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Comparative Study of Radiology Department in Derna City Before and After COVID-19 and Daniel Disasters

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ABSTRACT

Radiology departments play a vital role in emergency response, especially during disasters. In the city of Derna, Libya, the COVID-19 pandemic and Storm Daniel exposed critical gaps in disaster preparedness and response capabilities within radiology units. This study aims to compare the challenges, performance, and readiness of radiology departments in Derna during these two major crises and after the infrastructure governmental support of radiology departments. A descriptive cross-sectional study was conducted using a structured, self-administered questionnaire distributed face-to-face to 80 participants, including radiology staff and students in Derna. Descriptive statistical analysis was used to interpret the results, whereas the governmental support succeeded in restoring physical infrastructure (e.g., buildings, HVAC), enabling basic operations. Yet, the support failed to address systemic issues like staff training, equipment resilience, and safety protocols. Overall departmental performance during disasters was rated poor (mean = 2.32/4), despite adequate infrastructure were functionally restored (mean = 2.93/4). In conclusion Radiology departments in Derna showed partial readiness for disaster response but significant deficiencies in staff safety, equipment preparedness, and emergency planning persist. The study highlights the urgent need for structured disaster protocols, staff training, investment in portable imaging equipment, and institutional support to ensure radiology services remain functional during future emergencies.

1. INTRODUCTION

Radiology departments are a vital for any healthcare system. Educational skills and emergency training in radiology departments are critically important for valuable clinical performance with crucial models, including image analysis proficiency, proper organizing of radiological investigations, radiation protection guidelines, and exposure to interventional radiology (Gupta, et al., 2024) (NICE Guidelines, 2020).

In the city of Derna, recent emergencies have tested the resilience and preparedness of these departments. Two key events the COVID-19 pandemic and Storm Daniel have highlighted the pivotal role of radiology in emergency response and the unique challenges faced in this region (Elwafe, & Elshihany, 2024) (Elwafe, et al., 2025). During the COVID-19 pandemic, radiology services in Derna, as in many parts of Libya, were under significant pressure. Imaging was essential for diagnosis and patient monitoring. So far local departments struggled with limited resources, staff shortages, and lack of exclusive equipment for infected patients (Veerasuri et al., 2020) (Ilyas et al., 2019) (Bu'Hussain et al., 2021) (Elwafe, et al., 2025). In September 2023, Storm Daniel caused widespread devastation in Derna, exposing the fragility of its healthcare infrastructure. Radiology departments faced major challenges, including power outages, damaged equipment, insufficient emergency planning, and lack of personal protective equipment (Gibney et al., 2021; Aydin et al., 2023). The decentralization of Libya's health protection system, which hindered local response coordination, revealed logistical and administrative barriers and challenges faced by the radiology units (Sahih, 2021). Despite these barriers, the role of radiology remained critical in diagnosing injuries, internal bleeding, and guiding urgent care decisions during the disaster. Techniques such as radiography and computed tomography are vital in the rapid detection of fractures, internal hemorrhages, and other pathologies, aiding in clinical decision-making ("Arora & Dash, 2023") (Veerasuri et al., 2020); (Erjalia & Syakurah, 2021). In response to the aftermath of Storm Daniel, the Derna Reconstruction Fund (Reconstruction Fund for the City of Derna and Affected Areas) initiated efforts to rehabilitate affected medical facilities, including radiology departments. These initiatives included plans to restore damaged infrastructure and procure modern imaging equipment. While implementation is still ongoing, such efforts reflect a promising step toward building diagnostic resilience and improving emergency preparedness in Derna's healthcare sector (Gupta, et al., 2024) (Hui et al., 2020). Radiologists in Derna worked during COVID-19 pandemic under high-risk conditions, experiencing psychological stress and long working hours. Following that, Storm Daniel brought an entirely different set of pressures. Natural disasters require portable imaging and immediate reporting (Aydin, et al., 2023), yet radiology units in Derna were poorly equipped for such rapid response (Elwafe, & Elshihany, 2024) (Alkan & Cilengiroglu, 2022). The storm revealed critical gaps in preparedness: no emergency protocols, weak communication systems, and untrained staff (UNOSAT, 2023); (Gibney et al., 2021). Difficult situations and disaster management require the development of comprehensive plans to rebuild and improve healthcare infrastructure in radiology departments, by equipping them with portable devices and power generators, alongside training medical staff to effectively use these technologies and assess the severity of injuries with guiding immediate treatment plans. (Elwafe, et al., 2025) (Elwafe, & Elshihany, 2024). A well-prepared radiology department should establish detailed management plans that address staffing, equipment maintenance, communication protocols, and triage systems tailored to mass casualty events (Gupta et al., 2024). Mock drills are essential for evaluating preparedness, identifying procedural gaps, and strengthening coordination among teams. These drills enhance staff confidence and ensure familiarity with roles and equipment use under pressure. Moreover, incorporating triage protocols and alert systems helps in prioritizing urgent imaging and optimizing workflow during emergencies (Gupta, et al., 2024) (UNOSAT, 2023). Additionally, coordination with other departments and external agencies improves system-wide response (Gupta, et al., 2024) (OCHA, 2023). The proactive planning and collaboration with international agencies is essential to ensure the resilience of imaging services ("RAD-AID International, 2022").Government responsibility just not offers the infrastructural support to radiology department for diagnostic imaging, but it should make availability of opportunities for radiological stuff to engage with members of Congress, State legislators, officials in Federal and State agencies. For the reason that, it is important to put in order qualified stuff who can manage disaster strategies and apply survival support protocols during barriers (Idowu, & Okedere, 2020). In order to respond effectively the stuff can be prepared for accurately diagnose and assist those in need is a crucial issue (OCHA, 2023). The disaster plans need to be programmatic, flexible, and should be continuously reviewed and updated. For improving patient outcomes and lowering morbidity and mortality, radiologic technologists, radiologists, nurses, and other paramedic staff must actively participate in patient care (UNOSAT, 2023). Screening protocols, decontamination procedures, radiation monitoring, and staff training on personal protective equipments (PPE) usage are essential to minimize exposure risks (Gupta, et al., 2024). Governments must invest in modernizing diagnostic imaging infrastructure, developing structured educational programs for emergency preparedness, and establishing protocols for maintaining radiology services during crises ("Gupta et al., 2024").

