Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Knowledge, awareness, attitudes and practice regarding magnetic resonance imaging and computed tomography among physiotherapists in Sudan: a cross-sectional survey

Mustafa Ibrahim

mustafa01007755777@gmail.com

Alzaiem Alazhari University

Mohamed Ahmed

Al Neelain University

Research Article

Keywords: Physiotherapy, Diagnostic imaging, Magnetic resonance imaging, Computed tomography, Knowledge, attitudes and practice, Sudan

Posted Date: November 3rd, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11596117/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Physiotherapists increasingly use imaging reports, yet little is known about their understanding of magnetic resonance imaging (MRI) and computed tomography (CT) in Sudan. We conducted an anonymous cross-sectional online survey (23 September to 4 October 2026) of 54 physiotherapists (78% women; median age 26 years; 69% with less than one year of experience) to describe knowledge, awareness, attitudes and practice regarding MRI and CT. The questionnaire comprised an 18-item true/false knowledge test, awareness, attitude and practice scales scored from 1 to 5, and three clinical vignettes. Mean knowledge was 12.3 of 18 (69% correct); 31% of respondents had good, 43% moderate and 26% poor knowledge. Practical safety rules were well known (at least 81% correct), but only 39% knew that the MRI magnet remains active between acquisitions and 46% knew that MRI does not use ionising radiation. Awareness (mean 4.11) and attitude (mean 4.44) were high, and 89% agreed that more training is needed. Knowledge correlated with awareness (Spearman's rho 0.56), attitude (0.51) and practice (0.36), whereas attitude was unrelated to practice (0.00). Good knowledge was reached by 48% of respondents with formal imaging training and 12% of those without ($p = 0.016$). Only 48% would verify device compatibility before MRI for a patient with a pacemaker. In this small convenience sample, physiotherapists strongly favoured imaging education but showed gaps in MRI physics, CT radiation dose and device safety. Knowledge, rather than attitude, was linked to practice, so structured imaging education should be prioritised.

Introduction

Direct access, extended scope and imaging authority are changing physiotherapy practice. A survey of 81 World Physiotherapy member nations found affirmative imaging policies in only about one-third of countries, with marked variation between and within countries [1]. Even where physiotherapists cannot request imaging, they read reports, discuss findings with physicians and adapt treatment accordingly. For educators in the health professions, this raises the question of what entry-level graduates actually know about the modalities whose reports they will meet.

Imaging is relevant across physiotherapy caseloads. MRI and ultrasound are complementary for peripheral nerve injury, whereas CT is mainly useful for bony abnormalities [2]. In extra-articular hip impingement, CT defines bony morphology and MRI detects soft tissue pathology, yet MRI signal abnormalities also occur in asymptomatic people, so imaging must be interpreted with the clinical picture [3]. In young patients with low back pain, radiographs, CT and MRI each play a role in diagnosing spondylolysis and spondylolisthesis, and referral to a spine surgeon is advised when these conditions are suspected [4]. For elbow stiffness there is no consensus on the optimal imaging work-up, which challenges surgeons and physiotherapists alike [5]. In a Brucella sternoclavicular joint abscess, imaging strongly suggested infection but the diagnosis relied on epidemiological history and serology [6]. Imaging also supports body-composition assessment, for example opportunistic CT for sarcopenia [7]. Reading and acting on imaging safely therefore requires a working knowledge of what each modality can and cannot show.

MRI and CT also carry specific hazards. MRI uses static, radiofrequency and gradient fields that create risks such as projectile accidents, thermal injury and device complications, and an estimated 10–20% of MRI patients carry an implanted device [8]. CT involves ionising radiation and contrast reactions. Evidence suggests physiotherapists can use imaging appropriately: in a military direct-access clinic, 96.7% of low back pain encounters in physiotherapy complied with the Healthcare Effectiveness Data and Information Set (HEDIS) no-early-imaging measure versus 82.0% in primary care [9], and 91% of imaging orders by civilian physiotherapists were appropriate against American College of Radiology criteria [10].

Surveys from other low- and middle-income settings show positive attitudes but only moderate imaging training and competence. In Nigeria, 93.2% of 400 physiotherapists believed they should use imaging, but training and competence were moderate and were lowest for ultrasound, scintigraphy and dual-energy X-ray absorptiometry [11]. In Pakistan, 92.8% of 100 physiotherapists considered imaging significant for diagnosis, and about half reported that their knowledge came from job exposure rather than academic programmes [12]. Authors in this field have recommended upgrading entry-level imaging curricula [13]. To our knowledge, and within the sources reviewed for this paper, we did not identify equivalent data from Sudan.

We therefore aimed (i) to describe knowledge, awareness, attitudes and practice (KAP) regarding MRI and CT among physiotherapists in Sudan, (ii) to explore associations with training, experience and workplace, and (iii) to test how the four domains relate to each other. We hypothesised that knowledge would be positively associated with awareness, attitude and practice.

Materials and Methods

Design and reporting

This was a cross-sectional online survey reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement (checklist in Online Resource 2). The KAP approach follows earlier physiotherapy and imaging-safety surveys [8, 11].

Participants and recruitment

Physiotherapists working in or recently graduated from physiotherapy programmes in Sudan were invited to complete an online form (Google Forms) between 23 September and 4 October 2026. Invited 100 and the response Of 54 forms received, none was an exact duplicate and all 54 were analysed. Sex/gender was self-reported and is described as gender.

Instrument

The questionnaire contained 7 demographic items, 19 true/false knowledge statements (10 MRI, 9 CT), 6 awareness and 6 attitude statements (5-point Likert scale), 10 practice statements (never to always), three clinical vignettes, one question on the main barrier and one on preferred training topics (full questionnaire in Online Resource 1). The questionnaire was reviewed and evaluated by specialists in both fields (diagnostic imaging and physiotherapy) before distribution, and its internal consistency was assessed in this sample (Table 2). One CT statement (children are more sensitive to ionising radiation) appeared twice; 47/54 (87%) gave identical answers, and only the first copy was scored, leaving 18 knowledge items (10 MRI, 8 CT).

Scoring and data cleaning

Knowledge: correct = 1, incorrect or 'don't know' = 0 (range 0–18); modified Bloom cut-offs defined good (15–18, at least 80%), moderate (11–14, 60–79%) and poor (0–10, below 60%) knowledge. Awareness, attitude and practice: mean of items scored 1–5. The practice item 'I rely solely on MRI or CT findings' was reverse-worded and showed a negative corrected item-rest correlation (− 0.29); it was reported separately and excluded, giving a 9-item practice score (the 10-item version was retained as a sensitivity analysis). Vignettes (0–3 points): routine MRI unnecessary for low back pain without red flags; CT or X-ray (not MRI) for major trauma with suspected fracture; verify compatibility for a patient with a pacemaker.

Typing errors in response labels were repaired; 34 grid cells with two selected answers (awareness 6, attitude 7, practice 21) were set to missing; scale scores were computed when at least 80% of items were answered. Straight-lining (identical answers to all items) was identified in 6 respondents for practice and 14 for awareness/attitude and examined in sensitivity analyses. No values were removed.

