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A CROSS-SECTIONAL STUDY PROTOCOL: KNOWLEDGE, ATTITUDES AND PRACTICES OF DIAGNOSTIC RADIOGRAPHERS IN PERFORMING ROUTINE QUALITY CONTROL TESTS IN RADIOLOGY DEPARTMENTS

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Abstract

Background: Diagnostic radiographers are expected to be involved in quality control (QC) testing. However, in practice their level of involvement is often limited or inconsistent. The literature references a few active and recent studies on the involvement of radiographers performing QC tests in South Africa. The aim of this study is to investigate radiographers' knowledge and practices regarding QC in performing routine QC tests in radiology departments in Bloemfontein, South Africa.

Method: This study will apply a descriptive cross-sectional survey design at three public and two private hospitals in Bloemfontein. Data will be collected from a target population of 95 diagnostic radiographers using a questionnaire, with a sample size of 76 participants selected for the study. Purposive and convenience sampling will be used. Data analysis will be performed using SPSS Version 29 and applying descriptive and inferential statistics. ANOVA, chi-square, t-tests, and Pearson's correlation will all be used to examine the relationship between the variables. Qualitative responses will be analysed through thematic analysis to complement the numerical data.

Ethics and dissemination: Ethics approval for this study has been obtained from the Health Sciences Research Ethics Committee of the Faculty of Health Sciences at the University of the Free State (UFS-HSD2023/0556/2908-0004). To protect participants' privacy, strict measures will be implemented to ensure anonymity and confidentiality. The researchers intend to disseminate the results of this study through publication in a radiography journal, specifically *The South African Radiographer, Radiography,* and the *Journal of Medical Imaging and Radiation Sciences*.

Results: The results of this study are expected to identify and quantify the factors contributing to limited or inconsistent participation of radiographers in performing QC tests within radiology departments.

Conclusion: It is anticipated that the results of this study will enhance radiographers' participation in performing QC and promote it as a specialised area for professional growth in diagnostic radiography through evidence-based recommendations.

Keywords: Quality control, diagnostic radiographers, radiology, knowledge, attitudes, practices

INTRODUCTION

Quality control (QC) in diagnostic radiology is a structured process that aims to ensure that imaging equipment functions optimally while producing high-quality diagnostic images and minimising unnecessary radiation exposure.[1-3] Quality control involves routine technical assessments of parameters such as image receptor performance, beam alignment, and exposure consistency, which are essential for maintaining the radiation safety of patients and staff, as well as the accuracy of X-ray imaging services.[4,5]

Radiographers are expected to be knowledgeable and be involved in performing routine QC tests on X-ray imaging equipment.[6,7] The diagnostic radiographer who owns the diagnostic X-ray imaging unit is expected to have an X-ray

license and be knowledgeable and competent to perform routine QC tests.[3,8] Routine QC testing helps identify and address these problems early, improving both safety and diagnostic reliability.[5,9,10] These QC tests include (i) X-ray tube warm-up, (ii) evaluation of appropriate exposure charts, (iii) maintenance of lead rubber aprons, (iv) beam alignment and X-ray field centring, (v) field size dimensions, (vi) congruence between field size and light size, and (vii) the X-ray light beam centring. All of the tests should be performed regularly as prescribed in the South African Health Products Regulatory Authority (SAHPRA) manual.[8]

Research conducted by Ngoye, Motto and Muhogora in Tanzania found that routine QC testing was lacking in X-ray departments because radiographers did not have the skills to perform these QC tests accurately.[11] The literature review data reveals inadequate and vague information about the role of radiographers in performing routine QC tests, particularly on the African continent. In SA, limited studies about radiographers' involvement in performing routine QC tests are available. A study by Willemse, Williams, and Grobler suggests that X-ray departments often lack the necessary training, staff, or time to conduct these tests precisely and consistently.[9]

This study has the potential to uncover a deeper understanding of the knowledge, attitudes, and practices of diagnostic radiographers regarding their involvement in performing routine QC tests in radiology departments. This study aims to investigate the knowledge and practices of radiographers in conducting QC tests in the selected radiology departments in Bloemfontein in South Africa.

