

Temporal Trends and Shifting Age Dynamics in Tuberculosis: A Five-Year Analysis of Case Distribution and Diagnostic Advancements (2018-2023)

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Abstract

Background: Tuberculosis (TB) is an infectious disease caused by the tubercle bacilli called *Mycobacterium tuberculosis* (MTb). According to the World Health Organization (WHO), approximately a quarter (1.7 billion) of the world population are latently infected with MTb, where they have a 5–10% lifetime risk of becoming sick or infectious with TB.

Objective: To analyze the trends in NS+, NS-, and NEP tuberculosis cases from 2018 to 2023. To examine gender differences in tuberculosis prevalence across all categories and to assess the shift in tuberculosis incidence among different age groups. To evaluate the geographical distribution of tuberculosis across key cities in the Thi-Qar governorate and to investigate treatment outcomes, including cure rates and mortality trends, over the five-year period. To explore the impact of diagnostic improvements on the detection of asymptomatic and extrapulmonary tuberculosis cases.

Methods: An analysis was conducted on the electronic records of 2,743 TB patients officially registered at the Thi-Qar Chest and Respiratory Diseases Center. The dataset comprised records spanning from January 2018 to December 2023.

Results: Between 2018 and 2023, TB cases varied significantly. NS+ cases increased from 121 to 151, peaking at 181 in 2022, while NS- cases rose from 62 to 138. NEP cases surged from 182 to 332. Relapse cases fluctuated, and REP cases remained low. Males consistently had higher TB rates than females. The 25-34 age group had the most cases in 2018, but cases in the 35-44 and 45-54 groups grew by 2023. Most cases resulted in completion or cure, with slight increases in fatalities (five deaths in 2023).

Conclusion: The study delineates significant trends in tuberculosis (TB) from 2018 to 2023, indicating an increase in NS- and NEP cases, presumably attributable to advancements in diagnostic methods. The incidence of tuberculosis has risen in older age cohorts, especially individuals aged 35–54, indicating a change in demographic susceptibility.

Key Words : Tuberculosis, TB, *Mycobacterium tuberculosis*, Pulmonary T.B, Extra-pulmonary T. B, Prevalence

Background

Tuberculosis (TB) is an infectious disease caused by the tubercle bacilli called *Mycobacterium tuberculosis* (*MTb*). According to the World Health Organization (WHO), approximately a quarter (1.7 billion) of the world population are latently infected with *MTb*, where they have a 5–10% lifetime risk of becoming sick or infectious with TB⁽¹⁾. TB is a multi-systemic disease with a protean presentation. Pulmonary tuberculosis (PTB) is the most common clinical presentation of TB. TB also affects other sites (extrapulmonary tuberculosis, EPTB), such as pleura, lymph nodes, skeleton, meninges, etc. In contrast to PTB, the research of EPTB is less concerned by public health institutions. This may be because most forms of EPTB do not contribute to the spread of tuberculosis, or sometimes patients with PTB and EPTB at the same time are classified as PTB cases.⁽²⁾

WHO reported nearly 10 million new cases of active tuberculosis in 2019. Compared with women, men have a 1.8-fold higher incidence of active tuberculosis. The tuberculosis prevalence-to-notification ratio is also much higher in men. These sex disparities exist irrespective of geographic locale.⁽³⁾

An estimated global total of 10.6 million people (95% uncertainty interval [UI]: 9.9–11 million) fell ill with TB in 2021, equivalent to 134 cases (95% UI: 125–143) per 100 000 population. Among all TB cases, 6.7% were among people living with HIV. Geographically, most TB cases in 2021 were in the WHO regions of South-East Asia (45%), Africa (23%) and the Western Pacific (18%), with smaller shares in the Eastern Mediterranean (8.1%), the Americas (2.9%) and Europe (2.2%).⁽⁴⁾

Many potential medical and cultural confounding factors, such as the increased prevalence of diabetes, alcohol use, and smoking among men, and decreased access to healthcare among women, may account for sex differences in tuberculosis. Men have higher sputum bacterial loads and more severe tuberculosis-related lung disease seen at imaging than women.⁽⁵⁾

