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## Imaging findings of pulmonary and extrapulmonary tuberculosis

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### Abstract

Tuberculosis remains a global public health problem over the past decades. Mycobacterium tuberculosis affect the lungs causing pulmonary tuberculosis and may affect other organs causing extrapulmonary tuberculosis. Organs most commonly affected are the central nervous system, gastrointestinal tract, spleen, liver, musculoskeletal and genitourinary systems. Various findings of pulmonary and extrapulmonary tuberculosis are established by different imaging modalities. The aim of our research is to study the distribution and imaging findings of pulmonary and extrapulmonary tuberculosis among Saudi and non-Saudi patients in King Abdulaziz university hospital. Retrospective study included 446 patients, 248 males and 198 females presented with both pulmonary and extrapulmonary TB ranging in age from 9 months to 102 years. Data were collected and statistically analyzed using SPSS program. The incidences of pulmonary and extrapulmonary TB are 74% and 19.7% respectively while 6.3% have both patterns. Pneumonic consolidation is the most dominant findings with pulmonary tuberculosis (43%). Brain is the most frequently affected organ with extrapulmonary tuberculosis (35.6%). Both pulmonary and extrapulmonary tuberculosis are more dominant in non- Saudi patients compared to Saudis. Radiological investigations play a crucial role in evaluation of various types of tuberculosis including computed tomography, plain X ray, Ultrasonography and magnetic resonance imaging.

**Keywords:** Pulmonary tuberculosis, extrapulmonary tuberculosis, CT, X-ray, Saudi Arabia

### 1. Introduction

Tuberculosis remains a global public health problem over the past decades. According to world health organization (WHO), about one-third of people from many countries in the world are infected by Mycobacterium tuberculosis (MTB). The kingdom of Saudi Arabia (KSA) is one of these countries that suffer from the prevalence of TB <sup>[1]</sup>.

KSA is a country of large population and has a current population of more than 30 million. More than 6 million foreigners from TB endemic regions, like India, Indonesia and Pakistan work and live in Saudi Arabia. Moreover, more than 2 million Muslim pilgrims come to Saudi Arabia each year during the Hajj and Umrah seasons. These pilgrims, commonly old in age and from different countries where TB is endemic. These two reasons cause a unique challenge to Saudi Arabia <sup>[2]</sup>. Jeddah and Riyadh cities have the highest rate of prevalence of TB in KSA <sup>[3]</sup>.

The developments in healthcare have led to a decrease in the incidence of TB in the last few years. According to the Saudi ministry of health, the prevalence rates of TB incidence in locals (Saudis) are between 8.6-12.2/100,000 while the rate of incidence in non-Saudis is 24.3- 32.3/100,000 <sup>[4]</sup>.

Mycobacterium tuberculosis bacteria mainly affect the lungs causing pulmonary tuberculosis. This type of bacteria can affect other organs directly or through traveling of pulmonary infection through blood or lymphatic if it is not treated early and this issue is called extrapulmonary tuberculosis. Organs most commonly affected by tuberculosis are the central nervous system, gastrointestinal tract, spleen, liver, musculoskeletal system, bones, joints, and genitourinary system <sup>[5]</sup>.

TB patients undergo imaging to evaluate the disease level and the therapy response, or after finishing therapy to make sure that there are no residual infected tissues. In addition, imaging has an important role for guiding aspiration and biopsies. Numerous imaging modalities have

a sufficient role depending on the clinical case of the patient such as conventional radiography, computed tomography (CT), magnetic resonance imaging (MRI) and positron emission tomography /computed tomography (PET-CT) [6]. The aim of our research is to study the incidence of pulmonary and extrapulmonary tuberculosis among Saudi and non-Saudi patients in King Abdulaziz University Hospital (KAUH) and to determine the distribution and imaging findings of both.

