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Evaluating Film Reject Rates in Medical Imaging: A Five-Year Cross-Sectional Study from Nigeria

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ABSTRACT
Film Reject Analysis (FRA) is a critical quality control tool in medical imaging, offering insight into image quality and patient radiation exposure. This study assessed reject rates, causes, and examinations most frequently associated with rejected films. A total of 591 rejected radiographs were retrospectively reviewed over five years (2018–2022) at Sandaji Lafia Medical Center, Nasarawa State, Nigeria. Rejections were categorized into overexposure, underexposure, patient motion, incorrect positioning, artifact, collimation, fog, and incorrect patient identification. Data were analyzed using descriptive statistics, and graphs were generated with Python (version 3.8) employing Matplotlib and Seaborn libraries. Annual reject rates were 11.23% (2018), 4.54% (2019), 3.52% (2020), 9.89% (2021), and 5.71% (2022). Rates in 2019 and 2020 fell within the WHO recommendation of ≤5%. Overexposure and underexposure were the leading causes, highlighting the need for radiographer training and equipment quality assurance. These findings provide a benchmark for departmental performance and emphasize the importance of systematic FRA in improving diagnostic accuracy and patient safety.

Keywords: Film Reject Analysis, Radiography, Quality Control, Patient Dose, Overexposure, Underexposure

1.0 INTRODUCTION

X-ray imaging is one of the most widely used diagnostic modalities in healthcare, providing essential visualization of bones and soft tissues for clinical decision-making (Joseph et al., 2015). Although X-rays are employed in safe quantities, they are associated with radiation exposure, making image quality assurance a critical component of radiology practice. Film Reject Analysis (FRA) has therefore emerged as a key quality control tool, enabling departments to monitor technical performance, optimize radiographic procedures, and minimize unnecessary patient dose. A rejected film is considered non-diagnostic because its poor quality fails to provide sufficient information for clinical evaluation, thereby increasing patient exposure and reducing efficiency. The Quality Assurance Committee of the Conference of Radiographic Control Program Directors (CRCPD, 2001) recommended a rejection rate of 10%, while the World Health Organization (WHO, 2001) advises a threshold of 5%.

Several studies across different regions have investigated film reject rates and their implications. Arbese et al. (2018) analyzed reject rates in eight governmental diagnostic facilities in Ethiopia, while Atkinson et al. (2020) examined reject analysis in digital radiography within an Australian emergency department. Jwanbot et al. (2017) highlighted reject analysis as a quality assurance element in Nigeria, and Benza et al. (2018) reported causes of reject images in Namibia. Owusu-Banahene et al. (2014) studied film reject analysis in Ghana, whereas Audu et al. (2017) assessed reject rates in Northwestern Nigeria. Similar investigations have been conducted in Maiduguri (Sadiq et al., 2017), Jimma (Zewdu et al., 2017), Benin City (Osahon et al., 2016), and North-Eastern Nigeria (Joseph et al., 2015; Abubakar et al., 2016). Internationally, Jabbari et al. (2012) evaluated patient dose implications of rejects in Iran, and Anikoh et al. (2010) analyzed causes of rejects in Jos University Teaching Hospital, Nigeria. Collectively, these studies underscore the importance of FRA as a quality indicator, linking reject rates to staff efficiency, service delivery, dose optimization, and economic implications.

2.0. MATERIALS AND METHOD

The study utilized radiographic films obtained from the X-ray Department of Sandaji Lafia Medical Center, Nasarawa State, Nigeria. A total of 4,823 radiographic examinations were performed between January 2018 and December 2022. Of these, 591 films were identified as rejected and retrospectively analyzed. The rejected films represented examinations of six anatomical or skeletal regions: skull, chest, spine, abdomen, pelvis/hips, and upper and lower extremities.

Image evaluation was conducted by the senior radiologist in the department, who classified each radiograph as either diagnostically acceptable or rejected. Rejected films were further categorized into eight predefined groups: overexposure (OE), underexposure (UE), patient motion (PM), incorrect positioning (IP), artifacts, collimation errors, fogging, and incorrect patient identification (IPID).

Data were analyzed using descriptive statistical methods. The film rejection rate was calculated as a percentage of the total number of examinations performed during the study period, using the formula:

$$Reject\ Rate = \frac{\text{Number of rejected films}}{\text{Number of examinations}} \times 100 \qquad (1)$$

Graphs and visualizations were generated using Python (version 3.8) with the Matplotlib and Seaborn libraries to illustrate rejection rates and causes across anatomical regions and study years. The overall rejection rate across the five-year period was 12.25%, corresponding to 591 rejected films out of 4,823 examinations.

