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Cross-sectional study on subjective symptoms due to electromagnetic fields from mobile-phone base stations among adults

Universität Bielefeld
Gesundheits-Wissenschaften Public Health
AG Epidemiologie & Int. Public Health

JOHANNES GUTENBERG UNIVERSITÄT MAINZ
IMBEI

dkfz
AG Umweltepidemiologie

tns
TNS Healthcare

IMST
IMST

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- University of Bielefeld:
  - Gabriele Berg, Jürgen Breckenkamp, Bernd Kowall, Jörg Riedel
- University of Mainz:
  - Maria Blettner, Joachim Schüz, Sven Schmiedel,
- DKFZ Heidelberg:
  - Brigitte Schlehofer
- TNS Health Care:
  - Peter Potthoff, Ursula Reis, Claudia Barthold
- IMST
  - Christian Bornkessel

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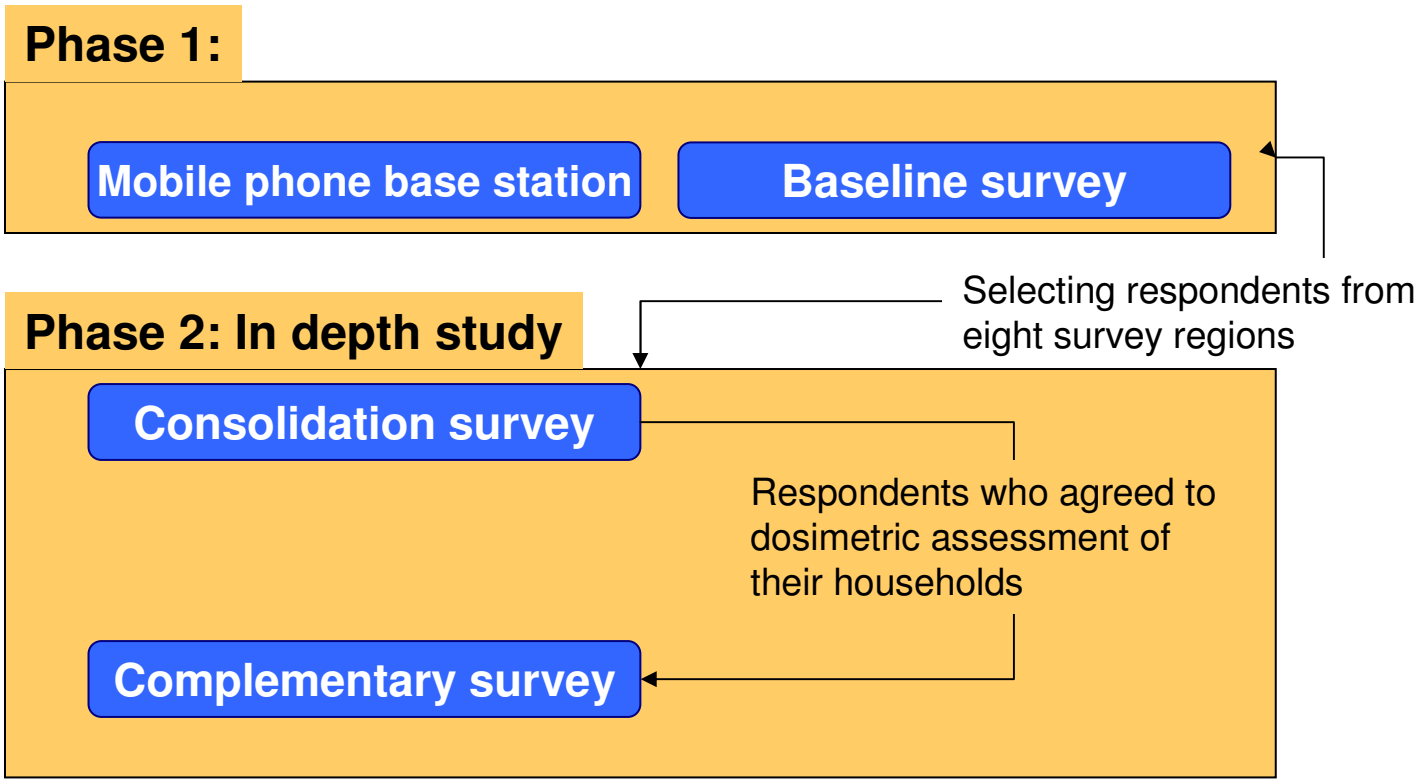
Structure

- Phase 0: Pilot study
  - Feasibility was tested
- Phase 1: Baseline study
  - Cross sectional data collection in Germany n= 30,000 households
  - Location and technical data of n=50,000 mobile phone base stations
- Phase 2: In depth study
  - In specific urban regions complementary questionnaires and dosimetric measurements
  - consolidation and complementary survey

Structure


Phase 1:
Mobile phone base station
Baseline survey
Selecting respondents from eight survey regions
Phase 2: In depth study
Consolidation survey
Respondents who agreed to dosimetric assessment of their households
Complementary survey

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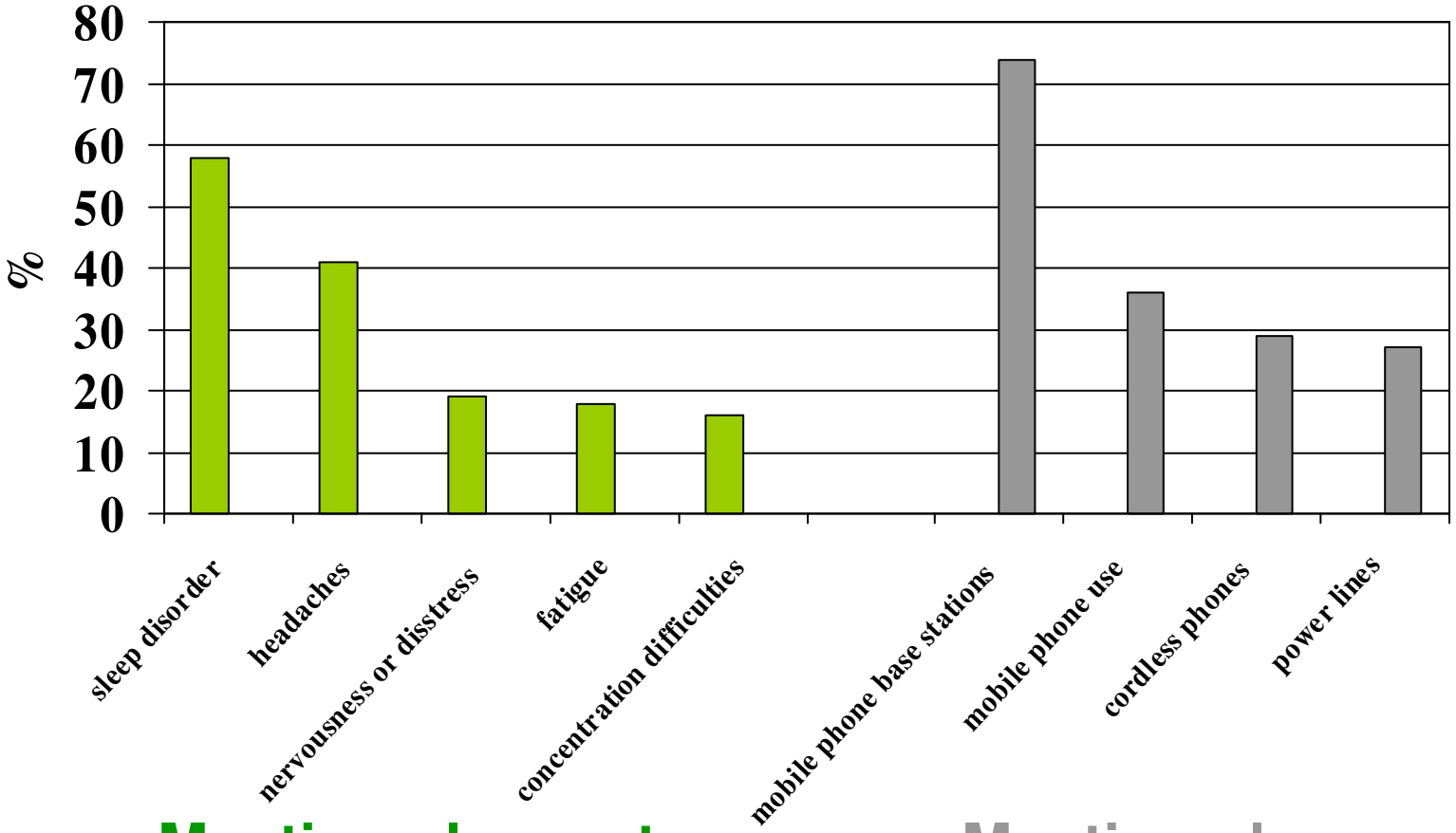
Contents