## 2. Patients and methods

### 2.1 Patients

The collected data belongs to 446 patients (248 males and 198 females) ranging in age from 9 months to 102 years with the mean age is 53 years. They presented with different types of tuberculosis from April 2014 to October 2019. All pulmonary tuberculosis patients presented with cough, fever, sputum, shortness of breath, hemoptysis, night sweats, weight loss and chest pain, while manifestations of the extrapulmonary tuberculosis varied according to the affected organ.

Exclusion criteria: patients referred from other hospitals with incomplete clinical data.

### 2.2 Methods

This is retrospective research to study the distribution and imaging findings of different types of tuberculosis among Saudi and non-Saudi patients based on data received from Statistic and Research Unit and collected from PACS of KAUH in Jeddah after obtaining an ethical approval from the unit of biomedical ethics research committee, KAU, reference number 640-19.

Collected data included age, gender, patient's medical history and complaint. X-ray was done using (Kodak Carestream), computed tomography was done using (Siemens 128 single source and 128,64 dual source), magnetic resonance imaging was done using (Siemens skyra 3T, symphony1.5T and vario 3T), Ultrasound was done using (Philips e bike 7th generation) and fluoroscopy was done using (Siemens machine). Expert radiologists interpreted all images.

### 2.3 Data analysis

Statistical analysis was done using Statistical Package for Social Science (SPSS), version 25. Frequency tables and percentage were used. Chi square test was used to study the correlation between different variables and to find the p value in each correlation. P value was significant if it was less than 0.05.

## 3. Results

According to our results, 330 patients have pulmonary TB and 88 patients have extrapulmonary TB, while 28 patients have both forms. Tuberculosis is more common among non-Saudi than Saudi patients (59.6% and 40.4% respectively). The age from (16 - 30 years) is the most commonly affected by tuberculosis (33%).

According to the gender, male patients are more affected by tuberculosis and represent 55.6% of all participants (pulmonary, extrapulmonary and both pulmonary and extrapulmonary TB represent 76.21%, 18.55% and 5.24% respectively), while female patients represent 44.4% (pulmonary, extrapulmonary and both pulmonary and extrapulmonary TB represent 71.21%, 21.21% and 7.58% respectively).

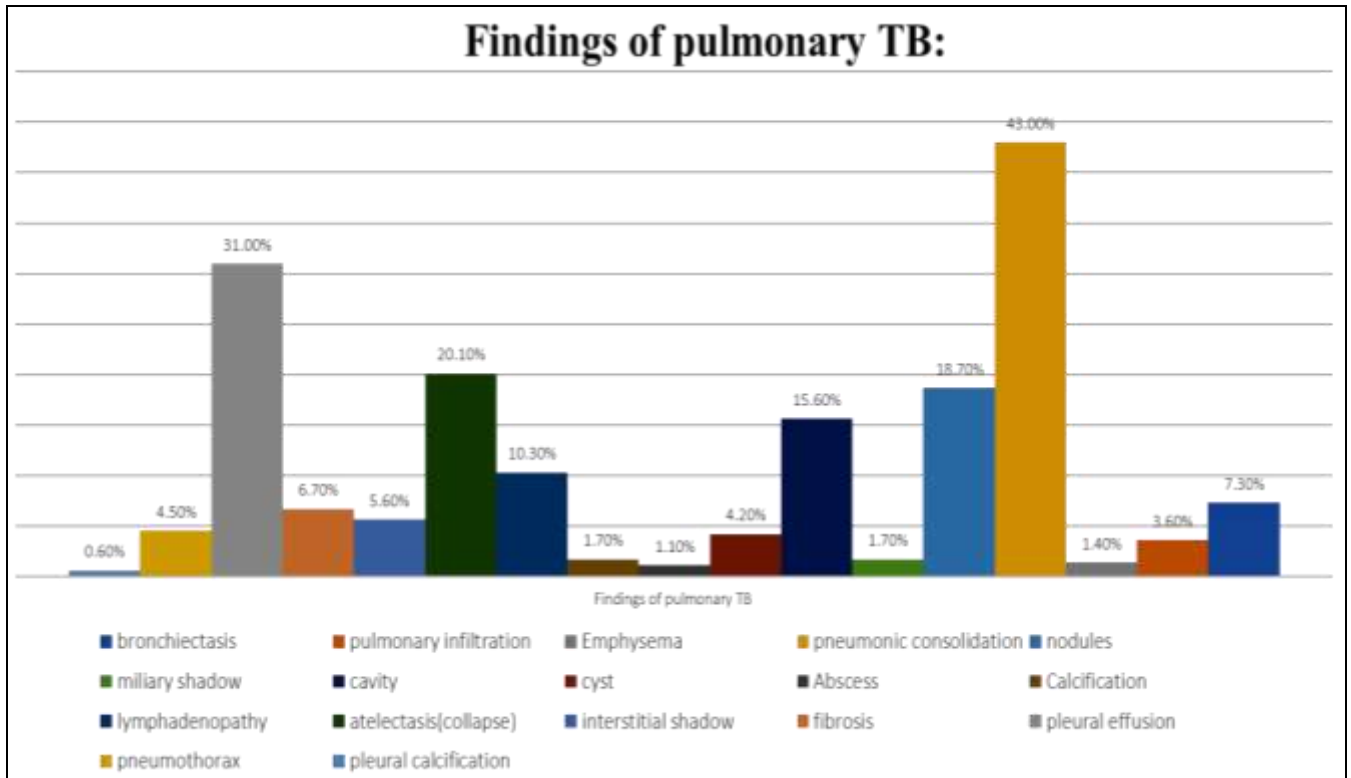
The most common symptoms of active pulmonary TB are cough 61.5% followed by fever 51.4%.

