

# **Adverse Fetal and Childhood Health Effect of In-Utero Exposure to Magnetic Fields Non-ionizing Radiation**

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# Story of EMF Health Effect

- Discovery in 1979:
  - Nancy Wertheimer and Ed Leeper findings
  - Their incredible luck
  - Their two unfortunate legacies
    - Poor EMF measurements
    - Outcome inefficient to study

# Current Prevailing Perceptions about EMF Health Effect

- Misconceptions – no association:
  - Poor measurement for EMF, though evolved:
    - Wire codes
    - Interviews
    - Distance from power lines or power stations
    - Spot measurements
    - Personal EMF measurement (carrying a meter)
    - Inability to measure EMF exposure: no association
- Bottom Line: You need to measure EMF correctly and accurately before claiming that there is no association.

# Current Prevailing Perceptions about EMF Health Effect

- *Inensitive* outcomes to study
  - Cancer
    - Long latency period: 20-25 years from exposure to diagnosis
    - Rare outcomes needing *Retrospective* ascertainment of EMF exposure (bad combination)
- Bottom line: Need to focus on sensitive endpoints first

# Current Prevailing Perceptions about EMF Health Effect

- Power line EMF and Cell phone EMF have different health effect
  - Both are EMF
  - Only difference is frequency: low vs. high
- Energy level
  - Heat injury (thermal effect), not the main concern
  - **Non-thermal** effect largely unknown and the main concerns (miscarriage, cancer, autoimmune diseases, obesity, etc.)

# Why EMF exposure ?

- Significant increase in last 30 years
  - Build out of wireless network 5G now
  - Wireless devices (e.g., cell phones)
  - Emerging evidence of adverse effects
    - Miscarriage
    - Blood glucose level
    - Childhood asthma
    - Childhood obesity
    - Childhood neurodevelopment disorders
    - Childhood abnormal thyroid condition
    - Poor sperm quality

# Our Latest Studies

- A prospective cohort study
- Exposure measured in pregnancy
- Outcome followed
  - Miscarriage in pregnancy
  - Childhood conditions (*no time to discuss today*)
    - Asthma
    - Obesity
    - ADHD
    - Abnormal thyroid condition

# Study Population & Recruitment

- Kaiser Permanente Northern California (KPNC) members in the San Francisco area
- All pregnant women
- Recruited in the 1<sup>st</sup> or 2<sup>nd</sup> trimester
- In-person interview



# Exposure Measurement

- All participants wore a meter for 24 hours in pregnancy (1<sup>st</sup> or 2<sup>nd</sup> trimester)
- **Diary of activities**
- Assessment of representativeness of measurement day: a **typical day** in pregnancy



# Findings on *In-utero* EMF Exposure

- Exposure to high level of MF non-ionizing radiation during pregnancy is associated with an increased risk of:
  - Miscarriage (RR=2.7)
  - Asthma in offspring (RR=2.5)
  - Obesity in offspring (RR=5.0)
  - ADHD (RR=2.9)
  - Abnormal thyroid function (RR=3.1)
- Dose-response relationship (long-term effects)
- Stronger when measured on a typical day

## Table 1. Daily Magnetic Field Exposure during Pregnancy and the Risk of Miscarriage

MF 99 <sup>th</sup> Percentile	Total N	N with miscarriage (%)	aHR <sup>a</sup> (95%CI)
<b><u>Overall</u></b>			
<2.5mg	219	36 (16.4%)	Ref
≥2.5mg	694	164 (23.6%)	<b>1.48</b> (1.03-2.14)
<b><u>Typical day</u></b>			
<2.5mg	106	11 (10.4%)	Ref
≥2.5mg	347	84 (24.2%)	<b>2.72</b> (1.42-5.19)
<b><u>Non-typical day</u></b>			
<2.5mg	113	25 (22.1%)	Ref
≥2.5mg	347	80 (23.1%)	<b>1.08</b> (0.67-1.73)

aHR: Adjusted Hazard Ratio.

<sup>a</sup>Adjusted for maternal age at interview, race, education, smoking since LMP and prior miscarriage

**Table 4. Daily Magnetic Field Exposure during Pregnancy and the Risk of Miscarriage – Dose-Response, on typical day only**

