Mobile Imaging Trailers

A scoping review of CT and MRI modalities

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Systematic Review

Mobile imaging trailers: A scoping review of CT and MRI modalities

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Introduction: Mobile Imaging Trailers enable moving diagnostic imaging equipment between locations requiring very little setup and configuration, example given CT-scanners and MRI-scanners. However, despite the apparent benefits of utilising these imaging capabilities, very little research on the subject exists. This study aims at gaining an overview of the current state of the literature, using the scoping review methodology.

Methods: The systematic literature search was conducted in three databases: Scopus, Embase and PubMed. Included sources were extracted based on the objectives of the scoping review, and inspired by the by PRISMA-ScR.

Results: 29 papers were included.

Conclusion: The results of the review showed that three general categories of research on this subject exist – trailers used in research, trailers as the object of research and trailers as an element or tool of the research. Of these, the most prevalent one used is the latter – trailers used as an element or tool of the research. This; however, is an issue for the use of trailers in a clinical setting, as very little research has been conducted on how they might be used and how they compare to fixed installations. As seen during the recent COVID-19 pandemic, the potentials for the use of MITs are immense; however, with the current lack of knowledge and understanding, the full potential has not been realised, suggesting further research should be focused in this area.

Implications for practice: This study has shown that the limited research in the area does point towards a few benefits of MITs; however, there is a clear lack of sufficient research on the field to say this with confidence.

Introduction

A mobile imaging trailer (MIT) is a semi-trailer containing diagnostic imaging equipment, example given (e.g.), a Computed tomography scanner (CT), Magnetic resonance scanning (MRI) or X-ray,[1,2] MITs have been in use since the 1980s.[2] The CT scanner was one of the first imaging units to "go mobile" followed by the MRI and other modalities such as mammography, gamma cameras, cardiac catheterization and X-ray equipment.[3]

Originally, one of the primary reasons for installing CT and MRI scanners in trailers was the high cost of building facilities and installation; depending on the installation type, it is significantly cheaper to use an MIT than building an MRI or CT facility.[3] Equipment using X-rays requires radiation shielding considerations in the building, MRI scanners require protection from electromagnetic interference and the surrounding area needs protection from the magnetic influence from the MRI.[4] Often, it is not an option to expand existing buildings, as the primary users of imaging equipment are hospitals, which are often built in dense urban areas.

Another reason for the introduction of MITs was to reach the majority of outpatients, and the MIT can be ideal for services to outlying areas.[3] This is especially true in countries with large rural populations, e.g., the United state of America (USA). Mobile mammography vans driving to rural areas have been proven to be an effective way to reach patients who normally would not go to mammography screening.[5] Screening for tuberculosis with X-ray equipment in a mobile van has proven effective in detecting patients with the illness, and has previously proven especially effective in urban and rural poor communities, for indigenous populations and in prisons.[6] MITs originated in the USA; however, they have since gained popularity in most parts of the world.

By using trailers to create a mobile imaging centre, it allows for a greater degree of flexibility and accessibility within the healthcare sector. Further, an MIT may ensure continuous operation if a

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stationary unit is inoperable, down for service or being replaced.[1] For periods with great patient volume, an MIT can provide the capacity to reduce the waiting time,[1,3] e.g., during winter periods where the number of patients with lung ailments increases and often exceeding the capacity of existing CT scanners.[7] Furthermore, it allows for hospitals to share diagnostic imaging equipment across geographical locations.[3]

MITs have been used in the USA since the 1980s,[8,9] and are currently a part of the official strategy for the National Health System (NHS) in the UK.[1,10] Regardless of the potential and years of experiences with MIT, there are very few evidence-based studies on the use of MITs. As such, the aim of this scoping review is to gain an overview of the research on MITs containing CT or MRI scanners, by looking into the available literature which both considers MITs on their own as well as MITs being merely a tool used instead of traditional scanner facilities. This will help understand the extent of current research that might inform future research and practice and provide information to policymakers.

Methods

The use of a scoping review is considered when it is necessary to map the existing literature in a research field.[11] It can be used to identify gaps, clarify key concepts and identify topics for future systematic reviews[12]; thus a scoping review is found to be the best way of getting an overview of the evidence-based literature on MITs containing CT- or MRI scanners. It is conducted according to the PRISMA-ScR statement for scoping reviews, suggested by Tricco et al.[13] This extension to the PRISMA methodology allows for considering little investigated areas of research, as well as emerging research areas.

