

## **The Microwave Syndrome: A preliminary Study in Spain**

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## ***The Microwave Syndrome: A preliminary Study in Spain***

### **ABSTRACT**

A health survey is carried out in a town of Murcia (Spain), in the vicinity of a Cellular Phone Base Station working in DCS-1800 MHz. This survey contains health items related with the “*microwave sickness*” or “*RF syndrome*”. The microwave power density was measured at home of the respondents, and a statistical analysis shows significant correlation between the declared severity of the symptoms and the measured power density. The separation of respondents in two groups with different exposure also shows an increase of the declared severity in the group with the higher exposure.

**Key words:** public health, cellular-phone, Base-Stations, microwave-sickness

### **INTRODUCTION**

The hypothesis of that radio frequency (RF) exposure might produce health damage has been analysed mainly from several epidemiological studies. Insomnia, cancer, leukaemia in children and brain tumours were the clinical entities more frequently described,<sup>1-5</sup>. Moreover, the clinical consequences of being exposed to microwave radiation such as the radar has been evaluated from military and occupational studies.<sup>6-</sup>

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A specific symptomatology was reported, linked to radar exposure at low levels of RF, was named “*microwave sickness*” or “*RF syndrome*”.<sup>9</sup> With few exceptions, functional disturbances of the central nervous system have been described as a typical kind of radiowave sickness, the neurasthenic or asthenic syndrome. The symptoms and signs include headache, fatigability, irritability, loss of appetite, sleepiness, difficulties in

concentration or memory, depression and emotional instability. This clinical syndrome is generally reversible if exposure of RF is discontinued.

Another frequently described manifestation is a set of labile functional cardiovascular changes including bradycardia, arterial hypertension or hypotension. This form of neurocirculatory asthenia is also attributed to nervous system influence. More serious but less frequent neurologic or neuropsychiatric disturbances have occasionally been described as a diencephalic syndrome.<sup>9</sup> All these disturbances following low level exposures (around microwatts/cm<sup>2</sup>) were reported for many years from Eastern Europe. The exposures have been mainly low-level and long term.<sup>9-10</sup>

Also, several articles found biological dysfunction at very low density of radiation without temperature elevation, favouring the hypothesis of the existence of “non thermal” biological effects and pointing the existence of clinical dysfunction below the actual standard of safety norms overall the European Union.<sup>11-28</sup>

Low levels of RF are found around the GSM-DCS cellular phone Base Stations (BS), where antennas are usually located on the roofs or in the top of tall towers. GSM-DCS cellular phones use pulsed microwaves, these signals have a spectral similarity with the radar signal. The spectral power distribution of pulsed signals has a leakage of low frequency harmonics. Typical pulse duration time range from 100ms to 0.050μs in radar, and 576.9μs has each slot of GSM-DCS.

From this point of view, the hypothesis of a “*microwave sickness*” in the neighbourhood of the GSM-DCS Base Stations is analysed in the presented communication. The presented analysis tries to evaluate if there is some statistical justification to complaints and related dysfunction that neighbourhood associates to the

RF exposition from the GSM-DCS Base Stations, as it has been found by previous studies<sup>29-31</sup>.

## **MATERIALS AND METHOD**

A local team of people, specially trained for this work, delivered the questionnaires in La Ñora, a town of Murcia in Spain during January 2001. This was always introduced to respondents as a part of a study to evaluate the impact on the area of the cellular phone Base Stations (GSM-DCS). In general, the people were quite prepared to co-operate (the ratio between “returned” and delivered was about 70%). The questionnaire was an adaptation to Spanish language of the Santini publication.<sup>29</sup> This was comprised of 25 different items concerning mainly health information about the respondents.

The respondents scored and marked from 0 to 3 the presence of the suffered health dysfunction: 0 never, 1 sometimes, 2 often, 3 very often.

The asked symptoms were those described in the microwave syndrome: Fatigue, irritability, headache, nausea, appetite loss, insomnia, depression, discomfort, difficulty in concentration, memory loss, skin alterations, visual dysfunction, auditory dysfunction, dizziness, gait difficulty, and cardiovascular alterations.

The asked questions included demographic data: address, sex, and age, also distance to the antennas (distance in meters to the Base Station), exposition time days/weeks, hours/days, and time from the beginning of the emissions. The questionnaire also collected information about proximity to power lines, and the use of personal computer and cellular phone.

