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28/06/2015 - April 2015 - Science Update

The following is a quick summary of another twenty papers that have come out over the last few months related to effects of electromagnetic radiation. All papers with a green background are highlighted as being particularly important or relevant.

1. N **Jin H** *et al*, (March 2015) *Effects on g2/m phase cell cycle distribution and aneuploidy formation of exposure to a 60 Hz electromagnetic field in combination with ionizing radiation or hydrogen peroxide in l132 nontumorigenic human lung epithelial cells*, Korean J Physiol Pharmacol. 2015 Mar;19(2):119-24. doi: 10.4196/kjpp.2015.19.2.119. Epub 2015 Feb 25 [View Author's abstract conclusions] [View on Pubmed]

The aim of the present study was to assess whether exposure to the combination of an extremely low frequency magnetic field (ELF-MF; 60 Hz, 1 mT or 2 mT) with a stress factor, such as ionizing radiation (IR) or H2O2, results in genomic instability in non-tumorigenic human lung epithelial L132 cells. To this end, the percentages of G2/M-arrested cells and aneuploid cells were examined. Exposure to 0.5 Gy IR or 0.05 mM H2O2 for 9 h resulted in the highest levels of aneuploidy; however, no cells were observed in the subG1 phase, which indicated the absence of apoptotic cell death. Exposure to an ELF-MF alone (1 mT or 2 mT) did not affect the percentages of G2/M-arrested cells, aneuploid cells, or the populations of cells in the subG1 phase. Moreover, when cells were exposed to a 1 mT or 2 mT ELF-MF in combination with IR (0.5 Gy) or H2O2 (0.05 mM), the ELF-MF did not further increase the percentages of G2/M-arrested cells or aneuploid cells. These results suggest that ELF-MFs alone do not induce either G2/M arrest or aneuploidy, even when administered in combination with different stressors.

2. P **Tessaro LW** *et al*, (March 2015) *Bacterial growth rates are influenced by cellular characteristics of individual species when immersed in electromagnetic fields*, Microbiol Res. 2015 Mar;172:26-33. doi: 10.1016/j.micres.2014.12.008. Epub 2015 Jan 19 [View Author's abstract conclusions] [View on Pubmed]

Previous studies have shown that exposure to extremely low-frequency electromagnetic fields (ELF-EMFs) have negative effects on the rate of growth of bacteria. In the present study, two Gram-positive and two Gram-negative species were exposed to six magnetic field conditions in broth cultures. Three variations of the 'Thomas' pulsed frequency-modulated pattern; a strong-static "puck" magnet upwards of 5000G in intensity; a pair of these magnets rotating opposite one another at ~30rpm; and finally a strong dynamic magnetic field generator termed the 'Resonator' with an average intensity of 250μT were used. Growth rate was discerned by optical density (OD) measurements every hour at 600nm. ELF-EMF conditions significantly affected the rates of growth of the bacterial cultures, while the two static magnetic field conditions were not statistically significant. Most interestingly, the 'Resonator' dynamic magnetic field increased the rates of growth of three species (Staphylococcus epidermidis, Staphylococcus aureus, and Escherichia coli), while slowing the growth of one (Serratia marcescens). We suggest that these effects are due to individual biophysical characteristics of the bacterial species.

3. P **Manzella N** *et al*, (March 2015) *Circadian gene expression and extremely low-frequency magnetic fields: An in vitro study*, Bioelectromagnetics. 2015 Mar 22. doi: 10.1002/bem.21915. [Epub ahead of print] [View Author's abstract conclusions] [View on Pubmed]

It is well known that circadian clocks are mainly regulated by light targeting signaling pathways in the hypothalamic suprachiasmatic nucleus. However, an entrainment mediated by non-photic sensory stimuli was also suggested for peripheral clocks. Exposure to extremely low frequency (ELF) electromagnetic fields might affect circadian rhythmicity. The goal of this research was to investigate effects of ELF magnetic fields (ELF-MF) on circadian clock genes in a human fibroblast cell line. We found that an ELF-MF (0.1 mT, 50 Hz) exposure was capable of entraining

expression of clock genes BMAL1, PER2, PER3, CRY1, and CRY2. Moreover, ELF-MF treatment induced an alteration in circadian clock gene expression previously entrained by serum shock stimulation. These results support the hypothesis that ELF-MF may be able to drive circadian physiologic processes by modulating peripheral clock gene expression.

