constant use, the electromagnetic radiation (EMR) emitted from the cell phone, base station and other household appliances cause adverse effects on human health. There is an increase concern about the interaction of EMR generated from mobile phones, with the human organs specially with brain because of its close and long proximity to human brain during the mobile usage. Concerns have shown whether these exposures could have effect on brain and its related disorders. Experimental studies have shown that the radiofrequency (RF-EMR) emitted from the mobile phones can affect the brain in various ways. Literature reveals that the exposure of radiation pose serious health hazard like change in sleep pattern, memory impairment, headache, cause oxidative stress and uncontrolled cell growth of brain cells. Special Care should be taken to avoid methodological limitations and to determine the patho-physiological relevance of any alteration found in EMFs-exposure to environment. Strategies must implement to ensure public health from EMF adverse effect.

Keywords: Cell phone, electromagnetic radiation, neurological disease, oxidative stress, brain cancer, behaviour.

INTRODUCTION

In today's global scenario one third of the world population prefer mobile for daily communication, due to this reason increasing exposure to mobile phone is the growing concern of possible adverse health effect.¹ It has been found that EMF exposure to human health, focuses on a range of clinical conditions including childhood leukaemia, brain tumours, genotoxicity and neurodegenerative disease, infertility, birth defects and increased risk of miscarriage.²⁻⁵

A study showed that the adult human head absorbs approximately 80% of the radiation emitted by from the mobile.⁶ Another study have reported contradictory results regarding effects of electromagnetic fields (EMF) of mobile phone on the nervous system. Many studies have showed that EMF emitted from mobile phone might affect brain activity; including sleep,⁷ attention,⁸ learning and memory^{9,10} and cognitive performance.¹¹ It has been suggested that the CNS harm from mobile phone might derive from the proven ability of EMF such as those from mobile phone to modify electrophysiological activity in human brain¹² and to alter neurotransmission.¹³⁻¹⁶ Many preclinical evidence of oxidative damage was reported in the brain tissues when rats were exposed to (RF/MW) radiation.¹⁷ It has been concluded that EMF like the ones emitted from mobile phones influence normal brain physiology.¹⁸

International Agency for Research on Cancer (IARC: part of the World Health Organization) on 31 May 2011 classified cell phone radiation as "possibly carcinogenic to humans" Many research have studied possible health symptoms of cell phone radiation. A study published in 2007 by the European Commission Scientific Committee

on Emerging and Newly Identified Health Risks (SCENIHR) concludes that the three lines of evidence, viz. animal, *in vitro*, and epidemiological studies, indicate that "exposure to RF fields is unlikely to lead to an increase in cancer in humans. Other latest WHO report released on 31 May 2011 classified cell phone radiation as a "carcinogenic hazard".¹⁹

Unfortunately, ignorance and non-awareness adds to this misery and all of us are absorbing this slow poison unknowingly. Even if people are aware of the radiation hazard, they may not have the choice to move away from it if the tower is installed near their office or residential building.²

Present data on electromagnetic radiation exposure to human being and animal has debated on epidemiological studies related to exposure of populations to RF from mobile phones or base stations causing health problems such as brain cancer, behavioural changes and brain abnormalities.

EMF and Oxidative Stress: Are they really related?

Free radicals are essential for normal physiological processes, especially in relation to brain metabolism.²¹ The brain is the highest consumer of oxygen in the human body and, most of the oxygen is converted into CO₂ and water with small amount of O₂ forming reactive oxygen species (ROS).²² The high metabolic rate and the composition rich in polyunsaturated fatty acids which are ROS targets in brain, makes brain more sensitive to oxidative damage.²³ Oxidative stress is a cellular or physiological condition of elevated concentrations of ROS that cause molecular damage to vital structures and functions.²⁴



Several studies demonstrated that radiation causes oxidative stress, which leads to activation of the apoptotic pathway. It has been reported that the effects of radiation on cell membranes induces apoptotic signal via lipid peroxidation.²⁵ Followed by its apoptotic effects by increasing oxidative stress.²⁶ An increase in free radical generation caused by radiations from mobile phones has also been reported in several other tissues.^{17,27,28} One of the study demonstrated that mobile phones biochemically cause oxidative damage by increasing the levels of NO, MDA, XO, and ADA activities in rat brain used as a model for EMR exposure.¹⁷ These continuously produced ROS are scavenged by SOD, glutathione peroxidase (GSH-Px) and catalase (CAT).²⁶

