

## Health Risks

- Russian and Eastern European scientists issued the earliest reports that low-level exposure to RF radiation could cause a wide range of health effects, including behavioral changes, effects on the immunological system, reproductive effects, changes in hormone levels, headaches, irritability, fatigue, and cardiovascular effects.
- Since the first reports appeared in the literature, scientists have recognized the near-ubiquitous use and exposure to cell phones and other radiofrequency technologies in the last decade, and have launched and completed many studies. As the science has matured, researchers and government officials have become increasingly concerned about exposures that affect pregnant women — and their fetuses. Their concern is also for children whose brains and organs do not fully mature until age 21.
- Non-ionizing radiation, with long wavelength and low frequency, does not break chemical bonds, but has sufficient energy to move electrons and heat body tissue, leading to biological effects at certain doses. Except for optical radiation, there is little data on the quantitative relationships between exposures to different types of non-ionizing radiation and effects on human health.
- In 1996, the World Health Organization (WHO) established the International EMF Project to review the scientific literature concerning biological effects of EMFs, and will conduct a formal risk assessment of all studied health outcomes from exposure to RF fields by 2012.
- The majority of studies examining biological and health effects of cell phone radiation have focused on the potential of cell technologies to cause cancer, nervous system disorders, and adverse reproductive effects. This literature is reviewed on the following pages.



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### Types of Brain Tumors

<b>Glioma</b>	Cancer that begins in brain cells
<b>Meningioma</b>	Tumor originating in the brain and spinal cord; not always malignant.
<b>Acoustic Neuroma</b>	Non-cancerous tumors that arise in nerve cells that supply the ear
<b>Salivary Gland Tumors</b>	Cancerous and non-cancerous

## Cancer

- Since RF-EMFs are emitted from cell phones in close proximity to the head, the potential for brain tumors has been a concern. Most studies have focused on potential associations between cell phone use and only a few types of brain tumors.
- Several studies have found an increase in the risk of developing some types of tumors after long-term exposure, but experimental studies are not available to explain the link, causing some to remain skeptical about the association. Overall, 33 peer-reviewed epidemiologic studies on cell phones and cancer have been conducted. Twenty-five of these studies have focused on brain tumors.<sup>22</sup> Some have found a risk of cancer with long-term use of cell phones,<sup>23</sup> while others have not.<sup>24</sup>
- Data derived from studies spanning decades may be dated by the time they are published, due to rapidly changing technology and cell phone use patterns. A National Cancer Institute (NCI) case-control study of brain tumors and use of cell phones by adults which began in 1994 — 11 years after the first commercial cell phone was activated in the United States — found no indication of higher brain tumor risk among people who had used cell phones compared with those who had not used them. However, patterns of cell phone use and the types of phones used in the United States have changed since the early to mid-1990s, and few users in the study reported using cell phones for five years or more.<sup>25</sup>
- Strong studies about the relationships between cell phone use and cancer have been published by Hardell et al. and WHO's International Agency for Research on Cancer (IARC). Both Hardell et al.

and IARC's Interphone studies are the subject of criticism about methodological deficiencies, inadequate exposure assessment, and problems with recall and response.

- **IARC's Interphone study**, the largest cell phone health study conducted, found "suggestions of an increased risk of glioma at the highest exposure levels" but notes "biases and error prevent a causal interpretation."<sup>26</sup> The Mobile Manufacturers forum notes that it provides assurance of the safety of cell phones, and the Food and Drug Administration (FDA) notes that these biases and errors limit the strength of conclusions that can be drawn from it. Others argue that the study may underestimate the real risk of cell phones today, noting that the average present-day user in the U.S. could fall into this "highest level of exposure" risk use category after about 13 years.<sup>27</sup>
- The Swedish researcher **Dr. Lennart Hardell et al.** have conducted six independently funded studies on cell phones and tumors, using the Swedish Cancer Registry, and has found a consistent pattern of increased risk for glioma and acoustic neuroma after 10 years of mobile phone use. Noting that the evidence for risks from prolonged cell phone and cordless phone use is "quite strong," Hardell et al. concluded, "For people who have used these devices for 10 years or longer, and when they are used mainly on one side of the head, the risk of malignant brain tumor is doubled for adults and is even higher for persons with first use before the age of 20 years."<sup>28</sup>
- Critics of Hardell's studies claim "recall bias" prevent objective data, and have prevented Hardell's work from supporting a theory of cancer causation in humans in legal decisions. The Daubert standard rule of evidence requires scientific evidence to be "reliable and relevant" in order to be admitted to federal court. Others argue that Hardell may have underestimated the risk from mobile phone use and that his research is less biased than that of the Interphone study.<sup>29</sup>



