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Cognisance of magnetic resonance imaging-induced vertigo and supported care: A study among a cohort of MRI radiographers in a country in West Africa

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ABSTRACT

Introduction: Magnetic resonance imaging (MRI) can induce vertigo in patients undergoing such examinations. The severity of the vertigo is thought to increase with higher magnetic field strengths and could cause a patient to fall.
The study assessed the awareness levels on MRI-induced vertigo among a cohort of MRI radiographers and their perspectives on the care that should be administered to patients post MRI examinations.
Methods: The study utilized a quantitative cross-sectional research design and a questionnaire. Out of a total of 40 MRI-radiographers identified nationwide, 31 participated in the study. Statistical Package for Social Sciences v.21.0 was used to analyse the data.
Results: Most participants ($n = 21$, 67.7%) were aware of MRI-induced vertigo. Many knew that patients (able and weaker) need to be assisted off the couch ($n = 28$, 90.3%) and escorted to the changing rooms post MRI examinations ($n = 31$,100%). There were statistically significant associations between the size of magnetic field strength used by the participants and their level of awareness about MRI-induced vertigo ($r = 0.691$, $p = 0.003$), appreciation of the needed support for patients post MRI examinations ($r = 0.530$, $p = 0.041$) and the frequency of occurrence of MRI-induced vertigo among their patients ($r = 0.530$, $p = 0.001$).
Conclusion: The radiographers were mostly cognisant of MRI-induced vertigo and the supported care they were supposed to administer to their patients. The size of magnetic field strength used by the participants correlated with their level of awareness about MRI-induced vertigo and their appreciation of the needed support for patients post MRI examinations.
Implication for practice: The study highlights the need for a refresher training to expand the knowledge-base of a few of the radiographers who were not very cognisant about MRI-induced vertigo.

Introduction

Magnetic resonance imaging (MRI) is an imaging modality that uses the inherent magnetization in body tissues to create useful diagnostic images. Since its introduction into medicine in the early 1980s, MRI has significantly improved medical care. MRI offers various advantages over alternative imaging techniques, including its ability to produce precise morphological and functional information of the body. It is also described as a safe modality because it is non-invasive and uses non-ionizing radiation to produce images.

Some publications[1–3] however, have reported transient sensory effects such as vertigo, nausea, dizziness and visual phosphenes in subjects exposed to static magnetic fields. Other studies[3–5] have emphasised that MRI examinations, particularly those that place the head in the bore of MRI scanners can significantly induce vertigo in patients who undergo such examinations. Although the mechanism leading to these effects has not been fully addressed in literature, studies[2–4] argued that MRI-induced vertigo is caused by an inner ear problem. Robert et al.[3] explained that during imaging, the MRI's strong magnet pushes on fluid that circulates in the inner ear balance centre of MRI patients, leading to gait problems. The static magnetic field created by the MRI scanner leads to interference with the vestibular system in the inner ear that prompts an electrical disturbance in the endolymph enriched potassium inside

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the semicircular canals and excites the hair cells of the vestibular system, thereby causing an abnormal sensation of movement and vertigo. This work was later supported with more detailed calculations of the Lorentz forces mechanism resulting from the ionic currents occurring naturally in the endolymph of the vestibular system.[6] Particularly, the Lorentz forces act to induce a constant deflection of the semicircular canal cupula of the superior and lateral semicircular canals, and the inner ear stimulation creates a sensation of rotation.[4–7] This rotation leads to vertigo.[3–5]

Predominantly, the vertigo is high when the head is in closer proximity to the epicentre of the MRI scanner bore.[8] Some studies[2,6] have argued that MRI-induced vertigo is common in MRI of magnetic field strength of 1Tesla (T) and higher. More recent works[2,4] further emphasised that MRI-induced vertigo is more prominent in 3T and above (eg. 7T) MRI systems. In a study[2] which placed the heads of normal subjects in a 7T MRI machine, without acquiring images, all subjects developed a spontaneous horizontal nystagmus (drift of the eyes). The study stressed that this magnetic field-induced nystagmus was likely responsible for a high vestibular imbalance occurred by the effect of the magnetic field on the inner ear labyrinths. It is also suggested that the incidence of vertigo symptoms increases with increased exposure times (>20 min) in higher-strength magnets and also with swift movements of the head in the MRI gantry.[3]

Gorlin et al.[9] had also reported a case of an acute MRI-induced vertigo effect among a staff member (anaesthesia provider) who experienced a sensation that the room was spinning whilst standing close to the gantry and providing sedation to a patient undergoing a 3T MRI scan. His experience was so intense that he felt a need to sit down. This instance confirms that MRI-induced vertigo is not exclusive to patients undergoing MRI examinations.