- Literature
- Baseline study:
  - Survey methods
  - Distribution of health disturbances and mobile phone base stations in Germany
- In depth study:
  - Field work
  - Quality assessment of dosimetric measurements
  - Data management and analysis strategy
- Summary and preview

Literature

Symptoms of ill health in electro-sensitive



Röösli et al., 2004 (cross sectional, n=429 - voluntary persons)

Sleep laboratory studies

N	Exposure	Main results	Source
13	900 MHz, pulsed 0.5 W/m² (8h)	Earlier falling asleep EEG power increased in all frequency bands during REM	Mann 1996
22	900 MHz, pulsed SAR: 0.2 W/kg² (8h)	No significant differences between sham and exposure – Only: Earlier falling asleep	Wagner 1998
24	900 MHz, pulsed SAR:1.0 W/m² (15 min)	Waking phase during sleep was reduced EEG power increased initial sleep phase (α and β)	Borbely 1999
13	900 MHz, pulsed SAR:1.0 W/m² (30min)	EEG power increased initial REM (α and β)	Huber 2000
13	900 MHz, pulsed SAR:1.0 W/m² (30min)	EEG power increased before sleep (α) EEG power Increased initial REM (β)	Huber 2002
25	900 MHz, pulsed SAR:1.0 W/m² (30min)	Earlier falling asleep REM sleep started earlier EEG power increased during REM (α)	Loughran 2005

Sleep laboratory studies

Mann & Röschke:

- Recent sleep laboratory studies have consistently reported a slight sleep promoting effect.
- However, the comparison of the studies is limited by their heterogeneity.

Mann & Röschke, 2004 (Review)

Health disturbances and mobile phone use

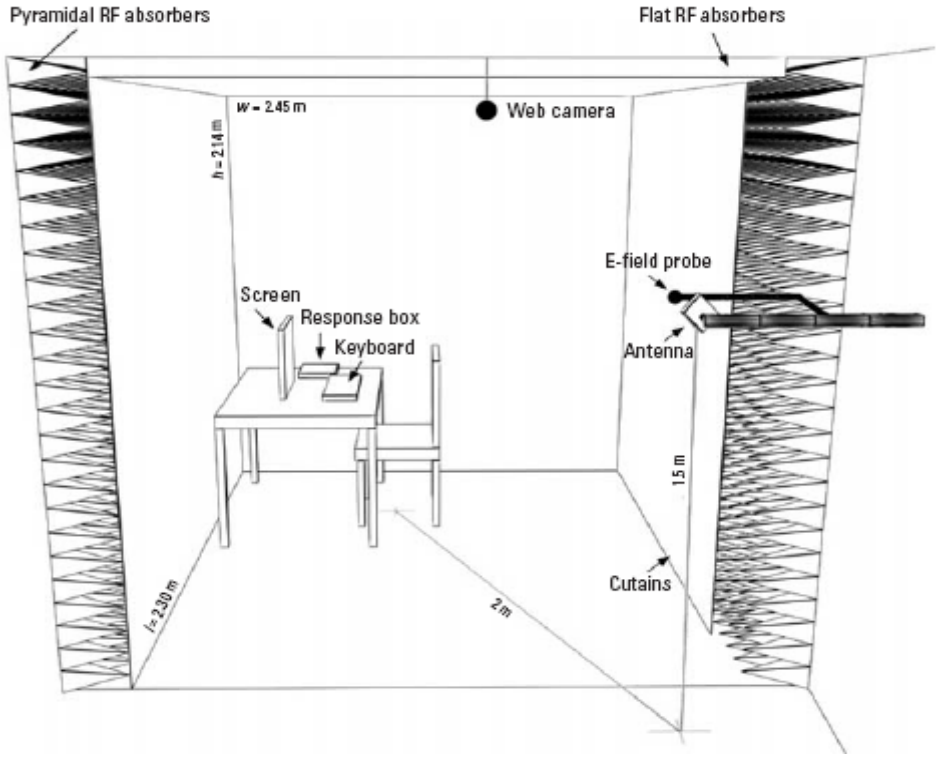
Source	Method	Results
Hocking 1998	Voluntary report from mobile phone users (invocation by a journal) n=40	“Burning feeling”
Chia et al. 2000	Cross sectional study: N=808, comparison between user and non user of mobile phones	Headache
Oftendal et al. 2000	Cross sectional study n=17 000 Only mobile phone users	Burning feeling
Sandström et al. 2001	Comparison between GSM (900 MHz, pulsed) and NMT (900 MHz not pulsed)	No difference found
Wilen et al. 2003	Cross sectional study n=2402 Only mobile phone users Subgroup from Oftendal et al. Analysis of dose response relationship	Dizziness Burning feeling Headache (?)

Laboratory study

- **Groups**:
  - A: electro sensitive (n=36)
  - B: not electro sensitive (n=36)
- **Exposure**:
  - GSM 900 MHz, GSM 1800 MHz und UMTS 2100 MHz, each 1 V/m.
  - Four phases for 30 minutes (randomized).
  - During these phases each participant filled in a questionnaire about subjective symptoms
- **Result**:
  - Between both groups there was a significant difference in subjective symptoms between Sham and UMTS-Exposure
  - No differences were found between sham and GSM 900 MHz as well as sham and GSM 1800 MHz
  - Cognition tests: no differences were found
- **Discussion**:
  - Differences are small
  - Carry-Over-Effects
  - Exposure time very short

Zwamborn et al. 2003

Replication of the study



- Groups:
  - A: Electro sensitive (n=33)
  - B: Not electro sensitive (n=84)
- Exposure:
  - UMTS 2100 MHz, each 1 V/m and 10 V/m
- Results:
  No short term effect of UMTS base stations exposure on well-being could be shown

Regel et al. 2006

Health disturbances and mobile phone base stations

Method:	France Santini et al. 2002	Spain Navarro et al. 2003	Egypt Abdel-Rassoul et al. 2006
N	530	101	165
Exposure	Distance (estimated by participants)	Measurement in three categories	Two regions
Frequency	?	1800 MHz	?
Measurements	No	Yes, to estimate exposed groups	Only exposed region
Confounder	No	No	No

Health disturbances and mobile phone base stations

Method:	Austria Hutter et al. 2006
N	336
Exposure	Measurement
Frequency	900 MHz
Measurements	Yes, to estimate exposed groups
Confounder	Yes
Results	Three factors in the list of 24 mentioned health disturbances of v. Zerssen were mentioned: headache, cold hands and feet, concentration difficulties Sleeping problems seem to be more due to concern of adverse health effects than to actual exposure

Conclusion

- Three studies with insufficient methods
- One Pilot study

→Up to now there is missing epidemiological knowledge about the association between RF-EMF of mobile phone base stations and health disturbances

PHASE 1
Baseline study

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Baseline study - aim

- Prevalence of persons living near MPBS
- Prevalence of concern and self reported disturbances due to MPBS
- Comparison between concern and self reported complaints due to MPBS and „pretended“ and „real“ distance of a MPBS

