# Checklists for Interpreting Chest Radiographs: A Scoping Review

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## Highlights

- Chest radiograph can be used to diagnose conditions affecting the chest and surrounding structures.
- The shortage of radiologists has been exacerbated by technological advances in digital imaging modalities.
- Checklists may improve communication, support teamwork, ensure patient safety, and enhance collaborative knowledge-sharing to enhance the interpretation of chest radiographs.

## Abstract

**Introduction:** Checklists reduce time to comprehensive radiographic reports, improve quality and consistency of abnormality detection on chest radiographs.

**Aim:** The aim of this review was to examine and survey the scope of published research on checklists for the interpretation of chest radiographs.

**Method:** We conducted a search of CINAHL, Scopus, Medline Ovid, Web of Science, ProQuest, and gray literature using search terms: chest radiographs, checklist, and image interpretation. Data were extracted from 16 articles. Data was analyzed numerically and thematically.

**Results:** The selected studies were conducted in the United States (37.5%), the United Kingdom (25%), Australia (12%), South Africa (12%), Turkey (6%), and Israel (6%). The codes were grouped into five categories related to the use of checklists, in chest interpretation.

**Conclusion:** In the selected studies, reports showed that there was no checklist for chest interpretation in South Africa and no evidence supporting checklists as an interprofessional communication tool for chest interpretation. The authors of this study recommended a chest interpretation checklist should be developed for use by health care professionals practicing in resource-limited settings where radiologists are not on site.

**Keywords:** Checklist; Chest interpretation; District hospitals; Medical doctors; Radiologists; Radiographers

## Background

Chest radiograph can be used to diagnose conditions affecting the chest and surrounding structures. Chest radiographs are anecdotally accepted to be the most commonly performed radiographic examination worldwide (Speets et al., 2006). Compared to computed tomography (CT), chest radiographs are easier to execute, cause less radiation exposure, and are relatively cheap (Raoof et al., 2012). Chest radiographs, have been used to diagnose numerous conditions, including those involving the chest wall, bones of the thorax, and structures within the thorax, including the lungs, heart, and large blood vessels. Chest radiographs are also used to diagnose infectious diseases of the respiratory tract and screen for job-related lung diseases in industries such as mining where workers may inhale harmful substances (Ibrahim et al., 2014).

Conventionally, radiologists are responsible for interpreting chest radiographs. Radiologists are medical practitioners who undergo intensive postgraduate education and training to become experts in analyzing, interpreting, and detecting abnormalities on radiographic images and giving a diagnostic report. In South Africa, the dearth of radiologists in the public sector means that medical doctors working in district hospitals often refer patients for X-rays and then have to analyze and interpret the images themselves because there are no radiologists on site. The shortage of radiologists has been exacerbated by technological advances in digital imaging modalities including magnetic resonance imaging, CT scans, and interventional radiology with more radiologists choosing to work with advanced modalities rather than interpret conventional radiographs. Plain radiographic examinations make up (52%) of imaging procedures undertaken (National Health Service, 2016), and many radiology departments are experiencing backlogs in interpreting plain radiographs that have led to incidents where pathologies have gone unreported, resulting in disease mismanagement (Care Quality Commission, 2018).

To overcome the shortage of radiologists, medical doctors may approach radiographers, or radiologic technologists, to help interpret radiographic images. Radiographers are responsible for performing radiographic examinations, positioning patients, and ensuring that quality diagnostic images are taken. It has been suggested that radiographer-led immediate image interpretation and reporting may alleviate the shortage of radiologists. The shortage of radiologists might also be alleviated through interprofessional collaboration (IPC) between radiographers and medical doctors, which is the process by which different health professionals' work together to improve professional practice and health-care outcomes (Reeves et al., 2011). IPC can be fostered by implementing tools or routines including communication tools, interprofessional meetings, and checklists (Reeves et al., 2017). Checklists may improve communication, support teamwork, ensure patient safety, and enhance collaborative knowledge-sharing to enhance the interpretation of chest radiographs.