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**Review studies note that insufficient time has passed to evaluate long-term risks associated with slow-growing brain tumors, but some studies already show possible evidence of an increased risk of brain tumors from the use of cell phones.**

**Table 1. Comparison of the Hardell and Interphone Studies**

AUTHOR	FINDING	CONCERNS	FUNDING
<b>Lennart Hardell et al.</b>	Increased risk for glioma and acoustic neuroma after 10 years of mobile phone use.	Recall bias; no dose-response relationship	Independently funded
<b>IARC's Interphone</b>	Suggestions of an increased risk of glioma at the highest exposure levels.	Biases and error prevent a causal interpretation.	Funded in part by industry with agreement to guarantee scientific independence.

- Data from ionizing radiation studies indicate a brain tumor latency time of between 20 and 55 years. Acoustic neuromas associated with childhood radiation exposure used to treat “enlarged” tonsils and adenoids appeared up to 55 years after the original exposure, with a mean of 38 years.<sup>30</sup>
- Review studies note that insufficient time has passed to evaluate long-term risks associated with slow-growing brain tumors, but some studies already show possible evidence of an increased risk of brain tumors from the use of cell phones. Almost all research on mobile phone radiation studying an exposure duration of 10 years or longer point towards the existence of an increased tumor risk in the head.<sup>31</sup>
- The most recent U.S. brain cancer incidence rates indicate that rates have declined slightly or remained the same, except in those aged 20 to 29. Females in this group experienced a statistically significant increase in frontal lobe cancers, but not in parts of the brain that would be more highly exposed to RF radiation from cell phones.<sup>32</sup>
- In 2011, WHO’s International Agency for Research on Cancer (IARC) classified electromagnetic fields as possibly carcinogenic to humans, citing an increased risk of glioma associated with wireless phone use.<sup>33</sup> The evidence linking wireless phone use to glioma

Table 2. RF Radiation from Cell Phones and Cancer: Conclusions of Peer-Reviewed Review Studies

AUTHOR	FINDINGS	AFFILIATION
Ahlbom A et al. (2009) <sup>34</sup>	"...the studies published to date do not demonstrate an increased risk within approximately 10 years of use for any tumor of the brain or any other head tumor... For slow-growing tumors... the absence of association reported thus far is less conclusive because the <b>observation period has been too short.</b> "	International Commission for Non-Ionizing Radiation Protection
Khurana VG et al. (2009) <sup>35</sup>	"...there is <b>adequate epidemiologic evidence to suggest a link</b> between prolonged cell phone usage and the development of an ipsilateral brain tumor."	Australian National University
Han YY et al. (2009) <sup>36</sup>	"Some studies of longer term cell phone use have found an <b>increased risk of ipsilateral AN [acoustic neuroma].</b> "	Center for Environmental Oncology–University of Pittsburgh Cancer Institute
Kohli et al. (2009) <sup>37</sup>	"The evaluation of current evidence provided by various studies to suggest the possible carcinogenic potential of radiofrequency radiation is <b>inconclusive.</b> "	Department of Internal Medicine, Government Medical College and Hospital, India
Myung et al. <sup>38</sup>	"...there is <b>possible evidence</b> linking mobile phone use to an increased risk of tumors from a meta-analysis of low-biased case-control studies."	National Cancer Control Research Institute, National Cancer Center, Korea
Croft et al (2009) <sup>39</sup>	"There are reports of small associations between MP-use ipsilateral to the tumour for <b>greater than 10 years</b> , for both acoustic neuroma and glioma, but the present paper argues that these are especially prone to confounding by recall bias."	Australian Centre for Radiofrequency Bioeffects Research
Abdus-Salam et al. (2008) <sup>40</sup>	"...published research works over several decades including some with over ten years of follow up have not demonstrated any significant increase in cancer among mobile phone users. However, the need for caution is emphasized as it <b>may take up to four decades</b> for carcinogenesis to become fully apparent."	Department of Radiotherapy, College of Medicine, University of Ibadan, Ibadan, Nigeria.
Kundi (2008) <sup>41</sup>	"The overall evidence speaks in favor of an increased risk, but its magnitude cannot be assessed at present because of <b>insufficient information on long-term use.</b> "	Institute of Environmental Health, Medical University of Vienna, Vienna, Austria

