Parental Occupational Exposure to Extremely-low Frequency Magnetic Fields and Childhood Cancer

Masterpiece Forum
SPH Conference, 25.08.2011
Leukämierisiko im Umkreis von AKWs signifikant erhöht
Kinderkrebs um Atomkraftwerke in Deutschland, Großbritannien und der Schweiz

Fact or Fiction?: Cell Phones Can Cause Brain Cancer
Should you be worried about that mobile plastered to your ear?
By Melinda Wenner | November 21, 2008

This summer, Ronald Herberman, director of the University of Pittsburgh Cancer Institute, sent a memo to staffers warning them to limit their cell phone use and to use hands-free sets in the wake of “growing evidence that we should reduce exposure” to cell phone radiation. Among the possible consequences: an increased risk of brain cancer.

Five months later, a top official at the National Cancer Institute (NCI) told a congressional panel that published scientific data indicates cell phones are safe.

Scientific American, 2008

Krebs wegen Starkstromleitung: Montafon besonders betroffen?

Electromagnetic Fields (EMF)

- **Low-frequency EMF**
  - Non-ionising
  - Heating
  - Ionisation

- **High-frequency EMF**
  - Non-ionising
  - Heating
  - Ionisation

<table>
<thead>
<tr>
<th>Cell stimulation</th>
<th>Heating</th>
<th>Ionisation</th>
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<tbody>
<tr>
<td>Non-ionising</td>
<td></td>
<td>Ionising</td>
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</table>

- **Infrared**
- **Ultraviolet**
- **X- and Gamma-ray**

**Visible Light**

- **Wave length (nm)**
  - 0
  - 0.3
  - 30
  - 300
  - 3000

- **Frequency (Hz)**
  - 0
  - 10^2
  - 10^4
  - 10^6
  - 10^8
  - 10^10
  - 10^12

3

- **Heating Cell stimulation**
- **Stimulation**
- **Ionisation**

- **Visible Light**
Aetiology of Childhood Cancer

- About 90% of all cases are of unknown origin
- Genetic and/or environmental factors?
- Two-hit model

Source: Greaves, Eur J Cancer, 1999
Residential ELF Magnetic Field Exposure

- Mean: $0.02 - 0.1 \, \mu T$
- Two-fold risk of childhood leukaemia above $0.4 \, \mu T$
- ELF-MF possibly carcinogenic to humans

BAFU 2005
Parental Magnetic Field Exposure

**Paternal exposure**
- Genetic alteration in the sperm?

**Maternal exposure**
- During pregnancy?
- Earlier in life?

Increased cancer susceptibility of the child?
MPH Thesis

- German case-control study on childhood cancer
  - Children <15 years, nationwide cancer registry
  - Controls from resident offices, matched by gender, date of birth and community
    - Residential ELF-MF and other factors

- Previous studies:
  - Paternal exposure associated with leukaemia
  - Mixed results for maternal exposure and solid tumours
  - Exposure assessment and/or sample size weak
  - Publication bias?

- Confirmation in a large study sample?
Total: 4625 Children

Occupation available

4431 Fathers
4572 Mothers

2049 Cases
2135 Cases

Leukaemia
n = 846
n = 885

Brain tumours
n = 444
n = 458

2382 Controls
2437 Controls

Other tumours
n = 759
n = 804

Response rates
- cases: 82.5%
- controls: 71%
Exposure Assessment

- Questionnaires and interviews: Periconceptional occupations of both parents

- **Job-exposure matrix** with 4 categories
  - Cut-off points: 0.1 μT, 0.2 μT, 1 μT

- Highly exposed occupations:
  - Electric welders
  - Metal workers
  - Motor vehicle mechanics
  - Electricians
Distribution of Parental ELF-MF Exposure

- Fathers (n=4431)
- Mothers (n=4572)

<table>
<thead>
<tr>
<th>Magnetic field exposure (µT)</th>
<th>Percentage (%)</th>
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<tbody>
<tr>
<td>&lt;0.1</td>
<td>43.6</td>
</tr>
<tr>
<td>0.1 - 0.2</td>
<td>32.2</td>
</tr>
<tr>
<td>0.2 - 1</td>
<td>16.8</td>
</tr>
<tr>
<td>&gt;1</td>
<td>7.5</td>
</tr>
</tbody>
</table>

Swiss TPH
Distribution of Paternal Exposure

- Case fathers (n=2049)
- Control fathers (n=2382)

Percentage (%)

