



## Original Article



## A Single-Center, Retrospective Study of Chest X-Rays in Potential Expatriates From KPK: A Descriptive Investigation

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## ABSTRACT

Lung diseases are serious medical conditions that significantly impact the migrant populations. Chest X-rays are one of the most commonly used and cost-effective diagnostic tools for identifying various lung conditions. **Objectives:** To establish the prevalence of lung anomalies detected on X-ray in prospective expatriates, to evaluate their distribution by age, gender, region, occupation, and to determine the unfit cases within these groups. **Methods:** In this study, the chest X-ray reports of 42,688 Pakistani candidates from the year 2022 (Jan-Dec) were analyzed, who underwent medical screening (chest X-rays) for overseas employment under the guidelines of the Gulf Cooperation Council (GCC). The candidates aged between 18 and 51 years, with a mean age of  $31.54 \pm 4.86$ . **Results:** Out of 42,688 candidates examined over a year, 1,347 (3.15%) were deemed unfit based on chest X-ray findings. Chest X-ray anomalies were most prevalent among costophrenic angle obliteration (0.63%), pleural effusion (0.42%), and moderate apical scarring (0.31%). The population in the study was predominantly male, with no unfitness among females. Of these anomalies (n=1347), the most infected age group was 31-35 years (39.9%), followed by 36-40 (35.4%) and 41-45 (12.6%) years. Occupationally, the most affected were laborers (88.2%) and drivers (4.97%), whereas geographically, the highest prevalence was in Peshawar (12%), Mardan (11.3%), and Bannu (8.16%). **Conclusions:** This research allows us to determine the burden and distribution of chest-related anomalies among prospective expatriates, identify demographic, occupational, and geographic groups, and provides baseline epidemiological evidence from an understudied screening population.

## INTRODUCTION

Chronic respiratory and lung diseases are a major public health concern, especially in areas of rapid industrialization coupled with mass workforce migration. Such is often seen in the Gulf Cooperation Council countries. Assessing the health status of expatriate workers before employment is an important strategy for ensuring individual fitness to work and compliance with the host-country health regulations. The GCC includes Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates; all these nations heavily rely on expatriate labor for sectors like construction, healthcare, and

domestic services [1]. Consequently, GCC member states have established a unified pre-employment medical screening program for expatriates. Commonly, this pre-employment medical testing involves clinical assessment, laboratory testing, and radiological investigations to determine the general health status of the candidates [2]. Chest radiographs (CRs) are widely used as the initial imaging modality for the assessment of thoracic diseases and represent one of the most frequently performed radiologic examinations worldwide, accounting for up to 26% of all diagnostic imaging procedures [3]. These



conditions may remain clinically silent until they progress to advanced stages [4]. The prevalence of chest x-ray (CXR) findings, i.e., infiltration, pulmonary lesions, calcific granuloma, and pleural effusion, is notable and aligns with the historic burden of TB in similar male predominant studies [5, 6]. Previous research in the Middle East region showed the prevalence of pulmonary lesions in endemic regions for tuberculosis (TB), with the rates varying based on geographic location. A large number of expatriate workers and refugees pose major challenges in achieving the program towards TB elimination [7]. Fibrotic lesions in the lungs are not uncommon in individuals from TB-endemic areas [8]. Nodular lesions in the chest x-ray are often classified as benign/malignant based on their size and growth pattern. Benign nodules, as noted in many studies, are seen in around 5-10% of CXR screening. Costophrenic angle obliteration closely associated with the intensity of asbestos exposure and suggests underlying pleural effusion or prior pleuritic episodes. A study conducted as a part of routine CXR screening reported 1.2% cases of CP obliteration [8]. Within the context of expatriate medical screening, CXRs serve as an efficient and cost-effective tool for identifying radiographic findings that may influence fitness-for-work decisions. While numerous studies in Pakistan and South Asia have described chest X-ray findings in clinical or TB-focused populations [9, 10], there is limited published evidence specifically describing the spectrum and prevalence of chest radiographic findings identified during GCC-mandated expatriate screening programs.