Most studies conducted globally have revealed that the highest burden of TB is among males. A similar male predominance of an approximately 2:1 ratio was also observed for pulmonary tuberculosis (PTB) and smear-positive PTB in Southern Mexico and Iran, respectively. Nevertheless, there were also studies recorded higher smear-positive PTB prevalence among females, such as in Quetta city and Hyderabad city in Pakistan. These sex-related variations may reflect the difference in biological, epidemiological and socioeconomic characteristics, and cultural barriers in accessing healthcare services.^(6,7,8)

Although prior population-based studies have highlighted sex differences in tuberculosis outcomes the findings are often unclear and inconsistent because of the inherent heterogeneity of study populations and the difference in the level of care between the sexes in low-income countries. In addition, many studies do not report sex-disaggregated data.⁽⁹⁾

The study aims to investigate the prevalence of tuberculosis infection between males and females, and explore the potential associations between socio-demographic characteristics and TB infection. Additionally, the study aims to examine whether there is a correlation between gender and mortality rates among TB patients, and determine the prevalence of pulmonary TB and extra-pulmonary TB.

Materials and Method

The study was executed in the Chest and Respiratory Disease Center in Thi-Qar province, Iraq. The facility offers various services, including diagnosing and treating tuberculosis. Patients suspected of having tuberculosis seek consultation and appropriate diagnostic and therapeutic measures at the center.

An observational and analytical epidemiological study it aims to provide valuable insights into the epidemiology of tuberculosis in Thi-Qar province and the factors that may contribute to differences in tuberculosis incidence and outcomes between males and females.

An analysis was conducted on the electronic records of 2,743 TB patients officially registered at the Thi-Qar Chest and Respiratory Diseases Center. The dataset comprised records spanning from January 2018 to December 2023. The ethical committee of the author's home institution approved the study. Statistics on age, gender, and precise place of residence were obtained from the electronic medical records of the patients. Furthermore, the location of the ailment (either pulmonary or extra-pulmonary) and the result of the treatment were documented. Before accessing their records, the patients were anonymized.

The five zones of Thi-Qar province were used to categorize the residences of the registered patients. Al Nasiriyah City is included in the central zone. The cities of Al Shatra and Rifai are included in the northern zone. Suq Al-Shuyukh is located in the southern zone. Jabaish City is included in the eastern zone. The central zone is a more congested area, characterized by quarters with outdated housing and infrastructure that serve as residences for economically disadvantaged individuals.

The data were analyzed using version 22 of the statistical package for the social sciences. SPSS® Statistics is the foremost statistical software globally utilized for addressing commercial and research challenges using ad hoc statistical analysis, hypothesis testing, and predictive analytics. The study includes descriptive analysis employing frequency and percentage estimates. A spatial analysis was conducted to determine the number of cases by quarter of residency in Thi-Qar province. The results were then displayed on a map that included all districts and territories.

Results

The findings are presented as figures for each year.

