ORIGINAL ARTICLE

The Views of Primary Care Physicians on Health Risks From Electromagnetic Fields

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SUMMARY

Background: The aim of this study was to find out what primary care physicians in Germany think about the possible health risks of electromagnetic fields (EMF) and how they deal with this topic in discussions with patients.

Methods: Questionnaires were mailed to a nationwide, representative sample drawn from the regional associations of statutory health insurance physicians in Germany, consisting of 2795 primary care physicians (7% random sample of the total number in the country). 435 of them returned four-page questionnaires (response rate, 23.3%), and 456 returned a one-page questionnaire (response rate, 49.1%). They were asked about their views on the health risks of electromagnetic fields and about their experience with patients on this topic.

Results: 61.4% of the primary care physicians reported having discussed the possible health risks of electromagnetic fields with at least one patient. In 73.4% of these discussions, the patient raised the subject first and presumed that such risks do, in fact, exist. Among all discussions in which the patient expressed this concern, the physician considered the association to be plausible only 24.1% of the time. In half of all consultations in which EMF was discussed as a possible danger, the physician recommended some type of protective measure. The most frequent recommendation was to remove electrical equipment; the second most frequent, to move to another location. The physicians' answers to the questionnaires revealed a poor knowledge of the properties and risks of electromagnetic fields.

Conclusion: Primary care physicians often discuss the putative health risks of electromagnetic fields with their patients, yet their recommendations very often are not evidence-based and might have major consequences in their patients' lives.

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The possible danger to health from electromagnetic fields (EMF) has been a repeated topic of public discussion since the introduction of cellular phone networks. The health risks still cannot be judged conclusively, but most reviews of the studies conducted to date estimate them as "slight" at most (1–4). Nevertheless, the media often describe the risk as high: "Germans baffled by new studies. Cell phone radiation—is it dangerous or not?" (translated from: *Bild*, July 28, 2009). This leads to uncertainty and anxiety among the population, creating just the kind of insecurity that is associated—independently of exposure to EMF—with health risks such as sleep disorders (5). Around 27% of Germans are concerned about the possible effects of EMF from cell phone networks on their health, and 9% believe that their health is adversely affected by EMF (6).

Primary care physicians are often the first port of call for persons who attribute their symptoms to exposure to EMF (7). Medical consultations on environment-related risks to health are fraught with difficulty (8–10). Patients with nonspecific symptoms often have a preconceived opinion regarding exposure to environmental factors as a potential cause of illness and want the doctor to confirm their suspicions. This attitude of expectation goes beyond the physician's treatment mandate (11). It is difficult to talk to these prejudiced patients about other potential causes of illness. Apart from confirmation of their self-diagnoses, such patients frequently expect the doctor to eliminate the general environmental exposure after it has been pinpointed, or to identify alternative ways of improving their lives (11–14). Finally the patient demands comprehensive explanation of the risks and possible solution strategies; these, however, may lead to further insecurity (9, 15). Moreover, the consultation can be complicated by the lengthy "career" of some patients, with visits to various doctors and an array of diagnoses. No exclusive and trusting relationship with the treating physician can then be created (13).

In this study we set out to investigate how the issue of EMF impacts primary care physicians in their routine daily work, the physicians' opinions and attitudes regarding this topic, and how these affect the doctor-patient relationship.

TABLE 1

Characteristics of the primary care physicians who completed the questionnaires

Questionnaire:		Short		Long	
		n	%	n	%
Total		456		435	
Sex	Male	296	64.9	279	64.1
	Female	160	35.1	156	35.9
Age	≤ 44	66	14.6	75	17.4
	45–54	179	39.6	160	37.0
	55–64	178	39.4	156	36.1
	>64	29	6.4	41	9.5
Specialist medical training (yes)		414	90.8	396	91.0
Additional qualification in alternative medicine (yes)		200	43.9	183	42.1
Have EMF ever been mentioned during a consultation?	No	158	34.7	167	38.6
	Yes, in the past 12 months	191	42.0	191	44.1
	Yes, but not in the past 12 months	106	23.3	75	17.3
Level of trust in the WHO	Very high/high	178	39.8	177	41.3
	Moderate	138	30.8	165	38.6
	Low	132	29.4	86	20.2
	No data	8	–	7	–
Subjective knowledge about EMF	Good	213	47.4	137	32.0
	Poor	266	52.6	290	68.0
	No data	7	–	8	–