Despite the widespread use of chest X-rays for pre-employment screening of expatriates, there is limited evidence on the prevalence and patterns of radiographic abnormalities among potential migrant workers from Khyber Pakhtunkhwa, Pakistan. Existing studies are predominantly clinical, TB-focused, or community-based, and often involve symptomatic or general populations, limiting their applicability to healthy, working-age expatriates. Additionally, there is a lack of multi-dimensional analysis examining the distribution of abnormalities across age, occupation, and geographic regions within this specific population. This gap underscores the need for systematic, descriptive data on radiographic findings in expatriate screening programs to inform regional health policies, occupational risk assessment, and targeted interventions. Localized, center-based data are important for understanding regional patterns of radiographic findings and for supporting quality assurance and policy refinement within expatriate health screening programs. Therefore, the present study aimed to report the prevalence and pattern

of chest radiographic findings among expatriates undergoing pre-employment medical screening at a GCC-approved Caring and Curing Center in Peshawar, Khyber Pakhtunkhwa, Pakistan. By providing updated, real-world data from this setting, the study contributes context-specific evidence that complements existing literature and supports ongoing evaluation of expatriate health screening practices.

## METHODS

This study is retrospective cross-sectional. The study protocol was reviewed and approved by the Ethical Committee of Yashfeen College of Pharmacy, Lahore. (Ref: YES/ERC/08-25/01/0007). Ethical research standards were adhered to concerning data confidentiality. In this study, data were retrieved from 42,688 individuals. Chest X-ray reports were gathered from workers originating from the districts of KPK from January 2022 to December 2022. The center maintained a computerized database, and candidates were imaged on 14-17-inch film. Radiographs were taken using the following parameters: PA standard view on green films, 20 mAs, 80 kV exposures with a focal film distance (FFD) of 1.8 meters/ 6feet. Read and interpreted by a qualified radiologist (cross-checked for reliability). The inclusion criteria of this retrospective descriptive study included all consecutive individuals who presented for GCC-mandated pre-employment medical screening during the study period. The screening protocol included chest radiography as part of a routine medical fitness assessment. Individuals ( $\geq 18$ ) undergoing pre-employment medical screening for GCC countries. Complete demographic information and radiographic reports are available in the screening records. Exclusion criteria included chest radiographs that were technically inadequate for diagnostic interpretation (e.g., poor exposure, motion artifacts, improper positioning). Incomplete or missing radiographic reports. Duplicate records from repeat screenings of the same individual during the study period. The Statistical Package for Social Sciences (SPSS) version 26.0 was used to examine and interpret the statistical data. Frequency and percentages were used to compute variables. Descriptive statistics were used to get the mean, mode, minimum, maximum range, and standard deviation of age.

## RESULTS

A total of 42,688 potential expatriates undergoing GCC-mandated pre-employment medical screening were included in the analysis. The screened population consisted predominantly of males ( $n=40,717$ ; 95.4%), while females accounted for 1,971 individuals (4.6%). The age of participants ranged  $\geq 18$  (Table 1).

**Table 1:** Demographic Characteristics

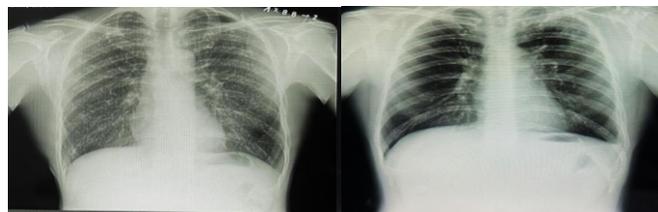
Age Group		Frequency (%)
Age	18-20	1423 (3.3%)
	21 - 25	16862 (39.5%)
	26 - 30	10494 (24.6%)
	31 - 35	7696 (18.0%)
	36 - 40	5087 (11.9%)
	41 - 45	1060 (2.5%)
	46 - 51	66 (0.2%)
Total	42688 (100.0%)	
Gender	Male	40717 (95.4%)
	Female	1971 (4.6%)

The total number of screened subjects was 42,688, out of which the abnormal finding of unfitness was reported in 1,347 (3.15%) candidates, and the normal finding of fitness was reported in 41,341 (96.8%) candidates. The 95% confidence interval (CI) was estimated by using a one-sample test,  $M=1.031$ , 95%CI (1.029-1.033). The highest finding was observed in minimal costophrenic angle obliteration, which was found in 269 candidates (0.63%), followed by pleural effusion in 182 candidates (0.42%), apical scarring in 135 candidates (0.31%), calcific granuloma in 128 candidates (0.29%), fibrocalcific changes in 124 candidates (0.29%), and nodular lung shadows in 119 candidates (0.27%). The other less common findings include solitary fibrotic changes in (0.24%), lymphadenopathy in (0.22%), interstitial lung shadowing in (0.15%), and hilar calcification in (0.18%) (Table 2).

