



# Health effects from exposure to static and extremely low frequency fields - Epidemiological studies

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## Static fields – exposure

- Earth magnetic field (weak: ~25-65 microtesla)
- MRI – magnetic resonance imaging  
strong occupational exposure source  
clinics with 0.5-7 Tesla, research institutions  
sometimes higher  
(in 2010, in NL ~60% were 1.5 T)

static field always present –  
Scanner room: static field exposure +  
time varying magnetic field exposure  
during image acquisition: also  
switched gradient fields during scanning (kHz range)  
RF fields inside the bore during scanning



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## Static fields – health effects

- Observational studies confirmed immediate effects of exposure from experimental studies
  - effect on central nervous system
  - vertigo, phosphenes, metallic taste
  - subgroup of affected persons
- To date there is very limited knowledge on potential long term effects in workers
  - only one study on accidents



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## Extremely-low frequency (ELF) fields - exposure

- Electricity generation, transport and use
- occupational exposure
  - if working close to machines that use a lot of electricity: e.g. welders, metal workers, pilots, conductors,...
- residential exposure
  - under high-voltage power lines (<200m)
  - directly adjacent to transformers
- average in households around 0.1 microtesla
- exposures >0.4 microtesla rare but occurs



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## ELF - Childhood leukaemia

13 years ago

- consistent observation of increased risk in children exposed to levels  $> 0.3 - 0.5$  microtesla
- unclear what the underlying mechanism is
- IARC classified magnetic fields as "2B carcinogen" (possibly carcinogenic) in 2002

New developments

- More studies done in children exposed to overhead power lines
- Power line studies criticized - specific selection population
- TransExpo - results will still take years



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## Adult leukaemia

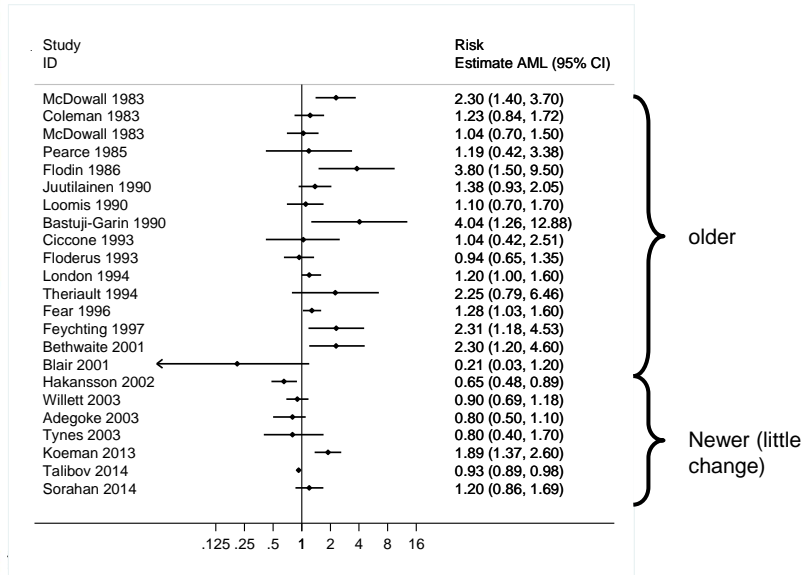
- Leukaemia uncertain (occupational studies report 10-30% increased risks in exposed workers)



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## Adult leukaemia



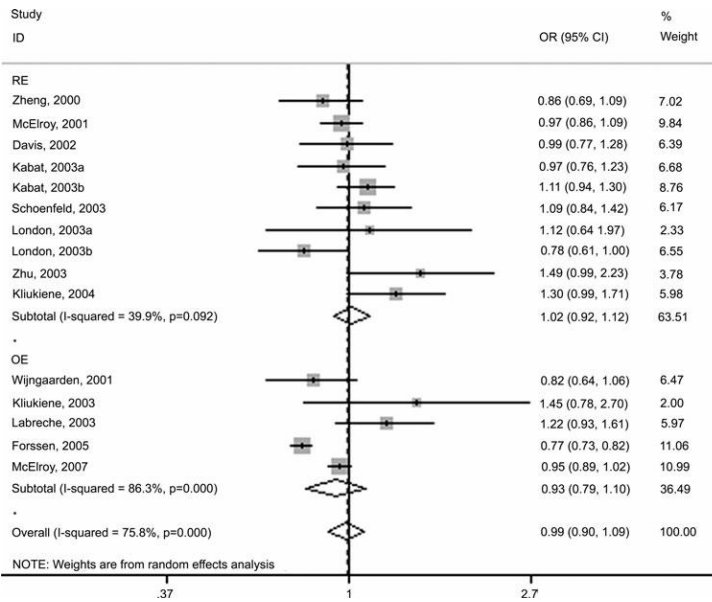
## Other cancers in adults

- brain cancer about 10% increased risk in exposed workers
- nearly all other cancers less evidence
- Little change over the last 13 years  
With one exception:





## ELF-MF and breast cancer



Source: Chen et al 2010



## Neurodegenerative diseases

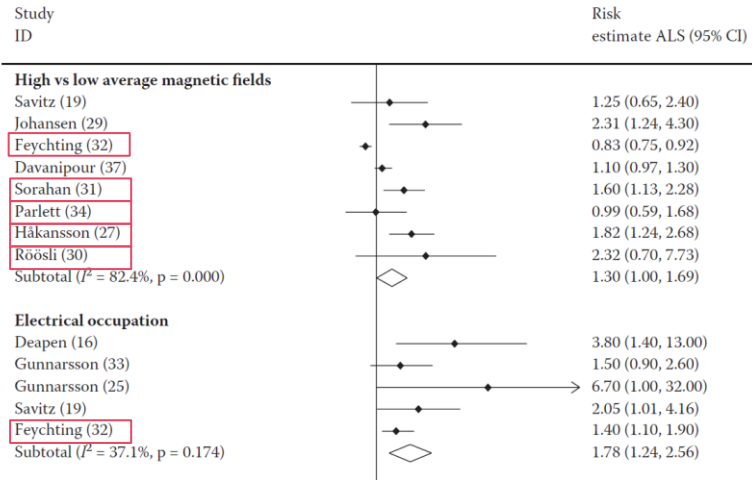
- Amyotrophic lateral sclerosis  
Motor neurons connecting brain to spinal cord and spinal cord to muscles degenerate
- More than 13 years ago:
  - early hypothesis of trauma as possible cause
  - case reports after electrical injury (1930')
  - first case-control study showing increased risks in "electrical occupations" in 1986
  - idea was that possibly electric shocks caused ALS
  - shocks are difficult to measure (accidental)
  - 1980' magnetic field meters became available
  - focus on magnetic fields



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## Amyotrophic lateral sclerosis



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Source: Epidemiology of Electromagnetic fields, Ed. M Rööslä, Chapter 11, 2014



## Amyotrophic lateral sclerosis

- in the last few years risk of shocks at work estimated
- Combination of shocks and magnetic fields analysed
  - in 4 countries
- Results are ambiguous
- Question still not solved



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## Neurodegenerative diseases

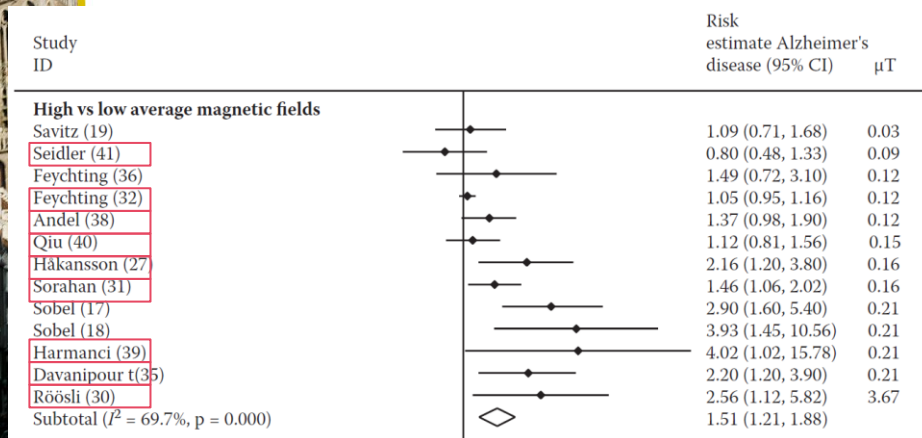
- Research on Amyotrophic lateral sclerosis
- triggered much broader interest also for other neurodegenerative diseases:
  - Alzheimer's disease
  - Parkinson's disease
- These two are the most frequently occurring ND



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## Alzheimer's disease



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Source: Epidemiology of Electromagnetic fields, Ed. M Röösli, Chapter 11, 2014



## Alzheimer's disease

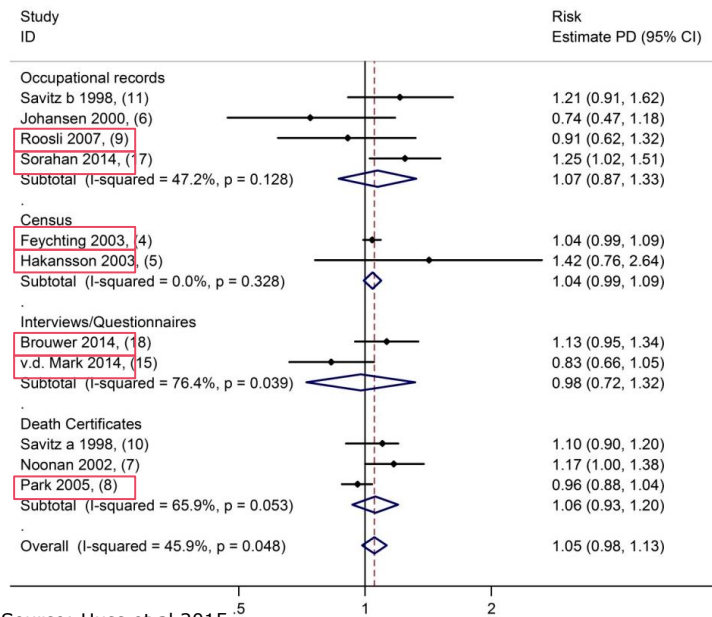
- Several studies performed over last 13 years
- Some also suggest exposure-response pattern
- Overall suggestion that association may exist
  
- Mechanism unclear



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## Parkinson's disease



Source: Huss et al 2015





## Parkinson's disease

- Several new studies
- Also studies addressing morbidity and not mortality
- Studies quite consistent in showing absence of effect



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## Conclusions on progress

- Cancer
  - childhood leukaemia little change
  - other cancers too
  - breast cancer evidence of absence
- Neurodegenerative diseases
  - ALS question electric shocks /magnetic fields?
  - Alzheimer's an association may exist
  - Parkinson's evidence of absence
- All associations based on observational studies.
- No mechanism proven how magnetic fields could cause these diseases.



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