and acoustic neuroma is considered "limited" and inadequate to draw conclusions for other types of cancers. "Limited evidence of carcinogenicity" is defined by IARC as, "a positive association... between exposure to the agent and cancer for which a causal interpretation is considered by the Working Group to be credible, but chance, bias or confounding could not be ruled out with reasonable confidence."<sup>42</sup>



In 2011, IARC classified radiofrequency electromagnetic fields (RF-EMFs) as possibly carcinogenic to humans, citing an increased risk of glioma associated with wireless phone use.

Table 3. IARC Cancer Groups

IARC's Groups	Number	Examples
Group 1: Carcinogenic to humans	107	Asbestos, arsenic, benzene, radon, solar radiation, vinyl chloride, tobacco smoke
Group 2A: Probably carcinogenic to humans	59	Nitrate or nitrite, UV radiation, trichloroethylene
Group 2B: Possibly carcinogenic to humans	266	Carbon tetrachloride, gasoline, diesel fuel (marine), lead, naphthalene, styrene, RF-EMFs
Group 3: Unclassifiable as to carcinogenicity in humans	508	Fluorescent lighting, Hepatitis D virus, personal use of hair coloring products, malathion, melamine
Group 4: Probably not carcinogenic to humans	1	Caprolactam (used in making plastics and nylon)

Source: WHO, IARC. Agents Classified by the IARC Monographs, Volumes 1–100

- The primary goal of IARC is to identify causes of cancer and it has established the most widely used system for classifying carcinogens. IARC has evaluated the cancer-causing potential of more than 900 likely candidates, placing them into one of the groups in Table 3.
- NCI's *2011 Annual Report to the Nation on the Status of Cancer* notes that the association between long-term (>10 years) cell phone use and brain cancer is *unclear*, “primarily because of the relatively recent adoption of widespread use of cellular phones, as well as issues of bias and study design.”<sup>43</sup>
- The NCI further acknowledges that “acoustic neuromas are of particular interest with regard to cellular phone use because of the proximity of these tumors to the phone” and that the “relatively large number of acoustic neuromas identified in the first four years of data collection suggests that etiologic studies will be possible in the future.”<sup>44</sup>

## Nervous System

- The effects of exposure to RF-EMFs from cell phones on the human nervous system have been the subject of a large number of studies in recent years. Minor effects on brain activity have been found, but have not been related to adverse health effects. No consistent significant effects on cognitive performance and memory have been observed.<sup>45</sup>
- Experiments by Narayanan et al. found that memory retention and retrieval were significantly affected in mobile phone RF-EMR-exposed rats.<sup>46</sup> Several other studies have also measured cognitive effects in animals (Table 4).
- Examples of effects in humans include impaired cognitive performance after exposure to a pulsed electromagnetic field<sup>47</sup> and slower response times to spatial working memory tasks when exposed to RF from a standard GSM cellular phone placed next to the head of male subjects.<sup>48</sup>
- Most studies have focused on changes in cognitive performance after short-term RF-EMF exposure, and most have involved young and middle-aged male and female subjects. Since children represent a sensitive subgroup, as their brains are not yet completely mature, they may react differently to RF-EMF exposure.<sup>49</sup>
- A 2011 review of the literature on the effects of RF-EMF exposure on cognitive performance measured in humans found inconsistent study results due to differences in methodology, sample size, composition of study groups, experimental design and exposure setup, as well as the exposure conditions. The authors note, “The lack of a validated tool, which reliably assesses changes in cognitive performance caused by RF-EMF exposure, may contribute to the current inconsistencies in outcomes.”<sup>50</sup>



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■ The effects of RF-EMF exposure from cell phones on central nervous system (CNS) disorders, such as Alzheimer's disease, migraine, or vertigo, has been the focus of recent epidemiological research in Denmark, which is the first country to investigate a possible association between the use of cell phones and the risk of CNS disorders.

