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A Survey on Abnormal Uterine Bleeding among Radiographers With Frequent MRI Exposure Using Intrauterine Contraceptive Devices

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Purpose: Based on a previous case report of menometrorrhagia (prolonged/excessive uterine bleeding, occurring at irregular and/or frequent intervals) in MRI workers with intrauterine devices (IUDs), it was evaluated whether this association could be confirmed.
Methods: A survey was performed among 381 female radiographers registered with their national association. Logistic regression was used to analyze associations of abnormal uterine bleeding with the frequency of working with MRI scanners, presence near the scanner/in the scanner room during image acquisition, and with scanner strength or type.
Results: A total of 68 women reported using IUDs, and 72 reported abnormal uterine bleeding. Compared with unexposed women not using IUDs, the odds ratio in women with IUDs working with MRI scanners was 2.09 (95% confidence interval 0.83–3.66). Associations were stronger if women working with MRI reported being present during image acquisition (odds ratio 3.43, 95% CI 1.26–9.34). Associations with scanner strength or type were not consistent.
Conclusions: Radiographers using IUDs who are occupationally exposed to stray fields from MRI scanners report abnormal uterine bleeding more often than their co-workers without an IUD, or nonexposed co-workers with an IUD. In particular, radiographers present inside the scanner room during image acquisition showed an increased risk. **Magn Reson Med 79:1083–1089, 2018. © 2017 International Society for Magnetic Resonance in Medicine.**

Key words: abnormal uterine bleeding; menorrhagia; metrorrhagia; intrauterine device; MRI exposure

INTRODUCTION

Abnormal uterine bleeding (AUB) may refer to reduced or increased blood loss during menses, decrease or increase in the number of menses, decrease or increase in duration of menses, or bleeding intervals between menses (1). For women in childbearing age, risk factors for abnormal uterine bleeding can include pregnancy or pregnancy-related conditions, medications, and iatrogenic causes such as anticoagulants or hormone replacement, copper intrauterine devices (IUD) or contraceptive pills, systemic conditions (eg, renal or thyroid disease), or genital tract pathology (2). Abnormal uterine bleeding is a common condition of women of childbearing age, with up to 30% of women reporting it (3) each year, and approximately 5% of women aged 30 to 49 years seek advice from their general practitioner regarding the condition (4).

In recent decades, MRI scanners have increased rapidly in numbers, use, and field strength (B_0); consequently, the number of technicians exposed, as well as exposure to stray static magnetic fields and motion-induced time-varying magnetic fields, has increased (5,6). A recent case series reported three women working in the radiology department in a hospital in Milan, Italy, with abnormal uterine bleeding (7), defined here as having either menorrhagia or metrorrhagia or a combination of both: prolonged for 7 or more days, or excessive uterine bleeding of 80 mL or more, occurring at irregular and/or frequent intervals. The three women had all used copper IUDs, and had had them for some years without apparent problems. The symptoms started after an increase in time spent in the MRI room and gradually subsided after the work schedule was adapted (7). We were interested in whether we could reproduce this finding in a cross-sectional survey among Dutch radiographers.

METHODS

Study Design

We performed the survey among registered radiographers in the Netherlands. In 2013, we sent invitation letters to 1637 members of the Dutch Society of Radiographers (Nederlandse Vereniging Medische Beeldvorming en Radiotherapie, NVMBR). The overall aim of the survey, as communicated with the radiographers, was, "To gain insight into the occurrence of health issues among radiographers and how they relate to underlying factors such as general health status, lifestyle and the work environment. A focus lies on the role of working with MRI-scanners and associated exposures to electromagnetic fields." Participants were invited to complete an online questionnaire inquiring about lifestyle, health,

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The ethics committee of the University Medical Centre Utrecht declared that ethical approval was not necessary for this survey (protocol number 13-066/C).

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perceived stress at work, and work practices; 526 (32%) persons responded to the invitation. Of the 526 respondents, we excluded 119 men (23%) and another 29 (5%) persons who did not provide information on whether they had been working with or near an MRI scanner in the past year. The current analysis thus pertains to 381 female radiographers (72%).