4. P **Gandhi G** *et al*, (July 2014) *A cross-sectional case control study on genetic damage in individuals residing in the vicinity of a mobile phone base station*, Electromagn Biol Med. 2014 Jul 9:1-11. [Epub ahead of print] [View Author's abstract conclusions] [View on Pubmed]

Mobile phone base stations facilitate good communication, but the continuously emitting radiations from these stations have raised health concerns. Hence in this study, genetic damage using the single cell gel electrophoresis (comet) assay was assessed in peripheral blood leukocytes of individuals residing in the vicinity of a mobile phone base station and comparing it to that in healthy controls. The power density in the area within 300?m from the base station exceeded the permissive limits and was significantly (p = 0.000) higher compared to the area from where control samples were collected. The study participants comprised 63 persons with residences near a mobile phone tower, and 28 healthy controls matched for gender, age, alcohol drinking and occupational sub-groups. Genetic damage parameters of DNA migration length, damage frequency (DF) and damage index were significantly (p = 0.000) elevated in the sample group compared to respective values in healthy controls. The female residents (n = 25) of the sample group had significantly (p = 0.004) elevated DF than the male residents (n = 38). The linear regression analysis further revealed daily mobile phone usage, location of residence and power density as significant predictors of genetic damage. The genetic damage evident in the participants of this study needs to be addressed against future disease-risk, which in addition to neurodegenerative disorders, may lead to cancer.

5. P **Morgan LL** *et al*, (May 2015) *Mobile phone radiation causes brain tumors and should be classified as a probable human carcinogen (2A) (Review)*, Int J Oncol. 2015 May;46(5):1865-71. doi: 10.3892/ijo.2015.2908. Epub 2015 Feb 25 [View Author's abstract conclusions] [View on Pubmed]

Quickly changing technologies and intensive uses of radiofrequency electromagnetic field (RF-EMF)-emitting phones pose a challenge to public health. Mobile phone users and uses and exposures to other wireless transmitting devices (WTDs) have increased in the past few years. We consider that CERENAT, a French national study, provides an important addition to the literature evaluating the use of mobile phones and risk of brain tumors. The CERENAT finding of increased risk of glioma is consistent with studies that evaluated use of mobile phones for a decade or longer and corroborate those that have shown a risk of meningioma from mobile phone use. In CERENAT, exposure to RF-EMF from digitally enhanced cordless telephones (DECTs), used by over half the population of France during the period of this study, was not evaluated. If exposures to DECT phones could have been taken into account, the risks of glioma from mobile phone use in CERENAT are likely to be higher than published. We conclude that radiofrequency fields should be classified as a Group 2A 'probable' human carcinogen under the criteria used by the International Agency for Research on Cancer (Lyon, France). Additional data should be gathered on exposures to mobile and cordless phones, other WTDs, mobile phone base stations and Wi-Fi routers to evaluate their impact on public health. We advise that the as low as reasonable achievable (ALARA) principle be adopted for uses of this technology, while a major cross-disciplinary effort is generated to train researchers in bioelectromagnetics and provide monitoring of potential health impacts of RF-EMF.

6. P **Lerchl A** *et al*, (April 2015) *Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans*, Biochem Biophys Res Commun. 2015 Apr 17;459(4):585-90. doi: 10.1016/j.bbrc.2015.02.151. Epub 2015 Mar 6 [View Author's abstract conclusions] [View on Pubmed]