Statistical analysis

Analyses used Python 3 (SciPy, NumPy). All scores departed from normality (Shapiro-Wilk p below 0.05), so non-parametric tests were used. Data are presented as n (%), mean (standard deviation, SD) and median (interquartile range, IQR). Reliability was assessed with Cronbach's alpha (Kuder-Richardson formula 20, KR-20, for knowledge). Groups were compared with the Mann-Whitney U test (effect size: rank-biserial r) and the Kruskal-Wallis test (epsilon-squared); categories were compared with the chi-square or Fisher's exact test. Spearman correlations (rho) are given with bootstrap 95% confidence intervals (CI; 5,000 resamples). The Benjamini-Hochberg false discovery rate (FDR) was applied within each family of tests. Two exploratory linear regression models used heteroscedasticity-consistent (HC3) robust standard errors and variance inflation factors (VIF); B denotes the unstandardised coefficient. Two-sided $p < 0.05$ indicated statistical significance. No a priori sample size was calculated.

Ethical considerations

The study used an anonymous online questionnaire (Google Forms). No research ethics committee reviewed the study, and no ethics approval or exemption was obtained. The questionnaire itself was

reviewed and evaluated by specialists in diagnostic imaging and physiotherapy before use. No names, e-mail addresses or other personal identifiers were collected, participation was voluntary, and all data were handled with full confidentiality.

An invitation statement on the first page of the form explained the purpose of the study (Online Resource 1), and participants gave electronic informed consent before proceeding, including consent to the use of their anonymised responses for research and publication. All respondents were aged 20 years or older. For analysis, respondents were relabelled P01–P54 and no direct identifiers were kept. The study was conducted in line with the principles of the Declaration of Helsinki with respect to voluntary participation, informed consent and confidentiality. The absence of ethics committee review is acknowledged as a limitation.

Use of artificial intelligence

A large language model (Claude, Anthropic) was used as described in the AI disclosure in the Statements and Declarations: for language editing, for formatting the manuscript to the journal's requirements, and for preparing the reporting checklist and supplementary files, The authors checked all outputs and are responsible for the content.

Results

Respondents

Respondents were young and early in their careers: median age 26 years (IQR 25–27, range 20–35), 42/54 (78%) women, 11/54 (20%) final-year students and 37/54 (69%) with under one year of experience. Private clinics (25/54, 46%) and musculoskeletal practice (25/54, 46%) predominated, and 29/54 (54%) reported formal MRI or CT education or training (Table 1).

Table 1
Characteristics of respondents (N = 54)

Characteristic	**n (%) or value**
Age, years: median (IQR); range	26 (25–27); 20–35
Gender	
Women	42 (78%)
Men	12 (22%)
Highest qualification	
Final-year undergraduate	11 (20%)
Bachelor's degree	41 (76%)
Master's degree	2 (4%)
Clinical experience	
< 1 year	37 (69%)
1–4 years	14 (26%)
> 5 years	3 (6%)
Primary workplace	
Private clinic	25 (46%)
Governmental hospital	15 (28%)
Private hospital	12 (22%)
Other	2 (4%)
Area of practice	
Musculoskeletal	25 (46%)
Neurological	15 (28%)
Paediatric	9 (17%)
Cardiopulmonary	3 (6%)
General / not specialised	2 (4%)
Formal MRI/CT education or training	29 (54%)

IQR, interquartile range; MRI, magnetic resonance imaging; CT, computed tomography. Percentages are rounded and may not sum to 100

Knowledge

Mean knowledge was 12.3 (SD 4.1) out of 18 (median 13, IQR 10–15; 69% correct; MRI 6.8/10, CT 5.6/8; KR-20 0.84; Table 2). Good knowledge was found in 17/54 (31%), moderate in 23/54 (43%) and poor in 14/54 (26%). Safety content was answered best: CT in trauma (48/54, 89%), MRI for soft tissue, implants requiring checks and metal posing a risk (each 46/54, 85%), and rejection of the false statements on implants and metal (each 44/54, 81%). Physics, contrast and dose items were weakest: the magnet stays active (21/54, 39%), MRI is non-ionising (25/54, 46%), gadolinium use (26/54, 48%), noise (27/54, 50%) and that CT dose must be considered (29/54, 54%) (Table 3, Fig. 1). Many errors were ‘don’t know’ (for example gadolinium 24/54, 44%), pointing to missing knowledge rather than mistaken beliefs.

Table 2
Knowledge, awareness, attitude, practice and vignette scores and internal consistency

Score (range)	**n**	**Mean (SD)**	**Median (IQR)**	**Cronbach’s alpha[a]**
Knowledge total (0–18)	54	12.3 (4.1)	13 (10–15)	0.84
Knowledge MRI (0–10)	54	6.8 (2.3)	7 (6–8)	0.71
Knowledge CT (0–8)	54	5.6 (2.2)	6 (4–7)	0.76
Awareness (1–5)	54	4.11 (0.67)	4.17 (3.54–4.57)	0.78
Attitude (1–5)	53	4.44 (0.69)	4.83 (4.00–5.00)	0.91
Practice, 9 items (1–5)[b]	50	3.53 (1.19)	3.78 (2.56–4.61)	0.96
Applied vignettes (0–3)	54	1.87 (0.91)	2.00 (1.00–2.75)	–

SD, standard deviation; IQR, interquartile range

[a] Kuder-Richardson formula 20 for the knowledge scales; Cronbach’s alpha for the other scales

[b] The reverse-worded item (relying solely on imaging) was excluded from the practice score

Table 3
Correct answers to the knowledge items (N = 54)

Item	Domain	Statement (abridged)	Correct, n (%)
K18	CT	Useful for some traumatic injuries	48 (89%)
K02	MRI	Metal/implants may pose a risk	46 (85%)
K05	MRI	Some implants need compatibility check	46 (85%)
K09	MRI	Useful for soft tissues	46 (85%)
K17	CT	Children more sensitive to radiation	45 (83%)
K03	MRI	Implant patients can undergo MRI without assessment (F)[a]	44 (81%)
K10	MRI	Metal poses no risk in scanner room (F)[a]	44 (81%)
K07	MRI	Claustrophobia may require sedation	41 (76%)
K13	CT	Evaluates bone and soft tissue	40 (74%)
K14	CT	Contrast media can cause reactions	39 (72%)
K16	CT	Previous contrast reactions should be considered	38 (70%)
K12	CT	Uses ionising radiation	31 (57%)
K11	CT	Higher dose than radiography	30 (56%)
K15	CT	Dose need not be considered (F)[a]	29 (54%)
K06	MRI	Can be noisy	27 (50%)
K08	MRI	Gadolinium contrast may be used	26 (48%)
K01	MRI	Does not use ionising radiation	25 (46%)
K04	MRI	Magnetic field remains active between scans	21 (39%)

[a] F, false statement (the correct answer is ‘false’); all other statements are true

Good knowledge was reached by 14/29 (48%) of respondents with formal training versus 3/25 (12%) without (chi-square p = 0.016; Fig. 2). Knowledge was higher with formal training (median 14 versus 12; U = 489.5, p = 0.028, r = 0.35) and with one or more years of experience (p = 0.037, r = 0.36), but no group comparison survived FDR correction (all adjusted p at least 0.24), and these results are exploratory (Fig. 3). In the adjusted model (R^2=0.283, adjusted R^2=0.209, p = 0.006), at least one year of experience (B = 2.40, 95% CI 0.16 to 4.64, p = 0.036) and governmental workplace (B = − 2.70, − 5.32 to − 0.09, p = 0.043) were associated with knowledge, and formal training was borderline (B = 2.12, − 0.12 to 4.37, p = 0.063).