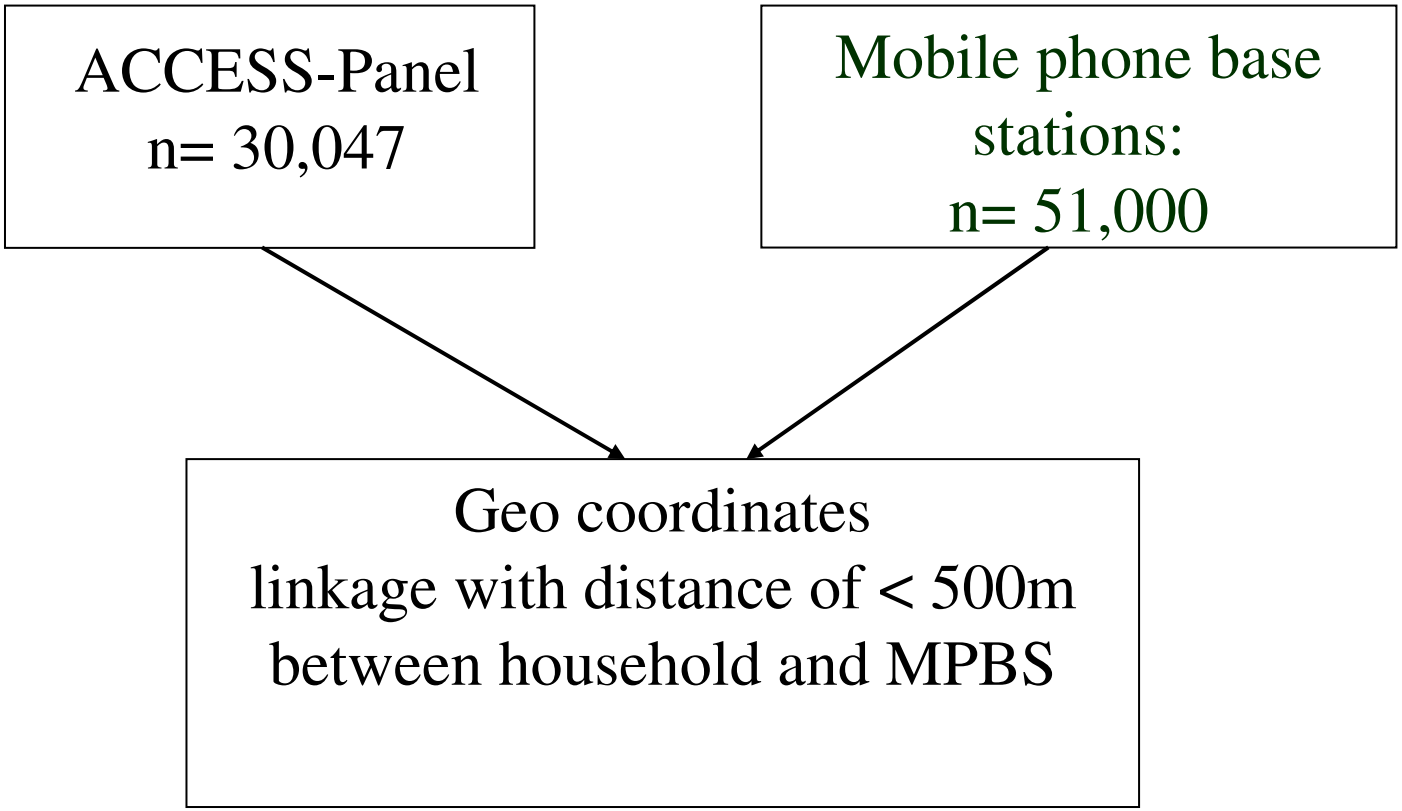
Method: ACCESS-Panel

- Written survey of individuals at the age of 14 to 69 years
- Between August and November 2004
- Addressed: 51,444 individuals;
  involved: 30,047 individuals
  (response rate = 58.4%).
- Representation of the distribution of the German population in private households.
- Geo-coordinates from all household-addresses

Method: Mobile phone base stations

- MPBS Location subject to registration in Germany, provided by the Federal Network Agency
- Technical data and the geographic coordinates
- About 51,000 locations with about 280,000 antennas

Method: Study activities



Study population

Subgroup	Classification	Absolute	Relative (%)
	All	30,047	100
Gender	Male	15,078	50.2
	Female	14,969	49.8
Age	14-19	2,770	9.2
	20-29	4,352	14.5
	30-39	6,368	21.2
	40-49	6,323	21.0
	50-59	4,902	16.3
	60-70	5,335	17.8
Education	Secondary school	17,659	58.8
	Higher education	9,171	30.5
	Other	3,211	10.7

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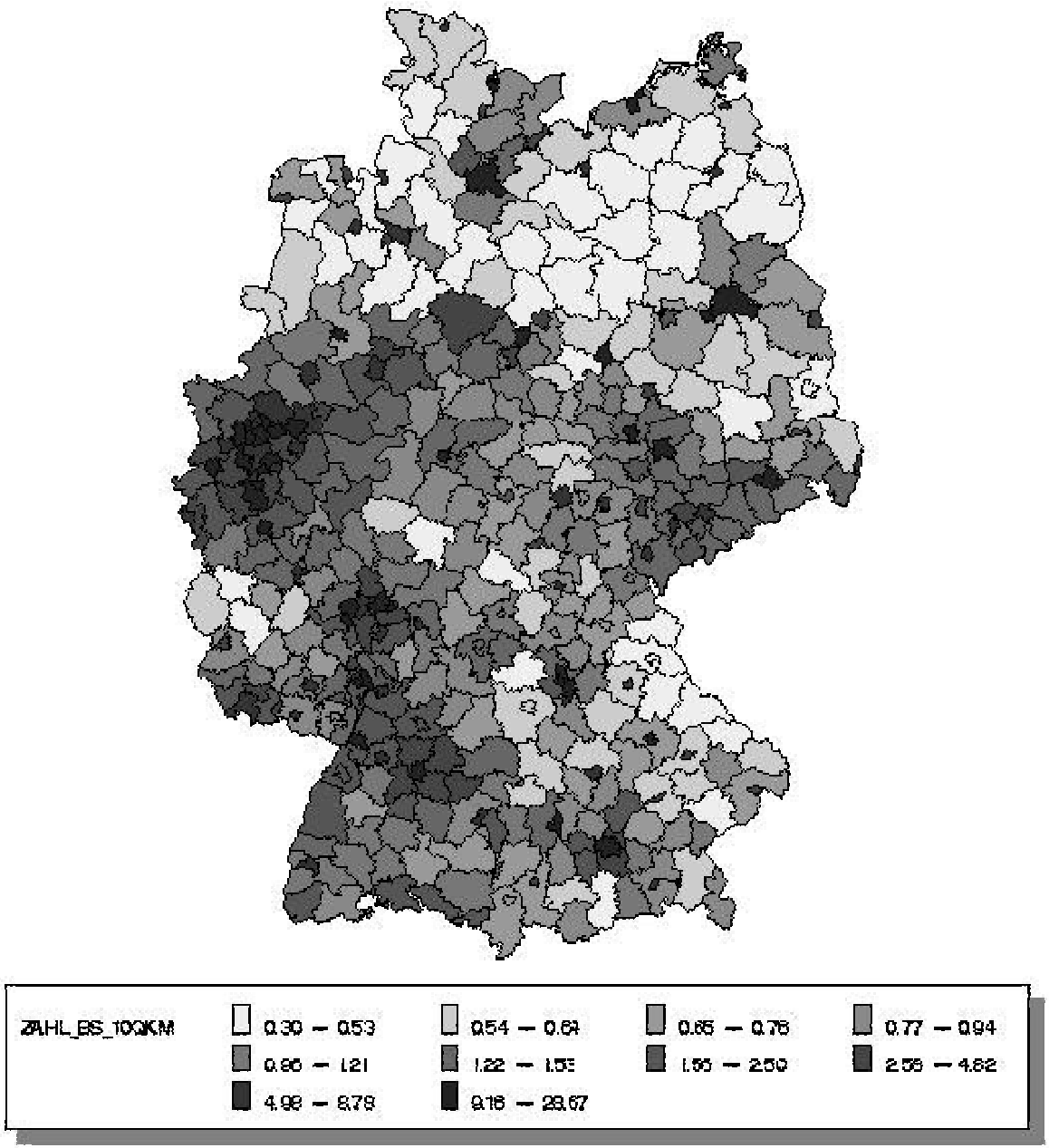
Figure 1:
Mobile phone base station locations in Germany
2004
(per 10km²)



Distance to mobile phone base stations

- 48.7% (14,503 / 29,805 households) within 500m distance
- This percentage rises after weighting for city categories to 53.5%.

