Competency Assessment of Primary Health-care Physicians in Iraq Regarding the Interpretation of Chest X-ray in Acute and Emergency Conditions

Oday Qussay Badraddin, Qays Ahmed Al-Timeme[1]

Family Physician, Ministry of Health, A-lkarkh Health Directorate, Al-dora Primary Health Care Sector, [1]Professor of Radiology, Department of Surgery, Al-kindy College of Medicine, University of Baghdad, Baghdad, Iraq

Abstract

Background: Primary health-care (PHC) physicians may encounter a wide variety of conditions including acute and emergent cases considering the limited access to diagnostic investigation in PHC practice. Chest X-ray (CXR) remains the imaging modality of choice to diagnose pulmonary, cardiac and other chest diseases, and it is the unique imaging technique available in Iraqi PHC centers (PHCCs), relatively inexpensive and has a low dose of radiation exposure. **Aim of the Study:** Competency assessment of diagnostic accuracy and confidence degree for Iraqi PHC physicians (PHCPs), regarding the interpretation of CXR in acute and emergent conditions. **Subjects and Methods:** A cross-sectional study that included a convenient sample of 330 participants through an online questionnaire, during the period from January 2023 to January 2024. The study included some background information such as gender, years in practice, training type, interest in pulmonary medicine and diagnostic radiology, and having adequate training on the interpretation of CXR. The questionnaire consists of 10 chest radiographs with brief clinical information for each case. Participants were asked to choose the most likely diagnosis and to rate their degree of confidence in the interpretation of the CXR for each case. Descriptive statistics were presented using tables and graphs, continuous variables summarized by mean and standard deviation. The categorical variables summarized by percentages and frequency distributions and compared using Fisher's exact test. The level of statistical significance was set at a $P < 0.05$. Cutoff point of diagnostic accuracy is considered equal or more than 5 correct answers from 10 is competent, and that of confidence rate equal or more than 3 scores from 5 is confident. **Results:** Overall diagnostic accuracy is 296 (89.7%) and overall diagnostic confidence is 116 (77%). Diagnostic accuracy among family medicine specialist 164 (91.1%) and diagnostic confidence are 138 (76.7%) within their group, while among nonspecialist PHCPs, diagnostic accuracy only 132 (88%) and diagnostic confidence 116 (77.3%) within their group. Proportion of competent family medicine specialists among all competent participants was more than half 164 (55.4%) and for nonspecialists was 132 (44.6%). A moderately positive correlation ($r = 0.417$) between diagnostic accuracy and confidence level appeared. Cardiogenic pulmonary edema 300 (90.9%) and normal CXR 284 (86.1%) cases had the highest diagnostic accuracy scores, whereas the lowest scores were for lobar collapse 168 (50.9%) and pneumomediastinum 140 (42.4%). More than half of the participants 202 (61.2%) lived in the capital and more than three quarters of the participants 266 (80.6%) were females. Family medicine specialists was constitute the largest number 180 (54.5%) of the participants and more than half of the sample 170 (51.5%) having more than 10 years of experience. Approximately 230 (70%) of the participants had no elective rotation in diagnostic radiology and about half of the sample 162 (49.1%) were uncertain about their training adequacy. More than three quarters of the sample 258 (78.2%) interested in diagnostic radiology and 198 (60%) interested in pulmonary medicine. **Conclusions:** The competency of Iraqi PHCPs in CXR interpretation in acute and emergency conditions was optimal generally. Nonspecialist PHCPs had fewer competencies than specialists that belong to knowledge and training deficiency. An introduction of radiology training courses in emergent conditions and the use of tele-radiology platform in PHCCs should be considered.

Keywords: Chest X-ray interpretation, competency, emergency conditions, primary health care

Introduction

Researches show that strong primary health care (PHC) is associated with good outcome and lower costs.[1] It includes all the basic health-care services to be provided to the community. Thus, PHC is essential for attaining an acceptable

Access this article online

Quick Response Code:

Website: https://journals.lww.com/ircm

DOI: 10.4103/IRJCM.IRJCM_28_24

Address for correspondence: Dr. Oday Qussay Badraddin, Ministry of Health, Al-karkh Health Directorate, Al-dora Primary Health Care Sector, Baghdad, Iraq.
E-mail: dr.oday78fm@gmail.com

Submitted: 09-Jun-2024 **Revised:** 21-Jun-2024
Accepted: 25-Jun-2024 **Published:** 20-Jan-2025

How to cite this article: Badraddin OQ, Al-Timeme QA. Competency assessment of primary health-care physicians in Iraq regarding the interpretation of chest X-ray in acute and emergency conditions. IRAQI J COMMUNITY MED 2025;38:17-26.

level of health for the public. It is also an integral and critical component of the health system of any country.[2]

Health services in Iraq are provided through a network of PHC centers (PHCCs) and hospitals. The Ministry of Health (MOH) adapted a referral system in late 2008 to ensure a close relationship among all the levels of health-care system (HCS) to ensure people receive the best possible care closest to home and to make cost effective use of hospitals and PHC services.[3] Although MOH has established a system for patient referrals, this mechanism does not function well because of the lack of other requirements for an efficient referral system.[4]

Referrals of patients from PHCCs to medical specialist care and back to primary care comprise an important activity in any HCS. There is evidence that the gate-keeping role of PHC physicians (PHCPs) increases the efficacy of the system and reduces costs. Patients present to PHCPs with undifferentiated illness such that the cause of disease may be in the physical, social, and or psychological domains.[3]

Emergencies can occur at any time and be life-threatening or cause permanent damage. Accordingly, the management of emergency cases is an integral part of PHC.[5] Health emergency is a sudden or unexpected threat to physical health or wellbeing, which requires an urgent assessment and alleviation of symptoms, the early identification of a medical emergency and subsequent management, will be helpful to save the patient's life.[6] PHC has an essential role to play in preventing, preparing for, responding to and recovering from any emergency situation.[7] Physicians in PHCCs depend largely on their skills in history taking and physical examination to establish a diagnosis considering limited access to other assessment tools.[8]

