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Health complaints among nurses working near MRI scanners—A descriptive pilot study

Jonna Wilén[a,*], Frank de Vocht[b,1]

[a] Department of Radiation Sciences, Umeå University, S-901 87 Umeå, Sweden
[b] Centre for Occupational and Environmental Health, School of Community Based Medicine, Manchester Academic Health Sciences Centre, University of Manchester, Oxford Road, Manchester, M13 9PL, United Kingdom

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ABSTRACT

A questionnaire-based descriptive pilot study was conducted among all nurses routinely working with MRI in the Northern part of Sweden to provide an indication of the self-reported prevalence of health complaints related to working with MRI systems.

Fifty-nine nurses (88% response rate), with on average 8 (±6) years experience with MRI scanning procedures, returned the questionnaire. In total, 9 nurses (15%) reported regularly experiencing at least one of the health complaints (1–5% for specific health complaints) attributed to arise or be aggravated by their presence in the MRI scanning room. Stratification of the results indicated that reporting of adverse symptoms was not related to the level of occupational workload/stress. However, reporting of health complaints was related to the strength of the magnet(s) the nurses worked with, with 57% of symptoms reported by those nurses working with the strongest systems (both 1.5 and 3 T scanners in this population).

Although this descriptive study did not include a control population and was based on self-reporting of health complaints, these data indicate that the prevalence of reported health complaints is not related to perceived work load or occupational stress, but does confirm data from other occupational sectors and indicates that the prevalence of adverse health complaints increases with the strength of the MRI system for nurses as well.

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1. Introduction

Radiology nurses working with MRI (magnetic resonance imaging) (MRI Nurses) are highly exposed to static magnetic fields near the MRI scanner. Today it is most common to have clinical MRI scanners of 1.5 or 3 T, but others exist as well (up to 7 T). Personnel operating MRI scanners can, in addition to other electromagnetic fields, be exposed to high levels of static magnetic fields (SMF) surrounding the MRI scanner (magnetic stray field) and symptoms like headaches, vertigo, nausea, a metal taste, and illusions of movement are sometimes reported, especially when moving fast around the magnet bore [1,2]. There is hardly any data available in the public domain, but what is available suggests that if symptoms are reported, these are acute and generally disappear quickly after the subject left the magnetic stray field [1,2], and at least some seem to have an established threshold level [3]. However, the only available data in occupational situations has been collected among MR engineers and these suggest that the frequency of the reported symptoms are related to the strength of the MRI system, the duration of presence in the stray field, and the speed at which a subject moves in the field [2]. Data from controlled trials suggest that movement in heterogeneous stray fields from MRI systems affects the visual perception and visuo-motor neurobehavioral domains, most likely through interference with the vestibulo-ocular reflex [4,5], and that the magnitude of the effects depends on the strength of the magnetic field combined with the movement speed [2,5,6]. It has further been argued that these effects are caused by movement in the spatial stray field itself, rather than by time-varying magnetic fields only [7] or by the gradient switching process in MRI procedures [8].

In view of the discussion about the implementation of the European Union Directive on occupational EMF exposure [9,10], and discussions of specially controlled environments where higher limit values for static magnetic fields could be applied, it is of interest to get further information about possible health complaints among personnel working close to the MRI magnet bore; especially since an EU commissioned study and a UK HSE commissioned study both showed that the original proposed limits would be exceeded

* Corresponding author. Tel.: +46 0 907851712, fax: +46 0 907851588.
E-mail addresses: jonna.wilen@radfys.umu.se (J. Wilén), Frank.deVocht@manchester.ac.uk (F. de Vocht).
[1] Tel: +44 0161 275 8500; fax: +44 0161 275 5595.

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Table 1
Number of individuals with symptoms in general and of those when being inside the MRI scanning room.

