



Pregnancy is a time when development is most vulnerable. Wireless radiation and electromagnetic fields are part of a growing list of environmental exposures thought to interfere with normal fetal brain development. Published research has found impaired communication skills, memory and learning deficits, congenital heart disease and behavioral problems associate with prenatal exposures.

Kaiser Permanente researchers have published several studies linking pregnant women’s exposure to magnetic field electromagnetic fields to not only increased [miscarriage](#) and but also increased [ADHD](#), [obesity](#) and [asthma](#) in the woman’s prenatally exposed children.

A [2020 case control study](#) of over 2000 pregnant women found that higher exposure to common electrical appliances such as computers, induction cookers and microwave ovens during their early pregnancy was associated with a higher risk of birth to infants with congenital heart disease. “Women should therefore reduce the usage of electrical appliances before and during pregnancy.” ([Zhao et al. 2020](#))

[\(Watch a webinar where Dr. Li presents this research.\)](#)

Dr. Taylor – Chair of the Department of Obstetrics, Gynecology and Reproductive Sciences at Yale University School of Medicine- authored [a study](#) showing significant behavioral changes- lower memory and increased hyperactivity- in the offspring of mice exposed to cell phone radiation during pregnancy. Another [study](#) of over 55,000 mothers and children in four countries found cell phone use during pregnancy linked to shorter pregnancy duration and increased risk for preterm birth.

This page lists important research evidence, summarizes scientific publications and offers resources for a healthy pregnancy.

Dr. Hugh Taylor, Chair of the Department of Obstetrics at Yale University School of Medicine Recommends Precautions

“There’s essentially no downside to being cautious and protecting your baby,” says Dr. Hugh Taylor, Chair of the Department of Obstetrics, Gynecology and Reproductive Sciences at Yale University School of Medicine. Dr. Taylor recently authored [a study](#) showing significant behavioral changes in the offspring of mice exposed to cell phone radiation during pregnancy.

“We have demonstrated clear cause and effect relationships in mice, and we already have studies showing that women who use cell phones have children with more behavioral problems. I think together that’s very powerful evidence.” —Dr. Hugh Taylor

Dr. Taylor and colleagues [found](#) that when mice were exposed to cell phone signals while pregnant, their offspring showed increased hyperactivity and lower memory scores. In addition, his neurological tests revealed abnormal development of neurons in the part of the brain linked to ADHD. [Several](#) other experiential studies have found that *in utero* cell phone exposure leads to damaged brain development in mice and rats. Most recently, the [National Toxicology Program](#) found genotoxic effects in the frontal lobe of the brain in mice and rats exposed to daily low levels of radiofrequency radiation.

Behavior Problems In Children

In addition to these animal studies, several studies on children have found that higher cell phone exposure during pregnancy is associated with behavioral issues in children. Researchers from the University of California School of Public Health in Los Angeles have published two studies ([2008](#) and [2012](#)) looking at tens of thousands of children. Researchers concluded that children exposed to cell phones both before and after birth were more likely to have emotional or behavior problems than children who were not exposed to phones. In 2017, [the largest study to date](#) to use data on prenatal cell phone use collected from parents in five countries found a link between high prenatal cell phone use and hyperactivity/inattention problems in children.

ADHD Symptoms When Lead Levels are Paired With Cell Phone Radiation

Further research investigating cell phone radiation in combination with the neurotoxin lead has [found](#) that children with lead levels had higher ADHD like symptoms if they *also* had higher cell phone use leading the researchers to consider a potential synergetic effect.

“EMF exposure during pregnancy could impact the fetal development, including endocrine and metabolic systems, predisposing offspring to higher risk of obesity,” —Dr. De-Kun Li

Kaiser Research Links EMFs to Asthma, ADHD, Obesity, Miscarriage and Thyroid Problems

A 2012 study conducted by scientists from [Kaiser Permanente Research Division](#) published in [Nature’s Scientific Reports](#), found that children who were exposed to high levels of magnetic radiation while in their mother’s womb had a 69% higher risk of suffering from weight problems and [obesity](#) during childhood than children with lower in-utero exposures. This study was part of a series of studies lead by Kaiser research scientist [Dr. De-Kun Li](#), who specializes in reproductive and prenatal epidemiology. His research group has also published research which found that higher magnetic field exposure during pregnancy was associated with a higher risk of [ADHD](#), [obesity](#) and [asthma](#) in the woman’s prenatally exposed children.

