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ORIGINAL ARTICLE

Satisfaction of newly qualified radiographers with undergraduate education and training in image interpretation in Zambia: a cross-sectional survey

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ABSTRACT

Background: Plain film image interpretation has been incorporated into the undergraduate radiography curriculum in Zambia. Despite this, no study has evaluated graduates' satisfaction with the module. This study aimed to assess newly qualified radiographers' satisfaction with classroom and clinical teaching in undergraduate plain-film image interpretation and their perceived readiness to apply this training in the workplace in Zambia.

Methods: A cross-sectional study was conducted using an online questionnaire. A census sampling technique was employed by inviting all newly qualified radiographers (n = 107) who graduated in 2023 and 2024. The questionnaire collected data on satisfaction with classroom and clinical teaching using a five-point Likert scale. Descriptive statistics were used to summarise the data, while the Mann–Whitney U and Kruskal–Wallis tests were used to compare satisfaction scores by entry route and institution, respectively.

Results: Seventy-five radiographers responded (70.1%). Most respondents were satisfied with module content (n = 66; 88.0%), alignment between teaching methods and learning outcomes (n = 54; 72.0%), and classroom assessments (n = 52; 69.3%). During clinical training, 51 (68.0%) were satisfied or very satisfied with applying image interpretation theory in practice, whereas 41 (54.7%) were dissatisfied or very dissatisfied with radiologists' support. Thirty-eight respondents (50.7%) were satisfied or very satisfied with their perceived readiness to provide informal verbal image interpretation opinions when requested by referring clinicians. Classroom teaching satisfaction differed significantly between institutions (p = 0.001), whereas clinical teaching satisfaction did not differ by institution (p = 0.16) or entry route (p = 0.72).

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Conclusion: Newly qualified radiographers rated classroom teaching more favourably than clinical teaching of the image interpretation module. Strengthening structured clinical supervision, feedback, radiologist involvement, and competency-based clinical assessment may improve graduates' perceived readiness to apply image interpretation skills in practice.

BACKGROUND

The traditional role of diagnostic radiographers is to perform imaging, while radiologists interpret the results. However, a change in practice occurred in the United Kingdom (UK) in the 1980s, when radiographers were permitted to flag abnormalities on trauma images. [1] This arose in response to an acute shortage of radiologists and contributed to a reduction in diagnostic errors. [1-3] Subsequently, in the 1990s, radiographers were also authorised to report on plain radiographs. [2,3] This practice benefits four key stakeholders in imaging services: radiographers, radiologists, referring clinicians, and patients. For radiographers, it leads to enhanced knowledge and skills, as well as increased job satisfaction. [2,4,5] For radiologists, it reduces workload and allows greater focus on advanced imaging examinations, such as computed tomography (CT), magnetic resonance imaging (MRI) and interventional radiology. [6,7] For referring clinicians, radiographer reporting provides timely access to imaging findings, supporting earlier clinical decision-making, diagnosis and appropriate management of diseases and injuries, while reducing the risk of missed or delayed diagnoses. [8] For patients, this can facilitate earlier diagnosis and treatment, improve continuity and efficiency of care, reduce delays in clinical decision-making, and increase satisfaction.[2,4]

As a result of these shifts in professional responsibilities, radiography education must adapt to ensure that new practitioners are equipped with the requisite knowledge and skills. [9,10] A review of the literature indicates that radiographer training in image interpretation follows three main pathways: the abnormality detection system (ADS), preliminary clinical evaluation (PCE), and clinical reporting. [2,11] The ADS pathway enables radiographers to identify potential abnormalities in trauma images, [12,13] whereas PCE allows them to concisely describe imaging findings when definitive reports are unavailable. [2,4] The third pathway, clinical reporting, involves radiographers providing diagnostic reports following specialised postgraduate training. [14] In the ADS and PCE pathways, radiographers acquire knowledge and skills in image interpretation during their undergraduate education. [13]