EMF, electromagnetic fields

Method

The data were acquired in the period March–May 2008. The names and addresses of practicing primary care physicians were derived from the registries of the regional associations of statutory health insurance physicians in Germany. Hereinafter the term "physicians" will be used for this group of general medical practitioners and family doctors. Nearly all such physicians are included in these registries. A 7% sample drawn from each of the 17 regional associations yielded a total of 2795 physicians' offices. A few associations supplied the samples themselves, and for the remaining regions the samples were obtained from the published registries with the aid of a random number generator. Two thirds of the physicians (n = 1863) received a four-page and one third (n = 928) a one-page questionnaire. Four of the physicians' offices in the sample no longer existed. Physicians who did not respond were sent the same questionnaire again four weeks later, and the one-page questionnaire was sent a third time.

The four-page questionnaire comprised questions on four topics:

- The physicians' perception of the risks associated with EMF
- Experience with EMF patients (doctor-patient interaction)
- State of knowledge and sources of information used
- Physicians' requirement for information on the subject of EMF and health.

Comparisons among groups were performed using the chi-square test with the limit of significance set at 0.05.

The one-page questionnaire contained the six most important questions, enquiring after:

- The physicians' medical training
- Their concerns about EMF
- Consultations in which exposure to EMF was mentioned
- Their own assessment of their knowledge regarding EMF
- The trustworthiness of selected bodies and institutions.

The goal of this short questionnaire was to achieve a higher response rate in a subgroup of physicians, in the hope of revealing any distortions that might be caused by the expected low completion rate of the long questionnaire.

Results

The long questionnaire was completed and returned by 435 of the sample of 1863 physicians (response rate:

TABLE 2

Personal concerns of physicians with and without training in alternative medicine compared with the general population*1 (%) regarding certain health risks

	INFAS 2006	Survey of physicians (long questionnaire)			
		Total	Alternative medicine		
			Without	With	p value*2
Total	2510	435.0	247.0	283.0	
Heavy smoking	42	77.0	79.4	74.3	0.22
Excessive alcohol consumption	23	72.9	76.1	68.6	0.09
Eating meat of unknown origin	53	57.2	55.8	59.7	0.52
Air pollution	56	54.7	54.7	54.6	0.99
Cell phone network transmission masts*3	26	43.7	33.6	56.3	< 0.0001
High-voltage electrical cables*3	16	43.0	37.2	50.3	0.007
Traffic noise	24	40.5	36.0	46.5	0.03
Vehicle use	28	37.7	32.4	43.2	0.02
Adverse effects of medicinal drugs	42	34.5	31.6	37.7	0.19
Use of cordless telephones*3	13	31.7	23.5	42.6	< 0.0001
Use of cell phones*3	17	31.0	23.5	41.0	0.0001
Radio and television transmitters*3	14	22.1	15.0	30.6	0.0001
Electrical equipment*3	25	20.5	14.6	27.9	0.0007

*1 Responses to: "Please state whether and to what extent you worry about the impact of various factors on your personal health." Responses indicating high and moderate concern were totaled to yield the percentages cited here;
*2 p value for comparison of primary care physicians with and without additional training in alternative medicine (chi-square test);
*3 Personal concern regarding electromagnetic fields; INFAS, German Institute for Applied Social Sciences

23.3%). Four hundred fifty-six of 928 physicians filled in the short questionnaire (response rate: 49.1%). The two groups of physicians differed very little with regard to sex distribution, age, specialist medical training, and additional training in alternative medicine. Approximately 65% of the participating physicians were male (long questionnaire: 64.1%; short questionnaire: 64.9%) *(Table 1)*. Most were between 45 and 64 years old. Ninety-one percent stated that they had completed specialist medical training. Approximately 43% of the physicians possessed an additional qualification in alternative medicine. The proportion of physicians who had had consultations in which the subject of EMF was discussed differed only slightly between the short questionnaire (65.3%) and the long questionnaire (61.4%).