■ The study found a weak, but statistically significant, association between cell phone use and migraine and vertigo. The Danish study recommended more research in this area, along with RF exposure-reducing measures, until more data have been obtained.<sup>51</sup>

**Table 4. RF Radiation from Cell Phones and Effects on Cognition, Learning, or Memory Findings**

Author	Year	Species	Frequency	SAR	Exposure Duration	Effect
Narayan SN et al. <sup>52</sup>	2010	Rat	900 MHz – 1.8 GHz	NS	50 missed calls (45 sec.); within 1 hr per day for 4 weeks	Altered passive avoidance behavior and hippocampal morphology
Fragopoulou AF et al. <sup>53</sup>	2010	Mouse	900 MHz	0.41 W/kg – 0.98 W/kg	1 hr 55 min. for the first 3 days; 3 hr 45 min. on the fourth day's probe trial	Deficits in consolidation and/or retrieval of learned spatial information
Daniels WM et al. <sup>54</sup>	2009	Rat	840 MHz	NS	Continuous for 3 hrs/day from day 2 to day 14 after birth	Decreased locomotor activity, increased grooming and a tendency toward increased basal corticosterone levels
Nittby H et al. <sup>55</sup>	2008	Rat	900 MHz	0.0006 W/kg – 0.06 W/kg	2 hrs/week for 55 weeks	Reduced memory functions after GSM exposure (P = 0.02)
Eliyahu I et al. <sup>56</sup>	2006	Human	890.2 MHz	NS	Continuous for 2 hours	Exposure to left side of brain slowed left-hand response time
Maier R et al. <sup>57</sup>		Human	902 MHz	NS	Continuous for 50 min	Pulsed EMF exposure impaired cognitive performance

## Reproduction

- Several research studies have examined the effects of RF-EMF on the male reproductive system. The focus of research has included effects on semen quality and potential changes associated with RF-EMF exposures and electromagnetic radiation.
- The potential effects of RF-EMF from cell phones on fertility were investigated in a 2005 epidemiological study, which found correlations between cell phone use and changes in semen quality.<sup>58</sup> An experimental study that same year involving exposure of male mice to RF-EMR noted a significant genotoxic effect on epididymal sperm.<sup>59</sup>
- Other studies have correlated the duration of exposure to cell phones with defects in sperm count, motility, viability, and normal morphology, but most of the studies have been small and the evidence remains equivocal.<sup>60</sup>
- Agarwal et al. found that cell phone use decreased semen quality in 361 men by reducing sperm count, motility, viability, and normal morphology, and that the decrease in sperm parameters was dependent on the duration of daily exposure to cell phones and independent of the initial semen quality. The same research group placed men's semen samples 2.5 centimeters (about an inch) away from a cell phone, in talk mode, for one hour. This is an average distance between the testes and the pants' pocket.
- Semen exposed to RF electromagnetic waves emitted from cell phones had higher levels of damaging free radicals, lower sperm motility (the ability of sperm to move and swim), lower sperm viability (the percentage of live sperm), and possibly greater oxidative stress.<sup>61</sup>



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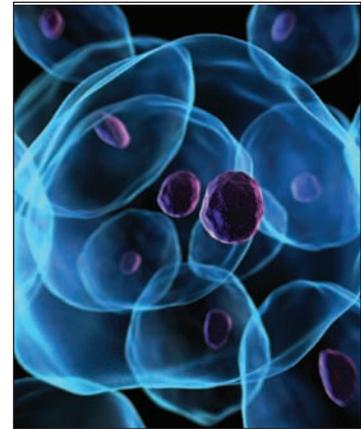
**Table 5. Select Cell Phone Radiation Studies Demonstrating Potential Effects on Fertility**