The vast majority of in vitro and in vivo studies did not find cancerogenic effects of exposure to electromagnetic fields (RF-EMF), i.e. emitted by mobile phones and base stations. Previously

published results from a pilot study with carcinogen-treated mice, however, suggested tumor-promoting effects of RF-EMF (Tillmann et al., 2010). We have performed a replication study using higher numbers of animals per group and including two additional exposure levels (0 (sham), 0.04, 0.4 and 2 W/kg SAR). We could confirm and extend the originally reported findings. Numbers of tumors of the lungs and livers in exposed animals were significantly higher than in sham-exposed controls. In addition, lymphomas were also found to be significantly elevated by exposure. A clear dose-response effect is absent. We hypothesize that these tumor-promoting effects may be caused by metabolic changes due to exposure. Since many of the tumor-promoting effects in our study were seen at low to moderate exposure levels (0.04 and 0.4 W/kg SAR), thus well below exposure limits for the users of mobile phones, further studies are warranted to investigate the underlying mechanisms. Our findings may help to understand the repeatedly reported increased incidences of brain tumors in heavy users of mobile phones.

7. P **Balmori A**, (June 2015) *Anthropogenic radiofrequency electromagnetic fields as an emerging threat to wildlife orientation*, Sci Total Environ. 2015 Jun 15;518-519:58-60. doi: 10.1016/j.scitotenv.2015.02.077. Epub 2015 Mar 4 [View Author's abstract conclusions] [View on Pubmed]

The rate of scientific activity regarding the effects of anthropogenic electromagnetic radiation in the radiofrequency (RF) range on animals and plants has been small despite the fact that this topic is relevant to the fields of experimental biology, ecology and conservation due to its remarkable expansion over the past 20years. Current evidence indicates that exposure at levels that are found in the environment (in urban areas and near base stations) may particularly alter the receptor organs to orient in the magnetic field of the earth. These results could have important implications for migratory birds and insects, especially in urban areas, but could also apply to birds and insects in natural and protected areas where there are powerful base station emitters of radiofrequencies. Therefore, more research on the effects of electromagnetic radiation in nature is needed to investigate this emerging threat.

8. - **Paul B** *et al*, (February 2015) *Mobile phones: Time to rethink and limit usage*, Indian J Public Health. 2015 Jan-Mar;59(1):37-41. doi: 10.4103/0019-557X.152856 [View Author's abstract conclusions] [View on Pubmed]

Radiofrequency waves generated from mobile phones cause potential public health problems. Short-term effects like changes in sleep, heart rate, and blood pressure, and long-term effects like carcinoma are well documented. The Government of India's efforts in laying down regulations regarding the safety limits, manufacture, marketing, and mobile use are still in nascent stage. The need for stringent enforcement of laws for prevention of phone usage while driving and guidelines of medical regulatory bodies regarding rules and regulations of phone usage while at class or attending patients is of utmost importance. This should be supplemented by mass media to raise awareness among people regarding the possible health effects of radiofrequency emissions from mobile phones and the guidelines to minimize its exposure. It is the need of the hour to teach young people to be structured, to know when to have the cell phone on, and to avoid becoming the slave of technology instead of its mastery.

9. N **Wilson JW** *et al*, (March 2015) *The effects of extremely low frequency magnetic fields on mutation induction in mice*, Mutat Res. 2015 Mar;773:22-6. doi: 10.1016/j.mrfmmm.2015.01.014. Epub 2015 Jan 30 [View Author's abstract conclusions] [View on Pubmed]

The growing human exposure to extremely low frequency (ELF) magnetic fields has raised a considerable concern regarding their genotoxic effects. The aim of this study was to evaluate the in vivo effects of ELF magnetic fields irradiation on mutation induction in the germline and somatic tissues of male mice. Seven week old BALB/cxCBA/Ca F1 hybrid males were exposed to 10, 100 or 300μT of 50Hz magnetic fields for 2 or 15h. Using single-molecule PCR, the frequency of mutation at the mouse Expanded Simple Tandem Repeat (ESTR) locus Ms6-hm was established in sperm and blood samples of exposed and matched sham-treated males. ESTR mutation frequency was also established in sperm and blood samples taken from male mice exposed to

1Gy of acute X-rays. The frequency of ESTR mutation in DNA samples extracted from blood of mice exposed to magnetic fields did not significantly differ from that in sham-treated controls. However, there was a marginally significant increase in mutation frequency in sperm but this was not dose-dependent. In contrast, acute exposure X-rays led to significant increases in mutation frequency in sperm and blood of exposed males. The results of our study suggest that, within the range of doses analyzed here, the in vivo mutagenic effects of ELF magnetic fields are likely to be minor if not negligible.