Awareness and attitude

Awareness was high (mean 4.11, SD 0.67; alpha 0.78) with 69–81% agreeing with each statement; the lowest was awareness that MRI does not use ionising radiation (69%), mirroring the 46% correct objective answer. Attitudes were more positive (mean 4.44, SD 0.69; alpha 0.91; 79–89% agreement). The statement that physiotherapists need additional imaging education had 48/54 (89%) agreement and no disagreement, and 45/53 (85%) agreed that imaging knowledge improves communication with physicians and radiologists (Fig. 4).

Practice

Reported practice was moderate and variable (mean 3.53, SD 1.19; n = 50; alpha 0.96). No behaviour was performed often or always by more than 58% of respondents: reviewing reports before treatment 29/50 (58%), asking about previous scans 26/52 (50%), asking about implants before MRI 25/51 (49%), and explaining MRI versus CT to patients 23/54 (43%) (Fig. 5). Fourteen of 53 (26%) said they often or always rely solely on imaging findings.

Clinical vignettes

In the low back pain vignette, 28/54 (52%) judged routine MRI unnecessary and 20/54 (37%) considered it necessary or usually necessary. For major trauma, 47/54 (87%) chose CT or X-ray and 7/54 (13%) chose MRI. For the pacemaker patient, 26/54 (48%) would verify device compatibility and follow the safety protocol, 11/54 (20%) would avoid MRI altogether, 6/54 (11%) would replace the pacemaker, 4/54 (7%) would proceed immediately and 7/54 (13%) did not know (mean vignette score 1.87, SD 0.91; Table 4). The trauma key accepted both CT and X-ray; with a CT-only key, 18/54 (33%) were correct.

Table 4
Responses to the clinical vignettes, main barrier and preferred training topic (N = 54)

Domain	Response	n (%)
V1 low back pain, no red flags: routine MRI	Not necessary / usually not necessary	28 (52%)
	Unsure	6 (11%)
	Usually necessary / necessary	20 (37%)
V2 major trauma, suspected fracture	X-ray	29 (54%)
	CT	18 (33%)
	MRI	7 (13%)
	Ultrasound	0 (0%)
V3 patient with pacemaker	Verify compatibility, follow protocol	26 (48%)
	Avoid MRI completely	11 (20%)
	Don’t know	7 (13%)
	Replace the pacemaker	6 (11%)
	Proceed immediately	4 (7%)
Main barrier	Lack of formal education or training	26 (48%)
	Limited interdisciplinary communication	12 (22%)
	Lack of educational resources	6 (11%)
	Limited access to imaging services	6 (11%)
	Work overload	4 (7%)
Preferred training	All topics	27 (50%)
	Clinical interpretation of findings	8 (15%)
	Basic MRI principles	7 (13%)
	Radiology reports; basic CT principles (each)	4 (7%)
	MRI safety	3 (6%)

Domain	Response	n (%)
	Radiation protection	1 (2%)
	Contrast media safety	0 (0%)

Barriers and training needs

The main barrier was lack of formal education or training (26/54, 48%), followed by limited interdisciplinary communication (12/54, 22%). Half (27/54, 50%) wanted training in all offered topics; clinical interpretation of findings (8/54, 15%) and basic MRI principles (7/54, 13%) were the most requested single topics (Table 4, Fig. 6).

Relationships between domains

Knowledge correlated with awareness, attitude, practice and the vignette score, whereas attitude showed no correlation with practice (Table 5, Fig. 7). Awareness and attitude were very strongly related (rho 0.77), partly reflecting a shared response style. In the practice model (n = 49), knowledge was the only significant predictor (B = 0.13 per knowledge point, 95% CI 0.02 to 0.23, p = 0.020), but the model overall explained little variance (adjusted R^2=0.043, p = 0.208). Findings were stable in sensitivity analyses: the knowledge-practice rho was 0.39 with the 10-item score and 0.34 after excluding straight-liners, and the attitude-practice rho remained non-significant (0.15, p = 0.39). The knowledge-vignette association (rho 0.32) was not significant with a CT-only key (rho 0.16, p = 0.237).

Table 5
Spearman correlations between key variables

Variables	n	Rho (95% CI)	p	FDR p[a]
Knowledge – awareness	54	0.56 (0.34 to 0.74)	< 0.001	< 0.001
Knowledge – attitude	53	0.51 (0.27 to 0.69)	< 0.001	< 0.001
Knowledge – practice	50	0.36 (0.10 to 0.58)	0.009	0.020
Knowledge – vignette score	54	0.32 (0.02 to 0.57)	0.018	0.036
CT knowledge – practice	50	0.38 (0.12 to 0.61)	0.006	0.014
MRI knowledge – practice	50	0.29 (0.03 to 0.52)	0.039	0.060
Awareness – attitude	53	0.77 (0.60 to 0.88)	< 0.001	< 0.001
Awareness – practice	50	0.17 (− 0.14 to 0.45)	0.240	0.320
Attitude – practice	49	0.00 (− 0.28 to 0.29)	0.995	0.995
Attitude – vignette score	53	0.38 (0.12 to 0.60)	0.005	0.013

CI, bootstrap confidence interval (5,000 resamples)

[a] Benjamini-Hochberg false discovery rate (FDR) adjusted over all 28 pairs in the full analysis

Self-rated awareness versus demonstrated knowledge

Self-rated awareness was a valid indicator for implant and metal safety (93% versus 55% correct among aware versus other respondents for implant assessment, p = 0.006; 92% versus 64% for MRI safety risk, p = 0.021) but not for radiation topics (MRI non-ionising: 51% versus 36%, p = 0.503; CT ionising: 65% versus 38%, p = 0.114) (Table 6).

Table 6
Self-rated awareness versus demonstrated knowledge

Self-rated awareness (agree/strongly agree) versus matching item	Correct among aware	Correct among others	Fisher p[a]
MRI non-ionising vs K01	21/41 (51%)	4/11 (36%)	0.503
CT radiation vs K12	26/40 (65%)	5/13 (38%)	0.114
MRI safety risks vs K02	37/40 (92%)	9/14 (64%)	0.021
Implants need assessment vs K05	40/43 (93%)	6/11 (55%)	0.006
MRI safety risks vs pacemaker vignette	22/40 (55%)	4/14 (29%)	0.124

[a] Fisher's exact test comparing the proportion correct among aware respondents with that among the others

Discussion

Principal findings

This survey suggests that physiotherapists in Sudan, mostly at the start of their careers, favour imaging education and know the practical safety rules, but have gaps in MRI physics, CT dose and device-safety decisions. Knowledge, not attitude, was linked to practice.

