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RESEARCH ARTICLE

Utilization and Diagnostic Yield of Chest X-Rays in a Tertiary Hospital in Nigeria: A Retrospective Observational Study

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Abstract

Background: Chest X-ray (CXR) is an important radiological tool for the diagnosis and management of cardiopulmonary disease. The aim of this study is to assess the patterns of chest X-ray utilization and radiographic findings at the University of Benin Teaching Hospital (UBTH), Nigeria.

Methods: A retrospective observational study of 1,624 patients who underwent chest X-ray examination at UBTH between January and December 2024.

Results: More females (58.1%, n = 943) were referred for CXR than males (41.9%, n = 681). The most common clinical indication was respiratory symptoms (29.5%, n = 480). Patients aged 36–50 years had the highest referral rate. The majority of referrals originated from the General Practice Clinic (GPC) (33.4%, n = 542). A high proportion of CXR results (65.1%, n = 1,058) were normal, while 34.9% (n = 566) showed abnormal findings. Cardiovascular changes were the most frequent abnormality (25.8%, n = 419). The majority of CXRs obtained for medical fitness/screening were normal (98.8%, n = 256).

Conclusion: This retrospective observational study found that CXRs are frequently ordered for diverse indications, with a high proportion yielding normal results (65.1%), particularly among referrals from the GPC. Cardiovascular changes were the most common abnormal finding. These findings highlight the need for more targeted clinical criteria to guide CXR utilization and reduce unnecessary radiation exposure.

Keywords: chest X-ray findings; chest X-ray referrals; chest X-ray request; clinical indication; patterns of findings.

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Introduction

A chest X-ray (CXR) is a type of projection radiograph used to diagnose conditions affecting the chest, its contents, and nearby structures. It remains the most common radiographic examination performed globally, with 8,789,840 undertaken in 2017/18 in the United Kingdom [1]. In the United States, approximately 129 million CXRs are performed annually [2]. CXRs are indicated for a range of clinical conditions, including pulmonary infection, cardiomegaly, congestive heart failure, lung masses, rib fractures, pleural effusion, and pneumothorax. They are also used for pre-operative assessment, pre-admission screening, and occupational medical examinations.

Chest X-rays have proven to be an important tool for diagnosing numerous cardiopulmonary conditions. Patients are referred for CXRs from diverse medical and surgical units, including the Intensive Care Unit (ICU), Accident and Emergency (A&E), Medical Emergency Response (MER), Oncology, Paediatric Emergency, and Neurology.

Routine admission CXRs rarely yield significant clinical value (<4%), such as altering patient management or identifying previously undetected disease [3]. Adverse consequences of unwarranted CXRs include unnecessary radiation exposure, financial cost, and the possibility of generating false-positive results that trigger further diagnostic investigations [4]. Diagnostic radiation has been implicated as a contributor to malignancy; one study estimated that approximately 1,861 cases, or 0.6% of all cancers in the United Kingdom, were attributable to diagnostic radiation [5].

Despite the widespread use of CXRs in Nigerian tertiary hospitals, there is limited published evidence on utilization patterns, referral sources, and diagnostic yield in this setting. This knowledge gap is particularly relevant in a resource-constrained health system such as Nigeria's, where radiology capacity is limited and unnecessary investigations carry both direct and indirect costs. The present study addresses this gap by examining CXR request patterns and radiographic findings at the University of Benin Teaching Hospital (UBTH), a major tertiary referral centre in southern Nigeria, in order to provide baseline data to inform more targeted referral practices.

Methods

Study Design

This was a retrospective observational study. Data were extracted from radiology request forms and radiologist reports submitted to the Radiology Department of UBTH during the period January to December 2024.

Study Setting and Participants

The study was conducted at UBTH, a tertiary referral hospital in Benin City, Edo State, southern Nigeria. All 1,624 consecutive conventional CXR requests registered during the study period were included using a census sampling technique. No records met the exclusion criteria.

Data Collection

Pro forma and checklist instruments were used to extract data from referral forms and radiologists' reports. Content validity was ensured through supervisor review. All CXR reports were formal departmental reports generated by qualified radiologists at UBTH. A single radiologist report per examination was used, and discordant or uncertain reports were not re-adjudicated in this study (see Limitations).

