

EVALUATION OF THE FREQUENCY, CONTRIBUTING FACTORS AND IMPACT ON PATIENT OF REPEAT EXAMINATION IN NON-INVASIVE IMAGING MODALITIES IN PESHAWAR, PAKISTAN

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DOI: <https://doi.org/10.5281/zenodo.19694191>

Received
24 February 2026

Accepted
04 April 2026

Published
22 April 2026

ABSTRACT

Introduction

Although non-invasive imaging is a major component of modern medical diagnosis, repeated examinations can result in increased radiation exposure, unnecessary costs, and treatment delays. Therefore, this study examines the frequency of repeat imaging in Peshawar, Pakistan, which identifies the underlying reasons for such repetitions, and evaluates their consequences on patients, with the aim of improving imaging practices and enhancing patient safety.

Methodology

Our study proposed a descriptive cross-sectional model which involved 150 radiologists and technologists from PGH, KTH, RMI, and NWGH, using structured questionnaires for data collection and SPSS for statistical analysis.

Results

Results show most repeat examinations were in the range of 1–5 among all 6 modalities and chest examinations were the most repeated one (38%). While assessing the causes of repeat examination results showed most of the repetition in x-ray (44.4%), CT (46.9%) and MRI (42.3%) were due to patient movement while in fluoroscopy (52.6%) and USG (57.9%) were due to uncooperative patients and in mammography they were due to inadequate compression and patient positioning (44.4%). Furthermore, Patient weight (78%), workload (64%) are also main contributors to repeat examinations. The most common negative impact of these examinations on patients was radiation overexposure (53.3%).

Conclusion

Overall, our study reveals that patient movement was the primary causes of repeat imaging tests, in X-rays, CT, and MRI, in fluoroscopy and ultrasound, it was uncooperative patients while in mammography it was positioning errors. Chest examinations are most often repeated. Repeat rates are greatly influenced by variables including patient size, workload, and technician education. Overexposure to radiation was shown to be the most frequent adverse effect on individuals.

Keywords: Imaging Modalities, Repeat Imaging Examinations, Radiation Overexposure.

INTRODUCTION

The term "repeat" in medical imaging refers to the necessity of re-acquiring images during a single examination due to factors such as patient repositioning or the application of improper imaging techniques. This concept is critical in the field of radiology, as it highlights a significant challenge that can lead to both increased operational costs for healthcare facilities and heightened exposure to radiation for patients (1). Indeed, errors in acquiring radiographs not only detract from the quality of patient care but also raise concerns about patient safety and the efficiency of radiological services (2).

The implications of repeat imaging are profound. First, the financial burden on hospitals can be substantial, stemming from the costs associated with additional imaging sessions, the use of resources, and the potential for delayed diagnoses (3). In an era where healthcare systems are under constant pressure to optimize costs and improve patient outcomes, understanding and mitigating the causes of repeat imaging is paramount. Moreover, from a patient perspective, unnecessary repetition of imaging procedures can lead to an increased cumulative dose of radiation. The long-term effects of radiation exposure are a crucial concern, particularly given the established risks associated with ionizing radiation and its potential to contribute to cancer risk over a patient's lifetime (4).

Images obtained from radiographic examinations that lack sufficient diagnostic value are deemed unacceptable. In these cases, the necessity to repeat the imaging not only compromises the timeliness of diagnosis but also places patients at an increased risk of radiation exposure (5). Consequently, there is an urgent need for corrective measures aimed at minimizing the frequency of repeat imaging. This necessitates the establishment of a systematic approach to evaluate the rejection of films, investigate the underlying reasons for inadequate imaging, and develop strategies to enhance the accuracy and reliability of radiographic techniques (6).

Furthermore, training and education for radiologic technologists play a critical role in addressing these issues. Improved protocols for

patient positioning, equipment calibration, and technique selection can significantly reduce the incidence of repeat images (7). Additionally, fostering a culture of continuous quality improvement within radiology departments encourages staff to engage in proactive measures to refine imaging processes and minimize errors (8).

As the healthcare landscape continues to evolve, with advancements in technology and imaging modalities, the challenge of repeat imaging remains relevant. Emerging techniques, such as digital imaging and artificial intelligence, hold promise for enhancing the quality and efficiency of radiographic examinations (9). However, without a comprehensive understanding of the factors contributing to repeat imaging, the potential benefits of these innovations may not be fully realized.

Overall, the phenomenon of repeat imaging in radiology poses significant challenges that require urgent attention. By establishing a robust framework for evaluating and addressing the causes of repeat imaging, healthcare providers can improve patient safety, reduce operational costs, and enhance the overall quality of care in radiologic practices. This exploration will focus on the key factors influencing repeat imaging, the implications for patient safety and healthcare efficiency, and the potential strategies to mitigate this critical issue.

Aims and Objectives

Aims

To reduce number of repeat examinations and to overcome unnecessary exposure and healthcare expenditure.

Objectives

- To quantify the frequency of repeat imaging examination across different imaging modality. (x-ray, CT scan, mammography, fluoroscopy, MR and ultrasound)
- To identify the factors that lead to repeat examination.
- To assess the effect of repeated examinations on patients.

Materials AND Methods

Study Design:

Descriptive Cross-sectional Study

Study Settings:

This study was conducted at RMI (Rehman medical institute), (NWGH) Northwest general hospital, (KTH) Khyber Teaching Hospital and (PGH) Peshawar General Hospital

Study Duration:

5 to 6 months (June to Dec)

Sample Size:

Sample size was calculated by standard formula:

$$n = \frac{x^2 \times P(1-P)}{d^2}$$

Population proportion (P)=0.11 (3)

Level of confidence (x)= 95%

Margin of error (d) = 5%

$$n=150$$

Sampling Technique:

Non-probability Convenience sampling technique was used.

Inclusion criteria

- Radiologists
- Radiology technologists

Exclusion Criteria

- Radiology Nurses

- Referring Medical physician

Data collection procedure

Data collection for this study was conducted after obtaining ethical approval from the relevant institutional review boards of various tertiary care hospitals including Rehman medical institute (RMI), Peshawar general hospital (PGH), northwest general hospital (NWGH) and Khyber teaching hospital (KTH). A data was collected through structured questionnaires from radiologists and radiology technologists.

Data analysis procedure

SPSS was used for data analysis and data was represented through graphs and figures.

RESULTS AND ANALYSIS

Total 150 responses, taken from the radiologists and radiology technologists involved in 6 different modalities were included in this study. The Results of this study were categorized into 3 sections.

Frequency of repeat imaging

Table 1 shows that out of total 150 radiologists and radiology technologists, 45 radiology personal were involved in X-rays, 32 in CT scan, 26 in MRI, 19 fluoroscopy, 19 Ultrasound and 9 in mammography. Fig 4.1 shows its graphical representation.

