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ASSESSING THE EFFICACY OF RADIOGRAPHIC INTERPRETATIONS IN IDENTIFYING ACTIVE PULMONARY TUBERCULOSIS: A STUDY OF CHEST X-RAY SCREENING IN REGION 2, PHILIPPINES

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ABSTRACT

This study evaluated the effectiveness of using radiographic interpretations to detect active pulmonary tuberculosis (PTB) in individuals who received chest X-ray (CXR) screenings as part of the GF-PBSP sponsored TB case-finding campaign in Region 2 of the Philippines in 2022. The study employs a quantitative descriptive cross-sectional approach and analyses of secondary data to investigate trends and patterns in the prevalence of PTB among various demographics and locations. It evaluates the accuracy of CXR results in detecting active PTB by assessing their sensitivity and specificity. The study examines the rates of enrolment, diagnostic follow-up, and bacteriological confirmation among patients with radiographic abnormalities that indicate pulmonary tuberculosis (PTB), using data from the Integrated Tuberculosis Information System (ITIS). The results demonstrate a significant rise in active instances of PTB as persons get older, with the elderly population having the largest percentage of cases. The differences in the prevalence of PTB between genders and localities indicate variations in healthcare access and diagnostic techniques. Furthermore, chest X-ray (CXR) readings that show specific findings of pulmonary tuberculosis (PTB) have a greater ability to predict the presence of the disease and better rates of confirmation by laboratory testing, compared to readings that only suggest the presence of PTB. These findings emphasize the significance of focused TB control measures, improved diagnostic initiatives, and the inclusion of modern imaging tools to ensure precise diagnosis and effective therapy of PTB.

Keywords: *Active pulmonary tuberculosis (PTB), Chest X-ray (CXR) screening, Radiographic interpretations, Diagnostic practices, Diagnostic initiatives*

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INTRODUCTION

Tuberculosis (TB) continues to pose a significant global health threat, particularly in low- and middle-income countries (LMICs). Even with best attempts to manage the disease, tuberculosis (TB) continues to rank among the top infectious killers globally, placing a significant strain on healthcare systems and economies. With about 1.6 million fatalities from tuberculosis (TB) recorded annually, the World Health Organization (WHO) underlined how urgently efficient methods to treat this illness are needed.

With the Philippines ranking fourth in the world for tuberculosis incidence, the disease is still a major worry (Flores et al., 2022). About 1 million TB cases are active in the nation, and this avoidable and treatable illness results in about 70 fatalities per day. These figures highlight the ongoing difficulties national tuberculosis control programs have in tackling TB transmission, diagnosis, and treatment (Flores et al., 2022). Many problems remain in spite of progress in TB diagnosis and treatment, especially with regard to the recognition and treatment of instances with active pulmonary tuberculosis (PTB). Even while recommendations include presumptive PTB diagnosis criteria, such a protracted cough or close contact with active TB cases, it is still difficult to correctly diagnose and treat PTB patients (WHO, 2023).

The WHO (2019) reports that there is a dual burden of tuberculosis and non-communicable diseases, with common risk factors and negative consequences on treatment results. Although it will need getting above resource and logistical obstacles, integrating NCD and associated risk factors screening into current TB initiatives has shown promise (Anand et al., 2018).

Particularly in vulnerable populations and high TB burden settings, active case finding's (ACF) ability to improve TB diagnosis and treatment outcomes has drawn interest. Research has shown that ACF may help to prevent transmission, lessen the severity of the disease, and diagnose tuberculosis patients early (Kranzer et al., 2013; Bohlbro, 2021). Target populations, screening techniques, and the incorporation of diagnostic technology like chest X-ray (CXR) screening are all aspects of the best practices for ACF implementation that are yet unknown. Though CXR has showed promise in TB diagnosis, cost, accessibility, and interpretation variability continue to be obstacles in the way of its broad use (Guo, 2020).

Especially in LMICs like the Philippines, closing these knowledge and practice gaps is crucial to enhancing the efficacy of TB control efforts. Through trend clarification, problem identification, and solution proposal, this study seeks to advance the development of evidence-based approaches for improving the identification and treatment of active PTB cases, so furthering the worldwide objective of tuberculosis elimination.