**Table 1:** Shows distribution of all symptoms.

Symptoms of active TB	Number	Incidence
Cough	220	61.5%
Fever	184	51.4%
Sob	114	31.8%
Weight Loss	96	26.8%
Night Sweat	73	20.1%
Chest Pain	57	15.6%
Hemoptysis	40	13.3%

Table 1: Distribution of pulmonary TB symptoms among the study population.

Radiological findings of pulmonary TB are shown in figure 1 where pneumonic consolidation is the commonest (43%). In addition, bilateral pulmonary lesions is more than unilateral affection and right lung affection is more than the left lung (47.5%, 35.2%, and 17.3% respectively). Figures 2, 3 and 4 show some findings of pulmonary TB.



**Fig 1:** Distribution of different findings in patients with pulmonary TB



**Fig 2:** Pulmonary tuberculosis, 22 years old patient presented with fever and productive cough. X ray shows left lower lobe pneumonic consolidation and pleural effusion (arrow).

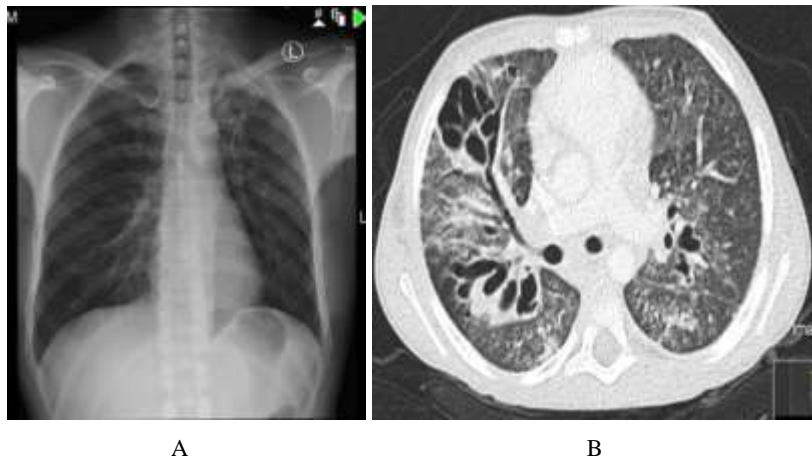


**Fig 3:** Pulmonary tuberculosis, CXR for 15 years old non-Saudi male with bilateral Nodular TB.

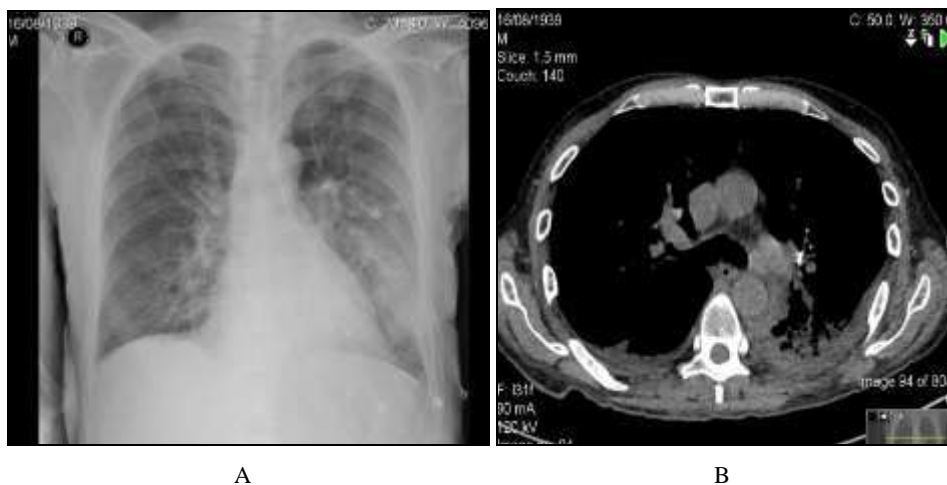


**Fig 4:** Pulmonary tuberculosis, CXR for 22 years old male with Right upper lob cavity (arrow).

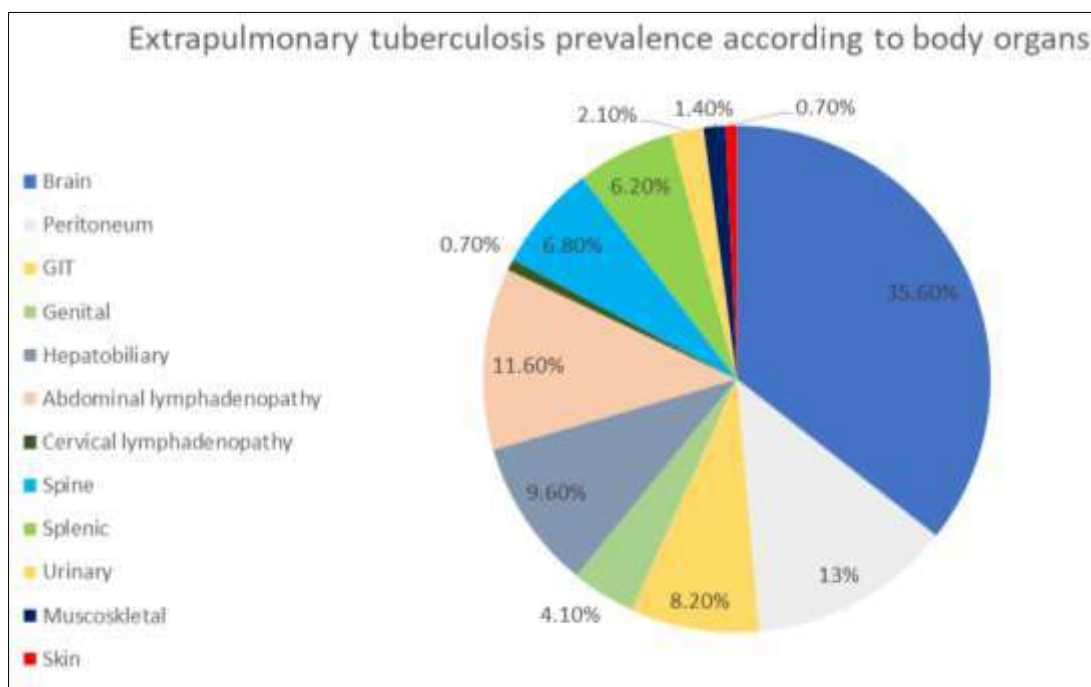
CT is significantly more sensitive than X ray in detecting bronchiectasis (figure 5), lymphadenopathy (figure 6), nodules, and calcification with P value = 0.05.



