Mobile Phone Base Stations Health and Wellbeing

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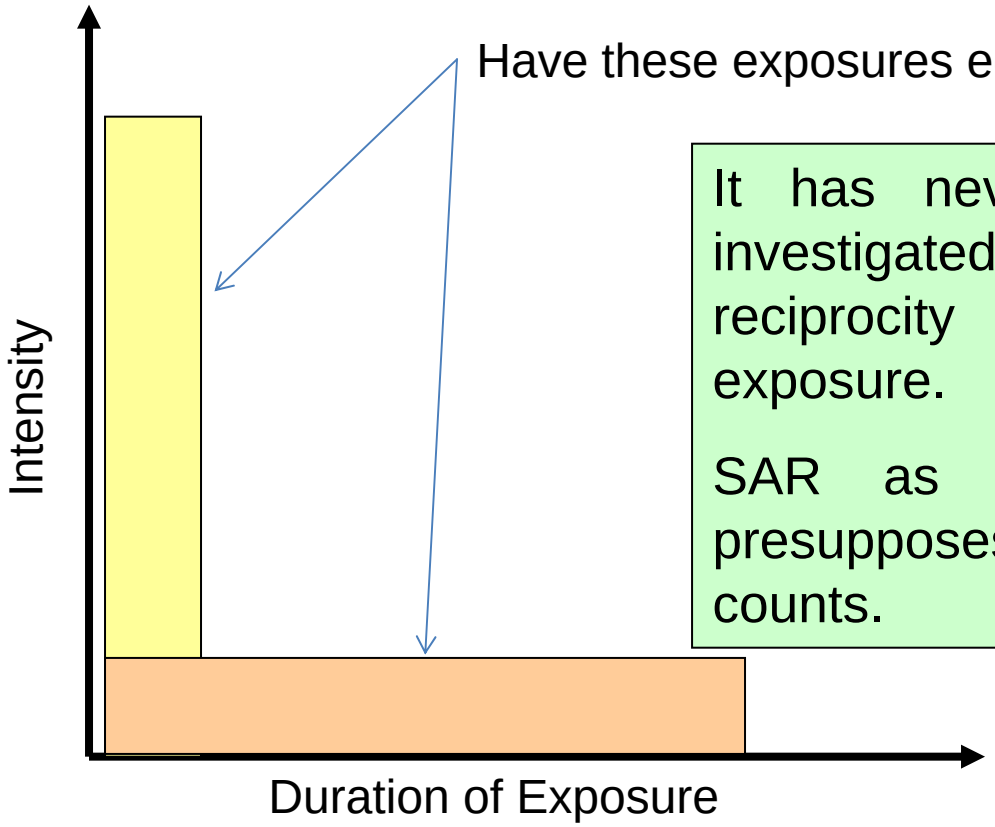
2006 WHO Research Agenda for Radio Frequency Fields

"Research on potential health effects from base station RF fields was deemed of low priority since studies of cancer risk related to such exposure are unlikely to be feasible and informative because of the difficulty of reconstructing adequately long-term historical exposures."

„From a scientific point of view COST Action 281 cannot therefore recommend that epidemiological studies of mobile telecommunication basestation exposures are carried out at this time. If there is a health risk from mobile telecommunication systems it should first be seen in epidemiological studies of handset use.“ (Nov. 2002)

Attributes	Mobile Phones	Base Station
Frequency	~900, 1800, 2100 MHz	~900, 1800, 2100 MHz
Intensity (Specific Absorption Rate)	~0.2-1.6 W/kg	~0.7-3.4 mW/kg (25 m distance)
Duration of exposure	intermittent, mostly short	continuous, up to 24 h/day
Modulation	GSM: pulsed UMTS: dependent on power regulation	GSM/UMTS: dependent on traffic density
Coupling mode	User: near field (head, hand) Neighbour (~1 m): far field	Service personnel: near field/far field Neighbours: far field, whole body
Other aspects	mostly voluntary “small and beautiful“	mostly involuntary big and threatening

The Bunsen-Roscoe Principle

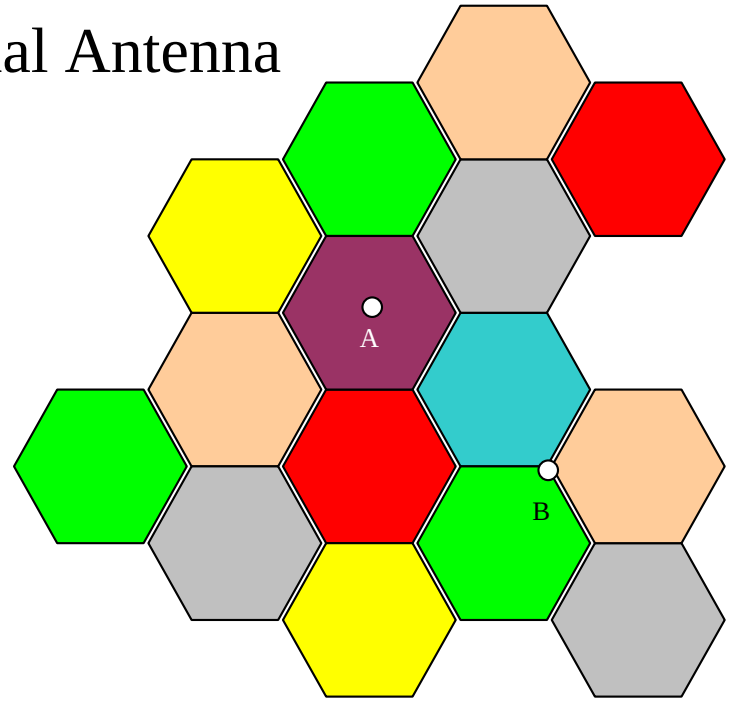


It has never been systematically investigated whether time-dose reciprocity holds for microwave exposure.

SAR as an exposure indicator presupposes that only intensity counts.