Vertigo may cause a sudden feeling of a tipping, whirling or dropping, spinning sensation and difficulty walking or standing.[10] Since vertigo is a known cause of disequilibrium and dizziness, patients who experience vertigo are at increased risk of falls and uncomfortable experiences.[11] In able patients, the risk of falls increases when patients attempt to get off the MRI couch unassisted after their procedures. This is because the usual assumption is that they are fit to walk out of the MRI room by themselves.

Gorlin et al.[9] indicated that the concept of MRI-induced vertigo is a well-known phenomenon within the radiology community, but it is not widely appreciated by all professionals. This current study, therefore, investigated the awareness levels of radiographers about MRI induced vertigo and their perspectives on the care that should be administered to patients post MRI examinations. The rationale was to create the necessary awareness on MRI-induced vertigo and to reinforce the need for extra care for all patients who undergone MRI examinations to reduce risk of falls associated with MRI-induced vertigo.[11]

Method

Research design, sample size and technique

A quantitative cross-sectional study design was used to undertake this study. Before commencing the study, ethical approval was sought and granted by an Ethical and Protocol Review Committee of a local University.

In the country where the study was undertaken, there was no national database of radiographers who performed MRI examinations at the time of the study. MRI locum jobs were also common in the study area and that further complicated the tallying of their numbers as there was the possibility of some of the radiographers using different scanners at different times. However, an estimated 40 radiographers were known to perform MRI examinations in 13 facilities across the country. A consecutive sampling was then used to reach out to each of them. A consecutive sampling is a sampling technique in which every subject meeting the criteria of inclusion is selected until the required sample size is achieved or all the population members are involved.[12]

Data collection tool

A structured questionnaire (Appendix 1) consisting of four parts (1–4) was designed for the study. Part I of the questionnaire focused on the demographics of the participants. Parts II, III and IV utilized a Likert Scale which focused on radiographer knowledge on MRI-induced vertigo, their perspectives on the care needed for patients post MRI examinations and the frequency of MRI-induced vertigo among patients. The Likert Scale tool chosen for the study was a 5-point scale with options such as “Strongly agree, Agree, Unsure, Disagree and Strongly disagree” to each statement. The statements were mainly positively worded with a few worded negatively. These negative items were intended to encourage the respondents to read all items carefully rather than use a set pattern of responding.

Validity and reliability of questionnaire

To ensure the validity of the questionnaire, two experts in the subject area assessed the functionalities of the questions/statements. A questionnaire assessment tool made up of a scale of 1–2 was used by the experts to score the importance of the questions/statements. In the scale, 1 represented not important while 2 represented very important. Subsequently, a questionnaire version 2 was acquired. A test-retest analysis was also performed with 4 radiographers, and the reliability coefficient was observed to be 0.96 which was an excellent reliability. The questionnaire was then employed in the main study.

Data collection

The MRI facilities were visited, and their radiographers were contacted and provided with information sheets which explained the purpose of the study, willingness to participate, risks, benefits, study duration and confidential issues. The information sheets were also used to invite radiographers and solicited their consent to be part of the study. Out of 40 radiographers, 31 (77.5%) agreed to voluntarily participate in the study. These respondents came from 11 out of 13 MRI facilities surveyed. Questionnaires were administered by one of the researchers who visited the study sites.

Data analysis

Data obtained were analyzed using the IBM Statistical Package for Social Sciences (SPSS) version 21.0. To descriptively present the Likert Scale results in a Table and graphs, the strongly agree and agree responses were considered together as “Agree” while the strongly disagree and disagree responses were grouped together as “Disagree”. Additional analyses conducted were tests of associations between the type of magnetic field strength used by the participants and their level of awareness about MRI-induced vertigo, and their appreciation of the needed support for patients post MRI examinations. Prior to the inferential analyses, each strongly agree, agree, unsure, disagree and strongly disagree response to a positive statement was assigned a score of 5, 4, 3, 2, and 1, respectively. The reverse score was used in a negative worded statement. A Pearson correlation test was used to evaluate the associations after the test variables were statistically proven as parametric data with a Shapiro Wilk test for normality. A p-value of

≤0.05 was used to interpret the findings of the inferential statistics as statistically significant.