Exposure

We asked the radiographers to report whether they had ever worked with or near an MRI scanner during the past year, and if so, on approximately how many days. The question asked in the survey was, "During the past 12 months, did you work in an MRI scanner room?" The words "scanner room" were further explained as "This is the room in which the MRI scanner is placed." If the response was positive, the follow-up question was "On how many days did you work in an MRI scanner room during the past 12 months? (provide an estimate)." To be able to differentiate between women exposed to only stray static magnetic fields (SMF) and motion-induced time-varying magnetic fields from walking to and from the MRI scanner, and women possibly additionally exposed to pulsed switched gradient fields (SGF) and radiofrequency (RF) fields that are only present during image acquisition, we additionally inquired about how many days the radiographers were present in the MRI room during image acquisition of the scanner: "During the past 12 months, did you work in an MRI scanner room during image acquisition?" Image acquisition was further explained as: "This is the moment when a scanner is busy taking an 'image' (ie, the actual moment of scanning). If you are not familiar with this process, the moment of acquisition can usually be recognized by the hard (buzzing or pulsating) sound produced by the MRI scanner." If the response was positive, the follow-up question was, "On how many days did you work in (or access) an MRI scanner room during image acquisition during the past 12 months? (provide an estimate)."

We also asked at what strength (magnetic flux density) in Tesla (T) the scanner(s) operated, and which type of scanners these were (closed bore, open bore, extremity scanner, upright scanner, other). Based on the type and strength, each scanner was classified into an exposure category. These categories were based on an extensive measurement survey among MRI technicians (6). Based on the maximum exposure category of the MRI systems, each participant was then classified into a low, medium, or high exposure-level category (low = working only with extremity scanners, or with closed-bore or open-bore scanners below 1.5 T; medium = working with closed-bore or open-bore scanners at 1.5 T; high = working with any scanners stronger than 1.5 T, or with upright scanners). Because just nine women fell into the low exposure category, we subsequently merged this group with the medium exposed group.

Outcome

We classified our participants as having menorrhagia or metrorrhagia (hereafter called abnormal uterine bleeding) if they reported that in the last year they had had irregular, strong or long-duration bleeding during their menses, or if they reported bleeding in between menstrual periods. We asked women not to report irregular or excessive bleeding if it was related to pregnancy, and we asked study participants whether they were pregnant. We further inquired about use of IUDs by asking whether they had used IUD contraception ("spiraaltje") during the past year, and if yes, what type of IUD (copper, hormonal, both, other, don't know) they used and since when they had used it.

Statistical Analysis

Study characteristics between participants who ever or never accessed an MRI room during the past year were compared using chi-squared tests on all categorical variables and with a Student's t-test for age.

We performed logistic regression to evaluate the risk of having self-reported abnormal uterine bleeding in women working with an MRI scanner. We also explored the association with the amount of days women worked with or near an MRI scanner per year, taking the median number of days among exposed women as a cut-off to classify as "sometimes" (1–60 days during the past year; average number of days in this group was 29 days) or "often" exposed (>60–200 days during the past year), compared with the unexposed women. The frequency distribution is shown in Supporting Figure S1. We additionally evaluated the effects of being present in the room during image acquisition. We again used the median of exposed women to classify being present during image acquisition as "1–3 days" (1–3 days per year) or ">3 days" (>3–100 days per year), versus "never." The frequency distribution is shown in Supporting Figure S2. We also evaluated any associations with the level of SMF exposure, based on our classification of the type and strength (B_0) of the MRI systems they had worked with. Next we evaluated the potential effect of working with MRI in women using IUDs. We tested linear trends for statistical significance by assigning the median values of the respective MRI or acquisition days to our exposure groups and values of 0, 1, and 2 to scanner strength groups, and using this as a continuous variable in our regression models. An overview of all exposure groups is shown in Figure 1.

We adjusted our models for age (and because we expected a nonlinear effect with age, also for a squared term of age) and self-reported physical, emotional, and general work stress using tertiles of the respective stress scores ("During the past 4 weeks, to which degree did you experience stress/emotional stress/physical strain at work?" answered on a 5-point Likert scale ranging from "very low degree" to "very high degree") in the models. We imputed missing information on stress scores for 22 (6%) participants based on their reported age, general health status, smoking status, amount of alcohol and caffeine consumption, body mass index, and sleep duration using linear regression. Imputation on missing stress scores for the small fraction of our participants was performed, as previous studies showed less bias yet higher power for an analysis based on imputed missing values compared with complete-case analysis or when using indicators for the missing information (8).