BACKGROUND

In X-ray imaging, QC is essential for maintaining consistent image quality and ensuring the safety of patients, staff, and visitors in public healthcare settings.[12] As a condition of licensing, X-ray departments are required to conduct regular QC tests on their equipment.[8] According to Section III.1 of the 2022 SAHPRA guidelines, the license holder, or a designated individual, is responsible for performing routine QC tests as outlined in Table 2.[8] In South Africa, SAHPRA serves as the national regulatory body responsible for ensuring the safety, efficacy and quality of health products, including medicines, medical devices and radiation-emitting equipment.[8] As part of its mandate, SAHPRA ensures that X-ray license holders comply to ensure that diagnostic imaging systems operate according to acceptable performance standards.[8]

Radiographers are required to hold a valid license to own X-ray equipment while working independently, ensuring compliance with regulatory standards by the SAHPRA. As part of their professional responsibilities, radiographers are expected to monitor equipment performance by identifying, assessing, documenting, and reporting any faults or irregularities.[13,14] The professional scope and practice of radiographers affirm that their involvement in QC is a technical obligation as well as a professional responsibility.[13-16] Radiographers' involvement in routine QC testing is therefore an essential component of ensuring accurate imaging and patient safety.[3,5,6,17]

However, not all diagnostic radiographers actively participate in routine QC testing within radiology departments. Contributing factors include insufficient formal training in QC procedures and a lack of institutional support for the structured implementation of QC programmes.[9,11,18] Radiographers are often underutilised in quality control (QC) roles, especially in resource-limited settings where training and essential tools are lacking.[19-21] Nonetheless, they continue to play a vital role in performing routine QC tests to ensure safe and effective diagnostic imaging.[22] Their responsibilities include detecting equipment performance deviations, recording faults, and initiating corrective measures, all of which are essential for maintaining high standards in X-ray imaging.[17]

Problem statement

Although professional expectations for diagnostic radiographers to actively participate in QC testing of X-ray units to ensure the safety, accuracy, and consistency of diagnostic imaging, evidence of their routine QC activities is not widely published in research publications and little research is done on this subject. In South Africa, there is little context-specific research documented or retrievable from the literature on the extent to which radiographers participate in QC tests in radiology departments. Therefore, little is known about knowledge, attitudes, and practices of radiographers regarding their involvement in performing routine QC tests on diagnostic X-ray equipment.

Research question

What are the knowledge and practices of diagnostic radiographers regarding the performance of routine QC tests on diagnostic X-ray equipment?

Research aim and objectives

This study aims to investigate the knowledge and practices of diagnostic radiographers in performing routine QC tests on diagnostic X-ray imaging equipment in Bloemfontein. The objectives set out for this study are as follows.

- To assess the knowledge, attitudes, and practices of diagnostic radiographers regarding the performance of routine QC tests in radiology departments.
- To evaluate the extent to which diagnostic radiographers regularly perform QC tests as part of their clinical responsibilities.
- To explore the perceived barriers and facilitators influencing radiographers' engagement in routine QC testing.

METHODS

Study design

This study will adopt a quantitative research approach using a descriptive cross-sectional survey design.[23] A descriptive design is appropriate for identifying and describing characteristics, frequencies, trends, and categories within the study population.[24] The cross-sectional survey strategy was selected because it enables the collection of data at a single point in time, allowing for the assessment of the current status of radiographers' knowledge, attitudes, and practices related to routine QC testing on diagnostic X-ray equipment.[25]

Research location

The study is set to take place in Bloemfontein, a city within the Free State province of South Africa. Data will be gathered from the radiology departments of three tertiary public hospitals and two private hospitals located in Bloemfontein.

Population and sampling

The target population for this study comprises 95 diagnostic radiographers employed at three public and two private hospitals in Bloemfontein, Free State, South Africa. A combination of purposive and convenience sampling will be used to select participants. Purposive sampling is appropriate because participants must meet the inclusion criteria of the study procedures. This strategy will ensure that data are collected from participants with the relevant knowledge and experience required to address the study objectives.[26,27]

Convenience sampling will be used to complement purposive sampling, mainly because of practical factors such as participants' availability, willingness to take part in data collection, and logistical challenges in accessing all potential participants across hospital shifts and facilities.[26] Given the limited and specific population size within a defined setting, these non-probability sampling techniques were considered practical for participant recruitment in the current study.