Table 2 presents the physicians' personal concerns about particular risks to health. Our results from 2008 are compared with the findings from a survey of a cross-section of the general population carried out in 2006. A glance at the figures clearly reveals that for most factors a higher proportion of physicians than of members of the public were concerned about potential risks. Physicians with and without training in alternative medicine differed hardly at all in their concerns about general health risks such as smoking. However, physicians with this additional qualification showed greater concern regarding the various sources of EMF than their colleagues without it.

Table 3 shows clearly that physicians are not confident about their knowledge with regard to EMF. The questions on this subject were answered with "Don't know" by 30% to 64% of respondents. Around 50% to 60% of the physicians knew that:

- The frequency of 100 Hz is in the low-frequency range
- The emissions from a cell phone decrease as the network signal increases in strength
- The average exposure to EMF in Germany is well below the legal limits.

Forty-three percent of the physicians knew that nerves and muscle cells can be stimulated by low-frequency EMF. Fewer than 30% knew what the SAR (specific absorption rate) value is or could accurately quantify either the temperature increase during a cell phone conversation or the depth of penetration of EMF into the organism. Only 13.6% of the physicians (59/435) knew of training courses on the subject of EMF, and only 34 of them (7.8%) had ever taken part in such a course.

The *Figure* shows the course of the conversation between doctor and patient during the most recent consultation for health problems thought to arise from exposure to EMF. Of the 435 physicians who completed the long questionnaire, 253 had been consulted because of symptoms assumed to be due to EMF, 73.1% of them (n = 185) within the last 12 months. In 73.4% of cases, the suspicion of a link between EMF

TABLE 3

Physicians' knowledge about EMF (responses to: "Please state whether the following statements about EMF are true or false")

	Right answer			Wrong answer		Don't know	
Statements	**Answer**	**n**	**%**	**n**	**%**	**n**	**%**
The frequency of 100 Hz is in the low-frequency range.	True	243	58.6	35	8.4	137	33.0
The emissions from a cell phone increase with increasing network signal strength.	False	223	52.7	72	17.0	128	30.3
The average exposure to EMF in Germany is well below the legal limits.	True	205	48.1	25	5.9	196	46.0
Low-frequency EMF can stimulate nerves and muscle cells .	True	185	43.3	49	11.5	193	45.2
The specific absorption rate (SAR) is the unit of measurement for the absorption of electromagnetic energy that is converted into body heat.	True	137	32.7	12	2.9	270	64.4
Long cell phone conversations and poor reception can lead to an increase in temperature of more than 1°C in the brain.	False	126	29.6	161	37.8	139	32.6
The higher the frequency of EMF, the greater the depth of penetration into the body.	False	111	26.4	168	39.9	142	33.7

EMF, electromagnetic fields

exposure and symptoms was expressed by the patient. The great majority of physicians who raised the possibility of such a connection also considered it plausible (92.3%). In cases where the suspicion of a link was uttered by the patient, only 24.1% of physicians found the association plausible. Overall, there were 108 consultations (42.7%) in which the physician was persuaded of the plausibility of a connection between EMF and the patient's complaints: 45 in which the assumption was expressed by the patient and 63 where the doctor suspected a link.

The following health problems were most frequently cited by the patients:

- Headache (21.6%)
- Sleep disorders (21.0%)
- Weakness, dizziness (9.2%)
- Abnormal fatigue (8.8%)
- Non-specific symptoms (8.0%).

Transmission masts and cell phones were most frequently mentioned as the suspected cause.

In 45.8% (116) of the 253 consultations, protective measures or treatments were suggested. The doctors' most frequent advice was to remove electrical equipment *(Table 4)*. Twenty-four patients were recommended to move to a different apartment or different town. Other protective measures or treatments mentioned during the consultation included sleeping in a different place, general shielding measures, and modifying the use of technical devices that had been cited as sources of risk.