Author	Year	Effect Noted
Deluliis et al. <sup>62</sup>	2009	"RF-EMR in both the power density and frequency range of mobile phones enhances mitochondrial reactive oxygen species generation by human spermatozoa, decreasing the motility and vitality of these cells while stimulating DNA base adduct formation and, ultimately, DNA fragmentation. These findings have clear implications for the safety of extensive mobile phone use by males of reproductive age, potentially affecting both their fertility and the health and well-being of their offspring."
Salama N et al. <sup>63</sup>	2009	"Low intensity pulsed radiofrequency emitted by a conventional mobile phone kept in the standby position could affect the testicular function and structure in the adult rabbit."
Agarwal A et al. <sup>64</sup>	2009	"Radiofrequency electromagnetic waves emitted from cell phones may lead to oxidative stress in human semen. We speculate that keeping the cell phone in a trouser pocket in talk mode may negatively affect spermatozoa and impair male fertility."
Agarwal A et al. <sup>65</sup>	2008	"Use of cell phones decrease[s] the semen quality in men by decreasing the sperm count, motility, viability, and normal morphology. The decrease in sperm parameters was dependent on the duration of daily exposure to cell phones and independent of the initial semen quality."
Yan JG et al. <sup>66</sup>	2007	"Rats exposed to 6 hours of daily cellular phone emissions for 18 weeks exhibited a significantly higher incidence of sperm cell death than control group rats through chi-squared analysis.... [A]bnormal clumping of sperm cells was present in rats exposed to cellular phone emissions and was not present in control group rats. These results suggest that carrying cell phones near reproductive organs could negatively affect male fertility."
Wdowiak A et al. <sup>67</sup>	2007	"In the analysis of the effect of GSM equipment on the semen it was noted that an increase in the percentage of sperm cells of abnormal morphology is associated with the duration of exposure to the waves emitted by the GSM phone. It was also confirmed that a decrease in the percentage of sperm cells in vital progressing motility in the semen is correlated with the frequency of using mobile phones."
Panagopoulos DJ et al. <sup>68</sup>	2007	"Both types of radiation were found to decrease significantly and non thermally the insect's reproductive capacity, but GSM 900 MHz seems to be even more bioactive than DCS 1800 MHz. The difference seems to be dependent mostly on field intensity and less on carrier frequency."
Erogul O et al. <sup>69</sup>	2006	"These data suggest that EMR emitted by cellular phone influences human sperm motility. In addition to these acute adverse effects of EMR on sperm motility, long-term EMR exposure may lead to behavioral or structural changes of the male germ cell. These effects may be observed later in life, and they are to be investigated more seriously."
Aitken et al. <sup>70</sup>	2005	"...while RF-EMR does not have a dramatic impact on male germ cell development, a significant genotoxic effect on epididymal spermatozoa is evident and deserves further investigation."
Fejes I et al. <sup>71</sup>	2005	"Low and high transmitter groups also differed in the proportion of rapid progressive motile sperm (48.7% vs. 40.6%). The prolonged use of cell phones may have negative effects on the sperm motility characteristics."

## Other Effects

### Genotoxic Effects/Cell Damage

- Researchers have studied the potential of RF-EMFs to cause changes in a cell's genetic material (DNA) and/or to damage the genome. "Genotoxic" substances can potentially cause genetic mutations or cellular damage that can contribute to the development of cancerous tumors.
- The European Union's *in vitro* REFLEX study of human cells exposed to cell phone microwave radiation (2000 to 2004) showed that radiation from cell phones has the potential to damage the genome of isolated human cells, but the findings were very controversial. The lead author of the study argues that there is enough evidence that RF radiation can alter the genetic material of exposed cells.<sup>72</sup> Other scientists agree: A recent review of 101 papers on the genotoxic effects of RF-EMF found that 49 reported a genotoxic effect.<sup>73</sup>
- Numerous studies in laboratory animals have demonstrated that mobile phones or simulated RF radiation exposures can damage cells. While some authors have suggested that this could lead to neurological damage, other authors have not.<sup>74</sup> There is no standard testing methodology for the evaluation of possible genotoxic effects of EMFs, which may in part explain why the findings are inconsistent.
- DNA studies have particular importance with respect to children. Researchers who placed a mobile phone at a one-meter (about a yard) distance from human cells found a reduction in DNA repair in cells with double-strand DNA damage. The strongest effects were observed in stem cells. Since stem cells are more active in children, researchers argue that children may be at an increased risk of cancer from cell phone exposures.<sup>75</sup>



