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# Electromagnetic hypersensitive Finns: Symptoms, perceived sources and treatments, a questionnaire study

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## Abstract

The aim was to analyze the subjective experiences of Finns who describe themselves as suffering from electromagnetic hypersensitivity (EHS), their symptoms, self-perceived sources of the health complaints and the effectiveness of medical and complementary alternative therapies. A total of 395 questionnaires were mailed to self-diagnosed EHS persons. Of the participants 345 belonged to a Finnish self-help group and 50 came from outside of the group. The return rate of the study was 52.1% (206) and 80.9% of the respondents were women. Before the onset of EHS the most common health complaints were different types of allergies (35.1%, 68). During the acute phase of EHS the most common symptoms were nervous system related: “stress” (60.3%, 117), “sleeping disorders” (59.3%, 115) and “fatigue” (57.2%, 111). The sources that were most often reported to have triggered EHS were: “personal computers” (50.8%, 94) and “mobile phones” (47.0%, 87). The same devices were also claimed to cause the most symptoms during the acute phase. After the acute phase of EHS had passed, the respondents still claimed to react to these same digital and wireless devices while their reactions to basic electrical appliances were reduced. According to 76% of 157 respondents the reduction or avoidance of electromagnetic fields (EMF) helped in their full or partial recovery. The best treatments for EHS were given as: “dietary change” (69.4%), “nutritional supplements” (67.8%) and “increased physical exercise” (61.6%). The official treatment recommendations of psychotherapy (2.6%) and medication (−4.2%) were not significantly helpful. According to the present results the official treatment protocols should take better account the EHS person’s own experiences. The avoidance of electromagnetic radiation and fields effectively removed or lessened the symptoms in EHS persons.

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**Keywords:** Electromagnetic hypersensitivity (EHS); Electromagnetic fields (EMF); Questionnaire study; Symptoms; Diet; Antioxidants; Supplements; Psychotherapy; Complementary alternative (CAM) therapies

## 1. Introduction

According to World Health Organization (WHO) electromagnetic hypersensitivity (EHS) manifests as a variety of non-specific symptoms and differs between individuals. WHO does not consider EHS as a medical diagnosis and the collection of symptoms is not associated with any known syndrome. The most common symptoms associated with EHS are dermatological, neurasthenic and vegetative symptoms. For long-lasting symptoms WHO recommends therapy for persons suffering from EHS and also notes that physicians should not be overly concerned about the reduction of electromagnetic fields (EMF) based on the individual’s requests

[1]. In Finland the officially recommended treatment for EHS is psychotherapy [2].

Previous studies have typically focused on population based surveys and the prevalence of EHS has been estimated at 1.5% in Sweden [3], 5% in Switzerland [4], 3.2% in California [5], 3.5% in Austria [6] and 4% in the UK [7]. In Taiwan the prevalence of EHS in the general population has been estimated at a surprisingly high percentage, 13.3% [8]. It has been suggested in the research literature that different ethnicities may have variable EHS risk [5].

For this study the prevalence of EHS in the general population was not addressed nor was the study group compared to the general population. This study did not seek to prove a causal relationship between EHS symptoms and electromagnetic field exposure (EMF).

Our study aim was to analyze the subjective reported experiences of Finnish people who describe themselves as

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suffering from EHS as there have been no previous studies about EHS symptoms and treatments in Finland. Similar studies have already been made in Switzerland (2004) [9] and Japan (2012) [10]. The questionnaire was designed to find answers to three main questions about the participants and their EHS related symptoms: the types of symptoms, the self-perceived sources for their symptoms, and the scope and effectiveness of different kinds of medical care and complementary alternative medicine (CAM) therapies.

## 2. Subjects and methods

The questionnaire was designed to survey EHS related health complaints, the environments and electrical equipments the subjects associated with their symptoms and the efficacy of medical or alternative remedies in subjects who had sought to get help in their symptoms.

In March 2011 a pilot questionnaire was arranged and mailed to 50 participants in order to test the questionnaire material for unforeseen omissions or problems in the phrasing of questions. Out of the 50 participants 23 returned their questionnaire i.e. the return rate was 46%. The returned material was helpful and minor adjustments were made to the questions.