The accurate interpretation of chest radiographs requires an understanding of the normal chest radiographic appearances, as obscuration of normally visualized structures may be the only clue to the presence of an abnormality. Radiography allows visualization and assessment of the chest wall, mediastinum, and hila including the heart and great vessels, central airways, the lungs including the pulmonary vasculature, the pleural surfaces including the fissures and the diaphragm. The superimposition of complex structures of various radiographic density (gas, water, calcium, metal, and fat) makes radiographic interpretation challenging. An understanding of normal interfaces allows for the detection of conditions that manifest with chest symptoms or as asymptomatic abnormalities.[9]

Chest X-ray (CXR) remains one of the most important and commonly performed examinations in radiology. It provides an easily accessible, cheap, and effective diagnostic tool. It is typically the first radiological examination obtained in patients presenting with respiratory symptoms, such as shortness of breath, cough, and hemoptysis, also in chest pain, acute abdomen and even in case of weight loss.[10] CXR need no patient preparations and indicated for evaluation of pleural and parenchymal pulmonary disease, mediastinal disease, cardiogenic and noncardiogenic pulmonary edema, congenital and acquired cardiac disease, and evaluation of possible pneumothorax.[11] Therefore, CXR is a crucial diagnostic tool because it is widely available, relatively inexpensive, has a low dose of radiation exposure and remain the starting point among imaging modalities for the diagnosis and management of cardiac and pulmonary conditions. Several studies have demonstrated the fundamental role of CXR in clinical decision-making.[12]

CXR should be used to answer targeted and specific clinical questions. Refining requests for CXR will result in a higher probability of demonstrating an abnormality that will result in a change in patient management. Evaluation of CXR may appear to be simple but is in fact a more complex task, requiring carful observation, understanding of chest anatomy, and the principles of physiology and pathology. A systematic approach to CXR review is essential to gain from the film and to avoid potential errors in the interpretation.[10]

Aim of the study

The aim of this study is the identification and measurement of diagnostic accuracy and degree of diagnostic confidence of PHCPs to CXR relating to acute and emergent conditions in Iraq.

Subjects and Methods

A cross-sectional study with a setting of online (Google Form) survey was performed from January 8, 2023 to January 7, 2024. PHCPs in Iraq were the target population, with a convenient sample of 330 participants. Data collection by an online questionnaire, the survey was distributed via Iraqi medical pages and medical groups on social media applications, like (Whats App, Facebook, Telegram, Viber and Messenger), and on Iraqi family physician association websites. Each invitation had a unique link, where the participants must open the (Google Form questionnaire) by entering their Email's that could not be used more than once, so that the survey was not compromised by duplicate responses. Participants were able to access the survey on their mobile phones, laptops, tablets, or computers.

The questionnaire began with background letter cover and socio-demographic questions, including: gender, governorate, years in practice, type of training, interest in pulmonary medicine and diagnostic radiology, having completed an elective course in diagnostic radiology, and perceived to have adequate training in interpreting CXR images.

The survey included a series of 10 cases that started with a brief clinical scenario and a CXR image, followed by a multiple-choice question asking for the most likely diagnosis from five choices. For each case, participants were also asked to rate their degree of confidence using a 5-point scale. The survey included an optional free-text field for participants to provide feedback or comments. No half marks were allocated due to that the questionnaire ten questions must be answered completely,

otherwise it will never be sent. All participants were received the correct answers on their E-mails but after completing data collection and closing the Google form questionnaire. All CXR images were selected from (Radiopaedia.org/an international radiology educational web resource). Moreover, the cases were selected to represent common emergent pulmonary and cardiac conditions that are encountered in medical practice. The questionnaire was revised by supervisor and two diagnostic radiology specialists in AL-Kindy College of Medicine, their modifications and advice regarding the proposed questionnaire was taken into consideration.

Inclusion criteria

All PHCPs who are working in PHCCs belong to Iraqi MOH and willing to participate in the study.

Exclusion criteria

All physicians who are not working in PHCCs, retired PHCPs, and who are not working in Iraq.

Ethical considerations

Institutional approval for the study (AL-Kindy College of Medicine\Department of Community and Family Medicine\ Ethical and Scientific Committee Opinion). All the participants are volunteers (Autonomy-make own decision to participate) and informed about the purpose of the study as well as the confidentiality of the gathered data. Anonymously and no personal identification data were requested or stored. Filling out the questionnaire by the participants, constitutes as agreement for participation and consent to use answers for research purposes only without revealing identity or personal data (this note was presented on the cover letter of the questionnaire).

Statistical analysis

Microsoft Excel was used to enter the collected data which then be loaded into Statistical Package for the Social Sciences (SPSS) software, version 23, IBM Corporation SPSS statistics for windows (233 South Wacker Drive, 11th Floor Chicago, Illinois, U.S.A) the results presented in tables and figures, continuous variables summarized by mean and standard deviation (SD), categorical variables summarized by percentages and frequency distributions and compared using Fisher's exact test. Level of statistical significance was set at a $P < 0.05$. Cutoff point of diagnostic accuracy was considered equal or more than 5 correct answers from 10 is competent and that of confidence rate equal or more than 3 scores from 5 is confident. Likert scale was used to give the appropriate self-perception about the correctness or incorrectness of their answers as reflected by their self-reported certainty in their answers.

Results

The study included 330 participants, with a gender distribution of 266 (80.6%) females and 46 (19.4%) males. This indicates a significant predominance of females in the sample. The training level distribution shows that family medicine specialists constitute the largest group 180 (54.5%), followed by family medicine permanents 68 (20.6%). The diversity in training levels suggests a varied perspective on diagnostic radiology. Participants were distributed across various governorates, with the majority from Baghdad 202 (61.2%), as shown in Table 1.

