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# Epidemiological studies – high frequency fields

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# Electromagnetic spectrum

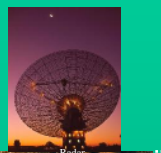

Gamma rays

X rays

UV

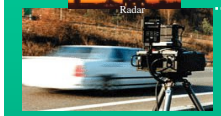
Visible light

Infrared

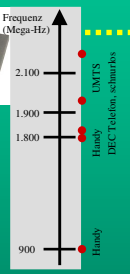


Radar

Microwaves



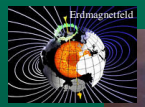







Radiowaves

Power frequency





Static fields

Optical

Frequency (Hz)

$10^{21}$
$10^{20}$
$10^{19}$
$10^{18}$
$10^{17}$
$10^{16}$
$10^{15}$
$10^{14}$
$10^{13}$
$10^{12}$ Tera
$10^{11}$
$10^{10}$
$10^{9}$ Giga
$10^{8}$
$10^{7}$
$10^{6}$ Mega
$10^{5}$
$10^{4}$
$10^{3}$ Kilo
$10^{2}$
$10^{1}$
1
0 Hertz

*Ionizing radiation*

*Non-ionizing radiation*

# Study Settings

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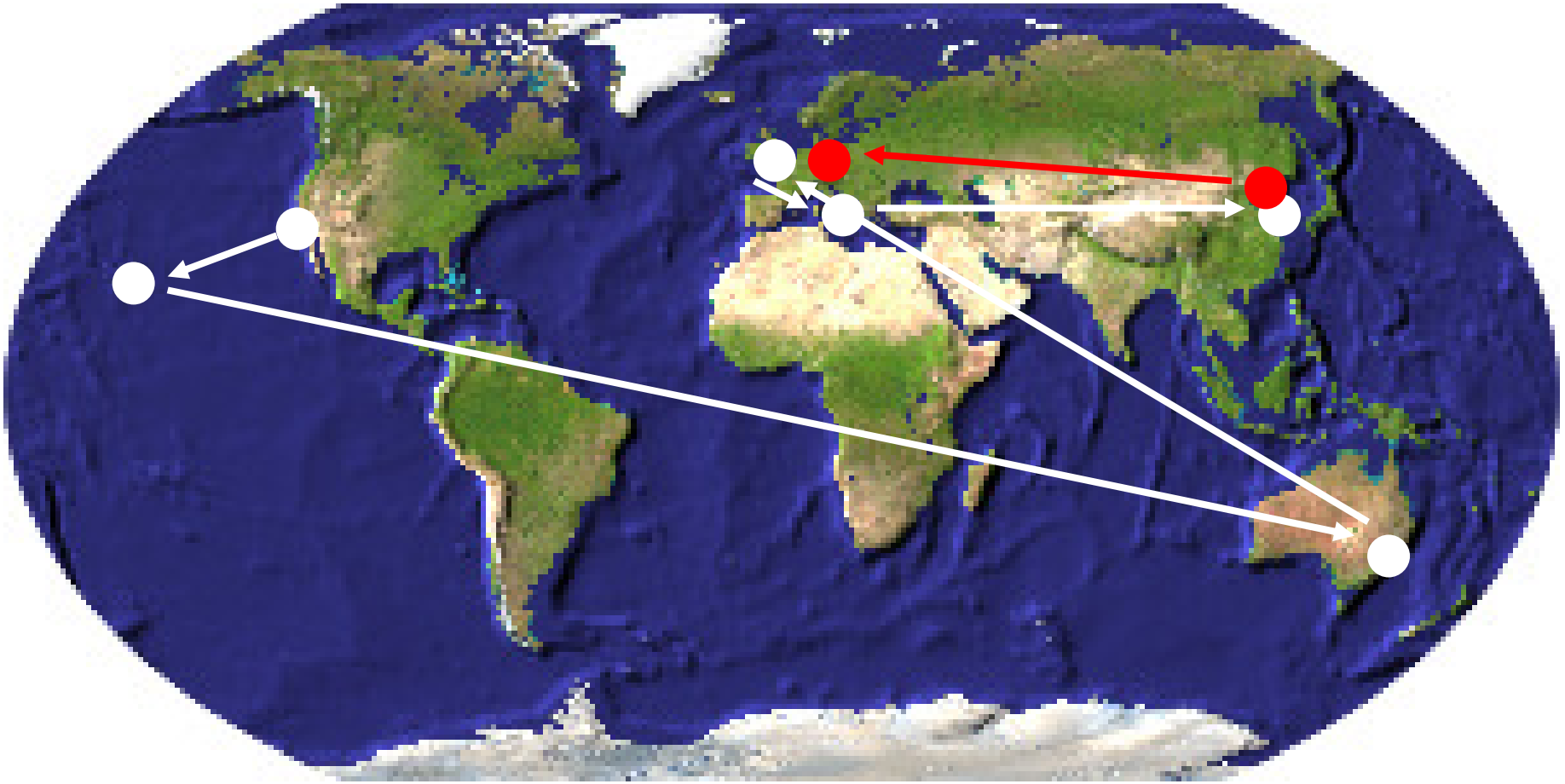