**Fig 5:** 50 year’s old patient presented with cough, chest pain and wheezes. A) CXR shows left upper lobe bronchiectasis (arrow) B) CT image shows bilateral bronchiectasis with superimposed infection.

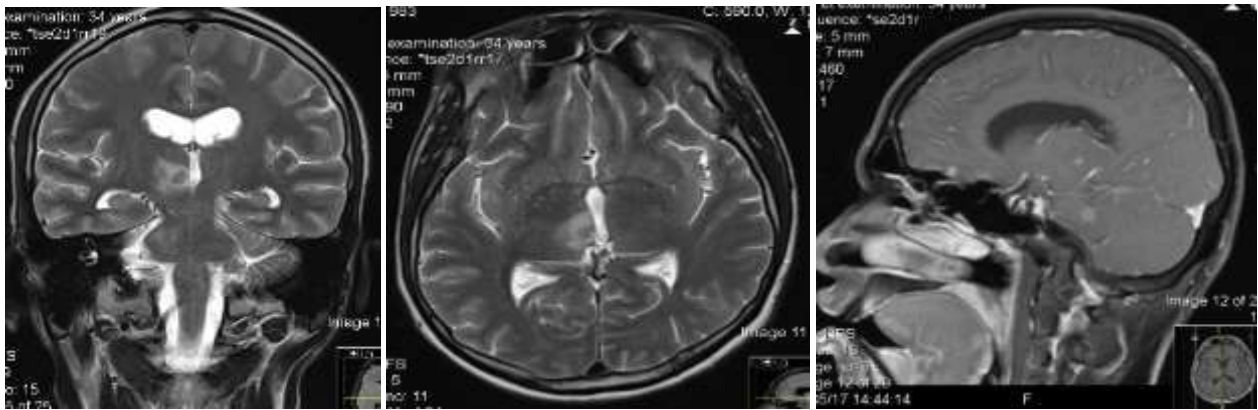


**Fig 6:** 78 years old patient presented with fever, cough and hemoptysis. A) Chest X ray shows enlarged left hilum. B) Chest CT shows enlarged, calcified left hilar lymph nodes.



**Fig 7:** The distribution of extrapulmonary tuberculosis among study population.

Tuberculoma 63.5% (Figure 8) and hydrocephalus 48.1% are the most frequent findings with brain tuberculosis (52 patients).



ABC

**Fig 8:** 34 year's old male medically free presented with fever, headache, photophobia and neck stiffness.

MRI A) Coronal T2WI B) Axial T2WI and C) T1WI with contrast show multiple brain tuberculomas (arrows). The most dominant finding of peritoneal tuberculosis is

ascites 89% (figure 9). Enlarged abdominal lymph nodes represents 94%. (figure 10).



**Fig 9:** 43 years old patient presented with lower abdominal pain and tenderness. Axial CT of the abdomen shows moderate ascites.



**Fig 10:** 27 Years old patient presented with fever, vomiting, abdominal pain and distension. Axial CT of the abdomen shows multiple paraaortic lymphadenopathy.

Most imaging findings of spinal tuberculosis are 90% destructive (Fig. 11) and 10% show additional calcification



**Fig 11:** 55 years old female patient, diabetic and hypertensive, complaining of low back pain and cough. MRI lumbosacral spine, T2 WI shows Pott's disease of L1, 2 vertebra and intervening disc.

