



Final Report

Project reference: 45
Applicant's name: Martin Rösli
Project title: Systematic review on radiofrequency electromagnetic field exposure in the everyday environment

1. State of Research.

1.1 Research activities performed, milestones and deliverables accomplished

- Systematic literature search in ISI Web of Science for relevant literature published between 1 January, 2000 and 30 April, 2015.
- Extraction of relevant data from eligible papers
- Descriptive analysis of the data
- Writing scientific paper
- To calculate the average RF-EMF dose absorbed by the body using a previously developed dosimetric model (Roser et al., 2015).

1.2 Findings

From 481 potentially relevant papers, 21 papers met the eligibility criteria and were considered in this review. These 21 papers consisted of spot measurement studies (n=10), personal measurement studies with trained researchers (referred to as mobile measurements) (n=5), personal measurement studies with volunteers (personal measurements) (n=5) and a mixed approach consisting of mobile and volunteer measurements (n=1). These papers covered 11 out of 29 European countries: Austria, France, Greece, Hungary, Slovenia and the United Kingdom, Sweden (2 papers), Germany (3), Switzerland (5), The Netherlands (6) and Belgium (7).

Mean RF-EMF exposure at home was 0.22 V/m (range of all study averages: 0.10-0.37 V/m). In the spot measurement studies, cordless phones and mobile phone base stations were the most relevant exposure sources contributing 50% and 22%, respectively. In personal measurement studies, the most relevant contributors were mobile phones (32%), mobile phone base stations (24%) and cordless phones (24%). The average contribution of WLAN was relatively small (ca. 10%).

Average outdoor exposure was 0.51 V/m (0.12-1.43 V/m). The lowest levels were observed in a personal measurement study conducted in France. The highest levels were measured in a mobile survey in the city centre of Stockholm, where the measurement device was mounted on a roof of a car. At outdoor locations, an average of 66% of RF-EMF originated from mobile phone base stations.

In public transport, average RF-EMF exposure was 0.60 V/m (0.04-1.96 V/m) with the highest contribution (80%) from mobile phones.

The average 24-hours-exposure to RF-EMF far field sources was 0.25 V/m (mobile phone base stations: 0.13 V/m, other people's mobile phones: 0.18 V/m, cordless phones: 0.10 V/m, WLAN: 0.05 V/m and broadcasting: 0.05 V/m). The total average whole body dose for these far field sources and for near field sources is 217 mJ per kilogram body weight per day. Near field sources contribute 76% and far field sources 24%. The most relevant near field sources are mobile phone calls (26%), data traffic via mobile phone (20%) or via other devices (20%). Regarding far field sources, the most relevant contributions originate from other people's phones (12%) and from mobile phone base stations (6%). The total brain dose is ca. 600 mJ/kg/day with 90% originating from near field sources (72% from mobile phone calls).

This systematic review demonstrates that in many European countries, typical RF-EMF exposure levels are substantially below regulatory limits. There was no indication for distinct differences between countries or temporal trends in the exposure situation. If such differences exist, they are



smaller than the data variability that is introduced from the heterogeneous study approaches. A comparable RF-EMF monitoring approach is thus needed to accurately identify typical RF-EMF exposure levels in the everyday environment in Europe, and to evaluate spatial and temporal variability.

Although the dose calculations are subject to considerable uncertainty, this study provides useful information for risk communication and risk management. The dose calculations confirm that near field sources are most relevant for a moderate wireless device user. Thus, any strategy to minimize the RF-EMF exposure of the population needs to target the emissions of the devices operating close to the body.

1.3 Problems

None

2. Annex

2.1 Publications

Peer reviewed publications

Radiofrequency electromagnetic field exposure in everyday microenvironments in Europe: a systematic literature review. *Journal of Exposure Science and Environmental Epidemiology*, Epub ahead of print, <http://rdcu.be/uGQU>.

Others:

Sagar S., Dongus S., Schoeni A., Roser K., Eeftens M., Struchen S., Foerster M., Meier N., Adem S., Rössli M. Radiofrequency electromagnetic field exposure in everyday microenvironments in Europe: a systematic literature review [Hochfrequente elektromagnetische Feldexposition im Alltag in Europa: systematische Übersichtsarbeit]. Annual report of FSM, in press

Conference proceedings:

Sagar S., Dongus S., Eeftens M., Struchen S., Foerster M., Rössli M. Radiofrequency electromagnetic field and its exposure situation in everyday microenvironments in Europe: a systematic literature review, *BioEM* 5.-9. 6. 2017, Hangzhou, China.

2.2 Documents

Date and Signature

Basel, 9.8.2017