All three Zambian higher education institutions (HEIs) that offer a Bachelor of Radiography programme have incorporated plain-film image interpretation into their curricula. Lusaka Apex Medical University (LAMU) introduced the programme in 2013, followed by the University of Zambia (UNZA) in 2019 and Levy Mwanawasa Medical University (LMMU) in 2020. The module content is consistent across institutions and covers the axial and appendicular skeletons, as well as the chest and abdomen. Despite this integrated training, no study has evaluated graduates' satisfaction with the module. Assessing graduate satisfaction is important because it provides a key indicator of curriculum quality and effectiveness, informs quality assurance processes, identifies areas requiring curriculum improvement, and offers insights into the extent to which training prepares graduates for clinical practice. [15,16] Therefore, this study aimed to assess newly qualified radiographers' satisfaction with classroom and clinical teaching in undergraduate plain-film image interpretation, as well as their perceived readiness to apply this training in the workplace in Zambia.

METHODS

Study design

A cross-sectional study was conducted using an online questionnaire. This design was selected for its efficiency in collecting data from a specific population at a single point in time [17,18] The study was guided by the Strengthening the Reporting of

Observational Studies in Epidemiology (STROBE) guidelines,[19] and the Checklist for Reporting Results of Internet E-Surveys (CHERRIES),[20] ensuring methodological rigour and transparency.

Study setting and participants

Zambia is a landlocked country in Southern Africa, with 153 public hospitals serving a population of approximately 21 million people.[21] The healthcare delivery system comprises four levels organised in a pyramidal structure: primary healthcare (PHC) services at the community level form the base, followed by first- and second-level hospitals at the district and provincial levels, respectively, and third-level (tertiary) and fourth-level (specialised) hospitals at the apex. [21]

This study included newly qualified radiographers (n = 107) who graduated in 2023 and 2024 from three HEIs offering a Bachelor of Radiography programme: LAMU, UNZA, and LMMU. The list of eligible graduates was compiled and verified using official institutional graduation lists obtained from the Heads of Radiography Departments of the three HEIs. Eligible respondents were graduates who had completed the image interpretation module as part of their undergraduate training and provided informed consent to participate in the study. Radiographers who graduated before 2023, diploma-only graduates, graduates from radiography programmes outside Zambia, those who had not completed the module, and those who did not provide informed consent were excluded. Given the small population size, all eligible radiographers were invited to take part in the study.

Data collection tool

An online self-report questionnaire was developed based on the literature and comprised three main sections. Section one collected socio-demographic data, including gender, age, training institution, and entry route into the Bachelor of Radiography programme. Questions 1–4 addressed these demographic characteristics, while questions 5–23 comprised 19 closed-ended Likert-scale statements assessing respondents' views of image interpretation training in relation to classroom teaching (10 statements) and clinical teaching (9 statements). These were designed using a five-point Likert scale: very satisfied, satisfied, neutral, dissatisfied, and very dissatisfied. Statements covered six domains: module content, learning outcomes, course materials, feedback and assessments, educator knowledge and support, and readiness to transfer training. [9,10,22,23] A pilot study was conducted with 11 radiographers who graduated from LAMU in 2022. The pilot identified spelling errors and ambiguous wording; minor revisions were then made to improve clarity and readability before administration. [17,24]

Data collection procedure

In January 2025, a link to the online questionnaire, together with a participant information sheet, was distributed via WhatsApp to graduates from the 2023 and 2024 cohorts. Class WhatsApp groups for former students remain active for up to two years following graduation. The questionnaire remained open for responses from January to February 2025. During the development of the questionnaire in Google Forms, response settings were configured to limit each respondent to a single submission, thereby preventing duplicate responses. The questionnaire was completed anonymously, with no IP addresses, email addresses, or other identifying information collected.[18] All questionnaire items were optional, allowing respondents to skip questions if so wished. Incomplete questionnaires were retained for analysis, with unanswered items treated as missing values. Respondents were able to review and modify their responses before final submission. To maximise the response rate, reminder messages were sent fortnightly via WhatsApp throughout the data collection period.