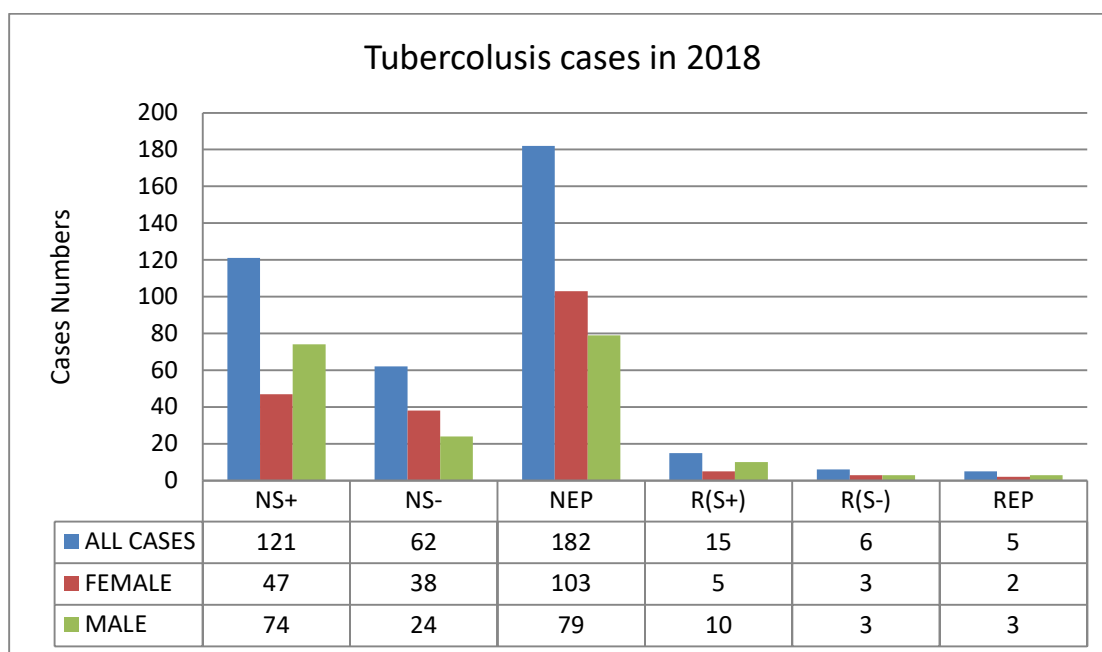


figure (1) tuberculosis cases in 2018

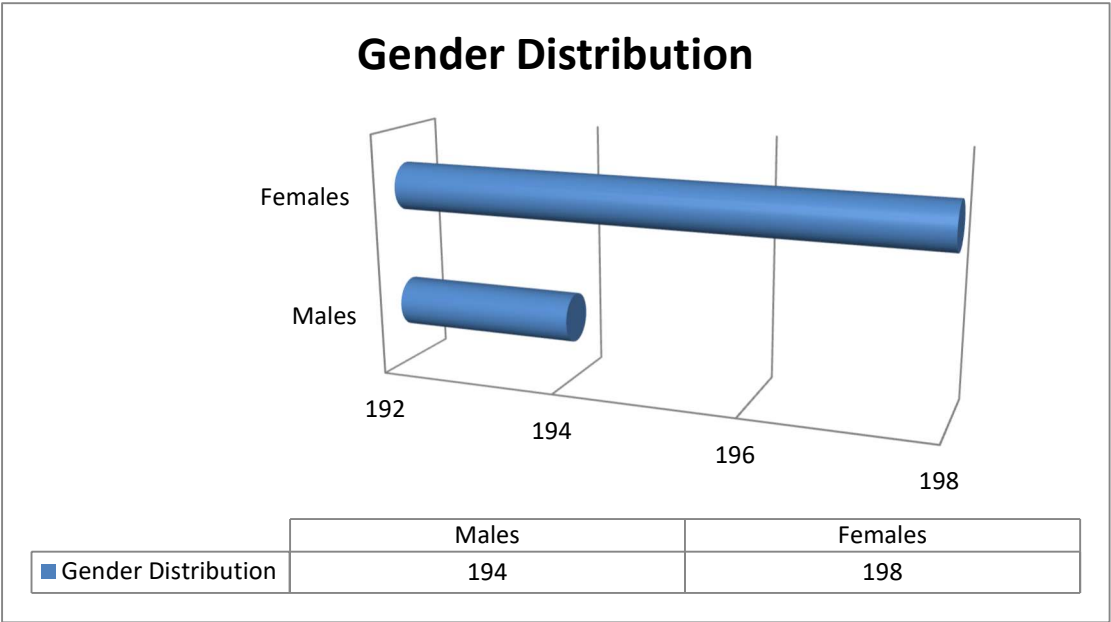


figure (2) gender distribution in 2018