More than a 5% of the population of La Ñora (around 1900 habitants) fulfilled the questionnaire. Questionnaires from people with a history of deep psychological or neurological disease were excluded. Finally, 101 surveys were considered valid.

The survey was completed with electric field measurement, conducted in February 24, 2001, and March, 10, 2001 (Saturday). Measurements were carried out from 11:00h to 19:00h each day, in the bedrooms of each respondent. More measurements were carried out in the streets during working days and weekends, to check the possible variability in time of the measurements. The measurement was added to the survey of each respondent.

A portable broadband (1MHz-3GHz) electric field meter (EFM) was used. The EFM was oriented with the hand in order to measure the maximum field strength above the bed. The electric field in each room presented a standing wave pattern because of reflection of the waves in the walls and metallic structures as windows and metallic piece of furniture. Therefore the EFM was hold around 1 meter from the walls, 1.2 meters above the ground, and was moved around a circle of 25 centimetres of radius, orienting the antenna to get the maximum electric field strength..

The EFM was calibrated in the anechoic chamber of the University of Valencia with a standard measurement set-up with a network analyser HP-8510C.

To check the intensity of TV and radio channels, as well as the number of working channels of the GSM-DCS Base Stations (BS), measurements of the spectral power density were carried out with a probe antenna and a portable spectrum analyser.

The TV and radio channels maintained the intensity during the measurements, however the cellular phone channels presented dramatic differences in amplitude from channel to channel, some of them going "on" and "of" the air at random times.

The probe was mounted on a linen phenolic tripod about 1.2 meters above the ground. The location of the probe was the same in both days, in a hill next to the town, 20 meters from the BS. With the spectrum analyser we scanned the GSM and DCS bands,

at the beginning of the journey, taking an average for a period of 6 minutes. The measurement of the spectrum was similar in both days, having a difference in the peak estimation (carriers of the channels) of about 1dB.

## **RESULTS**

The respondents were male (47%) and female (53%), with a wide age range: 15-25 years (22%), 26-35 years (22%), 36-45 years (19%), 46-35 years (11%), 56-65 years (13%), and more than 65 years (13%).

The exposition time, explained as the time spend in the vicinity of the BS was more than 6 hours per day, 7 days a week, in the 95% of the respondents. The place of permanence was declared the bedroom, the place were the electric field was measured, and included in the survey.

Concerning the attitude of the respondents about the use of cellular phone: 24% of them declared themselves to be active users of mobile GSM-DCS phone for more than 20 minutes per day.

The measurements were very low compared with the European safety guidelines 1999/519/EC DOCE 30/7/99. Actually the levels were lower than 0.2 microwatts/cm<sup>2</sup>, where the Spanish legislation establish a maximum limit of 450 microwatts/cm<sup>2</sup> at a single frequency (900MHz), the same than European safety guidelines 1999/519/EC DOCE 30/7/99. This is one of the characteristics of the presented work: the low levels of RF exposition.

We divide the surveys in two groups: One group with high exposure, an average exposure of 0.11 microwatts/cm<sup>2</sup>, constituted with 47 respondents. These respondents declared themselves to have living under a distance to the BS lower than 150mts. The

second group, has an average exposure of 0.01 microwatts/cm<sup>2</sup> with distance greater than 250m.

Obviously, both groups have a different distance to the BS, and we have to assume the risk of a distance perception that can influence the survey.

Table 1 shows the averaged declared severity in both groups.

A possible relationship between the declared severity of the symptom, and the microwave power density is explored. A mathematical model with logarithmic dependence with the measured electric field (EFM) is analysed. The statistical package SPSS, with their different regression methods has been used for these analysis, whose results for the correlation coefficient and statistical significance is presented in Table 2. Correlation coefficients were grouped in four sections: Astenic, diencephalic, sensorial, and cardiovascular symptoms.

## **DISCUSSION**

It is most interesting the comparison of the severity of the reported symptoms between both groups of Table 1: more severe symptoms were reported in the first group. The first group (<150 mt to BS) was exposed to a mean EMF power density 10 times higher than the second group (>250 mt to BS). Asthenic syndrome was a 42% higher in the first group, diencephalic syndrome was a 55% higher in the first group, sensorial alterations were a 25% higher in the first group and cardiovascular alterations a 55% higher as well.