A study on ELF-EMFs exposure (50 Hz, 0.1–1.0mT) resulted to elicit redox and trophic response in rat cortical neurons,²⁹ and also induce oxidative stress in mouse cerebellum.³⁰ As result, ELF-EMFs increase free radicals content with consequent lipid oxidative damage in brains mice and rats.^{31,32} In both *in vivo* and *in vitro* rat cortical neurons cultures, ELF-EMFs are associated to oxidative stress, that arises both from field interaction with chemical bonds of biomolecules, thus giving ROS a higher concentration and activity,^{29,33} and from unequilibrium in the enzyme-dependent scavenging ability.³⁴⁻³⁶

Table 1: preclinical and clinical studies relating EMF-R & CNS

S.No	Subject	EMF exposure condition	Examined parameter	Result	Reference
1	Wistar Albino Male Rat	60 min /day for 2 month to a 900,1800,2450 MHz	Effect on brain	Structural changes in the frontal cortex and brain stem	Eser O. <i>et al.</i> 2012 ⁴³
2	Wistar Rat Brain	2 hour/day for 35 days,9.9/Hz/1.0 W/kg	Biochemical parameter	Increase in calcium ion efflux and ornithinine decarboxylase. A significant decrease in PCK activities was also recorded	Pulraj and Behari 2012 ⁴⁴
3	Wistar Albino adult male rats	900 MHz emitted from mobile for 2 hr/day for 10 month	RF effect on beta-amyloid protein, protein carbonyl and malondialdehyde	Increase in protein carbonyl	Dasdag <i>et al.</i> 2012 ⁴⁵
4	Male mice	90 min exposure to 8 mT EMF	Memory in mice	Hippocampus and basal ganglia impairment, effect on memory	Foroozandeh <i>et al</i> 2011 ⁴⁶
5	Wistar rat brain	Exposure 2 hr/day for 45 day,2.45 Ghz/0.11 W/Kg	Biochemical parameter	Biochemical change induce oxidative stress. A significant increase in apoptosis cells and decrease protein kinase C activity in hippocampus	Kesari <i>et al</i> 2011 ⁴⁷
6	Male Wistar rat	RF-EMR for 1 hour per day for 4 week GSM(0.9 GHz/1.8 GHz	Passive avoidance and hippocampal morphology	Alter passive avoidance and hippocampal morphology	Narayanan <i>et al</i> 2010 ⁴⁸
7	Male and Female rat	3 hr/day exposure to a 840 MHz	Behaviour locomotor activity, grooming	Change in behaviour activity, decrease, locomotor activity,increase grooming, freezing behaviour	Willie <i>et al</i> 2009 ⁴⁹
8	Male Wistar rat	50 missed call/day for 4 week from GSM (900/1800 MHz)	Spatial memory performance	Affected spatial memory perform	Narayanan <i>et al</i> 2009 ⁵⁰
9	Wistar rat	900 MHz/2 W/kg (2hr/day for 4 week)	Effect of EMF on newborn rats	Induces pyramidal cell loss in hippocampal	Bas <i>et al</i> 2009 ⁵¹
10	Fisher rat brain	900 MHz/0.6 W/Kg, 2 hr/week for 55 weeks	Cognitive impairment	Reduced the memory function by albumin leakage	Nittyby <i>et al</i> 2008 ⁵²
11	Inhabitant	Mobile phone base	Neuro behavioural effects	Increase neuro-behavioural effect	Rassoul <i>et al</i> 2007 ⁵³
12	Rat	24 and 48 hr exposure to a 0.01-mt,60 Hz magnetic field	DNA strand breaks in brain cell of rat	Increase single and double strand breaks	Lai and Singh 2004 ⁵⁴
13	Human endothelial cell line EA hy 926 cells	900 MHz for 1 hr	Proteomics analysis	Changes in protein expression involved in the structure of cell	Nylund and Leszczynsk 2004 ⁵⁵
14	Male and female rats	EMR exposed for 2 hr to GSM	Nerve Cell damage	Neuronal damage in the cortex	Salford <i>et al</i> 2003 ⁵⁶
15	Male Sprague rat	Acute 2 hr exposure to a 60 Hz magnetic field	DNA strand	Break in brain cells	Lai and Singh 1997 ⁵⁷
16	Human being	high-frequency electromagnetic fields of digital mobile radio telephones	Sleep	shortening of sleep onset latency	Mann and Roschke 1996 ⁵⁸