The adopted questionnaire was mailed to the participants between July 2011 and January 2012. Initially the participants were selected from the membership registry of a self-help group, but later approximately 50 additional people claiming to suffer from EHS, but not directly involved with the self-help group who had heard of the study by word of mouth and asked to participate in the study. The questionnaire forms were sent to all who requested it. In total 395 forms were mailed and the return rate was 52.1% as 206 returned questionnaires. In this group 12 forms were disqualified from the study due to either being inadequately filled or the respondent did to not suffer from EHS themselves.

Out of the 194 valid responses 80.9% (157) were from women and 19.1% (37) were from men. The average age of the respondents was 55.4 years (27–98). The percentages of age-groups were (20–29) 1.1%, (30–39) 13.4%, (40–49) 19.9%, (50–59) 22.0%, (60–69) 29.0%, (70–79) 13.4% and 1.1% in age group (80–99) (Fig. 1).

In previous studies EHS symptoms have been typically related to skin conditions of the face and chest and various neurovegetative symptoms [11,12]. In the present study a list of 68 varied health complaints were reported. In addition to the typical EHS symptoms the list also included many generic health symptoms, which are generally not associated with EHS. The symptoms were grouped into 10 different categories. Symptoms of the nervous system, dermatological symptoms, symptoms generally located around the head as eye and ear symptoms, symptoms of the mouth, heart and lung symptoms, symptoms of the airways, muscle and joint symptoms and other problems.

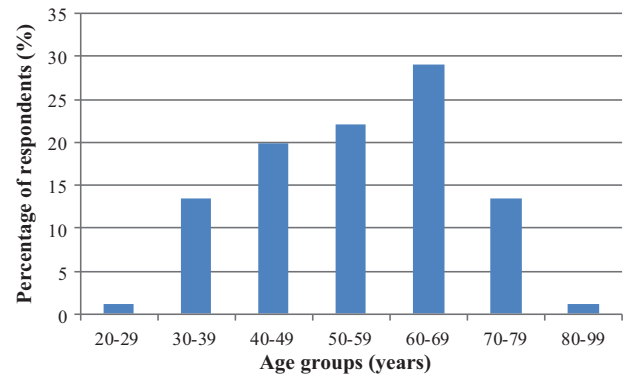


Fig. 1. Age distribution of respondents ( $n=186$ ).

The participants were requested to answer to which phase of EHS the symptoms were related. The questions were given as multiple choices for each symptom. The possible answers were 'none', 'before the onset of EHS', 'during the acute phase of EHS' and 'currently persisting'. The frequency and severity of the symptoms was not assessed further in the questionnaire. The concept of the acute phase of EHS exists in some member questionnaires of self-help groups [13] but is seldom found in peer-reviewed literature. In practice we have interviewed many people who have described to having experienced an 'acute phase' in their EHS syndrome. In this study we wanted to use this definition in order to analyze symptoms and reactions to different sources EMFs at different stages of EHS.

The questionnaire included two questions about the electrical devices and sources associated with the EHS symptoms. An open question asked which devices or sources they first associated with the onset of health complaints. It was followed by a multiple selection question with a list of 50 typical electrical home appliances (vacuum cleaners, electrical heating elements, refrigerators), electronic devices (personal computers, flatscreen TVs, compact fluorescent lights) wireless devices (mobile phones, wireless internet routers, mobile phone base station towers) and other types of commonplace electromagnetic emission sources. The answer options were about the perceived sources for symptoms during the different phases of the progression of EHS: none, before the emergence of EHS, during the acute phase of EHS or still persisting.

The perceived efficacy of medical and complementary alternative treatments in regards to EHS was evaluated by a multiple choice question. The medical treatments included: psychotherapy, medications, removal of dental amalgam fillings, dietary changes, vitamin B12 and other supplements, increased physical exercise. The CAM treatments included: natural dietary supplements, solarium, acupuncture, chiropractic/naprapathy/osteopathy, traditional bone setting therapy, physiotherapy, homeopathy, reflexology, shiatsu. Participants were given the answering choices 'Helped considerably', 'Helped somewhat', 'No effect' and 'Worsened the situation'. These were respectively given weighing

coefficients of 1, 0.5, 0 and  $-1$  for the purpose of calculating a weighed effect percentage for each treatment. Each of the weighed percentages was calculated from the sum of the answer options multiplied by the respective weighing coefficients and dividing it by the number of people who have tried the specific treatment.