However, the use of mobile phone was 30% in the first group and 17% in the second group. Use of the personal computer was a 16% in the first group, and 1% in the second group. Therefore, these differences could bias the health response. The use of the

mobile cellular phone implies a considerable higher exposition of the head to microwaves during the phone call, that could arrive roughly to  $5\text{mW}/\text{cm}^2$ , 10.000 times higher than the maximum EMF exposition attributed to the BS. Moreover, the symptomatic response could be influenced by personal or human idiosyncrasy. The exposition to radiation from the computer screen is relative to extremely low frequencies and is under  $0.3\ \mu\text{T}$ , at normal distance, therefore is not considered significant, and will be the subject of a future work.

Results from Table 2 indicate correlation between severity of the reported symptoms and the logarithm of the measured electric field (EFM) with  $p < 0.001$ . We find that discomfort (0.544), irritability (0.515), and appetite loss (0.485) are the most relevant symptoms correlated with exposure intensity. Others symptoms: fatigue (0.438), headache (0.413), difficulty in concentrating (0.469) and sleep disturbances (0.413) also show a significant correlation with exposure intensity. However, others such as auditory dysfunction, gait difficulty, and cardiovascular, do have a lower correlation coefficient, but significant  $p < 0.01$ .

However, the more interesting of our results is the significance of the dependence between both variables: The declared severity of the symptom and the logarithm of the measured electric field. Another interesting observation is that four of the high correlated symptoms (Table 2) such as headache, sleep disturbances, concentration difficulty and irritability also show the most relevant differences between both groups and the highest values in the clinical scale, 2.17, 1.94, 1.56 and 1.56 respectively (Table 1).

The validity and interpretation of the results of Tables 1-2, must be analysed in the proper context, by comparison with results from other researchers, or with results from us in previous similar surveys. Actually there are no similar studies to the presented in



this communication. However, our work shows a similitude in procedure and results with previous surveys on noise annoyance. Results for the correlation coefficients (Table 2) are similar to those obtained in previous social surveys on noise annoyance, where maximum correlation coefficient was around 0.35.<sup>32</sup>

If there is a casual relationship between severity of the symptoms and the measured electric field, maybe the logarithmic approach is still rough, and a more elaborated model would be convenient. The logarithmic model is extended in the analysis of noise annoyance; actually the devices used in noise measurements use logarithmic scales (dB<sub>A</sub>). Moreover, the used measurement was a spatial-point, time-point measurement. It is most probable an improvement in correlation for EMF averaged levels during days or weeks. However, the existence of appropriate instrumentation is a limitation.

It is worth to say that the noise is a recognised environmental pollutant, and the social surveys on noise annoyance are addressed to its subjective response. The noise is perceived by the senses nor is the electromagnetic field, therefore is more difficult the biasing in the present study, and results, probably are more objective than in the surveys on noise annoyance.

Trying to find more similarities between our results and previous work, we could claim a strong coincidence with the Lilienfeld Study,<sup>9</sup> that showed a dose-response relationships between various neurological symptoms and microwave exposition. These symptoms were grouped under the name "Microwave Syndrome" or "Radiofrequency Radiation Sickness".

The presented results demonstrate a significant correlation between several symptoms of the named microwave sickness and the microwave power density associated to the Base Station located in a hill at the edge of a town. The severity of the symptoms

weakens for people who live far away, at a distance greater than 250m from the main EMF source and a power density lower than  $0.1 \mu\text{W}/\text{cm}^2$ .

As there is a significant difference between both groups in terms of the irradiated power density, a hypothetical relationship between the DCS emission and the severity of both symptoms could exist.

There is a large and coherent body of evidence of biological mechanisms that support the conclusion of a plausible, logical and causal relationship between RF exposure and neurological disease. Hence it is probable that cell sites are causing many adverse health effects. Public health surveys of people living in the vicinity of cell site BSs should be being carried out now, and continue progressively over the next two decades. This is because prompt effects such as miscarriage, cardiac disruption, sleep disturbance and chronic fatigue could well be early indicators of the adverse health effects.

This is the first social survey about the microwave syndrome carried out in Spain, and is a preliminary study. Future surveys in another geographical locations are on the way. More research, and comparison of statistical results from different areas would be convenient.