Data management and analysis

Data management and analysis were performed using Microsoft Excel and Stata version 13.1. Frequencies and percentages were calculated for demographic variables and each Likert-scale item. Satisfaction items were scored from 5 (very

satisfied) to 1 (very dissatisfied), with no reverse scoring. Classroom (questions 5–14) and clinical (questions 15–23) composite scores were calculated by summing the respective items, with higher scores indicating greater satisfaction. All 75 respondents provided responses to the 19 Likert-scale items. Composite scores were used for between-group comparisons and were not converted into categorical thresholds of satisfied, neutral, or dissatisfied. One respondent did not report entry route; therefore, entry-route comparisons used n = 74, while institution comparisons used n = 75.

Shapiro–Wilk testing indicated that the composite satisfaction scores were not normally distributed. The Mann–Whitney U test (Wilcoxon rank-sum test) was therefore used to compare composite satisfaction scores by entry route, with Somers' D reported as an effect-size estimate. The Kruskal–Wallis test was used to compare scores across the three HEIs; where the overall test was significant, Dunn's post-hoc pairwise comparisons with Bonferroni correction were performed. Epsilon-squared (ε^2) was reported as the Kruskal–Wallis effect size. Statistical significance was set at $p < 0.05$. Internal consistency was assessed using Cronbach's alpha, with 0.70 used as a conventional benchmark.[25] The overall Cronbach's alpha for the 19 Likert-scale items was 0.90, indicating high internal consistency; this was not interpreted as evidence of construct validity.

Ethical considerations

The Research Ethics Committee of the Lusaka Apex Medical University (Ref: 0341/31/12/ 2024) approved this study. The online questionnaire included respondent information, and informed electronic consent was obtained before participation. Respondents were informed that participation was voluntary and that there were no academic or employment consequences for participation or non-participation. [17,18] Although recruitment was facilitated through Heads of Departments and alumni WhatsApp groups, confidentiality was maintained. No personally identifiable information was collected, and all survey data were password-protected and accessible only to the research team.

RESULTS

A total of 75 responses *(70.1% response rate)* were received in this study. More than half of the respondents (n = 42; 56.0%) were female, and a third (n = 25; 33.3%) were in the 26-30 age group. LAMU graduates constituted the largest proportion of respondents (n = 33; 44.0%). The most common entry method into the Bachelor of Radiography programme was through in-service (n = 47; 62.7%), whereby students held a radiography diploma before commencing the degree programme. These demographic findings are presented in Table 1.

Table 1: Demographic findings (n=75)

Variable	Categories	Frequency n (%)
Age group	<25 years	13 (17.3)
	26 – 30 years	25 (33.3)
	31 – 35 years	23 (30.7)
	36 – 40 years	9 (12.0)
	>40 years	5 (6.7)
Gender	Female	42 (56.0)
	Male	32 (42.7)
	Prefer not to say	1 (1.3)
Institution	Levy Mwanawasa Medical University (LMMU)	14 (18.7)
	Lusaka Apex Medical University (LAMU)	33 (44.0)
	University of Zambia (UNZA)	28 (37.3)
Type of entry	In–service	47 (62.7)
	Direct entrant	27 (36.0)
	Missing	1 (1.3)

Classroom teaching and learning in image interpretation

A significant proportion of respondents (n = 66; 88.0%) reported being either very satisfied (n = 20; 26.7%) or satisfied (n = 46; 61.3%) with the module content. In addition, more than half of the

respondents (n = 54; 72.0%) reported being very satisfied (n = 15; 20.0%) or satisfied (n = 39; 52.0%) with the alignment between teaching methods and expected learning outcomes. Responses show that 69.3% (n = 52) of the respondents were satisfied (n = 36; 48.0%) or very satisfied (n = 16; 21.3%) with the written examinations and the objective structured clinical examination (OSCE) used for summative assessment. Figure 1 presents these findings.