Health complaint[a]	Never/seldom	Regularly	Missing values	Contributed to MRI according to any nurse	Arise or aggravated by MRI according to affected nurse[b]	Missing values
Nurses with at least 1 complaint	31	28 (47%)		13	9 (15%)	
Total number of complaints		75		45	32	
Dizziness/vertigo	54	4 (7%)	1	9	2 (3%)	1
Nausea	53	5 (8%)	1	3	1 (2%)	0
Difficulties concentrating	46	12 (20%)	1	4	3 (5%)	0
Memory loss	50	6 (10%)	3	4	1 (2%)	3
Unusual drowsiness/tiredness	48	9 (15%)	2	4	1 (2%)	2
Headaches	51	7 (12%)	1	4	0 (0%)	1
Metal taste	55	3 (5%)	1	0	0 (0%)	1
Illusion of movement[c]	50	7 (12%)	2	8	1 (2%)	2
Ringing sensation in the head	50	8 (14%)	1	6	3 (5%)	1
Sleep disorders	47	11 (19%)	1	3	2 (3%)	1

[a] Never/seldom, less than once per week; Regularly, at least once per week.
[b] Affected nurses refers to those who report that they experience the specific symptom regularly.
[c] Illusion of movement refers to unsteady feeling, sense of drunkenness, spinning sensation, to waver.

regularly by people working close to the end of the magnet bore [11,12]. This was also showed by means of personal exposure measurements specifically for MR engineers [13].

In this descriptive pilot study a questionnaire has been distributed to all nurses routinely working with MRI in the Northern part of Sweden to obtain an overview of the degree of symptoms and when these health complaints normally occur. The aim of the pilot study was to provide an indication of the prevalence of MRI related health complaints among nurses routinely working with MRI systems.

2. Materials and methods

A questionnaire to all ($N = 67$) nurses routinely working with MRI systems, but who might on occasion also be involved in X-ray imaging, in any of nine hospitals in the Northern part of Sweden, has been sent out for an in depth study of their working environment and health complaints. At each hospital a contact person handed out and later collected the questionnaire.

The questionnaire concentrated on MRI related questions such as how frequently and for how long have they been present inside the MRI scanner room on average working days in the previous year, which type of scanner(s) they work with and for how many years they have been working with MRI. Furthermore, questions included the prevalence of symptoms mentioned in the literature to originate from exposure to magnetic fields [2]; dizziness/vertigo, nausea, difficulties concentrating, memory loss, unusual drowsiness or tiredness, headaches, metal taste, illusion of movement, ringing sensation in the head, and sleep disorders; as well as an open question for any other regularly experienced effects. A distinction was *a priori* made to divide the reported frequency of health complaints into never/seldom (never or less than once a week) and regularly (at least once a week). The prevalence of symptoms was asked in general, e.g. without any connection to work within the MRI scanning room, but each individual had to indicate whether the symptoms occurred, or were intensified, when in the MRI scanning room. Additional questions were also included to assess the prevalence of motion sickness when travelling by car or boat.

A psychosocial index was created based on four commonly used questions about workload, influence on work conditions, support from colleagues, and if the work was perceived as stimulating and interesting [14]. Summed scores were *a priori* divided in low (0–2), medium (3–5), and high (6–12), where "low" implied a good psychosocial climate and the lowest psychosocial workload.

Possible associations between self-reported symptoms and work near the MRI scanner were explored, as well as possible alternative explanations for the reported symptoms such as psychosocial climate and workload and predisposition expressed as susceptibility to motion sickness.

3. Results

In total 59 (out of 67) questionnaires were returned resulting in an 88% response rate. Out of those, 10 were returned by men and 49 by women. The mean age of the population was 47 years (standard deviation (SD): ±10 years) with on average 8 (±6) years experience with MRI scanning procedures. They were involved in on average 10 (±5) MRI procedures per day (range: 1–40) which resulted in an average of 61 (±36) min in the MRI examination room (range: 2–200 min).

The prevalence of symptoms, as well as whether subjects thought these were caused or aggravated by the magnetic field from the MRI system, are shown in Table 1. All symptoms were reported to occur at least once a week by at least one nurse, although difficulties concentrating, unusual drowsiness/tiredness, ringing sensation in the head, and sleep disorders were reported by more than seven nurses. Five nurses (8%) did not report experiencing any symptoms at all. In total, 28 nurses (47%) reported regularly experiencing at least one of the health complaints in the questionnaires, but of these only 9 individuals (15%), all women, reported regularly experiencing any of the symptoms and also attributed these to arise or be aggravated by to their presence in the MRI scanning room. For specific health complaints however only 1–5% of nurses reported regularly experiencing these symptoms when working in the MRI scanning room. Most reported symptoms were stated to occur within 15 min of entering the MRI scanning room, with the exception of concentration problems which were reported to mainly occur after at least 15 min in the MRI scanning room. In general, symptoms were reported to persist for more than 30 min. The most common measures reported to avoid or reduce the symptoms were avoidance of ($N = 5$), and cutting down ($N = 5$) the time near the scanner.