Table 1 Radiology personnel per modality

Modality	Frequency	Percent
X-RAY	45	30.0
CT	32	21.3
MRI	26	17.3
FLUOROSCOPY	19	12.7
USG	19	12.7
MAMMOGRAPHY	9	6.0
TOTAL	150	100.0

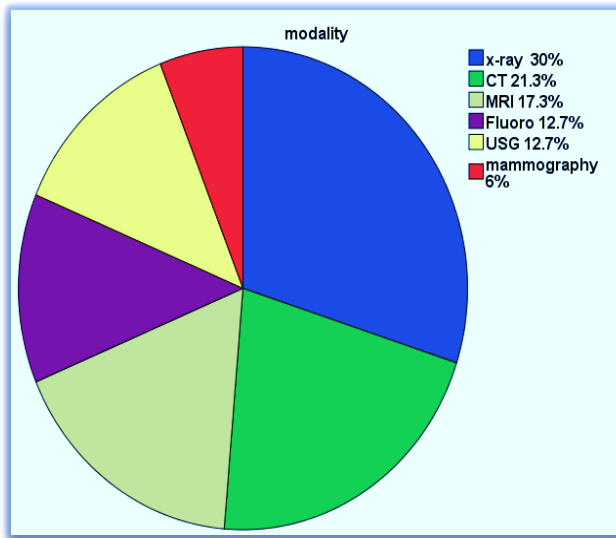


Fig. 4.1 Radiology personnel per modality

Table 2 represents the calculation of daily examination numbers across various imaging modalities. It shows that highest no. of examinations per day in x-ray and ultrasound occur in plus 40 range (17 and 11 responses respectively). In CT highest number of examinations performed per day was in the range

of 31 to 40 (12 responses). In MRI 21 to 30 and 31 to 40 range shows the highest number of examinations per day (8 responses each). In fluoroscopy and mammography highest number of examinations occur in 1 to 10 range (8 and 6 responses each). Fig. 4.2 shows this graphically

Table 2 examinations per day

Modality	examination/day					Total
	1 to 10	11 to 20	21 to 30	31 to 40	40+	
X-ray	5	1	8	14	17	45
Usg	0	1	4	3	11	19
Mri	6	4	8	8	0	26
Mammography	6	0	1	0	2	9
Fluoroscopy	8	4	2	3	2	19
Ct	3	6	5	12	6	32
Total	28	16	28	40	38	150

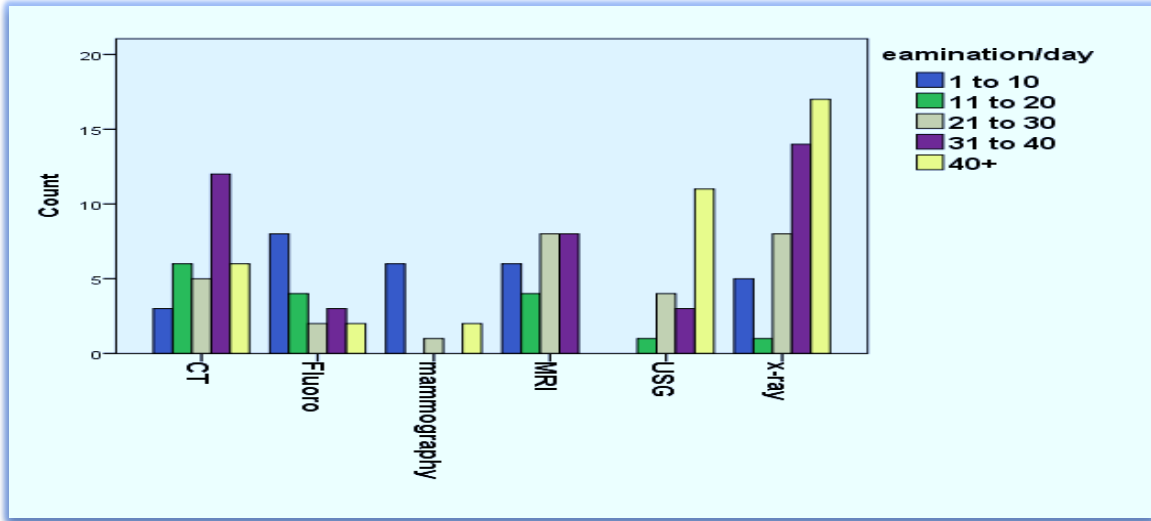


Fig.4.2 Examinations per day

Table 3 shows that the majority of repeat examinations performed per day fall in the 1 to 5/day range, totaling 106 across all modalities, with x-rays and CT having the highest frequency

(24 responses each). Followed by the 6 to 10/day range, again with x-ray having highest frequency (15 responses). Fig. 4.3 represents it graphically.

Table 3 repeat examination per day

Modality	Repeat examination/day				Total
	1 to 5	11 to 15	16 to 20	6 to 10	
X-ray	24	4	2	15	45
Usg	12	0	5	2	19
Mri	22	1	0	3	26
Mammography	8	0	1	0	9
Fluoroscopy	16	0	0	3	19
Ct	24	0	1	7	32
Total	106	5	9	30	150

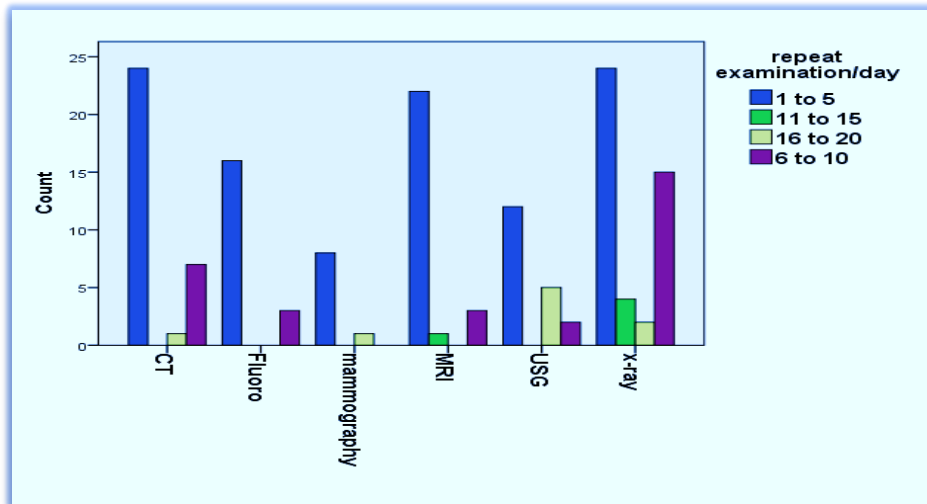


Fig.4.3 Repeat examination per day

On the basis of anatomical region chest examination is repeated highly accounting for 38% of the total. Abdomen follows closely after at 34.7%. Extremities and the skull display 10%

and 12%, respectively. Less frequency is seen in other areas such as the pelvis, lumbar spine, and spine. These statistics is represented in table 4 and figure 4.4 represents it graphically.