10. [P] **Dasdag S** *et al*, (March 2015) *Effects of 2.4 GHz radiofrequency radition emitted from WiFi equipment on microRNA expression in brain tissue*, Int J Radiat Biol. 2015 Mar 16:1-26. [Epub ahead of print] [View Author's abstract conclusions] [View on Pubmed]

MicroRNAs (miRNAs) play paramount role in growth, differentiation, proliferation and cell death by suppressing one or more target genes. However, their interaction with radiofrequencies is still unknown. The aim of this study was to investigate the long term effects of radiofrequency radiation emitted from a Wireless Fidelity (Wi-Fi) system on some of the miRNAs in brain tissue. The study was carried out on sixteen Wistar Albino adult male rats by dividing them into two groups such as sham (n: 8) and exposure (n: 8). Rats in the exposure group were exposed to 2.4 GHz radiofrequency (RF) radiation for 24 hours a day for twelve months (one year). The same procedure was applied to the rats in the sham group except the Wi-Fi system was turned off. Immediately after the last exposure, rats were sacrificed and their brains were removed. miR-9-5p, miR-29a-3p, miR-106b-5p, miR-107, miR-125a-3p in brain were investigated in detail. The results revealed that long term exposure of 2.4 GHz Wi-Fi radiation can alter expression of some of the miRNAs such as miR-106b-5p (adjP* = 0,010) and miR-107 (adjP* = 0,005). We observed that mir 107 expression is 3.3 times and miR-106b-5p expression is 3.65 times lower in the exposure group than in the control group. However, miR-9-5p, miR-29a-3p and miR-125a-3p levels in brain were not altered. Long term exposure of 2.4 GHz RF may lead to adverse effects such as neurodegenerative diseases originated from the alteration of some miRNAs expression and more studies should be devoted to the effects of RF radiation on miRNAs expression levels.

11. [N] **Masuda H** *et al*, (March 2015) *No Changes in Cerebral Microcirculatory Parameters in Rat During Local Cortex Exposure to Microwaves*, In Vivo. 2015 03-04;29(2):207-215 [View Author's abstract conclusions] [View on Pubmed]

The aim of this study was to determine whether cerebral microcirculatory parameters in rats were modified during local cortex exposure to a radiofrequency electromagnetic field (RF) under non-thermal conditions. The cortex tissue targeted was locally exposed to 1439 MHz RF using a figure-8 loop antenna at an averaged specific absorption rate of 2.0 W/kg in the target area for 50 min. Three microcirculatory parameters related to cerebral inflammation were measured by the cranial window method in real-time under RF exposure. No extravasation of intravenously injected fluorescent dye was observed during RF exposure. There was no significant difference either in pial venule blood flow velocity or diameter between exposed and sham-exposed rats. Histological evaluation for the brain immediately after RF exposure did not reveal any serum albumin leakage sites or degenerate neurons. These findings suggest that no dynamic changes occurred in cerebral microcirculation even during local cortex exposure under these conditions.

12. [-] **Redlarski G** *et al*, (February 2015) *The Influence of Electromagnetic Pollution on Living Organisms: Historical Trends and Forecasting Changes*, Biomed Res Int. 2015;2015:234098. Epub 2015 Feb 25. [View Author's abstract conclusions] [View on Pubmed]

Current technologies have become a source of omnipresent electromagnetic pollution from generated electromagnetic fields and resulting electromagnetic radiation. In many cases this pollution is much stronger than any natural sources of electromagnetic fields or radiation. The harm caused by this pollution is still open to question since there is no clear and definitive evidence of its negative influence on humans. This is despite the fact that extremely low frequency electromagnetic fields were classified as potentially carcinogenic. For these reasons, in recent decades a significant growth can be observed in scientific research in order to understand

the influence of electromagnetic radiation on living organisms. However, for this type of research the appropriate selection of relevant model organisms is of great importance. It should be noted here that the great majority of scientific research papers published in this field concerned various tests performed on mammals, practically neglecting lower organisms. In that context the objective of this paper is to systematise our knowledge in this area, in which the influence of electromagnetic radiation on lower organisms was investigated, including bacteria, *E. coli* and *B. subtilis*, nematode, *Caenorhabditis elegans*, land snail, *Helix pomatia*, common fruit fly, *Drosophila melanogaster*, and clawed frog, *Xenopus laevis*.