Comparison with previous studies

High agreement with imaging education mirrors findings in Nigeria and Pakistan [11, 12]. Our knowledge scores are not directly comparable with other instruments, but the pattern of stronger knowledge of simple safety rules and weaker knowledge of physics echoes a KAP survey in China, where healthcare providers had limited MRI safety knowledge (mean 10.9/28) alongside moderate attitudes [8]. The finding that formal training was associated with better knowledge agrees with calls to strengthen entry-level imaging curricula [13].

Our most distinctive result is the absence of an attitude-practice association. In the Chinese study, attitude mediated the effect of knowledge on practice [8]. Differences in constructs (MRI safety screening versus clinical use of imaging), the ceiling effect in our attitude scale (median 4.83) and the small sample may explain the discrepancy, which should be tested in larger studies. A French survey of physiotherapists likewise described a gap between knowledge (62%) and consistent application of differential diagnostic criteria (45%) [14], suggesting that translating knowledge into routine behaviour is a general challenge.

The pacemaker vignette is the clearest patient-safety signal: fewer than half would verify device compatibility. Physiotherapists in Sudan may not be the professionals who book MRI, but they often advise patients before scans, and with 10–20% of MRI patients carrying devices [8] misinformation

could matter. In contrast, the low back pain vignette suggests that about half of respondents already understand that routine imaging is unnecessary without red flags, in line with evidence that physiotherapists can limit unnecessary imaging [9, 10].

Self-rated awareness was reliable for implant safety but over-estimated for radiation topics, which suggests that self-report alone is an unsafe basis for planning education and that training needs should be assessed objectively.

Implications and recommendations

The following recommendations are drawn from our data and the cited literature, are relevant to educators designing imaging content in health professions curricula, and should be tested in intervention studies.

- *Curriculum*: integrate a short imaging module into entry-level programmes covering MRI physics (always-on magnet, non-ionising nature, contrast), CT dose and contrast reactions, and implant screening, with imaging framed as an adjunct to history and examination, not a substitute [11, 13, 15]. In our data these were the weakest items.
- *Safety checkpoint*: introduce a three-step 'ask, verify, refer' routine for any patient with an implanted device scheduled for MRI (ask about devices, verify compatibility with the imaging unit, refer or escalate when uncertain). Practice item scores for these behaviours were below 50%.
- *Case-based learning*: use vignette-based simulations, since applied decisions (pacemaker, low back pain) were weaker than recall of rules, and test competence objectively rather than by self-report.
- *Interprofessional communication*: establish structured physiotherapist-radiologist-physician communication; 22% named limited interdisciplinary communication as the main barrier and 85% saw communication benefits.
- *Continuing professional development*: offer modular, practice-oriented courses on interpreting reports and clinical correlation, the most requested single topic; pair them with local radiology services.
- *Policy*: professional bodies could clarify the scope of physiotherapists regarding requesting and interpreting imaging, as in other countries [1].
- *Research*: multicentre sampling with a documented response rate; a validated instrument; pre-post evaluation of an education package; and observed or audited behaviour rather than self-reported practice.

Strengths and limitations

Strengths are a transparent data-cleaning log, reliability testing, objective knowledge items alongside self-ratings, applied vignettes, bootstrap intervals, FDR control and sensitivity analyses. Limitations: the sample was small (N = 54), non-random and recruited online, with no response rate; voluntary samples tend to over-represent engaged respondents, and non-response mainly distorts prevalence estimates

rather than associations between variables [16], so we emphasise associations. The sample was young (69% under one year of experience; 20% students), mostly women, and overlapping experience and student status limit adjustment. Self-reported awareness and practice are open to social desirability bias, and ceiling effects reduced variability. Forty-two group comparisons were exploratory and none survived FDR correction; regression models had about 10 observations per predictor. The cross-sectional design precludes causal inference. Grid cells with two answers (n = 34) were set to missing, the trauma vignette key was ambiguous, and the reverse-worded practice item behaved inconsistently. The instrument was reviewed by specialists but was not formally psychometrically validated]. Findings describe this convenience sample of mostly early-career physiotherapists and should not be generalised to all physiotherapists in Sudan. Finally, the study had no ethics committee review or exemption, although participation was voluntary, anonymous and based on electronic informed consent.

Conclusions

Physiotherapists in this Sudanese sample held highly positive attitudes toward imaging education but showed gaps in MRI physics, CT radiation dose and MRI device-safety decisions. Because knowledge, not attitude, was linked to practice, structured MRI and CT education within physiotherapy training and continuing professional development should be prioritised, and tested in larger, multicentre and interventional studies.

Declarations

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Competing interests

The authors declare that they have no competing interests.

Ethics approval

This cross-sectional study used an anonymous online questionnaire (Google Forms). No research ethics committee reviewed the study, and no ethics approval or exemption was obtained. The questionnaire itself was reviewed and evaluated by specialists in diagnostic imaging and physiotherapy before use. No personal identifiers (for example names or e-mail addresses) were collected, participation was voluntary, and all data were handled with full confidentiality. The study was conducted in line with the principles of the Declaration of Helsinki with respect to voluntary participation, informed consent and confidentiality.

Consent to participate

An invitation statement at the beginning of the questionnaire explained the study purpose, and participants provided electronic informed consent before proceeding. Participation was voluntary, responses were anonymous, and participants agreed to the use of their anonymised data for research and publication.

Consent to publish

Not applicable. No identifying information is included in this article.

Data availability

The datasets generated and analysed during the current study are available from the corresponding author, Mustafa Ibrahim, on reasonable request. The data are anonymised (respondents relabelled P01–P54, without direct identifiers).

Author contributions

Mustafa Ibrahim and Mohamed Ahmed contributed to data collection, drafting, critical revision, and final approval of the manuscript. Both authors approved the final version of the manuscript and agree to be accountable for all aspects of the work.

AI disclosure

During the preparation of this work the authors used Claude (Anthropic; model claude-sonnet-5-5, accessed through the Claude app in October and November 2026) for language editing and grammar correction, for restructuring the manuscript to the formatting requirements of the journal, and for preparing the STROBE checklist, the supplementary files and the cover letter and for writing the Python code used for the statistical analysis and the figures]. Claude was not listed as an author. The authors reviewed and verified all AI-assisted content and take full responsibility for the accuracy, originality and integrity of the final manuscript.

References

1. Mabry LM, Boyles RE, Brismée JM, Agustsson H, Smoliga JM. Physical therapy musculoskeletal imaging authority: a survey of the World Confederation for Physical Therapy nations. Physiother Res Int. 2020;25:e1822. https://doi.org/10.1002/pri.1822.
2. Dong Y, Alhaskawi A, Zhou H, et al. Imaging diagnosis in peripheral nerve injury. Front Neurol. 2023;14:1250808. https://doi.org/10.3389/fneur.2023.1250808.
3. Itthipanichpong T, Thamrongskulsiri N, Menta SV, Ranawat AS. Extra-articular hip impingement: subspine, iliopsoas, and ischiofemoral impingement. EFORT Open Rev. 2025;10:733–44. https://doi.org/10.1530/EOR-2023-0179.

