Personal radio frequency exposure comparison among five countries in urban areas

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Introduction

Personal electromagnetic field exposure is nowadays assessed with personal exposure meters (exposimeters). In the last few years, several countries have performed measurement studies using exposimeters and results have already been published [1]. In some of these studies, namely microenvironmental studies, measurements were performed in different microenvironments such as offices or outdoor urban areas. The other studies were population surveys where the personal exposure distribution in the population of interest was determined. The strategies for the recruitment of the study participants as well as the data analysis methods differed between these studies, and therefore, a direct comparison of their results is difficult.

The objective of this paper is to offer for the first time a comparison of mean radio frequency electromagnetic field (RF-EMF) exposure levels and contribution of different sources in urban environments among five European countries by applying the same data analysis methods. The countries which are considered in this paper are Belgium, Switzerland, Slovenia, Hungary, and the Netherlands. In each of these countries large measurement studies using exposimeters were performed.

Materials and Methods

We defined a limited number of typical microenvironments for the general public in order to enable a comparison between the different countries. These microenvironments are denoted with a short name with the logic: “location – environment - time”: *outdoor* - *urban* – day, indoor – *office* – day, indoor - *train* – day, indoor - *car/bus* – day, indoor – *urban home* – day/night. In each of the countries, measurements were performed using the selective isotropic personal exposure meter of type DSP120 and 121 EME SPY of SATIMO. The exposimeter measures 12 frequency bands. For all frequency bands, the exposimeter detects power flux densities S (shortly noted as power density) between 0.0067 and 66.3 mW/m^2. The measurements were performed in the period 2007-2009. In the studies of Belgium and the Netherlands, measurements were made by hired staff whereas the studies of Switzerland, Slovenia, and Hungary were based on volunteers from a population sample. Details of these studies can be found in [2]. Data on mean exposure levels in the specific microenvironments were collected and the pooled data were analyzed in order to enable a comparison.

In all countries, all measurements taken in each microenvironment were combined and analysed in the same way. Since a large proportion of the measurements was censored, we applied the robust regression on order statistics (ROS) method proposed by [3] to determine the mean values of the power density S (mW/m^2) for each microenvironment.

Results

Figure 1 shows S_{tot} (mW/m^2) for mean exposures for all microenvironments and all countries. Exposure in all countries is of the same order of magnitude. All mean values are well below the ICNIRP exposure guidelines, which are the basis for exposure limits in the considered countries. Also, the more restrictive limits for Belgium (4 times lower than the ICNIRP guidelines and additionally 3 V/m at 900 MHz) and for specific situations in Slovenia and Switzerland (10 times lower than the ICNIRP guidelines at places of sensitive use (homes, offices)) are not exceeded.

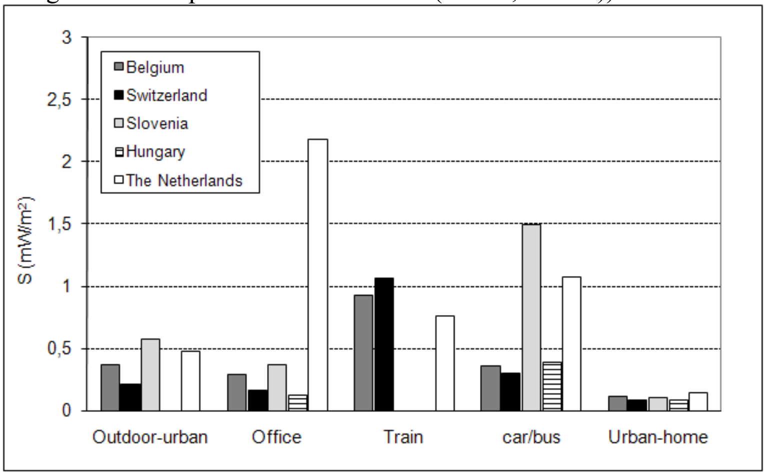

Figure 1: Mean total exposures (mW/m^2) for all considered microenvironments in all countries.

Fig. 1 demonstrates that highest exposure occurs in transportation vehicles (train and car/bus) for all countries except for the Netherlands, where the highest exposure levels were measured in offices. In all countries except for the Netherlands, the same pattern can be observed: highest exposures were measured in transportation vehicles (train, car/bus), followed by outdoor urban exposure, offices, and urban homes. Exposure is lowest in urban homes in all countries.

In all microenvironments, exposure to mobile telecommunication (downlink and uplink) is important and in most cases dominating. In Hungary, Slovenia, and the Netherlands mobile telecommunication exposure is the highest in all environments. Mainly mobile phone handset exposure is relevant for all countries: in the Netherlands, uplink exposure due to mobile phone calls even dominates in all environments except outdoor-urban. For outdoor-urban environments downlink exposure due to mobile phone base stations is important for all countries and dominating for Belgium and the Netherlands. Exposure in transportation vehicles (train and car/bus) is mainly due to radiation from mobile phone handsets (uplink, with percentages of 92.5 – 96.6 % for trains and 62.5 – 94.4 % in cars/busses. In urban homes, exposure contributions are very different among the different countries. Total exposure in homes is similar among the different countries and is somewhat higher in the Netherlands. TETRA, W-LAN, and TV/DAB are sources of minor importance in most of the microenvironments.

Summary and Conclusions

For the first time a comparison of mean personal RF-EMF exposure levels in urban environments among different European countries is presented. Exposure in all countries is of the same order of magnitude. In all environments, exposure to mobile telecommunication is important and mostly dominating. Consistently in all countries, exposure is lowest in urban homes and highest exposure contributions are obtained from mobile phone handsets, which are particularly dominant in transportation vehicles (trains). Future research should be the planning and execution of large common measurement studies among different countries. A joint study in which an equal study design is used in all the countries would enable a more detailed comparison. The different microenvironments could be defined according to the method proposed here.

References

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