This scoping review aimed to explore, map, and summarize the extent, range, and nature of published research on checklists available to interpret chest radiographs. The scoping review was guided by the question: What is known about checklists for interpreting chest radiographs? We explored the research conducted on checklists used for interpreting chest radiographs including publication dates and geographical location.

## Methods

### Protocol and Registration

Our protocol was developed using the scoping review methodological framework proposed by Arksey and O'Malley (Arksey and O'Malley, 2005) and further refined by the Joanna Briggs Institute (Tricco et al., 2018). The final version of the scoping review protocol is registered on the Open Science Framework.

### Eligibility Criteria

We included peer-reviewed articles that focus on checklists to enhance IPC between radiographers and medical doctors, articles that describe checklists for reducing diagnostic errors, checklists for analyzing chest radiographs, checklists for identifying abnormalities on chest radiographs, and checklists for reporting chest radiographs in all settings. We also included articles from the gray literature, including theses and dissertations found in relevant databases. The population, concept, and context checklist is shown in Table 1.

**Table 1**. Population, concept, and context framework for defining the research question for this scoping review on the available checklists for analyzing chest radiographs

| | | |
|---|---|---|
| **Population** | **Chest radiographs** | **Chest radiographs, chest x-rays, radiography of lungs or thoracic cage** |
| **Concept** | Checklists | Structured chest interpretations |
| | | Interprofessional communication |
| | | Reduce radiographic omission errors |
| | | Identify abnormal patterns on chest radiographs |
| | | Evaluate and analyze radiographs |
| **Context** | International | Literature from all government and private health settings |

We used snowball sampling to search the reference lists of relevant articles. All peer-reviewed articles had to have an abstract and clearly stated aims. Only articles in English, published between 1994 and 2022 were included in the review. We chose 1994 as the start because it covered the inception of the new constitutional dispensation in South Africa.

### Information Sources and Search Strategy

The search strategy is given in Table 2. The search strategy was developed by a librarian and peer-reviewed by another expert librarian using the Peer Review of Electronic Search Strategies checklist and modified as required (de Kock et al., 2020). The following databases were searched: CINAHL, Scopus, Medline Ovid, Web of Science, ProQuest, including the gray literature.

**Table 2**. Databases searched with dates of coverage and the number of articles retrieved

| Date | Database | Search strategy | Articles retrieved |
|---|---|---|---|
| **12/10/2022** | Ebsco CINAHL | ((MM "Checklists") OR (MM "Practice Guidelines") OR Checklist OR Practice guidelines OR Checklist) AND ((MM "Radiography, Thoracic") OR Radiography OR Chest radiography OR Thoracic) AND (interpretat∗ Or Image interpretation OR (MH "Radiographic Image Interpretation") | 27 |
| **12/10/2022** | Scopus | TITLE-ABS-KEY ("Checklist∗" OR "Practice guideline∗" AND "radiography∗" OR "chest radiography∗" OR "Chest X-ray∗" AND "interpretation" OR "image interpretation∗") AND PUBYEAR >1994 AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English")) | 209 |
| **25/08/22** | Web of Science | ("Checklist∗" OR ("practice guidelines") OR ("Best practice") OR ("reference standards") OR "Standards∗") AND ("Radiography∗" OR ("chest radiography")) AND ("interpretation∗" OR ("image interpretation")) | 122 |
| **Gray literature** | | | |
| **30/08/2022** | ProQuest News | ("Checklist∗" OR ("practice guidelines") OR ("Best practice") OR ("reference standards") OR "Standards∗") AND ("Radiography∗" OR ("chest radiography")) AND ("interpretation∗" OR ("image interpretation")) | 23 |
| **31/08/2022** | UP-Space | Checklist OR Practice guidelines OR Best practice OR reference standards OR Standard AND Radiography OR chest radiography AND interpretation OR image interpretation | 12 |
| **Medline search strategy 28/07/2022** | | | |
| **1** | Checklist. m_ | 9200 | |
| **2** | Practice Guideline.mp. | 268395 | |
| **3** | Best practice.mp. | 99225 | |
| **4** | Interpretation of chest.mp. | 1105 | |
| **5** | Radiography.mp. | 539714 | |
| **6** | Image interpretation.mp. | 74384 | |
| **7** | Chest X Rays.mp. | 17953 | |
| **8** | 1 and 5 | 39 | |
| **9** | 7 or 8 | 17992 | |
| **10** | 8 and 9 | 39 | |
| **English language and yr. = ”1994 - 2023** | | | |