Search strategy

The search was carried out in three-step strategy. An initial literature search was conducted using block search to structure the final search. Three categories were used for blocks: ‘Medical’, ‘Transportable’ and ‘Mode of transportation’. The databases searched were Scopus, PubMed, Web of Science, EBSCOhost and ProQuest to cover medical, engineering, and financial aspects. In relation to search restrictions, the date range was set to 1973–2022 since the first kind of scanners, both MRI and CT, were introduced in the early 1970s.[4] No location restrictions were placed on the search.

The initial literature search gave rise to an update of search terms, databases, and a narrower scope. The final systematic literature search was conducted in three databases: Scopus, Embase and PubMed and search terms were adjusted to fit the semantics of each database.

The final step was to perform snowballing on the identified papers. Table 1 shows the resulting block search carried out in Scopus.

In- and exclusion criteria

The inclusion and exclusion criteria were determined (Table 2).

Study selection

After database searching all duplicates were removed. Two reviewers independently screened the title and abstracts based on the inclusion criteria listed in Table 2. Any disagreements that arise between the reviewers was resolved through discussion until agreement were reach. Full text screening followed the same procedure, and for the last round of full text review data were extracted by the two reviewers, and the extractions were discussed until agreement were reach.

Data extraction

Relevant data and descriptive information from the included sources were extracted based on the objectives of the scoping review, and inspired by the methodology suggested by PRISMA-ScR research method.[13,14] Microsoft Excel (version 2023) was used for structuring the data. Data extraction included study characteristics (author, year, geographical location and main results), type of MIT, modality, and relevant aspects (the rationale for using MIT like research, validation of MIT, improving health, reaching urban citizens etc.). The type of methods used in the reviewed papers did not give grounds for inclusion nor exclusion, apart from a requirement to use a scientific method.

Data analysis

A bibliographic datapresentation of the papers were made to map a timeline of the publication years, to show the interest in the research field. This was done by counting the number of papers published per year, and summarising these. Further, a keyword analysis was added to investigate the self-determined aim of the

Table 1
Block search carried out in Scopus, 2022.

Medical	“Magnetic resonance imaging” OR “Computed tomography” OR CT OR MRI OR “Mobile CT scanner” OR “Mobile CT unit” OR “Mobile MRI scanner” OR “Mobile MRI unit” OR “Mobile MRI” OR “Mobile CT”
AND	
Transportable	Mobile OR Transportable OR Portable OR Moveable OR “on the go” OR Relocat*
AND	
Mode of Transportation	Truck OR Unit OR Trailer OR Lorry OR Vehicle OR Van OR Coach OR “Mobile site”

Table 2
Inclusion and exclusion criteria.

	Criteria	Rationale
Inclusion	Language: English, Norwegian, Danish, or Swedish MIT containing MRI or CT scanners	Due to the author's language proficiencies.
Exclusion	Published prior to 1973	Before 1973 there were no CT or MRI scanners.
	Bedside mobile modalities	Different scanner type with a similar name to MITs.
	Mobile stroke units with CT-scanners	The CT-scanners in the mobile stroke unit are not full-size scanners.
	Review studies	If any found, there will be a reference check to see if all appropriate papers are in the search

authors of the papers. The keyword analysis was performed using the Bibliometrix package in Rstudio,[15] which extracts the self-identified keywords from the authors, and connects these according to how they appear together. This scoping review does not focus on a specific part of the world, but rather on the use of MITs in general, with examples from different countries. Relevant aspects extracted from the included literature are presented in a thematic analysis, with the themes Practice, Research and Policy makers.

Results

A flow chart of the study selection procedure of each step of the review was performed, detailing when exclusion occurred as well as the reasons for exclusion.

A total of 4459 documents were found, and 80 papers were included in the final review. Full text review lead to exclusion of 51 papers as seen in Fig. 1. The 29 papers sum up the total research conducted, to the authors' knowledge, on the subject of MITs from 1973 till 2022, cf. appendix A. The majority of the studies originate from the USA (n = 6), Germany (n = 6), the UK (n = 8), Brazil (n = 2), China (n = 4), and Japan, finland and Italy were represented by one paper from each country.

Descriptive statistics

The papers included are published between 1993 and 2022, as seen from Fig. 2, with a clear increase in the number of papers published since 2017.

