Swiss study on the effect of UMTS base station-like exposure on well being and cognitive function in electrosensitive and non-sensitive human subjects

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Background

Most studies on the effects of radio frequency radiation on human subjects have been investigating signals from the second generation Global System for Mobile Communication (GSM) that is widely used around the world. In contrast, its successor the Universal Mobile Telecommunications System (UMTS), the third generation of mobile networks has so far been poorly explored.

The basis for the underlying study was the Dutch „TNO" study that has been carried out by Prof. P. Zwamborn and colleagues in 2003 at the *Netherlands Organisation for Applied Scientific Research* („TNO"). The study explored both the effects of GSM and UMTS base station-like radiation on well being and cognitive function in 24 electrosensitive and 24 non-sensitive subjects. It was the first study to indicate a reduction in well being in response to UMTS exposure in both groups of subjects, but there was no indication for an effect due to GSM electromagnetic fields. No consistent effect on cognitive performance in either study group was reported. The TNO study led to widespread public concern regarding the new UMTS technology, but has also been repeatedly criticised for weaknesses regarding design, methodology and analysis. As so far it has not been published in a peer-reviewed journal, the debate is still persisting.

The present experiment was designed as a follow-up study to clarify the reliability of the TNO results and to specifically investigate the effects of UMTS electromagnetic radiation on well being and cognitive function in human subjects.

Goals

The effects of UMTS-like electromagnetic radiation on well being and cognitive function were investigated using questionnaires and computerised cognitive tasks by applying the same exposure condition as in the TNO study. However, an additional higher electric field strength[1] was used to establish a dose-response relationship and the exposure setup was

1 The electric field strength describes the strength of an electromagnetic field emitted by a base station and is measured in Volts per meter (V/m). The immission value for the general public is set at 61 V/m and at 137 V/m for occupational exposure. In Switzerland, the value is regulated more stringently in areas of high sensitivity, such as schools, residential apartments, etc. There, immissions of a single base station are not to exceed 6 V/m.

improved. Two groups of subjects were investigated, consisting of individuals with and without self-reported sensitivity to radio frequency electromagnetic fields and an organ and brain tissue specific dosimetry (calculation of the absorbed energy in biological tissue) was performed.

To assess well being, a better suited and validated questionnaire was used than in the TNO study. However, the same questionnaire was also applied as a reference questionnaire to enable a comparison between the two studies. The methodology was further improved with respect to the experimental design and statistical analyses.

The experimental conditions applied were a control condition without radiation, the same field strength of 1 V/m as in the TNO study and a higher exposure of 10 V/m to establish a potential dose-response-relationship between exposure and well being and cognitive function.

A further goal of the study was to investigate whether the potential effects on well being or cognitive function would differ between electrosensitive and non-sensitive subjects.

Study design and methods

Study subjects

The effects of UMTS base station-like exposure were investigated separately in a group of 33 electrosensitive subjects and a group of 84 non-sensitive subjects. The two groups were matched with respect to age, gender and residential area (urban vs. rural) of the study participants. All subjects had to fullfill the inclusion[2]- and exclusion criteria[3].

Experimental procedure

The experiment was performed in specially adapted rooms of the sleep laboratory at the University of Zurich. It consisted of three experimental sessions at weekly intervals corresponding to the three exposure conditions (control, UMTS 1 V/m, UMTS 10 V/m). Each subject had to absolve a training session one week ahead of the first experimental session. Sessions were always scheduled at the same time of day for each study subject.

Exposure was computer controlled and neither the subjects nor the investigators knew which condition was being applied at which session (randomised, double blind crossover design). Each exposure session lasted 45 min, during which subjects were exposed to the control condition or to an UMTS electromagnetic field of either 1 V/m or 10 V/m[4]. Before and after exposure, subjects filled in the new questionnaire on well being, and after exposure, the reference questionnaire for comparison with the TNO study and another questionnaire surveying subjective field perception. During exposure, subjects performed two series of 6

2 Aged between 20 and 60 years; right-handedness; normal body weight (BMI >19 and <30 kg/m^2), written informed consent; self-reported sensitivity to radio frequency electromagnetic fields (only for electrosensitive subjects).