The participants' clinical practice duration varied, with 170 (51.5%) having more than 10 years of experience. This diverse experience level is essential in understanding the impact of experience on diagnostic performance. Only 100 (30.3%) of participants had elective rotations in diagnostic radiology, indicating a subset with specific exposure to this field. The majority 258 (78.2%) and 198 (60%) expressed interest in diagnostic radiology and pulmonary medicine, respectively, highlighting a positive attitude toward the field. Regarding CXR interpretation, 162 (49.1%) was uncertain about their training adequacy, emphasizing potential gaps in training, as shown in Table 2.

Table 1: Demographic distribution of the participants

Category	Frequency, *n* (%)
Gender	
Female	266 (80.6)
Male	64 (19.4)
Total	330 (100)
Training level	
Family medicine specialists	180 (54.5)
Family medicine practitioners	26 (7.9)
Family medicine permanents	68 (20.6)
General practice physicians	10 (3.0)
Other branches practitioners	18 (5.5)
Trainee doctors in rural regions	28 (8.5)
Total	330 (100)

Table 2: Primary health-care physician's profiles and perspectives in diagnostic radiology

Variable	Frequency, *n* (%)
Duration of clinical practice (years)	
<5	88 (26.70)
5–10	72 (21.80)
>10	170 (51.50)
Elective rotation in diagnostic radiology	
No	230 (69.70)
Yes	100 (30.30)
Interest in diagnostic radiology	
No	72 (21.80)
Yes	258 (78.20)
Adequate training in CXR interpretation	
Maybe	162 (49.10)
No	136 (41.20)
Yes	32 (9.70)
Interest in pulmonary medicine	
No	132 (40.00)
Yes	198 (60.00)
Total	330 (100)

CXR: Chest X-ray

Clinical scenarios

The lowest diagnostic accuracy was case 4 and the highest one was case 6 Table 3.

A 20-year-old male presented to a PHCC with shortness of breath, chest pain, and increasing wheeze. He is a known asthmatic. On examination, he had oxygen saturation of (84%) in room air and was afebrile. His respiratory rate was (28) cpm with a heart rate of (98) bpm. There were scattered wheezes throughout the lungs with reduced air entry bilaterally. His CXR is shown below. What is the most likely diagnosis? (Case number 4), as shown in Figure 1 and Table 4.

A 58-year-old male presented to a PHCC with progressive dyspnea and leg swelling, newly developed atrial fibrillation. He has a (20) pack/year smoking history. On examination, he is afebrile with saturations of (90%) in air. His heart rate is (98) bpm with a respiratory rate of (22) cpm. There is dullness and inspiratory crackles in both lower zones. His CXR is shown below. What is the most likely diagnosis? (Case number 6) Figure 2 and Table 5.

Diagnostic accuracy and confidence in ten clinical cases: [Table 3 and Figures 3, 4]

The diagnostic accuracy for ten clinical cases ranged from 140 (42.4%) to 300 (90.9%). Mean ± SD (6.72 ± 1.88), with corresponding confidence levels between 226 (68.5%) and 300 (90.9%). Mean ± SD (3.33 ± 0.75). The total sample overall diagnostic accuracy and confidence were 296 (89.7%) and 116 (77.0%), respectively. Diagnostic accuracy among family medicine specialist 164 (91.1%) and diagnostic confidence is 138 (76.7%) within their group, while among nonspecialist PHCPs, diagnostic accuracy only 132 (88%) and diagnostic confidence 116 (77.3%) within their group. Family medicine specialists proportion contributes to 164 (55.4%) and 138 (54.3%) of diagnostic accuracy and confidence in the sample respectively. While nonspecialist physicians proportion contributes to 132 (44.6%) and 116 (45.7%) of diagnostic accuracy and confidence in the sample, respectively.

Table 3: Diagnostic performance and confidence levels in ten clinical cases

Case	Diagnostic accuracy, *n* (%)	Diagnostic confidence, *n* (%)
Case 1 (normal CXR)	284 (86.1)	276 (83.6)
Case 2 (right lower lobe pneumonia)	260 (78.8)	300 (90.9)
Case 3 (lung abscess)	238 (72.1)	274 (83.0)
Case 4 (pneumomediastinum)	140 (42.4)	226 (68.5)
Case 5 (lobar collapse)	168 (50.9)	236 (71.5)
Case 6 (cardiogenic pulmonary edema)	300 (90.9)	286 (86.6)
Case 7 (pneumoperitoneum)	192 (58.2)	258 (78.2)
Case 8 (empyema)	172 (52.1)	248 (75.1)
Case 9 (pneumothorax)	200 (60.6)	242 (73.3)
Case 10 (COVID 19-pneumonia)	262 (79.4)	266 (80.6)

CXR: Chest X-ray

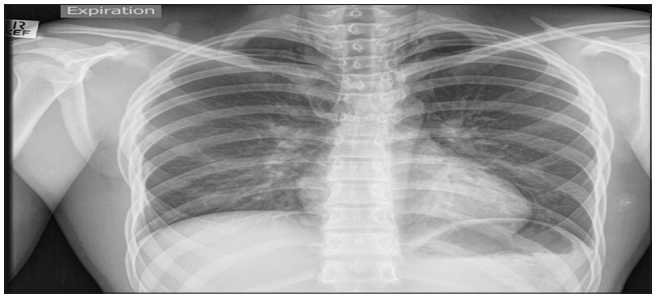

Figure 1: Chest radiograph of pneumomediastinum

Correlation between diagnostic accuracy score and diagnostic confidence level [Figure 5]

A moderately positive correlation (r = 0.417) between diagnostic accuracy and confidence level suggests that as diagnostic accuracy increases, confidence levels also tend to rise.