Fifty-nine of 67 nurses completed the questions on psychosocial workload and their answers suggest that about 20% of nurses experience a high psychosocial workload. Stratification of reported symptoms by psychosocial workload (Table 2) does not provide any evidence for an association between occupational workload/stress and symptom reporting suggest a moderate workload.

The MRI nurses included in the study worked with 1, 1.5 and 3 T scanners and stratification of the reported symptoms by the strength of the magnet(s) the nurses worked with (Table 3) showed

Table 2
Prevalence, total number within each category (and percentage) of MRI related symptoms within each category of the psychosocial index ($N = 59$).

	No	Yes	Total
Low	12	5 (38%)	17 (29%)
Medium	28	3 (23%)	31 (53%)
High	6	5 (38%)	11 (19%)
Total	46	13 (100%)	59 (100%)

Table 3
Prevalence (and percentage) of MRI related symptoms (Yes/No) for each combination of modalities (1 T, 1.5 T and 3 T), which the responders state that they work with ($N = 56$, $N_{missing} = 3$).

Modality	No	Yes	Reported health complaints
1 T	13	2	13%
1 T and 1.5 T	11	2	15%
1.5 T	13	1	7%
1.5 T and 3 T	6	8	57%
Total	43	13	23%

that more than half of the symptoms (57%) were reported by those nurses working with both 1.5 and 3 T scanners.

Additional analyses (not shown) did not provide any evidence that car sickness or sea sickness was associated to increased reporting effects from MRI. Among those reporting regular symptoms in relation to work near the MRI scanner a significant association was found with experiencing dizziness or a sense of fainting when suddenly standing up ($P = 0.04$).

Finally, in an open question enquiring about the most important work-related causative factors for increased work load, stress ($N = 27$), described as: "to much to do", "high speed", "time pressure", "always delayed", and "'complicated MRI procedures", and "noise ($N = 21$) from MRI scanner, telephones, conversations, computers, and ventilation" were most commonly reported.

4. Discussion

This pilot study aimed at examining the prevalence of self-reported symptoms that have been linked to exposure to the magnetic fields from MRI systems in nurses in the north of Sweden routinely working with MRI systems.

The most important disadvantage of this exploratory study is that the questionnaire was not distributed among a comparable comparison group to provide the 'natural occupational background' for these symptoms in the nursing population in the north of Sweden. As such, this study does not provide data to conclude whether the prevalence of symptoms among nurses working with MRI is higher than that reported by other nurses in the same hospitals and whether magnetic fields generated by MRI systems are causing these symptoms.

Furthermore, it should be recognized that this was a cross-sectional survey which only registered the prevalence of adverse effects. Susceptible individuals might have changed jobs early in their careers and whether such a healthy worker effect exists in the MRI community should be investigated in future cohort.

However, if we compare the prevalence of regularly experienced symptoms with those reported by MR engineers in a previous study [2], these are comparable to and somewhat higher than reported in the X-ray department in the same company. It is very interesting to see that, comparable to the results among MRI engineers, most symptoms are reported in the highest exposure category (routinely working with 1.5 T and 3.0 T systems in this study). This suggests that experiencing any symptoms related to working in the vicinity of MRI systems is related to the strength of the system, which is in agreement with the existing hypothesis on the relation between MF exposure and (health) effects, and further suggests noise generated by the MRI system might only to a small extent be responsible to any symptoms.

It is furthermore important to note that reporting of symptoms does not seem to be associated with the level of psychosocial workload and stress, which implies that somatisation [15] and/or idiopathic environmental intolerance [16], which have been associated to mental stress and subjective health complaints [17,18], are most likely not alternative explanations for the observed associations.

The results of this pilot study are in line with what have been previously reported among MRI engineers, which suggest that also MRI nurses are an occupational group to consider when discussing movement-induced symptoms. To be able to discuss whether their work environment is to be regarded as a "controlled environment" suggested by ICNIRP [19] more information about the severances of the symptoms are needed and what possible measures could be taken to reduce the symptoms, without affecting other work factor such as stress.

5. Conclusions

These data indicate that about 15% of nurses routinely working with MRI regularly experience one or more adverse health complaints which are caused or aggravated by MRI. Reporting of these symptoms is not related to occupational stress but seems related to the strength of the MRI system. This study provides a basis for a larger study where more hospitals which should include a proper control group, preferably on an international basis.

Conflict of interest

None declared.

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