3 Pacemakers; hearing aids; artificial cochleas; regular consumption of narcotics or psychoactive drugs; smoking; polymorbidity with respect to chronic diseases; pregnancy; head injuries and or neurologic/ psychiatric diseases; sleep disturbances; more than 10 units of alcohol per week; more than 450 mg caffeine per day; shift-work; Schichtarbeit; long-haul flights over more than 3 time zones within the last month prior to the experiment.

4 The UMTS signal had a carrier frequency of 2140 MHz and corresponded to a UMTS base station FDD mode (frequency division duplex) downlink configuration with no active voice calls (comparable to an early morning situation). The UMTS signal format was identical to the one used in the TNO study using the same control and synchronization channels.

cognitive tasks at the computer to examine their attention and working memory.

The behavioural data and the data on well being were analysed after the experimental phase using established statistical methods. In addition, an organ- and brain tissue specific dosimetry was performed.

Results

Well being was not affected by exposure, neither at the 1 or the 10 V/m condition. The result was the same for the newly applied as well as the reference questionnaire used for comparison with the TNO study. Irrespective of the actual condition, sensitive subjects however reported generally more health problems. Subjects in both the sensitive and non-sensitive group were not able to perceive field intensity better than expected by chance, but electrosensitive subjects indicated higher field strengths in all conditions, even though score values were not associated with actual exposure levels.

No consistent condition-induced effect of UMTS exposure on cognitive function could be observed. In total, 44 tests were analyzed, with no effect showing in 42 tests. However, at 10 V/m, a slight effect on speed in one of six tasks in sensitive subjects was found that manifested as a slight increase in reaction time in comparison with the control condition. A second effect was observed in non-sensitive subjects, also at 10 V/m, where in a different task accuracy was reduced by about one percent, also in comparison with the control condition.

The dosimetric analysis showed that at 10 V/m the peak spatial specific absorption rate for brain tissue was at least 100x below recommended safety limits (ICNIRP[5]) and therefore up to 100x below exposure levels as compared to usage of a mobile phone.

Discussion

The present findings cannot confirm the results reported in the TNO study. A number of factors may have contributed to the differences in outcome between the TNO study and the study at hand. For example, a much larger sample size was investigated (117 vs. 48 study subjects). The exposure set-up was improved to achieve a more uniform and reproducible base station-like exposure than was used in the TNO study. Furthermore, inclusion of an additional electric field strength of 10 V/m is likely to have contributed to a more reliable assessment of radio frequency exposure effects. Whereas in the TNO study well being was measured with a questionnaire not suited for short test-retest intervals, a new standardized and validated questionnaire was applied that more reliably measured changes in well being over short intervals. However, the Dutch resulsts could not be confirmed with the reference questionnaire, either.

Similarly, the findings regarding cognitive function could not be confirmed. The reported effects were marginal and may have occurred by chance. Statistically, there is a large probability that two tests out of 44 become randomly significant at the 5 percent level. To account for such random events, it is common practice to perform a correction for multiple endpoints, after which both effects disappeared.

5 International Commission on Non-Ionizing Radiation Protection, 1998

Further, no evidence was found that either sensitive or non-sensitive subjects had an ability to correctly perceive electromagnetic fields. Irrespective of exposure condition, sensitive subjects rated perceived field strengths higher than non-sensitive subjects and reported more symptoms.

It has to be noted that the current results only allow drawing conclusion about immediate effects of a short-term UMTS base station-like exposure on well being and cognitive funtion. No conclusions can be drawn regarding short term-effects of cell phone exposure or the effects of long-term, chronical base station-like exposure on human health. To gain further insights regarding the discrepancies between the present and the Dutch study and for a more conclusive evaluation other follow up studies that are underway in Denmark, the U.K. and Japan must be awaited.

Funding and Coordination

The study has been funded to 60% by governmental (FOPH, OFCOM, ComCom, FOEN, Dutch ministries) and to 40% by industrial (Swisscom Mobile AG, Orange Communications SA and TDC Switzerland AG) sponsors. The funding of the study amounted to 723'000 CHF and was organized and coordinated by the Swiss Research Foundation on Mobile Communication, which has also met a contractual agreement with the researchers including independency from the sponsors.