Table 4 repetition rate on the anatomical basis

Anatomical region	Frequency	Percent
Chest	57	38.0
Abdomen	52	34.7
Head	18	12.0
Extremities	16	10.7
Spine	3	2.0
Lumbar spine	2	1.3
Contrast studies	1	.7
Pelvic	1	.7
Total	150	100.0

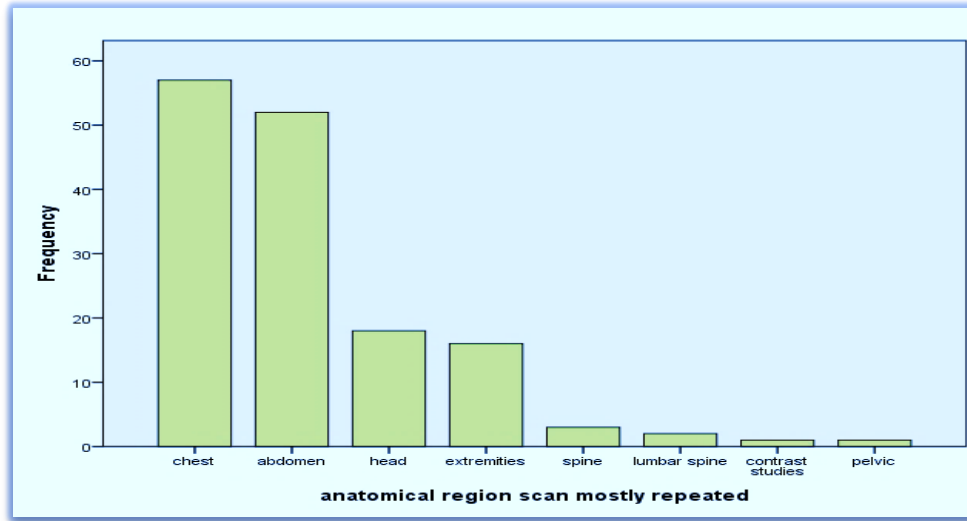


Fig. 4.4 Repetition rate on the anatomical basis

Factors Leading to Repeat Examination

Table 5 shows that the most common reason for repetition in x-ray was patient movement representing 44.4% of the sample (20 responses), the next common reason was incorrect

positioning 40% (18 responses). Incorrect exposure and technical issues were responsible for about 11.1% (5 responses), and 4.4% (2 responses) respectively. It's graphical representation is shown in fig. 4.5.

Table 5 reasons for x-ray repetition

Reasons for repetition in x-ray	Frequency	Percent
Pt. Movement	20	44.4
Incorrect positioning	18	40.0
Incorrect exposure	5	11.1
Technical issue	2	4.4
Total	45	100.0

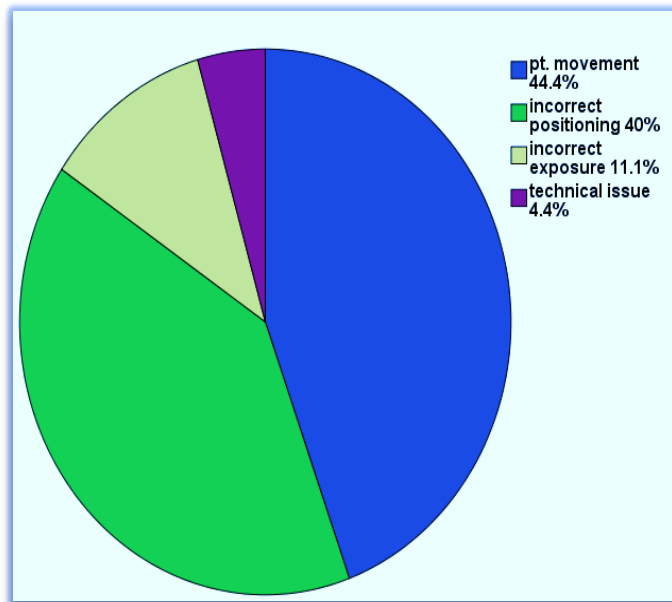


Fig. 4.5 Reasons for x-ray repetition

Total 32 radiology personal were associated with CT scan. Among these 46.9% results shows that the most common reason was patient movement, next was technical issues 21.9%, followed by contrast bolus miss tracking 15.6%. Incorrect

exposure and artifact from metallic object on the patient body was responsible for 12.5% and 3.1% of the repetitions. This statistic is shown in table 6 and its graphical representation in shown in fig. 4.6.

Table 6 reasons for CT repetition

Reason for repetition in CT	Frequency	Percent
Pt. Movement	15	46.9
Technical issue	7	21.9
Contrast bolus miss-tracking	5	15.6
Incorrect exposure	4	12.5
Metal object on body	1	3.1
Total	32	100.0

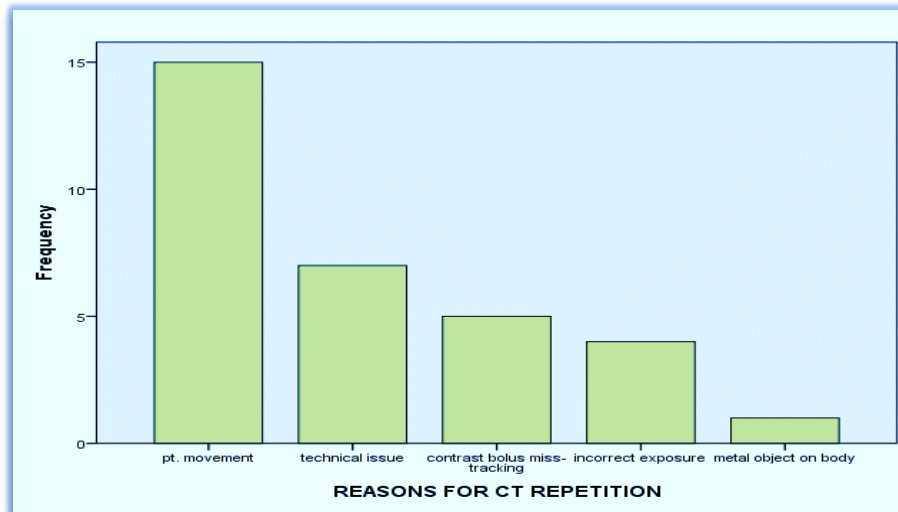


Fig. 4.6 Reasons for CT repetition

Table 7 shows that for MRI, patient movement was major cause of exam repetition accounting for 42.3% of the total, followed by artifacts due to metallic object and incorrect scan protocol

selection 26.9% each. While 3.8% of the results showed that the repetitions were due to technical issues. Its graphical representations are shown in fig.4.7.