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- For several decades, Swedish neuroscientists have studied the effects of RF-EMFs on nerve cells. They attached cell phones to the sides of young rats' cages to create intermittent exposures similar to human usages, and discovered neuron damage in the brains of young rats 50 days after weekly two-hour exposure.<sup>76</sup>

### Ocular Effects

- Thermal effects from microwave radiation have been reported to cause cataracts and effects on the retina, cornea and other ocular systems, but non-thermal effects are less well understood.<sup>77</sup> Studies of non-thermal effects of RF-EMFs from mobile phones are relatively recent. Researchers have recommended further study of effects on the eye lens and lens epithelial cells.<sup>78</sup>
- Electromagnetic fields from microwave radiation have been shown to have a negative impact on the eye lens. One study warns, "High-frequency microwave electromagnetic radiation from mobile phones and other modern devices has the potential to damage eye tissues, but its effect on the lens epithelium is unknown at present."<sup>79</sup>

### Psychological Effects

- The addictive nature of cell phones has concerned psychologists for years. Recently, psychologists have warned that smartphone users are especially at risk for becoming addicted to their devices. In a recent study, subjects checked their phones 34 times a day. People may check their phones out of habit or compulsion, but habitually checking can be a way to avoid interacting with people.<sup>80</sup>
- Some people can experience withdrawal symptoms typically associated with substance abuse, such as anxiety, insomnia, and depression, when they are without their smartphones. Most of the studies conducted on the potential psychological effects of cell phones have focused on young adults and adolescents.

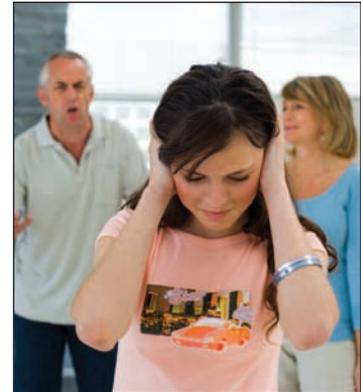
- According to a recent Columbia University study, “communication, responsibility, and relationships all seem to be negatively influenced by the use of text messaging” in both early and late adolescent groups.<sup>81</sup> Frequent mobile phone use has been associated with stress, sleep disturbances, and symptoms of depression among young adult men and women.<sup>82</sup> Yen et al. cite “withdrawal symptoms without cellular phone use” as a common psychological reaction in adolescents to the removal of cell phone access.<sup>83</sup>

## Electromagnetic Hypersensitivity

- Some individuals experience adverse medical symptoms from exposure to electromagnetic fields. People with electromagnetic hypersensitivity (EHS) report symptoms from even low levels of exposure to non-ionizing electromagnetic radiation.
- Concerns that cell phones may be associated with EHS are largely a result of complaints from cell phone users about headaches, nausea, dizziness, blurred vision, and other symptoms. Few studies have been conducted on electromagnetic hypersensitivity from exposure to mobile phones.<sup>84</sup>

## Studies Specific to Children

- Children may be potentially susceptible to RF effects because of their developing nervous systems, increased levels of cell division, undeveloped immune systems, thinner skulls, and more conductive brain tissue. Children experience greater RF penetration relative to head size, and longer lifetime exposure in comparison with adults.<sup>85</sup>
- Epidemiological studies demonstrating health effects of RF radiation from cell phones on children are extremely limited. The few studies that have specifically focused on cell phones and children have focused on cancer, behavior, and neonatal heart rate.