Among respondents with a known entry route (n = 74), the Mann–Whitney U test showed no statistically significant difference in classroom composite satisfaction scores between direct-entry and in-service graduates (z = -1.24, p = 0.22, Somers' D = 0.20). The Kruskal–Wallis test, using all respondents with known institution (n = 75), showed a statistically significant difference across the three HEIs ($\chi^2(2) = 14.6$, p = 0.001, $\varepsilon^2 = 0.20$). Dunn's pairwise comparisons with Bonferroni correction showed significant differences between LMMU and UNZA (p = 0.002) and between LAMU and UNZA (p < 0.001), but not between LAMU and LMMU (p = 0.40). Median classroom composite scores were 36 for UNZA, 29 for LAMU, and 26.5 for LMMU.

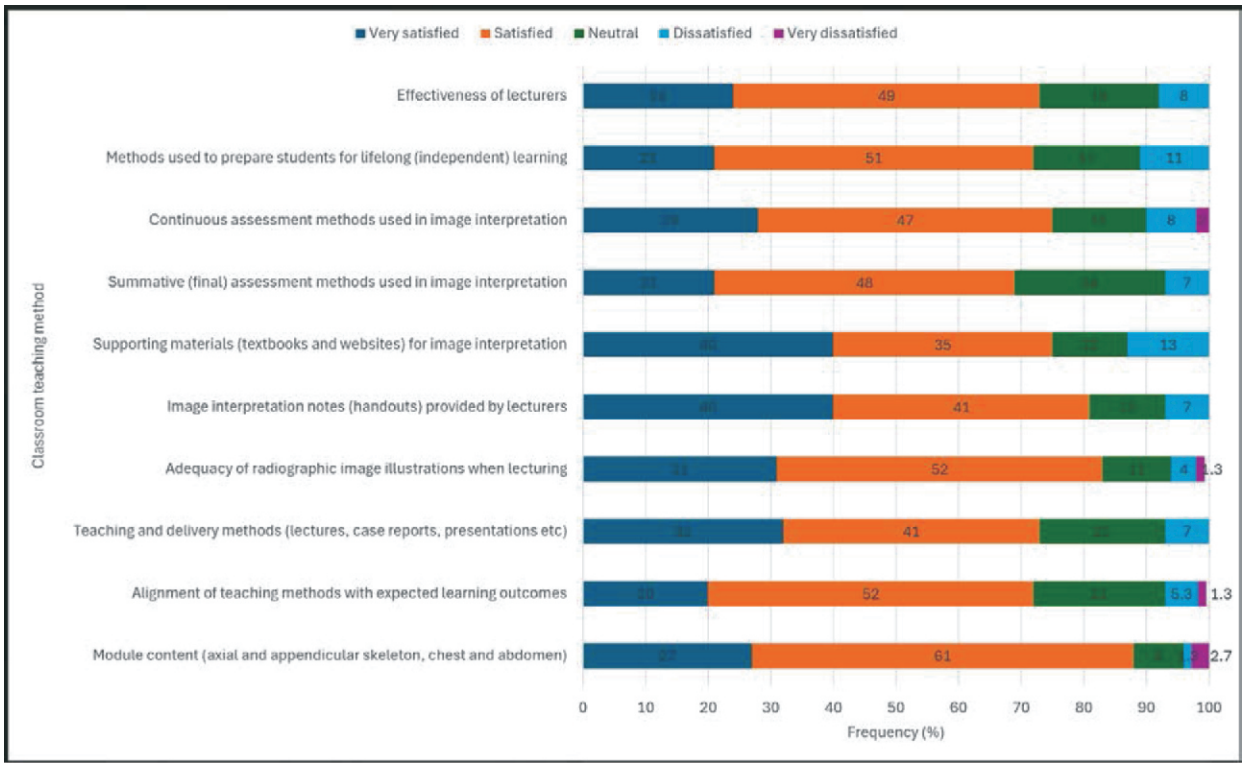


Figure 1: Satisfaction with classroom teaching and learning in image interpretation (n = 75 for each item)