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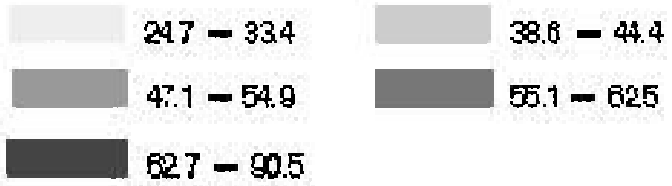
Figure 2:
Proportion of persons with at least one mobile phone base station in the surrounding of 500m of their household (n= 29,805)



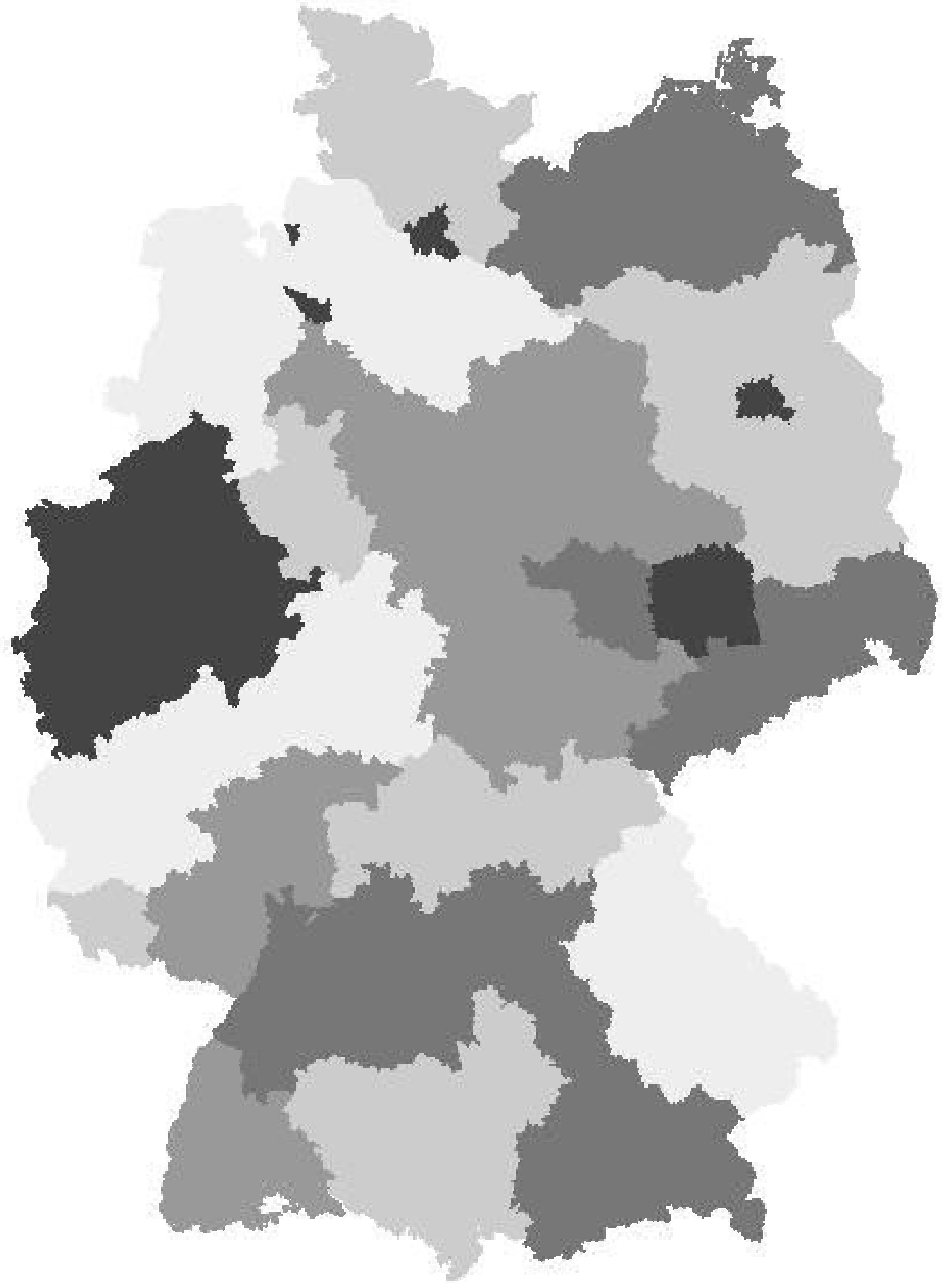


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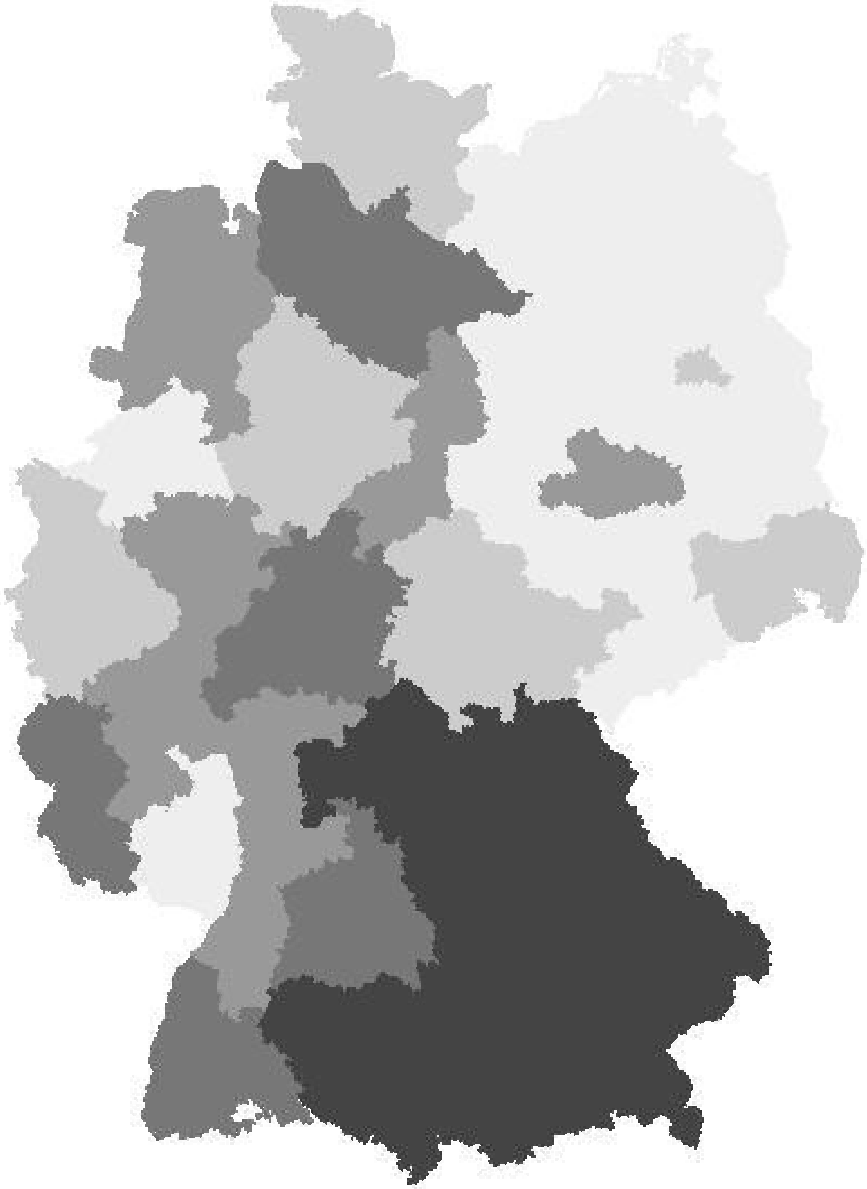
Figure 3:
Proportion of persons who mentioned to be concerned or impaired by RF-EMF of mobile phone base stations (n= 29,805)



PHASE 2
In depth Study

Consolidation survey
Complementary survey

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In depth study - aim

Is there an association between:

- RF-EMF of mobile phone base stations (MPBS) and relevant health disturbances?
- Concern about MPBS and relevant health disturbances?
- Is there an interaction between both?

In depth study study design

Selection of the study regions:

Predominantly urban regions were selected

→Higher density of mobile phone base stations

→Higher RF-EMF exposure (estimated by ECOLOG model)

→Logistic causes

Consolidation survey

Mailed questionnaire in eight city regions

Selection of persons who wanted to take part in measurement procedure

Complementary survey

Computer assisted interview and dosimetric measurement on the bed

Dosimeter

Fieldwork - in depth Study:

Health Outcomes Surveys

Measurement Surveys

In depth study

Consolidation and Complementary Surveys

Objective

The surveys aimed to investigate possible associations between electro-magnetic fields (EMF) of mobile phone base stations and health disturbances