First, we conducted an initial limited search of two online databases relevant to the topic, namely Medline and CINALH. We analyzed the keywords in the titles and abstracts of the papers retrieved in the preliminary search. We then updated our search strategy using all identified keywords and index terms, and reran the search across all databases.

**Selection of Evidence**

All the retrieved articles were imported into a reference management software. The results were presented and summarized using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis PRISMA-ScR (PRISMA extension for scoping reviews) checklist (Figure 1) (Tricco et al., 2018). The review process consisted of two levels of screening: a title and abstract review and a full-text review, which was undertaken by two independent reviewers.

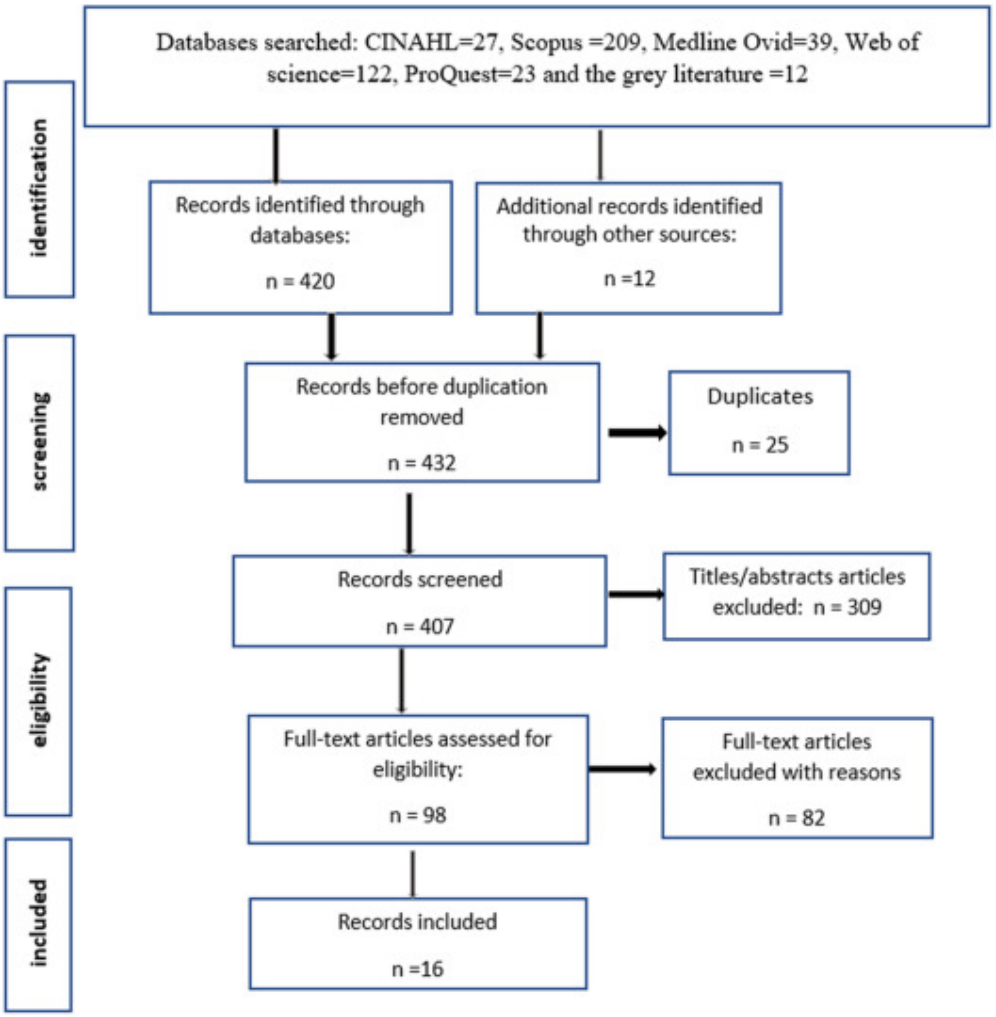


**Figure 1.** Prisma flow diagram charting the selection of studies for the scoping review.

During title and abstract review, the reviewers applied the inclusion and exclusion criteria solely on the titles and abstracts of the retrieved articles. The independent reviewers initially performed a calibration exercise using a random sample of 20 citations, to increase internal consistency among reviewers (Polanin et al., 2019). In the second step, each of the reviewers independently assessed the full-text articles for eligibility. Any discordant full-text articles

**Table 3**. Characteristics of studies included in the scoping review of checklists for interpreting chest radiographs

| Title | Author(s) | Year of publication | Study setting | Objectives | Study population and sample size | Key findings |
|---|---|---|---|---|---|---|
| **Measuring the effects of image interpretation: an evaluative framework** | Brealey, (2001a) | 2001 | University of York, UK | To delineate a basic framework for evaluating the overall impact of film reporting when choosing between alternative health care professionals. | Radiographers and other health care professionals | The researchers delineated a framework to measure the chain of events from the initial technical assessment to interpreting images using systematic search techniques to reduce costs and benefit society. |