Associations between primary health-care physicians characteristics and diagnostic performance metrics [Table 6]

Table 6 shows that there was a significant association between PHCPs characteristics and diagnostic performance metrics. Notably, family medicine specialists demonstrate the highest diagnostic accuracy 164 (91.1%) (Within their group), while PHCPs with an interest in diagnostic radiology and those with training in CXR Interpretation exhibit heightened accuracy 234 (90.7%) and 30 (93.8%), respectively, and confidence 208 (80.6%) and 30 (93.8%), respectively (within their groups). Longer clinical practice duration (5–10 years) and (>10 years) is linked to higher accuracy 66 (91.7%) and 155 (91.2%), respectively, and higher confidence rates 60 (83.3%) and 85 (73.9%), respectively. Elective rotation in diagnostic radiology is associated with increased accuracy 92 (92.9%) and confidence 85 (85.9%). The statistical analysis, employing (Fisher's Exact P values), underscores the significance of these associations, particularly with P values of (0.004) for both the interest in diagnostic

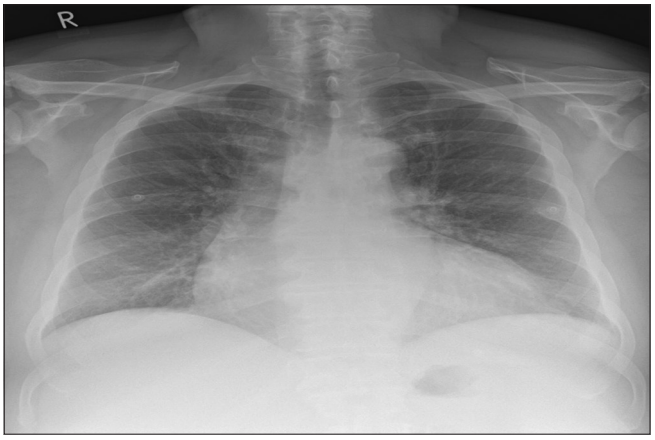

Figure 2: Radiograph of cardiogenic pulmonary edema

Table 4: Answers and confidence level distribution of Case 4

Diagnosis	Frequency, *n* (%)
Normal CXR	84 (25.5)
Pneumomediastinum*	140 (42.4)
Pneumothorax	74 (22.4)
Rib fracture	18 (5.5)
Right lower lobe pneumonia	14 (4.2)
Confidence level	
Very low	36 (10.9)
Low	68 (20.6)
Neutral	150 (45.5)
High	60 (18.2)
Very high	16 (4.8)
Total	330 (100)

*Pneumomediastinum. CXR: Chest X-ray

Table 5: Answers and confidence level distribution of Case 6

Diagnosis	Frequency, *n* (%)
Aortic dissection	20 (6.1)
Cardiogenic pulmonary edema*	300 (90.9)
Interstitial lung disease	6 (1.8)
Normal CXR	2 (0.6)
Pneumonia	2 (0.6)
Confidence level	
Very low	16 (4.8)
Low	28 (8.5)
Neutral	108 (32.7)
High	82 (24.8)
Very high	96 (29.1)
Total	330 (100)

*Cardiogenic pulmonary edema. CXR: Chest X-ray

radiology and the training in CXR Interpretation. These findings underscore the influence of (specialized training level) and (interests) on PHCPs diagnostic competency and confidence levels in CXR interpretation.

Association between receiving adequate X-ray training and some demographic variables [Table 7]

The results from Table 7 demonstrate statistically significant associations between adequate CXR training and both gender which was ($P = 0.000$) and training level which was ($P = 0.004$) among participants. Among females, 14 (43.8%) reported adequate training compared to 18 (56.3%) of males. Regarding training level, family medicine specialists showed the highest proportion 14 (43.8%) reporting adequate training, while other nonspecialists (PHCPs) had less proportions ranging from none (0.00%) to 8 (25.0%). PHCPs who reported that they had adequate training had more than (10 years') experience was 15 (46.9%).

Discussion

The primary perquisite for managing emergency cases is

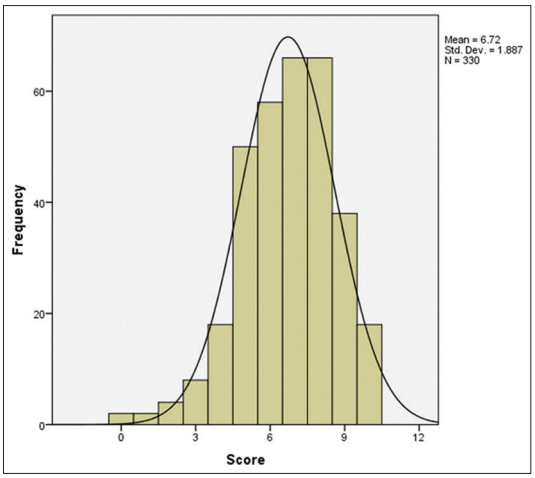

Figure 3: Distribution of diagnostic accuracy score among primary health care physicians

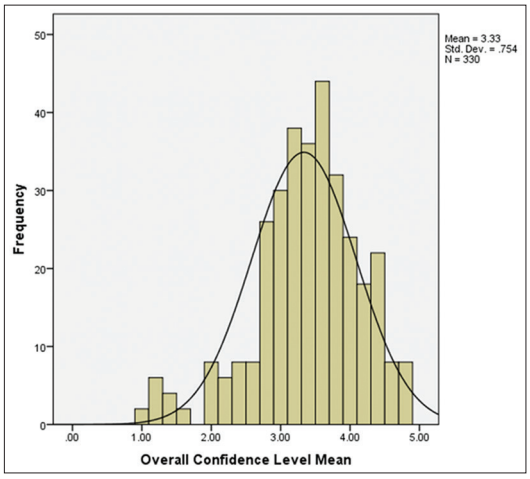

Figure 4: Distribution of overall confidence level mean among PHCPs

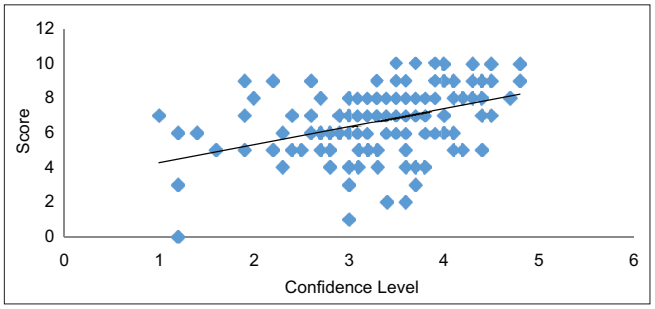

Figure 5: Correlation between diagnostic accuracy score and diagnostic confidence level