3.0. RESULTS AND DISCUSSION

A total of 4,823 radiographic examinations were performed during the five-year study period (January 2018–December 2022). Of these, 591 radiographs were rejected, yielding an overall rejection rate of 12.25%.

The distribution of examinations across anatomical regions revealed that the chest accounted for the largest proportion, with 1,174 films (24.34%), followed by the spine (1,039 films; 21.54%), skull (1,019 films; 21.12%), upper and lower extremities (984 films; 20.40%), pelvis/hips (948 films; 19.65%), and abdomen (658 films; 13.64%).

The rejection rates varied across the study years, reflecting fluctuations in technical performance and quality assurance practices. Tables 1–5 present the annual breakdown of rejected films by anatomical region, while Figures 1–5 illustrate the trends in rejection rates and causes. Collectively, these results demonstrate that although the overall rejection rate exceeded the WHO recommended threshold of 5% in most years, the distribution of rejected films provides valuable insight into areas requiring targeted intervention, particularly chest and spine examinations, which contributed the highest proportions of rejects.

Table 1: The Distribution of Reject Radiograph of body parts under examination from January to December 2018

Anatomical part	Number of Radiographs used for Examination	Number of Radiographs accepted	Number of Radiographs Rejected	Reject Rate (%)
Skull	180	157	23	2.15
Chest	228	203	25	2.34
Spine	225	203	22	2.05
Abdomen	68	58	10	0.93
Pelvic/Hips	191	172	19	1.77
Extremities	176	155	21	1.96
Total	1068	948	120	11.2

Table 2: The Distribution of Reject Radiographs of body parts under examination from January to December 2019

Anatomical part	Number of Radiographs used for Examination	Number of Radiographs accepted	Number of Radiographs Rejected	Reject Rate (%)
Skull	222	212	10	0.84
Chest	250	239	11	0.92
Spine	198	190	8	0.67
Abdomen	100	96	4	0.33
Pelvic/Hips	204	194	10	0.84
Extremities	214	203	11	0.92
Total	1188	1134	54	4.52

Table 3: The Distribution of Reject Radiographs of body parts under examination from January to December 2020

Anatomical part	Number of Radiographs used for Examination	Number of Radiographs accepted	Number of Radiographs Rejected	Reject Rate (%)
Skull	178	175	3	0.29
Chest	200	189	11	1.09
Spine	161	157	4	0.39
Abdomen	91	86	5	0.49
Pelvic/Hips	173	170	3	0.29
Extremities	198	192	6	0.59
Total	1001	969	32	3.14

Table 4: The Distribution of Reject Radiographs of body parts under examination from January to December 2021

Anatomical part	Number of Radiographs used for Examination	Number of Radiographs accepted	Number of Radiographs Rejected	Reject Rate (%)
Skull	247	222	25	1,96
Chest	196	177	19	1.49
Spine	250	229	21	1.64
Abdomen	204	189	15	1.17
Pelvic/Hips	180	168	20	1.57
Extremities	196	170	26	2.04
Total	1273	1155	126	9.89

Table 5: The Distribution of Reject Radiograph of body parts under examination from January to December 2022

Anatomical part	Number of Radiographs used for Examination	Number of Radiographs accepted	Number of Radiographs Rejected	Reject Rate (%)
Skull	192	180	12	0.93
Chest	300	279	21	1.62
Spine	205	189	16	1.23
Abdomen	197	191	6	0.46
Pelvic/Hips	200	185	15	1.15
Extremities	200	196	4	0.30
Total	1294	1217	74	5.71

The present study revealed an overall rejection rate of 12.25% across the five-year period, with annual variations ranging from 3.20% to 11.23%. The rejection rates for 2019 (4.54%) and 2020 (3.20%) were within the World Health Organization (WHO) recommended threshold of ≤5%, whereas the rates for 2018, 2021, and 2022 exceeded this benchmark. These findings highlight fluctuations in departmental performance, suggesting that technical proficiency, equipment calibration, and adherence to exposure protocols varied across the study period. The Conference of Radiation Control Program Directors (CRCPD) recommendation of 5–10% was met in 2018 and 2021, but exceeded in 2018 and fell below in 2019 and 2020, indicating inconsistent compliance with international quality assurance standards.