Cellular Structure of a Mobile Telephone Network

A...Omnidirectional Antenna

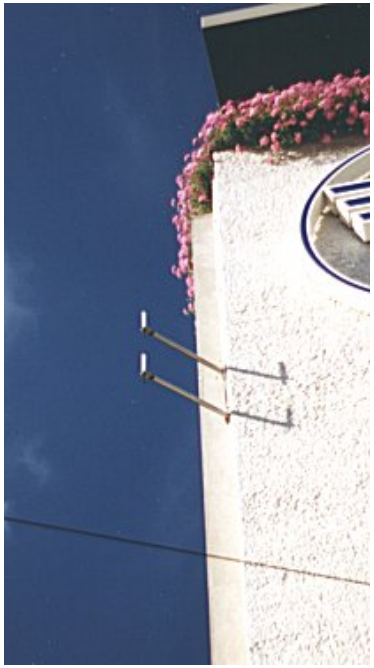


B...Sector Antenna

Types of Base-Stations

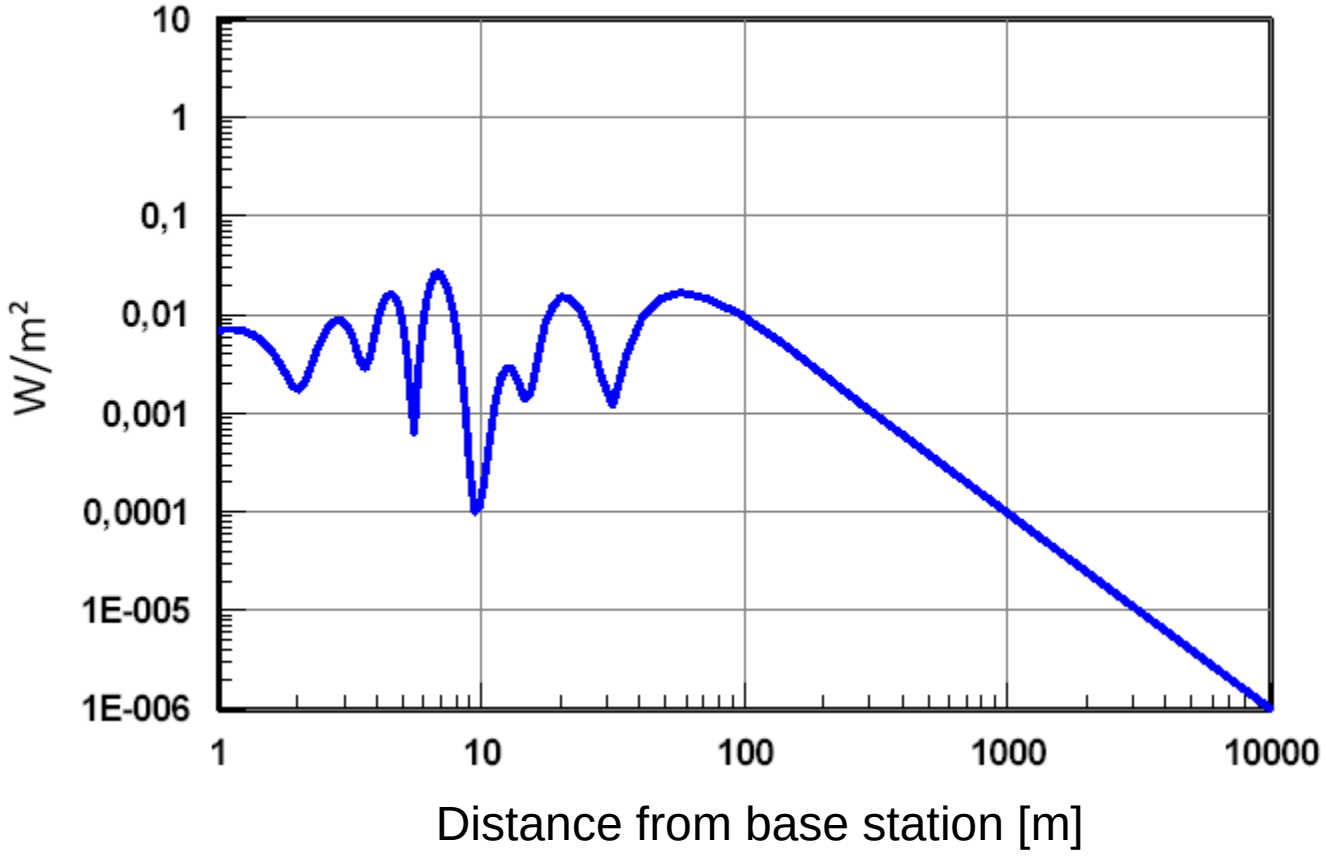
On roofs

Masts

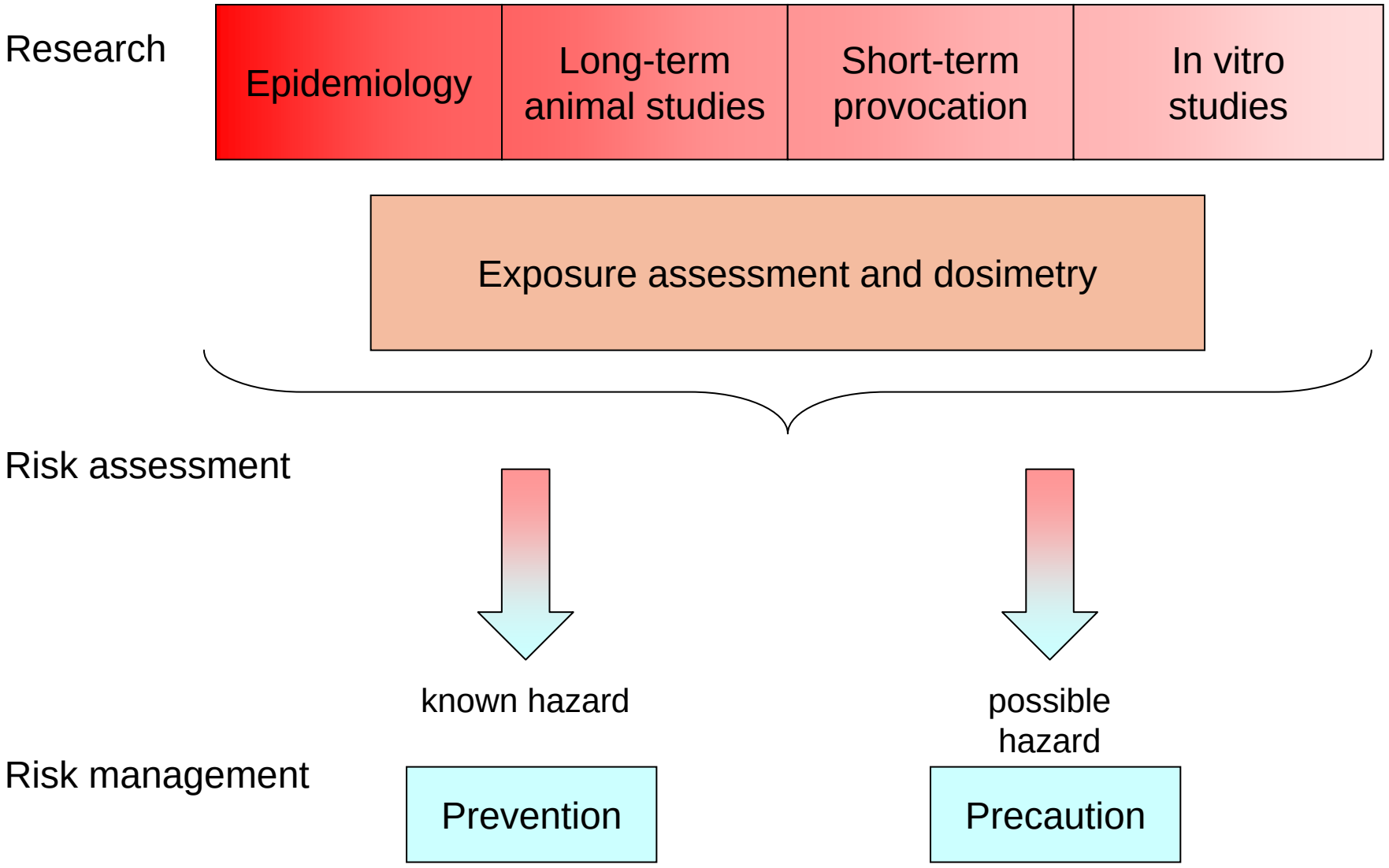


Microcells

Example of EMF Power Density from a Base Station



From Matthes (2004)


Research
Epidemiology
Long-term animal studies
Short-term provocation
In vitro studies
Exposure assessment and dosimetry
Risk assessment
known hazard
possible hazard
Risk management
Prevention
Precaution

Epidemiological Studies Wellbeing

Epidemiological Studies - Overview

Wellbeing and Performance

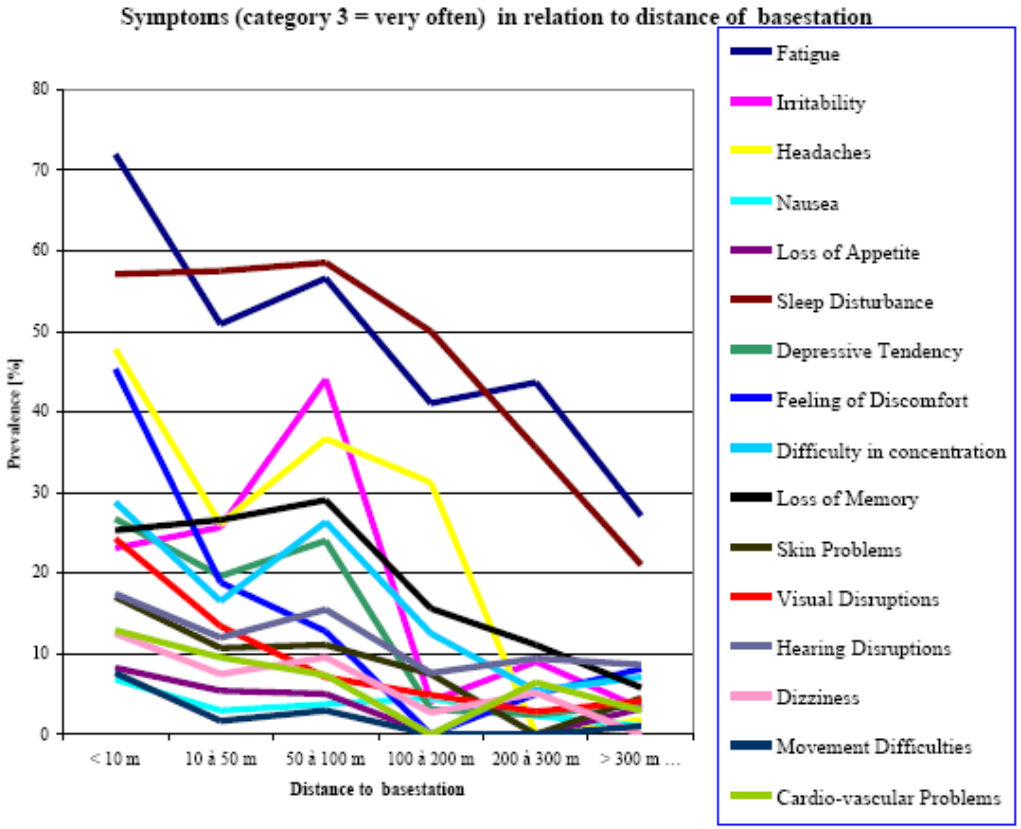
- Santini et al. (2002, 2003)
- Navarro et al. (2003)
- Hutter et al. (2006)
- Abdel-Rassoul et al. (2006)
- Heinrich et al. (2007)
- Thomas et al. (2008)
- Blettner et al. (2008)

