



*Supplementary*

# Magnetic Fields and Cancer

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## Supplementary Table S2.

### Relationship between magnetic fields and cancer in occupational MF exposure epidemiologic studies

| Type of cancer            | Study design and occupation                                                                            | Range of MFs                 | Location                                                                        | Conclusions                                                                                                                                                                         | Ref. |
|---------------------------|--------------------------------------------------------------------------------------------------------|------------------------------|---------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| brain cancer              | meta-analysis of occupational studies                                                                  | > 0.2 $\mu$ T                | worldwide                                                                       | Little or no association between electric and magnetic field exposure and brain cancer                                                                                              | [1]  |
| brain cancer              | risks experienced by employees of the former Central Electricity Generating Board of England and Wales | 0< $\mu$ T>20 per year       | U.K.                                                                            | No evidence to support the hypothesis that exposure to magnetic fields is a risk factor for gliomas                                                                                 | [2]  |
| brain tumour leukemia and | Swiss railway workers                                                                                  | 1-21 $\mu$ T annual exposure | Switzerland                                                                     | Some evidence of an exposure-response association was found for myeloid leukemia and Hodgkin's disease, but not for other hematopoietic and lymphatic malignancies and brain tumors | [3]  |
| brain cancer              | exposure to ELMFs                                                                                      | 0.11-0.62 $\mu$ T            | Australia, Canada, France, Germany, Israel, New Zealand, and the United Kingdom | Occupational ELF exposure may play a role in the later stages (promotion and progression) of brain tumorigenesis                                                                    | [4]  |
| brain cancer leukemia or  | Case-cohort analysis of brain cancer and leukemia in electric utility workers                          | 0.11-1.21 $\mu$ T            | U.S.A.                                                                          | Magnetic field exposure remained unrelated to leukemia mortality and positively associated with brain cancer mortality based on both cumulative and average magnetic field indices  | [5]  |
| breast cancer             | exposure to extremely low frequency MFs among women                                                    | 60 Hz; 0.022-3.636 $\mu$ T   | U.S.A., North Carolina                                                          | It is questionable whether exposure to power frequency magnetic fields is the cause of the increased breast cancer risk                                                             | [6]  |
| breast cancer             | Occupational exposure to MFs among men                                                                 | 0.3 > $\mu$ T > 0.6          | Canada                                                                          | Limited support for the hypothesis that exposure to MF increases the risk of breast cancer in men                                                                                   | [7]  |
| breast cancer             | exposure to MF                                                                                         | n.a.                         | n.a.                                                                            | A spurious negative association between magnetic fields and breast cancer could occur if the exposed group included a large number of immigrants from Asia and Africa               | [8]  |