Across the anatomical regions examined, the chest and extremities consistently contributed the highest proportions of rejected films, reflecting the technical challenges associated with patient positioning and motion in these examinations. Conversely, abdominal and skull radiographs demonstrated relatively lower rejection rates, possibly due to simpler positioning requirements. Importantly, overexposure emerged as the leading cause of rejection in all study years, accounting for up to one-third of rejected films, while patient motion and collimation errors were among the least frequent causes. This pattern is consistent with previous studies conducted in Ethiopia (Arbese et al., 2018), Ghana (Owusu-Banahene et al., 2014), Namibia (Benza et al., 2018), and Nigeria (Joseph et al., 2015; Audu et al., 2017), which similarly identified exposure errors as the predominant factor in film rejection.

The relatively low rejection rates observed in 2019 and 2020 may reflect improvements in radiographer training, stricter adherence to exposure protocols, or enhanced equipment performance during those years. However, the subsequent increase in 2021 suggests lapses in quality assurance practices, underscoring the need for continuous monitoring and retraining. Reject analysis not only serves as a measure of technical efficiency but also has direct implications for patient safety, as repeated exposures increase radiation dose unnecessarily. Furthermore, high reject rates contribute to economic losses through wasted resources and reduced departmental efficiency, as highlighted in studies from Ethiopia (Zewdu et al., 2017) and Nigeria (Osahon et al., 2016).

Overall, the findings emphasize the importance of systematic film reject analysis as a quality assurance tool. Regular monitoring, coupled with targeted interventions such as radiographer retraining, equipment calibration, and stricter adherence to positioning protocols, can reduce reject rates, optimize patient dose, and improve diagnostic accuracy.

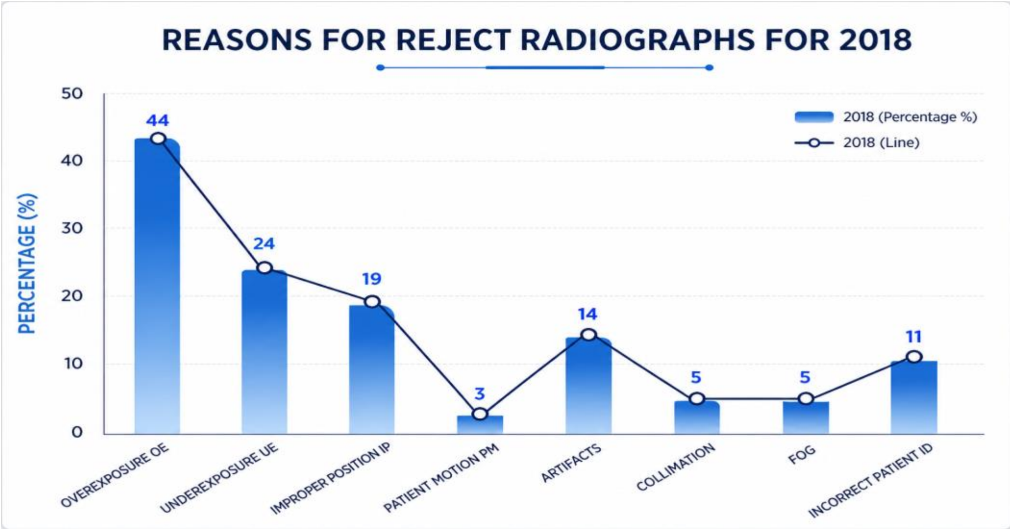

Figure 1: Bar chart representing the causes of rejects radiographs from January – December 2018