**Table 2:** Shows findings of different organs affected with extrapulmonary TB.

Organ affected	Radiological findings	Number of cases	%
Brain	Tuberculoma 63.5% Hydrocephalus 48.1%	52	35.6%
Spine	Destructive lesions including Pott's disease 90% Calcification 10%.	10	6.8%
Abdomen			
Hepatobiliary system	Hepatomegaly 62.3% Biliary duct dilatation 28.6%.	14	9.6%
Gastrointestinal tract	Ileocecal stricture 66.7% Bowel obstruction 41.7%.	12	8.2%
Peritoneum	Ascites 89% Nodules 21.1%	19	13%
Spleen	Splenomegaly 77.8% Tuberculoma 44.4%.	9	6.2%
LN	Enlarged abdominal lymph nodes 94%	17	11.6%
Genitourinary system			
Genital system	Epididymitis 33.3% Thick endometrium 33.3%	6	4.1%
Urinary system	Hydronephrosis 66.7%	3	2.1%
MSK	Osteomyelitis of elbow joint 100%	2	1.4%
Skin	Subcutaneous abscess 100%	1	0.7%
Neck	Cervical lymphadenopathy 100%	1	0.7%

#### 4. Discussion

The current study shows that TB affects males more than females. This is in our opinion because males are more in contact with the community due to their working conditions and crowded accommodations.

Previous studies stated that "TB incidence rate is higher in non-Saudis-compared to Saudi patients" [7]. This confirms our results where tuberculosis is more common in non-Saudis patients. Increased the number of non-Saudi with TB may be referred to the fact that TB is prevalent in their home countries. In addition, inactive forms may develop to active forms for several factors including poor housing conditions and poor nutrition.

There are many symptoms associated with active pulmonary tuberculosis including cough for two weeks or more or undetermined chronic fever or weight loss [8]. As reported by a study conducted in Los Angeles County, cough is the most common symptom of TB (52%) followed by fever (50%) while hemoptysis shows low sensitivity for TB diagnosis [9]. According to our result, symptoms of active pulmonary TB were cough (61.5%), fever (51.4%) followed by hemoptysis (11.2%). These findings correspond to the previously mentioned study. Inactive TB patients are asymptomatic and can progress to active TB in some patients [10]. Tuberculin skin test and chest x-ray can be done for the suspected inactive tuberculosis patients. The radiographic findings must be stable for 6 months to distinguish between active and inactive TB [11].

Radiological findings of active pulmonary tuberculosis are thick-walled cavities, pleural effusion center-lobular nodules, consolidation, miliary nodule, and necrotic lymphadenopathy. While thin-walled cavities, parenchymal nodal or pleural calcification, and fibrosis indicate inactive pulmonary tuberculosis [12]. Regarding our results, active TB showed pneumonic consolidation, pleural effusion, and atelectasis. While inactive TB represented with fibrosis. Although in many researches, the right lung is more affected by TB [13], the current study demonstrates that bilateral affection is more common than unilateral right or left lung affection.

Studies illustrate that the sensitivity of CT in the detecting mediastinal lymphadenopathy and parenchymal disease is high compared to x-ray [5], which is corresponding to our result with a significant P value (0.05) for detection of lymphadenopathy, calcification, bronchiectasis by CT.

Tuberculosis of the brain represents 10-15% of extrapulmonary cases with findings of meningitis, tuberculoma, abscess, and hydrocephalus which is due to the obstruction of cerebrospinal fluid (CSF) flow in the basal cisterns [12]. Regarding our results, brain tuberculosis represents the highest percentage of extrapulmonary TB (35%) with tuberculoma and hydrocephalus are the commonest findings. This may be referred to the fact that diabetes is a common disease in Saudi Arabia, and according to some studies e.g. [14], there is a relationship between the incidence of brain TB and diabetes, this could explain the increase in the rate of brain TB in Saudi patients. Spinal tuberculosis is the most common form of bone tuberculosis. Imaging findings of spinal tuberculosis include spondylitis and vertebral osteomyelitis. The infection always starts from the front of the vertebral body to the subchondral plate and spreads to the intervertebral disc, and the infection sequence of children are usually reversed [15]. In the current study, imaging findings of spinal tuberculosis were destructive, with Pott's disease and calcification.