13. [P] **Hori T** *et al*, (March 2015) *Exposure to 50 Hz electric fields reduces stress-induced glucocorticoid levels in BALB/c mice in a kV/m- and duration-dependent manner*, Bioelectromagnetics. 2015 Mar 27. doi: 10.1002/bem.21914. [Epub ahead of print] [View Author's abstract conclusions] [View on Pubmed]

Electric fields (EFs) can reduce elevated levels of stress-related hormones in some organisms. In this study, endocrine effects of exposure to a 50 Hz EF were investigated in male BALB/c mice. Specifically, plasma glucocorticoid (GC) levels were examined because GC is known to mediate the stress response in mice, including changes induced by immobilization. Mice were exposed to 50 Hz EFs (at 2.5-200 kV/m) for 60 min. They were immobilized for the latter half (30 min). At the end of exposure period, blood samples were collected and GC levels estimated by spectrofluorometry. GC levels were not influenced by EFs in absence of immobilization, but they were significantly higher in immobilized mice than in non-immobilized mice ($P < 0.01$). Elevated GC levels induced by immobilization were significantly reduced by exposure to an EF at 10 kV/m ($P < 0.05$), and the effect of EFs at 0-10 kV/m on GC levels increased in a kV/m-dependent manner ($P < 0.05$). In contrast, following treatment with EFs at 50 and 200 kV/m, GC levels were higher than those observed at 10 kV/m. To assess the effect of EF treatment duration, mice were also exposed to 50 Hz EFs (10 kV/m) for 6, 20, or 60 min. Immobilization-induced increase in GC levels was significantly suppressed by EF exposure for 20 and 60 min. Therefore, our results demonstrate that extremely low-frequency EFs alter stress response of mice in a kV/m- and duration-dependent manner.

14. [-] **Houshyari M** *et al*, (January 2015) *Incidence of Seminoma Cancer in Staffs that Worked in Electromagnetic Waves Station; Three Cases Report*, Iran J Cancer Prev. 2015 Jan-Feb;8(1):66-8 [View Author's abstract conclusions] [View on Pubmed]

Physical agents such as ultraviolet or ionizing radiation and repetitive trauma have been related to the causation of cancer in humans. Much less clear is the association between exposure to radiofrequency, such as radar and microwave radiation to the development of cancer. Sporadic case reports and small series suggest that this type of radiation might lead to cancer or contribute to its evolution. The association between radiofrequency and testicular damage and cancer is unproved, but clinical and experimental data are suggestive of such possibility. In this paper we have reported three cases of seminoma in person who worked in the same place that exposed to radio frequency (RF) waves.

15. [N] **Percherancier Y** *et al*, (April 2015) *Effects of 50 Hz magnetic fields on gap junctional intercellular communication in NIH3T3 cells*, Bioelectromagnetics. 2015 Apr 3. doi: 10.1002/bem.21908. [Epub ahead of print] [View Author's abstract conclusions] [View on Pubmed]

The present study focused on gap junctional intercellular communication (GJIC) as a target for biological effects of extremely low-frequency (ELF) magnetic field (MF) exposure. Fluorescence recovery after photobleaching microscopy (FRAP) was used to visualize diffusion of a fluorescent dye between NIH3T3 fibroblasts through gap junctions. The direct effect of 24 h exposure to 50 Hz MF at 0.4 or 1 mT on GJIC function was assessed in one series of experiments. The potential synergism of MF with an inhibitor of GJIC, phorbol ester (TPA), was studied in another series by observing FRAP when NIH3T3 cells were incubated with TPA for 1 h following 24 h exposure to MF. In contrast to other reports of ELF-MF effects on GJIC, under our experimental conditions we

observed neither direct inhibition of GJIC nor synergism with TPA-induced inhibition from 50 Hz MF exposures.