Incidence/Mortality „Ecological“ Studies  Case-Control Studies

# General concerns about ecological studies

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- Ecological fallacy:
  No knowledge on exposure of individuals

- Clustering illusion:
  Cluster initiates study NOT cluster observed in study
  „Texas sharpshooter fallacy“

- Publication bias:
  Positive studies more likely to be published

- Bias from inadequate comparison population:
  Surveillance of disease better closer to putative hazard?

➢ Hypothesis generating

# Studies: USA
# San Francisco & Hawaii

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- San Francisco:
  - Analysis of spatial data
  - 52 cases of childhood leukemia in study region
  - showing random pattern around broadcast transmitter

- Hawaii:
  - 12 childhood leukemia cases within 4 km of broadcast transmitter
  - SIR 2.09 (95% CI 1.08-3.65)
  - subsequent case-control analysis confirmed results

# Study: North Sydney

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**[Hocking, MJA,1996 / McKenzie, Austr NZL J Publ Health 1998]**

- Television antennas: 4 x 100 kW, 1 x 300 kW
- SIR Inner Circle vs. Outer Circle: 134 cases, 1.58 (95% CI 1.07-2.34)
- Increase restricted to Lane Cove

- Re-analysis: SIR Inner Circle vs. Outer Circle: 1.47 (95% CI 0.98-2.19)
- Incidence highest in 1972-78, before antennas went on 24 hrs transmission

# Study: United Kingdom

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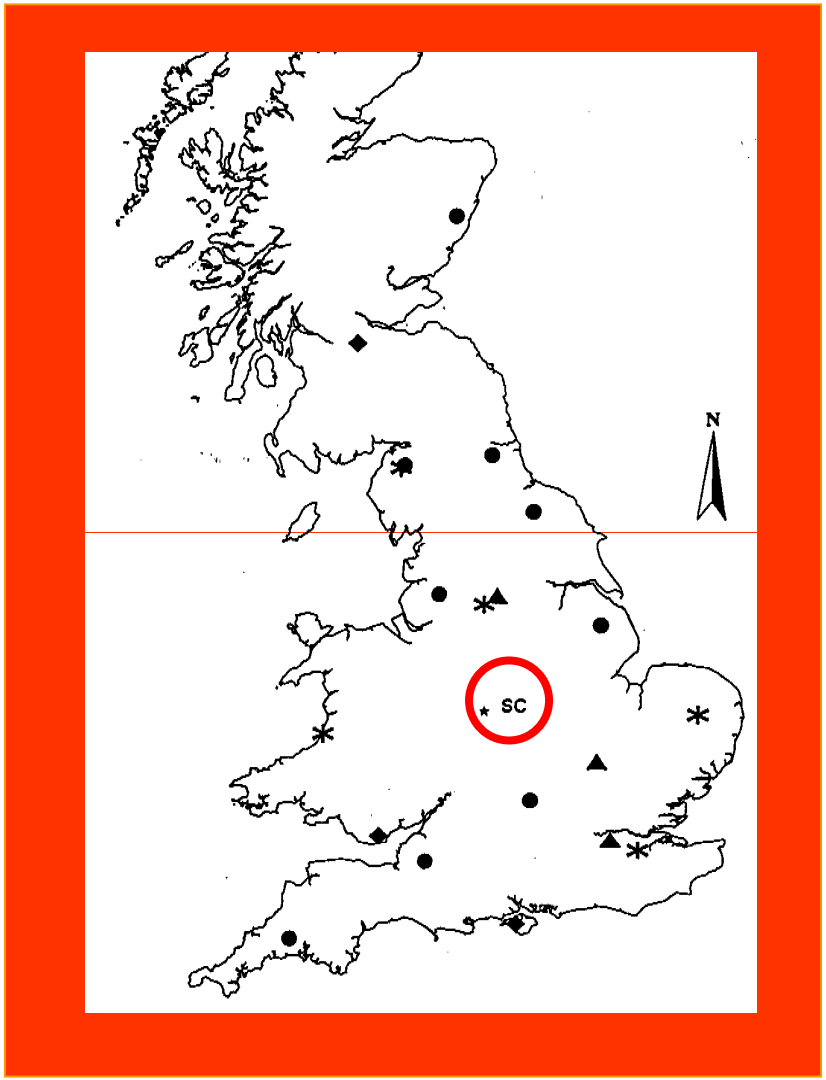
**[Dolk, Am J Epidemiol, 1997 / Cooper, Am J Epidemiol, 2001]**