A sample of 76 radiographers will be recruited from the target population of 95. This sample size was calculated using an appropriate sample size formula for proportions, with adjustments made to account for the finite population and anticipated response rate.[28] The sample size was determined using the formula below.

$$Sample\ size = \frac{Z_1^2 - \alpha/2P(1-P)}{d^2}$$

Where:

- n = sample size
- N = population size (95)
- Z = Z-value (1.96 for 95% confidence level)
- p = estimated proportion of the population (if unknown, use 0.5 for maximum variability)
- E = margin of error (5% for 0.05)

$$n_o = \frac{(1.96)^2 x 0.5(1-0.5)}{(0.05)^2}$$

$$n_o = \frac{(3.8416) x (0.25)}{0.0025}$$

$$n_o = \frac{0.9604}{0.0025}$$

$$n_o = 384.16$$

This yielded an initial sample size (n_0) of 384. However, the total eligible population (N) is known to be approximately 95 radiographers. Considering the small size of the population, the finite population correction (FPC) will be applied to adjust the sample size:

$$n = \frac{n_0}{1 + \frac{n_0 - 1}{N}}$$

$$n = \frac{384.16}{1 + \frac{384.16 - 1}{95}}$$

n=76

Therefore, the final required sample size is approximately 76 participants. This adjustment ensures that the study maintains statistical precision and avoids unnecessary oversampling.

Inclusion and exclusion criteria

The data for this study will be gathered from diagnostic radiographers working in the above-mentioned hospitals. Exclusion criteria will be radiographers without diagnostic qualifications, such as ultrasonographers and nuclear medicine radiographers, and students.

Research instrument

Data for this study will be collected using a self-administered questionnaire developed by the researchers. The design of the instrument was informed by a review of relevant literature on quality QC practices in diagnostic radiography, including international guidelines from the International Atomic Energy Agency (IAEA)[19] and SAHPRA.[8] The professional scope of practice for diagnostic radiographers in South Africa to ensure contextual relevance was also used in the questionnaire.[13,14] These sources guided the formulation of items related to radiographers' knowledge, training, and routine performance of QC tests.

The questionnaire consists of both closed-ended questions, designed to collect quantitative data, and some open-ended questions to allow participants to elaborate on their responses. This mixed-format design was intended to provide qualitative insights that support the interpretation of the quantitative findings. The questionnaire was developed in English, as this is the primary language of instruction in radiography education and clinical practice in South Africa.

Pilot study

A pilot study is a small-scale preliminary study conducted before the main research project. Its primary purpose is to test the feasibility, design, methods, and instruments of a planned larger study.[29,30] To assess content and face validity of the questions three experts (i.e., two radiographers and a medical physicist) checked the questionnaire. The research tool was also tested with five diagnostic radiographers; no changes were required to modify the survey instrument following the pilot test study. Biostatisticians contribute to the development of data collection instruments by ensuring content validity and aligning the construct with the research questions and hypotheses.[31] A biostatistician was consulted during the questionnaire development to enhance the methodological soundness of the questionnaire, ensuring that it accurately measures the constructs of interest and supports robust statistical analysis.

Participant recruitment and data collection

Once permission has been granted, the researchers will recruit participants to all research sites from April 2025 to June 2025, through the managers of the X-ray departments, with the intention of minimising disruptions to the workflow in the X-ray departments. The researchers will place drop-boxes at each research site for participants to drop off the completed questionnaires in order to protect their anonymity. All drop-boxes will be removed from the research sites after one month.

Data analysis

Quantitative responses from the paper-based questionnaire will be entered into the corresponding digital version in QuestionPro to facilitate data management and generate a downloadable dataset. This dataset will then be exported and imported into IBM SPSS Statistics software version 29 for data analysis. Descriptive statistics, including frequencies, percentages, means, and standard deviations, will be used to summarise participants' demographic characteristics and their knowledge and practices related to routine QC testing. Results will be presented using tables, pie charts, and bar graphs.

Inferential statistical analyses will be employed to identify significant differences and associations within the dataset. Independent samples t-tests, and one-way analysis of variance (ANOVA), will be used to compare knowledge and practice scores among radiographer groups. Before conducting these tests, assumptions of normality and homogeneity of variance will be assessed. Where assumptions of normality are violated, non-parametric alternatives such as the Mann-Whitney U test (for two groups) and the Kruskal-Wallis H test (for more than two groups) will be applied.

Associations between categorical variables will be evaluated using the chi-square test of independence. When expected cell frequencies are less than five, Fisher's exact test will be used to ensure statistical validity. Relationships between continuous variables will be explored using Pearson's correlation coefficient for normally distributed data and Spearman's rank-order correlation for non-normally distributed variables. A significance level of $p < 0.05$ will be used to determine statistical significance for all tests.

All quantitative analysis will be conducted using IBM SPSS Statistics software, and tests for normality (e.g., Shapiro-Wilk test) will guide the selection of appropriate statistical procedures. Qualitative responses from the open-ended questionnaire items will be captured using QuestionPro and analysed thematically. Data will be imported into Atlas.ti (version 23) for systematic coding and organisation. Thematic analysis will follow the six-phase framework proposed by Braun and Clarke, which includes: (1) familiarisation with the data, (2) generation of initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) producing the report.[32] This method is widely recognised for its flexibility and rigour in identifying, analysing, and reporting patterns within qualitative data.