In 2017, Li’s group presented his newest research at an [international conference](#) which found high magnetic fields during pregnancy were associated with increased risk of low thyroid hormone levels in offspring (low TSH levels) indicating “an adverse MF impact on the pituitary gland during in-utero fetal brain development.”

Replicated Science Finds EMF Exposure During Pregnancy Increases Miscarriage Rate

In 2017, Li made international news when he published [his second study](#) linking miscarriage to EMF exposure. Funded by the National Institute of Environmental Health Sciences with 913 women as subjects, Li and colleagues found that women who were exposed to higher magnetic field levels had 2.72 times the risk of miscarriage.

“This study provides evidence from a human population that magnetic field non-ionizing radiation could have adverse biological impacts on human health,” Li said in the [Kaiser Permanente press release](#).

Li previously had presented these [findings](#) at a 2016 international conference on bioelectromagnetics but the published paper has ricocheted around the world. His 2002 published study found [miscarriage](#) risk increasing with increasing magnetic field exposure. Microwave News published [an article](#) detailing how there were now at least 7 Studies showing an association between EMF and miscarriage rates.

In light of his research findings over the years, Li submitted [testimony to the US Federal Communications Commission](#) about the inadequacy of current RF exposure guidelines to protect the public.

“It has been demonstrated that communication between cells depends on EMF signals, likely in a very low level. External EMFs could conceivably interfere with normal cell communication, thus disrupting normal cell differentiation and proliferation. Such disturbance could lead to miscarriage, birth defects, and cancer.”
– [Dr. De-Kun Li](#)

Dr. De Kun Li has repeatedly written about the problem with FCC regulations and in his 2013 [expert testimony about radiofrequency and health](#) he stated, “Any such claim that RF-EMF is safe, is either ignorant or misleading.”

The EPA Recognized BabySafe Project

As a response to this growing body of evidence on the health effects of wireless radiation, Environmental Health Trust joined with [Grassroots Environmental Education](#) to support the development of the [BabySafe Project](#). The BabySafe Project Joint Statement on Pregnancy and Wireless Radiation, which advocates for precaution and continuing research has been endorsed by scientists and medical professionals from around the world. The statement calls for women to be informed about the risks of exposure to wireless radiation, and to take precautionary steps while more research is conducted.

Fetal Development

A 2020 study published in the Journal of Gynecology Obstetrics and Human Reproduction entitled [Mobile phone use during pregnancy: which association with fetal growth?](#) found that for newborns whose mothers used their mobile phones for more than 30 minutes/day there was an association with significantly lower fetal development scores.

RESOURCES TO SHARE

Wood, Patti. [“The BabySafe Project: What You Need To Know About Wireless Radiation and Your Baby.” The Green Gazette, 2017.](#)

[BabySafe Project Poster \(1 page\)](#)

[What Parents Need To Know About Safe Technology \(2 Page Color Flyer\)](#)

NEWS ARTICLES

[New Kaiser Permanente Study Provides Evidence of Health Risks Linked to Electromagnetic Field Exposure](#)

Ronnie Cohen, Reuters, [Miscarriage rates triple for women with top radiation exposures](#)

Malloy, Mary Esther. [“Babysafe Mode: Getting Smarter about Smart Technology and Pregnancy.”](#) Midwifery Today, 2015.

[“Group Launches Campaign Warning Expecting Mothers About Wireless Radiation.”](#) CBS New York, 2014.

Kaiser Permanente. [“In-utero exposure to magnetic fields associated with increased risk of obesity in childhood.”](#) ScienceDaily, 2012.

Peart, Karen N. [“Cell phone use in pregnancy may cause behavioral disorders in offspring.”](#) YaleNews, 2012.