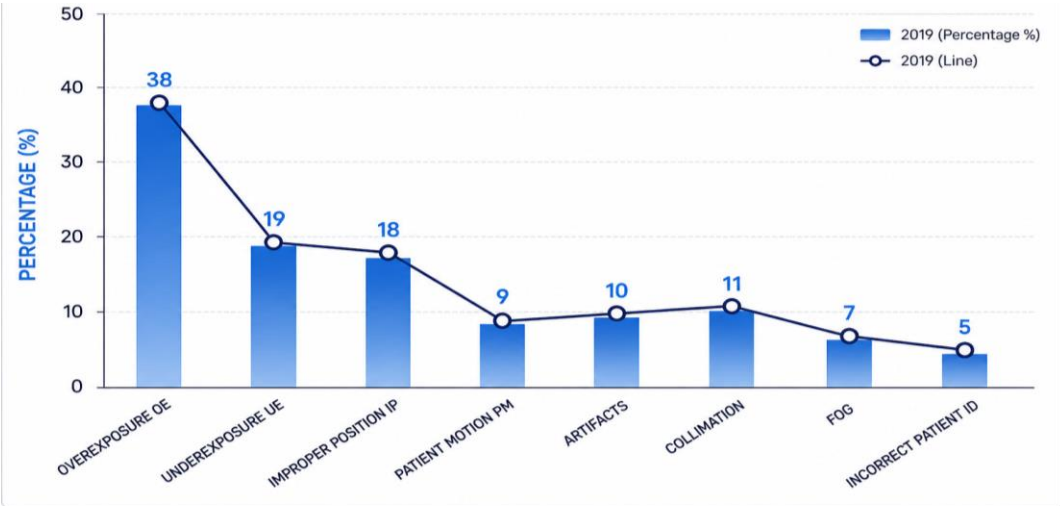

Figure 2: Bar chart representing the causes of rejects radiographs from January – December 2019.

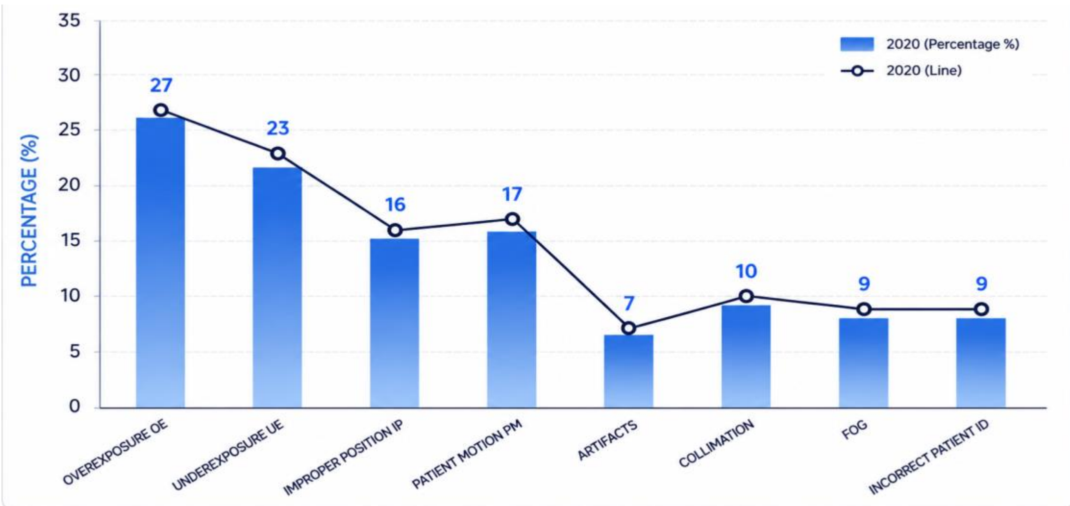

Figure 3: Bar chart representing the causes of rejects radiographs from January –December 2020

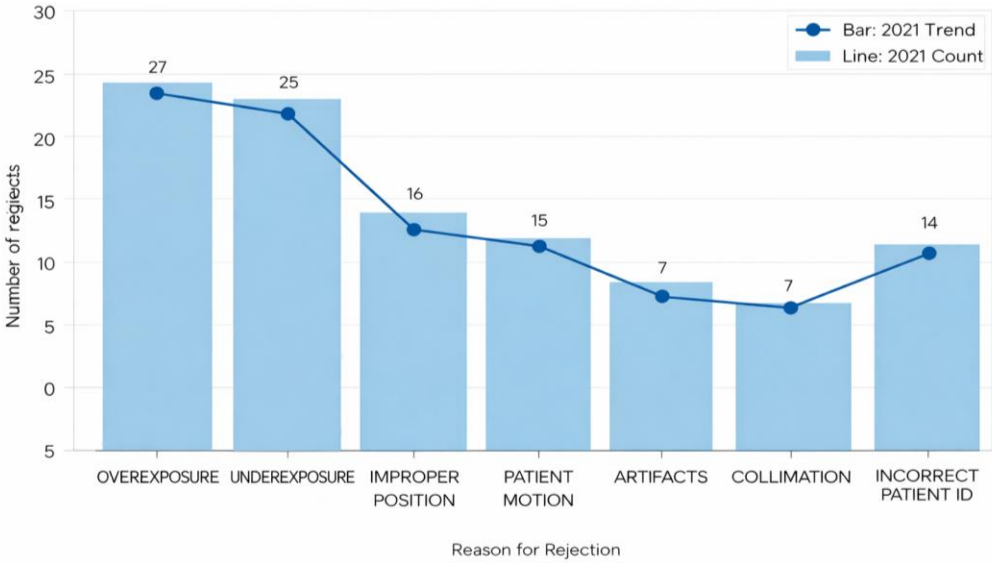

Figure 4: Bar chart representing the causes of rejects radiographs from January – December 2021.