Table 7 Reasons for MRI repetition

Reasons for repetition in MRI	Frequency	Percent
Pt. Movement	11	42.3
Metal object on body	7	26.9
Incorrect scan protocols	7	26.9
Technical issues	1	3.8
Total	26	100.0

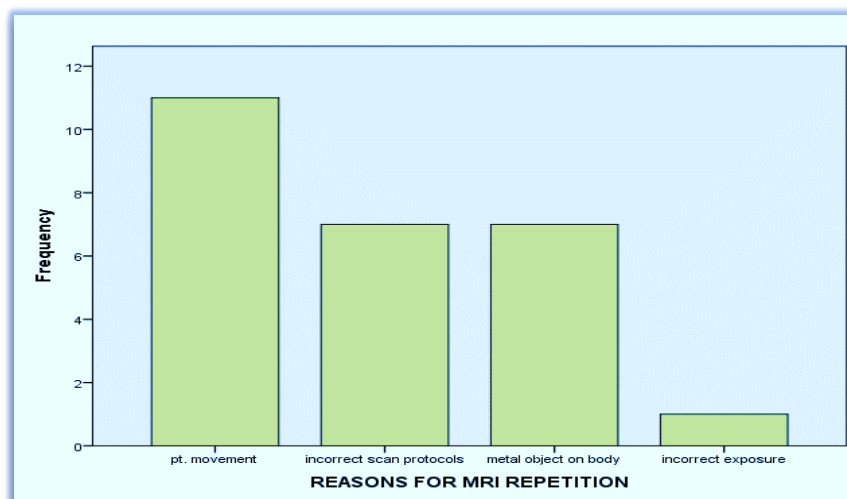


Fig. 4.7 Reasons for MRI repetition

The table 8, shows the causes of exam repeat in fluoroscopy on the basis of total 19 responses. Patients who were uncooperative accounted for 52.6% (10 responses) and were the primary cause of repeat. 15.8% of the repeats were caused by operator mistake and technical problems (3

responses for each). Additional contributory reasons were miss tracking the contrast bolus, improper exposure, and metal items on the body, each accounting for 5.3% of cases. Fig 4.8 shows its graphical representation.

Table 8 reasons for fluoroscopy repetition

Reasons for exam repetition in fluoroscopy	Frequency	Percent
Uncooperative pt.	10	52.6
Operator error	3	15.8
Technical issue	3	15.8
Contrast bolus miss-tracking	1	5.3
Incorrect exposure	1	5.3
Metal object on body	1	5.3
Total	19	100.0

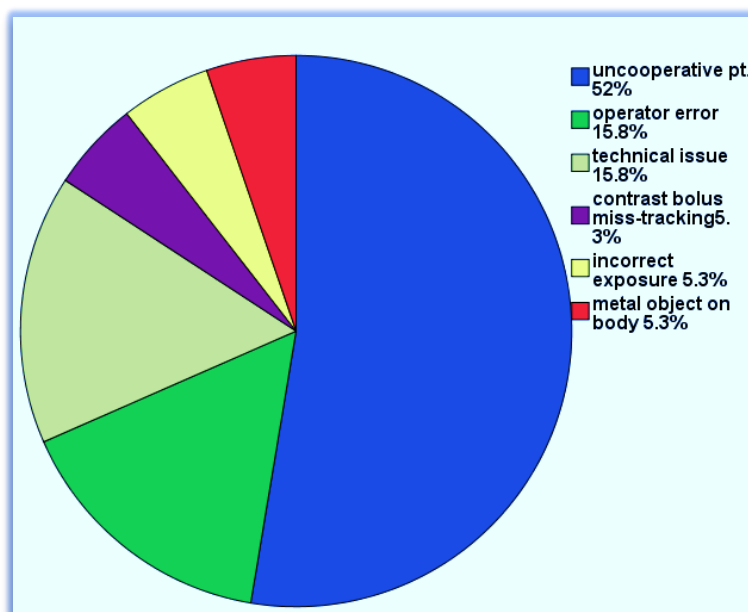


Fig. 4.8 frequency of reasons for fluoroscopy repetition

The table 9 lists reasons for repeat exams in ultrasonography. uncooperative Patients were the main cause of repeat, accounting for 57.9% of the total (11 occurrences). Technical problems and inadequate patient preparation each accounted for 15.8% of the total (3 occurrences).

Less frequently occurring factors that contributed 5.3% each were operator mistake and patient movement (1 incident each). In general, the most common reason for repeating an ultrasound exam was uncooperative patients. Fig 4.9 shows its graphical representation.

Table 9 reasons for ultrasound repetition

Reasons for exam repetition in ultrasound	Frequency	Percent
Uncooperative pt.	11	57.9
Inadequate pt. Preparation	3	15.8
Technical issue	3	15.8
Operator error	1	5.3
Pt. Movement	1	5.3
Total	19	100.0

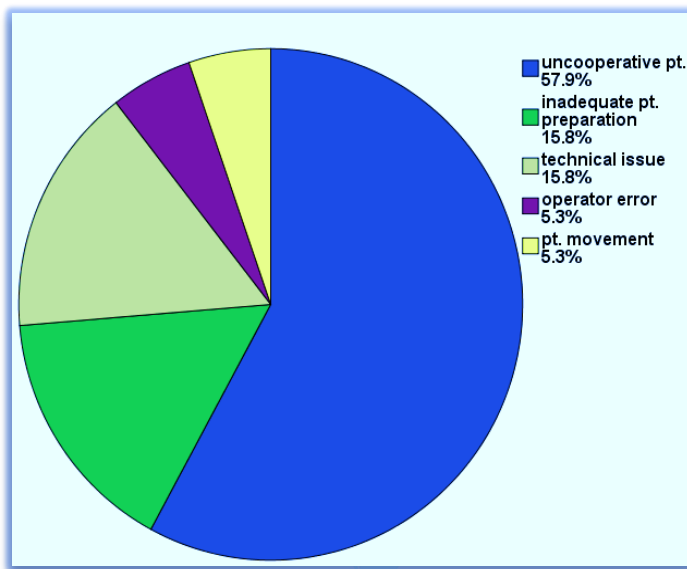


Fig. 4.9 Reasons for ultrasound repetition

Table 10 shows that the major reason for repetition of mammography examinations were inadequate compression and positioning error each representing 44.4% of the results (4

occurrences, followed by incorrect exposure 11.1% (1 occurrence). Fig. 4.10 shows its graphical representation

Table 10 reason for mammography repetition

Reasons for repetition in mammography	Frequency	Percent
Inadequate compression	4	44.4
Positioning error	4	44.4
Incorrect exposure	1	11.1
Total	9	100.0