Melnick, Meredith. [“Study: Could Cell-Phone Use in Pregnancy Affect Kids’ Behavior?”](#) TIME, 2010.

RESEARCH STUDIES

Tsarna et al., [Maternal Cell Phone Use During Pregnancy, Pregnancy Duration And Fetal Growth In Four Birth Cohorts.](#) Am J Epidemiol. 2019 Apr 17. pii: kwz092. doi: 10.1093/aje/kwz092.

- We explored if maternal cell phone use was associated with pregnancy duration and fetal growth. We used information from 55,507 pregnant women and their children from Denmark (1996-2002), the Netherlands (2003-2004), Spain (2003-2008) and Korea (2006-2011).
- We examined pregnancy duration (gestational age at birth, preterm/postterm birth), fetal growth (birth weight ratio, small/large for gestational age), and birth weight, low and high birth weight, and meta-analyzed cohort specific estimates.
- The intermediate exposure group had higher risk of giving birth at lower gestational age (Hazard Ratio=1.04, 95%CI 1.01, 1.07), and exposure-response relationships were found for shorter pregnancy duration (P<0.001) and preterm birth (P=0.003). We observed no association with fetal growth or birth weight.
- **In conclusion, maternal cell phone use during pregnancy may be associated with shorter pregnancy duration and increased risk for preterm birth.** Results should be interpreted with caution, as they may reflect stress during pregnancy or other residual confounding, rather than direct effect of cell phone exposure.

Sage, Cindy, and Ernesto Burgio. [“Electromagnetic Fields, Pulsed Radiofrequency Radiation, and Epigenetics: How Wireless Technologies May Affect Childhood Development.”](#) *BioInitiative & Child Development*, 2017.

New epigenetic studies are profiled in this review to be considered in the understanding of some neurodevelopmental and neurobehavioral changes due to exposure to wireless technologies. Symptoms of retarded memory, learning, cognition, attention, and behavioral problems have been reported in numerous studies and are similarly manifested in autism and attention deficit hyperactivity disorders, as a result of EMF and RFR exposures where both epigenetic drivers and genetic (DNA) damage are likely contributors.

Hardell, Lennart. [“Effects of Mobile Phones on Children’s and Adolescents’ Health: A Commentary.”](#) *Child Development*, 2017.

The scientific panel reached the conclusion that RF radiation from devices that emit nonionizing RF radiation in the frequency range 30 kHz–300 GHz is a Group 2B, that is, a “possible” human carcinogen.

With respect to health implications of digital (wireless) technologies, it is of importance that neurological diseases, physiological addiction, cognition, sleep, and behavioral problems are considered in addition to cancer. Well-being needs to be carefully evaluated as an effect of changed behavior in children and adolescents through their interactions with modern digital technologies.

Kyung-Hwa Choi, et al. [“Neurodevelopment for the first three years following prenatal mobile phone use, radio frequency radiation and lead exposure.”](#) *Environmental Research*, vol. 156, 2017, pp. 810-817.

This study examined neurodevelopment in children up to 36 months of age, following prenatal mobile phone use and radiofrequency radiation (RFR) exposure, in relation to prenatal lead exposure. Researchers found no association between prenatal exposure to RFR and child neurodevelopment during the first three years of life; however, a potential combined effect of prenatal exposure to lead and mobile phone use was suggested.

Bahreyni, Toossi, et al. "[Exposure to mobile phone \(900-1800 MHz\) during pregnancy: tissue oxidative stress after childbirth.](#)" *Journal of Maternal-Fetal and Neonatal Medicine*, 2017, pp. 1-6.

The present study has investigated the effects of mobile phone (900-1800 MHz)-induced electromagnetic radiation on redox status in the heart, liver, kidney, cerebellum, and hippocampus of dams and the offspring mice. Exposure to mobile phone (900-1800 MHz) during pregnancy induced oxidative stress in tissues of dams and their offspring.

Birks, Laura, et al. "[Maternal cell phone use during pregnancy and child behavioral problems in five birth cohorts.](#)" *Environment International*, vol. 104, 2017, pp. 122-31.