Clinical teaching and learning in image interpretation

More than half of the respondents (n = 51; 68.0%) reported being either very satisfied (n = 10; 13.3%) or satisfied (n = 41; 54.7%) with the application of image interpretation theory in practice. However, 41 respondents (54.7%) were either very dissatisfied (n = 9; 12.0%) or dissatisfied (n = 32; 42.7%) with the radiologists' support in teaching image interpretation during clinical practice. Despite these setbacks, more than half of respondents (n = 38; 50.7%) were either very satisfied or satisfied with their readiness to apply the training in their workplaces by offering verbal opinions on image interpretation when requested by referring clinicians. Figure 2 presents these findings.

Among respondents with a known entry route (n = 74), the Mann–Whitney U test showed no statistically significant difference in clinical composite satisfaction scores between direct-entry and in-service graduates (z = -0.36, p = 0.72, Somers' D = 0.03). The Kruskal–Wallis test, using all respondents with known institution (n = 75), also showed no statistically significant difference in clinical composite satisfaction scores across the three HEIs ($\chi^2(2) = 3.65$, $p = 0.16$, $\varepsilon^2 = 0.05$).

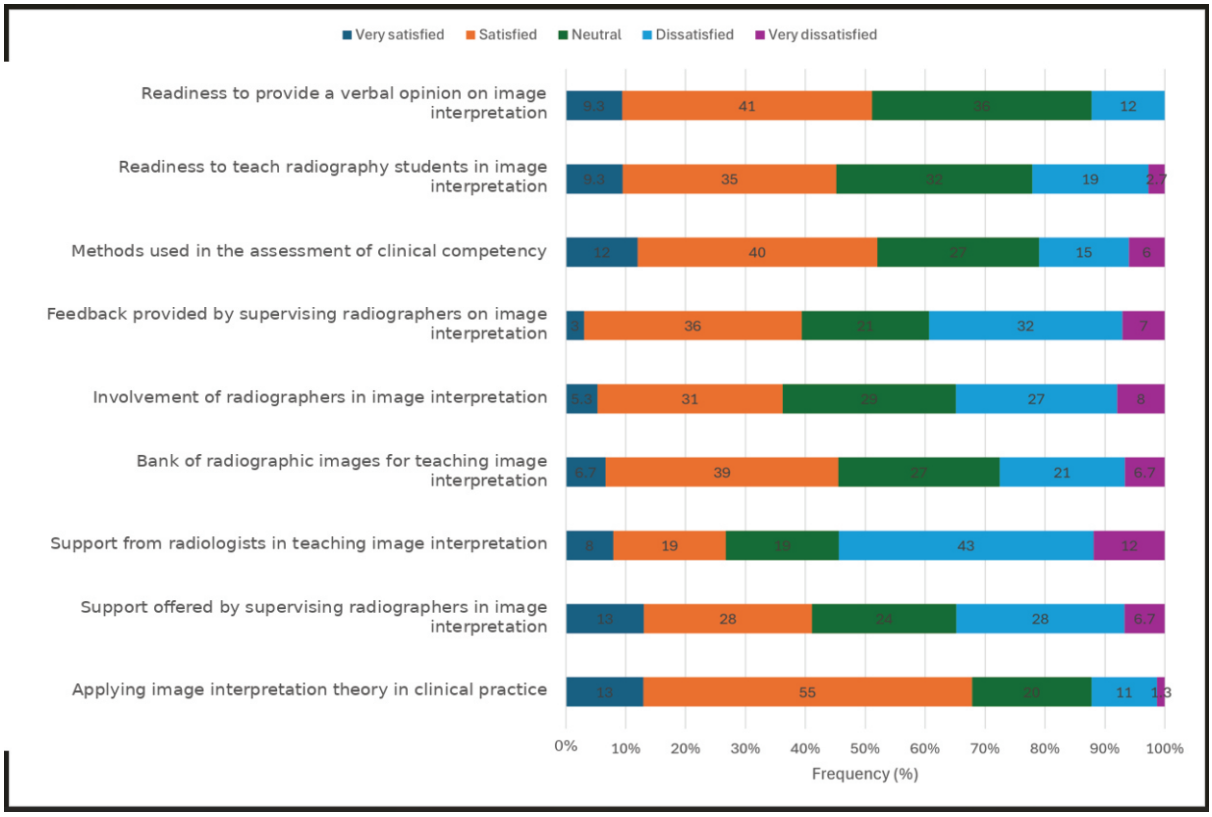


Figure 2: Satisfaction with clinical teaching and learning in image interpretation (n = 75 for each item)

DISCUSSION

This study assessed newly qualified radiographers' satisfaction with classroom and clinical teaching in undergraduate plain-film image interpretation and their perceived readiness to apply this training in the workplace in Zambia. Four principal findings emerged: classroom teaching items were rated more favourably than clinical teaching items; clinical teaching weaknesses were most evident in supervision, feedback, radiographer role modelling, and radiologist support; institution-level differences were observed for classroom but not clinical composite scores; and only about half of respondents reported favourable perceptions of their readiness to provide informal verbal image interpretation opinions. These findings describe graduates' perceptions and should not be interpreted as objective evidence of competence.

Classroom teaching and learning in image interpretation

In the current study, most radiographers reported high satisfaction with the content of the image interpretation module, which covered the axial and appendicular skeletons, chest, and abdomen. The scope of the module content is consistent with findings reported in the literature.[9,22,23] Most HEIs focus on conventional radiography. However, a recent study by Peter *et al*.[23] in the UK found that some institutions have begun incorporating head CT into an image interpretation module.