4. Mohile NV, Kuczmarski AS, Lee D, Warburton C, Rakoczy K, Butler AJ. Spondylolysis and isthmic spondylolisthesis: a guide to diagnosis and management. J Am Board Fam Med. 2022;35:1204–16. https://doi.org/10.3122/jabfm.2022.220130R1.
5. Lombard C, Teixeira P, Germain E, Dodin G, Louis M, Blum A, Gillet R. Elbow stiffness imaging: a practical diagnostic and pretherapeutic approach. J Clin Med. 2021;10:5348. https://doi.org/10.3390/jcm10225348.
6. Kou X, Pan X, Zhang Y, He B, You Z, Ma G. Brucella infection of the sternoclavicular joint with innovative localized drug delivery: a case report and review of the literature. Orthop Res Rev. 2026;18:567349. https://doi.org/10.2147/ORR.S567349.
7. Vogele D, Otto S, Sollmann N, et al. Sarcopenia – definition, radiological diagnosis, clinical significance. Fortschr Röntgenstr. 2023;195:393–405. https://doi.org/10.1055/a-1990-0201.
8. Zhang M, Lu G, Zhai D, Guo Y, Li Z, Xing Y. Knowledge, attitudes and practices regarding MRI safety among healthcare providers and patients/family members in China. Sci Rep. 2026;16:14571. https://doi.org/10.1038/s41598-026-44648-5.
9. Crowell MS, Mason JS, McGinniss JH. Musculoskeletal imaging for low back pain in direct access physical therapy compared to primary care: an observational study. Int J Sports Phys Ther. 2022;17(2):237–46. https://doi.org/10.26603/001c.31720.
10. Keil AP, Baranyi B, Mehta S, Maurer A. Ordering of diagnostic imaging by physical therapists: a 5-year retrospective practice analysis. Phys Ther. 2019;99(8):1020–6. https://doi.org/10.1093/ptj/pzz015.
11. Onyeso OK, Umunnah JO, Eze JC, et al. Musculoskeletal imaging authority, levels of training, attitude, competence, and utilisation among clinical physiotherapists in Nigeria: a cross-sectional survey. BMC Med Educ. 2022;22:701. https://doi.org/10.1186/s12909-022-03769-x.
12. Quratulain, Afzal MT, Aslam MA, et al. Physical therapist's knowledge and use of medical imaging in clinical practice: a cross-sectional survey. Pak J Health Sci. 2023;4(10). https://doi.org/10.54393/pjhs.v4i10.1051.
13. Boissonnault WG, White DM, Carney S, Malin B, Smith W. Diagnostic and procedural imaging curricula in physical therapist professional degree programs. J Orthop Sports Phys Ther. 2014;44(8):579–612. https://doi.org/10.2519/jospt.2014.5379.
14. Vigier-Fretey CS, Granados-Santiago M, Raya-Benitez J, Zamora-Tortosa J, Heredia-Ciuro A, Valenza MC. Beliefs, attitudes, knowledge, and behaviors of physical therapists towards differential diagnosis in chronic neck pain etiology. Hospitals. 2025;2:7. https://doi.org/10.3390/hospitals2010007.
15. Deyle GD. Musculoskeletal imaging in physical therapist practice. J Orthop Sports Phys Ther. 2005;35(11):708–21. https://doi.org/10.2519/jospt.2005.35.11.708.
16. Cheung KL, ten Klooster PM, Smit C, de Vries H, Pieterse ME. The impact of non-response bias due to sampling in public health studies: a comparison of voluntary versus mandatory recruitment in a Dutch national survey on adolescent health. BMC Public Health. 2017;17:276. https://doi.org/10.1186/s12889-017-4189-8.

Figures

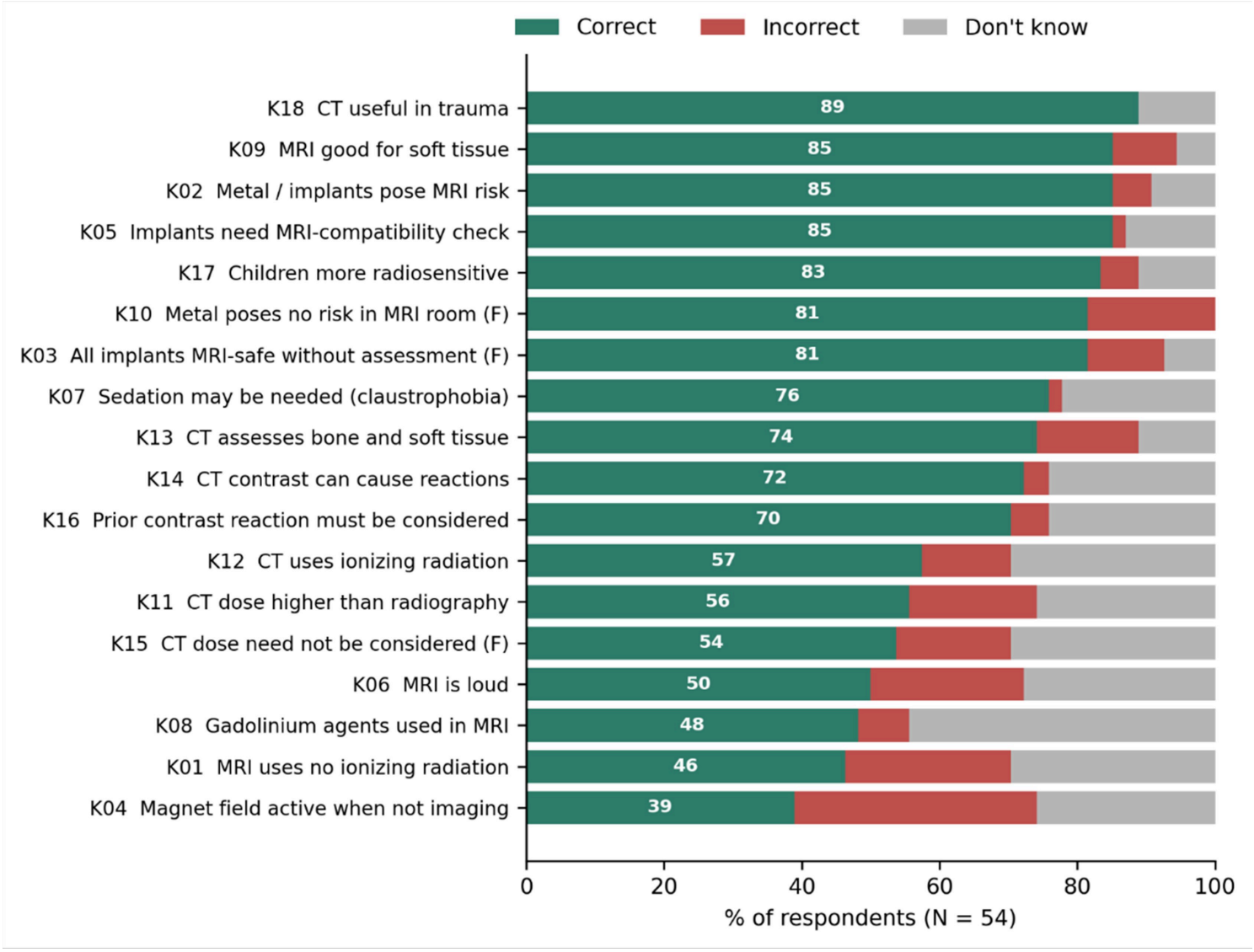


Figure 1

Responses to the 18 MRI and CT knowledge items (N=54). Bars show the percentage of correct, incorrect and ‘don’t know’ responses, as identified in the legend; the number inside each bar is the percentage correct. Items are sorted by percentage correct. (F) marks false statements, for which ‘false’ is the correct response