The weighed effect percentage was calculated from the 4 answer options for each treatment after assigning a different weighing multiplier for each option. The number of treated for each option was multiplied with the weighing multiplier and an average percentage was calculated. ‘Helped considerably’ is given a weighing factor of 1, ‘Helped somewhat’ 0.5, ‘No effect’ 0 and ‘Worsened the situation’  $-1$ .

### 3. Results

#### 3.1. Reported symptoms

The participants were asked about their subjective symptoms which they had during the different stages of their EHS syndrome progression. A total of 68 different symptoms were listed. The average number of symptoms per person before the onset of full EHS symptoms was 10.5. In the acute phase the average number of reported symptoms was increased up to 26.8.

The 10 most common symptoms (typically associated with EHS syndrome and) experienced by the participants before the onset of EHS are shown in Table 1. The most typical symptoms which were reported to have existed before the onset of EHS were different types of allergies i.e. in 35.1% (68) of the subjects. Unlike the most reported symptoms the number of allergies only rose to 37.1% (72) in the acute phase. The data show a high increase in average individual symptom incidence after the onset of EHS compared to the situation before. The pre-existing symptoms did not disappear and new symptoms appeared. For example the incidence of stress rose from 34.0% (66) to 60.3% (117) and sleeping disorders rose from 23.7% (46) to 59.3% (115).

During the acute phase of the EHS syndrome the most prevalent reported symptoms were related in nervous

system. Among the most common ones were stress (60.3%, 117), sleeping disorders (59.3%, 115), fatigue (57.2%, 111), concentration problems (56.7%, 110), memory problems (54.6%, 106) and anxiety (52.6%, 102). Common were also muscle and joint issues, symptoms of the head region, dermal problems and heart complaints. Table 2 lists the incidence rates of the 20 most reported symptoms after the EHS onset and also compares them to the rates before the onset of EHS. The highest increases in incidence rates were burning sensation of the skin (386%), hot sensation of the head region (368%), nausea (343%), dizziness (342%) and heavy sensation in the head (273%).

#### 3.2. Sources

Participants were asked about which electromagnetic sources they perceived to first have triggered their EHS syndrome. This was presented as an open question. Out of the 185 respondents the most common triggering sources listed were: personal computers (50.8%, 94), mobile phones (47.0%, 87), light sources (21.1%, 39), television sets (14.6%, 27) and mobile phone base stations (7.0%, 13). Many responders gave several first sources they found. The two most common sources, personal computers and mobile phones, appeared together in 50 responses.

The 10 most common reported electrical sources for EHS symptom complaints during the acute phase and the proportional rates for them during and after the acute phase are given in Table 3. The most common device complaints during the acute phase were due to GSM mobile phones (63.4%, 123), personal computer displays (61.3%, 119) and fluorescent tube lighting (54.6%, 106). The rates of change from the acute phase to after the acute phase for these complaints were  $-19.2%$  for personal computer screens,  $+4.9%$  for mobile phones and  $+6.6%$  for fluorescent lights. The complaint rates of some electronic devices had clearly increased after the acute phase. So the complaints about compact fluorescent bulbs increased by  $+17.8%$  and local wireless area network transmitters by  $+27.5%$ . In contrast to these the complaint rates due to basic electrical appliances reduced after the acute EHS phase. The rate changes were  $-27.5%$  for vacuum

Table 1

The prevalence of symptoms common before the onset of EHS and the comparative figures in the acute phase.

Symptom	Before the onset of EHS symptoms		During the acute phase of EHS symptoms	
	Proportion of respondents (%)	Number of respondents	Proportion of respondents (%)	Number of respondents
1 Allergies	35.1	68	37.1	72
2 Stress	34.0	66	60.3	117
3 Back ache	32.5	63	48.5	94
4 Abnormal fatigue	32.0	62	57.2	111
5 Muscle tension	31.4	61	55.7	108
6 Skin dryness	27.3	53	35.6	69
7 Sore joints	26.3	51	58.2	113
8 Migraine and similar headaches	25.8	50	43.8	85
9 Photosensitivity	24.7	48	54.1	105
10 Sleeping disorders	23.7	46	59.3	115

Table 2

The prevalence of health problems common during the acute phase of EHS and the comparative values before the onset of acute EHS symptoms.