- TV transmitters 500-1000 kW (erp)
  FM radio transmitters > 250 kW (erp)
  and combinations

- 21 transmitters across UK

- Childhood leukemia:
  based on 10 cases 0-2 km circle
  SIR 1.12 (95% CI 0.61-2.61)

- Update Sutton Coldfield:
  based on 1 case, SIR 1.13 (0.03-6.27)



# Study: Rome, Italy

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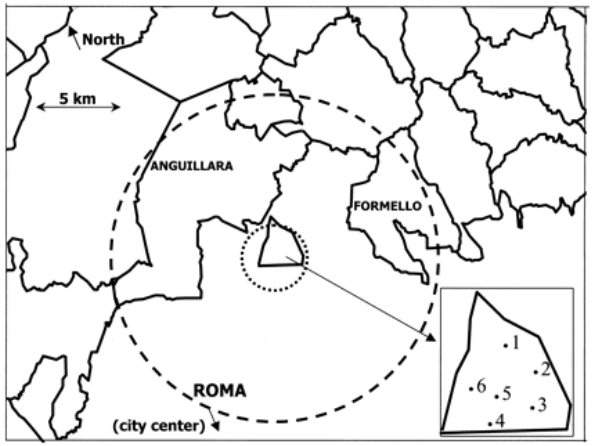


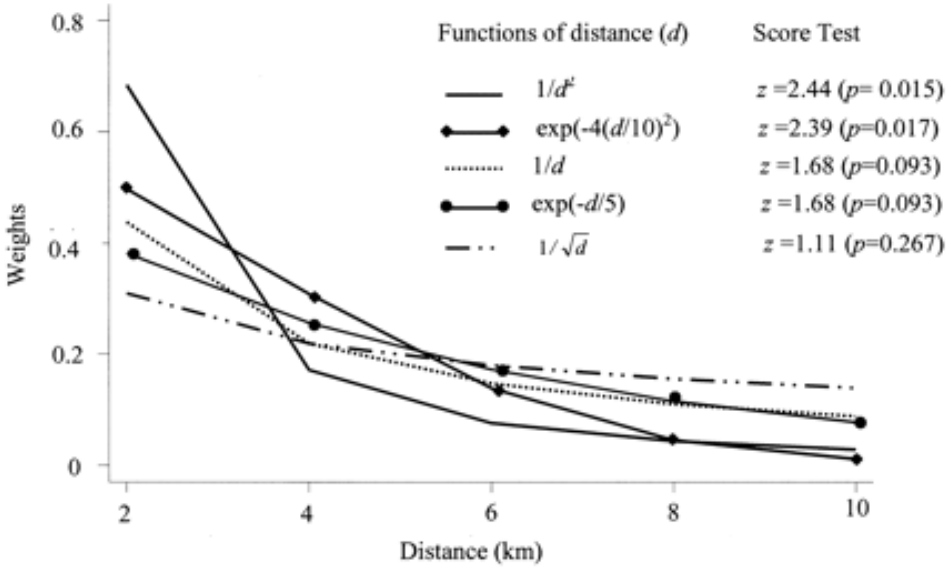


**[Michelozzi, Am J Epidemiol, 2002]**

- Various short-wave and medium-wave transmitters with powers ranging from 5 to 600 kW
- Observed cases, SIRs (95% CI):