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Objectives of the Study

The main goal of this study is to assess how well radiographic interpretations identify active pulmonary tuberculosis (PTB) in those who had chest X-ray (CXR) screenings in Region 2 of the Philippines in 2022 as part of the GF-PBSP funded active TB case-finding campaign. In particular, the study seeks to determine trends and patterns in the prevalence of tuberculosis by examining the frequency and percentage of identified cases across various age groups, sexes, and locales. It also attempts to assess the sensitivity and specificity of CXR results in identifying active PTB by comparing the percentage of cases found through CXR screenings with later bacteriological confirmation, so assessing the efficacy of radiographic screening. In addition, the study looks at the Integrated Tuberculosis Information System (ITIS) enrolment and diagnostic follow-up rates of patients with radiographic findings suggestive of PTB. It also assesses the percentage of patients who underwent bacteriological testing and the results. In order to ascertain the accuracy of CXR readings in diagnosing active tuberculosis, it also contrasts the predictive potential of specific vs suggestive CXR findings for active PTB by examining the rates of bacteriological confirmation in each group. By examining data on TB case enrolment, diagnostic follow-up, and confirmation rates, the study finally seeks to identify possible gaps and areas for improvement in TB screening and diagnostic practices within the region. It also offers suggestions for improving the accuracy and efficiency of TB diagnostic methods, especially in high-risk and underserved populations.

MATERIALS AND METHODS

Research Design

The quantitative descriptive cross-sectional design was applied with secondary data analysis. The objective of the study was to assess the degree of accuracy in radiographic interpretations of people who were later diagnosed with active PTB.

Sampling Technique

All those who completed CXR screening under the GF-PBSP-funded active TB case-finding in 2022 were included in a total enumeration sampling technique using the ACF contractor and mobile van X-ray machines.

Locale of the study

The Global Fund – Philippine Business for Social Progress supported the study, which was carried out in Region 2 of the Philippines and concentrated on the ongoing TB case-finding initiatives.

Research Instruments

PBSP secondary data were collected via DOH Region 2's NTP coordinator. The information comprised radiographic results, patient age and sex, and province/city of the CXR procedure.

Data Gathering Procedure

Region 02 Trauma Medical Centre Institutional Review Board (R2TMC-IRB) and the Cagayan

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Valley Health Research and Development Consortium (CVHRDC) Technical Review Board both granted approval. The PBSP then supplied the data after a formal letter was issued to DOH demanding access. A single data point per person was ensured and incomplete individual data was removed by the DOH NTP coordinator and staff. After that, the data were examined, paying particular attention to those who were diagnosed with active PTB and taking into account the initial CXR finding for those who had TB treatment.

Analysis of the Data/ Statistical treatment

Correctness and completeness of the data were checked before to analysis. Demographic profiles of study participants were computed using descriptive statistics (frequency, medians, percentages). Computed and divided by the total number of CXR patients was the frequency of active PTB CXR diagnoses. The information was examined to find any trends or patterns and to characterise the accuracy of radiography interpretations.

RESULTS AND DISCUSSION

Table 1a. Frequency and Percentage distribution of Active PTB cases enrolled in Integrated Tuberculosis Information System (ITIS) in terms of age and locality

LOCALITY	AGE												Total	
	1 year old and below		2-12		13-17		18-19		40-59		60 and above			
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Cagayan	0	0	1	17	5	38	21	16	97	27	170	32	294	28
Isabela	0	0	2	33	7	54	55	42	120	33	150	28	334	32
Nueva Vizcaya	0	0	0	0	0	0	16	12	19	5	31	6	66	6
Quirino	0	0	1	17	0	0	11	8	41	11	46	9	99	10
Tuguegarao	0	0	0	0	0	0	5	4	2	1	2	0	9	1
Santiago	0	0	2	33	0	0	17	13	54	15	98	19	171	16
Cauayan	0	0	0	0	1	8	4	3	23	6	15	3	43	4
Ilagan	0	0	0	0	0	0	1	1	9	2	15	3	25	2
Total	0	0	6	100	13	100	130	100	365	100	527	100	1041	100

The table provides the frequency and percentage distribution of active pulmonary tuberculosis (PTB) cases enrolled in the Integrated Tuberculosis Information System (ITIS) based on age and locality. With a total of 1,041 cases, the data underscores a notable trend where the frequency of active PTB cases tends to increase with age. This trend is predominantly evident in the demographic aged 60

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and above, highlighting a distinct vulnerability within this age group, aligning with findings from Perez-Guzman et al. that suggest an increased incidence of tuberculosis with advancing age. Such an increase can often be attributed to physiological changes in immunity and a higher likelihood of comorbid conditions like diabetes, which can compromise the body's ability to fight infections.