Cancer

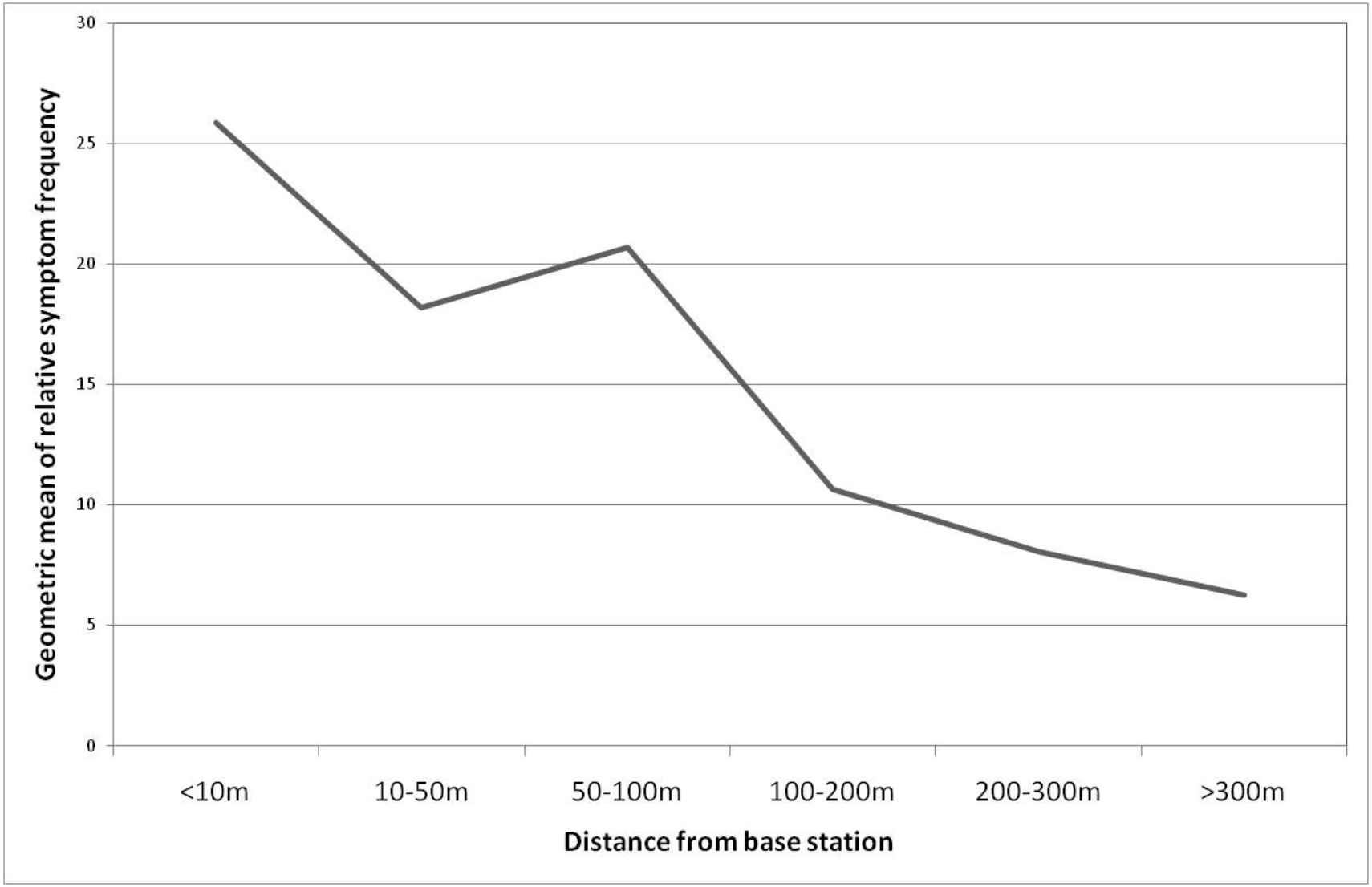
- Eger et al. (2004)
- Wolf & Wolf (2004)

Santini et al. 2002, 2003

- France
- 530 persons
- Selection by media announcement
- Exposure: participants' estimate of distance
- Outcome: list of 18 symptoms



Santini et al. 2002, 2003



Navarro et al. 2003

- Spain (La Nora, Murcia)
- 101 persons included
- Selection of 5% of population (70% response rate)
- Exposure: participants' estimate of distance and bedroom measurements
- Outcome: list of 18 symptoms

Symptom	<150 m (~1.1 mW/m²)	>250 m (~0.1 mW/m²)
Headache	2.17 ± 0.86 **	1.53 ± 1.00
Sleep disturbance	1.94 ± 0.92 **	1.28 ± 1.10
Concentration difficulties	1.56 ± 1.14 *	1.00 ± 1.06
Depression	1.30 ± 1.19 *	0.74 ± 1.01
Dizziness	1.26 ± 1.14 *	0.74 ± 1.05
Nausea	0.93 ± 0.99 *	0.53 ± 0.88

Hutter et al. 2006

- Austria (Vienna, Carinthia)
- 336 persons included
- Selection randomly base on estimated exposure
- Exposure: frequency selective measurements in bedrooms
- Outcome: v.Zerssen symptom list, Pittsburgh sleep questionnaire, cognitive performance

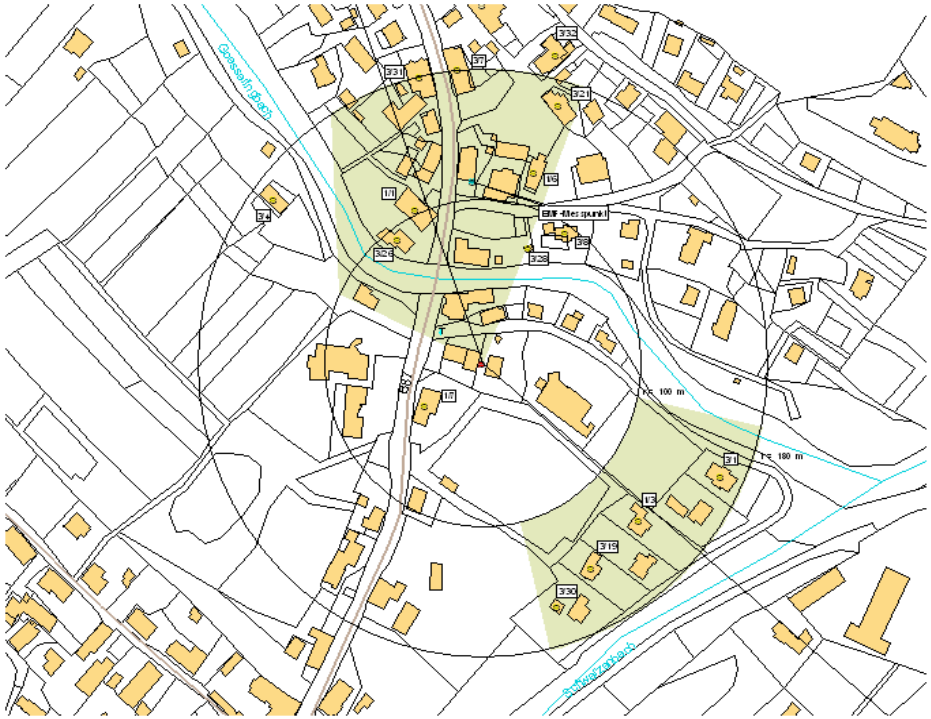


Table 4 Relative risk estimates of subjective symptoms of primary interest for categories of exposure to microwaves from base stations in the bedroom against lowest exposure category

Symptom	Exposure category (mW/m^2)	% with symptom	Relative risk*	95% CI	p value
Headaches	≤0.1†	61	1.00		0.017
	0.1–0.5	66	1.36	0.62–2.99	
	>0.5	79	3.06	1.22–7.67	
Vertigo	≤0.1†	17	1.00		0.306
	0.1–0.5	27	1.27	0.50–3.22	
	>0.5	32	1.54	0.68–3.50	
Palpitations	≤0.1†	26	1.00		0.444
	0.1–0.5	32	1.06	0.45–2.47	
	>0.5	38	1.37	0.61–3.11	
Tremor	≤0.1†	12	1.00		0.062
	0.1–0.5	9	0.68	0.19–2.41	
	>0.5	26	2.37	0.96–5.87	
Hot flushes	≤0.1†	32	1.00		0.739
	0.1–0.5	26	0.90	0.39–2.09	
	>0.5	26	0.87	0.37–2.01	
Sweating	≤0.1†	34	1.00		0.455
	0.1–0.5	38	1.05	0.47–2.32	
	>0.5	40	1.35	0.61–2.97	
Cold hands or feet	≤0.1†	40	1.00		0.019
	0.1–0.5	46	1.03	0.40–2.63	
	>0.5	62	2.57	1.16–5.67	
Loss of appetite	≤0.1†	13	1.00		0.069
	0.1–0.5	17	1.23	0.42–3.57	
	>0.5	24	2.40	0.93–6.18	
Loss of energy	≤0.1†	63	1.00		0.886
	0.1–0.5	63	1.32	0.61–2.84	
	>0.5	58	1.06	0.49–2.27	
Exhaustion	≤0.1†	44	1.00		0.098
	0.1–0.5	41	0.77	0.30–2.02	
	>0.5	51	2.07	0.87–4.89	
Tiredness	≤0.1†	64	1.00		0.258
	0.1–0.5	89	1.97	0.64–6.10	
	>0.5	88	1.92	0.62–5.96	
Difficulties to concentrate	≤0.1†	60	1.00		0.035
	0.1–0.5	64	1.32	0.61–2.86	
	>0.5	76	2.55	1.07–6.08	
Feeling strained	≤0.1†	44	1.00		0.450
	0.1–0.5	51	1.67	0.76–3.65	
	>0.5	40	0.74	0.33–1.63	
Urge for sleep	≤0.1†	47	1.00		0.630
	0.1–0.5	54	1.21	0.56–2.61	
	>0.5	51	1.17	0.53–2.54	

p values for exposure factor are shown.
*Adjusted for age, sex, region, regular use of mobile telephone, and fear of adverse effects of the base station.
†Reference category.