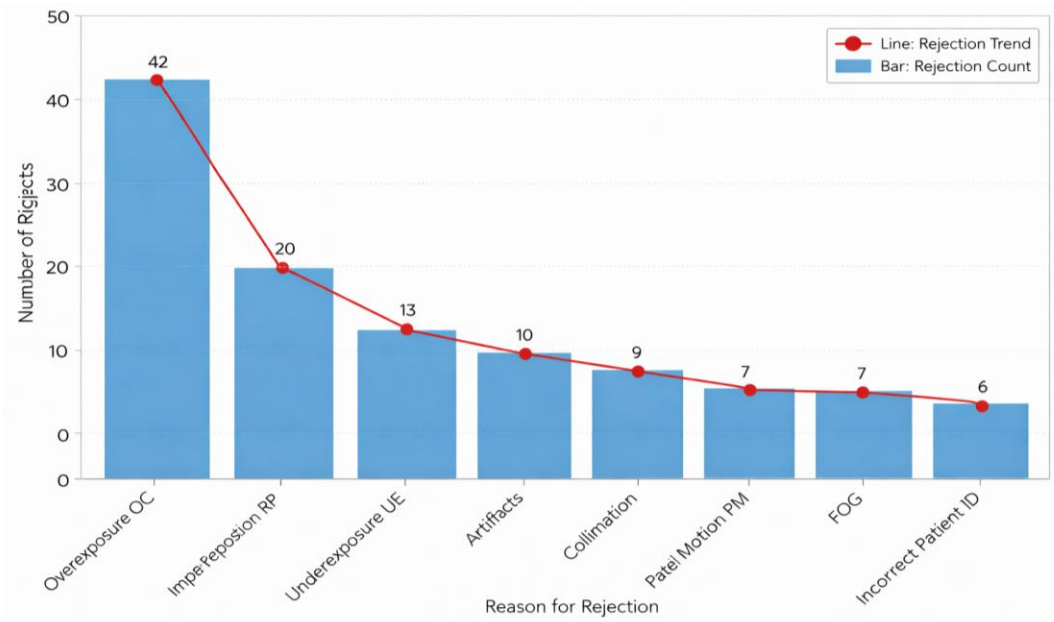

Figure 5: Bar chart representing the causes of rejects radiographs from January – December 2022

Figures 1–5. Trends in anatomical distribution and causes of rejected radiographs at Sandaji Medical Center, 2018–2022. Across the five-year period, the chest consistently accounted for the highest rejection rates, while the abdomen and extremities were least affected depending on the year. Overexposure was the predominant cause of rejection in most years, followed by secondary factors such as patient misidentification, artifacts, collimation errors, and patient motion. These findings highlight recurring technical challenges and emphasize the need for continuous quality assurance interventions.

4.0. CONCLUSION

This study demonstrated variability in film rejection rates over a five-year period, with values ranging from 3.52% to 11.23%. The rejection rates for 2019 and 2020 were within the World Health Organization (WHO) recommended threshold of ≤5%, while the rates for 2018, 2021, and 2022 exceeded this benchmark, highlighting inconsistencies in departmental quality assurance practices. The Conference of Radiation Control Program Directors (CRCPD) recommendation of 5–10% was met in some years but surpassed in others, underscoring the need for continuous monitoring. Across anatomical regions, the chest consistently exhibited the highest rejection rates, while overexposure was identified as the predominant cause of film rejection. Contributing factors included incorrect selection of exposure parameters, inadequate communication between radiographers and darkroom technicians, and insufficient quality control testing of processing equipment. These findings emphasize the importance of strengthening corrective action programs, including regular equipment calibration, radiographer retraining, and systematic quality assurance audits. In conclusion, film reject analysis remains a vital quality indicator in diagnostic radiology. By addressing the recurring causes of rejection, departments can reduce unnecessary patient radiation exposure, improve diagnostic accuracy, enhance staff efficiency, and optimize resource utilization. Sustained commitment to quality assurance is essential for achieving international standards and ensuring patient safety.

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