Discussion

More than half of all primary care physicians are consulted on matters related to EMF. In the present investigation, 65.3% of the physicians who completed the short and 61.4% of those who returned the long questionnaire stated that patients had raised the subject of EMF. Comparable studies have been conducted in Switzerland (16) and Austria (17). In both of these cross-sectional surveys of primary care physicians, most physicians reported experience of so-called EMF patients. In both cases around two-thirds of respondents stated that patients had raised the subject of EMF during consultations.

Concern regarding environmental and health risks is greater among primary care physicians than among the general population (18). This emerges from the findings of a survey of a representative cross-section of the German population carried out by the research institute INFAS (Institute for Applied Social Sciences) in 2006, in which the same questions were posed as in the present investigation (7). Identical cross-sectional surveys carried out by INFAS in the years 2004, 2005, and 2006 showed no differences in the appraisal of risk by the general population. The present survey on concern with regard to health risk factors on the part of primary care physicians was conducted in 2008. The comparability of the studies is therefore limited.

The primary care physicians were concerned about EMF, but their knowledge of the subject was not very extensive. Nevertheless, only 13.6% of all physicians who completed one of our surveys could recall training courses on EMF and health, and merely 7.8% had ever taken part in such a course. When one considers that the topic of EMF does not feature in the training program for new primary care physicians, it comes as no surprise that their degree of knowledge is low. It is problematic that the health implications of EMF have still not been conclusively evaluated to the present day, although most reviews estimate them as "slight" (1–4).

Critical consideration of recent studies on EMF and on the current state of knowledge is, however, difficult when one's own knowledge of EMF is limited.

The question of the patient's expectations of treatment is particularly relevant in visits to the doctor because of EMF. In 73.4% of consultations in which primary care physicians were confronted with the problem of the potential health effects of EMF, it was the patient that raised the subject of a link between EMF and their symptoms. The physician found this connection plausible in only 24.1% of such cases. The Swiss survey of physicians revealed a similar finding (16). The fact that patients frequently raise the possibility of a link but physicians rarely agree leads one to surmise the existence of a certain treatment expectation on the part of the patient in consultations for complaints that the patient connects with EMF. This treatment expectation may lead to the following interaction effects (10):

- **Rivalry of expertise:** Patients visit the doctor with self-acquired knowledge about EMF derived from allegedly scientifically conducted studies.
- **Ambivalence:** On the one hand the doctor understands the patient's health problems and would like to help, but on the other hand no clear, helpful, and appropriate treatment strategies are available. The doctor's professional competence is put in question (10).
- **Iatrogenic fixation:** Maintenance of a trusting relationship demands continuing empathy from the doctor despite the unrealistic expectations of the patient. Moreover, communication between doctor and patient is hampered by the lack of scientific accuracy in the quantification of a link between EMF and health risks. If the doctor truthfully states that science cannot exclude a health risk with absolute certainty, then the patient will take this as confirmation of their assumption and persist in their—from the objective viewpoint—distorted perception (10).

Protective measures or treatment were discussed in just under half the consultations for EMF. The physicians' second most frequent suggestion was that the patient should move house. This drastic recommendation is reflected in the studies carried out in Austria and Switzerland (16, 17). The doctors' precise reasons for recommending particular measures cannot be evaluated because the necessary data were not collected. Nevertheless, it is hard to understand why relocation was recommended in six consultations in which only the patient suspected a link between EMF and health risk and the physician considered such a connection implausible.

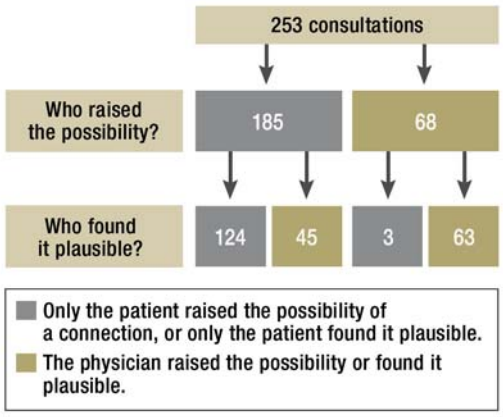
An obvious conclusion is that physicians' recommendations regarding EMF can have a considerable impact on their patients' lives—even if they suggest relocation only because they cannot dissuade them from the idea that EMF are making them ill. When one considers on one hand the costs and effort involved in moving house, and on the other hand the lack of