Increased risk for:
Headaches
Concentration difficulties
Cold hands/feet

Abdel-Rassoul et al. 2006

- Egypt (Shebin El-Kom)
- 160 employees of the agricultural directorate
- Selection unknown
- Exposure: under and opposite a building with a roof-top antenna + controls (2.5 km apart)
- Outcome: symptom list, neurological tests

Abdel-Rassoul et al. 2006

Symptom	Exposed	Controls	Odds Ratio
Memory changes	28%	5%	7.5 [2.3 – 27.0]
Dizziness	19%	5%	4.4 [1.3 – 16.5]
Headache	24%	11%	2.8 [1.1 – 7.4]
Sleep disturbance	24%	10%	2.8 [1.1 – 7.4]
Tremors	9%	0%	p<0.01
Depressive symptoms	22%	9%	2.8 [1.0 – 7.9]
Concentration problems	17%	10%	1.8 [0.7 – 5.0]
Blurred vision	22%	15%	1.6 [0.7 – 3.9]
Irritability	27%	20%	1.5 [0.7 – 3.3]

Heinrich et al. 2007

- Germany (Bavaria)
- 95 employees in a building with a UMTS roof-antenna
- Self-selection
- Exposure: double-blind field experiment (random 1-3 days on/off)
- Outcome: list of 21 symptoms

- Slightly ($p=0.08$) higher decrease of well-being on days with base station active
- Actual exposure not considered (some offices were not exposed), maximum 0.75 mW/m^2

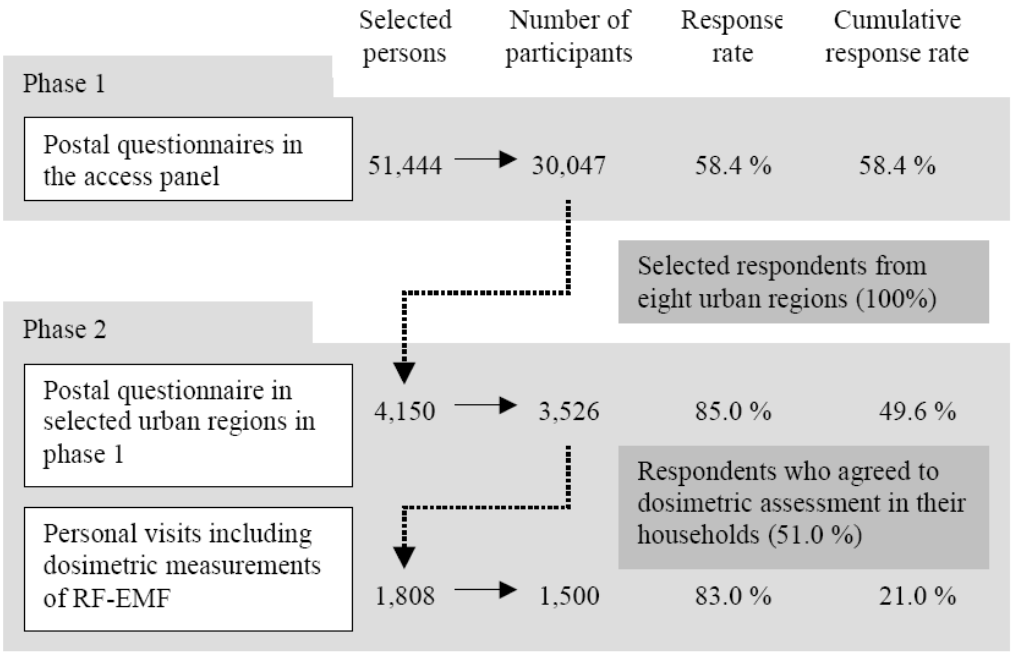
Thomas et al. 2008

- Germany (Bavaria)
- 329 participants
- Selection by media announcement
- Exposure: 24 h personal dosimetry
- Outcome: chronic and acute symptoms (v.Zerssen list)

- No significant effect of exposure detected
- Frequency of symptoms very low → power less than 40%
- Exposure very low: maximum daily average 0.24 mW/m²

Blettner et al. 2008

- Germany
- Phase 1: 30,047 persons
- Phase 2: 3,526 persons
- Selection: random population sample
- Exposure:
  - Phase 1: distance from geo-coded data
  - Phase 2: measurements in sleeping room
- Outcome:
  - Phase 1: Frick's symptom list
  - Phase 2: v.Zerssen list, Pittsburgh sleep questionnaire



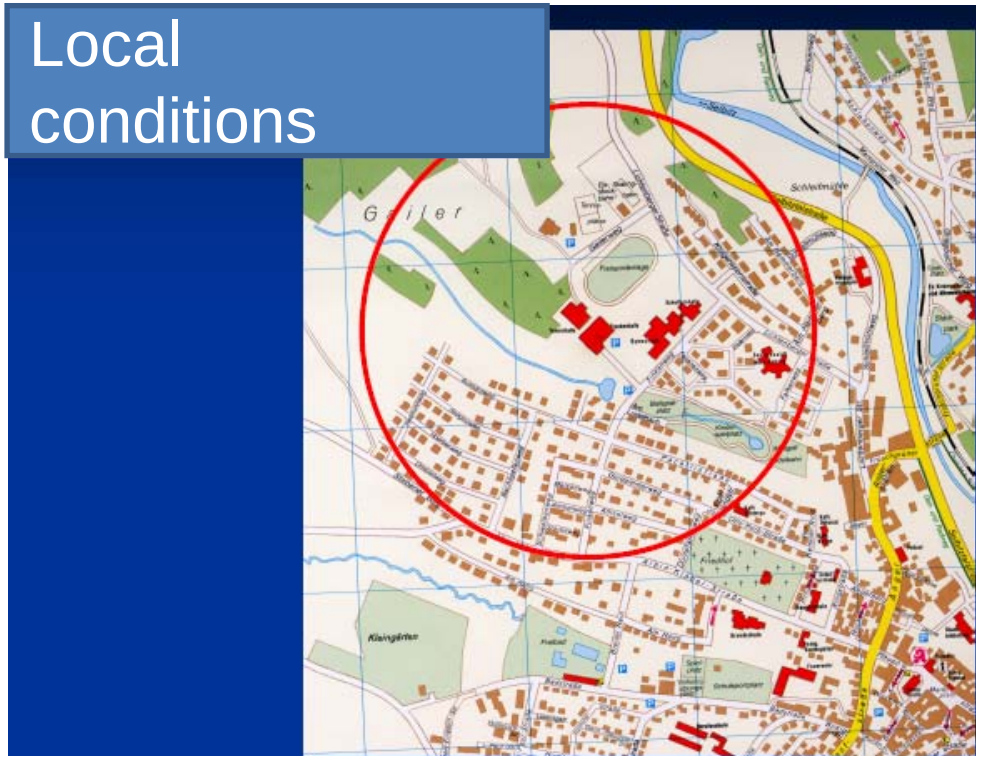
Blettner et al. 2008

- In Phase 1 a significant effect of distance from base station (< 500 m) on wellbeing was found
- In Phase 2 no effect was detected but exposure was too low to be meaningfully analyzed

Epidemiological Studies Cancer

Eger et al. 2004 (Neila-Study)

- Germany (Bavaria)
- Improved ecological design, with random selection of streets
- Exposure: area < 400 m from base-station
- Outcome: all incident cases of cancer during 10 years after start of operation

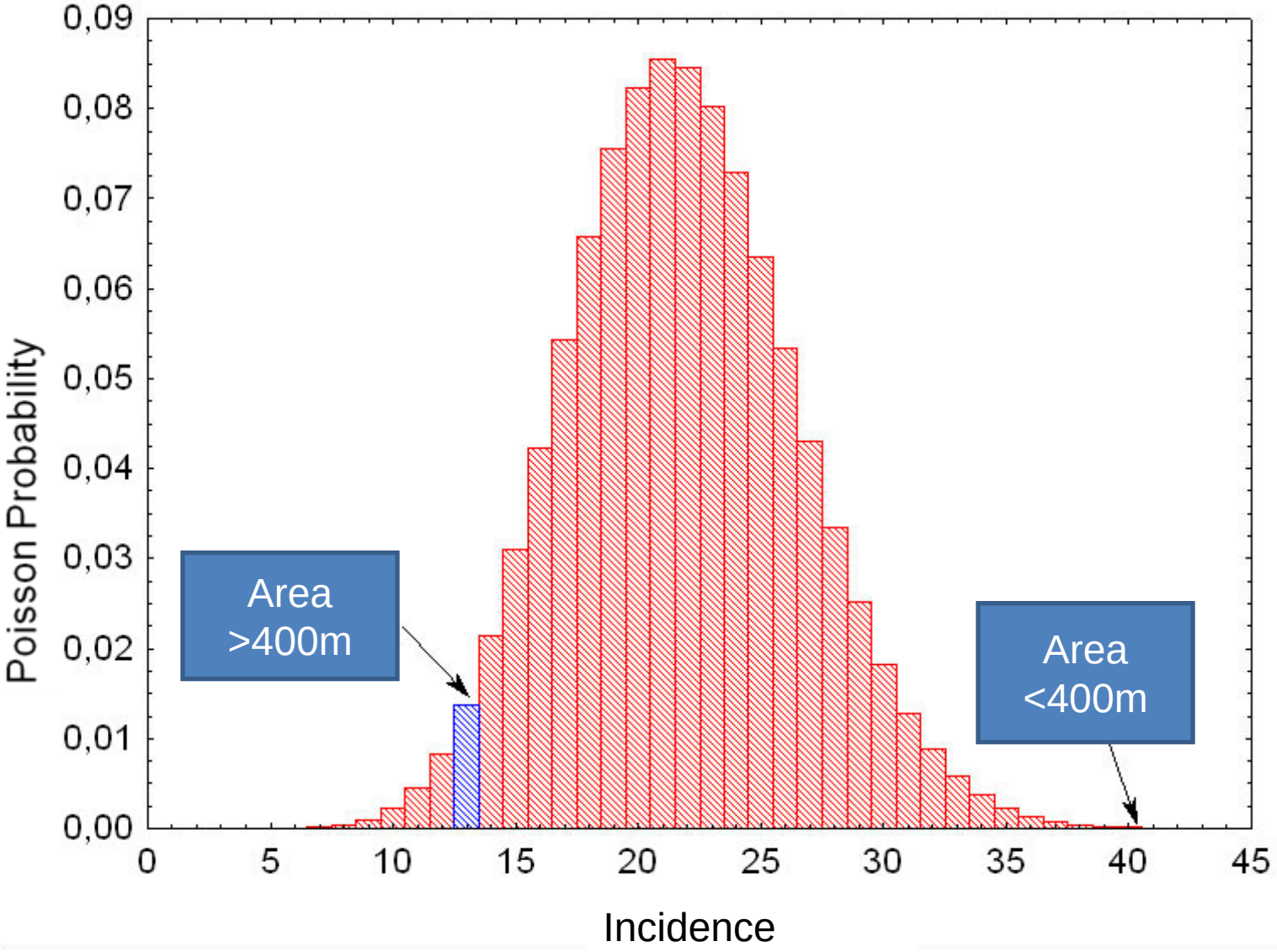


Eger et al. 2004 (Neila-Study)