Operational Definitions

The following definitions were applied for classification of radiographic findings:

Normal findings: chest X-ray with no identifiable cardiopulmonary or musculoskeletal abnormality as reported by the reviewing radiologist.

Cardiovascular changes: radiographic findings including cardiomegaly, pulmonary vascular congestion, or other cardiac contour abnormalities.

Infectious findings: radiographic features consistent with pulmonary infection, including consolidation, air bronchograms, or interstitial infiltrates. Pneumonia, as a common infectious pulmonary condition, is classified and reported as a subcategory of infectious findings in this study.

Other abnormal findings: any remaining radiographic finding not classified above, including pleural effusion, pneumothorax, bony lesions, and pulmonary masses.

PEPFAR/DOT Referral Category

In UBTH, PEPFAR and DOT refer to a co-located HIV/AIDS and tuberculosis clinic that functions as an integrated referral unit for patients enrolled in the President's Emergency Plan for AIDS Relief (PEPFAR)

Table 1: Demographic Characteristics of Participants (N = 1,624). Percentages are column-based.

Characteristic	Frequency	Percentage
Gender		
Female	943	58.1%
Male	681	41.9%
Age Group (years)		
0–18	144	8.9%
19–35	432	26.6%
36–50	498	30.7%
51–65	316	19.5%
65+	234	14.4%
Total	1,624	100.0%

programme and the Directly Observed Therapy (DOT) programme for tuberculosis. For the purposes of this analysis, referrals from this integrated unit were grouped together and are consistently labelled "PEPFAR/DOT" throughout the manuscript and tables.

Statistical Analysis

Data were analysed using IBM SPSS version 28.0. Descriptive statistics are reported as frequencies and percentages. Inferential analysis used the Fisher's exact test which is an alternative to Chi-square test where expected frequency is less than 5. No outliers were identified in the dataset. Level of statistical significance was set at $p < 0.05$. All percentages in Tables 1, 2, 3, and 6 are column-based; percentages in Tables 4 and 5 are presented within each column of findings (column-based).

Ethics

Ethical approval was obtained from the Health Research and Ethics Committee of UBTH. Patient identifiers, including names and hospital numbers, were removed from the dataset prior to analysis to ensure anonymity. Data were stored securely on a password-protected institutional device and accessed only by the research team.

Results

Table 1 shows the demographic characteristics of participants. The study included 1,624 participants, of whom 58.1% (n = 943) were female and 41.9% (n = 681) were male. The majority of participants were aged 36–50 years (30.7%), followed by those aged 19–35 years (26.6%). The least represented age group was 0–18 years (8.9%), while older adults aged 65 years and above accounted for 14.4%.

Table 2 shows the clinical indications and referral units for CXR. The most common clinical indication was respiratory symptoms (29.5%, n = 480), followed by cardiovascular indications (24.6%, n = 400) and pre-operative workup (21.4%, n = 348). Medical fitness/screening accounted for 15.9% (n = 259), while infectious disease (3.7%), other medical conditions (3.4%), trauma (0.9%), and oncology (0.4%) comprised the remainder. The predominant referral source was the GPC (33.4%, n = 542), followed by the National Health Insurance Scheme (NHIS) clinic (16.4%, n = 266) and the Surgical Out-Patient Department (SOP) (12.0%, n = 195). The Consultant Out

Table 2: Clinical Indications and Referral Ward/Unit for CXR (N = 1,624). Percentages are column-based.

Category	Frequency	Percentage
Clinical Indication		
Respiratory Symptoms	480	29.5%
Cardiovascular	400	24.6%
Pre-operative	348	21.4%
Medical Fitness/Screening	259	15.9%
Infectious Disease	60	3.7%
Other Medical Conditions	56	3.4%
Trauma	15	0.9%
Oncology	6	0.4%
Referral Ward/Unit		
GPC	542	33.4%
NHIS	266	16.4%
SOP	195	12.0%
Other Specialties	130	8.0%
COPD*	117	7.2%
Gynaecology	102	6.3%
Emergency/Medical Wards	99	6.1%
Cardiology	65	4.0%
PEPFAR/DOT	63	3.9%
Paediatrics	24	1.5%
Family Medicine	21	1.3%
Total	1,624	100.0%

GPC = General Practice Clinic; NHIS = National Health Insurance Scheme; SOP = Surgical Out-Patient Department; COPD* = Consultant Out Patient Department; PEPFAR/DOT = integrated HIV/AIDS and tuberculosis clinic (President's Emergency Plan for AIDS Relief / Directly Observed Therapy).

