

Musculoskeletal ultrasound imaging - an exploration of physiotherapists' interests and use in practice

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Abstract

Background

Musculoskeletal ultrasound imaging (MSKUSI) has recently gained popularity; several professions have expressed an interest in this application but the clinical use by physiotherapists has not been fully researched.

Objectives

To explore physiotherapists' interests and use of MSKUSI in practice.

Design

Sequential mixed-methods; questionnaire followed by in-depth interviews.

Method

A questionnaire was developed and distributed to gain initial information, (75 responses received). Analysis informed topic-guide development and enabled a purposive-sampling strategy for in-depth interviews that explored physiotherapists' interests, education and clinical use of MSKUSI (n=11). Interview data was analysed thematically.

Results:

Five themes were identified:

1. Professional skill set – physiotherapists' suitability for MSKUSI
2. Factors that have impacted physiotherapists' ability to use MSKUSI

3. Physiotherapists' motivation to use ultrasound - improving patient focused care
4. Quality assurance strategies
5. Application of biopsychosocial model

Themes revealed links between physiotherapists' core skills, knowledge and professional experiences that align with MSKUSI requirements. Some participants reported support accessing education but many described challenges finding appropriate mentorship. Participants observed education did not always reflect practice typical of physiotherapists. Application of clinical reasoning processes utilised by physiotherapists was regarded as integral to patient-focused scanning.

Conclusions:

Physiotherapists' professional training and musculoskeletal practice are seen as a foundation for education in MSKUSI. Accessing education can be challenging, in particular mentorship that fully incorporates the biopsychosocial model. Proposed roles for MSKUSI for physiotherapists include verification of clinical assessment findings for diagnosis and facilitation of patient education. The potential to streamline patient pathways and optimise resource management warrant further investigation.

Keywords:

Musculoskeletal ultrasound, sonography, physiotherapy, biopsychosocial assessment, education, clinical reasoning.

Introduction

Musculoskeletal ultrasound imaging (MSKUSI) is reported widely as a useful imaging modality and has becoming increasingly popular in the last decade (1,2,3). Although traditionally used predominantly by radiologists, other professions including physiotherapists, sports physicians, accident and emergency physicians and rheumatologists (3 ,4) have shown an interest. The popularity of MSKUSI has been attributed to several factors: it is highly portable, virtually risk free, non-invasive and relatively inexpensive when compared with other imaging modalities and can provide a dynamic assessment (5).

The evidence base relating to MSKUSI as a diagnostic tool is extensive and reflects the modality's suitability for imaging musculoskeletal tissues (5, 6, 7). Image formation is dependent on the ability of the tissues to reflect the ultrasound beam, consequently many components of the musculoskeletal system can be viewed. Strong reflectors such as bone and tendon appear as a bright white image and are termed 'hyperechoic', medium reflectors such as muscle and fat are grey and termed 'hypoechoic' and non-reflectors such as fluids are black and called 'anechoic' (8). Abnormal tissue can be identified by changes in echogenicity within a structure as well as alterations in shape, size and boundaries (5, 8).

The evidence base discussing MSKUSI use by professions outside radiology in the United Kingdom (UK) has recently expanded (3, 4). Several professions have published guidelines to assist training and ensure quality assurance (9,10,11). Guidelines for physiotherapists in the UK have not yet been agreed and the evidence base relating to the physiotherapy profession's use of MSKUSI is limited (4,12,13).

Existing literature provides extremely limited information regarding the influence of MSKUSI used by physiotherapists on patient assessment or management. Some authors have hinted that diagnostic ultrasound is well suited to physiotherapists (4,14), yet the impact of this modality on clinicians' clinical reasoning or patient management has not been fully explored. Physiotherapists' clinical reasoning has been evaluated by many authors, (15,16,17) and has been reported as a process that runs throughout patients' management. The relationship between physiotherapists' clinical reasoning and MSKUSI has not been discussed and it is not known if ultrasound could influence this process.