16. **Fiocchi S** *et al*, (Aprli 2015) *Assessment of foetal exposure to the homogeneous magnetic field harmonic spectrum generated by electricity transmission and distribution networks*, Int J Environ Res Public Health. 2015 Apr 1;12(4):3667-90. doi: 10.3390/ijerph120403667 [View Author's abstract conclusions] [View on Pubmed]

During the last decades studies addressing the effects of exposure to Extremely Low Frequency Electromagnetic Fields (ELF-EMF) have pointed out a possible link between those fields emitted by power lines and childhood leukaemia. They have also stressed the importance of also including in the assessment the contribution of frequency components, namely harmonics, other than the fundamental one. Based on the spectrum of supply voltage networks allowed by the European standard for electricity quality assessment, in this study the exposure of high-resolution three-dimensional models of foetuses to the whole harmonic content of a uniform magnetic field with a fundamental frequency of 50 Hz, was assessed. The results show that the main contribution in terms of induced electric fields to the foetal exposure is given by the fundamental frequency component. The harmonic components add some contributions to the overall level of electric fields, however, due to the extremely low permitted amplitude of the harmonic components with respect to the fundamental, their amplitudes are low. The level of the induced electric field is also much lower than the limits suggested by the guidelines for general public exposure, when the amplitude of the incident magnetic field is set at the maximum permitted level.

17. **Nofouzi K** *et al*, (April 2015) *Influence of extremely low frequency electromagnetic fields on growth performance, innate immune response, biochemical parameters and disease resistance in rainbow trout, Oncorhynchus mykiss*, Fish Physiol Biochem. 2015 Apr 14. [Epub ahead of print] [View Author's abstract conclusions] [View on Pubmed]

The effects of extremely low frequency electromagnetic fields on rainbow trout growth performance, innate immunity and biochemical parameters were studied. Rainbow trout (17-18 g) were exposed to electromagnetic fields (15 Hz) at 0.01, 0.1, 0.5, 5 and 50 μT, for 1 h daily over period of 60 days. Growth performance of fish improved in different treatment groups, especially at 0.1, 0.5, 5 and 50 μT. Immunological parameters, specifically hemagglutinating titer, total antiprotease and a1-antiprotease levels in treatment groups, were also enhanced. Total protein and globulin contents in the serum of fish exposed to 0.1, 0.5, 5 and 50 μT were significantly higher than those in the control group. No significant differences were found in serum enzyme activities, namely aspartate aminotransferase and alanine aminotransferase of fish in all treatment groups. Conversely, alkaline phosphatase level decreased in fish exposed to 0.01 and 50 μT electromagnetic fields. Meanwhile, electromagnetic induction at 0.1, 0.5, 5 and 50 μT enhanced fish protection against Yersinia ruckeri. These results indicated that these specific electromagnetic fields had possible effects on growth performance, nonspecific immunity and disease resistance of rainbow trout.

18. **Zhou LY** *et al*, (April 2014) *Epidemiological investigation of risk factors of the pregnant women with early spontaneous abortion in Beijing*, Chin J Integr Med. 2015 Apr 14. [Epub ahead of print] [View Author's abstract conclusions] [View on Pubmed]

The objective of this study was to determine the risk factors of the pregnant women with early spontaneous abortion in Beijing. A total of 34,417 cases of pregnant women were participated in the survey from January 2000 to December 2013. A questionnaire was informed to each woman. The content of questionnaire includes four parts: general condition, obstetrical history, past history and family history, and living environment and habits. The mental condition was evaluated with Self-Rating Anxiety Scale (SAS) and Self-Rating Depression Scale (SDS). A total of 32,296 questionnaires were collected. The spontaneous abortion rate in the total sample was 3.0%. There was no significant difference between the normal pregnancy group and spontaneous abortion group in terms of general condition, obstetrical and past history ($P>0.05$). Significant

differences between the two groups were found in terms of decoration during pregnancy, keeping pets, near mobile communication base station within 100 m around the residence, drinking during pregnancy, having a cold during pregnancy and SAS (P<0.05). Having a cold during pregnancy, decoration during pregnancy, near mobile communication base station within 100 m around the residence, keeping pets and high SAS were determined the independent risk factors of spontaneous abortion by Logistic regression analysis. Having a cold during pregnancy, decoration, keeping pets, near mobile communication base station within 100 m around the residence and high SAS are the independent risk factors of spontaneous abortion in Beijing.