Table 3: Radiographic Findings from Chest X-rays (N = 1,624). Percentages are column-based.

Finding	Total, n (%)
Normal	1,058 (65.1%)
Cardiovascular Changes	419 (25.8%)
Infectious Findings (Pneumonia)	51 (3.1%)
Other Abnormal Findings	96 (5.9%)
Total	1,624 (100.0%)

Pneumonia is classified as a subcategory of infectious findings.

Table 4: Association Between Demographic Characteristics, clinical indications and Radiographic Findings. Values are n (column %).

Characteristic	Cardiovascular Changes N = 419	Normal N = 1,058	Other Findings N = 96	Infectious Findings (Pneumonia) N = 51
Demographic characteristics				
Gender				
Female	317 (75.7%)	572 (54.1%)	39 (40.6%)	15 (29.4%)
Male	102 (24.3%)	486 (45.9%)	57 (59.4%)	36 (70.6%)
Age Group (years)				
0–18	6 (1.4%)	93 (8.8%)	15 (15.6%)	27 (52.9%)
19–35	39 (9.3%)	360 (34.0%)	21 (21.9%)	12 (23.5%)
36–50	147 (35.1%)	330 (31.2%)	15 (15.6%)	3 (5.9%)
51–65	113 (27.0%)	170 (16.1%)	24 (25.0%)	6 (11.8%)
65+	108 (25.8%)	102 (9.6%)	21 (21.9%)	3 (5.9%)
Clinical indications†				
Cardiovascular	158 (37.7%)	230 (21.7%)	9 (9.4%)	3 (5.9%)
Medical Fitness/Screening	3 (0.7%)	256 (24.2%)	0 (0.0%)	0 (0.0%)
Otherb	33 (7.9%)	83 (7.8%)	18 (18.8%)	3 (5.9%)
Pre-operative	105 (25.1%)	210 (19.8%)	30 (31.3%)	3 (5.9%)
Respiratory Symptoms	120 (28.6%)	279 (26.4%)	39 (40.6%)	42 (82.4%)

Patient Department (COPD*) accounted for 7.2% (n = 117), Gynaecology 6.3% (n = 102), Emergency/Medical Wards 6.1% (n = 99), Other Specialties 8.0% (n = 130), Cardiology 4.0% (n = 65), PEPFAR/DOT 3.9% (n = 63), Paediatrics 1.5% (n = 24), and Family Medicine 1.3% (n = 21).

Table 3 shows the radiographic findings. The majority of CXR results (65.1%, n = 1,058) were normal. Among abnormal findings (34.9%, n = 566), cardiovascular changes were most common (25.8%, n = 419), followed by other abnormal findings (5.9%, n = 96). Infectious findings, including pneumonia as a subcategory, accounted for 3.1% (n = 51). The majority of CXRs therefore yielded no clinically significant pathology.

Table 4 shows the association between demographic characteristics, clinical indications and radiographic findings. A gender-based analysis showed that females had a higher prevalence of cardiovascular changes (75.7%, n = 317) compared to males (24.3%, n = 102). Infectious findings (pneumonia) were more common in males (71%, n = 36) than females (29%, n = 15). Among age groups, infectious findings were predominantly observed in children aged 0–18 years (53% of infectious cases), while cardiovascular changes were most frequent in the 36–50 age group (35%). These distributions are consistent with established epidemiological patterns. The table also shows that cardiovascular indications were most frequently associated with cardiovascular changes (37.7%, n = 158), with a small proportion of infectious findings also recorded in this group (5.9%, n = 3). Medical fitness/screening referrals yielded normal CXRs in 98.8% of cases (n = 256). Respiratory symptom referrals had the highest proportion of infectious findings (82.4%, n = 42) and other abnormal findings (40.6%, n = 39). Pre-operative referrals

Table 5: Distribution of Radiographic Findings by Referral Unit (N = 1,624). Values are n (column %). Percentages are column-based.