the updated knowledge of the PHCPs that help in the early diagnosis and management of diseases. It is challenging for them to be have updated information and to be competent in every emergency that they may come across. Most of the physicians lack believes that they are competent enough to manage emergency cases in PHC settings. Thus, for a proper management of emergency cases, training and efficient personnel are not enough if they work in a place that is oriented

Table 6: Associations between primary health-care physicians characteristics and diagnostic performance metrics

Variable	Diagnostic accuracy (≥5), frequency (%)	*P**	Diagnostic confidence (confident), frequency (%)	*P**
Training level				
Family medicine specialist	164 (91.1)	0.057	138 (76.7)	0.845
Family medicine practitioner	20 (76.9)		22 (84.6)	
Family medicine permanent	60 (88.2)		52 (76.5)	
General practice physicians	8 (80.0)		8 (80.0)	
Trainee doctor in rural regions	28 (100.0)		22 (78.6)	
Other branch practitioner	16 (88.9)		12 (66.7)	
Interest in diagnostic radiology				
No	62 (86.1)	0.275	26 (36.1)	0.004
Yes	234 (90.7)		208 (80.6)	
Training in CXR interpretation				
Maybe	146 (90.1)	0.693	130 (80.2)	0.004
No	120 (88.2)		94 (69.1)	
Yes	30 (93.8)		30 (93.8)	
Clinical practice duration (years)				
<5	88 (14.8)	0.294	20 (26.3)	0.305
5–10	66 (91.7)		60 (83.3)	
>10	155 (91.2)		85 (73.9)	
Elective rotation in diagnostic radiology				
No	204 (88.3)	0.240	169 (73.2)	0.008
Yes	92 (92.9)		85 (85.9)	
Interest in pulmonary medicine				
No	120 (90.9)	0.585	98 (74.2)	0.025
Yes	176 (88.9)		156 (78.8)	

**P* significant at <0.05, CXR: Chest X-ray

Table 7: Association between adequate X-ray training with gender and training level

Category	Have you had an adequate training in CXR interpretation			*P**
	Yes, *n* (%)	No, *n* (%)	Maybe, *n* (%)	
Gender				
Male	18 (56.3)	14 (10.3)	32 (19.8)	0.000
Female	14 (43.8)	122 (89.7)	130 (80.2)	
Level of training				
Family medicine specialist	14 (43.8)	66 (48.5)	100 (61.7)	0.004
Family medicine practitioner	4 (12.5)	14 (10.3)	8 (4.9)	
Family medicine permanent	8 (25.0)	34 (25.0)	26 (16.0)	
General practice physician	4 (12.5)	4 (2.9)	2 (1.2)	
Other branch practitioner	2 (6.3)	8 (5.9)	8 (4.9)	
Trainee doctor in rural regions	0	10 (7.4)	18 (11.1)	
Duration of clinical practice (years)				
<5	13 (40.6)	31 (22.8)	44 (27.2)	0.000
5–10	4 (12.5)	46 (33.8)	22 (13.6)	
>10	15 (46.9)	59 (43.4)	96 (95.3)	

*Fisher's exact *P* value. CXR: Chest X-ray

to receive cold cases only, so proper and orderly oriented ground floor to receive emergency cases is a must, along with sufficiently equipped allocated rooms.[13] In order to be efficient in managing the possible emergency cases in PHCCs, the physicians need to have a wide scope of knowledge and expertise in different subjects, however if they believe that their information are deficient, their management will definitely be suboptimal, this concept is solidified by the systemic review done by Behghadami *et al*. in Iran, who mentioned that continuous medical education does not only improve patients' safety but also increases physicians motivations.[14]

Self-confidence and real life training of physicians working in PHCCs have crucial role in improving emergency care

management and outcome, and this concept was proved by Forde *et al*. who studied the effects of training of 14 general practitioner (GP) in real life scenarios and concluded that class room teaching prevents delivery of a rapid and effective emergency care.[15]

Due to the potential repercussions of incorrect CXR interpretation, accurate interpretation is essential for investigating and managing diseases. Despite chest radiography significant role in saving lives, it can endanger lives if interpreted improperly or with inadequate knowledge.[16]

It is unknown to what extent potential knowledge deficiency or experience gap exists for diagnosing the CXR findings in acute chest pathologies, such as in tension pneumothorax, aortic dissection, or more common scenarios such as pulmonary edema, inappropriate interpretation impacts immediate plan of care.[17]

As clinical decisions depend on readings, we sought in the current study to evaluate CXR interpretation competency and confidence rate at different levels of training regarding PHCPs in Iraq and to determine the factors associated with successful interpretation.

However, to the best of our knowledge, this is the first survey done in Iraq to assess the competency and confidence rate of PHCPs in CXR interpretation and how the patient's clinical history influences the CXR interpretation.

The training level distribution shows that family medicine specialists constitute the largest group 180 (54.5%). This revealed that the percentage of participation or response for (all other – non specialist-five training levels) was only 150 (45.5%). This might be explained by low interest in research work participation, especially in nonacademic environments and decrease their willingness to participate. Furthermore, low level of knowledge leading to low response rate to (nonobligate/voluntary) survey and (online/not direct face to face interview).