| Type of cancer                                                                                               | Study design and occupation                                                                                                 | Range of MFs                   | Location | Conclusions                                                                                                                                                                                                                                                                                                                                                                                                                                       | Ref. |
|--------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|--------------------------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| breast cancer                                                                                                | exposure to commercial sewing machines at garment facilities                                                                | 15-3000 Hz<br>0.04-3.7 $\mu$ T | U.S.A.   | The MF environment of sewing machine represents a work environment similar to other work or home environments                                                                                                                                                                                                                                                                                                                                     | [9]  |
| breast cancer                                                                                                | melatonin hypothesis for workers in light metal reduction plants and operators of medical MRT in hospitals                  | static MF 2-7 mT               | Norway   | No association between a single nocturnal exposure to a static MF and excretion of aMT6s in urine                                                                                                                                                                                                                                                                                                                                                 | [10] |
| breast cancer                                                                                                | melatonin hypothesis women occupationally exposed to extremely low-frequency MFs                                            | 0.1-1.0 $\mu$ T                | Finland  | Supports the hypothesis that daytime occupational exposure to MF enhances the effects of nighttime light exposure on melatonin production                                                                                                                                                                                                                                                                                                         | [11] |
| breast cancer<br>leukemia<br>malignant melanoma of the skin<br>nervous system tumors<br>non-Hodgkin lymphoma | possible carcinogenicity of electromagnetic fields and the scientific basis for environmental occupational standard setting | n.a.                           | n.a.     | An increased risk of leukemia in children and the existence of, or distance to, power lines in the vicinity of their residence, an increased risk of chronic lymphatic leukemia and occupational exposure to low frequency electromagnetic fields and an increased risk of breast cancer, malignant melanoma of the skin, nervous system tumors, non-Hodgkin lymphoma, acute lymphatic leukemia or acute myeloid leukemia and certain occupations | [12] |
| cancer in children                                                                                           | parent preconceptionally exposure at work to ELF-MFs                                                                        | > 0.2 $\mu$ T                  | Germany  | Risk is not linked to preconceptional parental ELF-MF exposure                                                                                                                                                                                                                                                                                                                                                                                    | [13] |
| glioblastoma multiforme                                                                                      | exposure to MFs in men                                                                                                      | 0.3-0.6 $\mu$ T                | Canada   | Occupational MF exposure increases the risk of glioblastoma multiforme                                                                                                                                                                                                                                                                                                                                                                            | [14] |
| hematological cancers                                                                                        | residence situated in a broad corridor around a high-voltage power line                                                     | 0.05 - 0.20 $\mu$ T            | Norway   | Occupational exposure showed no significant association to exposure for any site. Conclusions: Some elevated odds ratios were observed in the present study, but the results are based on small numbers and no firm conclusions can be drawn                                                                                                                                                                                                      | [15] |
| kidney<br>pituitary gland<br>biliary passages<br>liver                                                       | Four exposure groups were used by stratifying on mean workday ELF-MF exposure,                                              | 0.163-0.503 $\mu$ T            | Sweden   | Men in the very high exposure group showed an increased incidence of tumors of the kidney, pituitary gland, and biliary passages and liver; for these cancer sites an exposure-response relation was indicated. Women in the very high exposure group showed an increased incidence of astrocytoma I-IV, with                                                                                                                                     | [16] |

| Type of cancer                                                                                                   | Study design and occupation                                                                                        | Range of MFs      | Location                         | Conclusions                                                                                                                                                                                                                                                                                                                            | Ref. |
|------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|-------------------|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| astrocytoma I-IV<br>myeloma<br>leukemia                                                                          | using the lowest exposure group as reference                                                                       |                   |                                  | a clear exposure-response pattern. An association was suggested in the high exposure group only, for cancer of the corpus uteri and multiple myeloma<br><br>This large population based case-control study found little evidence to support an association between occupational exposure to electromagnetic fields and acute leukaemia | [17] |
| leukemia                                                                                                         | MF exposure of staff working in the offices located above or close to transformer stations and electric enclosures | 0.3-6.8 $\mu$ T   | Turkey                           | Most of the staff (83%) is under risk based on epidemiological studies that reported a statistically significant association between risk of leukemia and MF > 0.2 $\mu$ T                                                                                                                                                             | [18] |
| leukemia                                                                                                         | occupational exposure to ELFMFs                                                                                    | n.a.              | n.a.                             | The lack of consistency regarding the type of leukemia associated with magnetic field exposure might be explained by differences between the study designs or the populations studied, but based on the existing evidence, no firm conclusions can be drawn                                                                            | [19] |
| leukemia                                                                                                         | employees of the former Central Electricity Generating Board                                                       | 0.01-3.34 $\mu$ T | England and Wales                | There are no discernible excess risks of leukemia as a consequence of occupational exposure to magnetic fields in United Kingdom electricity generation and transmission workers                                                                                                                                                       | [20] |
| leukemia acute                                                                                                   | subjects classified as having worked in one or more of the "electrical occupations"                                | 0.1-3.7 $\mu$ T   | New Zealand                      | A dose-response effect was also found, indicating that acute leukemia risk was related to historical and current magnetic field exposures in an occupational context                                                                                                                                                                   | [21] |
| leukemia acute myeloid                                                                                           | association between occupational exposure to ELF-MF or electrical shocks                                           | n.a.              | Finland, Iceland, Norway, Sweden | Results do not support an association between occupational ELF-MF or electric shock exposure and AML                                                                                                                                                                                                                                   | [22] |
| leukemia acute myeloid (AML)<br>chronic myeloid leukaemia<br>lymphoid leukemia<br>diffuse large B-cell lymphomas | job exposure matrix for occupations                                                                                | 0.11-0.52 $\mu$ T | Switzerland                      | No convincing evidence for an increased risk of death from a range of hematolymphopoi-etic cancers in workers exposed to high or medium levels of ELF MFs.<br><br>An increased risk of acute myeloid leukemia is observed in workers exposed to high levels for a longer duration                                                      | [23] |