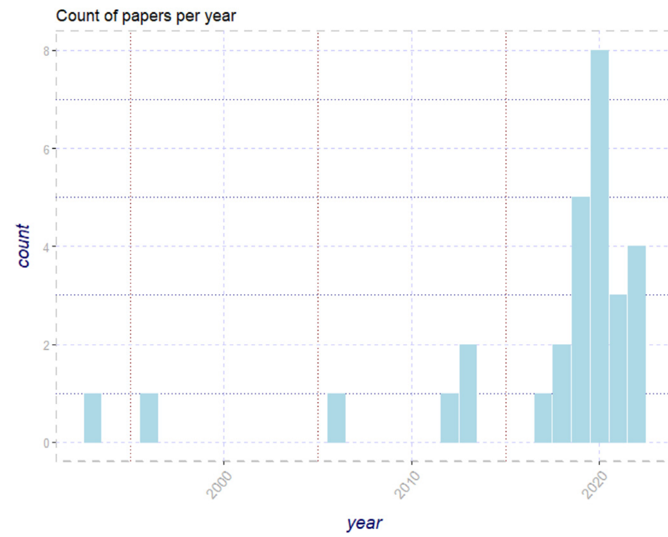

Figure 2. Count of included papers per year of publication.

A keyword analysis (cf. Fig. 3) shows that, although the focus in this review is on MITs, this is not the case in the papers reviewed. From the authors' keyword analysis, only a limited number has included the keyword “mobile health units”.

Through the analysis of the 29 included papers found by the systematic literature search, three overall categories for the uses of MITs in research were identified: 1) MITs for policy makers, 2) MITs

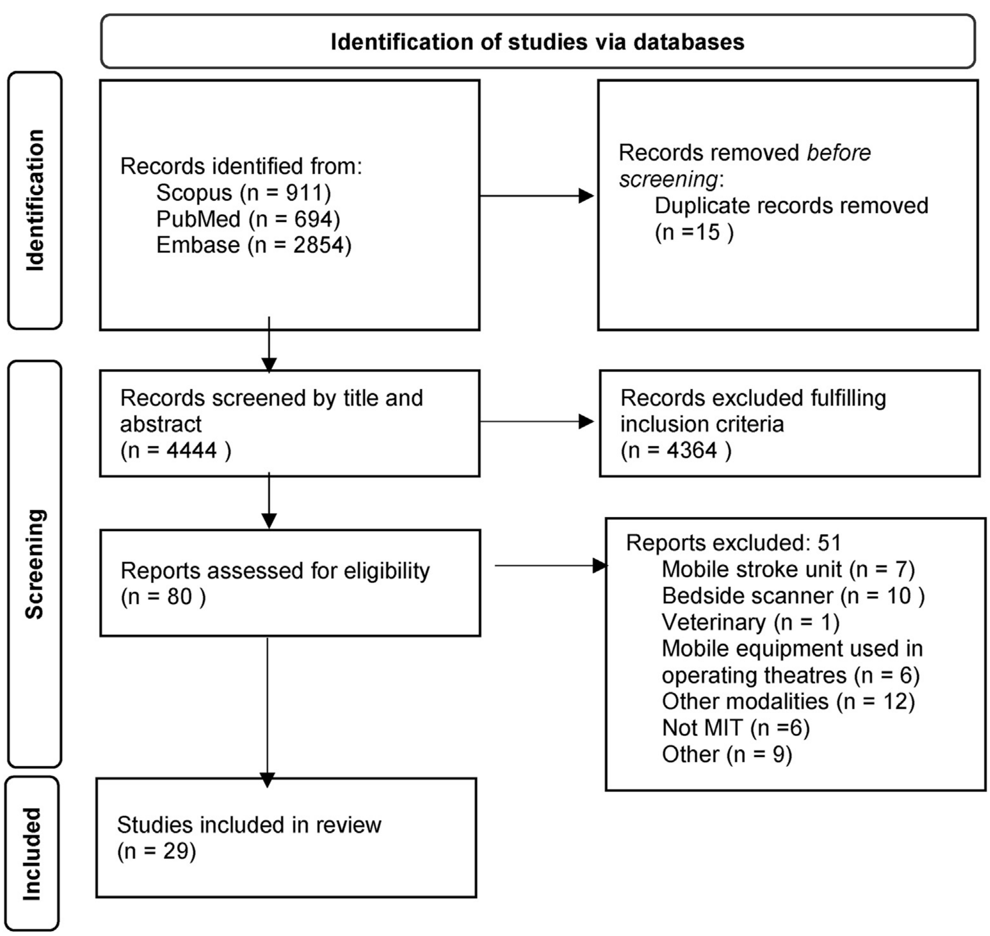

Figure 1. Flowchart of the literature search adapted from PRISMA.[13]