Results

Thirty-one (31) radiographers practicing in MRI were studied which achieved a response rate of 77.5%. Many ($n = 21$, 67.7%) of the participants were males (Fig. 1) and were in the age bracket of 25–45 years. The majority ($n = 11$, 35.5%) were 25–30 years of age and a few ($n = 5$, 16.1%) were 31–35 years old. Also, 36.5% ($n = 11$) of the participants had practiced for 0–5 years while 9 (29.0%) had practiced for 11–15 years. Details of the demographic statistics are presented in Fig. 1. The magnetic field strength of the MRI machines used by the radiographers ranged from 0.3T to 3.0T. Out of the 11 MRI scanners at the study sites 3 (27.3%), 7 (63.6%) and 1 (9.1%) were 0.3, 1.5 and 3.0T, respectively. Specifics of the magnetic field strengths used by the participants are presented Fig. 2. The majority ($n = 21$, 67.7%) of the participants indicated they were aware that MRI can induce vertigo. Details of the participants' levels of awareness about MRI-induced vertigo are presented in Table 1.

The radiographers further indicated that they rarely ($n = 25$, 80.6%) or never ($n = 4$, 12.9%) observed significant vertigo in patients during practice (Fig. 3). Participants also indicated that able patients must be assisted off the MRI couch and be asked about how they felt post examinations. Details of the participants' perspectives on the kind of support and care that should be administered to a patient after an MRI procedure are presented in Fig. 4.

There were statistically significant associations between the size of magnetic field strength used by the participants and their level of awareness about MRI-induced vertigo ($r = 691$, $p = 0.003$), their appreciation of the needed support for patients post MRI examinations ($r = 0.530$, $p = 0.041$) and the frequency of occurrence of MRI-induced vertigo among their patients ($r = 0.530$, $p = 0.001$). There was no statistically significant association between the participants' awareness levels and their years of practice ($r = 0.031$, $p = 0.871$), age ($r = -0.033$, $p = 0.871$) and educational level ($r = 0.056$, $p = 0.763$).

Discussion

The study assessed the awareness levels on MRI-induced vertigo among a cohort of practicing MRI radiographers and their perspectives on the care that should be administered to patients post MRI examinations. The respondents were male dominated and the majority had practiced for 5 years or less to suggest a less experienced working force in the MRI facilities. In the study site, MRI