The orthodox medical model of tissue-based pathology dominates MSKUSI literature (1, 5), there are references to 'incidental findings', 'normal variants' or 'age appropriate changes' but the implied link between tissue-based pathology and symptoms is prevalent. This model of tissue-based pathology is reflected in traditional ultrasound training and therefore the practice of clinicians including radiologists and sonographers (1,16,17). Physiotherapy education routinely explores non-nociceptive pain, complex pain states and biopsychosocial contributions to presentations,(19) and physiotherapists may therefore be in a strong position to

integrate these concepts into MSKUSI. This practice-based integration has not yet been included in literature, therefore, the aim of this study was to explore why physiotherapists are interested in MSKUSI and what are its clinical roles for this professional group?

Methods

Research Design

This research exploring professional interest and application of ultrasound by physiotherapists was divided into two sections; a survey and semi-structured interviews. The two components were distinct in that the data were collected at different times. The data analysis from the first component was used to inform the sampling for the semi-structured interviews and to identify concepts for exploration and elaboration. This mixed-methods study design follows, to some extent the explanatory-sequential design outlined by Cresswell and Plano Clark, (20) as it involves the collection and analysis of quantitative data, this is the priority data collection tool in their model. This phase is followed by the collection and thematic analysis of qualitative data that should enable explanation of the findings found in the quantitative study. Ethical approval for the research was granted by the X Ethics Committee, (Reference 13006).

Initial Survey

A questionnaire was used as the data collection instrument in the initial survey, one was developed as no existing questionnaire met the required criteria or were directly

relevant to the research questions. It was informed by publications dedicated to questionnaire development,(21) and those related to exploring the use of ultrasound, (23,4). Discussions with colleagues and research experts guided the content, structure and design. Several draft questionnaires were considered before one was formally piloted on a clinician known to use MSKUSI, this feedback on all questionnaire elements resulted in subtle adjustments before the data collection tool was finalised. The final questionnaire, (Fig 1) could be presented on a single sheet of A4 paper and comprised of a series of 4 closed questions related to MSKUSI, (each was followed by space for participants to elaborate on their answer). The questionnaire was distributed by hand at a physiotherapy conference, (Association of Chartered Physiotherapists in Orthopaedic Medicine and Injection Therapy), by email invitation for consenting members of a specialised professional group interested in ultrasound, (Electro-Physical Agents and Diagnostic Ultrasound network) and by a professional online discussion forum led by the United Kingdom's professional body, the Chartered Society of Physiotherapy. The questionnaire was accompanied by a participant information sheet that detailed the study's aims and researcher's background.

The intended roles of the survey included accessing physiotherapists with an interest in MSKUSI, collecting background data about the physiotherapists including their work environment and educational history in MSKUSI, enabling a purposive sampling strategy for the second part of the study and gaining consent from physiotherapists who would be willing to be interviewed.

Interview Method

A topic guide was generated to ensure interviews explored key concepts relevant to the research question, it was informed by issues identified from the questionnaire and the research aims. Participants were facilitated to describe their experiences with MSKUSI including education accessed, support or barriers experienced, current clinical application and their vision for using the modality in the future. 11 participants were interviewed at their place of work by XX, the interviews' duration was each approximately 1 hour, field notes were taken and interviews were digitally recorded and transcribed verbatim.

The primary researcher was a female doctoral student (XX) and physiotherapist with no clinical scanning experience. The researcher's professional background and familiarity with musculoskeletal terminology enabled exploration of topics during the in-depth discussions.

Figure 1: Survey Questionnaire

Questionnaire - Musculoskeletal Ultrasound Imaging Use by Physiotherapists

Please tick responses or provide brief answers in the areas indicated.

1. Do you use musculoskeletal ultrasound imaging in clinical practice?

Yes		No	
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If yes:

Briefly state the role of musculoskeletal ultrasound imaging in your clinical practice:

.....

If no:

What role(s) do you anticipate that musculoskeletal ultrasound imaging could have in your clinical practice?

.....