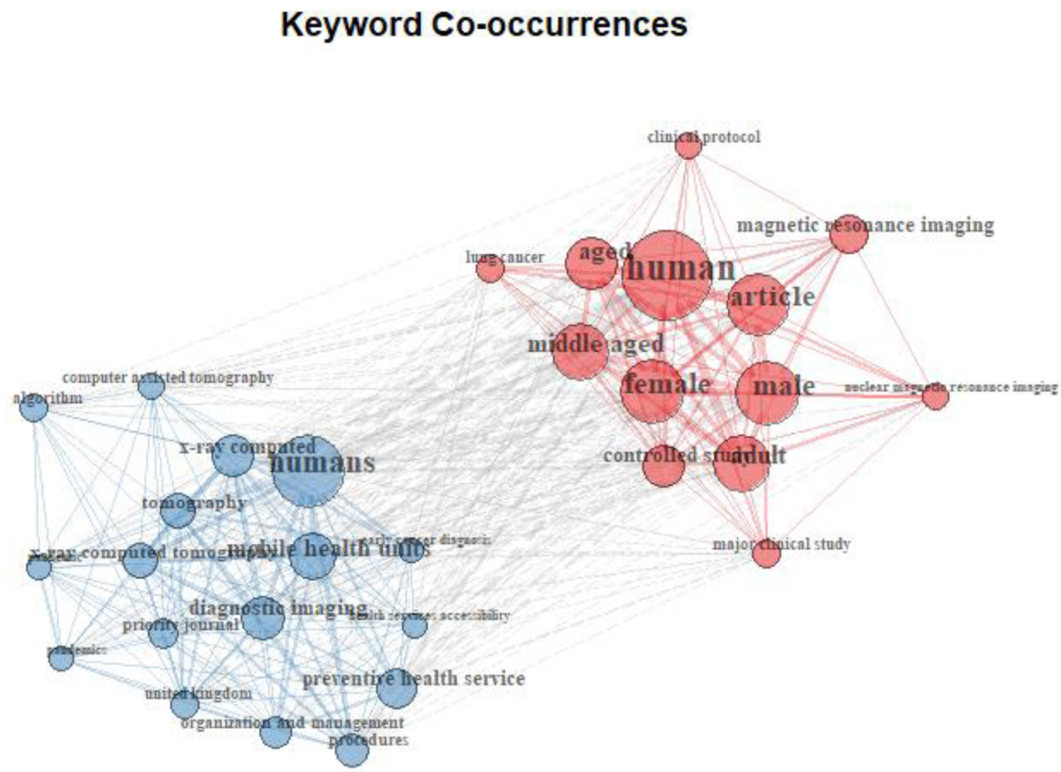

Figure 3. Keyword co-occurrences in the reviewed papers. The red colour red represents papers on MRI and the blue ones represent CT.

for research and 3) MITs for practice, see Table 3. The following sections will elaborate on the three uses.

MITs for policy makers

MITs for policy makers considers the use of MITs in relation to enacting policies and procedures and when it is feasible to use MITs instead of e.g., fixed installations.

Wright and Simoneaux considered the differences in relation to working environment and described the experiences they gained using an MIT during replacement of a stationary scanner.[45] They stress the importance of early communication and preparation in the collaboration with staff from other departments, example given, the emergency department and ICU, how to work in the MIT and the importance of environmental concerns, such as violent weather.[16]

Liu et al. compared the imaging quality and radiation dose of a CT scanner in an MIT with a stationary CT scanner, and did not find a significant difference in the subjective imaging scores.[17] The mobile unit had a greater image noise than the stationary scanner, and the signal-to-noise ratio, contrast-to-noise ratio and dose were found to be significantly lower in the mobile unit.[17]

The financial aspect is sparsely covered in the included papers. Headrick et al. present a break-even analysis for CT lung cancer screening with a donated MIT/bus on 428 scans pr. year; in the study this was exceeded by 28% in 10 months. They conclude limited financial risks for a mobile lung cancer screening programme.[34] One limitation to consider, however, is that of whether rural hospitals may benefit from the implementation of an MIT. Hartley et al. analyse this situation, and conclude that the hospitals themselves may benefit, however, the distance between hospital centres to a great degree influences the profitability of implementing MITs.[23] One way of approaching this issue, and ensuring profitability is to spend the resources in developing an optimisation methodology for sharing the MIT between hospitals, to ensure maximum usage. This further requires considerations on staff availability, parking facilities and patient booking.[24] To summarize, as no studies identify impaired quality in imaging quality and radiation dose when using MIT, it is suggested to be used when

Table 3
The included papers divided into categories.