The WHO emphasizes the importance of sustainable investment in diagnostic imaging, including workforce development and quality management systems to ensure safe and effective service delivery during emergencies (WHO, 2023). Moreover, collaboration with international organizations, such as Radiology Assistance and Development International, is crucial in bolstering radiology services during crises (RAD-AID, 2023). This help to bring radiology departments to low-resource areas by delivering education, equipment, infrastructure, and support. This study conducted to assess and compare the role, challenges, and preparedness of radiology departments during the COVID-19 pandemic, Storm Daniel and the governmental support to the infrastructure of Radiology departments in Derna City. It also aims to improve disaster response readiness in Derna and similar urban centers. Moreover, to find out subsidy support options which are provided to radiology departments in order to find the way how can economic challenges and declining reimbursements facing radiology departments. This research provides an overview of the current comprehensive strategy needed to maximize the radiology department's preparedness and response for disasters (Gupta, et al., 2024) in comparable with two former studies before the governmental support (Elwafe, & Elshihany, 2024) (Elwafe, et al., 2025).

2. METHOD

Research Design

In order to evaluate the difficulties, readiness, and function of radiology departments in Derna, Libya, during the COVID-19 pandemic and Storm Daniel, this study used a quantitative, descriptive cross-sectional design with a structured questionnaire. Participants' awareness, department readiness, response effectiveness, and post-disaster improvements were all examined in the study.

Population and Environment of the Study

Staff, students, and technicians employed or undergoing training in radiology departments at hospitals, clinics, and educational institutions in the city of Derna were the target audience for the survey. Their experiences during two significant crises were the main focus of the data collection: The COVID-19

Data Gathering Instrument

International radiology disaster response guidelines and pertinent literature served as the foundation for the creation of a specially created questionnaire. Both closed-ended and Likert scale questions were included in the survey. The survey was delivered in person to all of Derna's medical facilities. The survey was filled out by 80 people, including academic staff, students, and radiologic technologists. Each participant gave their informed consent, and participation was anonymous and voluntary. Disaster awareness, emergency department performance, infection control, resource availability, equipment functionality, and employee safety were among the subjects addressed in the questionnaire (Sekaran, 2006).

Data Analysis

The collected data were analyzed using descriptive statistical methods for the social sciences SPSS for data analysis (Cooper & Schondler, 2001) frequency were used to describe the sample and descriptive analysis used to answer questions of study (Mean, Std. Deviation). The Likert scale (1 = Strongly Disagree to 2 = Strongly Agree) was used to measure the level of agreement regarding radiology department preparedness and response.