Cancer incidence in the study areas

Period	farther area (>400 m)	closer area (<400 m)
1st five years after begin of operation (1994-1998)	24.7 / 10,000	31.3 / 10,000
2nd five years after begin of operation (1999-2003)	24.7 / 10,000	76.7 / 10,000 **

Eger et al. 2004 (Neila-Study)



Wolf & Wolf 2004 (Netanya Study)

- Israel
- Ecological design
- Exposure: area <350m from base station
- Outcome: all incident cases of cancer second year after start of operation
- Area A: <350 m from base station, 622 inhabitants
- Area B: in a region without bas station, 1222 inhabitants

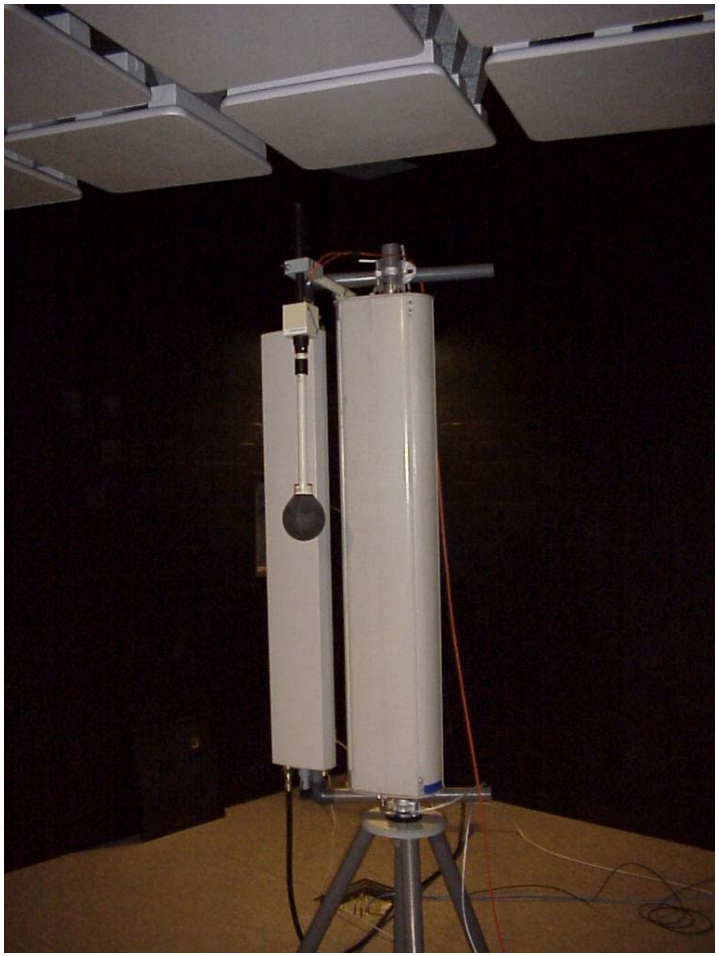
Wolf & Wolf 2004

	Male		Female	
	rate	Relative rate	rate	relative rate
Area A	33	1.4	262	10.5
Area B	17	0.7	16	0.6
Whole town	24	1	25	1

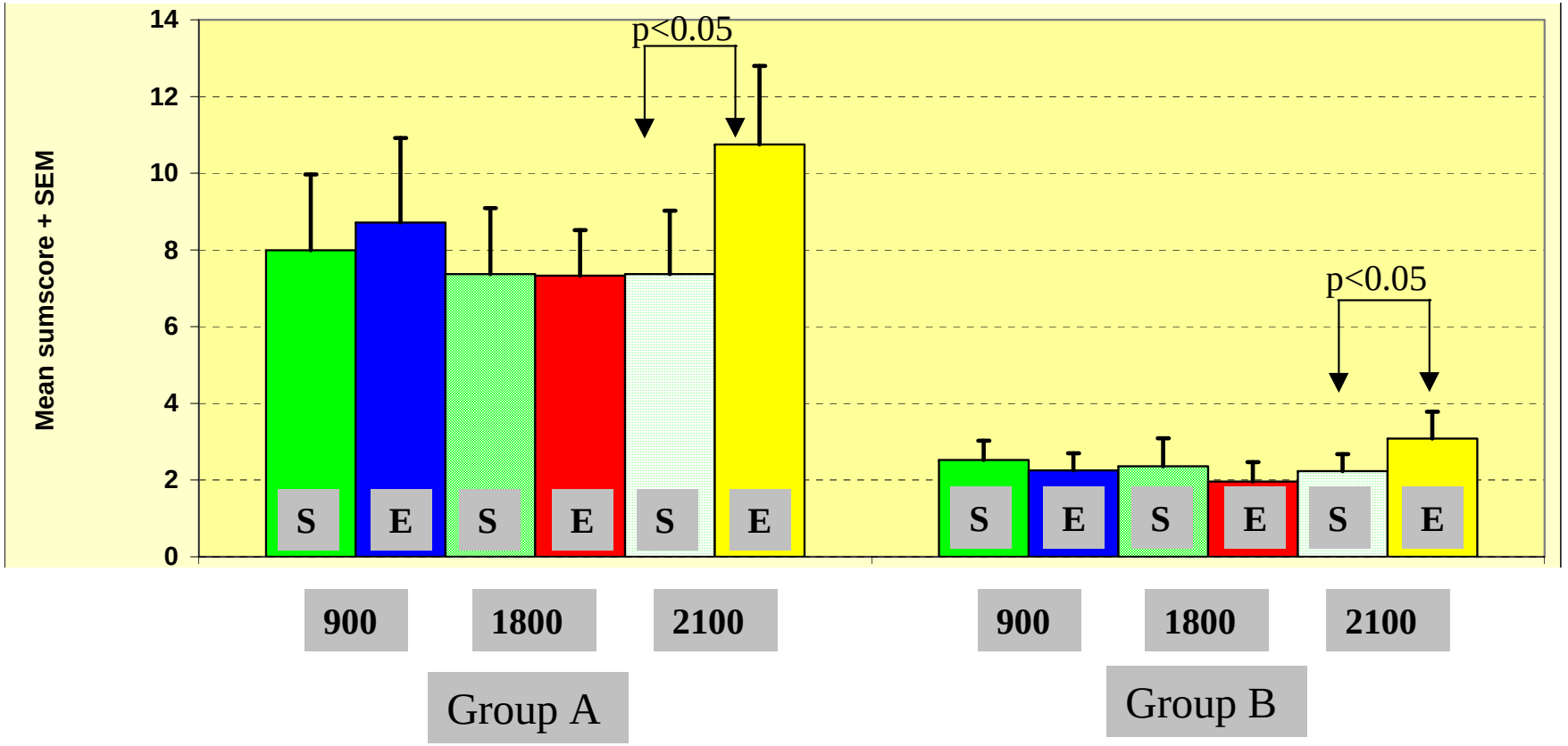
Human provocation studies

Zwamborn et al. 2003 (TNO Study)

- Netherlands
- Experimental groups: 36 EHS people, 36 controls
- Exposure:
  - Sham
  - GSM 900: 0.75 V/m
  - GSM1800: 0.75 V/m
  - UMTS: 1 V/m
- Outcome: wellbeing, cognitive performance