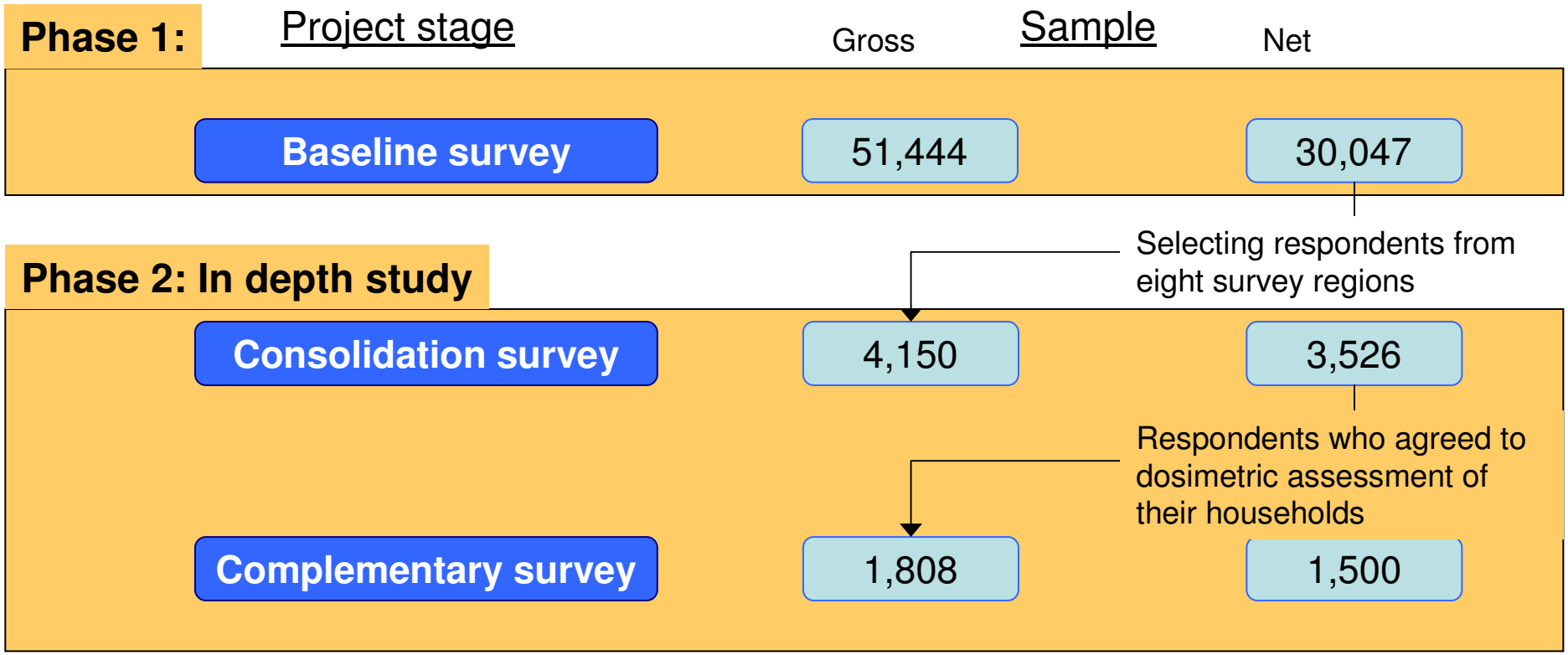
Health Outcomes (Consolidation) survey

- Written survey about potential EMF-associated health disturbances
- Fieldwork was narrowed down to include selected regions only

Measurement (Complementary) survey

- Dosimetric assessment of exposure levels in participating households

Structure


Phase 1:
Project stage
Gross
Sample
Net
Baseline survey
51,444
30,047
Selecting respondents from eight survey regions
Phase 2: In depth study
Consolidation survey
4,150
3,526
Respondents who agreed to dosimetric assessment of their households
Complementary survey
1,808
1,500

Consolidation survey

For the consolidation survey respondents from the base survey were selected from the following regions:

- Hamburg
- Hanover
- Berlin
- Ruhr West
- Cologne/Bonn
- Dresden
- Stuttgart
- Munich

Consolidation survey

Questionnaire outline

- Questions concerning the general state of health
- Physical and mental Health (SF-36)
- Pittsburgh Quality of sleep Index
- BL v. Zerssen (General Symptoms)
- Headache Impact Questionnaire
- Information on and evaluation of mobile communications / mobile phone base stations/towers and electro-magnetic fields
- Willingness to take part in the follow-up survey

Consolidation survey

- Gross sample: 4,150 received a written invitation to participate
- Field period: 1 February through 1 March, 2006
- Response after cleaning: n=3,526 equivalent to sample exhaustion of 85%
- Well over half of the 3,526 respondents agreed to dosimetric assessments of their homes
- Thus, in total 1,817 addresses were available for the complementary survey

Complementary survey

Contents of the report form

- To document location of the bedroom
- To record direction of the bedroom window (compass) and window type
- To document visibility of, and obstruction of view by, the base station tower from the bedroom
- To measure EMF, record reading time, to save data
- To document special incidents occurring during the measurement

Short questionnaire

- Questions relating to headaches on the day of the measurement and sleep disturbances during the previous night

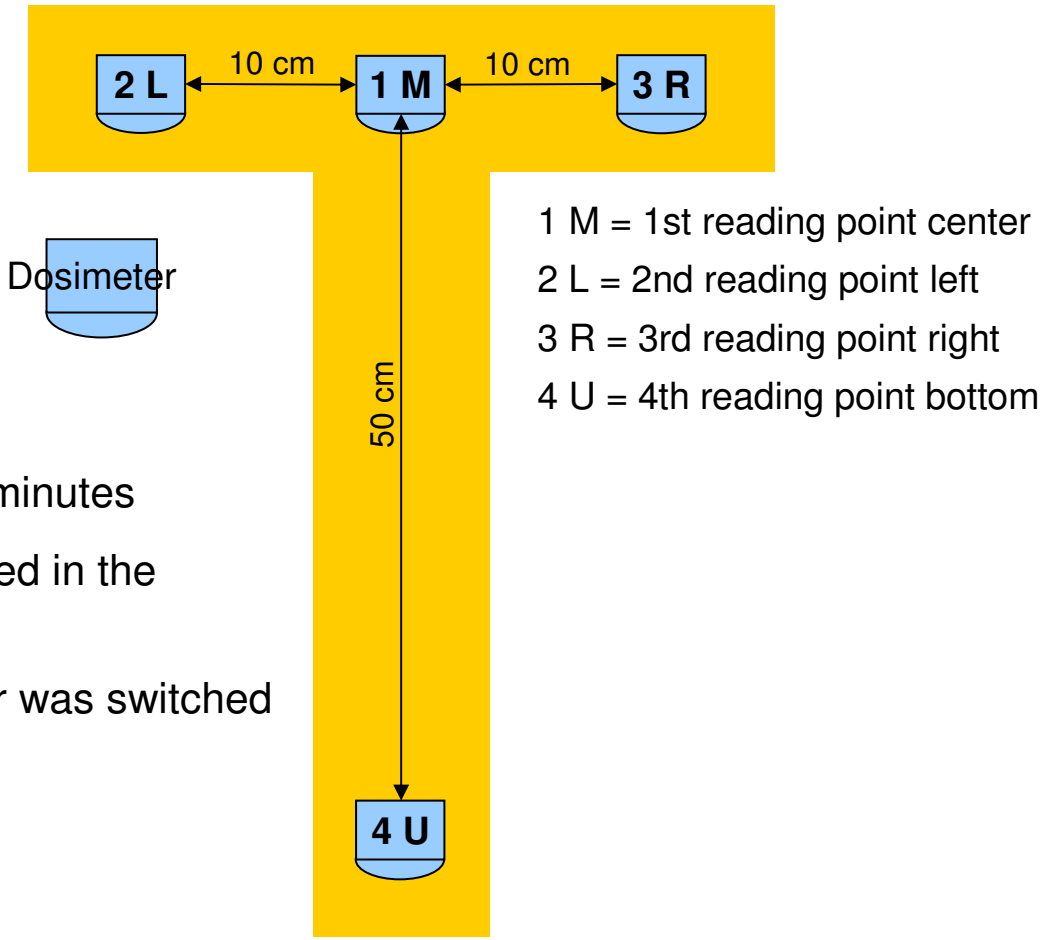
Complementary survey

Dosimeter

- **For EMF measurement 20 dosimeters from Antennessa were used**
- **The dosimeter software was linked to the CAPI program**
- **The IMST checked the correct performance of the meters**
- **The University of Bielefeld continually monitored the recorded data**

Complementary survey

Measurement template



EMF dosimetry

- Reading time per reading point - 5 minutes
- When possible, no one was permitted in the bedroom during the reading time
- The mobile phone of the interviewer was switched off
- Bedroom windows were closed

Complementary survey

- Addresses available from the consolidation survey: 1,817
- Drop-outs up to the beginning of the complementary survey: 9
- Addresses available for the complementary survey: 1,808
- Field period: 23 March through 23 August, 2006
- Sample neutral drop-outs: 18
- Interviews completed: n=1,500 equivalent to sample exhaustion of 84%

