

Electromagnetic fields, science and public concern

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This issue of *SPM* contains two articles on electromagnetic fields (EMF) and Health: "Magnetic field exposure and neurodegenerative diseases – recent epidemiological studies" by Kerstin Hug, Martin Röösli, Regula Rapp (Hug et al. 2006) and "The prevalence of symptoms attributed to electromagnetic field exposure: a cross-sectional representative survey in Switzerland", by Nadja Schreier, Anke Huss, Martin Röösli (Schreier et al. 2006). Reflecting the diversity and ubiquitous nature of EMF exposures in modern society, the articles cover a variety of sources and exposures such as mobile phones, power lines, employment in electric and electronic industries and occupational exposures to magnetic fields. Additionally, they reflect the diversity of central nervous system related health outcomes examined to date extending from neuropsychiatric symptoms to neurodegenerative diseases, in fact the articles summarized considered outcomes ranging from dementia and amyotrophic lateral sclerosis (ALS) to symptoms such as sleep disorders and headaches.

Although often simply referred to as EMF, the spectrum for non-ionizing radiation covers frequencies from 0 to 300 GHz. Corresponding to this broad spectrum of frequencies are numerous technologies: two major exposure scenarios are power frequency fields (or Extremely Low Frequency (ELF)) and more recently exposures from mobile phones (or radiofrequencies (RF)). Numerous health effects have previously been studied in relation to ELF exposure: cancer, reproductive disorders, as well as neurodegenerative and cardiovascular diseases. Cancer, especially childhood cancer, has received the most attention. The International Agency for Research on Cancer (IARC) classified ELF magnetic field as a "possible human carcinogen", based on consistent epidemiological evidence of an association between exposure to these fields and childhood leukemia and laboratory studies in animals and cells, which were

not supportive of exposure to magnetic fields causing cancer (IARC 2002). Overall, with over two decades of epidemiologic investigation into the relation of ELF and risk of various diseases we have learned a great deal. Investigations of major diseases, such as breast cancer and cardiovascular disease, although initially biologically driven, did neither confirm these biological hypotheses nor the results from early positive studies (Feychtung et al. 2004). There is now good evidence that these diseases are not associated with ELF exposure. The evidence for a link to neurodegenerative diseases remains weak and inconclusive (Kheifets et al. 2005), so we welcome the attempt to systematically review this literature and especially the focus on occupational high dose studies.

Biological mechanisms have been suggested linking ELF and Alzheimer's disease (AD) and a number of epidemiological studies also suggested an association between occupational ELF exposure and Alzheimer's disease, but findings have been inconsistent and currently there is little evidence to support this association (Feychtung et al. 2003; Hakansson et al. 2003; Qiu et al. 2004; Savitz et al. 1998). Furthermore, since no registries exist for any of the neurodegenerative disorders, occupational studies mostly rely on mortality records that are known to greatly underreport both Alzheimer's and Parkinson's disease, and the distinction between AD and dementia is not always clearly made on death certificates. The authors' choice to combine dementia and Alzheimer's disease into one category is unfortunate. Especially, since some studies include dementia in the comparison group (Sobel et al. 1996). ALS is fairly well documented on death certificates and epidemiological studies connecting ALS to electrical occupations are more consistently positive than those for AD (Feychtung et al. 2004; Davanipour et al. 1997). However, the coexistence of several occupational risk factors in

occupations linked to all three neurodegenerative diseases investigated limit our ability to interpret the findings reported. A particular problem in assigning causality to ELF for ALS is the frequent co-occurrence of electric shocks (Johansen & Olsen 1998; Deapen & Henderson 1986 capitalize this). Also evidence of biological mechanisms in ALS remains elusive. Thus, for ALS in particular, studies capable of distinguishing magnetic field exposures from electric shocks would be informative.

Neither the limited number of published epidemiological studies nor the limited biological understanding of the etiology of Parkinson's disease provide evidence that exposure to ELF or electrical occupations can cause this disease. Furthermore, it has recently been suggested that PCB exposures may be associated with PD and ALS (Steenland et al. 2006) and employees of the electric industries may historically have been exposed to these agents contained in insulating fluids (Loomis et al. 1997). In conclusion, future studies of ELF and neurodegenerative diseases need to improve on both exposure assessment and disease classification if they are to be informative.

The epidemiologic study of radiofrequencies (RF) is still in its infancy and little is known about RF exposure and potential health outcomes (Feychtig et al. 2004). Cross-sectional epidemiologic studies of symptoms related to mobile phone use, or proximity to base stations are of limited value. Usually subjects are asked to self-report their exposure, e.g., distance to nearest source or amount of mobile phone use, as well as their subjective symptoms used as measures of health outcome, and to date no attempt has been made to verify the exposure or symptoms. As acknowledged by the authors, both selection and reporting bias may be operating in these studies. Epidemiologic studies of symptom self-reports are particularly difficult to conduct validly. Nevertheless, symptoms such as sleep disturbance and headaches remain a frequent albeit anecdotal complaint and, thus, need to be investigated. To increase rigor in exposure assessment, they should incorporate newly developed personal RF exposure monitors and objective and at least standardized or reliable outcome measures. Studies of neurodegenerative disease and RF exposure, particularly mobile phone use, are feasible but sorely lacking (Ahlbom et al. 2004).

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