| **Quality assurance in radiographic reporting: A proposed framework** | Brealey, (2001b) | 2001 | University of York, UK | To provide radiographers or other professional groups with a robust framework for maintaining standards and improving quality. | | The researchers developed a framework for assuring the quality of radiographic reporting underpinned by the scientific method and audit cycle. |
| **Observer performance in detecting abnormalities of the chest** | Fuhrman et al., (2002) | 2002 | Pittsburgh, USA | Compare two methods of evaluating observer performance in detecting an abnormality on chest radiographs. | Eight observers viewed 117 chest radiographs | A checklist may prevent several practical problems associated with multitasking ROC experiments. |
| **Standardized interpretation of pediatric chest radiographs for the diagnosis of pneumonia in epidemiological studies** | Cherian et al., (2005) | 2005 | Australia | A standardized method for identifying radiological pneumonia would facilitate comparison of the results of vaccine trials and epidemiological studies of pneumonia. | 222 chest radiographic images evaluated by 20 radiologists and clinicians | Agreement in identifying pathology can be achieved by using standardized definitions and training. |
| **Can a checklist reduce SOS errors in chest radiography?** | Berbaum et al., (2006) | 2006 | Iowa City, USA | To determine whether a formal checklist reduces SOS effects in chest radiology | 57 chest radiographs, read twice by 20 observers | Using a self-prompting checklist to counteract SOS is not warranted. |
| **Evaluation of the World Health Organization criteria for chest radiographs for pneumonia diagnosis in children** | Ben Shimol et al., (2012) | 2012 | Israel | To compare the level of agreement for the diagnosis of pneumonia according to the WHO guidelines | 13 paediatricians, 2 radiologists interpreted 200 pediatric radiographs | The WHO guidelines resulted in a high level of agreement between readers for identifying chest pathology. |
| **Improving the quality of radiographs in** | Gupta et al., (2015) | 2015 | New York, USA | To develop an educational tool to improve the radiograph | Nursing staff, physicians and | Structured, collaborative educational intervention appears to be successful in |