- <0.1: 43.6, 43.5
- 0.1 - 0.2: 32.4, 32.0
- 0.2 - 1: 16.7, 16.9
- >1: 7.3, 7.6
Conditional logistic regression stratified for gender and age, adjusted for socioeconomic status and residential area.
Parental ELF-MF and Brain Tumours

Conditional logistic regression stratified for gender and age, adjusted for socioeconomic status and residential area.
Meta-Analysis: Paternal ELF-MF exposure and childhood leukaemia

- Pooled risk estimate 1.35 (95%-CI: 0.95 – 1.91)
- High degree of heterogeneity (p<0.01), suggestion of publication bias (Egger’s test, p=0.07)
Strength and Limitations

+ Population-based case-control study
+ Large sample size
+ High participation rates
+ Several covariates investigated
+ Publication bias ↓

– JEM based on job codes and restricted to occupations held by participants
– No individual measurements performed
– Few mothers in highly exposed occupations
Conclusions

- No increased cancer risks in children of fathers occupationally exposed to higher ELF-MF levels
- Few highly exposed mothers → no firm conclusions
- **Meta-analysis:**
  Some evidence from previous studies for an association between paternal ELF-MF exposure and childhood leukaemia
Original Contribution

Parental Occupational Exposure to Extremely Low Frequency Magnetic Fields and Childhood Cancer: A German Case-Control Study

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Initially submitted May 1, 2009; accepted for publication September 21, 2009.

Extremely low frequency magnetic fields (ELF-MFs) have been classified as possibly carcinogenic to humans by the International Agency for Research on Cancer. The authors investigated, in a population-based case-control study in Germany, if children whose parents were exposed preconceptionally at work to ELF-MFs had an increased risk of developing cancer. Cases aged 0–14 years were ascertained from the German Childhood Cancer Registry. Controls were selected from local resident registration offices. The parental occupational history was recorded in questionnaires and telephone interviews, and preconceptional magnetic field exposure was estimated according to a job-exposure matrix. The analysis included 2,382 controls and 2,049 cases (846 children with acute leukemia, 159 children with non-Hodgkin’s lymphoma, 444 children with central nervous system tumors, and 600 children with other solid tumors). Frequency-matched conditional logistic regression models revealed no increased cancer risks in children whose fathers were occupationally exposed to magnetic fields above 0.2 μT. Additionally, there was no evidence for a risk increase at magnetic field levels exceeding 1 μT. Based on much smaller numbers, maternal occupational exposure was also not related to increased cancer risks. In this large case-control study, the risk of childhood cancer was not linked to preconceptional parental ELF-MF exposure.
Thank you!

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IARC, Lyon

Leticia Grize  
Regula Rapp  
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## Occupations with high ELF-MF Levels

<table>
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<tr>
<th>ELF-MF (µT)</th>
<th>Occupational Groups</th>
<th>Number of fathers (n=4431)</th>
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<tbody>
<tr>
<td>&gt;100</td>
<td>Electric welders, Galvanizers</td>
<td>6 (0.1%)</td>
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<tr>
<td>10 – 100</td>
<td>Metal grinders, Tool grinders, Electric power engineers, Power plant operators, Locomotive engineers, Galvanizing engineers, Nuclear engineers, Motor vehicle mechanics, Aircraft construction and shipbuilding technicians</td>
<td>25 (0.6%)</td>
</tr>
<tr>
<td>&gt;1 -10</td>
<td>Metal builders, Sheet metal processors, Cutting machine operators, Tool makers, Furnace workers, Steel mill engineers, Mining engineers, Electricians, Electronics engineers and repairers, Construction mechanics, Motor fitters, Several other types of engineers, mechanics and technicians, Rail vehicle drivers</td>
<td>300 (6.8%)</td>
</tr>
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Cancer in Children

- Incidence rate: about 14 per 100,000 children <15 years

![Pie chart showing the distribution of different types of childhood cancers.](image-url)

- Acute leukemias: 32.8%
  - 80% lymphoblastic (ALL)
  - 20% myeloid (AML)
- CNS tumors: 21.7%
- Lymphomas: 12%
- Neuroblastomas: 8%
- Soft tissue sarcomas: 6.5%
- Wilms tumors: 5.9%
- Bone tumors: 4.6%
- Germ cell tumors: 3.1%
- Others: 3.9%

from: Rössig C, Workshop Berlin 2008

German Childhood Cancer Registry (GCCR Mainz, Germany)