Largest study to date to use prenatal cell phone use data collected prospectively found high prenatal cell phone use linked to hyperactivity/inattention problems in children whereas no prenatal cell phone use was linked to low risk for any behavioral problems in child.

Kim, Ju Hwan, et al. "[Long-term exposure to 835 MHz RF-EMF induces hyperactivity, autophagy and demyelination in the cortical neurons of mice.](#)" *Scientific Reports*, vol. 7, no. 41129, 2017.

The neuronal effects of 835 MHz RF-EMF on the cerebral cortex of the mouse brain at 4.0 W/kg for 5 hours/day for 12 weeks included induction of autophagy genes, production of proteins, accumulation of autolysosome, demyelination in cortical neurons and hyperactivity-like behavior.

Othman, Haifa, et al. "[Effects of prenatal exposure to WiFi signal \(2.45 GHz\) on postnatal development and behavior in rat: Influence of maternal restraint.](#)" *Behavioural Brain Research*, vol. 36, 2017, pp. 291-302.

The potential combined influence of maternal restraint stress and 2.45 GHz WiFi signal exposure on postnatal development and behavior in the offspring of exposed rats were shown to provoke several behavioral and biochemical impairments at both juvenile and adult age of the offspring, as well as disrupt the progeny brain oxidative balance and serum biochemistry.

Othman, H., et al. "[Postnatal development & behavior effects of in-utero exposure of rats to radiofrequency waves emitted from conventional WiFi devices.](#)" *Environmental Toxicology and Pharmacology*, vol. 52, 2017, pp. 239-47.

Effects of gestational exposure to 2.45 GHz WiFi signal for 2 h/day along gestation period on the offspring were studied. Maternal exposure to WiFi radiofrequencies led to various adverse neurological effects in the offspring by affecting neurodevelopment, cerebral stress equilibrium and cholinesterase activity.

Taktom, Sadeghi, et al. [“Preterm birth among women living within 600 meters of high voltage overhead Power Lines: a case-control study.”](#) *Romanian Journal of Internal Medicine*, 2017.

This case-control study examined the relationship between living near high voltage power lines and risk of preterm labor, finding a positive association between distance from power lines and risk of spontaneous preterm birth and birth defects in women.

Güler, G., et al. [“Neurodegenerative changes and apoptosis induced by intrauterine and extrauterine exposure of radiofrequency radiation.”](#) *Journal of Chemical Neuroanatomy*, vol. 75, pt. B, 2016, pp. 128-33.

1-month-old male and female rabbits exposed in utero and after birth to 1800 MHz mobile phone-like RFR was shown to increase apoptosis and oxidative DNA damage levels in both intrauterine and extrauterine periods in comparison to control animals.

Odaci, E., et al. [“Maternal exposure to a continuous 900-MHz electromagnetic field provokes neuronal loss and pathological changes in cerebellum of 32-day-old female rat offspring.”](#) *Journal of Chemical Neuroanatomy*, vol. 75, pt. B, 2016, pp. 105-10.

Following exposure to 900MHz EMF (1h/day during days 13-21) during the prenatal period, 32-day-old female rat pups showed significantly lower numbers of total Purkinje cells within the cerebellum compared to control and sham groups, indicating significant pathological effects that may persist after the postnatal period.

Sahin, D., et al. [“The 2100MHz radiofrequency radiation of a 3G-mobile phone and the DNA oxidative damage in brain.”](#) *Journal of Chemical Neuroanatomy*, vol. 75, pt. B, 2016, pp. 94-8.

Rats exposed to 2100 MHz radiofrequency radiation emitted by a generator, simulating a 3G-mobile phone, were observed to have increased oxidative DNA damage in the brain after 10 days of exposure, but decreased damage following 40 days of exposure, which could indicate adaptive DNA repair mechanisms.

Deshmukh, P.S., et al. [“Cognitive impairment and neurogenotoxic effects in rats exposed to low-intensity microwave radiation.”](#) *International Journal of Toxicology*, vol. 34, no. 3, 2015, pp. 284-90.