Categories		Studies
MITs for policy makers		Wright and Simoneaux, 2018[16]
		Liu et al., 2021[17]
		Hartley, Moscovice and Christianson, 1996[18]
		Rajagopalan and Hadjinicola, 1993[19]
MITs for research		Schütz et al., 2020[20]
		Klenk et al., 2018[21]
		Brix et al., 2013[22]
		Freund et al., 2012[23]
		Schütz et al., 2013[24]
		Bernhardt et al., 2006[25]
MITs for practice	Lung cancer screening	Raghavan et al., 2020[26]
		Khairy et al., 2017[27]
		Bartlett et al., 2019[28]
		Chiarantano et al., 2019[29]
		Balata et al., 2019[30]
		Crosbie et al., 2020[31]
		Bartlett et al., 2020[32]
		Crosbie et al., 2022[33]
		Headrick et al., 2020[34]
		Hamaguchi et al., 2022[35]
		Crosbie et al., 2019[36]
		Sampaio et al., 2022[37]
		Shao et al., 2022[38]
	MRI	Peltonen et al., 2020[39]
	Covid pandamic	Nair et al., 2020[40]
		Stramare et al., 2020[41]
		Mu et al., 2021[42]
		Liu et al., 2021[43]
	Forensic	Rutty et al., 2020[44]

appropriate. Still, there needs to be considerations at an organisational level, as the health professionals operating the MIT systems, need early communication, preparation, and collaboration before implementation. Financial considerations seem important, to ensure the right number of scans per operating day to minimise economical loss and ensure maximum usage, as well as to ensure optimal use of the technology.

MITs for research

Considering MITs for research means focusing on using MITs as a tool for research, i.e., using it to investigate a different objective than the MIT.

In the studies of runners in a multistage ultra-marathon running in 2009, a mobile MRI scanner was set up and taken down daily.[20–24] It required a daily check and support of all technical systems, and furthermore the infrastructure and placement of the MIT could be challenging at times, as the environments surrounding the MIT can have an impact on image quality, due to example given, power stations, large metal buildings etc. This only applies for the MRI modality.[23] The use of an MIT allows for easy access, no need to set up scan protocols and for ensuring consistency in the images.[24] Similarly to the studies presented, a study by Bernhardt et al., use an MIT containing an MRI for cardiac stress perfusion in a multicenter outpatient study on cardiac stress.[25]

The main research involving MITs is when these are used as a tool in the projects, rather than as a primary element of the research. Thus, the use in research projects where risk of body changes over time is the focus, an MIT seems appropriate, as it can be set up and taken down daily.

MITs for practice

Several studies include an MIT as an integral part of the study within the area of lung cancer screening, COVID-19 screening, MRI and one paper within the area of forensic science. Thus, these studies are primarily focused on performing research related to increasing the number of people who participate in the public screening programmes,e.g lung cancer screening and COVID-19. This way, MITs help drive new practices, or enable old practices to be performed in new ways, to ensure a broader reach or increased reachability in the communities.

Several studies mention the possibility of a community based location of the MIT, and find it attractive for lung screening,[28,30,32,36] as MITs may provide screening outside hospitals' normal opening hours,[35] and may be places where citizens have their daily living (nearby a shopping center or local health center).[29,33,36] It can have a temporary placement across different community locations.[31] One study examined risk of lung complication in an underserved population with occupational exposure to asbestosis.[37] The results are divergent when it comes to uptake and attendance, as some studies show that the participation satisfaction results, uptake and attendance were similar for mobile and stationary units,[32] others found that MIT did reduce travel time thus increase participation of patients from lower socioeconomic classes.[30,36] Khairy et al. found that MIT CT screening programmes in low-income communities were feasible to implement.[27] Balata et al. recommend community-based locations for a successful implementation of a future lung cancer screening programme,[30] but it needs to be balanced against the complexity of setting up the facilities.[28] As an interesting opportunity, Shao et al. found that the combination of deep learning and MIT might be useful in distant regions with little experience of lung cancer screening, as this would decrease the required staff necessary to drive and understand imaging and image analysis[38]