Furthermore, increased number of family physicians versus GPs in PHCCs which attributed to Iraqi MOH policy that encourage junior residents to get through (post rotation) FM permanency program instead of previous old GP system (after training in rural regions) and established a (bridging system) for the professional diploma in FM for previous old GPs in the few years ago.

The diversity in training levels suggests a varied perspective on diagnostic radiology. In other word, family medicine specialists (they was predominant in the sample) are more trained and interested in diagnostic radiology and have more interested to participate in the survey, due to postgraduate (high diploma and board studies) where the training curriculum include general diagnostic radiology and research methodology courses.

The diversity in experience level is essential in understanding the impact of experience on diagnostic performance. Where longer clinical practice duration (<10 years) is linked to high accuracy 155 (91.2%) (Within their group). This result agree with the result of a study done by Dreyer *et al*. at the University of the Witwatersrand medical school, in South Africa (2023), where the CXR interpretation diagnostic accuracy per years of experience was the highest in participants who have more than (10 years) of experience.[18] While another study done by Mehdipoor *et al*., where the participants were GPs only, revealed different results regarding physicians with more than 10 years where explained as years since graduation can impact the response, either because of more experience over time, leading into improved answers accuracy or being less fresh with given topics, leading into suboptimal accuracy and confidence levels[17] Surprisingly, in the current study, the training level of (trainee doctors in rural regions) had (100%) diagnostic accuracy, although none of them (0.0%) was agree with getting an adequate training in CXR interpretation. This might be explained by they were fresh postgraduation years, and however, their percentage was 28 (8.5%) of the total sample which is a small sample to explore this associations.

Although only 100 (30.3%) of participants had elective rotation in diagnostic radiology which indicating a subset with specific exposure to this field, elective rotation in Diagnostic Radiology is associated with increased accuracy 92 (92.9%) and confidence 85 (85.9%), this revealed the importance of the diagnostic radiology elective rotation in improving the accuracy and confidence of CXR interpretation. This results agree with Al Shammari *et al*. in Saudi Arabia (2021) in which the participants who reported completing an elective rotation in diagnostic radiology had higher diagnostic accuracy and confidence than who did not have.[19]

The majority of participants in the current study 258 (78.2%) expressed interest in diagnostic radiology and highlighting a positive attitude toward the field. Furthermore, PHCPs with an interest in Diagnostic Radiology and those with training in CXR Interpretation exhibit heightened accuracy 234 (90.7%) and 30 (93.8%), respectively, and confidence 208 (80.6%) and 30 (93.8%(respectively within their groups. This results reveled the importance of training in CXR interpretation for increasing the accuracy and confidence rate. The results of the current study are also similar to Al Shammari *et al*., in which the diagnostic accuracy of participants who reported having adequate training in CXR interpretation was slightly greater than who did not have. Interestingly, the diagnostic accuracy of participants in Al Shammari *et al*. study did not differ significantly based on years in practice or having an interest in diagnostic radiology or pulmonary medicine, which disagree with current survey where 198 (60%) of the current study participants was interested in pulmonary medicine, which also highlighting a positive attitude toward the field.[19]

Regarding CXR interpretation, 162 (49.1%) were (uncertain) about their training adequacy, 136 (41.2%) reported (no) training, and only 32 (9.7%) reported (yes) emphasizing potential gaps in training. Even so, this characteristic is

important and a statistically significantly associated with both gender and duration of clinical practice were ($P = 0.000$) and with training level were ($P = 0.004$) in PHCPs competency assessment of CXR interpretation. This is not agree with Al Shammari *et al*. study were the gender and years of practice did not differ significantly ($P < 0.05$).[19] However, in the comparative study by Eisen *et al*. found that although interpretation improved with training, important diagnoses were missed and recommended more effective training, especially in radiographic emergencies.[20] Similarly, Cheung *et al*. highlighted the importance of structured radiology methods of teaching that should aim at the early postgraduate year levels and recommended further research of the factors influencing confidence that could result in improvement in CXR interpretation.[21]

Elective rotation in diagnostic radiology is associated with increased accuracy 92 (92.9%) and confidence 85 (85.9%). The statistical analysis, employing (Fisher's Exact *P* values) underscores the significance of these associations, particularly with $P = 0.004$ for both the interest in diagnostic radiology and the training in CXR Interpretation. These findings underscore the influence of (specialized training level) and (interests) on PHCPs diagnostic competency and confidence levels in CXR interpretation.

Regarding the importance of receiving adequate X-ray training with some demographic variables relations, the results from Table 7 demonstrate statistically significant associations between adequate CXR training and both gender ($P = 0.000$) and training level ($P = 0.004$) among the participants. Regarding training level, family medicine specialists showed the highest proportion 14 (43.8%) reporting adequate training, whereas other nonspecialists (GPs) had less proportions ranging from none (0.00%) to 8 (25.0%). Furthermore, 15 (46.9%) of PHCPs who reported that they had adequate training were having more than 10 years' experience.

As mentioned above, FM specialties gets more opportunity to be familiar with CXR interpretation because of that the post graduate studies curriculum included with general radiology course. Long duration of practice is stick with more opportunity to get more training in CXR interpretation during continuous daily medical work and training courses.