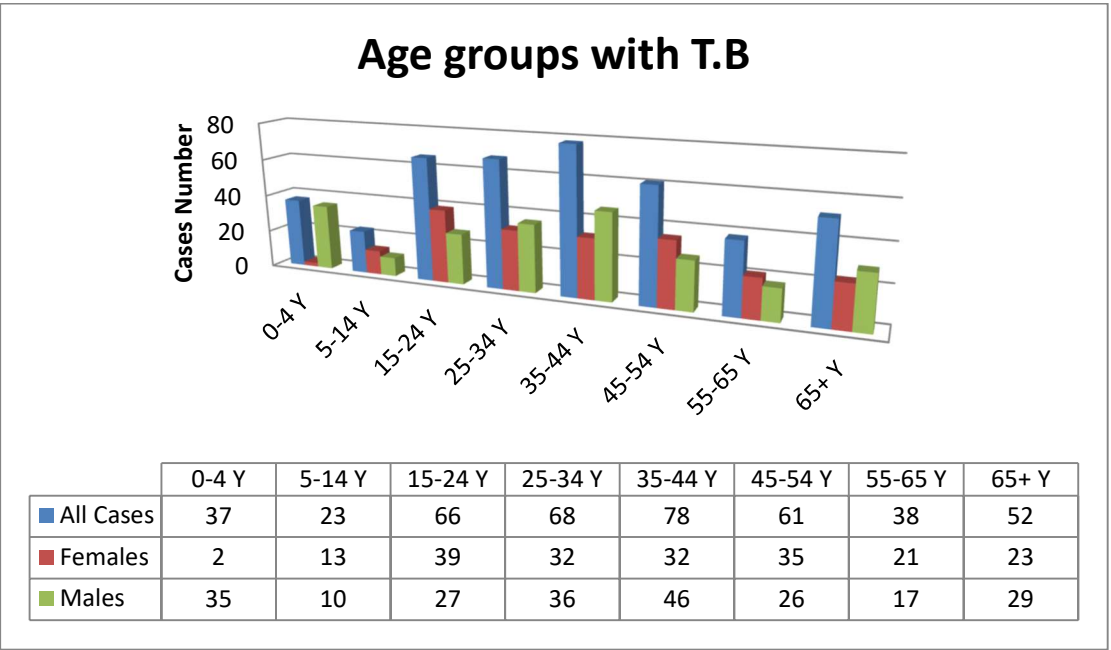


figure (3) age groups with TB in 2018

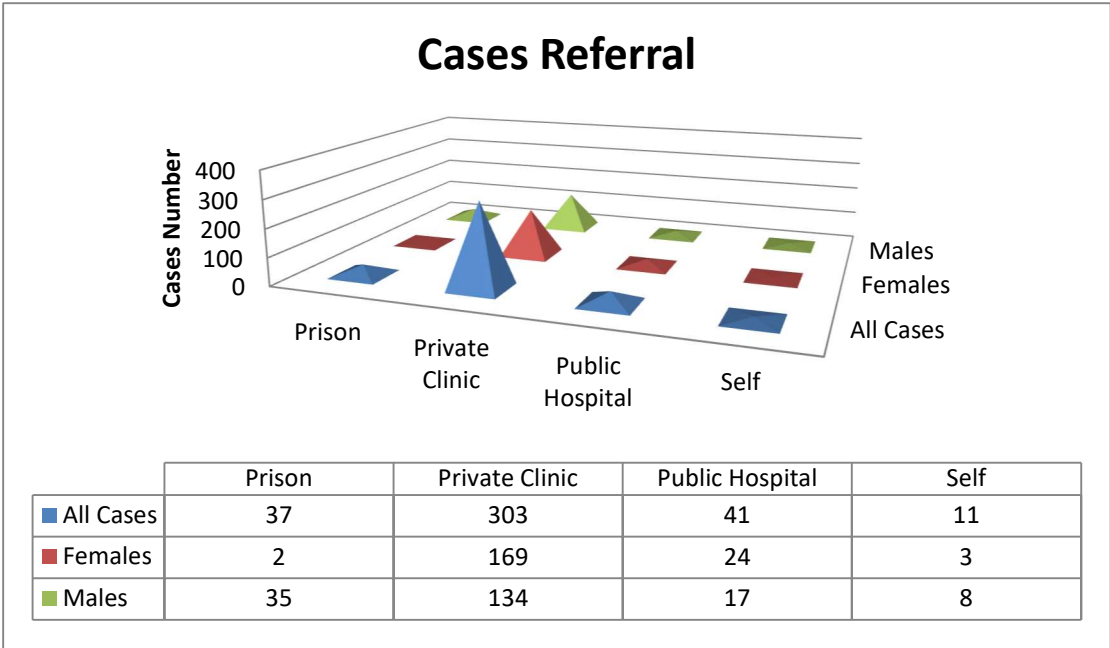