We performed several sensitivity analyses: First, we restricted our analysis to the 349 (92%) women reporting

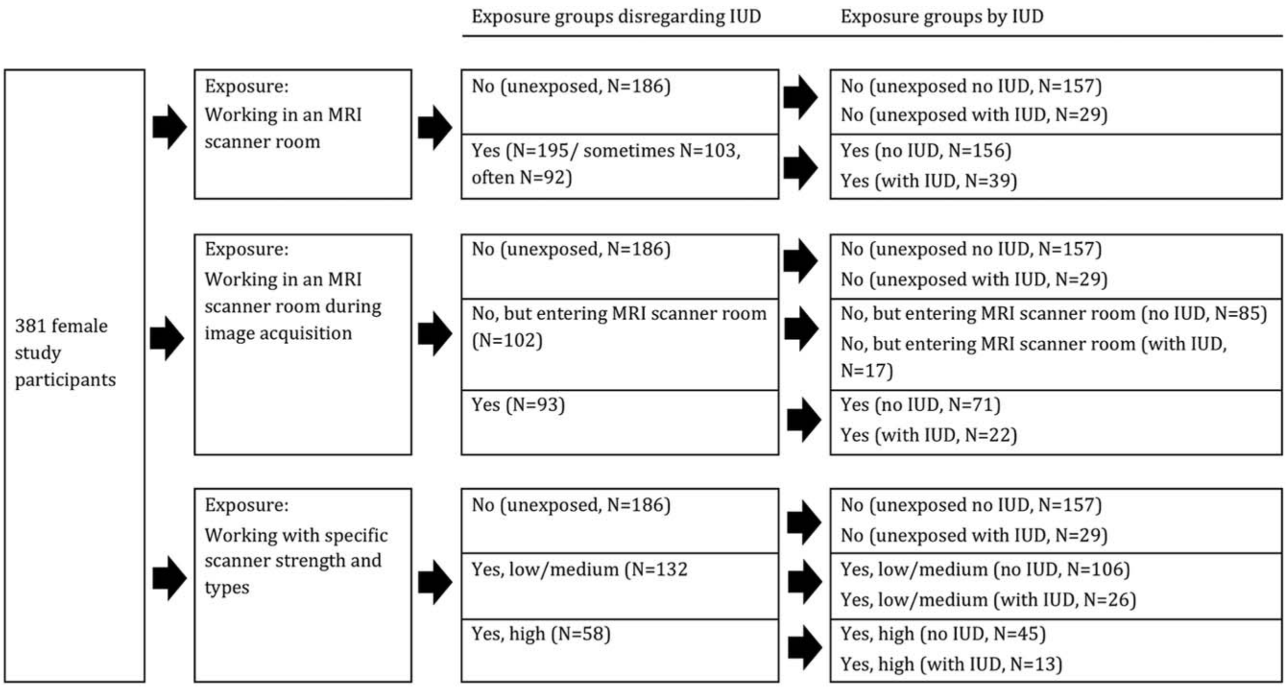

FIG. 1. Exposure categorization of participants. Results of exposure to “Working in an MRI scanner room” and “Working with specific scanner strength and types” are given in Table 2, and exposure to “Working in an MRI scanner room during image acquisition” are given in Table 3. A subgroup analysis of “Working in an MRI scanner room during image acquisition,” restricted to women with IUDs, is given in Table 4.