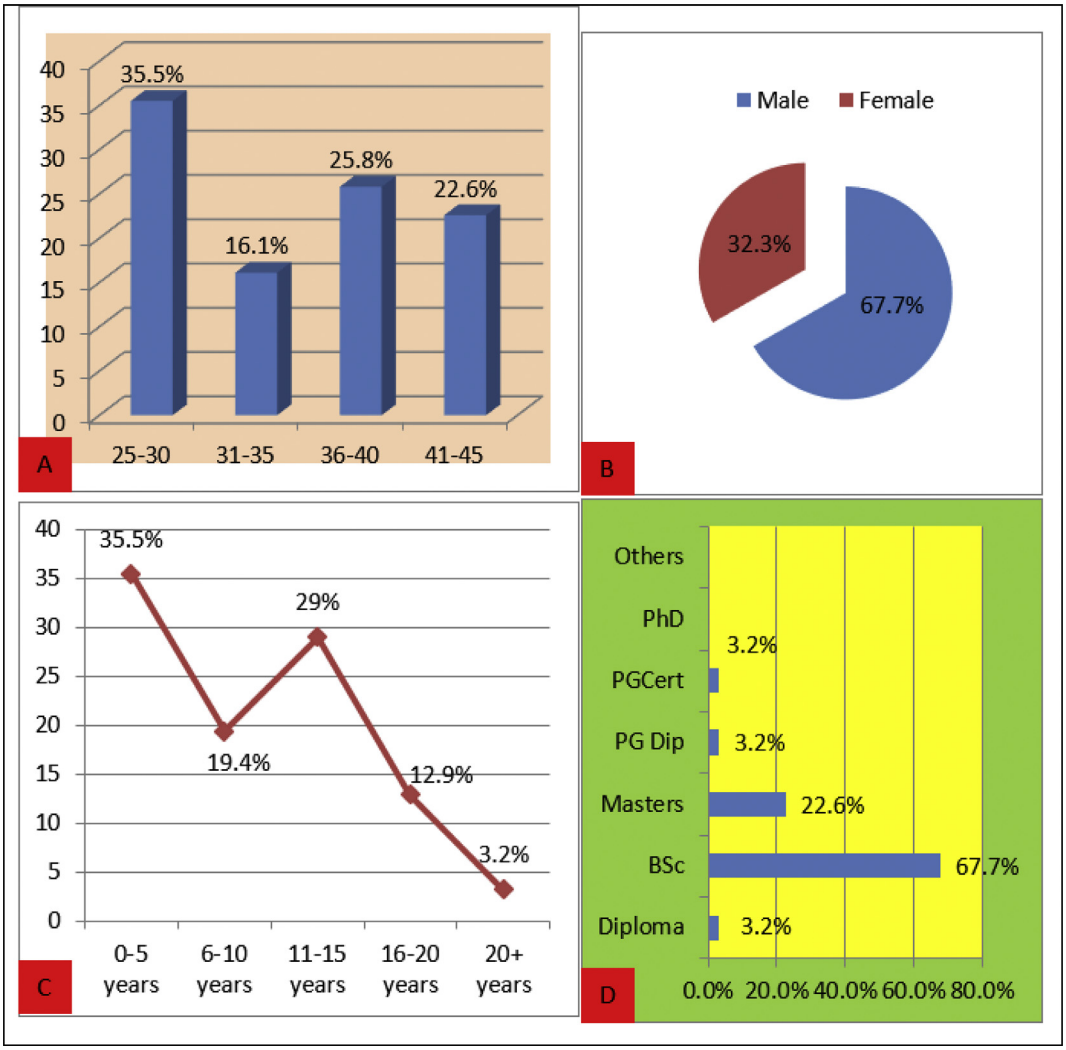

Figure 1. Respondents' demographic characteristics. Plates A, B, C and D show participants age range, years of practice, gender and educational background. PhD: doctor of philosophy, PG Dip: post graduate diploma, PG Cert: post graduate certificate, BSc: bachelor of science degree.

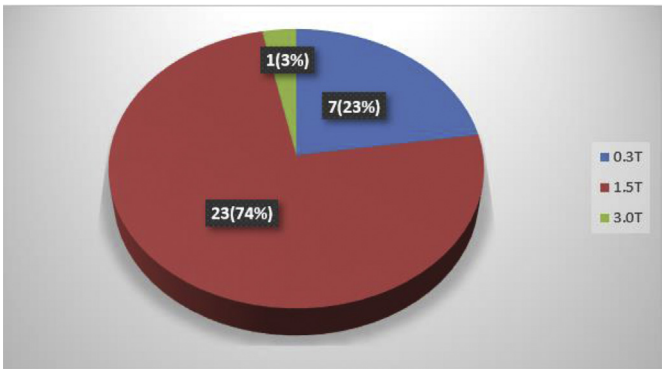

Figure 2. Frequency of magnetic field strengths used by the participants.

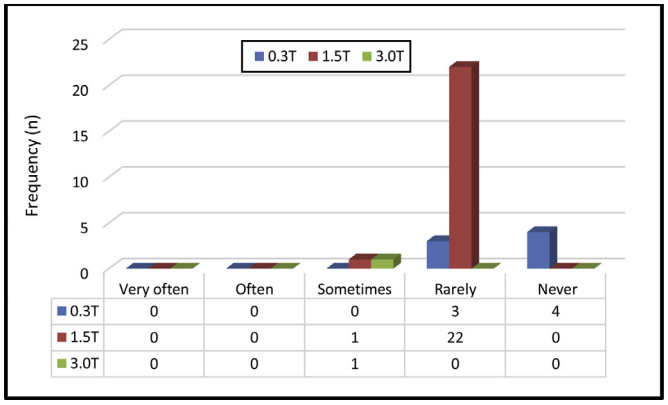

Figure 3. How often participants observe MRI-vertigo among their patients.

education is included in the four-year bachelor of science degree (BSc) programme. Therefore, BSc holders were capable and accredited to perform MRI examinations without necessarily undertaking a postgraduate programme. That is why many of them were involved in the MRI imaging. MRI scanners of high magnetic field strengths allow for a more detailed and faster imaging.[4] Out of the 11 MRI scanners at the study sites for head and body examinations, 3 and 7 were 0.3T and 1.5T respectively; only one MRI scanner with high (3T) magnetic field strength existed in the facilities.