Nowadays, the electromagnetic/microwave power density is not a recognised environmental pollutant. The reported results are obtained from one of the first social surveys on the health of the population who lives in the vicinity of a Base Station of GSM-DCS cellular phone. We could conclude the importance of the presented information to the knowledge of its possible implication on the public health.

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## **TABLE CAPTIONS**

**TABLE 1 :** Average severity of the reported symptoms in two groups having different exposure: Higher exposure with average power density  $0.11 \mu\text{W}/\text{cm}^2$  (distance<150mts), and lower exposure with average power density  $0.01 \mu\text{W}/\text{cm}^2$  (distance>250mts).

**TABLE 2:** Correlation between severity of the reported symptoms and the logarithm of the measured electric field.

**Table 1**

			P value
<b>Respondents</b>	N=54	N=47	
<b>Average Power density</b> $\mu\text{W}/\text{cm}^2$	0.11 $\pm$ 0.19	0.01 $\pm$ 0.04	<0.001
<b>Distance to BS</b>	<150 m 107 $\pm$ 57m	> 250 m 284 $\pm$ 24m	<0.001
	Average value of reported severity	Average value of reported severity	
<b>Fatigue</b>	1.11 $\pm$ 1.13	0.74 $\pm$ 1.07	n.s.
<b>Irritability</b>	1.56 $\pm$ 1.08	1.04 $\pm$ 1.02	<0.05
<b>Headache</b>	2.17 $\pm$ 0.86	1.53 $\pm$ 1.00	<0.001
<b>Nausea</b>	0.93 $\pm$ 0.99	0.53 $\pm$ 0.88	<0.05
<b>Appetite loss</b>	0.96 $\pm$ 1.03	0.55 $\pm$ 0.88	<0.05
<b>Discomfort</b>	1.41 $\pm$ 1.11	0.87 $\pm$ 0.97	<0.02
<b>Gait difficulty</b>	0.68 $\pm$ 0.93	0.94 $\pm$ 1.07	n.s.
<b>ASTENIC symptoms</b>	8.81 $\pm$ 4.79	6.21 $\pm$ 5.33	<0.02
<b>Sleep disturbance</b>	1.94 $\pm$ 0.92	1.28 $\pm$ 1.10	<0.01
<b>Depression</b>	1.30 $\pm$ 1.19	0.74 $\pm$ 1.01	<0.02
<b>Difficulty in concentration</b>	1.56 $\pm$ 1.14	1.00 $\pm$ 1.06	<0.02
<b>Memory loss</b>	1.41 $\pm$ 1.05	1.04 $\pm$ 1.08	n.s.
<b>Dizziness</b>	1.26 $\pm$ 1.14	0.74 $\pm$ 1.05	<0.05



<b>DIENCEFALIC symptoms</b>	7.46±3.90	4.81±4.34	<0.01
<b>Skin alterations</b>	0.72±0.96	0.45±0.93	n.s.
<b>Visual dysfunction</b>	1.11±1.07	0.96±1.12	n.s.
<b>Auditory dysfunction</b>	1.06±1.12	0.81±1.12	n.s.
<b>SENSORIAL symptoms</b>	2.89±2.72	2.32±2.45	n.s.
<b>Cardiovascular alterations</b>	0.76±1.10	0.49±0.93	n.s.

**Table 2**

	Correlation with Power density	P value
<b>ASTENIC symptoms</b>		
<b>Fatigue</b>	0.438	<0.001
<b>Irritability</b>	0.515	<0.001
<b>Headache</b>	0.413	<0.001
<b>Nausea</b>	0.354	<0.001
<b>Appetite loss</b>	0.485	<0.001
<b>Discomfort</b>	0.544	<0.001
<b>Gait difficulty</b>	0.127	n.s.
<b>DIENCEFALIC symptoms</b>		
<b>Sleep disturbance</b>	0.413	<0.001
<b>Depression</b>	0.400	<0.001

<b>Difficulty in concentration</b>	0.469	<0.001
<b>Memory loss</b>	0.340	<0.001
<b>Dizziness</b>	0.357	<0.001
<b>SENSORIAL symptoms</b>		
<b>Skin alterations</b>	0.358	<0.001
<b>Visual dysfunction</b>	0.347	<0.001
<b>Auditory dysfunction</b>	0.163	n.s
<b>CARDIOVASCULAR symptoms</b>		
<b>Cardiovascular alterations</b>	0.290	<0.01