EMF and its possible interaction with pathological changes, memory and behaviour:

EMF harmful effect on cognition, learning and memory in animals have been reported using an assortment of cognitive and behavioural tasks, tests and exposure conditions.³⁷ Behavioural and psychological studies states that exposure to EMF can affect human cognitive functions and behaviour of animals.³⁸⁻⁴¹ In this context, a study showed that rats were exposed to 25 or 50 Hz fields for the short term (7 days) or long term (25 days) and examined in the Y form maze indicated that neither short-term, nor long term exposure make any change in motor activity, but 50 Hz field exposure showed decrease recognition of new arm of the maze.⁴¹

The researchers believed that extremely low frequency (ELF) EMF can make changes in calcium ion homeostasis in neuronal tissues. Hippocampal regions of mouse brain which has exposed to 50 Hz field for 90 days (50 and 100 mT) were isolated and compared with the control group. It was found that exposure to ELF EMF increased Ca ions levels in cells.⁴²

Some preclinical and clinical studies relating EMF-R & CNS have been summarized in table-1.

Studies demonstrated that exposure to RF EMF emitted by cell phones has an effect on brain physiology. Changes in EEG power are manifested rapidly when exposure occurs during sleep.⁵⁹ They outlast exposure by at least 15 min when RF EMF is applied during waking prior to sleep.⁶⁰ Simulations of the SAR distribution within the brain support the interpretation that sub cortical structures may be responsible for the observed effect on the sleep EEG.⁵⁹

A study showed that radiation also causes memory loss, concentration difficulties, fatigue, and headache, in a dose response manner, headache, discomfort, nausea.^{61,62}

RMF and Brain Cancer: The missing link

The first report in 1979 about possible damaging effects of exposure to electric and magnetic fields by Whertteimer and Leeper was related to electrical fields and cancer in children.⁶³ In 1980 another study, revealed an increased risk of leukemia and brain tumors in individual who were exposed to (ELF EMF). Such evidences led to increased attention to the risk of EMF.⁶⁴ A study concluded that EMF exposure increased human brain tumor rate by 2.5 times.⁶⁵ Associated with an angiosarcoma (case study),⁶⁶ significant increases in Brain Cancer.^{67,68}

Another research showed a close link between increased risk for malignant brain tumours and use of mobile or cordless phones, followed by increased of risk with latency time and cumulative use. Experimental studies showed that highest risk was found in the group with first use of a wireless phone before 20 years of age.⁶⁹

On other hand, a research revealed that exposure to mobile phone radiation increase the incidence of brain tumors and acoustic neuroma, depending on the duration of mobile phone use.⁷⁰⁻⁷² A study investigated whether rat brain exposure to microwaves of the global system for mobile communication (GSM) induces 1) DNA breaks and 2) changes in chromatin conformation and gene expression.⁷³

SUMMARY AND CONCLUSION

In light of the research findings related to EMF radiation & its relation to CNS disorders we summarize that EMF radiations from electric devices have been suggested to increase the risk of several human diseases especially brain abnormalities: memory impairment, increase oxidative stress, change in behaviour and brain cancer.

The European Environment Agency,⁷⁴ the European Parliament,⁷⁵ and two recent papers have expressed preoccupations about the effects on human health, particularly on that of young people, by the continuous RF exposure produced in public places and at home by wi-fi for internet access and MP use.^{76,77}

Hence, there is an urgent need to fill the gaps and do further research in this field with emphasis on the effects of early life and prenatal RF-EMF radiation exposure in animals, dosimetry studies, cellular studies using more sensitive methods, and human epidemiological studies, especially on children and young adults on behavioral and neurological disorders and cancer.²⁰

While recognizing that mobile telephony is an outstanding technology of inestimable value, responsible science must raise awareness of the risks involved.⁷⁸

We thus conclude that already today there is sufficient epidemiological evidence to warrant application of the precautionary principle aimed that setting exposure limits that are precautionary; limiting the spread of wireless technology in schools and highly frequented places (libraries, offices, hospital wards); awareness-raising in schools through a campaign on the use of the various wireless transmission technologies; discouraging the use of MPs by minors under 14 Years.⁷⁸

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