The current study showed a significant positive correlation between the diagnostic confidence and accuracy in CXR interpretation. We assume that when a physician is confident in CXR interpretation, this interpretation is more likely to be accurate. Eisen *et al*. study showed a noticeable association between self-reported confidence in the diagnosis and the correctness of CXR interpretation.[20]

A particular feedback comment caught our attention: "the survey has a good selection of cases; however, the provision of clinical vignettes made the interpretation easier." This comment is valid because previous studies showed that diagnostic accuracy and confidence increase when clinical information is provided[22] while the clinical vignettes provided were not indicative of a specific diagnosis, the interpretation of CXR should not be made in isolation from the clinical information. For example, a patient with a pleural effusion will be diagnosed with a hemothorax when a clinical history of trauma is provided. Similarly, CXR with bilateral pulmonary infiltrates might be diagnosed as pulmonary edema. If a clinical history of fever and productive cough is provided, however, it is more likely to be diagnosed as multifocal pneumonia. Hence, providing clinical information is of paramount importance in CXR interpretation.[23]

The highest diagnostic accuracy was the case number (six)/(cardiogenic pulmonary edema) with diagnostic accuracy = 300 (90.9%) and confidence rate = 286 (86.7%). Heart failure (HF) is a common diagnosis in PHC setting; it is becoming one of the main causes of morbidity and mortality in the western world, which is related to poor prognoses. Even so, CXR permits differential diagnoses with other causes of dyspnea but has little power to exclude HF.[24] In Mehdipoor *et al*. study, participants of high percentage missing diagnoses of acute pulmonary edema which could have life-threating detrimental consequences,[17] unfortunately there was a thirty participants in the current study miss diagnose the chest radiograph.

The second highest diagnostic accuracy was the case number (one) in which the correct answer was normal CXR. With diagnostic accuracy = 284 (86.1%) and a confidence rate = 276 (83.6%), where high confidence lead to high diagnostic accuracy, but this mean that 46 participants or (13.9%) misdiagnosing the radiograph. The clinical information, however, may be a distraction and lead to false-positive interpretations. Therefore, it is suggested to review the radiological images before reading the clinical data[23] many physicians still use CXR for screening, with their number decreasing slowly over time. This practice may be harmful because the (positive predictive value) of chest radiography is low. Moreover, further evaluation of false-positive findings might be associated with increased cost and risk from inappropriate additional diagnostic or unnecessary and potentially harmful therapeutic interventions.[18,25]

The lowest diagnostic accuracy was the case number (four), in which the correct choice was pneumomediastinum with diagnostic accuracy = 140 (42.4%), although confidence rate = 226 (68.5%), spontaneous pneumomediastinum (SPM) is a benign condition that often presents with chest pain or dyspnea. It can develop without a triggering event and with no findings on chest radiography. SPM is an unusual occurrence with few cases reported. It is seen after intrathoracic pressure changes, leading to alveolar rupture and dissection of air along the tracheobronchial tree. The result in the current study is nearly similar to Caceres *et al*. 2008 study, in which CXR with SPM were diagnostic only in 69% of participants.[26]

This case was preceded by the case number (five) in which the correct answer was lobar collapse, with diagnostic accuracy 168 (50.9%), and confidence rate 236 (71.5%). Lobar collapse

refers to the collapse of an entire lobe of the lung. Individual lobes of the lung may collapse due to obstruction of the supplying bronchus.[27] Lobar atelectasis (LA) with marked volume loss is hard to recognize and may be easily missed. Also presenting as a mass-like opacity may be misdiagnosed as mediastinal or lung tumor. LA in an unusual location may also be misdiagnosed as other entities. Familiarity with such manifestations and consideration of anatomical alterations as the signs of LA are important in making the correct diagnosis.[28]

The total sample overall diagnostic accuracy for all the (ten) cases was 296 (89.7%) and overall diagnostic confidence was 116 (77%), which is apparently considered an optimal result for the entire sample as a hall. Moreover, the diagnostic accuracy and confidence among (FM) specialist within their group were 164 (91.1%) and 138 (76.7%), respectively. While for the nonspecialists was 132 (88%) and 116 (77.3%) within their group too. Proportion of competent FM specialists among all competent participants was 164 (55.4%) and proportion of confident FM specialists among all confident participants was 138 (54.3%). While proportion of competent nonspecialists among all competent participants was 132 (44.6%) and proportion of confident nonspecialists among all confident participants was 116 (45.7%).

In regard to competency, assessment of PHCPs in CXR interpretation is in acute and emergent conditions. These results were disagree with Al Shammari *et al*. in which the overall accuracy was (63.1%) and overall confidence (67.8%) which considered as (far from optimal).[19] And disagree with Mahdipoor study in which the diagnostic proficiency was (poor), and overall confidence was (59%).[17] Furthermore, in Dreyer *et al*. study result, the diagnostic accuracy was 50.5% only.[18]

Self-perceived certainty in making a diagnosis, even with years of experience, may not necessarily reflect on the correctness of diagnosis. Other studies such as the one by Eisen *et al*.[20] showed a noticeable association between self-reported confidence in the diagnosis and the correctness of diagnoses for CXRs, in our study; this was the case for a majority of vignettes (8 out of 10). The primary source of error for our participants, we believe, was knowledge and training deficiency, which led many of them astray, and explain the relative low response rate to participate in the current survey from noncompetent and/or nonconfident PHCPs in Iraq regarding CXR interpretation in acute and emergent conditions.