19. [-] **Hosseini M** *et al*, (May 2015) *Hazard zoning around electric substations of petrochemical industries by stimulation of extremely low-frequency magnetic fields*, Environ Monit Assess. 2015 May;187(5):4449. doi: 10.1007/s10661-015-4449-y. Epub 2015 Apr 16 [View Author's abstract conclusions] [View on Pubmed]

Electromagnetic fields in recent years have been discussed as one of the occupational hazards at workplaces. Hence, control and assessment of these physical factors is very important to protect and promote the health of employees. The present study was conducted to determine hazard zones based on assessment of extremely low-frequency magnetic fields at electric substations of a petrochemical complex in southern Iran, using the single-axis HI-3604 device. In measurement of electromagnetic fields by the single-axis HI-3604 device, the sensor screen should be oriented in a way to be perpendicular to the field lines. Therefore, in places where power lines are located in different directions, it is required to keep the device towards three axes of x, y, and z. For further precision, the measurements should be repeated along each of the three axes. In this research, magnetic field was measured, for the first time, in three axes of x, y, and z whose resultant value was considered as the value of magnetic field. Measurements were done based on IEEE std 644-1994. Further, the spatial changes of the magnetic field surrounding electric substations were stimulated using MATLAB software. The obtained results indicated that the maximum magnetic flux density was 49.90 μT recorded from boiler substation, while the minimum magnetic flux density of 0.02 μT was measured at the control room of the complex. As the stimulation results suggest, the spaces around incoming panels, transformers, and cables were recognized as hazardous zones of indoor electric substations. Considering the health effects of chronic exposure to magnetic fields, it would be possible to minimize exposure to these contaminants at workplaces by identification of risky zones and observation of protective considerations.

20. [P] **Aydogan F** *et al*, (April 2015) *The effects of 2100-MHz radiofrequency radiation on nasal mucosa and mucociliary clearance in rats*, Int Forum Allergy Rhinol. 2015 Apr 16. doi: 10.1002/alr.21509. [Epub ahead of print] [View Author's abstract conclusions] [View on Pubmed]

Nasal mucociliary clearance has an important role in voiding the airways from inhaled foreign substances. This activity could be disturbed by environmental factors such as radiofrequency radiation. The aim of the present study was to investigate short-term and relatively long-term effects of 2100-MHz radiofrequency radiation emitted by a generator, simulating a 3G-mobile phone, on the nasal septal mucosa and mucociliary clearance in rats. Thirty Wistar albino rats were divided into 4 groups. There were 6 rats in Group A and Group B, which served as the control groups (10-day and 40-day groups, respectively). Groups C (10-day exposure) and D (40-day exposure) were both composed of 9 rats; they comprised the radiofrequency radiation exposure groups. The rats in groups C and D were exposed to 2100-MHz radiofrequency radiation emitted by a generator, simulating a 3G-mobile phone, 6 hours/day, for 10 or 40 days, respectively. After exposure, nasal mucociliary clearance was measured by rhinoscintigraphy. After euthanization, the nasal septa of the animals were removed, and tissue samples of the nasal mucosa were examined using a transmission electron microscope. The differences in mucociliary clearances between groups A and C, groups B and D, and groups C and D were found to be statistically significant (p = 0.005, p < 0.001, p ^lt; 0.001, respectively). Although there were no histopathological abnormalities in the control groups, the exposure groups showed a number of degenerated and apoptotic cells, ciliary disorganization and ciliary loss in the epithelial cells, epithelial metaplasia, alteration of normal chromatin distribution and karyolysis in nuclei, changes in the basal cells, and lymphocytic infiltration. The histopathological changes were more

severe in group D. Radiofrequency radiation at 2100 MHz damaged the nasal septal mucosa, and disturbed the mucociliary clearance. Ciliary disorganization and ciliary loss in the epithelial cells resulted in deterioration of nasal mucociliary clearance.