TABLE 4

Protective measures mentioned in the most recent consultation (n = 155 measures in 116 consultations)

Protective measure	n	%
Remove electrical devices	39	25.2
Move house, relocate to different town	24	15.5
Change position of bed, sleep in another room	19	12.3
Miscellaneous: thorough cleaning of teeth, divining rod, increased mineral intake, ECG, avoidance of stress	12	7.7
Shielding measures (cables, curtains, bed hangings, clothing)	10	6.5
Change use of cell phone	10	6.5
Turn phones off	8	5.2
Renovation	8	5.2
Maintain or increase distance, avoid	6	3.9
Psychological or clinical treatment	6	3.9
Replace cordless phone	5	3.2
Turn electrical equipment off	4	2.6
Disconnect power	3	3.9
Action groups	1	0.1
Total	155	100.0

FIGURE



Flow diagram of the 253 EMF consultations, showing whether the patient (gray) or the physician (green) raised the possibility of a connection between electromagnetic fields (EMF) and health complaints and how often the two parties considered it plausible following the consultation

certainty about the health risk of EMF, it becomes clear that the need for development and dissemination of communication and treatment strategies for such patients is immense. Many physicians have only patchy knowledge of the properties and health risks of EMF, and some suggest drastic, non-evidence-based measures although the risks are indubitably slight. Moreover, it is unclear whether and how relocation can achieve a reduction in exposure. Patients with environmentally related complaints should always be treated by a multidisciplinary team of physicians, psychologists, and environmental experts (19).

One of the limitations of this study is the low response rate for both questionnaires. Particularly the response rate of 23.3% for the long questionnaire suggests a selection process may have taken place in this cross-sectional survey. Probably the physicians who responded were primarily those who took a critical interest in EMF. The proportion of responders who believed that some people's health is adversely affected by EMF was higher for the long questionnaire (57.3%) than for the short questionnaire (37.4%) (20). Comparison of the short and long questionnaires *(Table 1)* shows, however, that this selection process had no effect on the reported frequency of consultations because of EMF. Furthermore, one should consider that analysis was restricted to those physicians who had had experience of EMF patients and were therefore perhaps more likely to take a professional interest in this subject. It can thus be assumed that the low response rate is of only slight importance for interpretation of the findings.

A further limiting factor is the use of non-validated instruments in the questionnaire, because no validated instruments were available for the topics surveyed. This must be borne in mind when interpreting the findings. The results of this study show that doctor-patient interaction on the subject of EMF may have considerable consequences for certain individual patients, particularly if they follow some of the suggestions given by their physicians. The advice provided often does not correspond to the findings of recent scientific research on EMF. Patients invest a great degree of trust in their doctors, also on the subject of EMF and health. Therefore, it is in the interests of both sides for physicians' recommendations and treatment measures to reflect the current state of knowledge. Training courses to acquaint primary care physicians with study findings on the health risks of EMF would be beneficial.

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Conflict of interest statement
The authors declare that no conflict of interest exists according to the guidelines of the International Committee of Medical Journal Editors.

