OCCUPATIONAL AND ENVIRONMENTAL EXPOSURE TO EXTREMELY LOW FREQUENCY-MAGNETIC FIELDS IN A LARGE GROUP OF WORKERS

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ABSTRACT

The aim of this study was to provide: a) an evaluation of current ELF-MF exposure in workers, b) the specific contribution of occupational exposure to overall 24-hour exposure, and c) the representativeness of a Job Exposure Matrix. 543 workers were monitored for 2 whole days using personal meters. Time-Weighted Average (TWA) levels at work, at home, and outside the home (respectively work TWA, home TWA and environmental TWA) were calculated. Tasks were classified according to the ISCO 88 International Standard Classification of Occupations. In about 10% of the entire sample, the monitoring was repeated after 6-9 months. In the whole sample, the median of TWA am during work was 0.14 μT (5° - 95° percentiles: 0.04 - 2.50 μT). Median Home TWA and Environmental TWA were respectively 0.03 (5°-95° percentiles 0.01 - 0.24 μT) and 0.05 μT (5th-95th percentiles 0.02 – 0.28 μT). The correlation between TWA values during the first monitoring and the replication was r =0.80. The contribution of occupational exposure to the overall 24-hour exposure was estimated showing that, during working days, about the 60% of exposure is related to work. The variability of individual work TWA among subjects included in the same ISCO 88 task, evaluated using ANOVA, proved significant in 56% of the tasks

Key words: *ELF-MF, Occupational Exposure, Environmental Exposure, Personal Monitoring, TWA, Job Exposure Matrix*

1. INTRODUCTION

An adequate evaluation of exposure is a recognized problem in epidemiological studies on the possible adverse effects of occupational exposure to Extremely Low Frequency-Magnetic Fields (ELF-MF) [1], as misclassification of exposure can lead to misleading conclusions [2]. The aim of this study was to provide an evaluation of current ELF-MF exposure in workers, the specific contribution of occupational exposure to overall 24-hour exposure, and the representativeness of a Job Exposure Matrix based on the ISCO 88 classification [3].

2. METHODS

Five hundred and forty three workers (383 men and 160 women) were monitored. Tasks were classified according to the ISCO 88, yielding 31 ISCO 88 tasks. ELF-MF exposure was monitored for 2 whole days, including both working and non-working periods, using personal meters (EMDEX Lite). Time-Weighted Average (TWA) levels at work, at home, and outside the home were calculated, respectively work TWA, home TWA, and environmental TWA. To evaluate the repeatability of exposure data measurements, in about 10% of the whole sample, the monitoring was repeated after 6-9 months, using the same procedure. The variability of individual work TWA among subjects included in the same ISCO 88 task was evaluated using ANOVA.

3. RESULTS

For the whole sample, the median of TWAs am during work (work TWA am) was 0.14 μT, and the 5° - 95° percentiles were 0.04 - 2.50 μT, respectively; the median of TWAs gm was 0.08 μT (5°-95° percentiles 0.02 - 0.57 μT). Spearman's correlation coefficients between individual TWA am and TWA gm was $r = 0.85$ ($p < 0.001$): due to the high correlation found, in the rest of the paper, we have decided to focus discussion mainly on the results as TWA am, as this is the parameter currently applied in most epidemiological studies.

The correlation between individual work TWA am measured during the first monitoring and in replication performed in 53 workers some months later was: r =0.80 ($p < 0.001$), showing a good reliability. Similar results were obtained considering home TWA and environmental TWA.

The variability of work TWA among workers included in tasks classified according to ISCO 88 (ISCO 88 task), evaluated using ANOVA, is significant, showing differences in individual work-related exposures among workers included under the same ISCO Code, in more than half of the tasks considered (56%) (Table 1).

Median Home TWA (0.03 μT) was less than 20% of work TWA; the 5°-95° percentiles were 0.01 - 0.24 μT, respectively. The Environmental TWA was similar from a practical point of view: the median value was 0.05 μT and 5th-95th percentiles 0.02 – 0.28 μT. Finally, the contribution of occupational exposure to the overall 24-hour exposure was estimated (Table 2). Accordingly, for each subject, the ratio between work TWA am and the 24-hour exposure was calculated; the median ratio was found to be 0.59.

Table 1. *Results of variance analysis of the individual work TWA am of workers included in 24 jobs classified according to the ISCO 88 classification of occupations. The significance of differences was evaluated using Fisher's F distribution.*

ISCO 88 Classification	F	p value
3111-chemical and physical science technicians	21.65	0.000
3115-mechanical engineering technicians	8.23	0.001
411-secretaries and keyboard-operating clerks	2.46	0.003
4131-stock clerks	24.83	0.000
4211-cashiers	3.65	0.083
521-shop salespersons and demonstrators	5.48	0.000
721-welders	11.33	0.009
723-machinery mechanics and fitters	2.45	0.004
7241-electrical mechanics and fitters	0.43	0.659
7411-meat butchers and preparers	0.97	0.436
8121-metal converting and refining furnace operators	1.18	0.397
813-ceramic and related plant operators	0.60	0.797
8211-machine-tool operators	2.66	0.001
823-plastic machine operators	1.00	0.375
8240-wood products machine operators	1.20	0.306
8251-printing machine operators	1.12	0.359
8269-other textile products machine operators	8.73	0.001
827-food and related products machine operators	4.19	0.004
8271-meat processing machine operators	11.01	0.000
8279-brewers and wine and other beverage machine operators	0.65	0.542
8281-mechanical machinery assemblers	6.26	0.001
8283-electronic equipment assemblers	0.77	0.647
8333-crane, hoist, and related material-moving equipment operators	61.67	0.000
9322-hand packers and other manufacturing labourers	0.33	0.667

Table 2. *Occupational and Non-Occupational exposure at home and outside the home in the whole group of 543 workers monitored for 2 days using personal meters. Values are presented as TWAam, expressed in μT*

	Exposure at Home	*Environmental Exposure (Outside the Home)*	*Occupational Exposure*
Median value	0.03	0.05	0.14
5° - 95° percentiles	0.01-0.24	0.02-0.28	0.04-2.5
% of Workers with TWA levels exceeding:			
0.2 uT	94%	91%	65%
0.3 uT	96.81%	95%	75%
0.4 uT	97.20%	96%	80%

4. CONCLUSIONS

Current ELF-MF work-related exposure in workers engaged in the main occupational activities in our area proved low, and relatively higher levels were only observed in a small fraction of subjects: work TWA exceeding 0.4 μT, i.e., the threshold suggested for suspected long-term effects, was found in less than 20% of the whole sample and, considering the median value, in 13% of the ISCO 88 task-related TWAs.

Individual exposure at home was lower than the occupational exposure (the median home TWA am is about 20%) and, in the vast majority of subjects (97.2 %) lower than 0.4 μT ; the median exposure during periods spent outside the home (environmental TWA) was similar. In the group as a whole, exposure during occupational activities makes the largest contribution to overall 24-hour exposure: about 60% compared to less than 40% for home and outside exposure combined.

One last conclusion transpiring from this study is related to the use of JEMs for epidemiological research. In fact, by using the ISCO 88, i.e., one of the most common classifications, the same code frequently groups together workers with significantly different individual work-related TWAs, and there are no reasons to suppose that the problem can be avoided using other currently applied classifications, as most of them were developed for reasons other than the evaluation of exposure to hazardous risk factors. This problem, which could lead to misclassifications, should be adequately considered in future epidemiological studies.

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