Symptom	Before the onset of EHS symptoms		During the acute phase of EHS symptoms	
	Proportion of respondents (%)	Number of respondents	Proportion of respondents	Number of respondents
1 Stress	34.0	66	60.3	117
2 Sleeping disorder	23.7	46	59.3	115
3 Sore joints	26.3	51	58.2	113
4 Heavy sensation in the head	15.5	30	57.7	112
5 Muscle weakness	21.1	41	57.7	112
6 Abnormal fatigue	32.0	62	57.2	111
7 Concentration problems	21.6	42	56.7	110
8 Muscle tension	31.4	61	55.7	108
9 Burning sensation of the skin	11.3	22	55.2	107
10 Memory problems	19.1	37	54.6	106
11 Stinging sensation of the skin	16.5	32	54.6	106
12 Dizziness	12.4	24	54.6	106
13 Photo sensitivity	24.7	48	54.1	105
14 Hot sensations of the head region	11.3	22	53.1	103
15 General sensation of illness	20.1	39	53.1	103
16 Anxiety and restlessness	21.6	42	52.6	102
17 Additional heartbeats	16.5	32	52.6	102
18 Arrhythmia	18.0	35	48.5	94
19 Back aches	32.5	63	48.5	94
20 Nausea	10.8	21	47.9	93

Table 3

Perceived symptom sources during and after the acute phase of EHS.

EMF source	During the acute phase of EHS symptoms		After the acute phase of EHS symptoms	
	Proportion of respondents (%)	Number of respondents	Proportion of respondents (%)	Number of respondents
1 Mobile phones (GSM)	63.4	123	66.5	129
2 Personal computer displays	61.3	119	49.5	96
3 Fluorescent lights	54.6	106	58.2	113
4 Television set	53.6	104	40.7	79
5 Powerlines	52.6	102	46.4	90
6 Personal computer central unit	47.9	93	44.8	87
7 Laptop computer	42.3	82	50.0	97
8 Mobile phone basestation	42.3	82	41.8	81
9 Microwave oven	39.7	77	33.0	64
10 Newly made cars	39.7	77	42.3	82

cleaners, –21.3% for refrigerators, –30.2% for incandescent bulbs, –22.8% for washing machines and dishwashers, –16.9% for microwave ovens, –24.1% for television sets, –33.1% for AC powered radio receivers and –38.0% for Hi-Fi stereo sets.

### 3.3. Medical and CAM treatments

The questionnaire clarified also how the medical treatments and CAM therapies had subjectively helped people in EHS. Of the total 194 respondents 154 people had tried various treatments for their EHS symptoms. The average number of treatments tried per person was 5.4. The total amounts of different treatments tried and their weighed effectiveness are given in Table 4.

According to the subjective experiences of the respondents the best treatments were (in weighted percentages): dietary change (69.4%), nutritional supplements (67.8%), increased physical exercise (61.6%) and physical treatments

of the body. These included such therapies as shiatsu (64.3%), traditional bone setting (63.0%), chiropractic (48.1%) and reflexology (45.9%) therapies. They were well received by EHS sufferers and seemed to improve their well-being.

Out of all the working age i.e. under 65-years old respondents (145) 51.7% (75) were in the work force. Some treatments such as psychotherapy (2.6%) and medications based on established medical therapies (–4.2%) were not significantly helpful in EHS disorder related symptoms. Of the people who had tried psychotherapy for their EHS symptoms and were of working age 42.4% (19) were still in the work force.

In the questionnaire an open question presented asked about the actions they had taken and which had led to full or partial recovery. Out of the 157 responses to this question 76% (119) indicated that they had reduced or avoided EMFs. The most common ways were the avoidance of using personal computers or mobile phones and permanently moving away from city areas.

Table 4  
Weighed effects of medical and CAM therapies.