Raghavan et al. stress that the diagnostic equipment in form of a CT scanner has been tested repeatedly to ensure robustness and stability after transport and mobile use.[26] Another study, by Peltonen et al., found variation and baseline levels of quality assurance in 17 MRI scanners to differ significantly, but no clear dependency to the mobility of the scanner was found.[39]

The COVID-19 pandemic saw a marked increase in studies utilising MITs, as the potentials of using these as part of a screening programme have previously been proven.[17,40–43] Mu et al. found it challenging to get people with mobility problems on the CT examination table.[42] Another example is the use of MITs for post mortem scans on disaster victim identification, where the ability to move the scanning capability to the disaster area can be crucial.[44]

Discussion

Summary of review

This scoping review provides an overview of the extent of the research on MITs containing a CT or MRI scanner, and suggests that the primary research is focused on three main topics – MITs for policy makers, MITs used in research and MITs for practice. The literature has different approaches to the use of MITs, however, regardless of the approach the common theme shared is that the MIT in itself is rarely the target of research. This suggests that the work done has the potential to be the steppingstone to further research on MITs themselves.

As the aim of the studies differed greatly, comparison between them was difficult. This suggests that the MITs in themselves are a difficult topic, however, they allow for multiple avenues of research when acting as a tool.

What this study adds

As determined by this review, the literature on the research is scarce. Considering the vast amount of research on CT's and MRI's respectively, this gives rise to the question of why so little research is conducted on MITs. Several avenues of research are available, as can be seen, e.g., cost-effectiveness, technology, population health improvements etc.

Among the points raised by this review is the one that MIT's are used in practice every day, however, several questions have yet to be answered by researchers. The MITs are included as part of the framework agreements with the NHS in the UK,[45] suggesting that despite the lack of research, they are still an integral part of the healthcare system in some countries. Based on this, research on the operational management of healthcare including MITs would aid decision makers in optimizing the healthcare system to be more resilient in times of breakdowns, or to make the most of the resources available in rural areas. Furthermore, an interesting area of study would be that of barriers and facilitators to the use of MITs in clinical practice. This is also seen as the case on the area of mobile X-ray machines, where a few studies have considered just that.[46]

Cost-effectiveness

Little has been done in directly analysing the cost-effectiveness of MITs. A break-even graphic analysis of the MRI annual cost and income versus the annual or daily case load was performed by Freedman and O'Brien,[8] which, although old, is still a relevant issue despite the need for updating. They find a need of 8 patients per day 5 days a week for a break even with a stationary MRI, and for the mobile MRI the break-even is reduced to 8 patients per day for 2 days a week,[8] but these numbers are from the early days of MRI and with the shorter scan time today and the inflation, these recommendations are outdated and require further analysis. Furthermore, these numbers may not reflect the reality in other countries, and as such, local analyses would have to be made. Contrary to MITs, a number of studies have focused on the use of mobile X-rays, especially in the area of elderly care homes. In relation to cost-effectiveness, the studies by Dozet et al. and Kjelle et al. both show that it is necessary to determine and include all relevant costs, if a study is to successfully compare mobile units to fixed installations.[47,48] These same studies also suggest that the costs of using of using mobile X-rays are lower when seen in a social perspective. As MITs and mobile X-rays share many of the same characteristics, it should be considered whether these also apply to MITs.

Implications for practice

Based on the review, it is immediately apparent that very few studies focus specifically on the uses of the MITs, with a few studies focusing on the differences between mobile scanners and stationary installations; however, more attention should be devoted to this area, as one might expect this to be a primary concern for the practitioners of radiography. As previous studies have mentioned, added research could potentially pave the way for introducing more MITs to solve the known issues with scanning in rural areas, and ensuring the successful outcome of screening programs. A recent cooperation between a hospital trust and a private company delivering MITs, has shown how it is possible to add both MRI and CT capabilities at hospitals not initially built for this use, providing a beneficial use case.[49] The case in question has the hospital trust running three MITs, which will be moved either daily or on a 3-day interval, to cover the trusts 37 different locations. This is an example of how the use of MITs in practice might be approached.

An issue, which should be considered in practice, if MITs are a viable option, is that of patient satisfaction. In a survey of satisfaction after lung cancer screening at mobile site or stationary 96,7% answered strongly agree/agree to the question “I had enough space at the venue” for mobile site and 98,5% for stationary.[32] This indicates that there might not be concerns in relation to space in MITs, based on patient's experience. This should, however, be considered in the context that the interior design of MITs has changed over the years, with the scanners either being smaller or with increased functionality in the in same size, allowing for more free space inside the trailers, as is also seen with the introduction of e.g., the wide-bore MRI scanners.