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| **neonatal intensive care unit utilizing educational interventions** | | | | quality, sustain this improvement overtime, and reduce the number of repeat radiographs | radiology technologists | improving the quality of radiographs and reducing the number of repeat radiographs |
| **Guide to thoracic imaging** | Skinner, (2015) | 2015 | Australia | Presenting a simple framework for interpreting chest X-rays, suitable for trainees, and practitioners providing primary care imaging in rural and remote locations. | | A typical checklist will guide the practitioner to the most important thoracic structures but using a checklist will ensure that pertinent findings are not missed. |
| **The influence of a vocalized checklist on detection of multiple abnormalities in chest radiography** | Berbaum et al., (2016) | 2016 | Iowa City, USA | To test a vocalized checklist | 64 chest computed radiographs | The vocalized checklist is useful for organizing search and reporting. The checklist may have interfered with the radiologist's visual search because the order of elements in the printed checklist differed from the order used in the clinic. The checklist may have interrupted the radiologist's search as they had to take their eyes off the display to look at the booklet. |
| **Does periodic lung screening of films meet standards?** | Binay et al., (2016) | 2016 | Turkey | To assess the level of compliance among three specialities (pulmonologist, pulmonologist assistant, and radiologist) in evaluating chest radiographs taken by mobile X-ray systems in terms of technology and quality. | 400 chest radiographs evaluated by pulmonologists, radiologists, and pulmonologist assistants. | Readers interpreted the technical and quality characteristics of the films differently. A national program is needed to eliminate discrepancies between exposure, positioning techniques, and interpretation of radiographs especially in periodic screening. |
| **Does the use of a checklist help medical students in the detection of abnormalities on a chest radiograph?** | Kok et al., (2017) | 2017 | USA | To investigate the extent to which medical students benefit from using a checklist to detect abnormalities on a chest radiograph. | 40 medical students in the clinical phase assessed 18 chest radiographs | A checklist is a potentially important tool to improve radiology education in the medical curriculum. |

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| **Interpretations of chest x-rays by radiographers and general practitioners at district hospitals in the city of Tshwane** | Sethole, (2018) | 2018 | South Africa | To explore methods used by radiographers and GPs to interpret chest radiographs | 20 medical doctors and 20 radiographers | Recommended the use of a checklist, to train both radiographers and medical doctors to interpret images |
| **Digital training platform for interpreting radiographic images of the chest** | McLaughlin et al., (2018) | 2018 | Northern Ireland, UK | To investigate the use of a search strategy tool | | Eye tracking technology, a checklist, and voice recordings can be combined to form a digital training platform for interpreting chest images. |
| **Monitoring the use of extra images on chest radiography examinations** | Lee et al., (2019) | 2019 | Philadelphia, USA | To reduce the frequency of repeated chest radiograph. Collaborate with technologists to decrease the frequency and incorporate the process into a quality control program. | | Checklists were incorporated in a quality control program to reduce repeat rate due to improper patient preparation and positioning. |
| **Radiologist reporting and operational management for patients with suspected COVID-19** | Hammer et al., (2020) | 2020 | USA | To evaluate the adoption and outcomes of locally designed reporting guidelines for patients with possible coronavirus disease 2019 (COVID-19). | Radiologists | Radiologists rapidly adopted recommended guidelines for reporting terminology in patients suspected of COVID-19 |
| **Methods used by general practitioners to interpret chest radiographs at district hospitals in the city of Tshwane, South Africa** | Sethole et al., (2020) | 2020 | South Africa | To explore methods used by GPs to interpret chest radiographs at district hospitals | | Study recommended the development of checklists for chest image interpretation. |

were reviewed a second time, and further disagreements about eligibility were resolved by a third reviewer.

In total, we identified 432 articles published between 1994 and 2022. A total of 25 duplicates were removed prior to screening. Articles eligible for screening (n = 407) were exported to a screening software tool. After abstract and title screening, 309 articles were excluded and 98 full texts were screened. Following full text screening, 82 articles were excluded for various reasons (Figure 1). A total of 16 studies were ultimately included in the study (Table 3).

### Data Charting Process

Data extraction took place in two steps; firstly, we developed a standardized charting form using an Excel spreadsheet (Table 3). Secondly, the charting form was pilot tested by two reviewers with five papers to ensure consistency.

### Data Analysis

The included articles were numerically summarized and thematically analyzed. We counted the extent, nature, and distribution of the studies. Thematic analysis required reading and rereading until conceptual saturation was reached(Thomas and Harden, 2008). Then articles were coded to identify recurring words and phrases. The recurring words were then incorporated into a spreadsheet. An inductive method was used to develop categories and prominent themes.