In comparison to controls, rats exposed to chronic, low-intensity microwave exposure for 180 days at 3 different frequencies (900, 1800, and 2450 MHz) showed declined cognitive function, elevated HSP70 level, and DNA damage in the brain, indicating that this type of microwave radiation may have hazardous effects on the brain.

Hao, Y.-H., Zhao, L., & Peng, R.-Y. [“Effects of microwave radiation on brain energy metabolism and related mechanisms.”](#) *Military Medical Research*, vol. 2, no. 4, 2015.

This paper reviews the biological effects of microwave radiation, the features of brain energy supply and consumption and the effects of microwave radiation on mitochondrial energy metabolism and potential related mechanisms.

Roggeveen, S., et al. [“EEG changes due to experimentally induced 3G mobile phone radiation.”](#) *PLoS One*, vol. 10, no. 6, 2015.

Researchers found that the 15-minute placement of a 3G dialing mobile phone caused significant changes in the alpha, slowbeta, fastbeta, and gamma bands, while placement of the phone on the heart did not show significant results, supporting the notion that EEG alterations are associated with mobile phone usage and that the effect is dependent on site of placement.

Narayanan, S.N., et al. [“Possible cause for altered spatial cognition of prepubescent rats exposed to chronic radiofrequency electromagnetic radiation.”](#) *Metabolic Brain Disease*, vol. 30, no. 5, 2015, pp. 1193-206.

Researchers exposed 4-week old prepubescent male rats to chronic and repeated radiofrequency electromagnetic radiation (900 MHz for 1 h/day, for 28 days), finding decreased progressive learning abilities, spatial memory deficits, poor spatial memory retention and structural changes in the hippocampus in the RF-EMF exposed group in comparison to control group.

Zarei, S., et al. [“A Challenging Issue in the Etiology of Speech Problems: The Effect of Maternal Exposure to Electromagnetic Fields on Speech Problems in the Offspring.”](#) *Journal of Biomedical Physics and Engineering*, vol. 5, no. 3, 2015, pp. 151-4.

Researchers found a significant association between maternal exposure of different sources of electromagnetic fields either using call time ($P=0.002$) or history of mobile phone use (months used) and speech problems in the offspring ($P=0.003$), however, other exposures had no effect on the occurrence of speech problems.

Zehra, Topal, et al. [“The effects of prenatal long-duration exposure to 900-MHz electromagnetic field on the 21-day-old newborn male rat liver.”](#) *Turkish Journal of Medical Sciences*, vol. 45, 2015.

The study results show that a 900-MHz EMF applied in the prenatal period caused oxidative stress and pathological alterations in the liver in the postnatal period.

Júnior et al. [“Behavior and memory evaluation of Wistar rats exposed to 1.8 GHz radiofrequency electromagnetic radiation.”](#) *Neurological Research*, vol. 36, no. 9, 2014, pp. 800-3.

Following exposure to 1.8 GHz RF-EMR from a GSM cell phone for 3 days male rats showed increased stress behavior actions, but did not present anxiety patterns or working memory impairment.

Qiao, Simo, et al. [“Reduction of Phosphorylated Synapsin I \(Ser-553\) Leads to Spatial Memory Impairment by Attenuating GABA Release after Microwave Exposure in Wistar Rats.”](#) *PLoS ONE*, vol. 9, no. 4, 2014.

Researchers found that in rats, p-Syn I (ser-553) plays a key role in the impaired GABA release leading to induction of cognitive dysfunction and spatial memory deterioration following microwave exposure for 5 min at a mean power density of 30 mW/cm².

Chen, Chunhai, et al. [“Exposure to 1800 MHz radiofrequency radiation impairs neurite outgrowth of embryonic neural stem cells.”](#) *Scientific Reports*, vol. 4, no. 5103, 2014.

Following embryonic neural stem cell exposure to 1800 MHz RF-EMF at specific absorption rate (SAR) values of 1, 2, or 4 W/kg for 1, 2, or 3 days, researchers did not find that eNSC apoptosis, proliferation, cell cycle, mRNA expressions of related genes, or ratio of eNSC differentiated neurons and astrocytes was altered due to RF-EMF exposure, however neurite outgrowth of eNSC differentiated neurons and protein expression for crucial proneural genes was inhibited after 4W/kg exposure for 3 days.