Quality assessment of dosimetric measurements

Dr. Christian Bornkessel,
IMST GmbH Kamp-Lintfort

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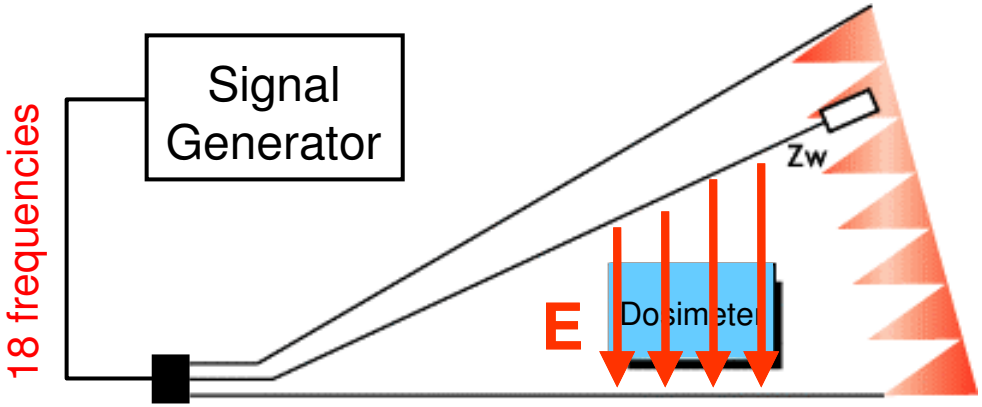
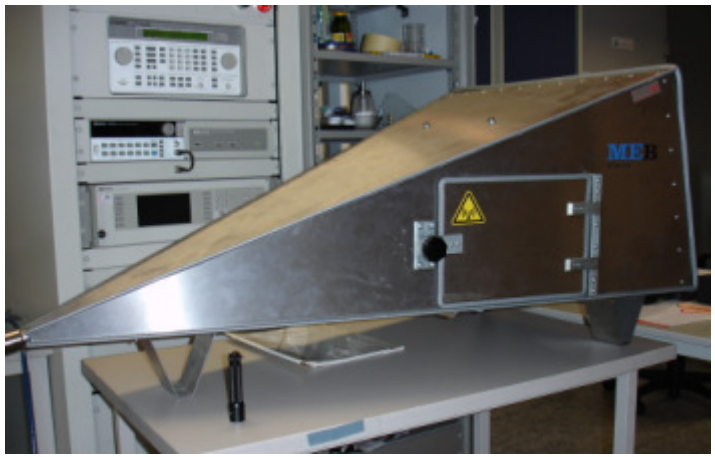
Task description

- Quality assurance during field work
- Dosimeter tests before, during and after field work
- Development of a test concept
- Detection of electrical, mechanical and software failures

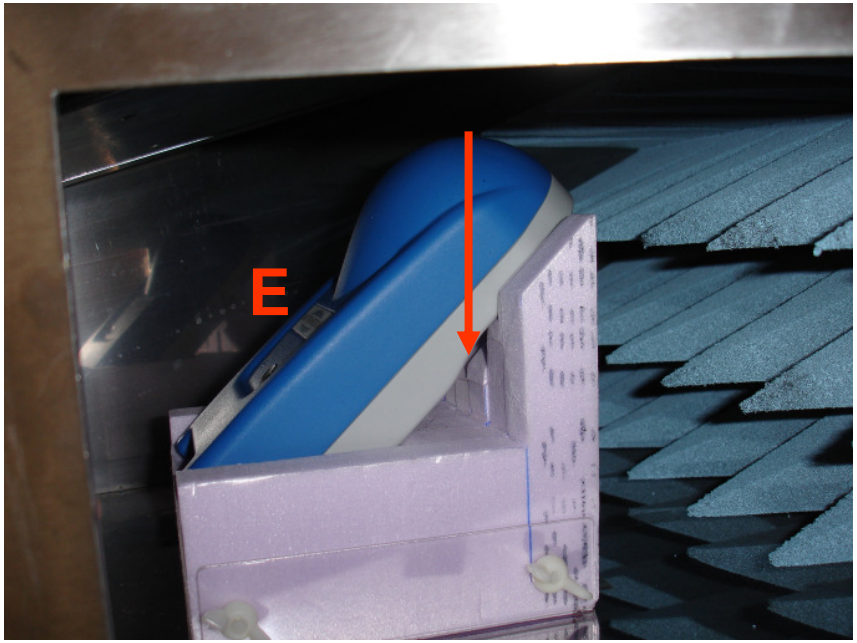
Test equipment: GTEM cell

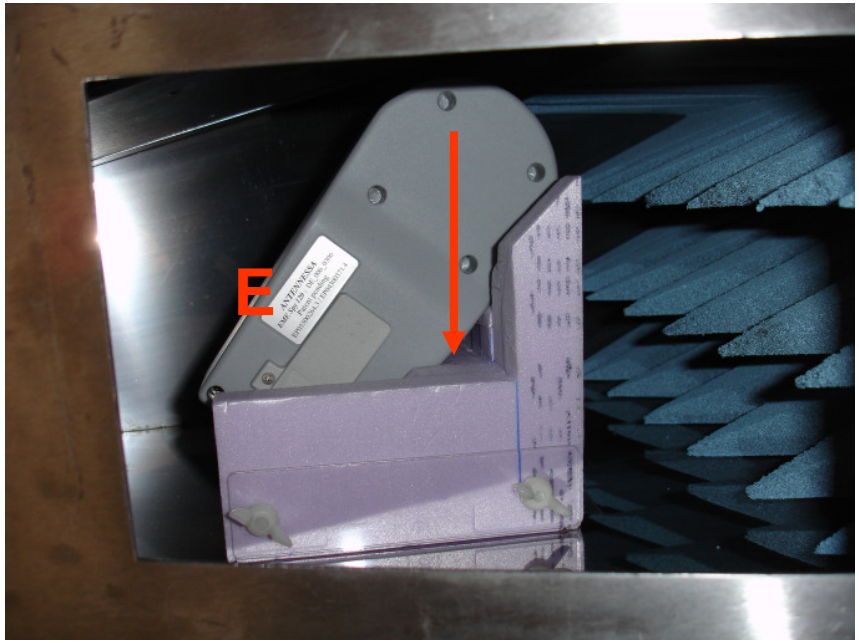




- Defined and reproducible field conditions
- Shielding to ambient signals
- Moderate field strengths with small input power