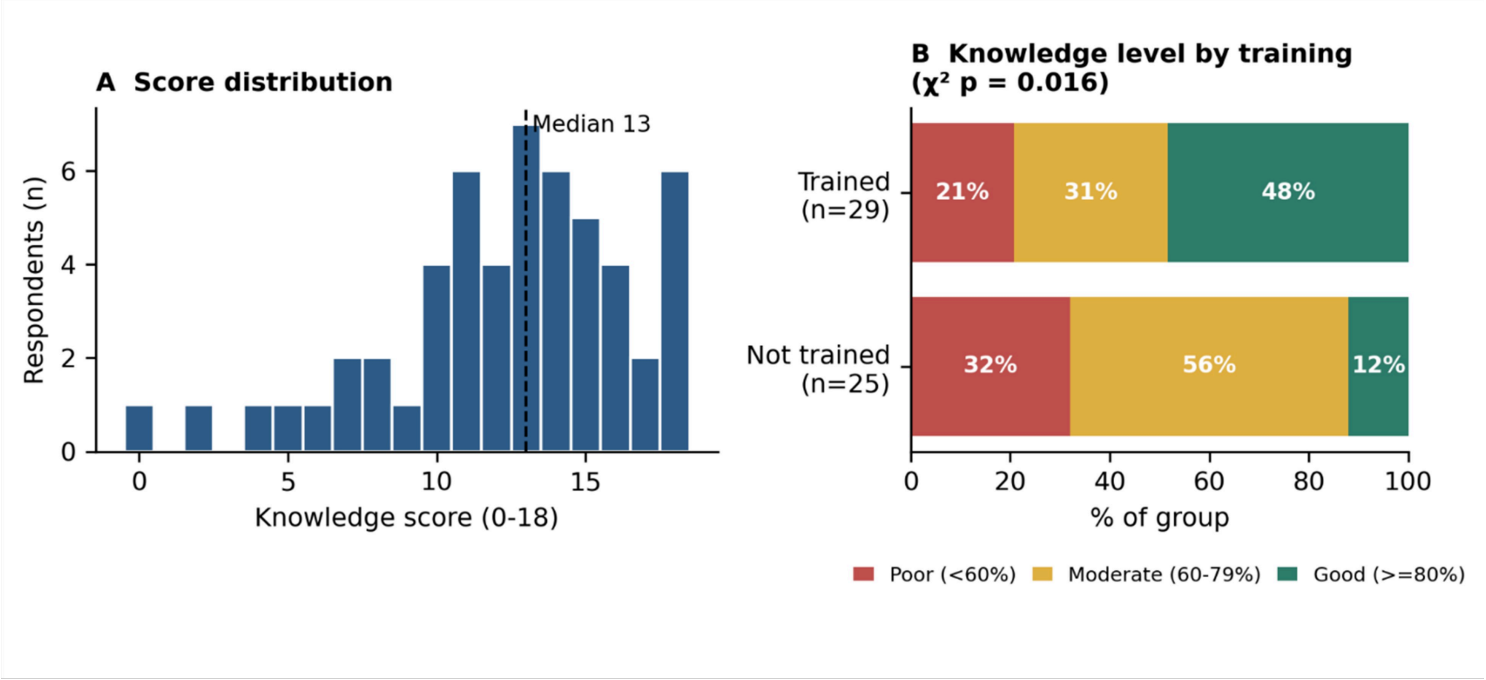


Figure 2

(a) Distribution of knowledge scores (dashed line: median 13). (b) Knowledge level by formal MRI/CT education or training (chi-square p=0.016); poor, moderate and good knowledge are defined as below 60%, 60–79% and at least 80% correct

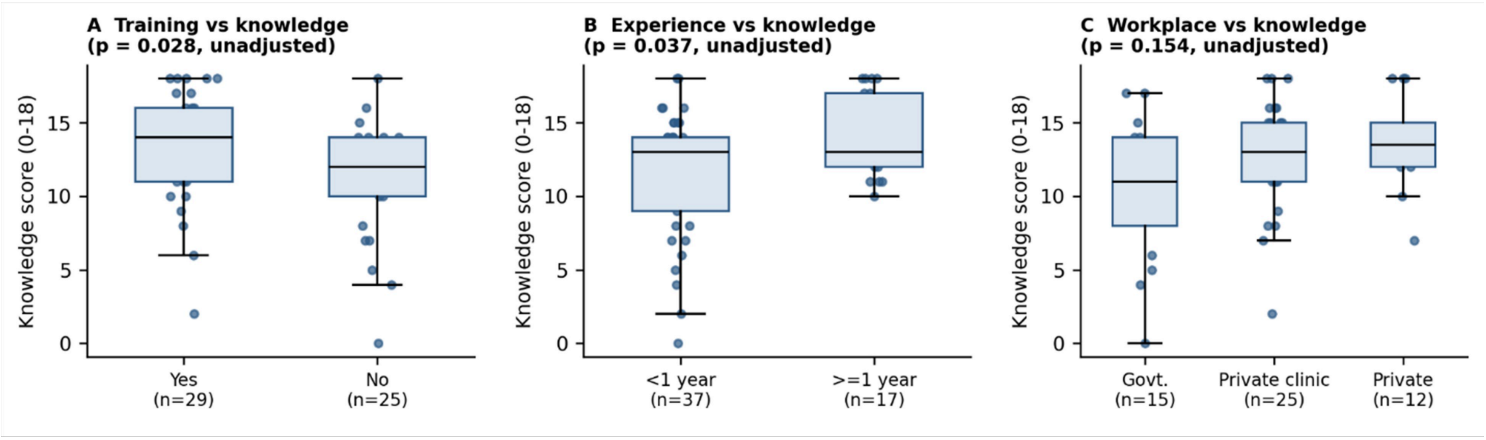


Figure 3

Knowledge score by formal training (a), clinical experience (b) and workplace (c). Box plots show the median and interquartile range, and points are individual respondents. The p values are unadjusted (Mann-Whitney U test for a and b, Kruskal-Wallis test for c); none remained significant after false discovery rate correction. Govt., governmental hospital; Private, private hospital