| | | |
|---|---|---|
| 0-2 km | 1 | 6.1 (0.4-27.5) |
| 2-4 km | 2 | 2.3 (0.4-7.2) |
| 4-6 km | 5 | 1.9 (0.7-4.0) |
| 6-10 km | 0 | vs. 3.1 expected |

- Sample measurements yielded quite high exposures at some nearby houses, e.g., > 2 V/m ~ 4 km distance
- More systematic measurements show considerable variation by distance, e.g. a factor of ~ 20 at 2-3 km

# Study: Korea (Ecological)

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- Exposed areas:
  - administrative units that include main AM radio transmitters
  - among 107 transmitters, 10 of > 100 kW were chosen
- Control areas:
  - four control areas matched to each exposed area
  - same population size, same province, no broadcast towers
  - at least 2 km distant from towers in exposed areas

- Investigation of childhood leukemia mortality rates

- SMR:
  - based on 11 cases
  - 2.29 ((95% CI 1.05-5.98)

**[Park, Int Arch Occup Environ Health, 2004]**

# Study: Korea (Case-Control) -1

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- All cases with childhood leukemia diagnosed in Korea between 1993 and 1999, mixture of active search and use of Cancer Registry
- Controls: Hospital-based controls with respiratory illnesses
- Study numbers:
  1928 cases with leukemia
  3082 controls
  (but conditional analysis)

**[Ha, Am J Epidemiol, 2007]**
**[Ha, Am J Epidemiol, 2008 – Reply letter]**

# Study: Korea (Case-Control) -2

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- SIR within 0-2 km distance:
  total leukemia: 36 cases, 2.15 (95% CI 1.00-4.67)
  No significant p for trend

**TABLE 1. Odds ratios and 95% confidence intervals of childhood leukemia according to the level of exposure to radio-frequency radiation from AM radio transmitters among children under the age of 15 years, South Korea, 1993–1999**

| | No. of controls | Lymphocytic leukemia | | | Myelocytic leukemia | | | All leukemia | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | No. of cases | Odds ratio* | 95% confidence interval | No. of cases | Odds ratio* | 95% confidence interval | No. of cases | Odds ratio* | 95% confidence interval |
| Total radio-frequency radiation exposure (mV/m)† | | | | | | | | | | |
| Quartile 1 | 513 | 514 | 1.00 | Referent | 177 | 1.00 | Referent | 737 | 1.00 | Referent |
| Quartile 2 | 514 | 241 | 0.69 | 0.50, 0.96 | 110 | 0.74 | 0.46, 1.18 | 362 | 0.75 | 0.58, 0.97 |
| Quartile 3 | 515 | 188 | 0.57 | 0.41, 0.78 | 122 | 0.96 | 0.62, 1.49 | 330 | 0.70 | 0.55, 0.90 |
| Quartile 4 | 513 | 353 | 0.93 | 0.67, 1.29 | 100 | 0.55 | 0.33, 0.93 | 494 | 0.83 | 0.63, 1.08 |
| Unknown | 9 | 4 | 0.34 | 0.06, 1.87 | 1 | 0.28 | 0.02, 3.52 | 5 | 0.39 | 0.10, 1.54 |
| $p_{trend}$‡ | | | | 0.05 | | | 0.1 | | | 0.44 |
| Peak radio-frequency radiation exposure (mV/m)§ | | | | | | | | | | |
| Quartile 1 | 513 | 360 | 1.00 | Referent | 130 | 1.00 | Referent | 525 | 1.00 | Referent |
| Quartile 2 | 515 | 239 | 1.14 | 0.85, 1.54 | 105 | 0.67 | 0.43, 1.06 | 367 | 0.95 | 0.75, 1.20 |
| Quartile 3 | 514 | 229 | 0.92 | 0.68, 1.24 | 92 | 0.76 | 0.49, 1.17 | 349 | 0.86 | 0.68, 1.09 |
| Quartile 4 | 513 | 468 | 1.40 | 1.04, 1.88 | 182 | 0.63 | 0.41, 0.97 | 682 | 1.02 | 0.81, 1.29 |
| Unknown | 9 | 4 | 0.39 | 0.07, 2.26 | 1 | 0.29 | 0.02, 3.67 | 5 | 0.43 | 0.11, 1.75 |
| $p_{trend}$‡ | | | | 0.07 | | | 0.25 | | | 0.43 |