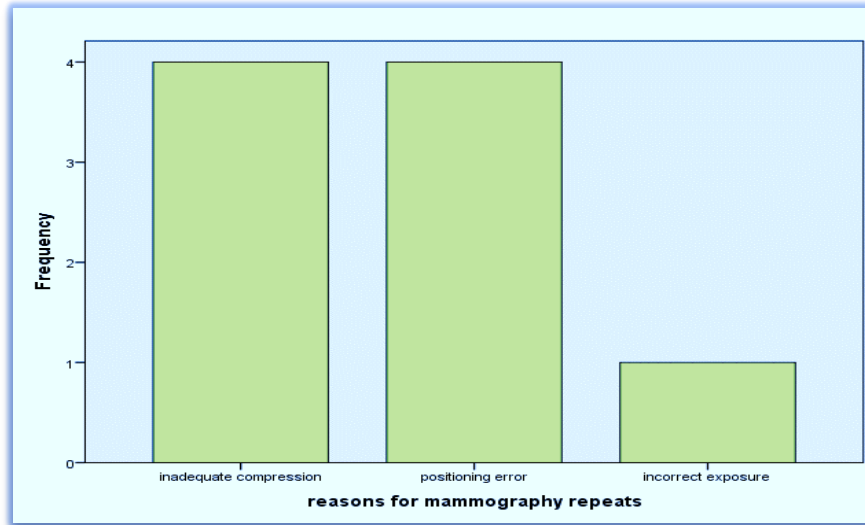


Fig. 4.10 Reasons for mammography repetitions

Table 11 shows that majority of the Responses agreed that workload often effects the number of repeated examinations (64%), while 42% of responses show that it is affected sometimes.and

17% and 18% says that it is rarely and never effected respectively Fig.4.11 represents it graphically.

Table 11 effect of workload

Effect of workload	Frequency	Percent
Often	64	42.7
Sometimes	61	40.7
Rarely	17	11.3
Never	8	5.3
Total	150	100.0

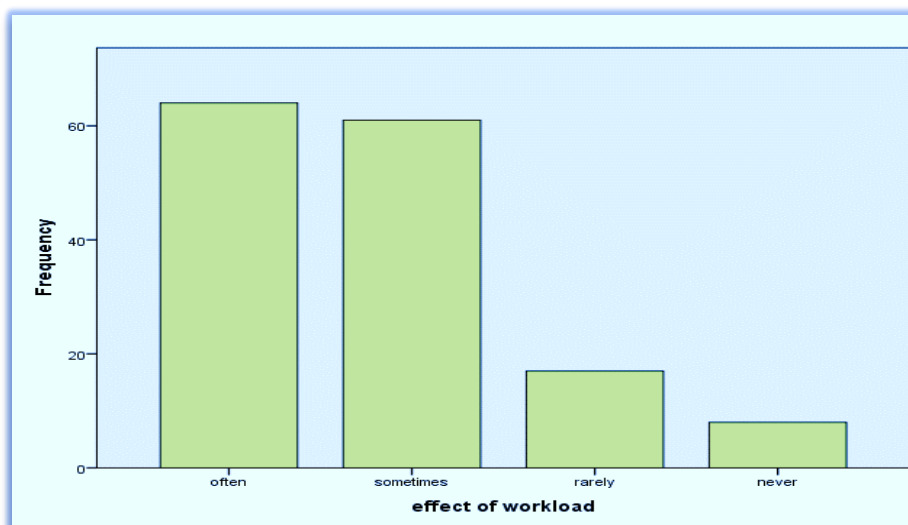


Fig. 4.11 Effect of workload

Table 12 shows that out of total 150, 78% agreed that obesity of patients can effect the number of repeat examinations, while 22% said

that no number of repeat examination is not effected by the obesity. Fig 4.12 shows it graphically.

Table 12 effect of obesity

Effect of obesity	Frequency	Percent
yes	117	78.0
no	33	22.0
Total	150	100.0

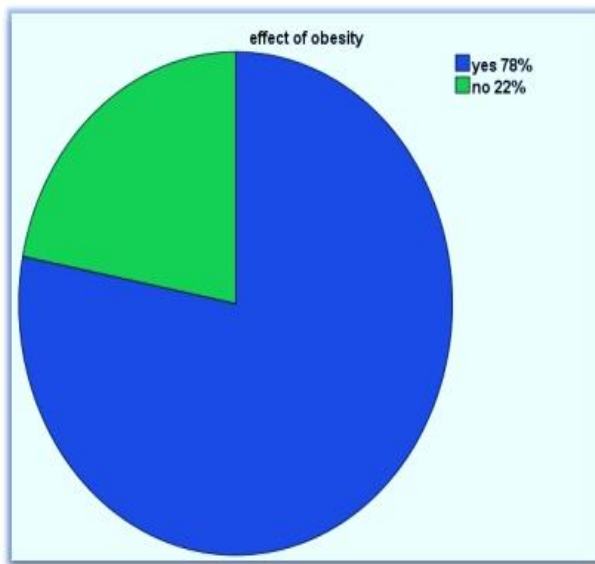


Fig. 4.12 Effect of obesity

Based on 150 replies, the effect of education and training of technologist is shown in the table 13. A significant 45.3% (68 cases) said they often observe the impact. Furthermore, 37.3% (56 cases) said that it happens sometimes. Reportedly, fewer respondents said it happened rarely (11.3%) and never (6.0%), 17 and 9 occurrences respectively. Fig. 4.13 shows it graphically.

Table 13 effect of technologist education and training

Effect of tech. Education/training	Frequency	Percent
Often	68	45.3
Sometimes	56	37.3
Rarely	17	11.3
Never	9	6.0
Total	150	100.0

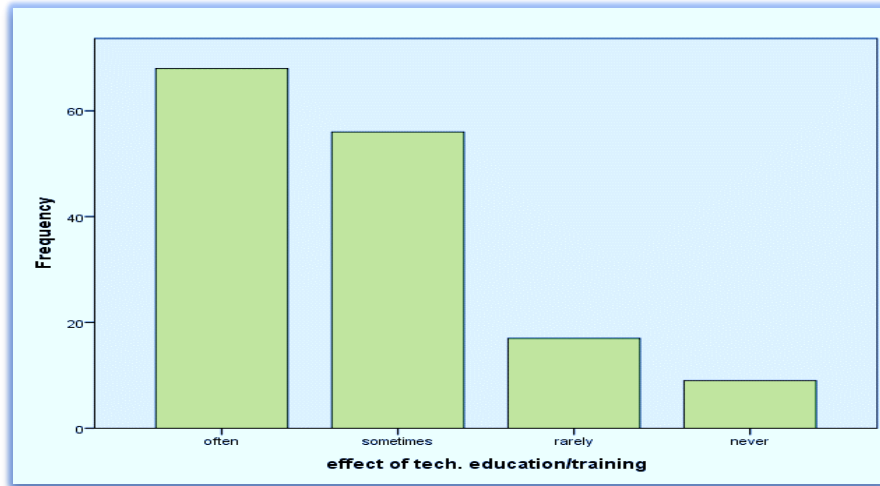


Fig. 4.13 Effect of technologist education and training

Impact on Patient

The table 14, lists the negative effects of repetition of imaging examinations on patients. Overexposure of patients was the most common, as expressed by 53.3% of cases (80 cases). 28.7%

(43 cases) reported treatment delays, while 12.7% (19 cases) reported that it increases patient anxiety. Lastly, 5.3% (8 occurrences) mentioned that it rises healthcare costs. Fig 4.14 represents it graphically.