2. Nature of your clinical practice:

NHS	
Private practice	
Private hospital	
Sports team or institute	
Research	

3. Have you undertaken any education in musculoskeletal ultrasound imaging?

Yes		No	
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If yes, state the nature and duration of the education;

.....

4. Have any factors influenced your ability to use musculoskeletal ultrasound imaging in clinical practice?

Yes		No	
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If yes, please state these factors:

.....

This survey will be followed by an interview based study involving a small number of subjects. If you are happy to be contacted to participate in an interview that will explore the issues affecting physiotherapists' use of musculoskeletal ultrasound, please provide your details below, thank you:

Name	Tel number:
e-mail address:	

Results

75 questionnaires were returned. Of the 75 respondents, 34 reported that they used MSKUSI in clinical practice and 41 reported that they did not, the professional demographic of these groups has been provided in Table 1. The individuals who were using MSKUSI in practice were asked to briefly state the role of the modality and those who were not using it, were asked to comment on anticipated roles in practice.

Table 1: Nature of clinical practice for respondents.

Professional Environment	Environment reported by all respondents (n=75)	Environment reported by scanning respondents (n=34)
NHS	43	19
Private practice	31	15
Private hospital	4	2
Sports team or institute	8	3
Research	10	5

The respondents using ultrasound provided varying levels of detail regarding its role, similarly, the respondents not using the modality but with an interest in using it reported their perceived roles. Considerable repetition was evident enabling categorization of the answers which have been presented below in Table 2 alongside the number of participants who stated each role. Most participants stated more than one role for the modality.

Table 2: Summary of role of ultrasound imaging from questionnaire

respondents: respondents who use MSKUSI and from respondents who do not use the modality but expressed an interest in its use.

Role of musculoskeletal ultrasound imaging	Number reporting this role from 34 respondents using ultrasound	Number reporting this role from 41 respondents not using ultrasound but with interest in the modality
Diagnostic	24	31
Support clinical decision making	10	8
Feedback / patient education	5	7
Tendon imaging	6	3
Guide injections	8	8
Monitor recovery	9	2
Research	1	2
Career progression	1	0
Animal physiotherapy	0	1

The responses also provided information regarding the MSKUSI education accessed by each respondent and the factors that had influenced their engagement with the modality. Categorisation of the influential factors has been presented in Table 3, factors 1 – 7 were negative factors and factors 8 – 10 were factors that positively influenced participants' engagement with the modality.

Table 3. Factors identified that have influenced respondents' ability to use MSKUSI. Respondents who reported a factor, (n=57) and then divided into groups of those using the modality and those not.

Factor identified	Respondents who reported a factor had influenced their use of MSKUSI Total (n=57)	Respondents using MSKUSI, reporting factor had influenced their use of modality (n=28)	Respondents not using MSKUSI reporting factor that had influenced their use of the modality (n=29)
1: Cost and availability of ultrasound machines	21	6	15
2: Availability of appropriate education / courses	7	6	1
3: Availability of supervision	10	4	6
4: Resistance from radiologists or other colleagues	6	3	3
5: Time pressures	5	3	2
6: Lack of evidence to support its use	2	1	1
7: Personal commitment needed	5	2	3
8: Positive professional support from colleagues	12	12	0
9: Business case enabling a cost saving	8	7	1
10: Practical ease of use	15	12	3
11: Other	2	2	0

Purposive Sampling Strategy for In-depth Interviews

The questionnaires informed a purposive sampling process, the aim was to produce an information rich cohort of participants appropriate for the second stage of data collection, the semi-structured interviews.

A stratified purposive sampling process, guided by Patton's 16 strategy classification, (23) was used to ensure the interviewed subjects were representative of the questionnaire respondents. This process does not aim to be statistically

representative but informationally representative and accesses subjects based on preselected parameters of central importance to the research question,(23). The parameters included ensuring representation of physiotherapists who reported they were using MSKUSI from varying work environments, from formal and informal educational backgrounds and who had reported a selection of factors that had influenced their scanning experiences. 11 participants were selected for the second part of the study, the semi-structured interviews, their demographics and summary responses from the questionnaire have been presented in Table 4. Whilst purposive sampling underpinned the recruitment strategy, the analysis process commenced with the first interview and continued until data saturation was evident, (23a).