# Study: Germany (Case-Control) -1

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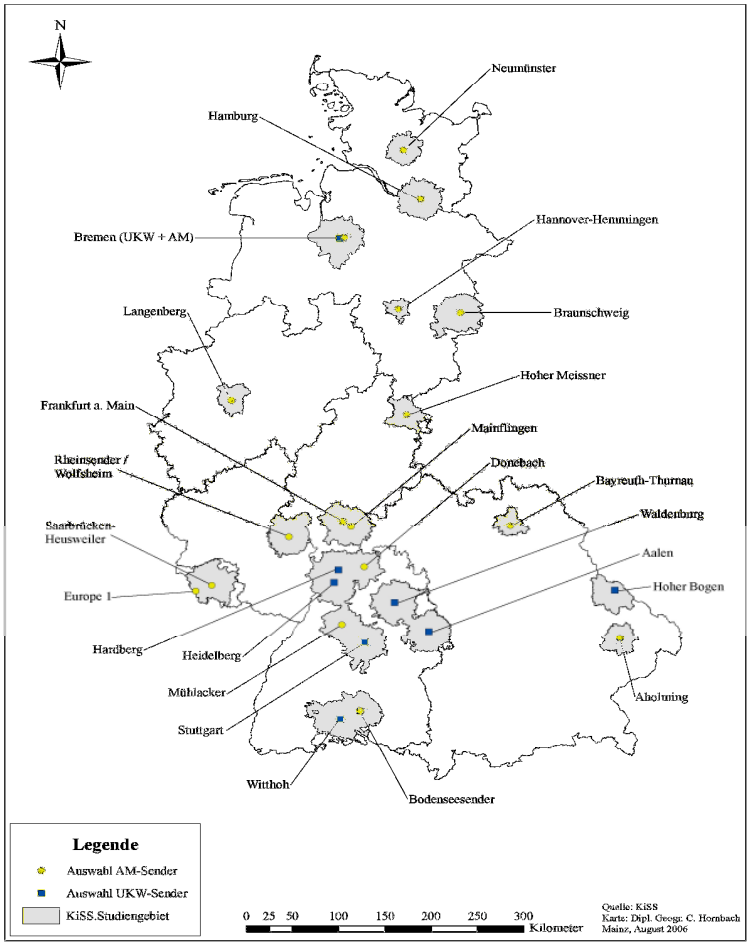


**[Schmiedel, submitted – Validation study]**

- All cases with childhood leukemia diagnosed between 1984 and 2003 based on the German Childhood Cancer Registry
- Controls: 3 population-based matched historical controls per case
- Study numbers:
  1959 cases with leukemia
  5848 controls
  (conditional analysis)

# Study: Germany (Case-Control) -2

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Definition of the study area:

- Exclusion of East Germany
- Identification of high power AM radio transmitters (> 500 kW emrp) and FM radio/TV transmitters (> 200 kW erp)
- Identification of all communities within the doubled expected 1 V/m circle (AM) / single ~0.3 V/m (FM/TV) circle around transmitters
- Exclusion of 5 AM transmitters in very sparsely populated areas
- 16 AM transmitters / 8 FM/TV transmitters
  > 900 communities & > 300 low power transmitters

Validation study

- Measurement survey in Baden-Württemberg
- Test of the prediction model with measured values
- Independent data source of case-control study

# Summary

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- Some but not all ecological studies indicate an increased risk of childhood leukemia in the vicinity of radio and TV broadcast towers

- More recent case-control studies show:
  - no increased risk with predicted total RF EMF exposure
  - predicted RF EMF exposure better exposure proxy than distance

- No other RF EMF sources are investigated
  - lack of exposure information
  - question of priority