	Form of therapy	Weighed effectivity (%)	Number of responses
1	Change of diet	69.4	85
2	Nutritional supplements	67.8	115
3	Shiatsu	64.3	21
4	Traditional bone setting	63.0	27
5	Increased physical exercise	61.6	95
6	Removal of dental amalgams	55.3	94
7	Chiropractic/naprapathy/osteopathy	48.1	52
8	Reflexology therapy	45.9	61
9	B12 injections	45.5	22
10	Homeopathy	44.4	62
11	Acupuncture	40.8	60
12	Physiotherapy	27.4	42
13	Psychotherapy	2.6	38
14	Solarium treatment	0.0	4
15	Medicinal therapy	−4.2	48

#### 4. Discussion

The questionnaire was sent to people who self-assessed themselves as suffering from EHS and EMFs in their environment. In total 395 questionnaires were sent and out of those 345 were mailed to members of the Finnish EHS self-help association and 50 to people were independent of the association influence. It is important to note that in this study there were significant numbers of respondents from outside the self-help association, because it is likely that the members of such an association share considerable amounts of speculative information about symptoms, treatments and EMF sources biasing their responses. As also in several previous EHS studies the clear majority of respondents were women and this might have also affected the results [5,6,10].

The first question was to clarify what health symptoms EHS sufferers claimed to attribute to their EHS. The prevalence of typical symptoms was charted out both before and after the onset of major EHS complaints. The majority of symptoms before the acute phase were allergies (35.1%, 68), but they increased only 6% in acute phase. This result might provide some insight into the shared backgrounds of EHS sufferers.

In an earlier Swedish EHS study from the 1990s the skin symptoms were the leading health complaints and the symptoms of the nervous system were less common [12]. In the present study the nervous system symptoms dominated in the acute phase i.e. stress, sleeping disorders, fatigue, concentration problems and memory problems were among the ten most typical symptoms during the acute phase. In a similar Japanese questionnaire study in the self-help group ( $n = 75$ ) in 2012 the symptoms of the nervous system such as fatigue, difficulty in concentration, sleeping disorder, irritation and anxiety were also among the 10 most common symptoms [10]. In the Japanese study no additional information about the phases of EHS was asked in relation to the major symptoms. The EHS symptom prevalence was, however, similar in Japan and Finland.

In this study the suspected EHS onset triggers were asked in an open question. The most common triggers given were personal computers (50.8%, 94), mobile phones (47.0%, 87) and light sources (21.1%, 39). The comparable percentages for the Japanese study were lower and the clearly most common onset source reported in that study was mobile phone base stations and personal handy phones (PHS) (37.3%). Neither mobile phone base stations (7.0%) nor PHS systems (2.7%) were the major symptom onset contributors in the present study. These results cannot directly be compared because PHSs and mobile base stations have been combined under one category in the Japanese study. The apparent discrepancy in the percentage for PHS systems could at least partially be explained by the different popularities of the technologies in these two countries. PHS systems for example have never been very popular in Finland.

Common sources for complaints especially during the acute phase were wireless devices and digital electronic devices which are known to radiate purposeful EMFs or incidental electromagnetic noise. These include mobile phones (GSM) (63.4%, 123), personal computer displays (61.3%, 119) and fluorescent lights (54.6%, 106). The mobile phones (GSM) and fluorescent lights complaints remained at same levels both during the EHS acute phase and also after the acute phase had passed. In contrast to this especially the complaints about basic electrical appliances such as vacuum cleaners, plugged in radio receivers, incandescent light bulbs, refrigerators and microwave ovens become fewer after the acute phase. A majority of persons claimed that their EHS symptoms were reduced noticeably and their life-quality had improved after they had reduced to use of these appliances which were the major sources of EMF and avoided locations with high EMFs. Similar results were also reported in the Swiss study [9].

Our respondents had tried a wide variety of medical and complementary alternative therapies. The treatments

reported to work the best were dietary change, nutritional supplements and increased physical exercise. In this study 115 respondents tried nutritional supplements and 94% (108) found them very helpful or somewhat helpful. The category ‘nutritional supplements’ included a broad spectrum of supplements including antioxidants suggesting their need in tissue repairs. The efficiency of antioxidant supplements alone at treating EHS symptoms have been found ineffective in a Swedish randomized controlled trial on 16 EHS from 2001 [14]. Considering this and the subjective positive effect of nutritional supplements in our study it could be interesting to further break down the different kinds of supplements that people have taken for their EHS symptoms.