figure (4) cases referral in 2018

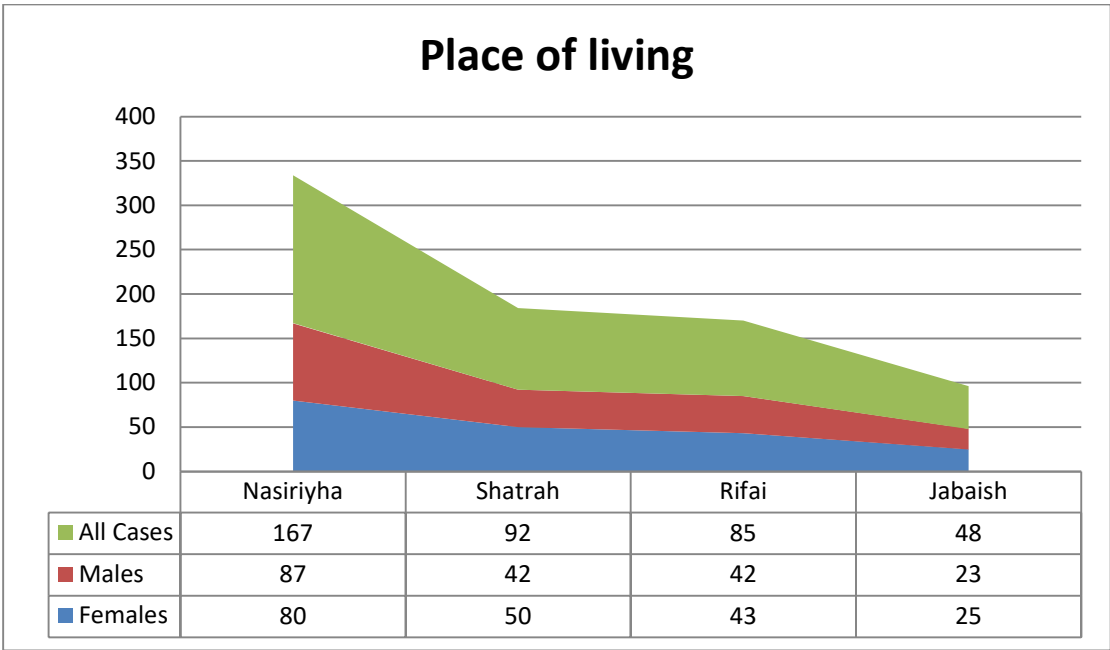


figure (5) place of living in 2018

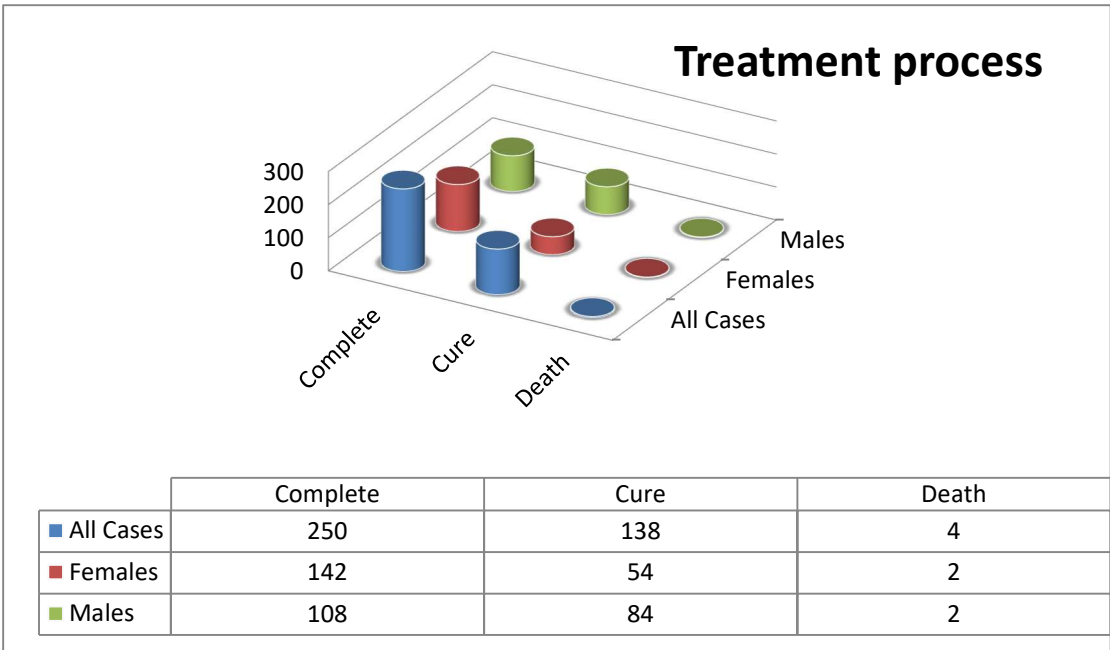