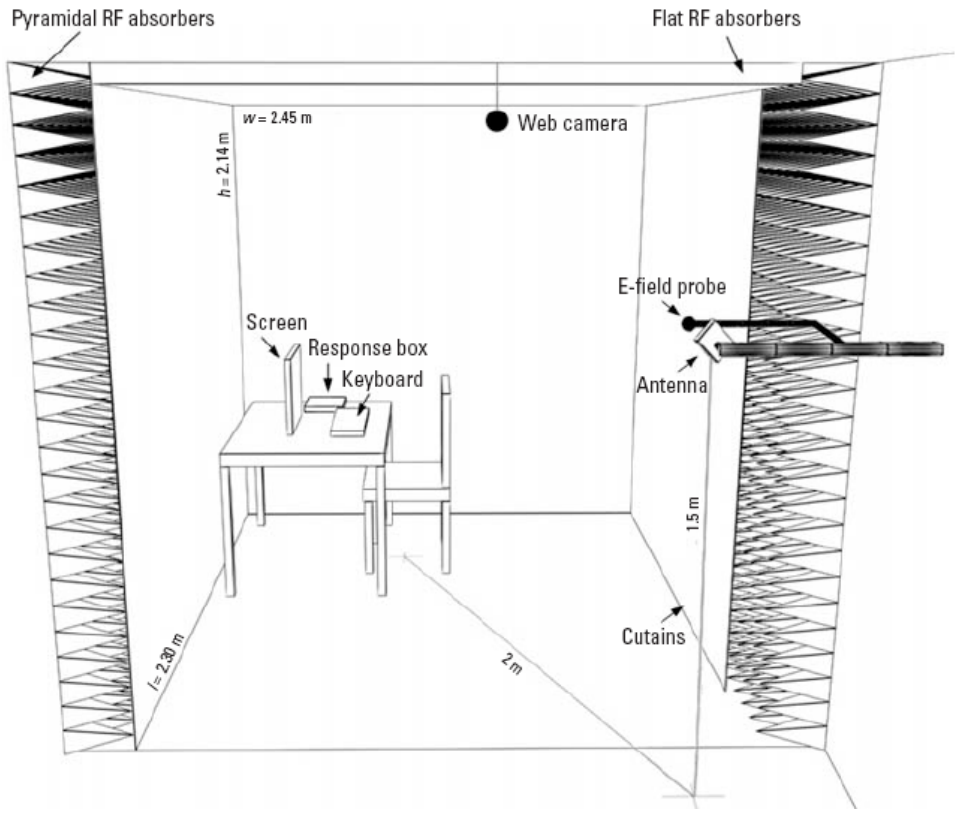


Zwamborn et al. 2003 (TNO Study)



Regel et al. 2006

- Switzerland
- Experimental groups: 33 EHS people, 84 controls
- Exposure:
  - Sham
  - UMTS 1 V/m
  - UMTS 10 V/m
- Outcome: wellbeing, performance



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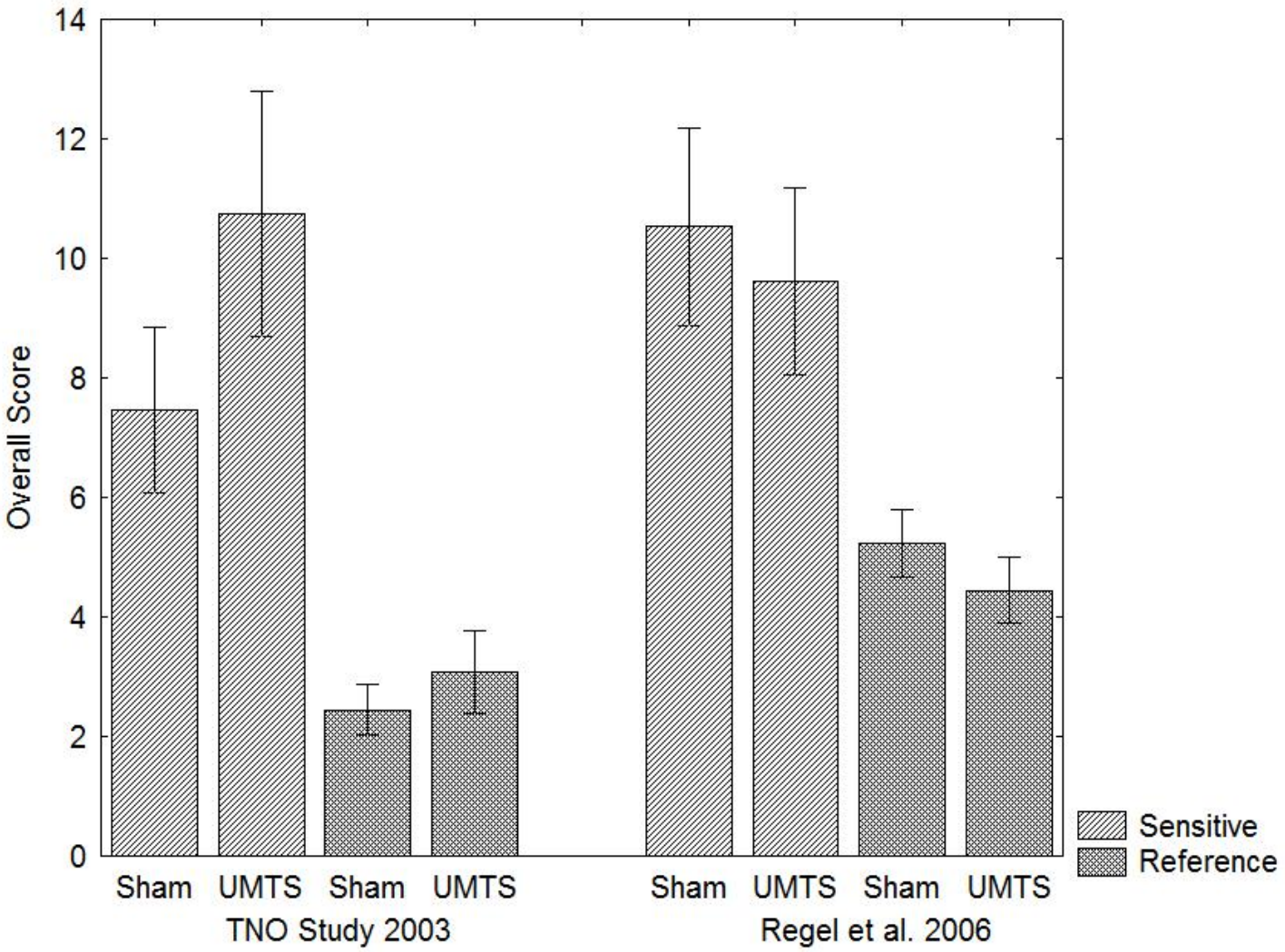
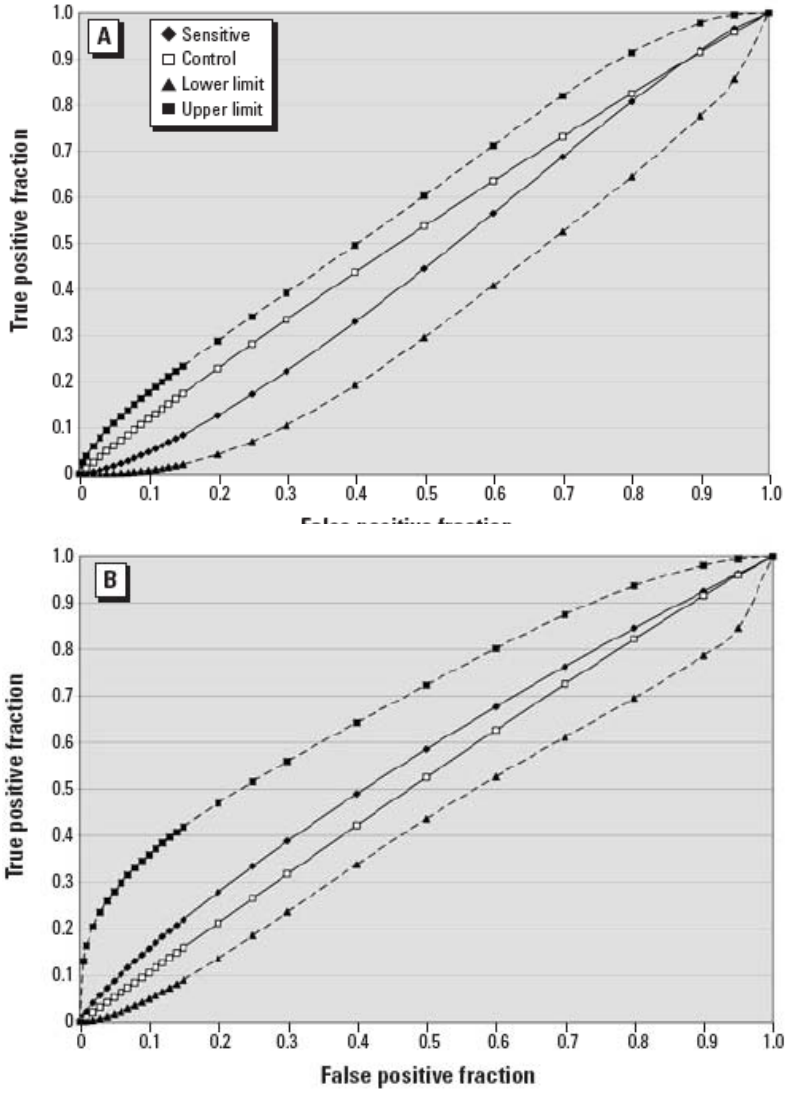


Eltiti et al. 2007

- Great Britain (Essex)
- Experimental groups: 44 sensitive, 115 control individuals
- Exposure:
  - Sham
  - GSM (900+1800) 10 mW/m²
  - UMTS 19 mW/m²
- Outcome: wellbeing, performance, physiological measurements