to be a radiographer (and not an assistant, in education, advanced practitioner, or other) and not working in any other field than radiology, such as in nuclear medicine. This was done to restrict our analysis to participants with a more similar work profile. Women with abnormal uterine bleeding may be advised to use hormonal IUDs, as these usually reduce symptoms after some time (9). Hormonal IUDs have been reported to lead to lighter bleeding within a few months of insertion (10). For this reason, we calculated the risks of exposure to MRI-related stray fields only in women with an IUD. The use of painkillers (such as aspirin) can extend the duration of menses (11). We did not collect data about the use of aspirin; however, because headache is a symptom sometimes reported in association with MRI exposure (12,13) and may trigger the use of aspirin, we additionally checked whether adjusting for women experiencing any headache during MRI-related work during the past year had an effect on our risk estimates. As aspirin is indicated for use against pain and fever, we considered other frequently reported symptoms related to MRI work (eg, phosphenes, metallic taste) as less likely to trigger use of aspirin, and therefore did not evaluate other reported symptoms reported from MRI exposure. Finally, we excluded pregnant women as well as women older than 45 years of age in order to reduce the data set to premenopausal women.

RESULTS

Of our study subjects, 186 (49%) reported not having accessed an MRI room in the past year, but 195 (51%) did. Sixty-eight subjects (18%) reported using IUDs, and the average duration of use was approximately 2.5 years. Seventy-two (19%) women reported menorrhagia or metrorrhagia. Characteristics of our study participants are presented in Table 1. Across the whole group of women, and independently of whether they used IUDs, we observed slightly elevated, statistically nonsignificant risks of abnormal uterine bleeding in women who worked with or near MRI systems at least once in the past year (Table 2). Risks were higher in women who worked with MRI more frequently and who worked with scanners with higher exposure levels. These associations were attenuated especially when we adjusted for age (Table 2). Compared with unexposed women without an IUD, the adjusted odds ratio (OR) for women who had an IUD and who reported working with MRI scanners was 2.09 (95% confidence interval (CI) 0.89–4.90, $P = 0.09$). There was no clear evidence for a linear trend of an increasing risk in women who worked with MRI more often ($P = 0.27$). We observed an inconsistent pattern in women with an IUD and exposure categories based on the reported scanners the women worked with: working with scanners that result in low/medium SMF exposure levels and using an IUD had a higher OR compared with women working with scanners resulting in high SMF exposure levels (Table 2).

Table 3 lists the results after further grouping the women based on their reported presence near the scanner during image acquisition. Women with an IUD who worked with MRI scanners but who were never present during image acquisition had an adjusted OR of 0.94 (95% CI 0.24–3.71). Women with an IUD who reported to have been present during image acquisition had an

Table 1
Characteristics of Study Population

	Never accessed MRI room in past year, N (%)	Ever accessed MRI room in past year, N (%)	P^a
Age, mean (SD)	46.7 (9.9)	42.5 (10.7)	< 0.0001
Job title			
Radiographer	169 (90.9)	185 (94.9)	
Other	17 (9.1)	10 (5.1)	0.127
Work stress			
Low	66 (35.5)	62 (31.8)	0.62
Medium	66 (35.5)	76 (39.0)	
High	54 (29.0)	57 (29.2)	0.75
Emotional stress at work			
Low	54 (29.0)	63 (32.3)	
Medium	79 (42.5)	71 (36.4)	
High	53 (28.5)	61 (31.3)	0.48
Physical strain at work			
Low	81 (43.5)	70 (35.9)	
Medium	51 (32.9)	71 (36.4)	
High	62 (33.3)	54 (27.7)	0.02
Uses			
IUD	29 (15.6)	39 (20.0)	0.26
Hormonal IUD	26 (38.2)	33 (48.5)	
Copper IUD	3 (4.4)	4 (5.9)	
Other	0 (0)	2 (2.9)	0.5

[a]*P* values of group differences between women never versus ever accessing the MRI room in the past year are based on a t-test for age, and on chi-squared tests for all other categories. SD, standard deviation.