In the context of localities, Isabela province records the highest number of active PTB cases, followed by Cagayan. Within the cities, Santiago City emerges as the locality with the most significant number of active cases. These figures may reflect the varying levels of healthcare access, the efficiency of local health monitoring systems, or even the effectiveness of health campaigns in encouraging individuals to seek medical attention and screening.

Tuguegarao City and Cauayan City diverge from the general trend, with lower incidences among the elderly population. This deviation could be indicative of local healthcare initiatives effectively targeting and managing tuberculosis in older demographics, or it might reflect different population structures or healthcare behaviors in these localities.

The observations about the prevalence of tuberculosis in the elderly corroborate the study by Caraux-Paz et al. (2021), which recognizes the TB epidemic as a particular challenge in older populations. The progressive increase in notification rates with age, especially peaking after 65 years, underscores the complexity of managing TB in the elderly. This complexity arises not just from age-associated immunodeficiency but also from the multifaceted interplay between comorbidities common in older age, the potential for drug interactions between antituberculosis medications, and treatments for other conditions. Relatively, the number of cases may be due to quota or patients' need and willingness.

Table 1b. Frequency and Percentage distribution of Active PTB cases enrolled in ITIS in terms of sex and locality

LOCALITY	SEX				Total	
	Male		Female			
	Freq.	%	Freq.	%	Freq.	%
Cagayan	154	29	140	28	295	28
Isabela	165	31	169	33	334	32
Nueva Vizcaya	35	7	31	6	66	6
Quirino	54	10	45	9	99	10
Tuguegarao	6	1	3	1	9	1
Santiago	85	16	86	17	171	16
Cauayan	24	4	19	4	43	4
Ilagan	12	2	13	3	25	2
Total	534	100	506	100	1041	100

This table is crucial for public health planning, as it provides a detailed breakdown of active PTB cases by gender and locality, offering insights into the distribution of the disease across different demographic groups.

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As indicated, most of those who availed of the TB screening were females but as to the turnout of those with active TB cases, male cases are slightly greater than females. Isabela has the highest total number of cases (334), with a fairly balanced distribution between male and female groups. The overall total of active PTB cases is 1,041, with 534 (51%) being male and 506 (49%) being female.

The female group might generally be more proactive in seeking healthcare services, including TB screening, as compared to males. This could result in a higher number of females availing TB screening services. In like manner, gender-specific differences in access to healthcare facilities or awareness of available services might influence screening participation. If females have better access or awareness, they may be more likely to undergo screening (Courtenay, W. H. 2000).

Table 1c. Frequency and Age-specific Proportion of Active PTB cases enrolled in IT IS

	Age						
	1 year old and below n=7	2-12 n=638	13-17 n=745	18-39 n=4411	40-59 n=5248	60 and above n=4071	Total n=15120
Active TB Cases enrolled in ITIS	0	6	13	130	365	527	1041
Proportion	0	0.94 %	1.74 %	2.95 %	6.96 %	12.95	6.88 %

The data in the table reflects the age-specific prevalence of active pulmonary tuberculosis (PTB) cases enrolled in the Integrated Tuberculosis Information System (ITIS). It is apparent that while the most significant number of individuals who underwent chest X-ray (CXR) screening are within the 18-39 age group, representing a total of 5,248 cases, it's the senior citizens, those aged 60 and above, who exhibit the highest proportion of active PTB at 12.95%. This suggests a lower conversion rate from screening to diagnosis in the younger age bracket and a higher rate in the older population.

The proportion data implies that despite higher screening numbers among the younger unit, older adults are more likely to be diagnosed with PTB, reflecting patterns of tuberculosis susceptibility due to factors such as age-related immunological changes and increased exposure to comorbidities. This aligns with global health observations that while TB can affect individuals at any age, the risk and severity tend to escalate with age. The data underscores the critical need for targeted TB control strategies across different age demographics, especially among the elderly, to effectively manage and treat this infectious disease.