In a previous review of EHS treatments psychotherapy was found to be varyingly beneficial. In three of the four studies reviewed psychotherapy offered some help to patients describing themselves as EHS sufferers [15]. The persons in our study who tried medical treatment and psychotherapy found them generally unhelpful and often even harmful. These experiences combined with the reported commonplace negative attitudes of the medical establishment could explain the high rate of persons experimenting with CAM therapies and lifestyle changes.

## 5. Conclusion

The officially recommended psychotherapy treatment for EHS was not effective. The treatment protocols should thus take better into account the patients’ perception of their own condition. The avoidance and already a reduction of EMFs effectively alleviated experienced symptoms.

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## References

- [1] WHO Fact Sheet No. 296, Electromagnetic Fields and Public Health, Electromagnetic Hypersensitivity, 2005.
- [2] M. Hannuksela, Sähköliherkkyyks, Duodecim, 2012.
- [3] L. Hillert, N. Berglind, B.B. Arnetz, T. Bellander, Prevalence of self-reported hypersensitivity to electric or magnetic fields in a population based questionnaire survey, *Scandinavian Journal of Work Environment & Health* 28 (1) (2002) 33–41.
- [4] N. Schreier, A. Huss, M. Rössli, The prevalence of symptoms attributed electromagnetic field exposure: a cross-sectional representative survey in Switzerland, *Sozial-Und Präventivmedizin* 51 (4) (2006) 202–209.
- [5] P. Levallois, R. Neutra, G. Lee, L. Histova, Study of self reported hypersensitivity to electromagnetic fields in California, *Environmental Health Perspectives* 110 (4) (2002) 619–623.
- [6] J. Schröttner, N. Leitgeb, Sensitivity to electricity-temporal changes in Austria, *BMC Public Health* 8 (2008) 310.
- [7] S. Eltiti, D. Wallace, K. Zougkou, R. Russo, S. Joseph, P. Rasor, et al., Development and evaluation of the electromagnetic hypersensitivity questionnaire, *Bioelectromagnetics* 28 (2007) 137–151.
- [8] M-C.M. Tseng, Y.-P. Lin, T.-J. Cheng, Prevalence and psychiatric comorbidity of self-reported electromagnetic field sensitivity in Taiwan: a population-based study, *Journal of the Formosan Medical Association* 110 (2011) 634–641.
- [9] M. Rössli, M. Moser, Y. Baldinini, M. Meier, C. Braun-Fahrlander, Symptoms of ill health ascribed to electromagnetic field exposure – a questionnaire survey, *International Journal of Hygiene and Environmental Health* 207 (2004) 141–150.
- [10] Y. Kato, O. Johansson, Reported functional impairments of electrohypersensitive Japanese: a questionnaire survey, *Pathophysiology* 19 (2012) 95–100.
- [11] U. Bergqvist, E. Vogel, Possible health implications of subjective symptoms and electromagnetic fields: a report by a European group of experts for the European Commission, DG V. Solna, European Commission DG V. National Institute for Working Life, Sweden, 1997.
- [12] L. Hillert, B. Kolmodin Hedman, E. Sökerman, B.B. Arnetz, Hypersensitivity to electricity: working definition and additional characterization of the syndrome, *Journal of Psychosomatic Research* 47 (5) (1999) 429–438.
- [13] L.A. Solberg, B.G. Tilset, Eloverfølsomme i Norge – Rapport fra spørreundersøkelse 2007–2008, Oslo, 2010 (not peer-reviewed).
- [14] L. Hillert, B. Kolmodin-Hedman, P. Eneroth, B.B. Arnetz, The effect of supplementary antioxidant therapy in patients who report hypersensitivity to electricity: a randomized controlled trial, *Medicine in General Medical* 3 (2001) 11.
- [15] G.J. Rubin, J.D. Munshi, S. Wessely, A systematic review of treatments for electromagnetic hypersensitivity, *Psychotherapy and Psychosomatics* 75 (2006) 12–18.