OR of 3.43 (95% CI 1.26–9.34, $P = 0.02$) (a comparison of exposed women with an IUD to the reference group, who were unexposed women without an IUD, is found in Table 3). For this latter OR, adjusting for reported headache during MRI work had no noticeable effect on risk estimates (OR 3.44, 95% CI 1.26–9.40). Most of our participants reported using a hormonal-type IUD, only seven reported using a copper IUD, and one a combined copper-hormone type of IUD. Restricting the analysis to radiographers not using copper-containing IUDs had no material effects on this risk estimate (OR 3.47, 95% CI 1.189–10.13). There was no strong effect on the risk estimate when we excluded pregnant women (OR 3.38, 95% CI 1.22–9.39), and OR slightly increased when women aged 45 years or older were excluded (OR 4.53, 95% CI 1.24–16.56). When we restricted the group to only radiographers (thus excluding assistants, radiographers in education, advanced practitioners, or other), this latter

Table 2
Association among Working with MRI Scanners, Maximum Scanner Strength, and Abnormal Uterine Bleeding in Women with and without IUD

	N_t	N_c	OR (95% CI)	OR (95% CI)[a]	P^c
Unexposed	186	28	Referent	Referent	
Entered MRI room at least once during past year	195	44	1.64 (0.97–2.78)	1.43 (0.82– 2.50)	0.20
Unexposed	186	28	Referent	Referent	
Sometimes working with MRI	103	20	1.36 (0.72–2.56)	1.17 (0.60–2.28)	0.65
Often working with MRI	92	24	1.99 (1.08–3.68)	1.75 (0.92–3.32)	0.09
Unexposed	186	28	Referent	Referent	
Low/medium scanner strength	132	29	1.59 (0.89–2.83)	1.36 (0.74–2.49)	0.33
High scanner strength	58	15	1.97 (0.97–4.01)	1.74 (0.83–3.66)	0.15
Unexposed, no IUD	157	24	Referent	Referent	
Unexposed, with IUD	29	4	0.89 (0.28–2.78)	0.77 (0.24–2.48)	0.66
Working with MRI, no IUD	156	31	1.37 (0.76–2.47)	1.22 (0.66–2.25)	0.53
Working with MRI, with IUD	39	13	2.77 (1.25–6.14)	2.09 (0.89–4.90)	0.09
Unexposed, no IUD	157	24	Referent	Referent	
Unexposed, with IUD	29	4	0.89 (0.28–2.78)	0.77 (0.24–2.50)	0.67
Low/medium exposure level,[b] no IUD	106	19	1.21 (0.63–2.34)	1.03 (0.51–2.06)	0.94
Low/medium exposure level,[b] with IUD	26	10	3.46 (1.41–8.53)	2.54 (0.98–6.54)	0.05
High exposure level,[b] no IUD	45	12	2.02 (0.91–4.44)	1.81 (0.80–4.11)	0.16
High exposure level,[b] with IUD	13	3	1.66 (0.43–6.49)	1.25 (0.30–5.30)	0.76

[a]Adjusted for age and age squared, work stress, emotional stress, and physical strain at work.
[b]Based on scanner strength and type of scanner.
[c]*P* value from Wald tests in adjusted models.
N_t = total number of persons in category; N_c = number of cases with abnormal uterine bleeding in category.

Table 3
Association among Working with MRI Scanners, Being Present during Image Acquisition, and Abnormal Uterine Bleeding in Women with and without IUD

	N_t	N_c	OR (95% CI)	OR (95% CI)[a]	P[b]
Unexposed	186	28	Referent	Referent	
Working with MRI scanners but never present during image acquisition	102	23	1.64 (0.89–3.04)	1.44 (0.74–2.78)	0.28
Working with MRI scanners and present during image acquisition	93	21	1.65 (0.88–3.09)	1.43 (0.74–2.76)	0.29
Unexposed, no IUD	157	24	Referent	Referent	
Unexposed, with IUD	29	4	0.89 (0.28–2.78)	0.76 (0.24–2.46)	0.65
Working with MRI scanners but never present during image acquisition, no IUD	85	20	1.71 (0.88 - 3.31)	1.54 (0.76–3.13)	0.23
Working with MRI scanners but never present during image acquisition, with IUD	17	3	1.19 (0.32–4.45)	0.94 (0.24–3.71)	0.93
Working with MRI scanners and present during image acquisition, no IUD	71	11	1.02 (0.47–2.21)	0.91 (0.41–2.02)	0.81
Working with MRI scanners and present during image acquisition, with IUD	22	10	4.62 (1.79–11.88)	3.43 (1.26–9.34)	0.02

[a]Adjusted for age and age squared, work stress, emotional stress, and physical strain at work.
[b]*P* value from Wald tests in adjusted models.
N_t, total number of persons in category; N_c, number of cases with abnormal uterine bleeding in category.