The study found that the cohort of radiographers generally showed a good understanding of issues of MRI-induced vertigo, and their cognisance levels did not have any statistically significant association with their demographic characteristics such as years of practice ($r = 0.030$, $p = 0.871$), age ($r = -0.033$, $p = 0.861$) and educational levels ($r = 0.056$, $p = 0.763$). Particularly, most (67.7%) of the radiographers were correctly aware of the MRI-induced vertigo phenomenon and were also familiar with the theory that a prolong stay of a patient in an MRI equipment could induce more vertigo as reported by MacGill.[13] Moreover, the majority appropriately indicated that subject-specific factors such as weight, age and gender do not predispose one to experience vertigo in MRI as reported by De Wilde et al.[8] and De Vocht et al.[14]

xMany studies[2–6,8] have established that MRI-induced vertigo increases with increasing magnetic field strength. Almost one-third of the participants were familiar with this concept. Literature[2,3,15,16] further shows that MRI-induced vertigo is caused by an interference of the vestibular system in the inner ear by a strong magnetic field. However, only 16.1% of this study's respondents were cognisant of these facts. The findings call for some education on the mechanisms leading to MRI-induced vertigo. Nonetheless, most of the respondents were rightly aware that the position of the patient's head and swift movement of a patient's head within the magnetic bore could increase MRI-induced vertigo effects. The head position plays a crucial role in the vertigo induction because a head placed in the bore where the strength of the static magnetic field is intense leads to more MRI-induced vertigo effects.[17] This concept was well understood by a good number (58.1%) of the radiographers as they correctly indicated that a head MRI examination was more likely to induce vertigo than a knee MRI procedure.

Patient care, especially risk assessment during and after an MRI examination is very crucial.[11] In this study, all respondents correctly indicated that as part of proper care, patients, particularly, ambulant patients should not be left to get off the MRI couch unassisted after their procedures. They further indicated that such patients should even be assisted to their changing rooms as it would have been the case for weaker patients. These findings suggest that the radiographers were very knowledgeable about the correct support required for their patients post MRI examinations to handle any potential MRI-induced vertigo issues such as risk of falls.

The study found that the radiographers rarely (80.6%) or never (12.9%) experienced vertigo in practice. All those who have never experienced vertigo were those using 0.3T MRI scanners. Among the two respondents who sometimes experience MRI-induced vertigo 1 was using a 1.5 T while the other was using a 3T scanner. MRI-induced vertigo is more prominent in 3T and above (eg. 7T) MRI systems.[2,4] The fact that only one respondent used a 3T scanner could explain the above findings. A test of association further showed a statistically significant correlation ($r = 0.731$, $p = 0.001$) between the participants' size of magnetic field strength used and the frequency of MRI-induced vertigo among patients to suggest that those using higher magnetic field strengths were likely to encounter more MRI-induced vertigo than those using lower magnetic field strengths. Moreover, the awareness levels of the participants about MRI-induced vertigo ($r = 0.069$, $p = 0.003$) and their appreciation of the needed support for patients post MRI

Table 1
MRI-induced awareness level of participants.

Statement	Response		
	Agree	Not sure	Disagree
1. MRI can induce vertigo in patients	21 (67.7%)[c]	9 (29.0%)[w]	1 (3.2%)[w]
2. Prolonged stay of a patient in an MRI machine induces more vertigo	19 (61.3%)[c]	10 (32.3%)[w]	2 (6.5%)[w]
3. MRI-induced vertigo can be caused interference of the vestibular system in the inner ear by a strong magnetic field	5 (16.1%)[c]	22 (71.0%)[w]	4 (12.9%)[w]
4. Higher magnetic field strength influences more vertigo	22 (71.0%)[c]	5 (16.1%)[w]	4 (12.9%)[w]
5. Swift movement of a patient's head within the bore the magnet can increase MRI-induced vertigo effects.	16 (51.6%)[c]	12 (38.7%)[w]	3 (9.9%)[w]
6. The position of the patient's head in the scanner affects MRI-induced vertigo	19 (61.3%)[c]	11 (35.5%)[w]	1 (3.2%)[w]
7. Subject-specific factors such as weight, age and gender predispose one to experiencing more vertigo in MRI	2 (6.5%)[w]	13 (41.9%)[w]	16 (51.6%)[c]
8. A head MRI is more likely to induce vertigo than a knee MRI	18 (58.1%)[c]	3 (9.7%)[w]	10 (32.3%)[w]

Key: [c] = correct responses,[w] = wrong responses.

