

IARC Monographs on the Evaluation of Carcinogenic Risks to Humans

Static and Extremely Low-Frequency Electric and Magnetic Fields (Vol. 80) (19-26 June 2001)

A working group of 21 scientific experts from 10 countries met in Lyon to evaluate possible carcinogenic hazards to human beings from exposures to static and extremely low frequency (ELF) electric and magnetic fields. This volume is the first in a planned series of two IARC Monographs volumes on various kinds of non-ionizing radiation in the frequency range below that of visible light.

ELF magnetic field exposures result from proximity to electric power transmission lines, household wiring, and electric appliances and are in addition to the exposure that results from the earth's magnetic field. Magnetic fields are measured in units of microTesla; the earth's static magnetic field varies from 25 microTesla at the equator to 65 microTesla at the poles.

Since the first report suggesting an association between residential electric and magnetic fields and childhood cancer, notably leukaemia, was published in 1979, dozens of studies have examined this association. Overall, for the vast majority of children who are exposed to residential ELF magnetic fields less than 0.4 microTesla, there is little evidence of any increased risk for leukaemia. There is inadequate evidence that electric fields are associated with childhood leukaemia, and there is no consistent relationship between childhood brain tumours or other childhood solid tumours and residential ELF electric and magnetic fields. However, pooled analyses of data from a number of well-conducted studies show a fairly consistent statistical association between childhood leukaemia and power-frequency residential magnetic field strengths above 0.4 microTesla, with an approximately two-fold increase in risk. This is unlikely to be due to chance, but may be affected by selection bias. Therefore this association between childhood leukemia and high residential magnetic field strengths was judged *limited evidence* for excess cancer risk in exposed humans.

There is no consistent evidence that residential or occupational exposures of adults are related to excess risks of cancer at any site. Evidence for excess cancer risks of all other kinds, in children and in adults, as a result of exposure to ELF electric and magnetic fields was considered *inadequate*.

Numerous studies to investigate carcinogenicity of magnetic fields have been conducted in experimental animals. These have included long-term bioassays of exposures to magnetic fields alone, and exposures of rats and mice to magnetic fields in combination with known carcinogens. Bioassays of magnetic fields alone generally were negative, although one study that was conducted in both mice and rats of both sexes showed non-exposure related increases in thyroid C-cell tumours in male rats only. Multistage carcinogenesis studies showed no consistent enhancement of chemically initiated mammary tumours in rats or of skin tumours in mice. Magnetic fields had no effects on the incidence of chemically initiated liver tumours in rats or of leukaemia/lymphoma in mice or rats. Overall, evidence for carcinogenicity of ELF magnetic fields in experimental animals was judged *inadequate*. No data on carcinogenicity to animals of static magnetic fields, or of static or ELF electric fields, were available to the working group.

Although many hypotheses have been put forward to explain possible carcinogenic effects of ELF electric or magnetic fields, no scientific explanation for carcinogenicity of these fields has been established.

Overall, extremely low frequency magnetic fields were evaluated as *possibly carcinogenic to humans (Group 2B)*, based on the statistical association of higher level residential ELF magnetic fields and increased risk for childhood leukaemia. Static magnetic fields and static and extremely low frequency electric fields *could not be classified as to carcinogenicity to humans (Group 3)*.