OR increased slightly to 4.20 (95% CI 1.49–11.85, $P = 0.007$). Grouping women into lower or higher frequency of presence during image acquisition (ie, 1–3 days or > 3 days per year) provided evidence for a linear trend, indicating an increasing risk with more frequent presence during image acquisition (P for trend = 0.03).

In a further analysis we restricted the analysis to those 68 female radiographers who reported using IUDs, so the referent group consisted of unexposed women using IUDs. In this analysis, the OR for working with MRI scanners was 5.35 (95% CI 1.13–25.37, $P = 0.04$). For women who reported to have been present during image acquisition, the OR was 9.35 (95% CI 1.72–50.95, $P = 0.01$) (Table 4). Note that the increase in OR from crude to adjusted models is the result of age adjustment only. Among women using IUDs, risks tended to increase with increasing exposure, both for frequency of working with MRI scanners (P for trend 0.03) as for frequency of presence during image acquisition (P for trend 0.04). Adjusting only for age and age-squared, the latter OR was 9.89 (95% CI 1.96–50.00, $P = 0.006$). Given the small number of events, we additionally calculated the exact logistic regression, which resulted in an OR of 9.20 (95% CI 1.61–74.16, $P = 0.008$) when adjusting for age and age squared.

DISCUSSION

Among women using IUDs, we observed an increased risk of abnormal uterine bleeding among female radiographers working with MRI. Risks were more pronounced in the group reported being present in the MRI room during image acquisition. Directions of association were not consistent for SMF exposure based on the MRI scanner type and strength with which the radiographers reported to work. Our results point to an association with MRI-related stray fields. However, instead of an association with exposure to stray static magnetic fields and motion-induced time-varying fields, the increased risk for presence during image acquisition suggests a possible association as a result of exposure to stray switched-gradient fields and possibly RF fields. In line with the literature, unexposed women using IUDs showed slightly reduced risks of abnormal uterine bleeding (9).

Although there have been at least two previous case reports (7,14), to the best of our knowledge, we are the first to evaluate the size of associated risks by comparing MRI-exposed radiographers to unexposed radiographers. Strengths of our study include the reasonable size that allows us to explore effects using different exposure

Table 4
Association among Working with MRI Scanners, Being Present during Image Acquisition, and Abnormal Uterine Bleeding in Women Using IUDs

	N_t	N_c	OR (95% CI)	OR (95% CI)[a]	P[b]
Unexposed	29	4	Referent	Referent	
Working with MRI scanners	39	13	3.13 (0.90–10.88)	5.35 (1.13–25.37)	0.04
Unexposed	29	4	Referent	Referent	
Working with MRI scanners but never present during image acquisition	17	3	1.34 (0.26–6.86)	2.01 (0.29–13.72)	0.48
Working with MRI scanners and present during image acquisition	22	10	5.21 (1.35–20.06)	9.35 (1.72–50.94)	0.01

[a]Adjusted for age and age squared, work stress, emotional stress, and physical strain at work.
[b]*P* value from Wald tests in adjusted models.
N_t, total number of persons in category; N_c, number of cases with abnormal uterine bleeding in category.

metrics and evaluate exposure–response associations, while adjusting for a range of potential confounders. Limitations of our study include low participation rate in our cross-sectional study, which might have given rise to selection bias if affected persons were more likely to respond to the survey. Another limitation relates to self-reporting of both exposure as well as abnormal uterine bleeding, which could lead to increased reporting of the condition if participants were aware of a possible association. Given that IUD use has not been previously shown to increase risks of abnormal uterine bleeding among radiographers, however, we consider it unlikely that selection bias or information bias could have introduced the strong increased risks among exposed women using IUDs observed in our study. We did not collect information on several factors that have been described to be risk factors for AUB, such as hormone therapy, systemic conditions, genital tract pathology, or medication. However, none of these factors would be expected to be associated with the MRI-related electromagnetic fields–exposure metrics studied. Magnetic resonance imaging–exposed workers have been reported to attribute headaches to their exposure to MRI to a certain extent (12,13). Experiencing headaches may tempt women to use nonsteroidal anti-inflammatory drugs such as aspirin when being exposed and experiencing headaches. Intake of aspirin can extend the duration of menses (11) and thus potentially increase abnormal uterine bleeding. However, in our study less than 5% of our population attributed headache to MRI work. Consequently, it had no material effect on our risk estimates when we accounted for it in our regression models.

