

# Effects of radiofrequency radiation on the nervous system

## An EWG fact sheet

Wireless devices like cell phones, tablets and Wi-Fi routers and many other types of communications equipment give off radiofrequency radiation, a type of electromagnetic wave.

Radiofrequency radiation is absorbed by the body – more in parts with higher salt and water content. Children have a thinner bone structure, thinner skin and higher tissue conductivity. So, as studies show, their bodies, including the brain, absorb more radiation, compared to adults<sup>1, 2, 3</sup>

In human and animal studies, exposure to radiofrequency radiation has been associated with changes in electrical activity and biochemical alterations in the nervous system, as well as behavioral and cognitive changes (see table below). The changes include alteration in glucose metabolism in the brain<sup>4</sup> and changes in brain blood flow<sup>5</sup> and electrical activity in the brain detected by electroencephalography<sup>6</sup>. Radiofrequency radiation exposure has also been linked to changes in behavior<sup>7</sup>, sleep<sup>8</sup>, learning capacity and memory<sup>9</sup>, and an increased risk of headaches<sup>10</sup> and brain tumors.<sup>11</sup>

These effects have been observed within the radiofrequency range emitted by cell phones and

from cell phone towers. They’ve also been observed when the exposure lasts between 20 and 50 minutes, or up to 24 hours per day in animal studies.

Scientists are still studying the effect of radiofrequency radiation on the nervous system. Research suggests the effects may result from disruption of the blood-brain barrier and changes to cell membrane permeability and how well membrane channels are functioning. Radiofrequency radiation exposure also increases the formation of reactive oxygen species, which can cause wide-ranging effects on cell signaling and function in the body.

Studies usually consider how specific frequencies in the radiofrequency range affect the nervous system. The Federal Communications Commission has defined these frequencies as spanning from **9 kilohertz, or kHz, to 3,000 gigahertz, or GHz**. In this range, the frequency of exposure, and how long it lasts, influence how deeply it penetrates and affects the body.<sup>12, 13</sup>

More research is needed. But the health concerns that studies have identified are likely applicable to multiple frequency bands in the radiofrequency range.

### Effects on the nervous system associated with exposure to radiofrequency radiation

PHYSIOLOGICAL EFFECTS	EVIDENCE FROM HUMAN AND ANIMAL STUDIES
<b>Changes in brain glucose metabolism</b>	Among healthy adults, cell phone exposure is associated with increased brain glucose metabolism in the area closest to the cell phone when compared to controls. <sup>4</sup>
<b>Changes in brain blood flow and brain activities</b>	Increases in blood flow in the brain and altered electrical brain activity (detected through changes in the alpha-wave power of electroencephalography) have been associated with cell phone exposure in human studies. <sup>5, 14</sup> Evidence of how radiofrequency radiation affects brain function in response to auditory stimulation has also been observed in human studies. <sup>15, 16</sup> Other studies have found inconsistent associations. <sup>17, 18, 19, 20, 21</sup>
<b>Changes in sleep</b>	Changes in sleep structure were observed following exposures to radiofrequency radiation among healthy adults. <sup>8, 22, 23</sup>



HARM TO HEALTH	EVIDENCE FROM HUMAN AND ANIMAL STUDIES
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<b>Increased risk of headaches</b>	The use of cell phones has been associated with headaches and migraines, as well as skin itching among children/adolescents <sup>24</sup> and adults. <sup>25, 26</sup>
<b>Effects on memory</b>	<p>Loss of memory and concentration, as well as headaches, dizziness, tremors, depressive symptoms and sleep disturbance, were reported at higher rates among individuals living near cell phone stations, compared to those who didn't.<sup>9</sup></p> <p>Changes in behavior, learning and memory function have also been observed in laboratory mice<sup>27</sup> and rats<sup>28</sup> exposed to radiofrequency radiation.</p>
<b>Behavioral changes</b>	<p>Exposure to cell phones prenatally, and to a lesser degree postnatally, was associated with behavioral difficulties in children at age 7.<sup>7</sup></p> <p>Damage to the nervous system and evidence of altered behavior has also been observed in animal studies following radiofrequency radiation exposure.<sup>27, 29</sup></p>
<b>Increased risk of brain tumors</b>	<p>Long-term repeated exposure to cell phones on one side of the body has been associated with an higher risk of brain and inner ear tumors in humans.<sup>11, 30</sup></p> <p>In animals, exposure to radiofrequency radiation has been associated with an increased risk of malignant brain tumors.<sup>31, 32</sup></p>

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