Data management plan

This study will adhere to strict data management procedures to ensure the security, confidentiality, and integrity of the data, in compliance with the Protection of Personal Information Act (POPIA), (Act No. 4 of 2013).[33] All electronic data will be stored on the principal investigator's password-protected computer and backed up on the institutionally managed and access-controlled secure OneDrive cloud storage at CUT, Free State. All physical copies of the questionnaires will be securely stored in a locked cabinet, with access restricted to the principal investigators. Only principal investigators and designated biostatisticians will have access to both electronic and physical data.

All data will be retained for a minimum of five years following the completion of the study and publication of the research results. Upon expiry of the retention period, electronic data will be permanently deleted from all storage devices and cloud servers using secure data destruction protocols. Any hard-copy documents will be disposed of through confidential shredding.

Ethics considerations

This study has received ethical approval from the Health Sciences Research Ethics Committee of the Faculty of Health Sciences at the University of the Free State (UFS-HSD2023/0556/2908-0004). Gatekeeper permission was obtained from the Free State Department of Health as well as from the participating hospitals. The researchers will bear all costs associated with conducting the study utilising their research funds at CUT.

Participation in this study will be entirely voluntary and only radiographers who provide informed consent will be invited to complete the paper-based questionnaire. The survey tool will include a clear statement indicating that submission of the completed questionnaire implies consent to participate.

An information sheet outlining the purpose and potential benefits, and risks of the study will be attached to the questionnaire.

To safeguard the anonymity and confidentiality of radiographers working in small or closely connected professional environments, no names, staff numbers, hospital identifiers, or other personally identifiable information will be collected. Each questionnaire will be assigned a unique alphanumeric code to facilitate systematic data organisation while maintaining confidentiality. Qualitative responses will be assigned a unique code in the findings, without any identifiers of the hospital.

Dissemination of findings

The researchers aim to disseminate the findings of this study through publication in reputable peer-reviewed radiography journals, including *The South African Radiographer, Radiography*, and the *Journal of Medical Imaging and Radiation Sciences*. This approach will facilitate the broad dissemination of the results to both local and international audiences within the radiography profession.

Additionally, the findings will be shared with participating hospitals through summary reports and feedback sessions with departmental heads to ensure practical engagement with the results. The study outcomes will also be presented at relevant professional platforms, such as the biennial congress of the Society of Radiographers of South Africa, as well as at local professional development and continuing professional development events targeted at radiographers.

CONCLUSION

This study aims to investigate the knowledge, attitudes, and practices of diagnostic radiographers regarding their involvement in routine QC testing within radiology departments. The evidence generated is expected to guide targeted strategies that strengthen radiographers' engagement in QC activities and support the recognition of QC as a specialised area of professional development within diagnostic radiography. Additionally, the study seeks to address the existing gap in knowledge related to QC practices among South African radiographers and to encourage greater adherence to radiation regulatory standards in X-ray imaging environments.

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AUTHOR CONTRIBUTIONS

MB, SM, MM, TO, MM, and KR (CUT) developed a first draft of this research protocol. NMP, VSN (CUT) were responsible for drafting the research protocol manuscript for publication. NMP VSN (CUT) together, they led the development of the research methodology, including the study design, setting, population and sampling strategy, inclusion and exclusion criteria, research instruments, participant recruitment, data collection procedures and ethical considerations. NMP (CUT) coordinated the ethics approval process. Both authors NMP, VSN (CUT) were involved in revising the study and reviewed and approved the final manuscript.

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INSTITUTIONAL REVIEW BOARD STATEMENT

The study has been approved by the Health Sciences Research Ethics Committee of the Faculty of Health Sciences at the University of the Free State (UFS-HSD2023/0556/2908-0004)

INFORMED CONSENT STATEMENT

A letter of information will accompany the questionnaire, outlining the purpose of the study, what participation entails, and the participants' rights, including the right to withdraw at any time without consequence. The questionnaire will be anonymous and will not require participants to provide any personal or identifiable information on the questionnaire. Participants will be clearly informed that completing the questionnaire implies their consent to take part in the study.

DATA AVAILABILITY STATEMENT

Not available yet.

CONFLICT OF INTERESTS

The authors declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)

AI was used for language editing to improve clarity, coherence, and grammar. No content was generated or altered beyond language refinement.

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