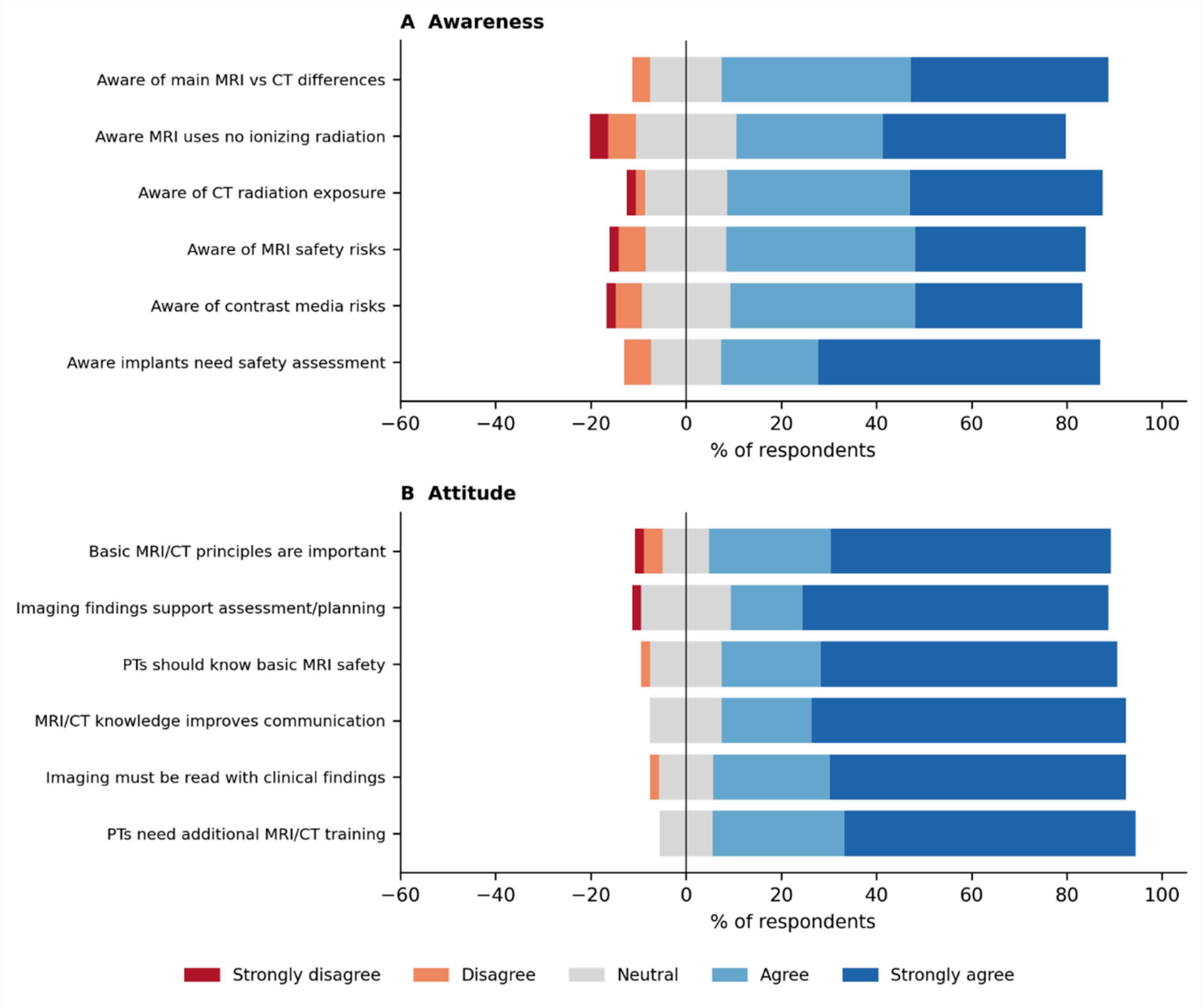


Figure 4

Self-rated awareness (a) and attitude (b) statements regarding MRI and CT. In these diverging stacked bars, neutral responses are centred on zero, disagreement extends to the left and agreement to the right. Bar lengths are percentages of respondents who answered each item (n=51–54)

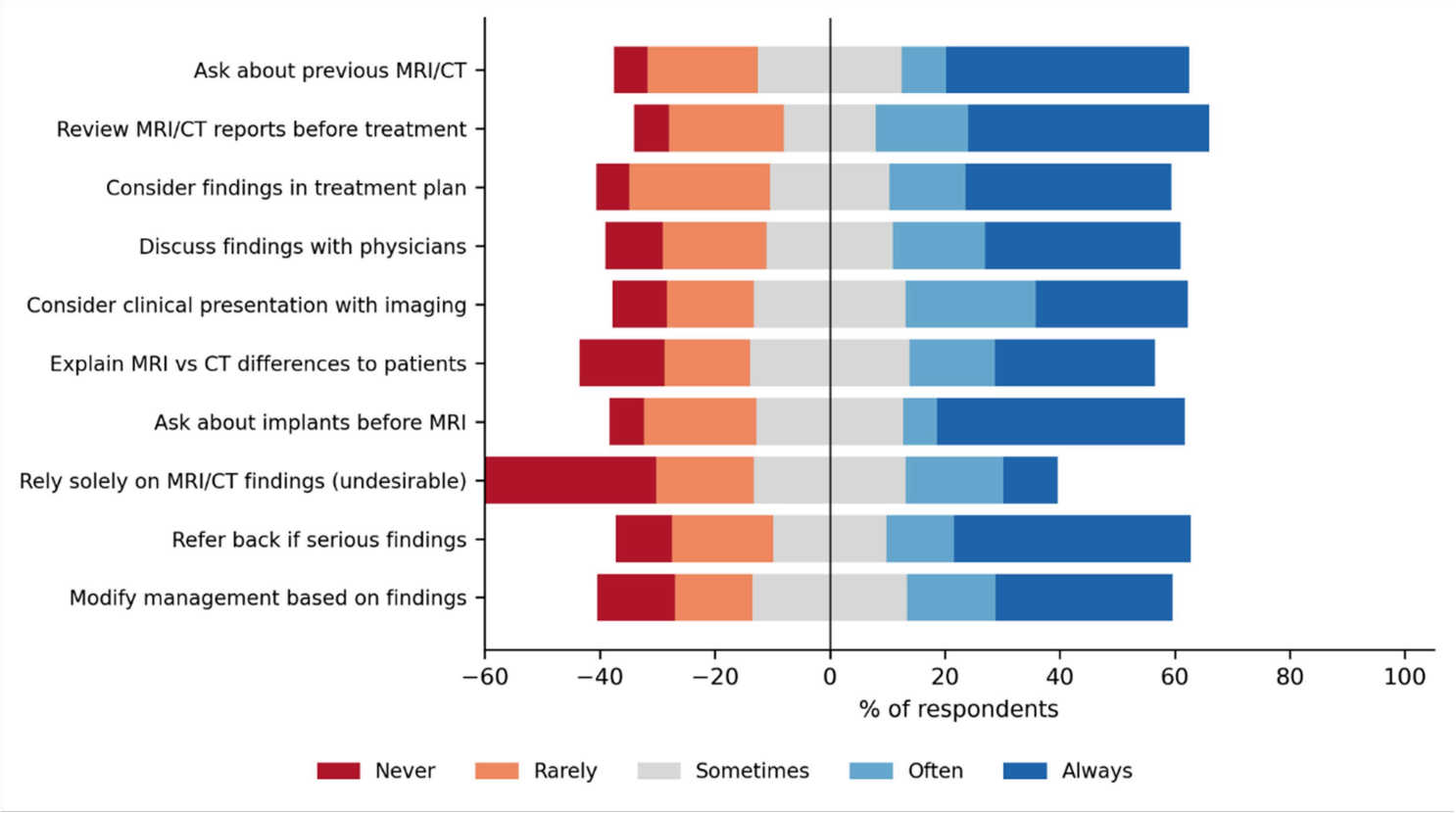


Figure 5

Self-reported frequency of ten imaging-related practice behaviours (diverging stacked bars; n=50–54 per item). For the item ‘Rely solely on MRI/CT findings (undesirable)’, the often and always categories indicate the unwanted direction; this item was excluded from the practice score