| Type of cancer                                                                                 | Study design and occupation                                                        | Range of MFs                      | Location         | Conclusions                                                                                                                             | Ref. |
|------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-----------------------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------|------|
| follicular lymphoma<br>Waldenstrom's macroglobulinemia<br>multiple myeloma<br>lymphoma Hodgkin |                                                                                    |                                   |                  |                                                                                                                                         |      |
| leukemia childhood                                                                             | parental occupational exposure to extremely low-frequency magnetic fields (ELF-MF) | n.a.                              | China            | No association between parental occupational ELF-MF exposure and childhood leukemia risk                                                | [24] |
| leukemia childhood                                                                             | parental occupational exposure to extremely low-frequency magnetic fields (ELF-MF) | $\geq 2 \mu\text{T}$              | multinational    | No associations between parental occupational ELF-MF exposure and childhood leukemia                                                    | [25] |
| leukemia lymphatic                                                                             | cytogenetic analysis on cultured peripheral lymphocytes of railway employees       | 16 2/3 Hz; 10-100 $\mu\text{T}$   | Sweden           | Exposure to MF at mean intensities of 2-15 $\mu\text{T}$ can induce chromosomal damage                                                  | [26] |
| leukemia lymphoblastic                                                                         | ELF magnetic field exposures for a wide range of jobs commonly held by women       | 0.66-0.70 $\mu\text{T}$           | Canada           | New information on expected levels of exposure in a wide range of jobs commonly held by women                                           | [27] |
| lymphoma non-Hodgkin (NHL)                                                                     | exposure to occupational MFs                                                       | 50/60 Hz; 0.26-2.35 $\mu\text{T}$ | Australia        | Weak support for the hypothesis that MFs increase the risk of NHL                                                                       | [28] |
| neuroblastoma                                                                                  | incidence in offspring of parental occupational exposures to EMF and radiation     | $> 0.4 \mu\text{T}$               | U.S.A and Canada | Scant supportive evidence of strong associations between parental exposures in electro-magnetic spectrum and neuroblastoma in offspring | [29] |
| neuroblastoma<br>Nervous system tumor                                                          | meta-analysis of case-control and cohort studies                                   | n.a.                              | worldwide        | Limited evidence for the association between maternal occupational exposure to ELF-MF and increased risk of childhood CNS tumors        | [30] |
| neuroma acoustic                                                                               | association of occupations with ELF-EMF exposure                                   | 8.52 $\mu\text{T}/\text{year}$    | Sweden           | Occupational ELF-EMF was not associated with an increased risk for acoustic neuroma                                                     | [31] |

| Type of cancer | Study design and occupation                                                            | Range of MFs      | Location | Conclusions                                                                                                                | Ref. |
|----------------|----------------------------------------------------------------------------------------|-------------------|----------|----------------------------------------------------------------------------------------------------------------------------|------|
| thyroid cancer | ionizing radiation and extremely low-frequency MF in relation to occupational exposure | 0.15-0.35 $\mu$ T | Sweden   | No support for the possibility of occupational exposure to ELFMF being a risk factor for the development of thyroid cancer | [32] |

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