**Table 2:** Prevalence of Different Screening Parameters

Parameters	Frequency (%)
Pulmonary Infiltration by Soft Shadows in the Lungs	42 (0.09%)
Calcific Granuloma in the Lungs	128 (0.29%)
Fibrocalcific Lesion in the Lung	124 (0.29%)
Hilar Calcification	77 (0.18%)
Interstitial Lung Shadowing	68 (0.15%)
Lymphadenopathy	97 (0.22%)
Minimal Costophrenic Angle Obliteration	269 (0.63%)
Moderate Apical Scarring	135 (0.31%)
Nodular Lung Shadow	119 (0.27%)
Pleural Effusion	182 (0.24%)
Solitary Fibrotic Lesion/ Pulm Scar	106 (0.24%)
Fit Cases	41341 (96.8%)
Total	42688

Calcific granuloma and pulmonary infiltration (Fibrotic streaks in the apical region of the left side) are shown (Figure 1).



**Figure 1:** Calcific Granuloma and Pulmonary Infiltration (Fibrotic Streaks in the Apical Region of the Left Side)

Fibrocalcific lesion (bilateral upper zone) and a solitary fibrotic lesion (fibro-calcification in the middle lobe of the right side) are shown (Figure 2).



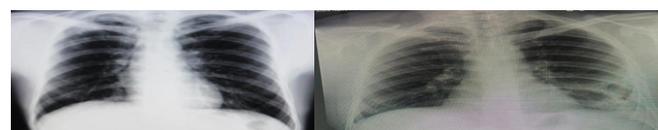
**Figure 2:** Fibrocalcific Lesion (Bilateral Upper Zone) and Solitary Fibrotic Lesion (Fibro Calcification in the Middle Lobe of the Right Side)

Results show the nodular lung shadow in the right upper lobe and hilar calcification (Figure 3).



**Figure 3:** Nodular Lung Shadow (in the Right Upper Lobe) and Hilar calcification

Findings show Apical fibrosis and CP angle obliteration (Left Lower Lobe collapsed) (Figure 4).



**Figure 4:** Apical Fibrosis and CP Angle Obliteration (Left Lower Lobe)

Radiographic abnormalities were observed across different age groups, but were most frequently reported among individuals aged 31-35 years, followed by those aged 36-40 years and 41-45 years. Fewer abnormalities were observed among individuals below 25 years of age and those above 45 years (Table 3).

**Table 3:** Prevalence of Different Screening Parameters Among Different Age Groups

Parameters	Unfit Cases Among Different Age Groups						
	18-20	21-25	26-30	31-35	36-40	41-45	46-51
Pulmonary Infiltration by Soft Shadows in the Lungs	0	10	32	0	0	0	0
Calcific Granuloma in the Lungs	0	08	0	02	111	5	02
Fibrocalcific Lesion in the Lung	0	04	0	02	113	03	02

Hilar Calcification	0	04	02	65	04	02	0
Interstitial Lung Shadowing	0	02	01	59	02	04	0
Lymphadenopathy	0	03	02	92	0	0	0
Minimal Costophrenic Angle Obliteration	0	03	04	219	02	41	0
Moderate Apical Scarring	0	09	0	02	120	02	02
Nodular Lung Shadow	0	05	02	46	53	13	0
Pleural Effusion	0	04	04	51	73	50	0
Solitary Fibrotic Lesion/ Pulm Scar	0	07	48	0	0	51	0
Total	00	59	95	538	478	171	06

All radiographic abnormalities identified during the study period were recorded among male candidates. No unfit cases were reported among female participants. Given the relatively small proportion of females in the screened population, no conclusions regarding sex-based differences in disease prevalence can be drawn. Radiographic abnormalities were identified among candidates from all districts of Khyber Pakhtunkhwa included in the study. The highest absolute number of unfit cases was reported from Peshawar (n=162), followed by Mardan (n=153), Dir (n=110), and Bannu (n=110) (Table 4).