Table 4: Demographics of Interview Participants from Questionnaire

Responses

Participant Number	Nature of practice	Nature of MSKUSI education	Factors that have influenced ability to use MSKUSI
1	NHS Private practice	PGCert	Availability of appropriate education / courses Positive professional support from colleagues
2	NHS	Informal – work based peer taught	Positive professional support from colleagues Business case enabling a cost saving
3	NHS	PGCert	Cost and availability of ultrasound machines Positive professional support from colleagues
4	NHS	MSc	Availability of supervision Resistance from radiologists or other colleagues Business case enabling a cost saving
5	Private practice	PGCert	Cost and availability of ultrasound machines Positive professional support from colleagues Practical ease of use
6	NHS	Assessed special interest group course.	Availability of appropriate education / courses Resistance from radiologists or other colleagues
7	Research	Informal - peer taught.	Lack of evidence to support its use Practical ease of use
8	NHS Private practice	PGCert	Positive professional support from colleagues Practical ease of use
9	NHS	University – accredited short course	Positive professional support from colleagues
10	Private practice Sport institute	PGCert	Availability of supervision Practical ease of use
11	NHS	University – accredited short course	Cost and availability of ultrasound machines Business case enabling a cost saving

Interview Data Analysis

The transcribed interview data were analysed thematically. This method for identifying and reporting patterns in data is well suited to exploratory studies that require inductive reasoning whereby the investigator's analysis facilitates identification of codes and themes from the data (24, 24a). The coding process associated was guided by the principles documented by Saldaña,(25). Identification of initial codes was followed by an analysis process facilitated by MAXQDA, (Version 11, Verbi Software) enabling formation of subcategories, categories and themes. Data coding and theme formation were verified by a second researcher, (X) who was independent from the data collection process.

Interview Results

Data analysis resulted in the identification of five themes, each one reflecting a key element that participants highlighted that related to the research question. The themes were named to reflect the essence of their content:

1. Professional skill set – physiotherapists' suitability for MSKUSI
2. Factors that have impacted physiotherapists' ability to use MSKUSI
3. Physiotherapists' Motivation to Use Ultrasound - Improving Patient Focused Care
4. Quality Assurance Strategies
5. Application of Biopsychosocial Model

Each theme's key findings have been summarised below and supported with quotations from participants. These theme summaries are concise, a subsequent publication provides greater detail of one of the themes, (theme 5):

Theme 1, 'Professional Skill set – Physiotherapists' suitability for MSKUSI'

Participants reported a close association between their core physiotherapy skills and knowledge and those of MSKUSI. This knowledge base was regarded as a foundation for ultrasound training:

'...for the first time, you are looking at your anatomy live and you are looking on screen, you know those structures, you have heard of them, you studied up on them. But when you are looking at them physically, that fascinated me and that started it.'

(PT1)

Participants emphasised that they regarded knowledge of musculoskeletal medicine and management as an essential basis for effective use of MSKUSI. The impact of professional experience was highly valued as it enabled them to link imaging with clinical information:

'arrogantly maybe, we are in a unique position to take this on because I think that we have that broader perspective.' (PT5)

The dynamic application of MSKUSI was reported to align well with physiotherapists' interest in functional movement analysis:

'I think it is ideal for physiotherapists because you are actually watching things move, which is what we do, it is all about movement, that is what we are about, joints and

muscles moving and the fantastic thing about ultrasound is that, that was my immediate impression, 'finally I can actually watch things moving in real time'. (PT7)

Theme 2, 'Factors that have impacted physiotherapists' ability to use MSKUSI.