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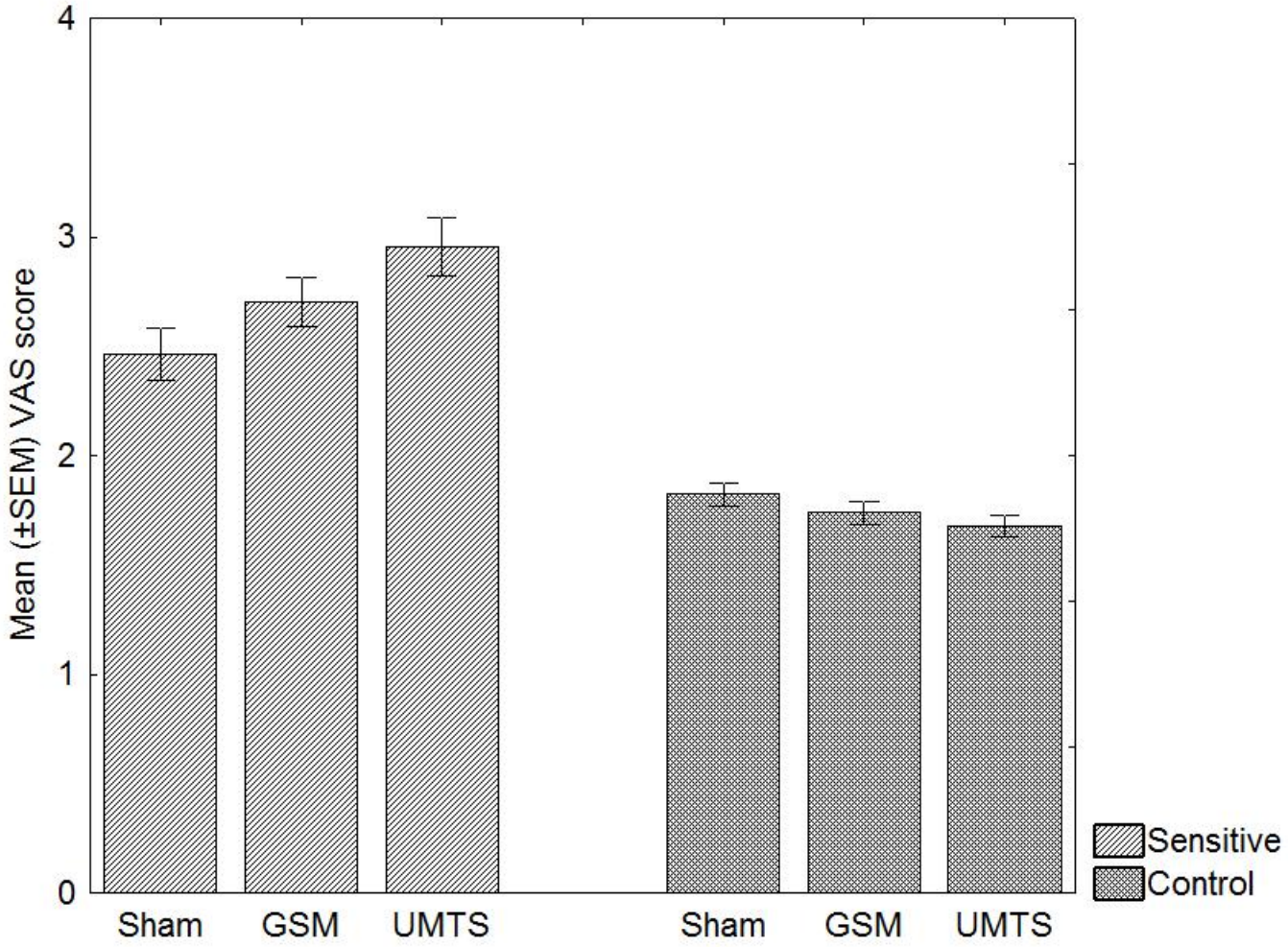
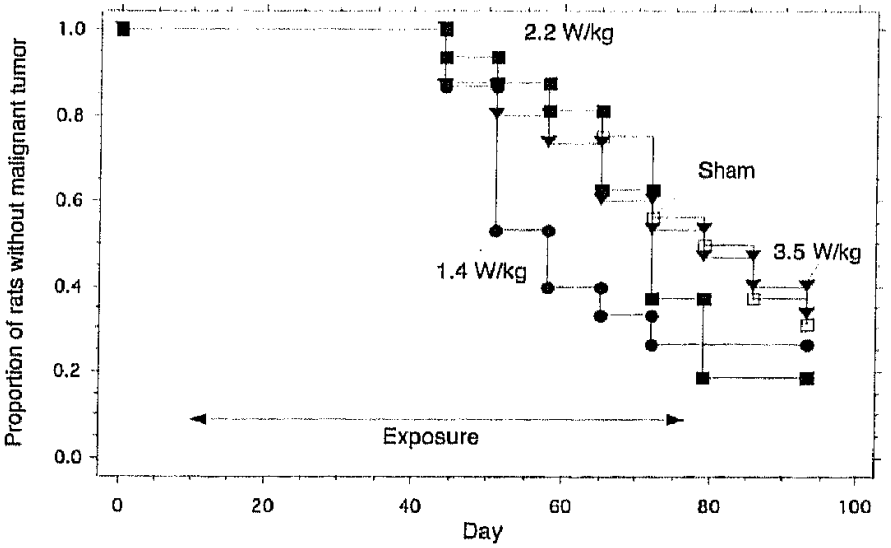
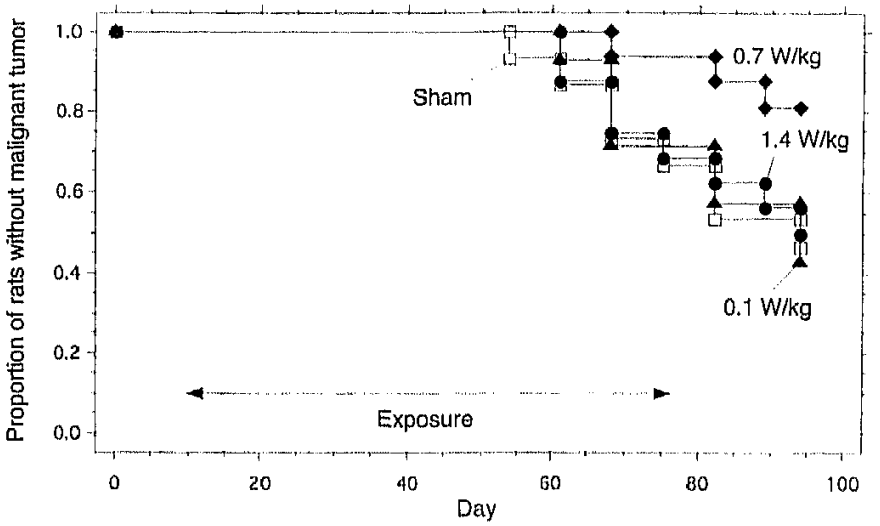


Animal studies

Anane et al. 2003

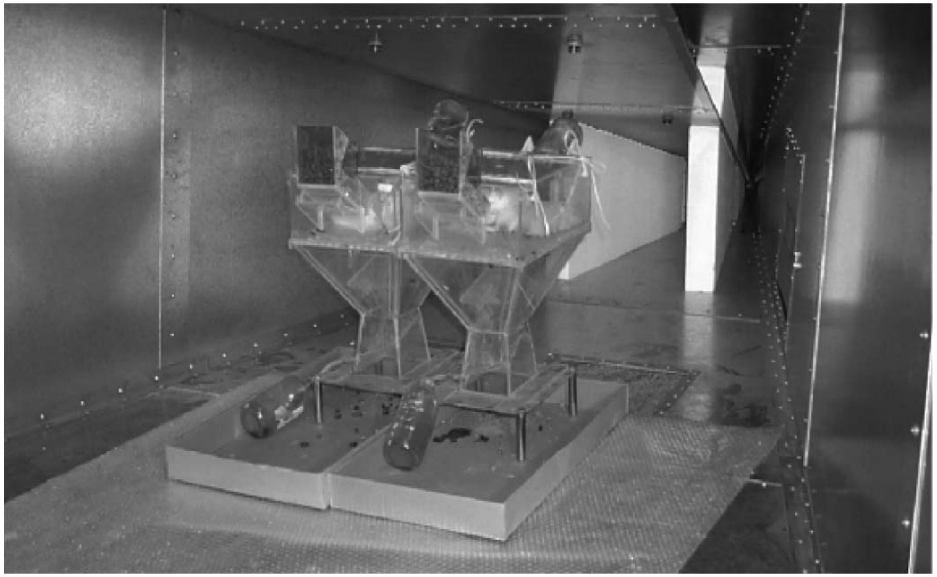
- France
- DMBA induction of mammary tumours in Sprague-Dawley rats
- Exposure: 2h/d, 9 weeks 16 animals/group
  - Sham
  - GSM 1.4, 2.2, 3.5 W/kg
  - GSM 0.1, 0.7, 1.4 W/kg
- Outcome: mammary tumours





Yurekli et al. 2006

- Turkey
- Wistar albino rats
- Exposure: 7h/d, 8 days
  - Sham
  - GSM 900 11.3 mW/kg
- Outcome: malondialdehyde, reduced glutathione, superoxide dismutase