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### ■ Cancer, Hardell study

At the first international conference on mobile phones and health in 2008, Lennart Hardell, M.D., Ph.D., reported that people who started mobile phone use before the age of 20 had a more than five-fold increase in glioma. Those who started using mobile phones when they were young were also five times more likely to develop acoustic neuromas.<sup>86</sup>

### ■ Cancer, CEFALO study

*The CEFALO is an international, multicenter, case-control study of the association between mobile phone use and brain tumor risk in children aged 7 to 19.*

- Published in July 2011, the CEFALO study was conducted in Denmark, Sweden, Norway, and Switzerland. It included children and adolescents aged 7–19 years who were diagnosed with a brain tumor between 2004 and 2008.
- The study found that children and adolescent patients with brain tumors were not statistically significantly more likely to have been regular cell phone users than control subjects. The authors note that the possibility that cell phones might confer a small increase in risk cannot be ruled out and emphasize “the importance of future studies with objective exposure assessment or the use of prospectively collected exposure data.”<sup>87</sup>
- The report has some shortcomings; most notably, it can take 10 years or more to develop cancer following exposure, but only seven years have passed since the beginning of the study.
- Second, phone use patterns have changed significantly since the study was conducted. In the study, one call per week counted as “regular” use, skewing the results.
- An analysis of a subset of the data corresponding only to heavy cell phone users, however, found different results. In the author’s words: “[There] was a highly significant association between the

time since first subscription and brain tumor risk. Children who used cell phones for at least 2.8 years were more than twice as likely to have a brain tumor than those who never regularly used cell phones.”<sup>88</sup>

## ■ Behavior

*Professor Leeka Kheifets, M.A., Ph.D., of the Department of Epidemiology at the University of California, Los Angeles, and her colleagues conducted several studies on children’s exposure to mobile phones early in life and the association with behavioral problems.*

- One study, involving 13,000 children who reached age seven by 2006, concluded that exposure to mobile phones prenatally and postnatally was associated with behavioral difficulties.<sup>89</sup>
- More recently, a dataset consisting of nearly 29,000 children who reached age seven by 2008 replicated the previous study, demonstrating that mobile phone use was associated with behavioral problems in children.<sup>90</sup>
- **Environment and Human Health, Inc.’s forthcoming animal research study shows a relationship between cell phone use in pregnancy and behavioral issues in the offspring.**

## ■ Heart Rate

Pregnant women exposed to EMF emitted by mobile phones on telephone-dialing mode for 10 minutes a day during pregnancy and after birth had babies with statistically significant increases in fetal and neonatal heart rate. The study involved 90 women with uncomplicated pregnancies. The authors suggest that this may result from a physiological response to the pulsed magnetic fields, and recommend avoidance of cellular phone use during early weeks of gestation, and also recommend further studies.<sup>91</sup>

- Several other epidemiological studies on children are ongoing, but results of these studies are not yet available.



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**Table 6. Epidemiological Studies on Children and Potential Health Effects from Mobile Phone Use**

Study	Date	Health Effect	Finding	Location
Hardell et al.	2008	Brain tumors	Those who used cell phones before age 20 had >5-fold increase in glioma risk.	Sweden
CEFALO Study	2004–2008	Brain tumors	“Regular users of mobile phones were not statistically significantly more likely to have been diagnosed with brain tumors compared with nonusers.”	Denmark, Norway, Sweden, and Switzerland
Danish National Birth Cohort/ UCLA	1998–2008	Behavioral	Behavior problems	Denmark
Rezk et al., Egyptian hospitals	2003–2004	Heart rate	Increased fetal and neonatal heart rate	Egypt
MOCHE	2006–2010	Environmental exposures during pregnancy and childhood	Pending	Korea
MOBI-KIDS Study	Began 2010	Brain tumors	Pending	Australia, Austria, Canada, France, Germany, Greece, Israel, Italy, New Zealand, Spain, Taiwan, and the Netherlands
MoRPHEUS	2005–2010	Cognitive ability, blood pressure, or hearing	Shorter response times on learning tasks; less accurate working memory	Australia

Source: McLaughlin Centre for Population Health Risk Assessment. <http://www.rfcom.ca/young/index.shtml>