Several participants engaged in validated university-based education because the award provided formal recognition of competent and would be valued by employers:

'...how can you prove to someone that in a court of law that potentially you are competent? That has to be formal training that has to be - it is not an attendance thing, it is a 'I have been examined thing...' (PT10)

Accessing mentorship was reported as a challenge by many. Mentorship offered by radiologists and other medical professionals was gratefully received but may not have included some MSKUSI applications of interest to physiotherapists such as optimising dynamic imaging in response to functional aggravating activities and correlation of imaging with clinical examination. Participants also noted that assessment of competency by non-physiotherapist colleagues rarely included thorough evaluation of clinical reasoning:

'... our assessment is totally different to the orthopaedic surgeon or rheumatologist, and radiologists don't assess at all. So I am thinking that if I assess something and it is telling me something different, I will probably use the ultrasound in a different way because I'm looking for something different to them.' (PT11)

Barriers to MSKUSI utilisation by physiotherapists includes limited mentor access, lack of machine availability, lack of managerial support and opposition from other professional groups.

'... they spend more money to get the supervision than they are spending on the course, it is hard now, but that is how it is' (PT 1)

'I am still soldiering on with an ancient device' (PT 7)

'I approached the radiology department and was flatly refused.' (PT 4)

Some participants were able to report high levels of support from education providers, mentors and colleagues from medical specialisms.

'But because (mentor's name) is so high up and does so much teaching, it just been a doddle really, because he is on tap' (PT2)

'I think the mentoring (with consultant radiologist) was absolutely critical to that process. The course gave me the academic underpinning, it gave me awareness, but did not give me the practical competency that came from the mentoring and I continued after that course up until fairly recently' (PT5)

Theme 3, 'Physiotherapists' Motivation to Use Ultrasound - Improving Patient Focused Care'.

Participants reported MSKUSI has a role verifying clinical examination findings and contributes to the physiotherapist establishing a diagnosis.

'It is the way I see ultrasound, is a way of validating my clinical assessment and I see it absolutely in that way and it is about for me correlating what I am finding with my clinical examination with the available radiological findings' (PT5)

'Yes, does it make sense? When I scan, does it actually confirm what I am expecting to find? I won't treat on a scan' (PT2).

They also emphasised that patient management could be influenced by MSKUSI as physiotherapists performed interventions such as guided injections and incorporated imaging information into their clinical reasoning processes.

Participants reported patients' belief and trust in the physiotherapists' message was enhanced with MSKUSI and may positively influence patients' compliance with management

'I think that it definitely helps with understanding and education is an important part of trying to dictate compliance, I think there might be that. I think it gives confidence, therapeutic alliance, believing someone, being credible'. (PT 5)

The only participant who regularly used MSKUSI to image muscle activity regularly worked in a research role, other participants reported imaging muscle activity had initially been an interest but this had not endured:

'... not looking at isolated muscles at all. I probably have not done that now for about 6 or 7 years, so it was pretty soon after I bought it for that intentional purpose but decided not to use it for that purpose.' PT10

Theme 4, 'Quality Assurance Strategies'.

Participants reported that they were keen to comply with their professional body's standards but specific MSKUSI related guidance from their professional body was not yet available. Some expressed concern that poorly considered guidance from their professional body or increased sonographic regulation could limit innovative physiotherapy practice:

'it is an unregulated profession, there will come a time when it is regulated, but at the moment it is unregulated. What will happen is, if we do not take the bull by the horns, if we do not seize this opportunity to actually produce our own guidelines, guidelines will be thrust upon us and that may actually limit physios' practice, not enhance physios' practice.' (PT 4)

All participants engaged with quality assurance processes to minimise professional risk, misinterpretation of images or failing to identify a sinister pathology were identified as risks so diverse strategies were reported included formal image auditing processes and scanning in pairs.

'it could come back and haunt you and your profession because you are misusing it.' (PT 11)

Theme 5, 'Application of Biopsychosocial Model'.

Participants reported that MSKUSI findings were incorporated into the biopsychosocial framework of musculoskeletal assessment and management.