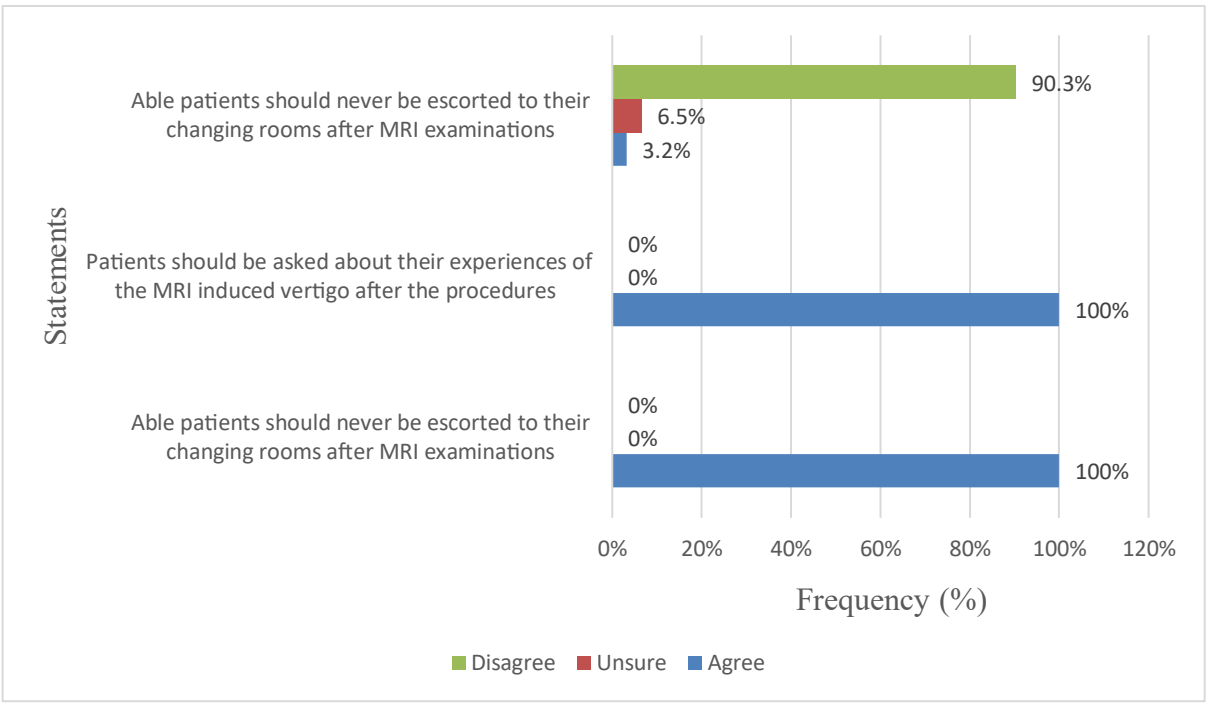

Figure 4. Participants' perspectives on the kind of support and care that should be administered to a patient post MRI scan ($N = 31$).

examinations ($r = 0.053$, $p = 0.041$) increased with increasing size of the magnetic field strengths they were using.

Conclusion

The MRI radiographers involved in this study were mostly aware of MRI-induced vertigo in MRI examinations. They were also aware of the supported care they were supposed to administer to their patients post MRI examinations to avoid the risk of MRI-induced falls. Particularly, most of them indicated that patients should be assisted off the MRI couch after their procedures and their experiences about MRI induced vertigo should be sought. Moreover, all agreed that patients needing changing room services must be escorted and supported after each procedure to prevent any falls associated with MRI-induced vertigo. There were statistically significant associations between the size of magnetic field strength used by the participants and their level of awareness about MRI-induced vertigo, and their appreciation of the needed support for patients post MRI examinations. Refresher training courses on MRI-induced vertigo through continuing professional development programmes may help to further expand the knowledge-base of a few of the radiographers who were not very cognisant about the phenomenon.

Implication for practice

The study highlights that many of the MRI radiographers in the study were aware of MRI-induced vertigo and the supported care they were supposed to be giving to patients undergoing MRI procedures. However, there is a need for some form of refresher training to further expand the knowledge-base of a few of the radiographers who were not very much aware about MRI-induced vertigo.

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Conflict of interest

None

Appendix 1. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.radi.2020.05.007.

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