The predominant method for delivering the theoretical component reported in the literature is lectures.[9,22,23] In the present study, most radiographers (n = 55; 73.3%) indicated satisfaction with the use of lectures in the module. Effective lecturing requires alignment among teaching content, instructional methods, and learning outcomes,[16] ensuring that graduates acquire the requisite knowledge and skills.[10] However, lectures are largely passive learning experiences and may fail to fully engage students. [16] To address this limitation, the use of image illustrations is recommended to enhance engagement during image interpretation lectures. [10] Overall, most radiographers in this study expressed satisfaction with lecturers' effectiveness and the use of image illustrations (Figure 1).

This study evaluated two components of the module: formative and summative assessments. Formative assessment provides feedback on students' progress, whereas summative assessment evaluates the achievement of learning outcomes at the end of training. [26] In this study, approximately three-quarters of radiographers (n = 56; 74.7%) reported satisfaction with the online multiple-choice questions and case studies used for formative assessment. The literature indicates that written examinations are the primary method for assessing the theoretical component of image interpretation modules, [9,22,23] and most radiographers in this study expressed satisfaction with this approach.

In countries with a critical shortage of radiologists, such as Zambia, newly qualified radiographers often experience increased demand for image interpretation skills and a need for further professional development. [5,12] This underscores the importance of preparing radiography students for lifelong learning. [23] In the present study, most radiographers (n = 54; 72.0%) expressed satisfaction with the use of case studies to support lifelong learning within the image interpretation module. In addition to handouts, students were provided with supplementary learning resources, including textbooks and websites, to facilitate independent learning. Approximately three-quarters of radiographers (n = 55; 73.3%) reported satisfaction with these training resources.

This study found no statistically significant differences in satisfaction with the classroom teaching component between radiographers who entered the programme through direct entry and those who entered via in-service routes. However, newly qualified radiographers from UNZA reported higher levels of satisfaction than those from LMMU and LAMU. This variation may reflect differences

in teaching staff across the three HEIs, as the module is delivered by radiologists and radiographers qualified in image interpretation.