The references to this integrated assessment process were numerous and participants were keen to demonstrate they retained and applied their holistic view of patients' presentations when scanning:

'I see an awful lot of what you might refer to as yellow flags, things that you immediately flag up in the sonography room..' (PT8)

'You cannot make a diagnosis based on a scan and you certainly never treat a scan.' (PT4)

The impact of imaging related communication was discussed by all of the participants. They reported that they implemented communication strategies to educate patients about their presentations, to optimise compliance in rehabilitation, to minimise unhelpful beliefs and behaviour associated with sustained pain presentations and to provide links between functional impairments and clinical findings:

'I have got that responsible position of using ultrasound in a way that does not then make the patient scared, catastrophising concern about findings that are not relevant.... education is an important part of trying to dictate compliance, I think it gives confidence, therapeutic alliance, believing someone, being credible'. (PT 5)

Participants also expressed a sense of responsibility to ensure patients were assessed thoroughly for tissue based pain causes even when excessive pain or other yellow flags were evident.

'...you have to keep an open mind, sometimes those patients you think are making a fuss, you scan them and find something....'(PT3)

Discussion

This study aimed to explore the interest and clinical application of musculoskeletal ultrasound for physiotherapist. The findings reflect a significant interest from physiotherapists in the modality, some physiotherapists have directed this interest into accessing education and attempting to integrate ultrasound imaging into their clinical practice. Several challenges experienced by the participants who pursued education are unlikely to be unique to the physiotherapy profession but some elements relating to ultrasound education and its clinical application appear to be profession specific.

Association between Physiotherapy Skills and MSKUSI Skills

The close association reported by participants between core physiotherapy skills and the requirements of MSKUSI is not surprising as pre-existing knowledge of musculoskeletal anatomy, pathology and treatment pathways is likely to be beneficial. The impact from this association may be more extensive than merely assisting MSKUSI education, as participants were keen to explain how ultrasound imaging could enhance and sometimes verify information gained from clinical assessment. This symbiotic relationship between imaging skills and musculoskeletal assessment expertise appears to have facilitated scanning technique development; participants readily described modifying standard protocols to optimise information, for example by asking patients to perform a provocative activity before imaging or by scanning in positions that resembled patients' functional problems. Dynamic scanning protocols are beginning to appear in publications but are predominantly

limited to the shoulder area,(26) and tend to be guided by biomechanics rather than by patients' symptoms. It is evident that physiotherapists are well positioned to make full use of dynamic imaging options and perform patient-focused scanning underpinned by traditional protocols, biomechanical knowledge and patients' mechanical pain behaviour.

Mentorship

Access to mentorship is a challenge that is widely reported in the literature, (4,12, 28). It is evident that most of the mentorship availability to the participants was in radiology departments and whilst all clinicians reported respect for their mentors and valuable educational experiences, limitations were noted. Very few participants had access to mentorship in alternative clinical environments where MSKUSI is used, for instance point-of-care imaging in sporting environments, rheumatology services, accident and emergency units or physiotherapy departments. In light of the difficulties accessing a single mentor who is prepared to oversee students' learning, alternative models of mentorship should be considered, for example where students are encouraged to access a number of mentors in varying environments and gather a portfolio of experiences.

Communication and MSKUSI

Profession specific skills and standard clinical practice appeared to be the foundation for participants' views regarding communication and MSKUSI. Physiotherapists who work in the musculoskeletal field have been exposed to the biopsychosocial model

and its application for the last two decades,(29,30). This model is embedded in physiotherapy preregistration education, contemporary assessment processes, management pathways for many presentations and throughout publications written by and intended for the physiotherapy profession(30,31). Integration of the biopsychosocial approach into patient management includes recognition of the value of education and communication, in particular in the presence of psychosocial risk factors for chronic pain,(30,32).

Integration of MSKUSI into the biopsychosocial model of assessment was a topic that all participants discussed at length, in particular the role of communication during and following ultrasound imaging. Participants explained that poorly considered communication could promote yellow flag related beliefs and negatively influence a patient's recovery. Participants made links between their knowledge of complex musculoskeletal pain and communication and selected terms carefully when communicating with patients. Terms such as 'tear', 'damage', 'injury', 'rupture' were reported as terms to use prudently, sometimes to be avoided and in all cases to be supported with information regarding management options and education (29).