Abdominal tuberculosis involves peritoneum, gastrointestinal tract, and lymph nodes. Patients usually present with pain, fever, and weight loss [16]. Tuberculosis of peritoneum is one of the frequent types of abdominal tuberculosis. It divided into three types; wet which is the commonest type and leads to ascites, the dry which leads to omental and mesenteric thickness, and the fibrotic type which appears as mesenteric or omental masses [12]. Regarding our results, ascites is the most common presentation of abdominal TB followed by enlarged mesenteric, paraaortic and peripancreatic lymph nodes.

Hepatobiliary tuberculosis is infrequent from all tuberculous infections. Fever and right upper abdominal pain are common in hepatobiliary TB. The most common abnormality found in the clinical examination is

hepatomegaly. Hepatic nodules and abscesses are also common findings<sup>[17]</sup>. These findings match with the current study where all patients with hepatobiliary tuberculosis complain of right flank pain, fever, weight loss, diarrhea, and bloating. Hepatomegaly followed by biliary dilatation are the dominant findings in hepatobiliary TB.

Splenic TB is one of the rarest types of extrapulmonary tuberculosis. The manifestations of splenic TB are splenomegaly, abscess, and tuberculoma<sup>[18]</sup>. Regarding our results, splenic tuberculosis is not common, and present as splenomegaly and tuberculoma. It is to be mentioned that hepatic and splenic TB are common in the current study more than mentioned in literature.

Urinary tuberculosis involves the renal parenchyma and calyces, ureters and urinary bladder causing papillary necrosis, hydro nephrosis, calcification and ends with auto nephrectomy<sup>[19]</sup>. Patients present with hematuria and flank pain. Regarding our results, all patients with urinary tuberculosis complain from renal tuberculosis only with the findings of hydro nephrosis and calcification. No cases of renal failure or auto nephrectomy as TB is not a common cause of renal failure.

TB can affect male and female genital tracts mostly involving the prostate and seminal vesicles in males and the endometrium and fallopian tubes in females<sup>[20]</sup>. Epididymitis, enlarged prostate and seminal vesicles are the findings seen in males affected with genital TB in our study, while affected females show thickened endometrium with calcification. The endometrium is commonly affected by genital tuberculosis. Findings in female genital tuberculosis may vary from a thickened endometrium, calcification, enlargement of ovaries and dilatation or occlusion of Fallopian tubes<sup>[21]</sup>.

The most common site of TB lymphadenopathy is cervical lymph nodes, often manifested as bilateral painless lymphadenitis, which is known as scrofula. Imaging findings and symptoms are non-specific; usually, painless neck swelling, followed by abscesses and weight loss, but in advanced cases, may lead to underlying bone erosion<sup>[22]</sup>. In our study, only one patient presents with tuberculous cervical lymphadenopathy. Imaging shows enlarged, matted lymph nodes with central necrosis.

Skin tuberculosis is rare in all extrapulmonary tuberculosis. The diagnosis of this type of tuberculosis can be difficult<sup>[23]</sup>. Affection include nodules, chronic ulcers, inflammatory papules, and abscesses<sup>[24]</sup>. These finding confirm our results where only one patient has skin tuberculosis with subcutaneous abscess.

Musculoskeletal TB is one of the least common types of extrapulmonary tuberculosis<sup>[25]</sup>. Which is the same like our study where only two patients have elbow joint osteoarthritis. The most common findings for musculoskeletal TB are knee and hip osteoarthritis<sup>[26]</sup>.

This study has a potential limitation. The data collection process is limited due to the effect of the coronavirus outbreak and the sudden stoppage of hospital work.

## 5. Conclusion

Both pulmonary and extrapulmonary tuberculosis are more in non- Saudi patients compared to Saudis. Radiological investigations play a critical role in evaluation of various types of tuberculosis. Pneumonic consolidation and pleural effusion are the most frequent pulmonary TB manifestations. The brain is the commonest organ affected by extrapulmonary tuberculosis.

## 6. Acknowledgment

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