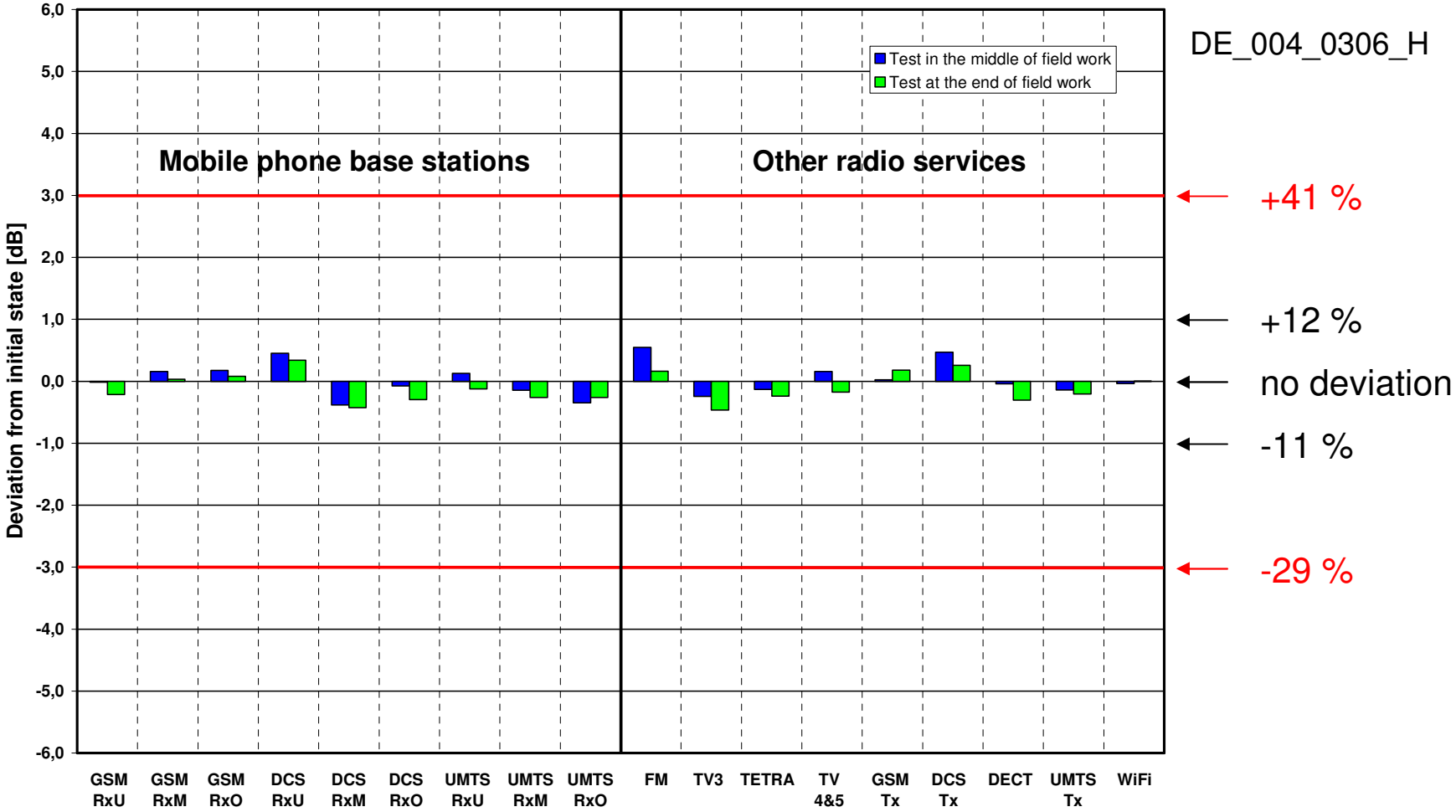
Dosimeter fixture



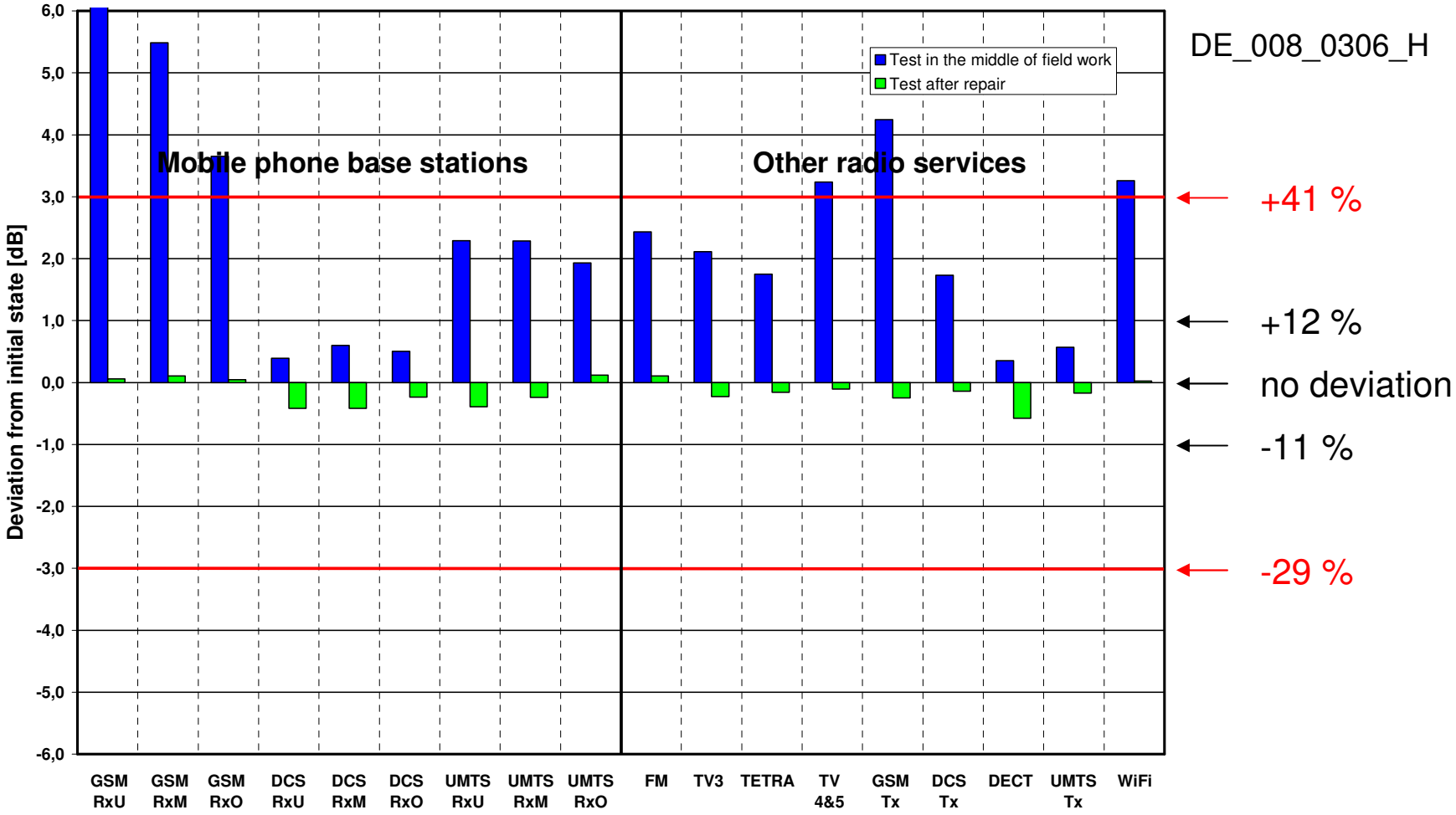


- By testing of 2 sloping positions all 3 antenna axes of the dosimeter are taken into account
- Reproducibility of positioning ~0.2 dB (downlink)

Results: "Typical" device



Results: Faulty device



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Conclusion

- 19 out of 20 dosimeters have made stable and reproducible measurements during the field work
- Tests resulted in maximal deviations of ~1 dB
- At base station downlink frequencies the deviations were mostly below 0.5 dB (±6 %)
- One device was detected as faulty and has been repaired by Antennessa
- With the help of these quality tests, the confidence in the field work measurement results has been strengthened

Data management and analyses strategy

Data handling

- Dosimetric data
  - Measured values of 12 frequencies
  - Date, time, temperature, voltage

- Data of the computer assisted personal interview (CAPI)
  - documentation
  - short questionnaire

Controls

- Date and time
- Temperature during measurement (>10°C)
- Voltage of the battery (>3.500 mV)
- All measurements done
  (in total for one person: 4x75 – 12 frequency bands)
- Any value per person
- Maximum: 5 V/m
- Maximum: 3 V/m

Data cleaning

- In total: 1,500 persons
  - 83 persons excluded due to the defect dosimeter
  - 28 persons excluded due to disagreements in the data collection
- In total: 1,390 persons

Statistical method I

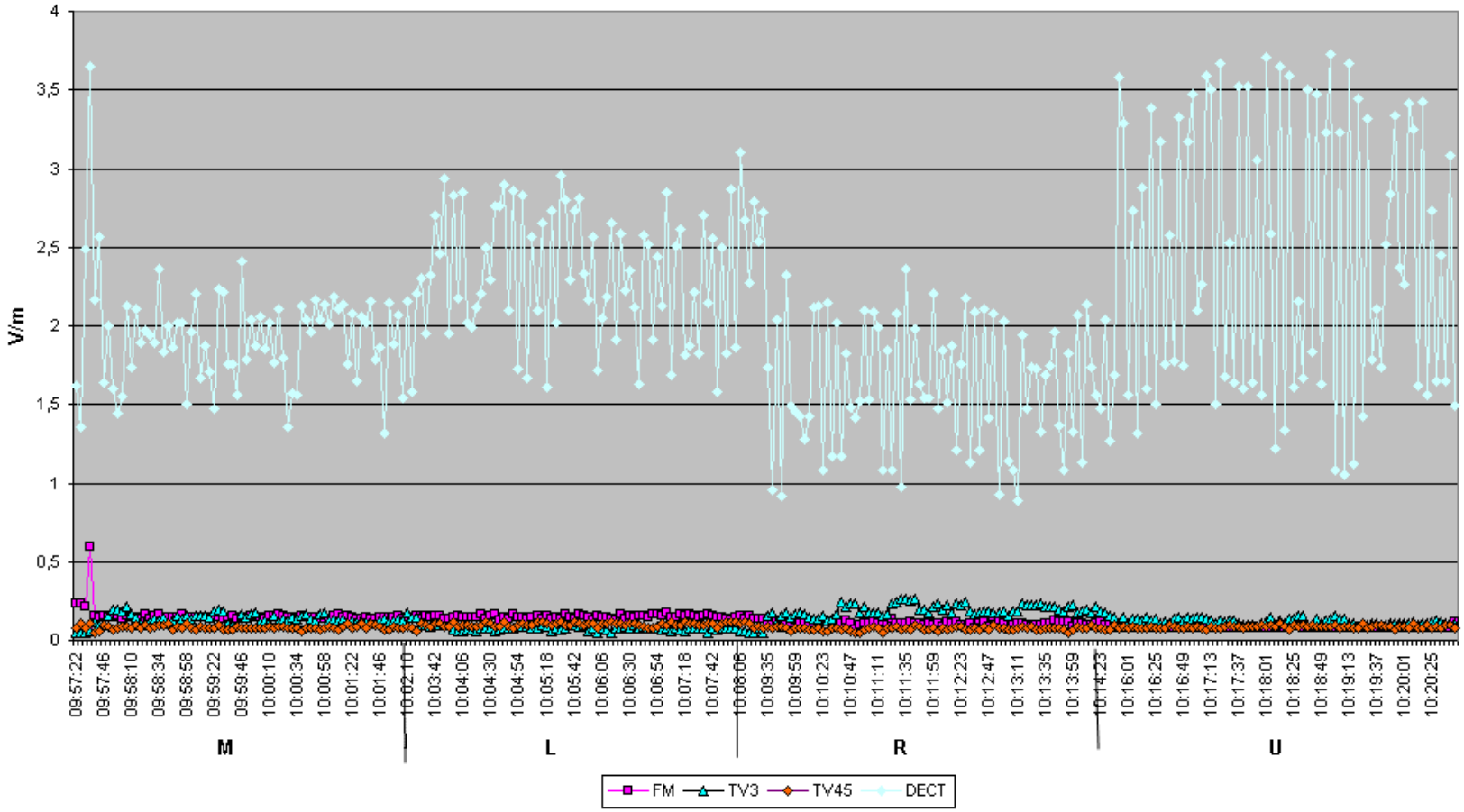
- Outcome variables (score)
  - Headache HIT-6
  - Sleep quality index PSQI
  - List of complaints (v. Zerssen)
  - SF-36 physical and mental health
- Exposure variables
  - Exposure of RF-EMF10% highest percentile of 20 min measurement, 900 downlink, 1800 downlink, and UMTS downlink
  - Mentioned cognition by the participants in three categories
    - subjectively disturbed
    - concerned, but not subjectively disturbed
    - neither subjectively disturbed nor concerned