Strengths and limitations

Among the limitations of this study is the issue that some of the papers are old, and there has been a major development of both MRIs and CR scanners, making transportation of the scanners easier. This adds to the case that MITs are worth considering if it does make it difficult for a review study to show.

Considering the studies found under the theme of MITs for research, a number of papers per published from the study using an MIT to scan marathon runners. This can be considered a limitation as several of the papers have overlapping authors, which lowers the amount of individual studies performed involving an MIT.

A strength of this study is the thorough review of several databases covering a wide variety of themes, both economic, technological, medical, etc. This approach adds weight to the study as otherwise studies on e.g., the cost-effectiveness of MITs might have been missed, had they been published as an economic study.

Conclusion

The overview of research in MITs, presented in this study, shows that minimal research on the technology of MITs exists. Further, the use of MITs is only increasing, thus suggesting research on the use of MITs is an area with great potential for future research. Several research avenues are available, e.g., organisational research, technical research on the environment, technical research on the scanners and improved usage.

As seen during the recent pandemic, the potentials for the use MITs are immense; however, with the current lack of knowledge and understanding, the full potential may not be realised. Thus, the argument for increased focus on research in the area.

Implications for practice

This study has shown that the limited research in the area does point towards a few benefits of MITs; however, as is also shown, there is a clear lack of sufficient research on the field to say this with confidence. As such, it is the recommendation that the potential benefits be highlighted through further research, thereby fully exploring the potential impacts for practice, of using (or not) an MIT.

Authors participation

The authors have participated equally in the writing process.

Conflict of interest statement

None.

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Appendix A

Author(s), year	CT/ MRI	Country/origin	Aim/purpose	Relevant aspects
Hamaguchi et al., 2022[35]	CT	Japan	Verify and elucidate current lung cancer screening programme and CT screening programme	• Screening using MIT outside opening hours. • MIT increased access for people in areas with limited access
Crosbie et al., 2019[36]	CT	UK	Minimise barriers for lung cancer screening programmes	• MIT was located next to a shopping center to reduce travel and increase convenience. • It improved participation of patients from lower socioeconomic classes.
Balata et al., 2019[30]	CT	UK	Participants view on mobile CT screening and its importance for participation in lung cancer screening	• 74.7% found the scanner location as an important factor when deciding to attend the screening programme. • For lung cancer screening, programme accessibility and community based locations are important factors.

(*continued*)

