

Personal exposure to high frequency electromagnetic fields in Slovenia

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INTRODUCTION

Due to the introduction of different new technologies which are emitting electromagnetic fields (EMF) typical exposure of the public is increasing. Since classic measurement methods using wideband instruments or spectrum analyzer lack time and spatial information, personal exposure meter (PEM) gives good estimation of the actual personal exposure [1-3]. Such data allow time evaluation of the contributions of different sources to the overall personal exposure. To evaluate the typical exposure of Slovenian inhabitants, a study was carried out in 2007 and 2008, in which the exposure of 54 volunteers was measured using PEM.

MATERIALS AND METHODS

To capture the typical exposure of inhabitants it is important to include population from different living environment and with different daily habits. To obtain a representative sample an open invitation was published in media inviting volunteers to participate in this study. At the beginning, the volunteers were instructed to carry the PEM on the belt, in a pouch or in backpack whereas when sleeping they were allowed to place the PEM close to them. They were also instructed to fill the diary about their activities during the measurements. Since we used Antennessa EME SPY 120 (now Satimo EME SPY 121) PEM, which has very good capability to separately measure contributions of different high frequency technologies (see Table 1), combining the data from the diaries with the results of measurements allows identification of the patterns of exposure to different technologies. The PEM separately measures radio (FM, 88–108 MHz) and TV broadcasting (TV₃, 174–223 MHz; TV_{4&5}, 470–830 MHz), private mobile network (Tetra, 380–400 MHz), mobile phones (Gsm_{tx}, 880–915 MHz; Dcs_{tx}, 1710–1785 MHz; Umts_{tx}, 1920–1980 MHz) and base stations (Gsm_{rx}, 925–960 MHz; Dcs_{rx}, 1805–1880 MHz; Umts_{rx}, 2110–2170 MHz), cordless phones (Dect, 1880–1900 MHz) and Wireless Local Area Network (Wlan, 2400–2500 MHz).

When the PEM was handed to the volunteer, it was already programmed to measure EMF for 34 hours with the sampling rate of 3 samples per minute; giving a total of more than 6000 samples.

RESULTS

54 volunteers were carrying the PEM from July 2007 to November 2008. Taking together, over 280 000 measurements were acquired. Based on the data from the diaries of volunteers measurements were classified according to the area of exposure: 34% of total was considered as exposure at home, which is situated in the urban area (Home/Urban); 28% as the exposure at home, which is situated in the rural area (Home/Rural); 14% as the exposure at work (Work); 9% as the exposure outside in the urban area (Outdoor/Urban) and 3% as the exposure outdoor in the rural area (Outdoor/Rural). 12% of the remaining duration of exposure was not classified due to the inadequate information.

Table 1: Maximum and average value of the measured electric field strength and number of measurements for each area are presented.

[V/m]	FM	TV ₃	Tetra	TV _{4&5}	Gsm _{tx}	Gsm _{rx}	Dcs _{tx}	Dcs _{rx}	Dect	Umts _{tx}	Umts _{rx}	Wlan
Home/Urban	Number of measurements: 95653; Number of measurements below lower detection limit: 43082 (45%)											
max	0.34	0.12	0.14	0.15	5.01	1.39	5.01	0.49	5.01	0.43	0.33	5.01
avg	0.05	0.05	0.05	0.05	0.06	0.09	0.05	0.05	0.06	0.05	0.05	0.05
Home/Rural	Number of measurements: 78633; Number of measurements below lower detection limit: 57363 (73%)											
max	0.53	0.42	0.05	0.09	5.01	0.76	4.46	0.19	5.01	0.19	0.12	2.93
avg	0.05	0.05	0.05	0.05	0.06	0.07	0.05	0.05	0.05	0.05	0.05	0.06
Work	Number of measurements: 38242; Number of measurements below lower detection limit: 19234 (50%)											
max	0.41	0.61	0.24	0.26	5.01	4.79	5.01	1.08	5.01	0.14	0.23	2.37
avg	0.05	0.05	0.05	0.05	0.08	0.13	0.06	0.06	0.06	0.05	0.05	0.05
Outdoor/Urban	Number of measurements: 24605; Number of measurements below lower detection limit: 7041 (29%)											
max	0.63	0.19	0.79	0.30	5.01	3.90	5.01	1.08	0.53	0.05	0.25	1.58
avg	0.05	0.05	0.05	0.05	0.07	0.16	0.06	0.07	0.05	0.05	0.05	0.05
Outdoor/Rural	Number of measurements: 8946; Number of measurements below lower detection limit: 4301 (48%)											
max	2.44	0.20	0.05	0.87	5.01	0.98	5.01	0.17	2.69	0.05	0.13	0.89
avg	0.08	0.05	0.05	0.05	0.08	0.07	0.05	0.05	0.05	0.05	0.05	0.06

Since the lower detection limit of the PEM is 0.05 V/m, all the values below the detection limit were set to 0.05 V/m. As could be seen from the Table 1 a lot of average values are equal to 0.05 V/m meaning that the average exposure due to these sources is low (FM, TV, Tetra, Gsm_{tx}, Dcs_{tx}, Umts_{tx}, Dect, Wlan). But for some of these sources (Gsm_{tx}, Dcs_{tx}, Dect) which are body worn the maximum value is reaching the upper detection limit of the PEM (5 V/m).

The ratio between the measurements with all the measured values below the lower detection limit and the total number of measurements is an informative description of the exposures. Below the lower detection limit were 45% of the measurements for Home/Urban class, 73% of the Home/Rural, 50% of the Work, 29% of the Outdoor/Urban and 48% of the Outdoor/Rural class. Overall, more than half of the time (53%) the volunteers were exposed to very low values (all the measured values below the detection limit of the PEM).

CONCLUSIONS

The results clearly show that the average personal exposure to high frequency EMF in Slovenia is quite low. Not only that more than half of measurements had all the measured values below the lower detection limit, also the highest average exposure levels are low: 0.16 V/m for the Outdoor/Urban exposure to the base stations (Gsm_{rx}). In the Rural area, the average values are even lower, the maximum values are 0.08 V/m for the Outdoor/Rural exposure due to the radio broadcasting (FM) and base stations (Gsm_{rx}). This means that the average exposure in the Rural environment is lower than in Urban environment.

The most important contributors to the maximum exposures are these technologies used close to the body: mobile phones (mainly in Gsm and Dcs frequency ranges), Dect cordless phones and Wlan devices.

REFERENCES

- [1] S. M. Mann, D. S. Addison, R. P. Blackwell, and M. Khalid. *HPA-RPD-008 - Personal Dosimetry of RF Radiation. Laboratory and Volunteer Trials of an RF Personal Exposure Meter*. HPA, Chilton, 2005.
- [2] M. Rössli, P. Frei, E. Mohler, C. Braun-Fahrlander, A. Bürgi, J. Fröhlich, G. Neubauer, G. Theis, and M. Egger. Statistical Analysis of Personal Radiofrequency Electromagnetic Field Measurements With Nondetects. *Bioelectromagnetics* 29 (): 471-478, 2008.
- [3] G. Thuróczy, F. Molnár, G. Jánossy, N. Nagy, G. Kubinyi, J. Bakos and J. Szabó. Personal RF exposimetry in urban area. *Ann. Telecommun.* 63:87-96, 2008.