figure (6) treatment process in 2016

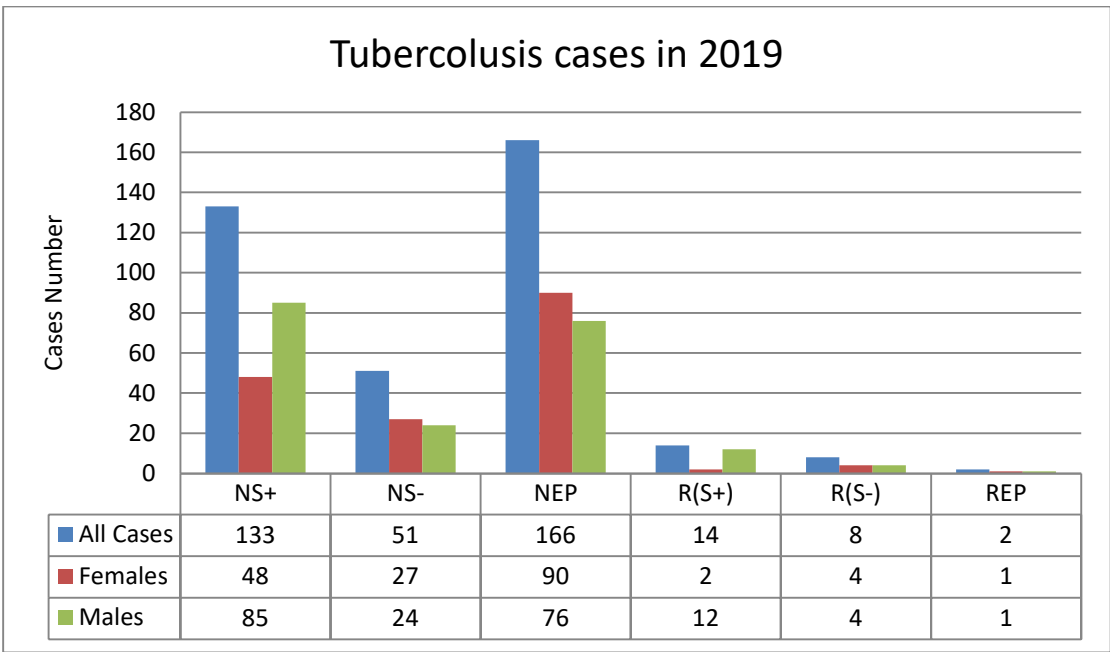


figure (7) tuberculosis cases in 2019

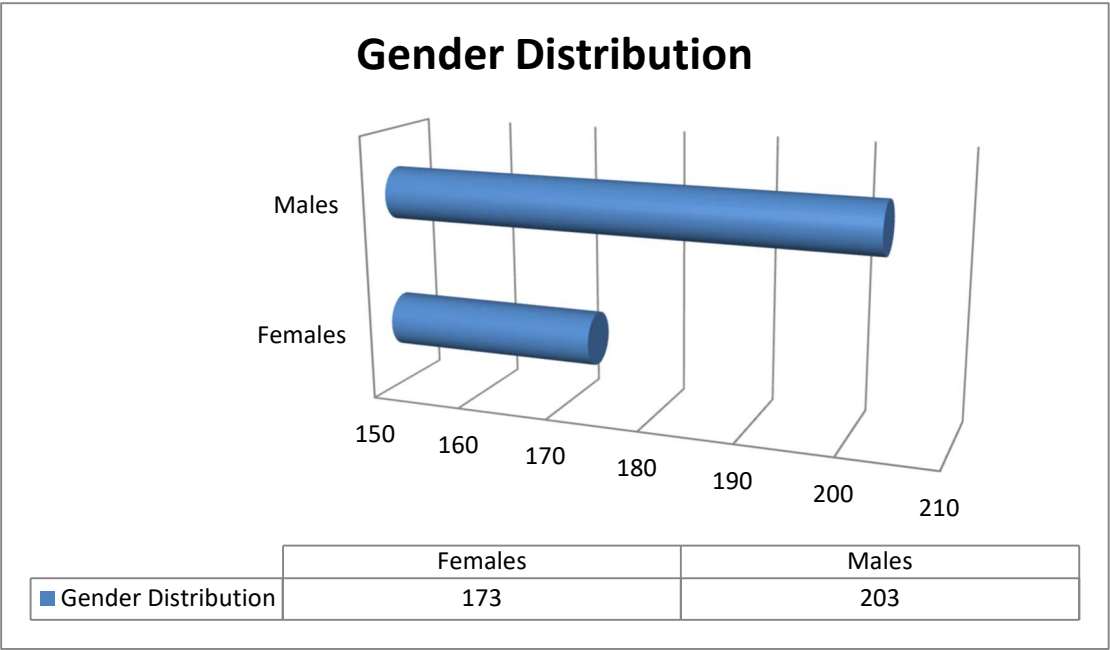