**Table 4:** Geographic variations in disease prevalence

Geographic Areas	A	B	C	D	E	F	G	H	I	J	K	Total
1 Abbottabad	1	6	6	6	5	6	12	4	6	7	4	63
2 Bannu	2	10	11	6	7	9	23	9	11	13	9	110
3 Batagram	2	4	6	3	2	3	7	4	3	4	2	40
4 Batkhela	1	4	4	4	3	3	6	2	3	4	3	37
5 Buner	3	5	3	2	3	3	12	6	5	8	6	56

**Table 5:** Occupation-Related Disease Prevalence

Detected Abnormalities	Occupations										
	Carpenter	Comp. Operator	Electrician	Driver	Engineer	Labor	Mason	Painter	Salesman	Shuttering	Welder
Active Pulmonary Infiltration by Soft Shadows in Lungs	0	01	04	0	0	34	03	0	0	0	0
Calcific Granuloma in Lungs	03	0	06	0	0	116	03	0	0	0	0
Fibrocalcific Lesion in Lungs	01	03	13	0	02	99	06	0	0	0	0
Hilar Calcification	02	0	04	0	0	69	02	0	0	0	0
Interstitial Lung Shadow	0	0	01	0	01	63	0	0	01	0	02
Lymphadenopathy	0	0	0	03	0	91	0	0	0	02	01
CP Angle Obliteration	07	0	12	0	0	243	07	0	0	0	0
Moderate Apical Fibrosis	05	0	07	0	0	115	03	0	05	0	0
Nodular Lung Shadowing	03	03	13	0	02	90	07	01	0	0	0
Pleural Effusion	0	0	02	01	01	173	01	0	01	01	02
Solitary Fibrotic Lesion	03	0	05	0	0	96	02	0	0	0	0
Total	24	07	67	04	06	1189	34	01	07	03	05

## DISCUSSION

In this study, a descriptive analysis of the chest radiographic findings among the prospective expatriates from Khyber Pakhtunkhwa is discussed, a population that has been inadequately described in radiologic literature. The abnormal chest X-ray findings were noticed in about 3.15% of the individuals. The observed chest X-ray findings

6 Charsadda	2	8	9	4	6	6	20	12	12	15	11	105
7 Dir	2	12	9	5	8	9	24	7	11	15	8	110
8 Haripur	1	3	3	2	2	3	7	2	3	5	1	32
9 Karak	3	7	6	4	3	4	12	7	4	8	3	61
10 Kohat	0	3	5	1	1	3	6	3	3	4	3	32
11 Mansehra	2	5	6	3	3	3	14	7	4	10	6	63
12 Mardan	5	13	12	8	6	9	31	18	15	22	14	153
13 Nowshera	0	1	1	1	1	1	3	1	2	2	1	14
14 Parachinar	3	6	6	4	1	5	11	7	4	9	4	60
15 Peshawar	7	15	16	9	6	12	32	17	12	22	14	162
16 Shangla	3	10	7	5	3	6	17	10	7	13	6	87
17 Swabi	2	4	4	2	2	3	7	5	3	6	3	41
18 Swat	3	11	7	7	5	8	22	12	10	13	7	105
19 Waziristan	0	1	3	1	1	1	3	2	1	2	1	16

A= Active pulmonary infiltration by soft shadow in lungs, B= Calcific granuloma in the lungs, C= Fibrocalcific lesion in the lungs, D= Hilar calcification, E= Interstitial lung shadowing, F= Lymphadenopathy, G= CP angle obliteration, H= Moderate apical scarring, I= Nodular lung shadowing, J= pleural effusion, K= Solitary fibrotic lesion. Subjects recruited for this study were categorized by their respective areas, along with the results of their screening tests. Findings of radiographic abnormalities were highest in individuals who were occupation-based, labor-intensive workers, such as laborers and drivers. As the data have been descriptive in nature, inferences on the causal relationship between occupation and findings of radiographic abnormalities cannot be made (Table 5).