## Results

The geographic distribution of studies was conducted in the USA (n = 6, 37.5%), UK (n = 4, 25%), Australia (n = 2, 12%), South Africa (n = 2, 12%), Turkey (n = 1, 6%), and Israel (n = 1, 6%). Two studies, conducted in South Africa, recommended the development of a checklist to interpret chest radiographs in resource constrained settings (Sethole, 2018, Sethole et al., 2020). One study conducted in Turkey recommended that a national program be developed to eliminate the discrepancies between radiographic exposure factors, positioning techniques, and interpretation of radiographs for periodic screening (Binay et al., 2016).

The research methods used in the studies included retrospective and prospective studies, a survey, and a trial. Nine articles included participants who were responsible for chest interpretations. Participants included radiologists, and nonradiologists which included radiographers, medical doctors, medical students, other health care professionals, nursing staff, paediatricians, pulmonologists, and physicians.

The following codes were identified: standardization, identification of pathology, development, eliminate discrepancies, exposures, positioning technique, errors, self-prompting, vocalized, framework, collaborative education, improving quality of radiographs, reporting terminology, medical curriculum, radiology education, systematic approach, training, voice recordings, multitasking problems, reporting, and guiding. The codes were grouped into five different categories that were related to the research question.

1. Checklists for training

2. Checklists for improving quality of radiographs

3. Checklists for standardization of definitions

4. Checklists for searching and reporting chest radiographs

5. Types of checklists used

**Checklists for Training**

Six studies described using checklists for training (Cherian et al., 2005; Gupta et al., 2015; Kok et al., 2017; McLaughlin et al., 2021; Sethole, 2018; Skinner, 2015). Different checklists have been used to standardize definitions, identify radiological abnormalities in chest diseases (Cherian et al., 2005), and to train students and health care providers (Kok et al., 2017; Sethole, 2018). McLaughlin, Hughes (McLaughlin et al., 2021) described using a combination of checklist, eye tracking technology, and voice recordings to form a digital training platform for chest interpretations. Checklists were presented as a structured collaborative educational interventional tool used to reduce repeat radiographs (Gupta et al., 2015).

**Checklists for Improving Quality of Radiographs**

Four studies aimed to investigate if using checklists could improve the quality of radiographs. The report recommended checklist to improve the radiograph quality and to sustain the improvement overtime (Gupta et al., 2015). Checklists can also be used to prepare patients and helps to eliminate discrepancies in terms of technical exposure and positioning technique (Binay et al., 2016; Lee et al., 2019). Checklist can be used to guide the evaluation of films and maintain quality standards in radiography (Brealey, 2001b).

**Checklists as Frameworks for Standardization**

Four studies reported on standardization of definitions. One study standardized reporting terminology for identifying COVID-19 (Hammer et al., 2020). One study proposed a checklist as a proposed framework for quality assurance in radiographic reporting (Brealey, 2001b). One study provided standardized definitions and training methods for identifying radiological pneumonia in pediatric patients (Cherian et al., 2005). The World Health Organization (WHO) provided guidelines for pattern recognition in diagnostic imaging (Ben Shimol et al., 2012).

**Checklists for Developing a Systematic Approach for Searching and Reporting**

Four studies reported the use of checklists for systematically searching for abnormal patterns during X-ray reporting. One study recommended the use of a checklist to guide systematic chest interpretation (Sethole et al., 2020). In contrast, another study suggested that a checklist interrupts search patterns (Berbaum et al., 2016), and prevents practical multitasking problems (Fuhrman et al., 2002). Using a checklist may enhance a systematic approach and help practitioners to reduce omission errors (Berbaum et al., 2006).

**Types of Checklists**

Three studies reported on other types of checklists. Self-prompting checklist was not recommended (Berbaum et al., 2006). Vocalized checklists were useful for organizing search and reporting (Berbaum et al., 2016). Voice recordings, coupled with eye tracking technology was recommended for digital training (McLaughlin et al., 2018).