Clinical teaching and learning in image interpretation

Clinical teaching enables radiography students to apply theoretical knowledge to practical situations.[27-30] In this study, fewer than half of the newly qualified radiographers (n=31;41.3%) reported satisfaction with the support they received from supervising radiographers in applying image interpretation theory to clinical practice (Figure 2). The literature has also highlighted concerns regarding the theory-practice gap, whereby supervising radiographers tend to focus primarily on radiographic techniques rather than image interpretation during clinical supervision.[10] This disparity may impede students' learning and limit their perceived readiness to apply knowledge following graduation.

In Zambia, radiographers at clinical training sites supervise radiography students.[31,32] One of their roles involves teaching image interpretation, and less than half of the newly qualified radiographers in this study (n=33; 44.0%) reported feeling prepared to undertake this responsibility (Figure 2). Another key role of supervising radiographers is providing feedback on students' clinical performance, including image interpretation.[33-35] Students have described effective supervision as involving constructive feedback, with positive reinforcement of good performance and corrective feedback to identify areas for improvement.[36,37] In this study, however, fewer than half of the newly qualified radiographers were satisfied with the feedback they received from their supervising radiographers during their clinical training (Figure 2). Supervising radiographers are also involved in student assessment.[33-35] More than half of the survey respondents reported satisfaction with the objective structured clinical examination (OSCE) used to assess competency in image interpretation (Figure 2).

During clinical practice, radiography students also learn image interpretation through role modelling, consistent with Social Learning Theory, which posits that individuals learn through observation, imitation, and modelling.[38] In this context, modelling involves actively supervising radiographers engaged in image interpretation, including assessing radiographic images for technical adequacy and quality, differentiating normal from abnormal appearances, and providing verbal opinions when requested by referring clinicians. [23, 39] In this study, fewer than half of newly qualified radiographers were satisfied with the level of involvement of supervising radiographers in image interpretation during clinical training (Figure 2).

More than half of the newly qualified radiographers (n=41;54.7%) reported dissatisfaction with the level of support they received from radiologists during clinical practice. This may reflect the critical shortage of radiologists in Zambia, where workforce constraints, heavy clinical workloads, and limited protected teaching time could reduce opportunities for clinical supervision and teaching during clinical placements of radiography students.

In Zambia, formal radiographer reporting is not currently within the scope of practice.[39]

However, newly qualified radiographers should be prepared to provide informal verbal interpretations of images upon request from referring clinicians. [5] In Southern Africa, medical doctors have reported that, in the absence of a radiologist, radiographers assist in interpreting radiographic images.[8,10,40] In this study, 38 respondents (50.7%) reported favourable perceptions of their readiness to perform this role. This informal practice may support diagnostic decision-making and patient management, although these effects were not directly assessed.[1,10] Further research should examine referring clinicians' perspectives and the feasibility of any formal radiographer reporting pathway in Zambia. Any future role extension should be preceded by formal competency assessment, regulatory clarification of scope of practice, structured supervision, continuing

professional development, quality assurance and audit, and appropriate medico-legal safeguards.

The present study found no statistically significant differences in satisfaction with the clinical teaching component of the module among newly qualified radiographers, irrespective of their entry route into the radiography programme or the HEI from which they graduated. Zambia has 40 clinical training sites, all of which are utilised by the three HEIs for undergraduate radiography student placements. [32] This shared clinical training environment may explain the observed similarity in satisfaction levels among newly qualified radiographers.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are proposed to improve the undergraduate image interpretation module:

- Develop a structured clinical supervision framework for image interpretation, with clearly defined learning outcomes for clinical placements.
- Incorporate image interpretation into the clinical assessment logbook for radiography students during their clinical placements.
- Conduct regular image review sessions involving radiography students, radiographers, and radiologists to enhance image interpretation during clinical placements.
- Establish anonymised digital teaching radiographic image banks at each radiography clinical training site to support student learning and assessment.
- Introduce standardised OSCE and workplace-based assessment tools for clinical image interpretation competencies across training institutions.
- Strengthen interprofessional teaching through scheduled sessions involving radiologists, radiographers, and referring clinicians.
- Develop structured postgraduate and continuing professional development pathways in image interpretation, preliminary clinical evaluation, and reporting where these are consistent with the approved scope of practice.
- Engage HEIs, the Health Professions Council of Zambia, the Radiological Society of Zambia, radiologists, radiographers, employers, and other relevant stakeholders before implementing any expansion of radiographer image-interpretation roles.

LIMITATION OF THE STUDY

This study has several limitations. Its cross-sectional design limits causal interpretation, and satisfaction levels may have differed between respondents and non-respondents. [40] Recall bias and socially desirable responding may have influenced retrospective ratings of training experiences. [17,40] The study measured self-reported satisfaction and perceived readiness rather than objectively assessed image-interpretation competence. The questionnaire was developed from the literature and pilot tested, and it demonstrated high internal consistency; however, it did not undergo comprehensive psychometric validation, and Cronbach's alpha alone does not establish construct validity. Only the 2023 and 2024 graduating cohorts were included, which limits generalisability. Institution-level comparisons may have had limited statistical power, particularly for LMMU, which contributed 14 respondents. Characteristics of non-respondents were not available. The questionnaire also did not determine whether respondents had already entered employment, which may have influenced perceived readiness to apply training in the workplace. Recruitment through alumni WhatsApp groups may have excluded graduates who were no longer active in those groups, and the online format may have preferentially captured graduates with reliable internet access or greater interest in the topic, introducing coverage and selection bias. [18]

CONCLUSION

Newly qualified radiographers in Zambia rated classroom teaching of plain-film image interpretation more favourably than clinical teaching. Clinical training weaknesses were identified in supervision, feedback, role modelling, teaching-image resources, and radiologist support. Approximately half of respondents reported favourable perceptions of their readiness to provide informal verbal image interpretation opinions when requested by referring clinicians; this reflects perceived readiness rather than objectively measured competence. The findings support strengthening structured clinical supervision, competency-based assessment, interprofessional teaching, and quality-assured clinical learning before considering any expansion of radiographer image-interpretation roles.

WHAT IS ALREADY KNOWN ON THIS TOPIC

- Plain-film image interpretation is increasingly taught in undergraduate radiography programmes.
- Graduate satisfaction is an important indicator of curriculum quality and training effectiveness.
- No previous study has assessed Zambian radiography graduates' perceptions of image interpretation training or their readiness to apply it in clinical practice.

WHAT THIS STUDY ADDS

- This study provides the first evidence on newly qualified radiographers' perceived satisfaction with undergraduate plain-film image interpretation training in Zambia.
- Newly qualified radiographers reported higher levels of satisfaction with classroom teaching than with clinical teaching, highlighting deficiencies in clinical supervision, feedback, role modelling, and radiologist support.
- The findings identify priorities for strengthening undergraduate image interpretation training through structured clinical supervision, competency-based assessment, and interprofessional support to improve graduates' perceived readiness for practice.

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DATA AVAILABILITY STATEMENT

The data are available from the corresponding author upon reasonable request.

CONFLICT OF INTEREST

The authors declared they have no conflicts of interest.

AUTHORS' CONTRIBUTIONS

Osward Bwanga: Study conception and drafting of the manuscript.

Leon-say Mudadi: Data analysis and drafting of the manuscript.

Stefan Kafwimbi: Data collection, drafting **and editing of the manuscript.**

Bornface Chinene: Drafting and editing of the manuscript, and supervision.

Brian Mubanga: Data collection, ethical approval and drafting the manuscript.

All authors reviewed, read, and approved the final version of the manuscript.

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