Author(s), year	CT/ MRI	Country/origin	Aim/purpose	Relevant aspects
Mu et al., 2021[42]	CT	China	Advice and recommendation on radiology management procedure and the infection protection from makeshift hospital in Wuhan, China	• MIT CT had space-saving advantages. • People with mobility problems were challenging in MIT.
Headrick et al., 2020[34]	CT	USA	Development of a mobile lung screening programme	• The mobile programme can offer value to those at risk. • There are limited financial risks.
Khairy et al., 2017[27]	CT	USA	Pilot mobile lung cancer screening programme in low-income communities	• Feasible to implement MIT CT screening programme. • Planning to use MIT in 4 community centers.
Wright and Simoneaux, 2018[16]	CT	USA	The anticipated and unanticipated prior to the use of MIT	Concerns to be addressed prior to the use of MIT during removal and installation of new CT scanner: • Environmental concerns • Earlier communication to other departments • Anesthesia decided that patients could not be safely performed in MIT • Sedation team and Code team provided services off-site. • Communication is the key
Stramare et al., 2020[41]	CT	Italy	Optimising the diagnostic pathway during the COVID-19 outbreak	MIT used a few day after the beginning of the pandemic for patients with COVID-19 Patients in critical condition cannot be transported to the MIT
Rutty et al., 2020[44]	CT	UK	Illustration of the process pathway, development and testing of new INTERPOL radiological reporting form	• Postmortem scans with an MIT placed on the site for 7 days. • Setup and the first scans were on the same day.
Nair et al., 2020[40]	CT	UK	The CT scanners role in the COVID-19 pandemic	• MIT outside the hospital to minimise scanner down time during deep cleans between patients. • MIT in community can be used in the pandemic.
Liu et al., 2021[17]	CT	China	Workflow for use of MIT and identifies the value and reliability when screening for COVID-19	• MIT is easy to use, efficient and sensitive for the diagnosis of COVID-19 Comparation of MIT and stationary CT: • Greater image noise with MIT • Effective dose was lower in MIT • No significant difference in subjective image quality scores
Crosbie et al., 2020[31]	CT	UK	Key questions of relevance for lung cancer screening implementation	• Uses a single MIT across community locations on a monthly basis.
Chiarantano et al., 2019[29]	CT	Brazil	Design an integrated lung cancer programme using MIT	• The hospital has a large tradition on the use of MIT to cancer screening in underserved populations. • MIT placed near primary health care centers
Bartlett et al., 2019[28]	CT	UK	Baseline statistics for a lung cancer screening pilot study in which patients were scanned in either a community based MIT CT or a stationary CT	• Community based MIT may provide additional capacity to lung screening programmes • Benefit to participant uptake needs to be balanced against the complexity of setting up MIT
Bartlett et al., 2020[32]	CT	UK	Compare participant uptake between MIT and stationary CT and evaluate cancer detection using two lung cancer risk models	• No difference in participant satisfaction results between MIT and stationary. • Similar levels of participants uptake and attendance in MIT vs fixes site scanner.
Schütz et al., 2020[20]	MRI	Germany	Characterize the effect of multistage ultra-marathon running using serial MRI recordings over several weeks	• Using MIT MRI travelling with the runners
Raghavan et al., 2020[26]	CT	USA	Proposed that MIT would improve access for lung cancer screening in underserved groups	• Uses MIT that has been repeatedly tested to ensure robustness and stability of the diagnostic equipment after transport and use.
Klenk et al., 2018[21]	MRI	Germany	The effect of running a multistage ultra-marathon of 4486 km on 64 consecutive days on the heart	• MIT MRI was used
Brix et al., 2013[22]	MRI	Germany	Evaluates morphological and biochemical changes within the patellar and trochlear cartilage during a multistage ultra-marathon.	• MIT MRI was used and travel with the runners
Freund et al., 2012[23]	MRI	Germany	Determine prospectively if sustained maximal load during an ultra-marathon leads to damage to the foot	• Using MIT MRI travelling with the runners • Placing the MIT was challenged by infrastructure and local situations

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(*continued*)

Author(s), year	CT/ MRI	Country/origin	Aim/purpose	Relevant aspects
Schütz et al., 2013[24]	MRI	Germany	Characteristics and changes in body composition during the Transeurope footrace 2009 measured by continuous MIT MRI	• Uses MIT MRI • Setup and take down daily at each stopover with checks and support of the all technical system
Bernhardt et al., 2006[25]	MRI	Germany	Demonstrate the feasibility, practicability and safety of stress perfusion ceMRI in a multi-center outpatient setting with one MIT MRI	• The protocol used in a MIT MRI in a multicenter outpatient population was practicable and safe
Hartley, Moscovice and Christianson, 1996[18]	CT MRI	USA	Investigate the phenomenon of mobile hospital technology (CT, MRI and mammography) in rural hospitals	• Rural hospitals can benefit from access to MITs, but it differs greatly whether it is profitable or not, depending on the distance between hospital centers.
Rajagopalan and Hadjinicola, 1993[19]	MRI	USA	Allocation and scheduling problems when a small group of hospitals are leasing a mobile MRI	• Develop an optimization methodology for sharing MITs between hospitals, to ensure maximum usage.
Crosbie et al., 2022[33]	CT	UK	Response to lung cancer screening and analysis of non-response and non-uptake	• Opportunity to make a low-dose CT immediately after healthcare check in an MIT. • The MIT was placed near supermarket/retail centre or council car parks.
Sampaio et al., 2022[37]	CT	Brazil	Screening with low-dose CT in MIT in underserved population with occupational exposure to asbestos	• Uses MIT CT
Shao et al., 2022[38]	CT	China	Lung cancer screening with MIT CT in rural areas and deep learning systems was constructed	• Some patients preferred CT scan in hospital instead of MIT. • The combination of deep learning and MIT might be useful in distant regions with little experience of lung cancer screening
Peltonen et al., 2020[39]	MRI	Finland	Variations and normal baseline in imaging quality for daily single imaging phantom acquisitions on 17 MRI scanners with different field strengths and both stationary and MIT were included.	• No clear dependence in imaging quality relative to the scanners mobility.
Liu et al., 2021[43]	CT	China	Description of layout and functioning for a typical shelter hospital	• MIT used in the shelter hospital.

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