figure (8) gender distribution in 2019

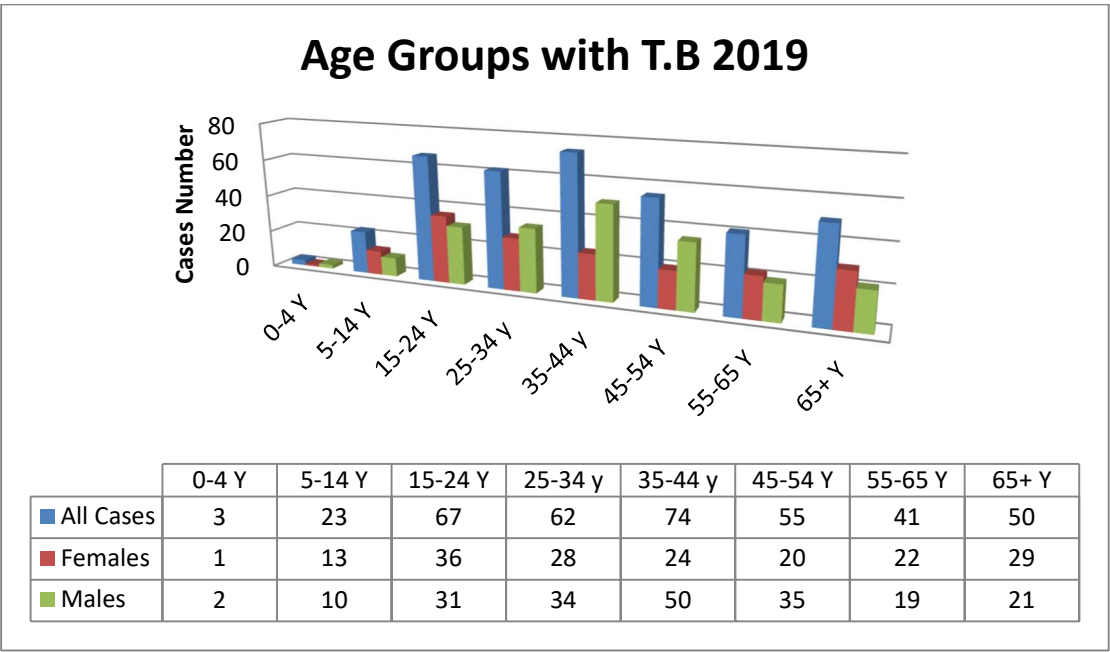


figure (9) age groups with TB