Statistical method II

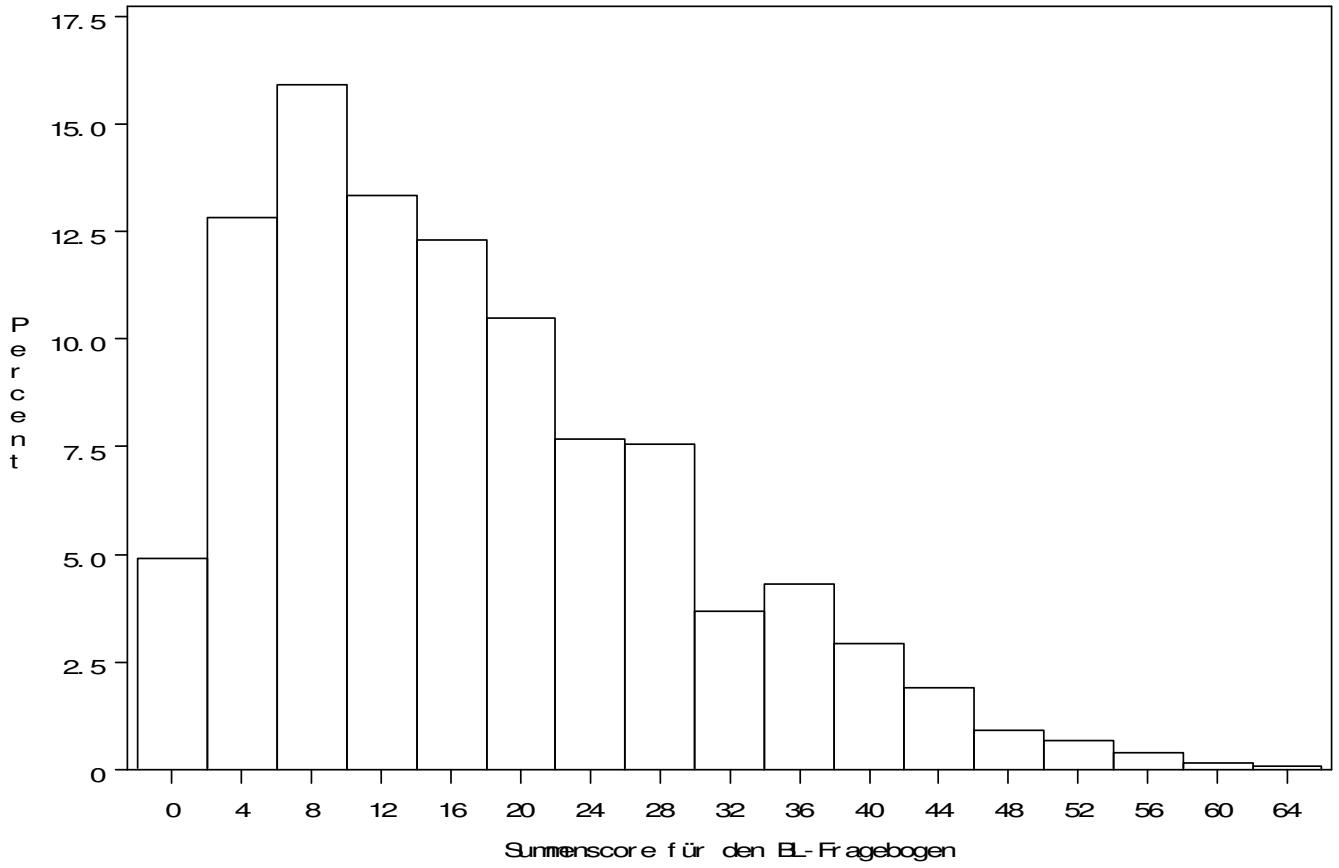
Multiple linear regression model:

- Confounders
  - Sex
  - Age
  - Rural or urban area
  - Education
  - Mobile phone use
  - Stress-Score (TICS)
  - HADS-A-Score
  - HADS-D-Score
- Interaction between objective exposure and mentioned cognition

Measurement example



Distribution of the score of Zerssen´s complaint list



(N = 1326)

Summary
&
Preview

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Summary

- Phase 1 (Baseline study):
  - 53.5% of households have mobile phone base stations within 500m distance
  - Mobile phone base stations are mainly located in urban areas
  - Health complaints varied between North- and South-Germany
  - Health complaints are explainable by subjective and not objective distance to mobile phone base stations
- Phase 2 (in depth study):
  - Results will be available soon

Preview

- Possible selection bias must be considered in further analysis
  - Up to now there is no evidence for possible bias
- Estimation of exposure
- Multiple linear regression
  - How much variance is explained by our exposure variables?
  - What are the variables explaining most of the variance?

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- Thank you very much for your attention!

Complaint list (BL) normative sample and study population

	German normative sample (1975)	Study population
Number of cases	1761	1326
Mean	14.3	16.8
Standard deviation	10.8	12.0
25. Percentile	5.5	8.0
Median	11.5	14.5
75. Percentile	20.5	24.0
Minimum / maximum	0 / 59	0 / 65

Complaint list (BL) BGS* (1998) and study pop.

	Mean	Standard deviation
BGS (1998) Western Germany	17.1	11.1
BGS (1998) Eastern Germany	15.6	10.5
Study population	16.8	12.0

*BGS: German national health interview and examination survey

Distribution of the score of the Headache Impact Test

Range of scores	Effects on daily life	Study population N (%)
< 50	None or very little	892 (67.3)
50 to 55	Only little	222 (16.7)
56 to 59	Strong influence	86 (6.5)
60 and more	Very strong influence	126 (9.5)

Pittsburgh Sleep Quality Index (PSQI) in the study population

Range of scores	Quality of sleep	Study population N (%)
<= 5	Good sleepers	829 (62.5)
> 5	Bad sleepers	497 (37.5)

(N = 1326)

Representative cross sectional study of Austrian population aged 15 years and older (n=1049).
Percentage of bad sleepers: 32.1 % (Zeitlhofer et al. 2000)

Coherence between subjective and objective closeness to MBS and afraid cognition

		Not afraid	afraid/ affected	OR§	95% CI
Common		21.929	7.876		
Subjective closeness	Yes	3.348	1.680	**1,52**	**1,42-1,62**
	No*	18.581	6.196	1	Reference
Objective closeness	Yes$	10.693	3.810	1,00	0,94-1,06
	No	11.236	4.066	1	Reference

* no included: not exposed and no data available
$ Objective closeness coded as: MBS within a radius of 500 m around the address
§ Logistic Regression to adjust for education, federal state, city size, age, gender and household size

DATA BASE - PHASE 1: baseline study