## Discussion

In this scoping review, we identified 16 primary studies, published between 2001 and 2021, addressing checklists used for image interpretation of the chest. We found evidence that checklists could be used to train and educate professionals; as well as, in practice when interpreting chest radiographs. With the universal shortage of radiologists (du Plessis and Pitcher, 2015), medical officers in public health care facilities often have to interpret and report on radiographs. In poorly-resourced countries, the shortage of medical officers may lead to even the most acute trauma radiographs being unreported (du Plessis and Pitcher, 2015). Checklists may provide a viable option for helping medical officers to interpret radiographs.

In this study, we aimed to identify studies that have used checklists to enable image interpretation. This could guide the implementation of solutions to alleviate the problem of chest image interpretation in resource constrained settings when there is no radiologist on site. The WHO provides guidelines for interpretation of chest radiographs that can be used in locations where the presence of fully trained specialist are rare (Ellis and Flower, 2006). Our review found that there is no evidence in South Africa and in Africa on the development and the use of checklists to interpret chest radiographs. There is, thus, a need to develop a tool suited for assisting medical practitioners to interpret chest radiographs in settings where there are no radiologists on site. Aside from staff shortages, checklists can help to overcome clinical problems caused by stressful conditions and time limitations (Ely et al., 2011). Checklists usually focus on one error-prone area, and they can be used to reduce errors of omission, summarize large quantities of information, formulate reliable evaluations that can be reproduced, and also improve quality standards (Scriven, 2000). According to the Royal College of Radiologists (Kilic and Illyas, 2021), checklists are catalysts to improve communication and tools for supporting teamwork and patient safety. In spite of the value of checklists, there are few standardized checklists available interpreting chest radiographs.

We also found few studies that focused on using checklists for IPC during interpretation of chest radiographs. While there is increasing knowledge about technological advancements in communications, it is important to note that not all resource constrained settings have the necessary facilities to train practitioners and develop capacity. To overcome this limitation, checklists may enable effective IPC processes and practices, which is important during and after imaging examinations. Communication errors are common in radiology and impact directly on patient care (Siewert et al., 2016). Checklists may facilitate structured inter professional briefings and address communication errors (Lingard et al., 2004). A checklist may serve as a two-way communication tool between medical professionals involved in image interpretation, referring practitioners, and radiographers. Using checklists, medical practitioners can provide vital information about patients' clinical history and justification why a chest radiograph is needed. Radiographers performing the chest examination will be able to inform practitioners of any changes in normal radiographic technique used, for example, anatomical variants detected on radiographs. Similarly, any adjustments made to routine techniques should be communicated to referring practitioners.

### Limitations

We may have missed relevant studies because we only searched certain databases. Our search period was limited from January 1994 to 2022. We may have missed relevant studies published in other languages. Our findings are supported by the use of the PRISMA-ScR Checklist (Tricco et al., 2018).

## Conclusion

This scoping review primarily explored, mapped, and summarized the extent, range, and nature of published research on checklists that are available to interpret chest radiographs. Our scoping review confirms that there is limited evidence on the use of checklists to interpret chest radiographs, especially to enhance IPC. The literature suggests that checklists can be used as training tools to improve radiology education, improve quality assurance, and standardize definitions. Checklists can be used to ensure that patients are correctly prepared and positioned before radiography. Little research has been conducted in South Africa and Africa on the use of checklists to interpret chest radiographs. There is, thus, a need to develop innovative solutions, including checklists, to help medical practitioners working in collaboration with radiographers to interpret chest radiographs, especially where there are no radiologists on site and no digital systems in place.

## CRediT authorship contribution statement

**Khethiwe Margaret Sethole:** Conceptualization, Methodology, Project administration, Data curation, Visualization, Writing – original draft, Validation. **Nombeko Mshunqane:** Conceptualization, Data curation, Visualization, Supervision. **Kuhlula Maluleke:** Methodology, Data curation, Visualization. **Mable Kekana:** Conceptualization, Supervision. **Linda Mbonambi:** Validation.

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