Table 1d. Frequency and Sex-specific Proportion of Active PTB cases enrolled in ITIS

Sex

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	Male n=5723	Female n=9397	Total n=15120
Active TB Cases enrolled in ITIS	534	506	1041
Proportion	9.33%	5.38%	6.88%

The table presents a striking contrast in the sex-specific proportions of active pulmonary tuberculosis (PTB) cases enrolled in the ITIS. While females were more likely to undergo chest X-ray (CXR) screening, with 9,397 females screened compared to 5,723 males, the proportion of active PTB cases is significantly higher in males at 9.33% versus 5.38% in females. This discrepancy suggests that although females are more proactive in seeking CXR screening, males have a higher yield of positive PTB findings when they do get screened.

This data may indicate underlying differences in health-seeking behavior between sexes, with females potentially accessing healthcare services more frequently, but males presenting with TB at a more advanced stage, reflecting a higher disease burden or perhaps delays in seeking diagnosis.

Table 1e. Frequency and Locality-specific Proportion of Active PTB cases enrolled in IT IS

	Locality								
	Cagayan n=3510	Isabela n=4689	Nueva Vizcaya n=1853	Quirino n=2265	Tuguegarao City n=713	Santiago City n=1491	Cauayan City n=433	Ilagan City n=166	Total n=15120
Active TB Cases enrolled in ITIS	295	334	66	99	9	171	43	25	1041
Proportion	8.40%	7.12%	3.56%	4.37%	1.26%	11.47%	9.93%	15.06%	6.88%

The data outlines the frequency and locality-specific proportions of active PTB cases enrolled in ITIS, indicating significant variability across different regions. Isabela had the most individuals undergoing CXR screening, totaling 4,689. However, when considering the proportion of active TB cases in relation to screenings, Ilagan City reported the highest proportion at 15.06%, despite a lower screening count, followed closely by Santiago City at 11.47%. This suggests that certain localities, although screening fewer individuals, may have a higher prevalence of active TB or more effective diagnostic practices in place.

The contrast between the high volume of screenings in Isabela and the high proportion of positive cases in Ilagan and Santiago Cities could reflect varying levels of TB transmission in these areas or

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differences in the accessibility of screening services. The data may also hint at the possibility that regions with lower screening numbers could benefit from enhanced TB screening and diagnostic initiatives to manage and control the spread of TB effectively.

Table 2a. Frequency & Percentage distribution of PTB Cases with Radiographic Findings that are certain of active PTB

Enrollment Status			Frequency (n=1169)	Percentage
	Not enrolled in IT IS		567	48.50
	Enrolled		602	51.50
Confirmatory Result of Enrolled Cases				
	No Bacteriological test done		9	1.50
	Bacteriological test done	Positive	218	36.21
		Negative	375	62.29

The table provides insights into the enrollment status and confirmatory test results of PTB cases, which is crucial for effective tuberculosis management and surveillance. The table above shows that there are 1169 number of patients with either TB or mixed PTB radiographic findings. A slightly greater number (51.50%) were enrolled in Integrated Tuberculosis Information System (ITIS). Among those enrolled in ITIS, 36.21% were confirmed bacteriologically whereas a small number (1.50%) were clinically confirmed. The fact that 51.50% of the patients with TB or mixed PTB radiographic findings are enrolled in the Integrated Tuberculosis Information System (ITIS) suggests a substantial effort to monitor and manage TB cases systematically. Enrolling patients in ITIS facilitates better tracking, management, and coordination of healthcare services (WHO). The data implies that among those patients enrolled in the ITIS, 36.21% were confirmed using bacteriological test.

Among the enrolled cases in ITIS, 36.21% were confirmed bacteriologically. This implies that a significant portion of the diagnosed cases underwent tests to identify the presence of the tuberculosis bacterium. Bacteriological confirmation is crucial for accurate diagnosis and is often required to determine the appropriate course of treatment.

Table 2b. Frequency & Percentage distribution of PTB Cases with Radiographic Findings that Suggests active PTB

Enrollment Status			Frequency (n=164)	Percentage
	Not enrolled in ITIS		94	57.32
	Enrolled		70	42.68
Confirmatory Result of Enrolled Cases				
	No bacteriologic test done		2	2.86
	Bacteriologic test done	Positive	25	35.71
		Negative	43	61.43

The table above shows that there are 164 number of patients with radiographic findings suggestive of TB. There are 57.32% who were not enrolled in ITIS because of several reasons, such as

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ITIS shutdown, system lagging, late enrollment as well as not complying for the follow-up check-up.

Meanwhile, 42.68% were enrolled in ITIS. Among those enrolled, 97.14% subjected themselves for further bacteriologic tests. This is a positive indicator as it reflects a high level of compliance with the diagnostic process, which is crucial for accurate TB diagnosis.