Table 14 negative impact on patients

Negative impact on patient	Frequency	Percent
Overexpose patient	80	53.3
Delay in treatment	43	28.7
Increase pt. Anxiety	19	12.7
Increase health care expense	8	5.3
Total	150	100.0

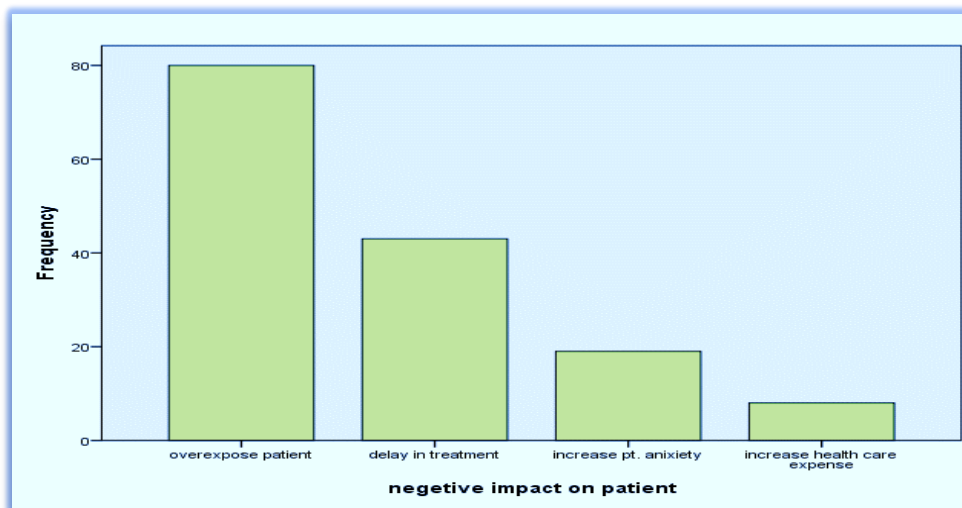


Fig. 4.14 Negative impact on patients

Table 15 shows that 48.7% of the patients receive DLP higher than the initial scan while having a repeat examination. 46.7% responses show that they receive the same DLP as the initial scan

while 7% responders think that patient receive less radiation dose than initial. This is represented in table 15 and figure 4.15 shows its graphical representation.

Table 15 DLP Received by patients

DLP received by patients	Frequency	Percent
Higher than initial scan	73	48.7
Same as initial	70	46.7
Less than initial scan	7	4.7
Total	150	100.0

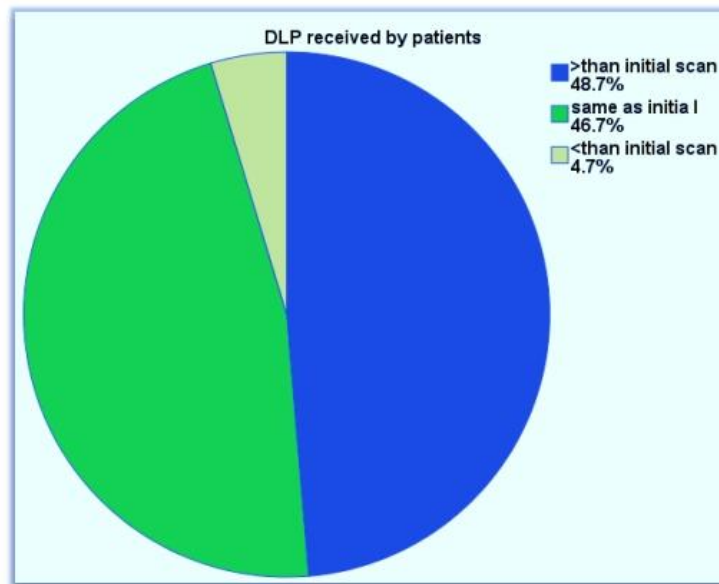


Fig.4.15 DLP Received by patients

DISCUSSION

Medical Imaging examinations are essential diagnostic tools utilized in modern medicine because they allow healthcare professionals gain insight into structures inside human body and spot anomalies. Sometimes, the quality and diagnostic clarity of the images obtained through initial imaging exams are inadequate. It may be due to multiple reasons including both operator error as well as mistakes from the patients. These examinations are repeated, and present substantial difficulties to both patients and hospitals. In this study we aim to find out frequency and causes of repeat imaging examinations among 6 different imaging modalities including X-rays, CT, MRI,

Ultrasound, fluoroscopy and mammography in major hospitals of Peshawar. Additionally, the impact of repeat imaging examinations on patients was also evaluated in this study. Responses were taken from 150 radiologists and radiology technologists. Out of total 150 radiology personnel, 45 (30%) were involved in x-ray, 32 (21.3%) in CT Scan, 26 (17.3%) in MRI, 19 in ultrasound (12.7%), same 19 (12.7%) in fluoroscopy and 9 (6%) in mammography.

This research study demonstrates the daily usage frequency of 6 different imaging modalities including X-Rays, CT, MRI, ultrasound, fluoroscopy, and mammography. The findings show that X-rays and ultrasound seem to be the

most commonly used, while mammography and fluoroscopy examinations performed per day shows comparably lower numbers.

According to results in x-rays and ultrasound highest number of examination lie in the 40+/day range. This large number of exams (40+) shows that they are frequently used in medical settings. This could be as a result of their affordability, speed, and accessibility. On the other hand, the statistics shows that CT exams are more frequently performed in the 31-40 range, while MRI exams are more frequently performed in the 21-30 and 31-40 ranges. This indicates that these modalities are used at a moderate level and are often saved for more complicated situations where in-depth imaging is needed. In fluoroscopy and mammography highest number of examinations occur in 1 to 10/day range. The limited quantity of mammography and fluoroscopic examinations may suggest they are not frequently used. This may be because fluoroscopy is a more specific in nature as it is used only in specific procedures rather than routine examination and mammography is limited to breast examination only. The results of this research study are consistent with the previous research conducted by M.Hasaneen et al (2022) whose results also showed that per shift the highest radiography examinations performed was in 30 + category (19). Findings from a study by H. Manoocheh Koshyani et al. (2014) indicate that 34395 x-ray exams were carried out in a single month (10), Results of our research study shows that the majority of repeat examinations performed per day fall in the 1 to 5/day range, across all 6 modalities included in our study (x-ray, CT, MRI, USG, mammography, fluoroscopy) with x-rays and CT having the highest frequency (24 responses each). These results are consistent with the results of research study of M.Hasaneen et al (2022) where the most common response about the number of repeated imaging examinations per day given by the radiographers was in the range of 1 to 5 images (19). While F.Holmes et al (2017) shows in his research that out of the total 370 patients who were transferred to trauma

center and had CT scan, 103 underwent repetitions(34).