Razavinasab, M., K. Moazzami and M. Shabani M. [“Maternal mobile phone exposure alters intrinsic electrophysiological properties of CA1 pyramidal neurons in rat offspring.”](#) *Toxicology and Industrial Health*, vol. 30, no. 2, 2014, pp. 101-96.

Researchers found that rats prenatally exposed to 900 MHz pulsed-EMF from mobile phones for 6h/day during gestation expressed a significant decrease in action potential in response to current, decreased neuronal excitability within the hippocampus, altered learning acquisition and altered memory retention in comparison to control animals.

Bin, Lv, et al. [The alteration of spontaneous low frequency oscillations caused by acute electromagnetic fields exposure.](#) *Clinical Neurophysiology*, vol. 125, no. 2, 2014, pp. 277-86.

Researchers examined the alteration of regional resting state brain activity induced by 30 min of RF-EMF exposure, finding decreased low frequency fluctuation (ALFF) values in the left superior temporal gyrus, left middle temporal gyrus, right superior temporal gyrus, right medial frontal gyrus and right paracentral lobule following exposure.

Saikhedkar, N., et al. [“Effects of mobile phone radiation \(900 MHz radiofrequency\) on structure and functions of rat brain.”](#) *Neurological Research*, vol. 2, no. 6, 2014, pp. 2499-504.

Rats exposed to 900 MHz RFR for 4h/day for 15 days showed significant changes in behavior, including more anxiety and poorer learning as well as increased production of reactive oxygen species due to exhaustion of enzymatic and non-enzymatic antioxidants and increased lipid peroxidation, which indicate extensive neurodegeneration in selective areas of CA1, CA3, DG, and the cerebral cortex.

Byun, Y-H, et al. [“Mobile Phone Use, Blood Lead Levels, and Attention Deficit Hyperactivity Symptoms in Children: A Longitudinal Study.”](#) *PLoS ONE*, vol. 8, no. 3, 2013.

Researchers investigated the association between mobile phone use and Attention Deficit Hyperactivity Disorder (ADHD) symptoms in children, finding a significant association between mobile phone voice calls and ADHD symptoms in children exposed to relatively high lead exposure levels, suggesting that simultaneous exposure to lead and RF from mobile phone use is associated with increased ADHD symptom risk.

Deshmukh et al. [Effect of low level microwave radiation exposure on cognitive function and oxidative stress in rats.](#) *Indian Journal of Biochemistry and Biophysics*, vol. 50, no. 2, 2013, pp. 114-9.

Results of 900 MHz MW radiation exposure for 30 days (2h/day, 5 days/week) on cognitive function and oxidative stress in blood in rats showed significant impairment in cognitive function and increases in oxidative stress, as evidenced by the increase in levels of MDA (a marker of lipid peroxidation), protein carbonyl (a marker of protein oxidation) and unaltered GSH content in blood.

Ozgur, E., et al. ["Effects of prenatal and postnatal exposure to GSM-like radiofrequency on blood chemistry and oxidative stress in infant rabbits, an experimental study."](#) *Cell Biochemistry and Biophysics*, vol. 67, no. 2, 2013, pp. 743-51.

Investigated of the potential hazardous effects of prenatal and/or postnatal exposure to 1800 MHz GSM-like radiofrequency radiation (RFR) on the blood chemistry and lipid peroxidation levels of infant rabbits resulted in increased oxidative stress and changes in blood chemistry parameters within RFR-exposed animals in comparison to control animals.

Divan, H.A, et al. ["Cell phone use and behavioural problems in young children."](#) *Journal of Epidemiology and Community Health*, vol. 66, no. 6, 2012, pp. 524-9.

Researchers observed mothers and children from the Danish National Birth Cohort for prenatal and postnatal exposure to cell phone use, and found that the highest OR for behavioural problems were for children who had both prenatal and postnatal exposure to cell phones compared with children not exposed during either time period.