Table 2c. Comparison on the Percentage of PTB Cases with Radiographic findings which Certain's and Suggests PTB

Enrollment Status		Percentage of Certain	Percentage of Suggestive
Not enrolled in IT IS		48.50	57.32
Enrolled		51.50	42.68
Confirmatory Result of Enrolled Cases			
No bacteriologic test done		1.50	2.86
Bacteriologic test done	Positive	36.21	35.71
	Negative	62.29	61.43

The above table compares the last 2 tables wherein it can be deduced that the predicting power of CXR is higher when the CXR images were read more certainly than mere suspiciously with TB findings. The percentages of those enrolled and positive bacteriologically were always higher in those CXR readings certain of TB. Less number of certain findings underwent bacteriologic test compared to those with suggestive findings.

Picazzo et al, 2014 stated that doing CXR to detect PTB has good sensitivity, but poor specificity especially in determining the latency of infection. Hence, they recommend the use of a CT scan to detect if PTB is active or not.

CONCLUSIONS

Ultimately, the purpose of this study was to evaluate the precision and effectiveness of radiographic analyses in detecting active pulmonary tuberculosis (PTB) in patients who received chest X-ray (CXR) screenings in Region 2 of the Philippines in 2022. By doing a thorough examination of the data, we have identified numerous significant discoveries. The study found that as people get older, the number of current cases of PTB increases significantly, indicating that the senior population is more susceptible to tuberculosis. This is consistent with worldwide data and emphasizes the importance of focused tuberculosis control programs, particularly among older populations.

Furthermore, there were distinct disparities between genders in terms of both involvement in screening and the percentage of positive instances of PTB. Specifically, males had a greater proportion of active PTB cases while undergoing fewer screens. This indicates possible differences in health-seeking behavior between genders and underscores the significance of customized strategies for tuberculosis screening and awareness initiatives. There was a notable variation in the occurrence of active PTB in different areas, highlighting the necessity for targeted interventions and allocation of resources to effectively address the transmission and management of TB in specific regions.

Moreover, the study emphasized the need of registering cases of pulmonary tuberculosis (PTB)

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in the Integrated Tuberculosis Information System (ITIS) for organized surveillance and control. Obtaining bacteriological confirmation of enrolled cases is essential for precise diagnosis and the beginning of suitable treatment.

Finally, the study emphasized the greater accuracy of CXR readings that were more confident in identifying TB, compared to those that only hinted at the presence of the disease. This highlights the necessity for enhanced diagnostic techniques, which could involve the integration of CT scans to improve accuracy in detecting active PTB.

In summary, this study offers significant insights into the trends, patterns, and issues related to tuberculosis (TB) screening and diagnosis in Region 2 of the Philippines. The findings of this research can provide valuable insights for developing future public health policies and initiatives that aim to enhance TB control and alleviate the impact of this contagious illness in the region.

RECOMMENDATIONS

According to the results of this study, it is recommended that public health authorities in Region 2 of the Philippines concentrate on carrying out specialized interventions to meet the distinct requirements found within various demographic groups and localities. In order to address the growing occurrence of active pulmonary tuberculosis (PTB) in the aged demographic, it is imperative to intensify initiatives aimed at delivering easily accessible and age-appropriate tuberculosis screening services. These efforts should be complemented by educational campaigns that aim to promote awareness regarding tuberculosis prevention and early diagnosis among older individuals. In addition, it is important to develop plans to tackle the gender inequalities that exist in screening participation and the diagnosis of preterm birth (PTB). This should include a specific focus on involving males in tuberculosis (TB) awareness initiatives and encouraging them to undergo regular health examinations. Furthermore, the variation in tuberculosis (TB) prevalence among different areas highlights the significance of customizing treatments to tackle the distinct difficulties encountered by each community. This includes enhancing the availability of healthcare facilities and reinforcing TB surveillance systems. Considering the increased accuracy of tuberculosis (TB) diagnosis with more certain findings from chest X-ray (CXR) readings, it is advisable to incorporate modern diagnostic tools like CT scans to improve the accuracy of pulmonary TB (PTB) diagnosis. This is especially important in cases when CXR results are unclear. To achieve a reduction in the burden of TB and enhance the efficacy of TB control activities in Region 2 of the Philippines, public health authorities should adopt these recommendations.

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