Repeated examinations on the basis of anatomical region were evaluated in this study. According to our results chest examinations were repeated mostly about 38% of the total. It was followed by abdomen 34.7%, then extremities (10%) and skull (12%), while examinations of pelvis and spine were repeated less frequently. This results are similar to the results of published articles of D.Rouchmayanti et al (2023) J.I.fatukasi et al (2022), and A.Ibrahim et al (2022)and in which they concluded that chest imaging examinations are most frequently repeated examinations (55,22, 56).

This research examined the causes of recurrent imaging examinations using fluoroscopy, ultrasonography, mammography, CT, MRI, and X-rays. The information gathered from radiology personnel exposed a number of common elements that lead to reexaminations, underscoring important areas in need of improvements.

Our results show that the most common reason for repetition of x ray examination was patient movement 44% of the results, followed by incorrect positioning (40%), incorrect exposure (11.15%) and technical issues (4.4 %). These results are similar to the result of T.F. Ali et al (2021) who agreed that patient mobility was the primary contributor (57). However, incorrect placement was found to be the primary cause of radiographic repeat by H. Dahmarde et al. (2023), with patient movement coming in second (51). Furthermore, it was observed by M. Hasaneen et al. (2022) that the majority of artifacts were caused by patient movements, both involuntary and voluntary (19).

According to our analysis, patient movement accounted for 46.9% of repeat scans in CT exams, making it the most common reason for the exam repetition. Following at 21.9% were technical problems, miss tracking of contrast bolus with 15.6%, inaccurate exposure at 12.5%, and metallic object artifacts at 3.1%. This is in contrast to research by I. Haddad (2023), where the results showed that the most common cause of repeat CT exams was improper patient

positioning (53). however, J.F. Holmes (2017) pointed out that inadequate picture quality and the non-availability of the first CT report were important factors contributing in CT exam repetition in trauma patients (34).

In mammography, the results revealed that the major reason for repetition of mammography examinations were inadequate compression and positioning error each representing 44.4% of the results, followed by incorrect exposure 11.1%. these results diverge from the results of S. Maratandale (2023) who concluded that patient movement is the primary reason for repetition followed by positioning error (39).

Regarding the main reasons for repeat scans with MRI, fluoroscopy, and ultrasound, no particular research articles were found. Our investigation assessed these causes and produced important new information.

According to our results Patient movement was the primary reason of scan repeat in MRIs, accounting for 42.3% of the total. Artifacts resulting from metallic objects and incorrect scan protocol selection followed at 26.9% each. However, 3.8% of the data indicated that technical problems were the cause of the repeats.

The reasons behind exam repetition in fluoroscopy based on all 19 answers. Uncooperative patients were the main reason for recurrent visits, accounting for 52.6% (10 replies). Operator error and technical issues accounted for 15.8% of the repetitions (3 replies for each). Mistracing the contrast bolus, incorrect exposure, and metal objects on the body were other contributing factors, each accounting for 5.3% of cases.

Among the reasons of the repetitions of ultrasonic examinations the results of this research survey show that uncooperative Patients were the main cause, accounting for 57.9% of the total, followed by technical problems and inadequate patient preparation each accounted for 15.8% of the total and operator mistake and patient movement 5.3% each.

Moreover, effect of that workload, training and education of technologist and obesity on no. of repeat imaging examinations were determined in our research study. The vast majority of

respondents (64%) said that the number of repeat examinations were frequently impacted by workload. This implies that heavier workloads might make radiology staff members more stressed and exhausted, which could lead to distractions or mistakes made during procedures that make repeat scans necessary. Furthermore, 42% of participants mentioned that workload sometimes affects repeat rates. These results are similar with the results of M.Hasaneen et al (2022) which 79 % of the results shows that increasing workload increases exam repetition (19). Regarding the obesity of patients, 78% of participants think that patient obesity has a major impact on the quantity of follow-up exams performed in radiology, whereas 22% disagree. The results of this study regarding training and education of technicians/technologists suggest a Norway association between training/education and the quality of images. A significant 45.3% of the responses from the radiology personnel shows that they often observe the impact. Furthermore, 37.3% acknowledged that it happened sometimes. Similarly, Literature of J.nol et al (2013) Shows that most of the rejected radiographs were from students and junior technologists (29). Moreover, the same results were obtained in a study performed by H. Manoochehri Khoshinani et al (2014) (10).

The detrimental effects of repeated imaging tests on patients were assessed in this study, which produced important results on overexposure, delays in treatment, anxiety, and higher medical expenses. The primary problem found was patient overexposure to radiations, which occurred in 80 cases, or 53.3% of the total. In addition, 28.7% (43 cases) reported treatment delays, while 12.7% (19 cases) reported that it increases patient anxiety. Lastly, 5.3% (8 occurrences) mentioned that it rises healthcare costs. Evaluating the dose absorbed by patients during repeated imaging showed that 48.7% of patients had a Dose Length Product (DLP) which was greater than that of the first scan. This suggests that with repeated examinations, a higher radiation dose is usually observed. In contrast, 46.7% of the patients had encoded the same DLP as that which was present during their

initial scan. In support of these findings, J.F. Holmes et al. (2017) reported in their study that 3.5% of the patients received an effective dose greater than 10 mSv while undergo repeated CT scans (34).

CONCLUSION

The study identifies important characteristics that lead radiology staff members in different modalities to perform repeat imaging exams. Highest no. of daily and repeated scans were performed in x-ray, mostly as a result of patient movement and improper patient positioning. In CT and MRI most, common reason for repetition was patient movement, in ultrasound and fluoroscopy it was uncooperative patients and in mammography it was patient positioning error and inadequate compression. Anatomically chest examinations were mostly repeated with the abdomen coming in second. The frequency of repeat tests is also influenced by factors like patient size, workload, and technologist education, with radiation overexposure being the most common adverse impact, which emphasize the need to improve imaging procedures.

RECOMMENDATIONS

Regular training sessions for radiology staff are strongly advised in order to improve the overall quality of medical imaging. The main goals of these programs should be improving skills in the field and guarantee that operators are knowledgeable about the newest imaging methods and technology. Enhancing patient education is likewise important. The patients should be given thorough and clear pre-exam instructions; it lowers the chance of movement and also helps the patients understand their responsibilities in the imaging process. Further research is also needed to investigate the measures to reduce the repeat imaging examinations in radiology departments.

