

Do Mobile Phones Cause Brain Tumors?

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In May 2011, the World Health Organization (WHO) classified mobile phones as “possibly carcinogenic to humans” and a “carcinogenic hazard”. Whether mobile phones are carcinogenic or not, however, remains a controversial topic [1]. Evidence both for and against the carcinogenic hazards of mobile phones are available in medical literature.

WHY SHOULD WE BE CONCERNED?

Increasing number of mobile phone subscribers:

The use of cell phones is on the rise, with over 5 billion subscribers worldwide in 2010 [2]. With time, people have started using them more frequently and for a longer duration.

Exposure to electromagnetic radiation:

Mobile phones use non-ionizing electromagnetic radiation, specifically microwaves, for relaying information from a hand-set's antenna to cellular phone towers, and vice versa. These waves lose their intensity with distance and are absorbed maximally by the area closest to the phone. Theoretically (anatomical association), this puts the head, more specifically the temporal lobe of the brain, and the neck at the greatest risk of developing mobile-related diseases, including cancers.

The question:

Considering these two factors, a question arises as to whether the device emitting electromagnetic radiations, used this extensively throughout the world, poses a risk to health or not.

EFFECTS OF MOBILE PHONE USE

Thermal effects:

Non-ionizing radiation does not cause damage to DNA. As the microwaves used in phones are at very low levels, their thermal effect is negligible [3].

Non-thermal effects:

A study [4] showed increased glucose metabolism in brain tissue present on the same side of the

head as the phone's antenna, as compared to the opposite side of the head. Other effects include an increase in the production of heat-shock proteins [5], which may lead to carcinogenesis if produced often or over a long period of time, production of stress hormones [6] and proteins [7], increased permeability of the blood-brain barrier [8, 9], and damaging effects on the dopamine-opiate systems of the brain. Contradictory studies also exist [10, 11].

Other effects:

Though contradictory data does exist, the reported studies include neurological, immunological, reproductive, genetic and circulatory effects of mobile phones. Neurological effects include association with: headache, dizziness, fatigue, local tingling, impaired learning and short-term memory, slowed reaction time [12], disturbed sleep pattern [13, 14, 15], and neuronal damage [16]. Some studies show depressed [17] or improved [18] immunity in mobile phone users. One study showed the presence of many pathogenic bacteria in mobile phone users and proposed the possible spread of infectious diseases due to frequent contact with mobile phones. Adverse effects on intra-uterine development [19], decreased fertility [20], decreased sperm motility [21] and genotoxic effects [22, 23] have been reported from laboratory and animal studies. Increased tumor growth in vitro, in the presence of mobile phone microwaves [24], has been reported by multiple studies. Contradicting evidence also exists, e.g. several studies in rats and mice have found no increased tumor growth in cells exposed to mobile phones in the presence of known carcinogens [25, 26]; and the symptoms, like headache and tingling, can be attributed to stress [27].

BRAIN TUMORS AND MOBILE PHONES

Many epidemiological and experimental (human and animal) studies do not show a definite causative relationship between mobile phone exposure and adverse effects on humans, although some studies do support the existence of such a relationship.

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Mobile phones are possibly associated with brain tumors:

Increased risk of acoustic neuroma [28, 29] and glioma [29]; increased risk of tumors on the side of the head ipsilateral to mobile phone use [29, 30]; and a latent period of at least 5 to 10 years [29], have been associated with cell phone use. In a review by Hardell *et al*, the increased risk was greatest for those who used mobile phones for the first time before the age of 20 [31].

Mobile phones may not be associated with brain tumors:

Most of the studies [32-36], however, contradict the presence of such an association. The INTERPHONE study [37], the largest case-control study on this topic, was done in 13 countries on more than 5,000 people with gliomas or meningiomas of the brain and on a similar group of subjects, but without tumors. There was no link between brain tumors and mobile phone use. However, there was an increased risk of gliomas, and a minute increased risk of meningiomas in individuals who use mobile phones excessively.