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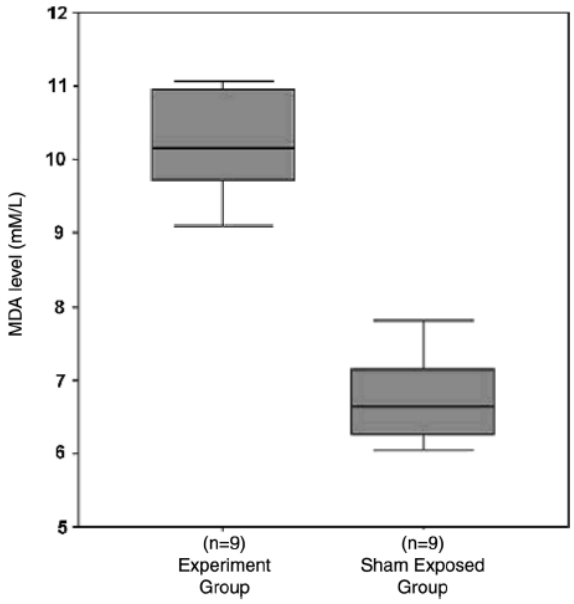
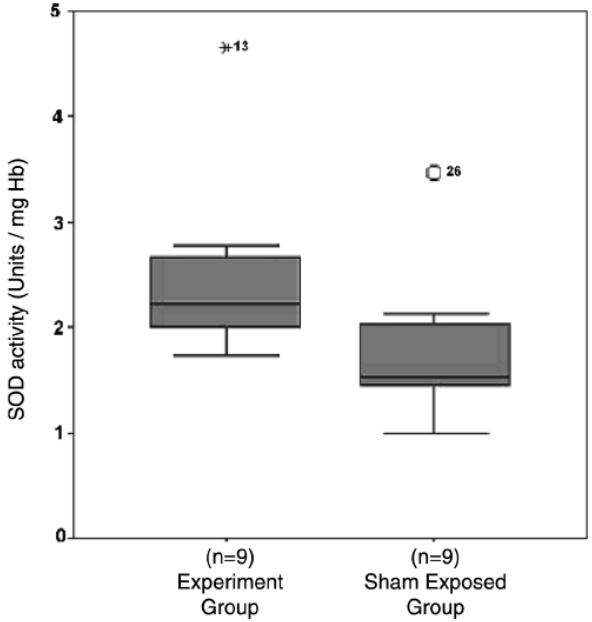
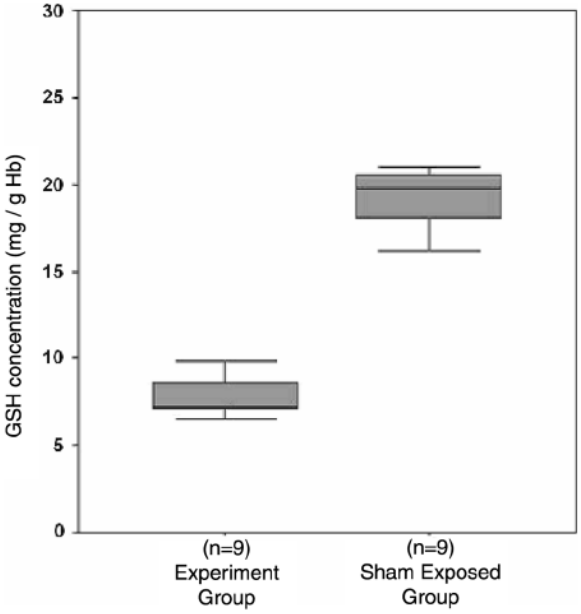


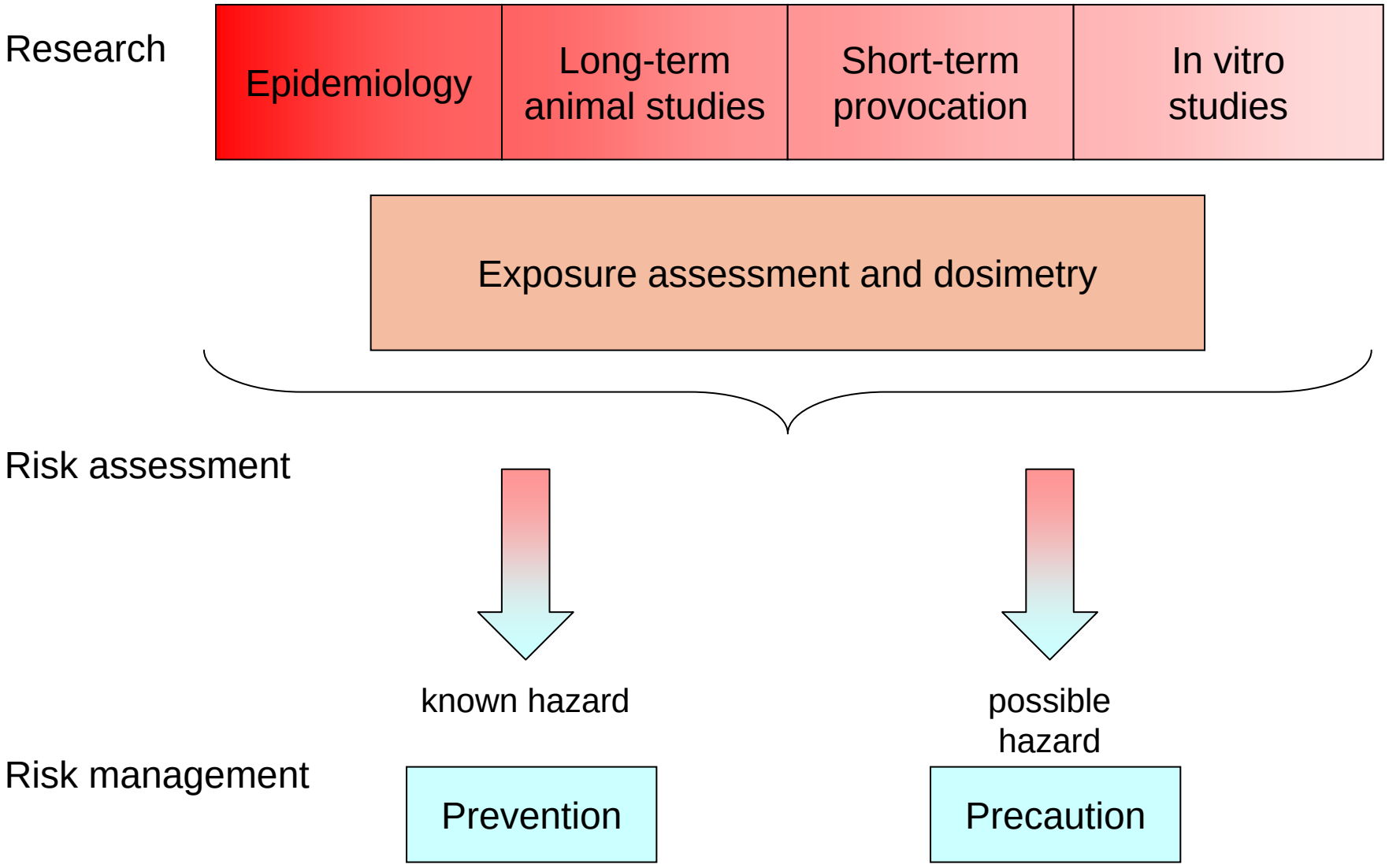




Conclusions

Only few investigations deal with mobile phone base stations
Discouraging such studies by authoritative bodies like WHO and COST 281 may have contributed to this unfavourable situation

The majority of epidemiological investigations found an association between wellbeing and exposure from base stations
Experimental investigations found weak evidence for a reduced wellbeing in sensitive individuals after short term exposure to base station signals (in particular UMTS)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Long-term animal studies
Short-term provocation
In vitro studies
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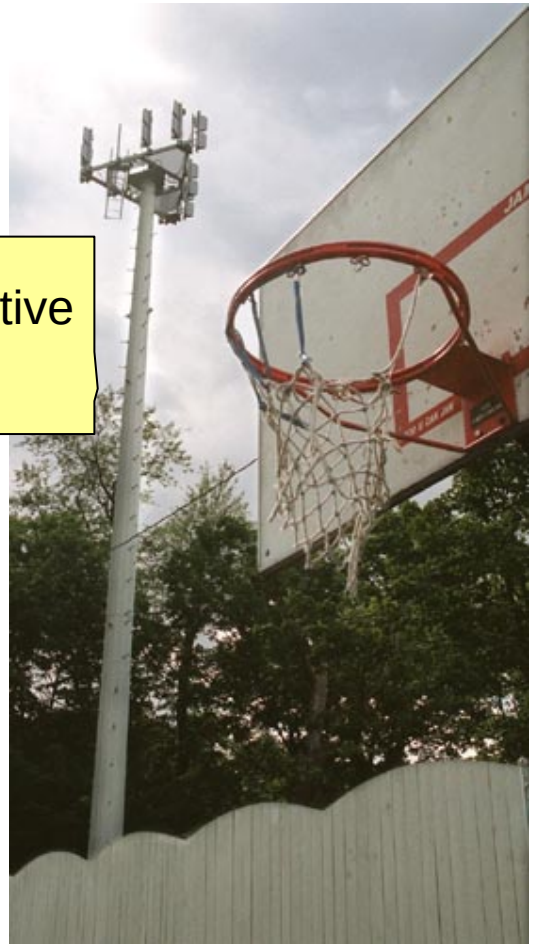
Risk assessment
known hazard
possible hazard
Risk management
Prevention
Precaution

Precautionary Measures

Don‘t use too low height

Increase distance

Avoid sensitive areas



Precautionary Measures

- Siting of base-stations
  - Choose location such as to minimize exposure of neighbors
  - Choose lowest intensity compatible with function of the network
  - Network providers should not commit to network availability at places affording high powered base-stations (elevators, basements etc.)

Take Home Message

At present there is no reason for exaggerated fear of great impact on health neither for mobile phones nor their base-stations!

However! There is definitely a case for precaution! All attempts should be made to reduce exposure as much as possible.