REFERENCES

1. Hinzpeter R, Sprengel K, Wanner GA, Mildenerger P, Alkadhi H. Repeated CT scans in trauma transfers: an analysis of indications, radiation dose exposure, and costs. *European journal of radiology*. 2017;88:135-40.
2. Pan L, Sun C, Zhou K, Figini M, Wang B, Shanguan J, et al. Transcatheter intraarterial perfusion MRI approaches to differentiate reversibly electroporated penumbra from irreversibly electroporated zones in rabbit liver. *Academic radiology*. 2020;27(12):1727-33.
3. Tay YX, Ong ME, Foley SJ, Chen RC, Chan LP, Killeen R, et al. True cost estimation of common imaging procedures for cost-effectiveness analysis-insights from a Singapore hospital emergency department. *European Journal of Radiology Open*. 2024;13:100605.
4. Kleinerman RA. Cancer risks following diagnostic and therapeutic radiation exposure in children. *Pediatric radiology*. 2006;36(Suppl 2):121-5.
5. Cook SH, Fielding JR, Phillips JD. Repeat abdominal computed tomography scans after pediatric blunt abdominal trauma: missed injuries, extra costs, and unnecessary radiation exposure. *Journal of pediatric surgery*. 2010;45(10):2019-24.
6. Tung M, Sharma R, Hinson JS, Nothelle S, Pannikottu J, Segal JB. Factors associated with imaging overuse in the emergency department: a systematic review. *The American journal of emergency medicine*. 2018;36(2):301-9.
7. Hobbs JB, Goldstein N, Lind KE, Elder D, Dodd III GD, Borgstede JP. Physician knowledge of radiation exposure and risk in medical imaging. *Journal of the American College of Radiology*. 2018;15(1):34-43.
8. Broder JC, Cameron SF, Korn WT, Baccei SJ. Creating a radiology quality and safety program: principles and pitfalls. *Radiographics*. 2018;38(6):1786-98.

9. Thrall JH, Li X, Li Q, Cruz C, Do S, Dreyer K, Brink J. Artificial intelligence and machine learning in radiology: opportunities, challenges, pitfalls, and criteria for success. *Journal of the American College of Radiology*. 2018;15(3):504-8.
10. Dahmarde H, Abiri M, Sistani SS. Analysis of the potential reasons for repeated radiography: a study in a major hospital in south eastern Iran. *Healthcare in Low-resource Settings*. 2023;11(1).
11. Moradian SA, Zamani H, Dalvand S. An Analysis of the Rate and Reasons for Rejected Radiographs in Emergency and Non-emergency Radiology Departments in Yasuj, Iran. *Frontiers in Biomedical Technologies*. 2023.
12. Haddad L, Saleme H, Howarth N, Tack D. Reject analysis in digital radiography and computed tomography: a belgian imaging department case study. *Journal of the Belgian Society of Radiology*. 2023;107(1).
13. Bantas G, Sweeney RJ, Mdletshe S. Digital radiography reject analysis: A comparison between two radiology departments in New Zealand. *Journal of Medical Radiation Sciences*. 2023;70(2):137-44.
14. Rochmayanti D, Adi K, Widodo CE. REPEAT ANALYSIS PROGRAM AS A QUALITY ASSURANCE SYSTEM FOR RADIOLOGY MANAGEMENT: CAUSAL REPEAT AND AN OVERVIEW. *Journal of Medical Imaging and Radiation Sciences*. 2023;54(3):S31.
15. Hasaneen M, AlHameli N, AlMinhali A, Alshehhi S, Salih S, Alomaim MM. Assessment of image rejection in digital radiography. *Journal of Medicine and Life*. 2023;16(5):731.
16. Ahmed AI, Babiker AA, Abbas SM, Alsulayyim N, Dous Gb, Alanazi G, et al. Reject analysis in digital radiography prospective study. *Scholars J Appl Med Sci*. 2022;6(896):e9.
17. Fatukasi J, Osho E, Olowookere C, Ogunsemoyin A. Evaluation of Repeat Analysis and Dose Burdens of Patients Examined in the Radiology Department of a Medical University Teaching Hospital in Nigeria. *Journal of Applied Sciences and Environmental Management*. 2022;26(5):793-9.
18. Ali T, Mohammed M. Reject rate analysis in radiography in Primary health care corporation. Qatar. p. 13.
19. Shehzad S, Gillani SIS, Farooq A, Khan K, Asif M, Sartaj M. REASONS OF REPEATED RADIOGRAPHS IN A PRIVATE DENTAL TEACHING HOSPITAL: A PREVENTABLE RADIATION HAZARD. *Pakistan Oral & Dental Journal*. 2021;41(3):185-8.
20. Jusnaidi NA, Ismail NF. Repeat rate analysis of lower limb radiograph for digital radiography in general radiography at Pantai Klang Hospital Selangor. *Journal Of Applied Sciences*. 2020;5(2):112-6.
21. Alyousef KA, Alkahtani S, Alessa R, Alruweili H. Radiograph reject analysis in a large tertiary care hospital in Riyadh, Saudi Arabia. *Global Journal on Quality and Safety in Healthcare*. 2019;2(2):30-3.
22. Benza C, Damases-Kasi C, Daniels ER, Amkongo M, Nabasenja C. The causes of reject images in a radiology department at a state hospital in Windhoek, Namibia. *South African Radiographer*. 2018;56(1):35-9.
23. Holmes JF, Siglock BG, Corwin MT, Johnson MA, Salcedo ES, Espinoza GS, Lamba R. Rate and reasons for repeat CT scanning in transferred trauma patients. *The American Surgeon*. 2017;83(5):465-9.
24. Einstein AJ, Moser KW, Thompson RC, Cerqueira MD, Henzlova MJ. Radiation dose to patients from cardiac diagnostic imaging. *Circulation*. 2007;116(11):1290-305.

25. Atkinson S, Neep M, Starkey D. Reject rate analysis in digital radiography: an Australian emergency imaging department case study. *Journal of medical radiation sciences*. 2020;67(1):72-9.
26. Hofmann B, Rosanowsky TB, Jensen C, Wah KHC. Image rejects in general direct digital radiography. *Acta radiologica open*. 2015;4(10):2058460115604339.
27. Jones AK, Polman R, Willis CE, Shepard SJ. One year's results from a server-based system for performing reject analysis and exposure analysis in computed radiography. *Journal of digital imaging*. 2011;24:243-55.
28. Daghighi M, PESYANIAN E, POURISA M. A STUDY OF CAUSES AND RADIOGRAPHIC REPEAT RATE AT TWO HOSPITALS IN TABRIZ. 2008.