3. ETHIC APPROVAL

The study adhered to ethical guidelines based on the Belmont Report principles (Gronowski et al, 2019). Participants were informed of the purpose of the study, assured of confidentiality, and given the right to withdraw at any time. No identifying personal data were collected.

4. RESULT

Sample characteristics

Questionnaire were distributed to the workforce the radiology departments by face to face was distributed. The result showed that, 80 respondents (70 %) were males and 24 respondents were female (30%). On other hand, educations about 46 respondents (57.5%), were students and respondents were Bachelor about (62.5 %) Age was 20 to less than 30. But, less than 10 were about (82.5%). Experience most of the respondents about 43.8% were no experiences. The following is the description of the respondents; See Table (1).

Table (1) Sample characteristics

Variables	Frequency	Percentage
Gander		
Male	70.0	56
Female	30.0	24
Education	5	
Student	7.5	46
Diploma	11.3	9
Bachelor	27.5	22
Master	2.5	2
PhD	1.3	1
Age		
20 to less 30	82.5	66
Less than 31-to 41	12.5	10
From42 And more	5.0	4
Experience		
No Experience	43.8	35
Less Than10	42.5	34
10 to 15	5.0	4
15 and more	8.8	7
Total	80	100

Descriptive statistics is the most valuable method to present and outline the data in tables, charts, in this study used as frequency to describe the sample. Also, means and ST deviation to determine the most challenges faced the radiology department.

Mean, Std. Deviation of the most challenges faced radiology departments

The survey recorded 80 valid responses and to measure the responses rate and their agreements
about the challenges faced the radiology departments, Table (2) shown response rate. The indication challenges overall, with significant opportunity for improvement in disaster preparedness and protocol.

Table (2) Mean, Std. Deviation Challenges Faced Radiology Department's

Items	Mean	Std. D	Percentage%	Degree
Are you part of the functional or academic staff in the radiology department?	1.95	.219	97.5	High
Were you aware of the scale of the COVID-19 pandemic outbreak?	1.78	.420	89	High
Were you aware of the magnitude of Hurricane Daniel's disaster before it occurred?	1.18	.382	59	moderate
Is there a clear plan to address resource shortages during emergencies?	1.20	.403	60	moderate
Did you work in the radiology department during disaster periods?	1.41	.495	70.5	moderate
Do you think the current technology used in disaster management is sufficient?	1.24	.428	69	moderate
Was the radiology department equipped with all necessary resources during disaster periods?	1.38	.487	69	moderate
Is performance evaluated after each incident to extract lessons and improve future plans?	1.50	.503	75	High
Were outbreaks of pandemics within the radiology department investigated and controlled?	1.36	.484	68	moderate
Were infection control and decontamination measures implemented during disasters?	1.69	.466	84.5	High
Has the radiology department been improved following the COVID-19 pandemic?	1.48	.503	74	High
Has the radiology department been improved following Hurricane Daniel?	1.80	.403	90	High
Did the department provide services faster and more efficiently after the COVID-19 pandemic?	1.60	.493	80	High
Did the department provide services faster and more efficiently after Hurricane Daniel?	1.79	.412	89.5	High
Was it necessary to include a radiology technician and a portable X-ray device in rescue teams for Hurricane Daniel victims?	1.85	.359	92.5	High
Has the radiology department been equipped with capabilities and strategies in preparation for future disasters?	1.41	.495	70.5	High
Have new protocols been developed in the radiology department based on lessons learned from past disasters	1.54	.502	77	High
Total	1.53	.196	75	High

Mean, Std. Deviation of Most the evaluate the radiology department's ability

As presented in Table (3) shown measure the evaluation of the radiology department's ability, based on below table the Mean is about 2.32 and Std. Deviation is (.723). It seems that the department has foundational capabilities but lacks consistency or advanced preparedness in critical areas. The department maybe refers to the department struggles to ensure staff safety during disasters, with critical gaps in protocols, infrastructure, and preparedness.