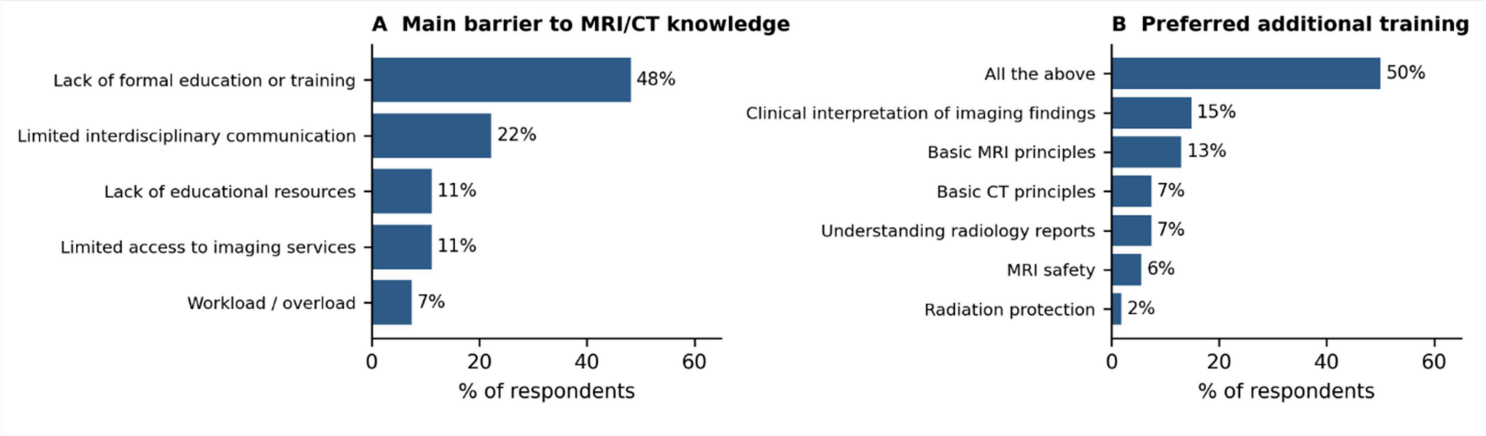


Figure 6

Main perceived barrier to physiotherapists’ MRI and CT knowledge (a) and preferred additional training topic (b) (N=54; one option per respondent). ‘All the above’ refers to all topics offered in the questionnaire

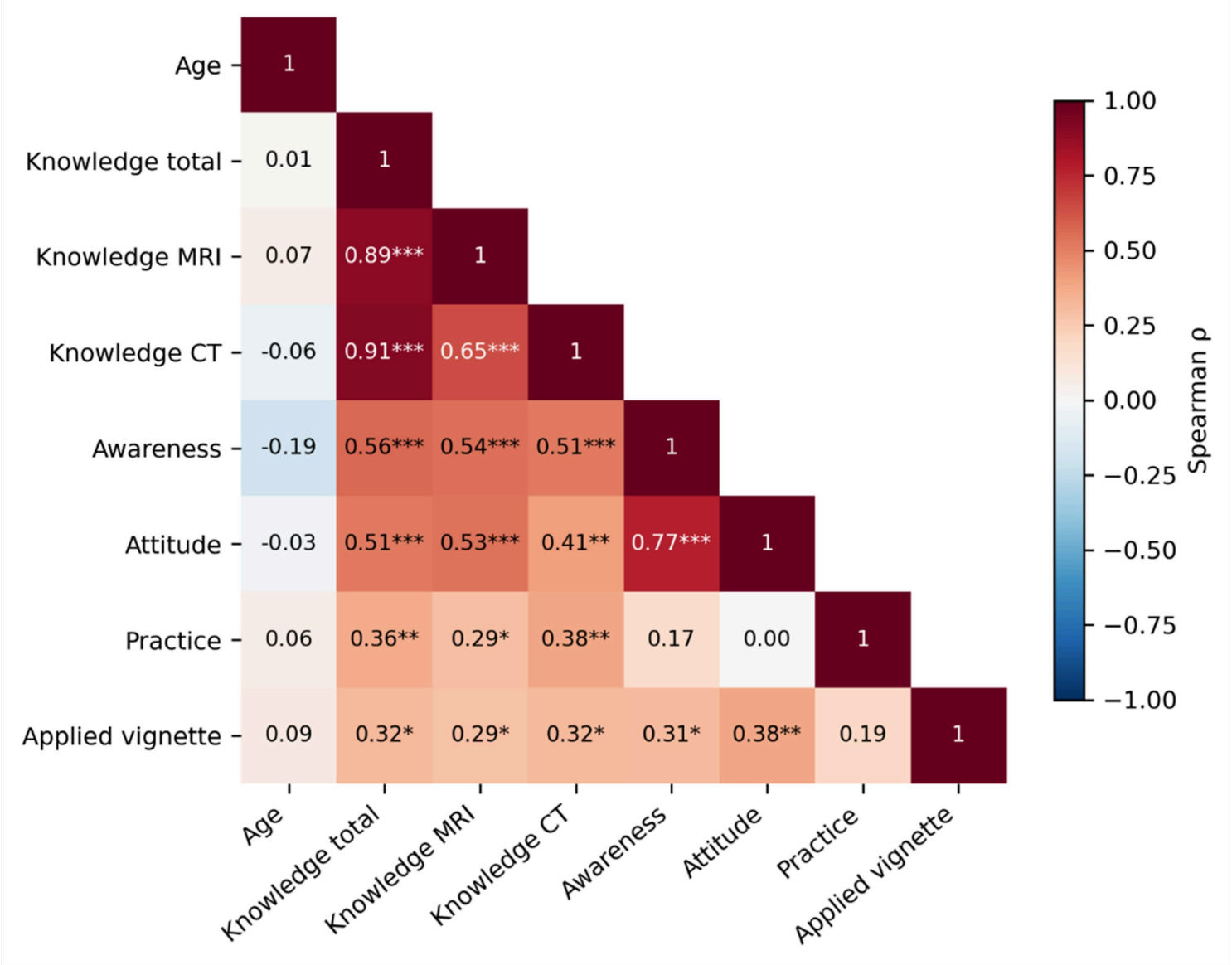


Figure 7

Spearman correlation matrix of age, knowledge (total score and MRI and CT sub-scores), awareness, attitude, practice and applied vignette score. Cell values are Spearman's rho; * p<0.05, ** p<0.01 and *** p<0.001 (unadjusted). The total knowledge score is mathematically coupled with its MRI and CT sub-scores

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Supplementaryinformationinfo.docx