The content and role of communication during scanning was also influenced by knowledge of pain physiology and its relevance to musculoskeletal presentations. It is evident that participants responded to psychosocial markers and applied their understanding of how these can cause pain amplification and sustain painful presentations(32). Clinical reasoning skills informed the clinicians that for some patients with psychosocial markers alongside persistent pain, imaging findings were

unlikely to fully explain symptoms and for these patients, the priority was communication and education (30,31,32).

Communication was also reported as an opportunity to impact the clinician-patient relationship and ultimately to improve patient compliance. Several participants highlighted the possible link between credibility and compliance, suggesting patients who believe in their physiotherapist's opinion and are provided with education may be more compliant with recommended management than those who do not have this relationship. The impact of therapeutic alliance, trust in the physiotherapist, perceived competence, communication and compliance appear to positively influence clinical outcomes,(32a,32b) Participants suggested that the ultrasound information aided explanations to patients and their perception was that compliance improved. The evidence base exploring the link between ultrasound imaging and patient's clinical outcomes is extremely limited but there are suggestions of positive effects,(33,34).

Regulatory and Service Delivery Issues

In the United Kingdom, the practice of sonography has very few regulations and is not limited to specific professions for instance radiologists and sonographers.

Despite this, it is a modality that requires education to ensure it is used appropriately in the clinical domain and there are many publications that reflect this substantial training requirement (35,36). The participants in this study had all received extensive training and were aware of the limited guidance that currently exists for physiotherapists who hope to integrate this imaging modality into their practice.

Interestingly, they also observed that poorly considered guidance or regulation from professional bodies could limit innovative physiotherapy practice.

Several participants proposed that service delivery frameworks that included ultrasound imaging had resulted in financial savings and a decrease in the number of attendances required in patient pathways. Research to explore financial implications, patients' experiences and clinical outcomes when physiotherapists include ultrasound imaging in their services is required.

Strengths and Limitations

All research has weaknesses that have to be considered and there are some methodological limitations within this study. The questionnaire's development process could have been extended to optimise the rigour of this data collection tool. The distribution methods were selected to facilitate responses which were substantially higher than the number reported from a previous study in the United Kingdom(4) but limitations are acknowledged. Some international publications have explored MSKUSI for physiotherapists and whilst some similar quantitative outcomes have been reported, no qualitative data has been collected in these studies, (12,13,37). It is not known if any of the anonymous questionnaires came from beyond the United Kingdom and influenced the data but classification systems did not identify isolated themes and the interview participants were all based in the United Kingdom. The purposive sampling strategy to select the interview participants was designed to be informationally representative for specific parameters but it is accepted that these parameters affect the transferability of the study. Recruitment strategies were also strengthened by the inductive thematic analysis process which

ensured data saturation was achieved, it was noted that the final interviews conducted did not require the generation of new codes or themes, (23a). Member checking was not formally included and would have further strengthened the analysis process.

Overall, this study benefits from several methodological strengths including the multiple questionnaire distribution methods that enabled a large number of physiotherapists to be approached. Additional strengths include the purposive sampling strategy that accessed participants representative of the entire sample for selected criteria, the rigorous thematic analysis and the impact of researcher's professional experience that enabled detailed discussions related to the physiotherapy profession and musculoskeletal medicine.

Conclusion

This study has explored physiotherapists' interest and clinical use of MSKUSI, it has revealed ultrasound imaging is a modality associated with many positive reports of clinical applications alongside uncertainties regarding its professional role. It is also a modality that has been accessed by the physiotherapy profession for a relatively short period of time and many professional and regulatory issues need to be explored further to enable physiotherapists to optimally integrate MSKUSI into their practice.

Ethical Approval

Ethical approval was awarded by Ethics Committee, University of Essex, reference number: 13006

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