Table (3) Mean, Std. Deviation evaluate the radiology department's ability

Items	Mean	Std. D	Percentage%	Degree
How do you evaluate the radiology department's ability to provide essential medical services during a hurricane	2.31	.894	57.7	Poor
How do you assess the safety level for staff working in the department during disasters	1.99	.934	49.7	Poor
How do you evaluate the organization of work within the radiology department during disasters?	2.15	.995	53.7	Poor
How do you assess the speed of repairing medical equipment in the radiology department after Hurricane Daniel	2.26	.978	56.5	Moderate
How do you evaluate the level of necessary repairs to buildings and facilities in the radiology department after the hurricane?	2.93	1.041	73.2	Good
Total	2.32	.723	58	Poor

Critical Challenges

1. Inconsistent Resource Allocation: Maybe Portable devices, PPE, and staff training need standardization.
2. Infection Control Gaps: 31% felt decontamination measures were inadequate.
3. Technology Upgrades: Maybe Legacy systems and interoperability issues persist for 24% of respondents

Evaluation of department facilities according to the results

1. The majority believe facilities (e.g., imaging suites, electrical/HVAC systems) were functionally restored to meet operational needs.
2. The department's ability is perceived as predominantly Poor (57.7% of responses), with maybe critical gaps in:
   - Infrastructure: Lack of storm-resistant equipment or backup power.
   - Training: Insufficient disaster-response drills.
   - Coordination: Poor teamwork during emergencies.

3- Speed of Medical Equipment Repairs Post-Hurricane:

- Repairs were delayed for critical devices (e.g., CT scanners, X-ray machines), disrupting patient care.

4- Safety Level for Staff during Disasters:

- Safety is perceived as Poor, with maybe critical gaps in:
  1. Protocols: Missing PPE, blocked emergency exits.
  2. Infrastructure: Flooded workspaces, unstable equipment.

Evaluation of governmental support during reconstruction based on the survey results; Governmental support during the reconstruction period partially enabled the radiology department to restore services, but critical gaps remain.

The nuanced analysis:

1. Successes (Attributed to Governmental Support):

❑ Facility Restoration: The majority reported that buildings and facilities (imaging suites, electrical/HVAC systems) were functionally restored (Mean = 2.93/4), indicating governmental efforts likely funded critical infrastructure repairs.

❑ Shortcomings (Areas Where Support Fell Short): Poor Service Delivery During Disasters (Mean = 2.31). Despite rebuilt facilities, the department's ability to provide services during hurricanes was rated Poor (57.7%) of responses (Lack of storm-resistant equipment or backup power, insufficient disaster-response drills and poor teamwork during emergencies).

❑ Slow Equipment Repairs (Mean = 2.26 Repairs for critical devices (e.g., CT scanners) were delayed, disrupting care.

❑ Lack of standardized repair protocols and spare parts, suggesting governmental support did not prioritize long-term maintenance strategies. Poor Staff Safety (Mean = 1.99) Safety protocols were inadequate (e.g., missing PPE, blocked exits). Infrastructure Risks: Flooded workspaces and unstable equipment persisted.

Accordingly, Governmental support succeeded in restoring physical infrastructure (e.g., buildings, HVAC), enabling basic operations). While, the support failed to address systemic issues like staff training, equipment resilience, and safety protocols.

Evaluation of current services and future preparedness, the survey results, state that the radiology department's current services show partial preparedness for future challenges, but significant gaps remain. The breakdown details:

❑ **Current Preparedness (Strengths)**

1- Restored Infrastructure: Facilities (e.g., imaging suites, electrical systems) are functionally operational post-reconstruction (Mean = 2.93).

2 - Baseline Functionality: Most equipment is operational for non-disaster scenarios, enabling standard patient care.

❑ **Critical Gaps for Future Challenges (Weaknesses)**

1- Disaster Response Capability:

- Poor ratings for service delivery during disasters (Mean = 2.31) due to:
  1. Lack of storm-resistant equipment (e.g., flood-proof X-ray machines)
  2. No backup power for prolonged outages.

2-Staff Safety:

- Safety levels rated Poor (Mean = 1.99/4), with risks like:
    1. Missing PPE and blocked emergency exits .
    2. Flooded workspaces and unstable equipment .

3- Slow Equipment Repairs:

- Delays in fixing critical devices (Mean = 2.26) disrupt care during/after disasters.
- No standardized repair protocols or spare part stockpiles.

4-Training and Coordination: Staff lacks disaster-response drills, leading to poor teamwork during emergencies.

Regarding to the question, Is the department ready for future challenges, partially, but not fully affirm that restored infrastructure and basic services provide a foundation. Critical gaps in disaster resilience staff safety, and rapid response protocols leave the department vulnerable.

5. DISCUSSION

The study's goal was to determine the difficulties the radiology department faced during the crisis and whether the suggested fixes, which included government assistance for the departments' infrastructure, satisfied the need for upgrades. Additionally, the questionnaire's items were created to pinpoint the difficulties that the radiology department in Derna City, Libya, faced both during and after the disasters.