The Danish study [38, 39] was a cohort study done on 420,000 mobile phone subscribers identified from their billing information. It reported results between 1982 and 2002 and showed no increased risk of brain tumors, salivary gland tumors, overall cancer or brain cancer subtypes with mobile phone use for even more than 10 years.

THE DANISH STUDY UPDATE: 2011

Frei *et al* [40] conducted a nation-wide cohort study in which he divided the Danish population of more than 30 years of age, into mobile phone subscribers and non-subscribers based on their mobile phone subscription records. 358,403 subscribers (3.8 million person years) to mobile phone services were included. There was no overall increase in risk of tumors of the central nervous system, or of all cancers combined, with the use of mobile phones. In male mobile subscribers, there was a decreased risk of meningioma, and though gliomas occurred more frequently, this was not statistically significant. The risk of gliomas was independent of the duration of use of the phone. There was no increased risk of temporal lobe tumors.

CRITICISM OF DANISH STUDY**The merits:**

The Danish study is the largest cohort on mobile phone use and its association with possible brain tumors. Being a cohort and a nation-wide study, recall bias and participation bias, the major limitations of previous retrospective case-control studies, were excluded. Compared to its predecessor that published the results of the same study in 2002, the study has more person years (1.2 million now vs. 170,000 in 2002), and it has more subjects with brain tumors in long-term (>10 years) mobile phone usage.

Limitations:**Exposure Group:**

Though there were 620,602 "subscribers" in the original data set, only 58% of these were included in the study. The exposure group was defined by the number of years a person remained subscribed to the mobile phone operator. The present data cannot appreciate the amount of time that the subscriber uses the phone, thus including excessive and almost infrequent users of mobile phones in the same group. Moreover, it cannot differentiate between people who mostly use hand-held phones, and thus have maximal head exposure to radiation, and those who use hands-free phones.

Non-Exposure Group:

The 200,507 corporate subscribers whose names were unknown, and another 61,692 mobile phone users, were excluded from the study. These subscribers were probably included in the non-exposed group. Moreover, the study subjects were classified as exposed and non-exposed based on the 1995 subscription data. The proportion of the Danish population using mobile phones increased from 10% to 95% between 1995 and 2004. Therefore, the majority of non-subscribers were actually mobile phone users and may have used their phones for over 10 years. This is a major confounder, making the data impossible to compare.

Outcome: Brain tumors

The size of the cohort was quite small, thus lacking statistical power and leading to false-negative results for a relatively rare disease. Moreover, since brain tumors have a latency of ten years or more, the subjects who were in this group were quite few. The risk of glioma cannot be ruled out despite the non-significant p-value due to an underpowered study.

MOBILE PHONE TOWERS

Electromagnetic radiation from mobile phone towers is continuous but at a low level. The whole body is irradiated by these microwaves. The mobile phone, on the other hand, sends intermittent, intense waveforms. Different studies [41-43] have shown headaches, nausea, impaired alertness, tiredness, depression, memory loss, lowered libido, blurred vision and disorientation as possible effects of mobile phone towers on health. Some consider these symptoms to be due to the presence of possible confounders [44], or to the placebo effect.

THE WAY FORWARD

Prevention:

The WHO still recommends that people make short phone calls and use hands-free devices to decrease electromagnetic wave exposure from the phone

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Universal effects of mobile phones:

Whether a person is indoors or outdoors, the entire community is exposed to the electromagnetic waves associated with mobile phone towers in particular, but also, to some extent, to the waves emitted from mobile phones. Like cigarettes, they may harm both the users and near-by non-users.

Future research needed:

Studies with increased sample size, improved collection of exposure and non-exposure data, and focused research on the correlation between gliomas and mobile phone usage are needed.

It is best for now that people take the results of the Danish study in a guarded manner, and use mobile phones according to the WHO's recommendations.

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