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REFERENCES

1. Stewart W: Mobile phones and health. IEGMP. Ed. Clinton, Oxon: National Radiological Protection Board 2000.
2. Valberg PA, van Deventer E, Repacholi MH: Workgroup report: Base stations and wireless networks—radiofrequency exposures and health consequences. Environ Health Perspect 2007; 115: 416–24.
3. Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR): Possible effects of electromagnetic fields on human health 2007. http://ec.europa.eu/health/ph_risk/risk_en.htm
4. Croft RJ, McKenzie RJ, Inyang I, Benke GP, Anderson V, Abramson MJ: Mobile phones and brain tumours: a review of epidemiological research. Austral Phys Eng Sci Med 2008; 31: 255–67.
5. Berg-Beckhoff G, Blettner M, Kowall B, et al.: Mobile phone base stations and health disturbances: Phase II: Cross sectional study with measured radio frequency electromagnetic fields. Occup Environ Med 2009; 66: 124–30.
6. INFAS (Institut für angewandte Sozialwissenschaft): Ermittlung der Befürchtungen und Ängste der breiten Öffentlichkeit hinsichtlich möglicher Gefahren der hochfrequenten elektromagnetischen Felder des Mobilfunks – jährliche Umfragen. Abschlussbericht über die Befragung im Jahr 2006.
7. Huss A, Küchenhoff J, Birchner B, et al.: Are environmental medicine problems relevant in Switzerland? Swiss Medical Weekly 2004; 134: 500–7.
8. Potthoff P: Sozialverhalten von Arzt und Patient. In: Rosemeier HP, (ed.): Medizinische Psychologie und Soziologie. 4. überarbeitete und erweiterte Auflage. Stuttgart: Enke 1991.
9. Ruff FM: Risikokommunikation als Aufgabe für die Umweltmedizin. In: Aurand K, Hazard BP, Tretter F, (eds.): Umweltbelastungen und Ängste – Erkennen, Bewerten, Vermeiden. Opladen: Verlag für Sozialwissenschaften 1993; 327–64.
10. Gottwald B, Kupfer J: Psychologische Aspekte der Umweltmedizin. In: Brähler E, Strauß B, (eds.).: Handlungsfelder in der Psychosozialen Medizin. Göttingen, Bern, Toronto, Seattle: Hogrefe 2002: 245–65.
11. Bullinger M: Umweltmedizinische Patienten – Behandlungserwartungen und Betreuungsmöglichkeiten aus psychologischer Perspektive. In: Beyer A, Eis D, (eds.): Praktische Umweltmedizin. Berlin, Heidelberg, New York: Springer-Verlag 1999.

KEY MESSAGES

- A cross-sectional survey of primary care physicians showed that more than half of doctors have to deal with the subject of electromagnetic fields (EMF) in their professional practice.
- Although primary care physicians exhibit a high level of concern with regard to EMF, their knowledge about EMF is not very extensive.
- The doctor-patient interaction on the subject of EMF may have serious consequences for the patient. Physicians' advice regarding EMF often does not reflect the current state of knowledge.
- Treatment of patients with potentially environment-related illnesses should be put in the hands of an interdisciplinary team.
- Training courses to acquaint primary care physicians with study findings on the health risks of EMF would be beneficial.

12. Siegrist J: Medizinische Soziologie. 6. neu bearbeitetete und erweiterte Auflage. München, Jena: Urban und Fischer 2005.
13. Borgetto B, Käble K (eds.): Medizinsoziologie – Sozialer Wandel, Krankheit, Gesundheit und das Gesundheitssystem. Weinheim, München: Juventa 2007.
14. Herr C, Otterbach I, Nowak D, Hornberg C, Eikmann T, Wiesmüller GA: Clinical Environmental Medicine. Dtsch Arztebl Int 2008; 105 (30): 523–31.
15. Laugewitz W: Arzt-Patienten-Kommunikation, Mitteilen schlechter Nachrichten. In: Brähler E, Strauß B, (eds.): Handlungsfelder in der psychosozialen Medizin. Göttingen, Bern, Toronto, Seattle: Hogrefe-Verlag 2002.
16. Huss A, Röösli M: Consultations in primary care for symptoms attributed to electromagnetic fields – a survey among general practitioners. BMC Public Health 2006; 30 (6): 267.
17. Leitgeb N, Schröttner J, Böhm M: Does „electromagnetic pollution" cause illness? An inquiry among Austrian general practitioners. Wien: Medizinische Wochenzeitschrift 2005; 155 (9–10): 237–41.
18. Blettner M, Schlehofer B, Breckenkamp J, et al.: Mobile phone base stations and adverse health effects: Phase I: a population-based cross-sectional study in Germany. Occup Environ Med 2009; 66; 118–123.
19. Steiner-Rüedi E, Gilli Y, Semadeni C, German B, Aufdereggen B: Mobilfunk und Gesundheit. Schweizerische Ärztezeitung 2007; 88: 6.
20. Kowall B, Breckenkamp J, Heyer K, Berg-Beckhoff G: German wide cross sectional survey on health impacts of electromagnetic fields in the view of general practitioners. Int J Public Health 2010; 55(5): 507–12.

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