



Cell Phone Radio Frequency Radiation

Final reports from the [rat](#) and [mouse](#) studies, plus the [press release](#) and [fact sheet](#), are now available.



Research Overview

Status: Completed

Substances: [Cell Phone Radiation: GSM](#), [Cell Phone Radiation: CDMA](#)

Nominated: May 1999

BACKGROUND INFORMATION

Cell phones are currently used by [95%](#) of American adults. The U.S. Food and Drug Administration (FDA) [nominated](#) radio frequency radiation (RFR) used by cell phones for an NTP study because of widespread public use of cell phones and limited knowledge about potential health effects from long-term exposure.

NTP STUDIES & FINDINGS

NTP conducted two-year toxicology studies in rats and mice to help clarify potential health hazards, including cancer risk, from exposure to RFR like that used in 2G and 3G cell phones which operate within a range of frequencies from about 700–2700 megahertz (MHz). These were published as Technical Reports in November 2018.

What did the studies find?

NTP uses a [standard scale \(graphic of NTP's Level of Evidence Rating System for Cancer Studies\)](#) to determine the strength of the evidence for an association between the exposure and findings in the tissues or organs studied. The scale ranges from the highest rating of “clear evidence,” followed by “some evidence,” then “equivocal evidence,” and finally “no evidence.” Different organs or tissues can have different conclusions.

The NTP studies found that high exposure to RFR (900 MHz) used by cell phones was associated with:

- **Clear evidence of an association with tumors in the hearts of male rats.** The tumors were malignant schwannomas.
- **Some evidence of an association with tumors in the brains of male rats.** The tumors were malignant gliomas.

- **Some evidence of an association with tumors in the adrenal glands of male rats.** The tumors were benign, malignant, or complex combined pheochromocytoma.

It was unclear if tumors observed in the studies were caused by exposure to RFR in female rats (900 MHz) and male and female mice (1900MHz).

As a follow-up, NTP published an [article](#) in October 2019 that evaluated DNA damage in three regions of the brain, the liver, and in blood cells in rats and mice that were removed at an earlier timepoint from the ongoing 2-year toxicology study. DNA damage, if not repaired, can potentially lead to tumors. This work was also included in NTP's published Technical Reports, but this study includes analyses of the data in the supporting information not included in the Technical Reports.

NTP scientists found that RFR exposure was associated with an increase in DNA damage. Specifically, they found RFR exposure was linked with significant increases in DNA damage in:

- the frontal cortex of the brain in male mice,
- the blood cells of female mice, and
- the hippocampus of male rats.

There are many factors that influence whether damaged DNA will lead to tumors. NTP plans to conduct additional studies to learn more about how RFR might cause DNA damage. Please see the FAQs below for more information about the specific studies and NTP's cell phone RFR program.

What are NTP's future plans for studying cell phone RFR?

NTP is working to better understand the biological basis for the cancer findings reported in its earlier RFR studies. The program has developed smaller RFR exposure chambers for additional short-term studies that will take weeks and months to complete rather than years. NTP aims to better understand the underlying effects of RFR on biological systems, such as looking at biomarkers of damage. The biomarkers are measurable physical changes, such as DNA damage, that can be seen in shorter amounts of time than it takes to develop cancer and that might be predictive of disease. NTP scientists also want to know if heat or exposure-related stress plays a role in cancer development.

With 5G technology on the horizon, many questions have been raised about what this means with respect to human exposures to RFR. One significant difference between 5G networks and the current networks is that 5G will utilize a broader range of frequencies, including those much higher than NTP previously evaluated (> 6000 MHz). The lower frequency ranges that are currently in use (700-2700 MHz) remain relevant since they will continue to be used in existing cellular communication networks, as well as the 5G network. The higher frequencies, known as millimeter waves, can rapidly transmit enormous amounts of data with increased network capacity compared with current technologies. Millimeter waves do not travel as far and do not penetrate the body as deeply as do the wavelengths of the lower frequencies. Since these millimeter waves are likely to penetrate no deeper than the skin, there is less concern that these frequencies can cause harmful effects in the heart and brain. However,

scientists do not know if millimeter waves may cause toxicity in the skin and other human tissues. Since the NTP's studies have demonstrated that there is some interaction between RFR exposure at the tested frequencies and cancers of certain tissues, there is a need to understand the interaction between RFR and biological tissues and the factors that affect that interaction.

The exposure system is also designed to allow NTP to conduct studies with various RFR frequencies and modulations used by cell phones to keep up with changing technologies in the telecommunications industry. In general, NTP scientists want to understand the impact of exposure to RFR on biological tissues, regardless of generation, or G.

INFORMATIONAL RESOURCES

Fact Sheet and NIEHS Health Topic

FAQ

Additional Resources

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Newsletters

Presentations

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Photos of the Radiofrequency Radiation Research Facility

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Web page last updated on June 1, 2022

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