Conclusions

The competency of Iraqi PHCPs in CXR interpretation in acute and emergency conditions who was participating in this study was generally optimal. Overall accuracy is 89.7%). Nonspecialist PHCPs was less competent (88%) than FM specialists (91.1%) within their groups that pointing to knowledge and training defect. Training level (specialty), long experience >10 years, interest in diagnostic radiology, and pulmonary medicine training in CXR interpretation, elective rotation in diagnostic radiology were of high value in increasing participant's diagnostic accuracy and diagnostic confidence in CXR interpretation in the acute and emergent conditions.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Coumou HC, Meijman FJ. How do primary care physicians seek answers to clinical questions? A literature review. J Med Libr Assoc 2006;94:55-60.
2. Almoajel A, Fetohi E, Alshamrani A. Patient satisfaction with primary health care in Jubail City, Saudi Arabia. World J Med Sci 2014;11:255-64.
3. Alkhazrajy LA. Quality of primary care center referral letters and feedback reports among sample of PHCCs in Baghdad/Al-Rusafa health directorate during 2015. Al-kindy Medical College Journal 2019;13:1-7. Available from: https://jkmc.uobaghdad.edu.iq/index.php/MEDICAL/article/view/114. [Last accessed on 2023 May 18].
4. Al-Shatari SA, Hasan LA, Shwaish ZT, Abutiheen AA, Ryhan TH, Younise MH, *et al*. Practice and opinion of doctors in primary health care centers toward referral system: Samples from nine governorates in Iraq. Al-kindy Medical College Journal 2021;17:100-6. Available from: https://jkmc.uobaghdad.edu.iq/index.php/MEDICAL/article/view/296. [Last accessed on 2023 May 19].
5. Al Mahrouqi A, Al Maqbali RH, Al Fadhil F, Al Salmani AA. Types of primary healthcare emergencies in Muscat, Oman: A retrospective cross-sectional study of five primary care centres. Sultan Qaboos Univ Med J 2021;21:572-7.
6. Morgans A, Burgess SJ. What is a health emergency? The difference in definition and understanding between patients and health professionals. Aust Health Rev 2011;35:284-9.
7. Affun-Adegbulu C, Ricarte B, Belle SV, Damme WV, Pas RV, Put WV, *et al.* Primary Health care and Health Emergencies. World Health Organization; 2018.
8. Wong WC, Lindsay M, Lee A. Diagnosis and Management in Primary Care: A Problem-Based Approach. Hongkong: Chinese University Press; 2008.
9. Klein JS, Rosado-de-Christenson ML. A systematic approach to chest radiographic Analysis. In: Hodler J, Kubik-Huch RA, von Schulthess GK, editors. Diseases of the Chest, Brest, Heart and Vessels 2019-2022: Diagnostic and Interventional Imaging. Ch. 1. Cham (CH): Springer; 2019.
10. Puddy E, Hill C. Interpretation of the chest radiograph. Contin Educ Anaesth Crit Care Pain 2007;7:71-5. Available from: https://doi.org/10.1093/bjaceaccp/mkm014. [Last accessed on 2023 May 22].
11. Corne J, Au-Yong I. Consultant physician, consultant radiologist. In: Chest X-Ray Made Easy. Fifth International Edition. Ch. 1. Scotland: Elsevier Limited; 2023. p. 2.
12. Speets AM, van der Graaf Y, Hoes AW, Kalmijn S, Sachs AP, Rutten MJ, *et al.* Chest radiography in general practice: Indications, diagnostic yield and consequences for patient management. Br J Gen Pract 2006;56:574-8.
13. Abdul-Mahdi SS, Aldabbagh AY. Evaluation of family physicians knowledge, attitudes and practice for emergency services. Iraqi Postgrad Med J 2022;21:368-72. Available from: https://www.iasj.net/iasi/download/74e439faec85fef9. [Last accessed on 2023 Aug 02].
14. Behghadami MA, Janati A, Sadeghi-Bazargani H, Gholizadeh M, Rahmani F, Arab-Zozani M. Assessing preparedness of non-hospital health centers to provide primary emergency care; A systematic review. Bull Emerg Trauma 2019;7:201-11.
15. Forde E, Bromilow J, Jackson S, Wedderburn C. Managing emergencies in primary care: Does real-world simulation-based training have any lasting impact? BMJ Simul Technol Enhanc Learn 2019;5:57-8.

16. Al Elq A, Alfayez AA, AlQahtani MI, Alshahrani RS, Alotaibi GA, Aldakheel AA, *et al.* The effects of various teaching methods on chest X-ray interpretation skills among medical students and interns: A systematic review. Cureus 2023;15:e44399.
17. Mehdipoor G, Salmani F, Arjmand Shabestari A. Survey of practitioners' competency for diagnosis of acute diseases manifest on chest X-ray. BMC Med Imaging 2017;17:49.
18. Dreyer RG, van der Merwe CM, Nicolaou MA, Richards GA. Assessing and comparing chest radiograph interpretation in the department of internal medicine at the university of the Witwatersrand medical school, according to seniority. Afr J Thorac Crit Care Med 2023;29:12-7.
19. Al Shammari M, Hassan A, AlShamlan N, Alotaibi S, Bamashmoos M, Hakami A, *et al.* Family medicine residents' skill levels in emergency chest X-ray interpretation. BMC Fam Pract 2021;22:39.
20. Eisen LA, Berger JS, Hegde A, Schneider RF. Competency in chest radiography. A comparison of medical students, residents, and fellows. J Gen Intern Med 2006;21:460-5.
21. Cheung T, Harianto H, Spanger M, Young A, Wadhwa V. Low accuracy and confidence in chest radiograph interpretation amongst junior doctors and medical students. Intern Med J 2018;48:864-8.
22. Loy CT, Irwig L. Accuracy of diagnostic tests read with and without clinical information: A systematic review. JAMA 2004;292:1602-9.
23. Griscom NT. A suggestion: Look at the images first, before you read the history. Radiology 2002;223:9-10.
24. Devroey D, Van Casteren V. Signs for early diagnosis of heart failure in primary health care. Vasc Health Risk Manag 2011;7:591-6.
25. Mauri D, Kamposioras K, Proiskos A, Xilomenos A, Peponi C, Dambrosio M, *et al.* Old habits die hard: Chest radiography for screening purposes in primary care. Am J Manag Care 2006;12:650-6.
26. Caceres M, Ali SZ, Braud R, Weiman D, Garrett HE Jr. Spontaneous pneumomediastinum: A comparative study and review of the literature. Ann Thorac Surg 2008;86:962-6.
27. Gaillard F, Saber M, Deng F. Lobar Lung Collapse. Radiopaedia.org. Available from: https://radiopaedia.org/articles/lobar-lung-collapse. [Last accessed on 2023 Aug 18].
28. Ashizawa K, Hayashi K, Aso N, Minami K. Lobar atelectasis: Diagnostic pitfalls on chest radiography. Br J Radiol 2001;74:89-97.