were mainly observed among those aged 31-40 years and laborers (88.2%), and drivers (4.97%) were the predominant ones. Costophrenic angle obliteration (0.63%), pleural effusion (0.42%), and apical scarring (0.31%) were the main observed radiographic findings, while Peshawar (12%), Mardan (11.3%), and Dir (8.1%) districts had the highest

number of unfit cases. Despite the importance of chest radiographic evidence among potential expatriates, few studies exist on chest radiographic findings among potential expatriates, and the only major similar study is that carried out by Naz *et al.* among Pakistani nationals. The results of our study match closely with the major study of chest radiographic findings among 63,648 male applicants, who reported that costophrenic angle obliteration was present in 0.5%, apical scarring of 0.27%, and pleural effusion of 0.05%, each 0.1%, of the screened population [11]. This match indicates that radiographic findings show fidelity among expatriate-nominated subjects. A study among routine chest radiographic findings of the general population of 180 subjects in AJK, Pakistan, reported that non-pulmonary lesions were the most prevalent chest radiographic findings, while pulmonary lesions remain rare findings [12]. The present study opposes those findings since pulmonary structural pathological changes remain the predominant findings. Unlike our screened subjects among expatriates, community, and clinical-based studies show radically differing general chest radiographic findings. Clinic and hospital-based studies based on symptomatic subjects like COVID-19 patients have reported unprecedented widespread lung involvement, such as ~98% abnormal chest radiographs, among subjects suffering from COVID-19 infection [13]. Unlike our screened subjects, large-scale community-based general chest radiographic findings of general subjects have reported findings of up to ~35% subjects with incidental findings of non-cancer lesions like fibrosis of ~8.2%, lesions of granulomas of ~10.7%, and pleural changes of ~3.6%, findings grossly divergent from healthy subjects screened for expatriates [14]. Furthermore, general community chest radiographs of symptomatic and general subjects screened before surgical procedures have reported general chest radiographic findings of nearly 45% subjects, which encompass generalized chest radiographic findings like COPD, Atelectasis, and pleural changes not related to expatriate subjects [15]. Similar findings from other regions within South Asia also validate this pattern. In related research, pre-screening analyses conducted among Indian nationals (n=4113) indicated a total abnormal radiograph of ~4.9%, post-inflationary scarring making up 3.3%, and pleural effusion or other important pulmonary findings being exceedingly rare at ~0.02% [16]. The clear implication from this evidence is that chronic pulmonary alterations remain the main abnormality findings in pre-screening migrant groups, again validating our findings. International research findings also consistently show that the vast preponderance of chest radiography analyses from migrant personnel show normal results, again validating our findings of 97% normal findings among potential migrants. For instance, European

refugee screening in Germany [17], UAE visa screening [18], and a Malaysian migrant worker cohort [19], all demonstrated predominantly normal films, i.e. 90%, 95% and 98%, respectively. Occupational analysis showed that laborers and drivers were most affected, likely due to higher exposure to dust, environmental irritants, and physically demanding work, which may predispose them to chronic radiographic changes [20]. Geographically, higher abnormality rates among Peshawar, Mardan, and Swat districts may reflect a combination of population density, migration trends, and occupational clustering, rather than a true regional disease burden. The novelty of this study lies in its descriptive, population-level focus on potential expatriates in KP, providing quantitative evidence of radiographic anomalies in a demographic including age, gender, occupational, and regional distributions, which is rarely analyzed independently. By comparing our findings with national [11], regional [12], and South Asian [13] studies, we also describe that pulmonary structural anomalies predominate in migrant screening populations, whereas non-pulmonary abnormalities are more frequent in general populations, highlighting the unique epidemiology of expatriate-bound studies. This study has several limitations that should be acknowledged. The single-center design may limit the generalizability of the findings to other regions or screening facilities. The retrospective and descriptive nature of the study precludes clinical correlation and does not allow inference of causality between radiographic findings and demographic or occupational factors. The marked gender imbalance reflects the demographic profile of the expatriate screening population and limits sex-based comparisons.

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## CONCLUSIONS

This retrospective descriptive study has focused on the prevalence and distribution of chest radiographic abnormalities observed among potential expatriates undergoing GCC-mandated medical screening in Khyber Pakhtunkhwa. There was a small proportion of subjects with abnormal findings, while the commonest radiographic patterns were obliteration of the costophrenic angle, pleural effusion, and apical scarring. These abnormalities were more common among middle-aged males involved in labor-intensive jobs and from different districts of KP. The study contributes significant regional data from an under-represented expatriate study and also gives weight to the role of systematic radiographic reporting in pre-employment screening programs.

## Authors' Contribution

Conceptualization: UA

Methodology: UA, MHEA, SR

Formal analysis: UA

Writing and drafting: UA, NA

Review and editing: UA, MJQ, NA, MHEA, SR

All authors approved the final manuscript and take responsibility for the integrity of the work.

## Conflicts of Interest

The authors declare no conflict of interest.

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