Referral Unit	Total N = 1,624	Normal N = 1,058	Cardiovascular Changes N = 419	Infectious Findings (Pneumonia) N = 51	Other Findings N = 96
Cardiology	65 (4.0%)	47 (4.4%)	18 (4.3%)	0 (0.0%)	0 (0.0%)
COPD*	117 (7.2%)	48 (4.5%)	45 (10.7%)	3 (5.9%)	21 (21.9%)
Emergency/Medical Wards	99 (6.1%)	24 (2.3%)	51 (12.2%)	6 (11.8%)	18 (18.8%)
Family Medicine	21 (1.3%)	18 (1.7%)	3 (0.7%)	0 (0.0%)	0 (0.0%)
GPC	542 (33.4%)	368 (34.8%)	147 (35.1%)	9 (17.6%)	18 (18.8%)
Gynaecology	102 (6.3%)	66 (6.2%)	36 (8.6%)	0 (0.0%)	0 (0.0%)
NHIS	266 (16.4%)	236 (22.3%)	24 (5.7%)	0 (0.0%)	6 (6.3%)
Other Specialties	130 (8.0%)	98 (9.3%)	32 (7.6%)	0 (0.0%)	0 (0.0%)
Paediatrics	24 (1.5%)	0 (0.0%)	3 (0.7%)	21 (41.2%)	0 (0.0%)
PEPFAR/DOT	63 (3.9%)	30 (2.8%)	15 (3.6%)	9 (17.6%)	9 (9.4%)
SOP	195 (12.0%)	123 (11.6%)	45 (10.7%)	3 (5.9%)	24 (25.0%)
Total	1,624 (100%)	1,058 (65.1%)	419 (25.8%)	51 (3.1%)	96 (5.9%)

GPC = General Practice Clinic; NHIS = National Health Insurance Scheme; PEPFAR/DOT = integrated HIV/AIDS and tuberculosis clinic; SOP = Surgical Out-Patient Department; COPD* = Consultant Out-Patient Department. Data are presented as n (column %).

showed cardiovascular changes in 25.1% (n = 105) and other abnormal findings in 31.3% (n = 30). A statistically significant association was observed between clinical indication and radiographic finding (Fisher's exact $p < 0.001$), indicating that clinical indication is strongly associated with the likelihood and type of pathology detected.

Table 5 shows the distribution of radiographic findings by referral unit. Cardiovascular changes were most common among GPC referrals (35.1%, n = 147) and Emergency/Medical Ward referrals (12.2%, n = 51). Infectious findings were most frequent among referrals from Paediatrics (41.2%, n = 21) and PEPFAR/DOT (17.6%, n = 9), consistent with the high prevalence of respiratory infections in these patient groups. Referrals from NHIS and Gynaecology were associated with the lowest proportions of abnormal findings.

Discussion

This study examined CXR utilization and radiographic findings at a tertiary hospital in southern Nigeria. The predominant finding was a high proportion of normal radiographs (65.1%), particularly among referrals from the GPC. These results raise important questions about referral appropriateness in resource-limited settings.

Al Shahrani and Al-Surimi [6] found that 96.8% of ICU patients underwent daily routine CXRs, with 73% of clinicians expressing preference for an on-demand approach. The present study differs in context: rather than ICU-dominated utilization, we observed a broad distribution of referral indications, with respiratory symptoms (29.5%) and cardiovascular indications (24.6%) accounting for the largest shares. This broader distribution suggests that CXR use in this Nigerian tertiary setting extends well beyond intensive care, consistent with its role as a general diagnostic workhorse in a resource-constrained environment.

Gupta et al. [7] reported that 85.7% of CXRs in a paediatric ICU were linked to ventilated patients. The present study encompasses a wider indication spectrum, including respiratory, cardiovascular, pre-operative, and screening referrals. This reflects the breadth of CXR application in a general tertiary hospital, as opposed to a specialist ICU setting.