It is conceivable that high workload could contribute to abnormal uterine bleeding by causing physical harm on the uterine tissue. We therefore adjusted our models for self-reported work stress, emotional stress and physical strain, but found that these factors did not materially affect our risk estimates either. We observed higher emotional stress as an additional risk factor for AUB. Given the cross-sectional nature of our study, causality for the observed association is unclear. An alternative explanation could be that women experiencing abnormal uterine bleeding were at higher risk of emotional stress at work.

Associations with maximum SMF exposure based on the scanner strength and type were inconsistent, which might have been caused by the fact that at many facilities, there were several MRI scanners in operation with different magnet strengths. Although we asked the radiographers for the strength and types of all scanners they used, we do not know which scanners they worked with most frequently. This means that our metric likely captured the potential for peak exposures that radiographers had experienced during the past 12 months, but not necessarily the SMF exposure level of the scanner they worked with on a more frequent basis.

We have no explanation regarding the underlying mechanism. Movements (torque) of metallic IUDs when in the vicinity of MRIs have been previously excluded as a possible underlying mechanism, given that metallic IUDs are usually made from copper, which is not ferromagnetic (15). Alternative suggested mechanisms include heating from electric currents evoked by the time-varying magnetic fields when moving in the vicinity of an MRI scanner, or by exposure to the switched gradient fields or RF fields during image acquisition, although this would require being very close or even within the bore of the MRI scanner during image acquisition. It has been hypothesized that these currents could underlie inflammatory processes leading to bleeding (7). Curiously, nearly all radiographers with IUDs in our study reported using hormonal IUDs. Only 12% of IUDs were reported to be made from copper or to be hormone copper–type IUDs, and women with IUDs containing copper were not overrepresented in the highest exposure category evaluated in our study. Of course, we cannot exclude misreporting of the type of IUD used, but we consider that not to be very likely, given the high educational background of our participants. In addition, predominant use of hormonal IUDs is consistent with reports on frequency of type of IUDs in Europe (16). Hormonal IUDs are usually made from polyethylene (15), but contain barium sulfate—an x-ray contrast medium (17)—and a string (for removal) treated with iron oxide; however, it remains unclear how these materials could be associated with abnormal uterine bleeding at exposures potentially received during image acquisition (RF and switched gradient fields). Radiofrequency exposure levels have been reported to be low outside of the bore, and RF exposure will occur only during specific procedures (19,20). In addition, to experience exposure to the switched gradient fields, radiographers would have to get close to the bore during image acquisition (21). Unfortunately, we have no information about the specific work processes of our study participants and therefore cannot assess whether or when this exposure to RF fields and switched gradient fields may have occurred. Previous surveys reported procedures when MRI staff entered the scanner room during image acquisition, during which they could come very close to the bore and thus may encounter exposures to multiple types of stray fields, including SGF and RF fields (19,20,22). In the Netherlands, radiographers may attend to pediatric, anxious, sedated, or otherwise high-care patients during scanning, which could subsequently lead to SGF and possibly RF exposure. Although our data point to an effect of image acquisition rather than working with or close to MRI systems as such, we would like to point out that we were limited in our ability to clearly disentangle the effects of these two exposures. This was because women who reported more frequent presence during image acquisition also reported approximately 50% more work with or near to MRI systems.

Menorrhagia or metrorrhagia, as such, are not life-threatening conditions, but have been associated with anemia (23), increased health-care consumption and work absences (24), and reduced health-related quality of life (25). Even though an explanation of our findings is not available, they still need confirmation to assess whether occupationally exposed radiographers and other women working with or close to MRI scanners and planning to use IUDs may be at an increased risk of the condition.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article.

Fig. S1. Frequency distribution of reported scanner room access days in the past year.

Fig. S2. Frequency distribution of self-reported days with presence during image acquisition in the past year.