Aldad, T.S., et al. ["Fetal Radiofrequency Radiation Exposure From 800-1900 MHz-Rated Cellular Telephones Affects Neurodevelopment and Behavior in Mice."](#) *Scientific Reports*, vol. 2, no. 312, 2012.

In a study examining the association between prenatal cell phone use and hyperactivity in children, researchers found that mice exposed in-utero were hyperactive and had impaired memory as determined using the object recognition, light/dark box and step-down assays and recordings of excitatory postsynaptic currents revealed that these behavioral changes were due to altered neuronal developmental programming.

Megha, K., et al. ["Microwave radiation induced oxidative stress, cognitive impairment and inflammation in brain of Fischer rats."](#) *Indian Journal of Experimental Biology*, vol. 50, no. 12, 2012, pp. 889-96.

Exposure to 900 MHz or 1800 MHz microwave radiation for 30 days (2 h/day) produced significant impairment in cognitive function, induction of oxidative stress in brain tissues, and significantly increased the levels of cytokines in microwave exposed rats in comparison with sham exposed groups.

Jing, J., et al. ["The influence of microwave radiation from cellular phone on fetal rat brain."](#) *Electromagnetic Biology and Medicine*, vol. 31, no. 1, 2012, pp. 57-66.

This study found that in comparison with the control group, fetal rat brains which had been chronically exposed to cellular phones in utero showed significantly different levels of superoxide dismutase, glutathione peroxidase, malondialdehyde, noradrenaline, and dopamine.

Li, De-Kun, et al. [“A Prospective Study of In-utero Exposure to Magnetic Fields and the Risk of Childhood Obesity.”](#) *Scientific Reports*, vol. 2, no. 540, 2012.

This prospective study measured levels of magnetic fields during pregnancy and conducted subsequent follow-up records, resulting in a dose-response association between prenatal exposure to high MF level and increased risk of obesity in offspring in comparison to lower MF level exposure.

Sudan, M., et al. [Prenatal and Postnatal Cell Phone Exposures and Headaches in Children.](#) *The Open Pediatric Medical Journal*, vol. 6, 2012, pp. 46-52.

Researchers found a significant association between cell phone exposure and headaches in children, within which prenatal, postnatal or both types of exposure were related to an increased risk of migraines and headache-related symptoms compared to children with no exposure.

Li, De-Kun, Hong Chen and Roxana Odouli. [“Maternal Exposure to Magnetic Fields During Pregnancy in Relation to the Risk of Asthma in Offspring.”](#) *Archives of Pediatric and Adolescent Medicine*, vol. 165, no. 10, 2011, pp. 945-50.

This epidemiological cohort study found a statistically significant linear dose-response relationship between increasing maternal exposure to high levels of magnetic fields during pregnancy and an increased risk of asthma in offspring.

Volkow, Nora D., et al. [“Effects of cell phone radiofrequency signal exposure on brain glucose metabolism.”](#) *Journal of the American Medical Association*, vol. 305, no. 8, 2011, pp. 808-13.

In healthy participants and compared with no exposure, 50-minute cell phone exposure was associated with increased brain glucose metabolism, a marker of brain activity, in the region closest to the antenna.

Sirav, B. and N. Seyhan. [“Effects of radiofrequency radiation exposure on blood-brain barrier permeability in male and female rats.”](#) *Electromagnetic Biology and Medicine*, vol. 30, no. 4, 2011, pp. 253-60.

In female rats, no albumin extravasation was found in the brain after RFR exposure, however a significant increase in albumin was found in the brains of the RF-exposed male rats when compared to sham-exposed male brains, suggesting that exposure to 0.9 and 1.8 GHz CW RFR at levels below the international limits can affect the vascular permeability in the brain of male rats.

Sonmez, O.F., et al. [“Purkinje cell number decreases in the adult female rat cerebellum following exposure to 900 MHz electromagnetic field.”](#) *Brain Research*, vol. 1356, 2010, pp. 95-101.

Results showed that the total number of Purkinje cells in the cerebellum of the EMFG was significantly lower than those of the control group ($p < 0.004$) and sham group ($p < 0.002$).