The information gathered through the questionnaire is coded and then put into the SPSS software for statistical analysis in order to determine the causes. Each Five Likert Scale option has a weight of 1 (strongly disagree), 2 (disagree), 3 (unsure), 4 (agree), and 5 (strongly agree).

With a high degree of agreement (97.5%), the radiology departments' equipped setups in this study showed similarities in terms of demographics, falling under the same ministry and sharing the goal of providing examinations to both inpatients and outpatients.

The study found that, with a moderate 60% agreement rate, a lack of qualified radiological equipment in emergency situations significantly affects the ability to provide radiological services efficiently. The study found that current disaster preparedness measures are insufficient, with the same degree of agreement. This is in line with reports from around the world that the UK, China, Australia, New Zealand, and Singapore are experiencing shortages of radiologists, which is causing backlogs and inadequate services (WHO, 2020) (Regulation of The Minister of Health Republic Indonesia, 2016) (Michigan Medicine, 2017).

While there was significant agreement (92.5%) regarding the necessity of portable devices, equipment capabilities, and crisis plans, there was restricted agreement (70.5%) regarding the radiology department's need to be equipped with capabilities and strategies for any future disasters.

The evaluation of the necessary repair levels of buildings and facilities in the radiology department after the hurricane was good at 73.2%, despite the fact that there was a glaring lack of radiological services during the previous crisis (COVID-19 and Storm Daniel) with poor assessment (Elwafe et al., 2025; Elwafe & Elshihany, 2024).

This means the governmental support during the reconstruction period partially enabled the radiology department to restore services through success infrastructure repairing, but critical gaps remain due to lack of standardized repair protocols and the delay of restoring critical devices (e.g., CT scanners and shortening of portable devices). Globally, reports indicate an increased utilization of medical imaging services, particularly advanced modalities such as CT and MRI due to their increased sensitivity and diagnostic accuracy among other reasons (WHO, 2020) (Regulation of The Minister of Health Republic Indonesia ,2016) (Cailey, 2021) (Omidiji et al, 2022).

Somewhat, the restored infrastructure and basic services provide a foundation for future challenges. However, still there are critical gaps in disaster resilience staff safety, and rapid response protocols leave defenseless gap for the radiology departments to face any future disasters.

Study limitations

The study’s sample size was small; on the other hand, participants expressed extensive awareness and proficiency, donating to data saturation. Regardless of this limitation, the insights stay behind the volubility of the experience within low-resource circumstances.

6. CONCLUSION

In the end, based on the result of study, there were agreement with that there is a problem related to the inadequacy of the number of well trained and qualified stuff in radiology departments. Also, there is a gap between disaster strategies and safety protocols and the real training practice. Therefore, collaboration with well-established training centers and organizations in the developed world is the demand.

Also, they were agreed that there was no protective protection for the stuff and it was agreed that not all advanced technologies learned, could be covered and it would be important for the department's staff to be fully involved in educational activities.

While the enhancement of qualified radiological stuff remains the ideal clarification, its achievability is limited in low-resourced circumstances. The proper integration of radiological stuff into image analysis presents a promising solution. An inclusive estimation of the image analysis methods, including radiographer proficiency in image analysis, is recommended to update evidence-based adjustments that may improve service provision, and guarantee sustainable imaging services in such low-resource situation.

The findings of this study highlight the urgent need for comprehensive disaster response strategies, regular staff training, and institutional investment in portable imaging equipment. Strengthening these areas is essential to ensure the continuity and effectiveness of radiology services in future emergencies.

Recommendations for full preparedness:

1. Upgrade Infrastructure through investing in storm-resistant equipment (e.g., flood-proof MRI machines) and backup power systems.
2. Staff Training is mandatory for disaster drills and safety workshops (e.g., Infection control, emergency repairs).
3. Standardize Protocols by developing clear workflows for equipment repairs, patient triage, and staff safety during disasters (emergency plans).
4. Invest in Portable Imaging Equipment: Prioritize the procurement of mobile X-ray and ultrasound machines and Integrate Technology and Tele-radiology: Expand digital systems and remote diagnostic services.
5. Improve Staff Safety Measures: Ensure the availability of PPE, safety guidelines, and mental health support.
6. Promote Interdepartmental and Governmental Coordination: Facilitate collaboration with hospitals and agencies besides seeking International Collaboration: Partner with organizations like WHO and RAD-AID for support and training.
7. Conduct Periodic Preparedness Assessments: Use tools like HVA and FMEA to identify and fix gaps.

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