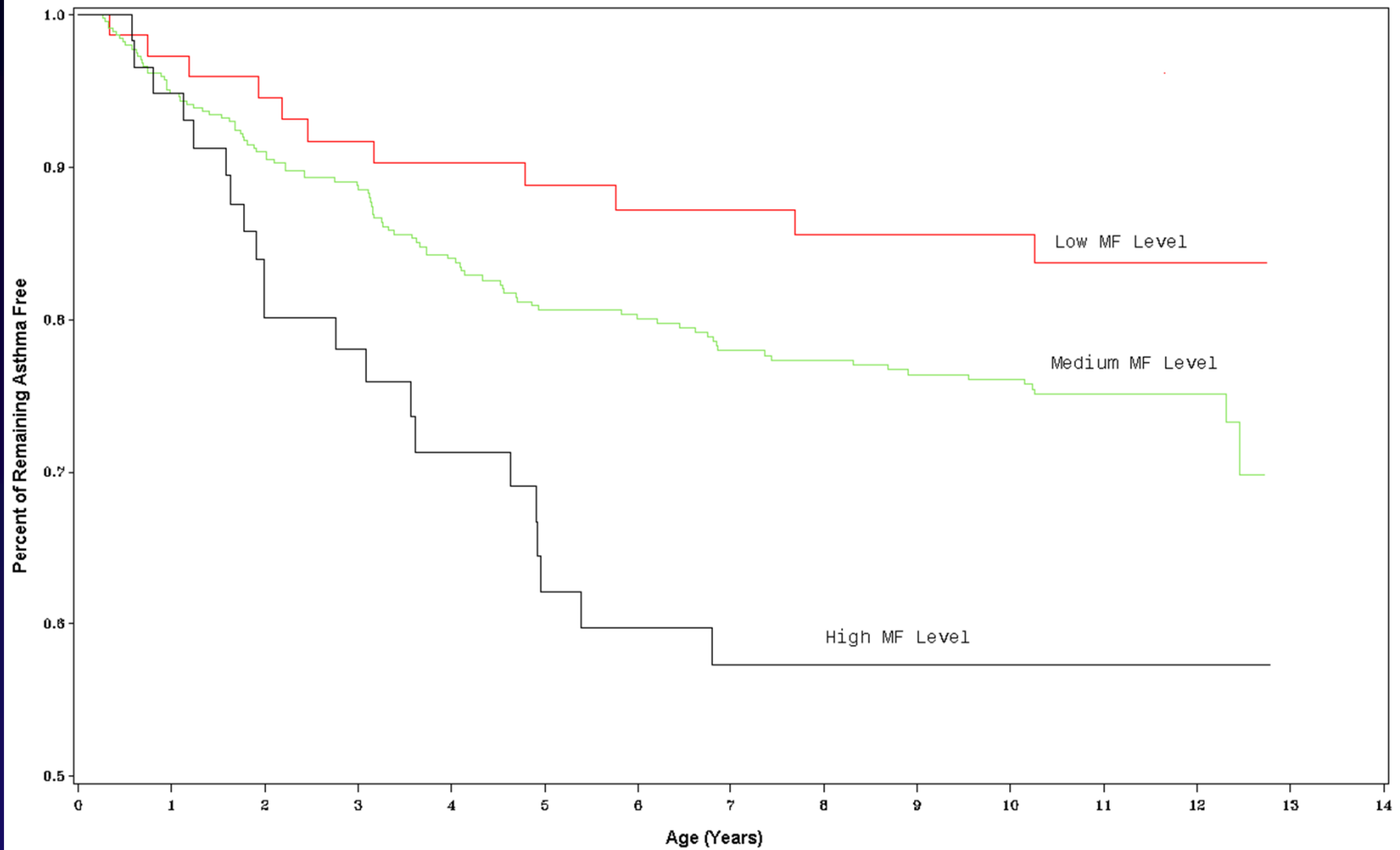
MF 99 <sup>th</sup> Percentile	Total N	N with miscarriage (%)	aHR <sup>a</sup> (95%CI)
<b><u>Overall</u></b>			
<2.5mg	106	11 (11.4%)	ref
2.5mg-5.0mg	195	53 (27.2%)	<b>3.11</b> (1.58-6.13)
≥5.0mg	152	31 (20.4%)	<b>2.29</b> (1.13-4.64)

aHR: Adjusted Hazard Ratio.

<sup>a</sup>Adjusted for maternal age at interview, race, education, smoking since LMP, and prior miscarriage.

<sup>b</sup>Adjusted for maternal age at interview, race, education, smoking since LMP, and gravidity.

Figure 1. Kaplan-Meier Estimates of Asthma Risk by Maternal Magnetic Field (MF) Exposure Level during Pregnancy



# DISCUSSION

- Need a better measurement of EMF to see any effect even with personal measurements
- Potential Mechanisms:
  - Epigenetics
  - Known effect:
    - Cell-cell communication
    - Cell activities: metabolism (JAMA publication)

# LIMITATIONS

- No measurement throughout pregnancy
  - For childhood outcomes
  - Non-differential misclassification
- No measurement after birth
  - Non-differential misclassification

# STRENGTHS

- Prospective study design
  - Reduce participation bias
- Objective measurement both exposure (MF level) and outcome (asthma)
  - Reduce recall bias or errors
- Synergistic effect with known risk factors for asthma



# CONCLUSION

- Exposure to high level of MF non-ionizing radiation during pregnancy is associated with
  - an increased risk of **miscarriage** (immediate effect)
  - Likely a threshold effect, thus, no apparent dose-response relationship

# CONCLUSION

- Exposure to high level of MF non-ionizing radiation during pregnancy is associated with long-term adverse impacts on offspring
  - Childhood asthma
  - Childhood obesity
  - Neurodevelopmental disorders like ADHD
  - Abnormal thyroid condition
- Does-response relationship