Bas O, et al. [“900 MHz electromagnetic field exposure affects qualitative and quantitative features of hippocampal pyramidal cells in adult rat.”](#) *Brain Research*, vol. 1265, 2009, pp. 178–185.

Results showed that postnatal EMF exposure caused a significant decrease of the pyramidal cell number in the cornu ammonis of the EMF-exposed group ($P < 0.05$), indicating that this type of electromagnetic radiation may have a chronic effect on the human brain.

Bas, O., et al. [“Chronic prenatal exposure to the 900 megahertz electromagnetic field induces pyramidal cell loss in the hippocampus of newborn rats.”](#) *Toxicology and Industrial Health*, vol. 25, no. 6, 2009, pp. 377–84.

It was found that 900 MHz of electromagnetic field significantly reduced the total pyramidal cell number in the cornu ammonis of the electromagnetic field group ($P < 0.001$).

Bellieni, C.V., et al. [“Electromagnetic fields produced by incubators influence heart rate variability in newborns.”](#) *Archives of Disease in Childhood-Fetal and Neonatal Edition*, vol. 93, no. 4, 2008, pp. F298-F301.

EMFs produced by incubators influence newborns' HRV, showing an influence on their autonomous nervous system.

Divan, H.A., et al. [“Prenatal and postnatal exposure to cell phone use and behavioral problems in children.”](#) *Epidemiology*, vol. 19, no. 4, 2008, pp. 523-9.

Exposure to cell phones prenatally-and, to a lesser degree, postnatally-was associated with behavioral difficulties such as emotional and hyperactivity problems around the age of school entry.

Odaci E., O. Bas and S. Kaplan. [“Effects of prenatal exposure to a 900 megahertz electromagnetic field on the dentate gyrus of rats: a stereological and histopathological study.”](#) *Brain Research*, vol. 1238, 2008, pp. 224–9.

Prenatal exposure of maternal rats to 900 MHz EMF (60 min/day between first and last days of gestation) was shown to cause a decrease in the number of granule cells in the dentate gyrus.

Rezk, Ahmed Y., et al. [“Fetal and neonatal responses following maternal exposure to mobile phones.”](#) *Saudi Medical Journal*, vol. 29, no. 2, 2008, pp. 218-23.

A statistical significant increase in fetal and neonatal HR, and statistical significant decrease in stroke volume and COP before and after use of mobile phone were noted. All these changes are attenuated with increase in gestational age.

Li, DK, et al. [“A population-based prospective cohort study of personal exposure to magnetic fields during pregnancy and the risk of miscarriage.”](#) *Epidemiology*, vol. .13, no. 1, 2002, pp. 9-20.

This study asked pregnant women to wear a magnetic field measuring meter for 24-hours and correlated this data to pregnancy outcomes, showing an increased miscarriage risk with an increasing level of maximum magnetic field exposure with a threshold around 16 milligauss. “Our findings provide strong prospective evidence that prenatal maximum magnetic field exposure above a certain level (possibly around 16 mG) may be associated with miscarriage risk.” These findings were replated in a later study [presented at the 201 BEMS Conference](#).

Li, De-Kun, et al., [“Exposure to Magnetic Field Non-Ionizing Radiation and the Risk of Miscarriage: A Prospective Cohort Study”](#), *Scientific Reports* 7, Article number: 17541 (2017)

“This prospective cohort study of 913 pregnant women examined the association between high MF exposure and miscarriage risk.

After controlling for multiple other factors, women who were exposed to higher MF levels had 2.72 times the risk of miscarriage (hazard ratio = 2.72, 95% CI: 1.42–5.19) than those with lower MF exposure. The increased risk of miscarriage associated with high MF was consistently observed regardless of the sources of high MF. The association was much stronger if MF was measured on a typical day of participants’ pregnancies. The finding also demonstrated that accurate measurement of MF exposure is vital for examining MF health effects. This study provides fresh evidence, directly from a human population, that MF non-ionizing radiation could have adverse biological impacts on human health.”