The finding that 31% of recipients were aged 36–50 years is broadly consistent with Gaget et al. [8]'s observation of increased plain radiograph use among older Australians. In the Nigerian context, this age group likely represents working-age adults with a higher burden of cardiovascular and respiratory disease, contributing to the observed predominance of cardiovascular changes (25.8%) as the most frequent abnormality.

The 65.1% normal CXR rate observed in this study is consistent with Porter et al. [9]'s finding that routine post-operative CXRs rarely lead to a change in clinical management (0.4%). The high proportion of normal results in the present study was particularly marked in medical fitness/screening referrals (98.8% normal), supporting the recommendation to restrict routine pre-employment or pre-admission CXRs. Comparable findings have been reported from another tertiary institution in Nigeria which reported that only 10% of routine CXRs had abnormal findings in their centre, with cardiomegaly as the leading abnormality, underscoring a regionally consistent pattern of broad CXR utilization with limited incremental diagnostic yield [10].

Infectious findings (pneumonia) were observed in 3.1% of the overall sample but were disproportionately concentrated in paediatric referrals (52.9% of infectious cases were in the 0–18 year age group) and in PEPFAR/DOT referrals (17.6%), consistent with the high prevalence of respiratory infections in immunocompromised and paediatric populations. Saraya et al.[11] described consolidation as the dominant finding in paediatric Mycoplasma pneumoniae pneumonia. The low overall prevalence of infectious findings in the present study suggests that pneumonia is not the primary driver of CXR demand at this institution; rather, cardiovascular and respiratory symptom indications dominate.

A notable gender disparity was observed: females accounted for 75.7% of cardiovascular changes, a pattern that may reflect sex-specific differences in the presentation of hypertensive heart disease and cardiomegaly in this population, which warrants further investigation.

The CXR referral landscape at UBTH is dominated by the GPC, which generated one-third of all requests. The GPC's high normal-CXR rate (34.8%) suggests that clinical decision support tools or pre-referral checklists could help optimise referral practice.

Limitations

This study has several limitations that should be considered when interpreting the findings. First, the retrospective design relied on existing records, which precluded verification of clinical details or independent review of radiological reports. Although no records were excluded due to incomplete documentation in the present study, the reliance on routine clinical records rather than prospectively collected standardised data introduces the possibility of information bias, particularly with respect to variability in how clinical indications were documented across different referral units. Second, as a single-centre study at one tertiary hospital in Edo State, the findings may not be generalisable to primary or secondary care settings, or to other regions of Nigeria. Selection bias inherent to this setting should be noted, as the patient population and referral patterns of a tertiary institution may differ substantially from those of lower-level facilities. Third, potential classification and reporting bias may have arisen from reliance on a single radiologist report per examination without inter-rater reliability assessment. Fourth, this study did not apply a validated appropriateness framework (such as the American College of Radiology Appropriateness Criteria) against which referrals could be formally benchmarked; therefore, conclusions regarding referral appropriateness should be interpreted with caution. Finally, recall bias is not applicable given the record-based retrospective design; however, future prospective studies incorporating standardised data collection instruments would allow for more robust assessment of referral patterns and diagnostic yield across diverse Nigerian healthcare settings.

Conclusion

This retrospective observational study found that CXRs at UBTH are frequently ordered for diverse indications, with a high proportion yielding normal results (65.1%). Cardiovascular changes were the most common abnormal finding, particularly in females and in middle-aged and older adults. Infectious findings were concentrated in paediatric and PEPFAR/DOT referrals. The high proportion of normal radiographs, especially among medical fitness/screening and GPC referrals, indicates that targeted referral criteria and clinical decision support may help optimize CXR utilization and reduce unnecessary radiation exposure in this setting.

Declarations

Conflict of Interest

The authors declare no conflicts of interest.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request, subject to applicable institutional data-sharing policies.

Ethical Approval

Ethical approval was obtained from the Health Research and Ethics Committee of the University of Benin Teaching Hospital. Patient identifiers were removed prior to analysis to ensure anonymity, and data were stored securely on a password-protected institutional device.

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