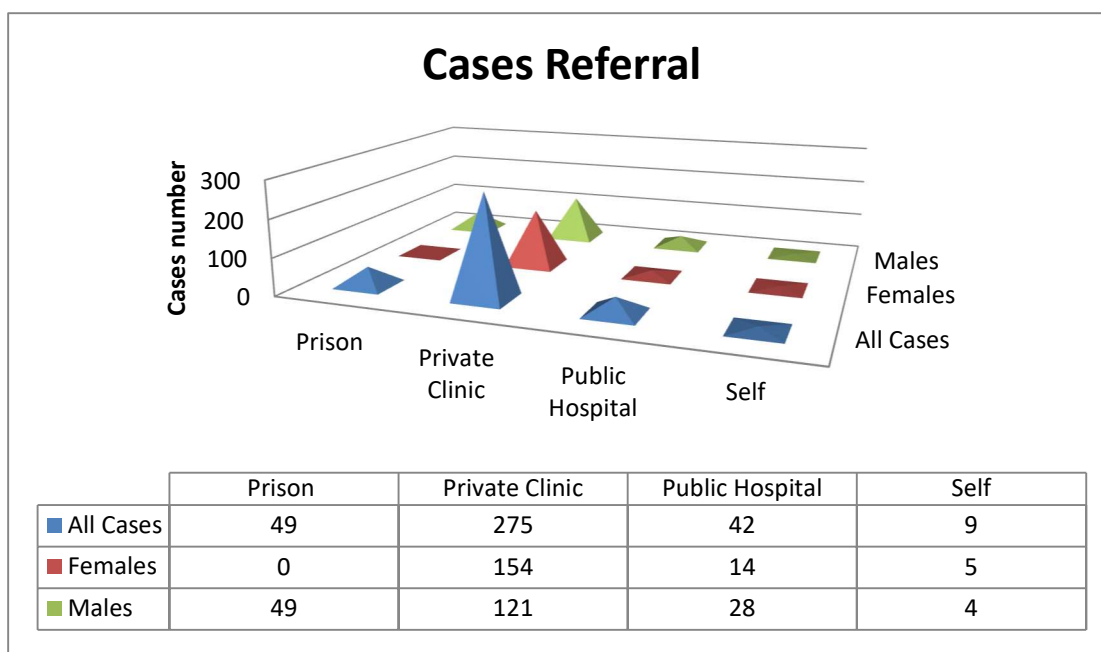


figure (10) cases referral in 2019

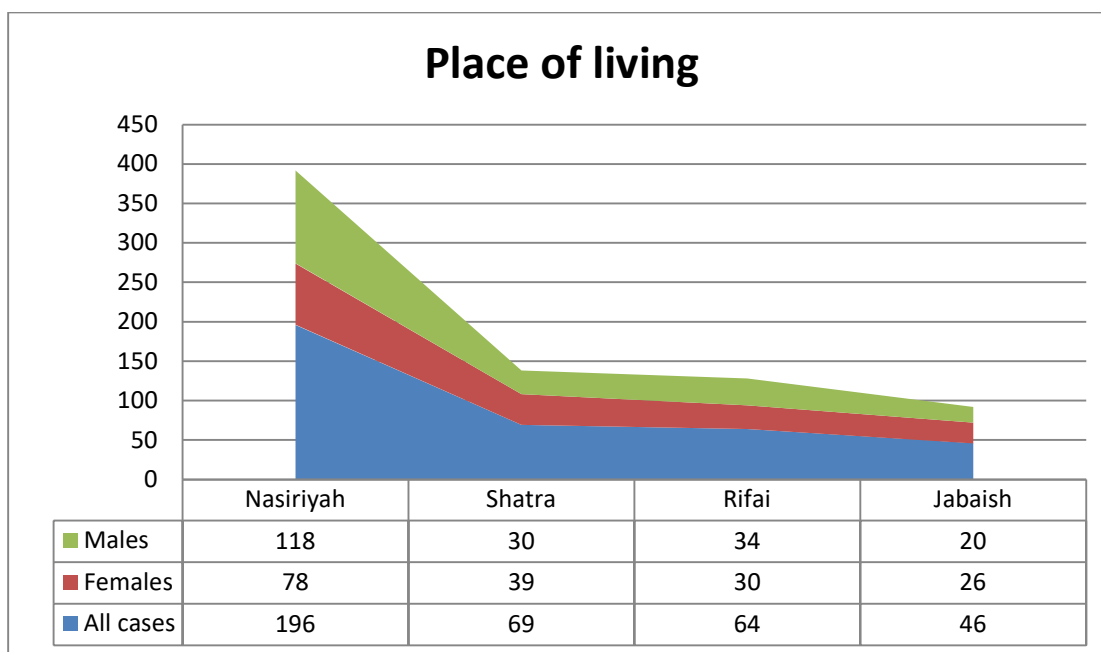


figure (11) place of living in 2019

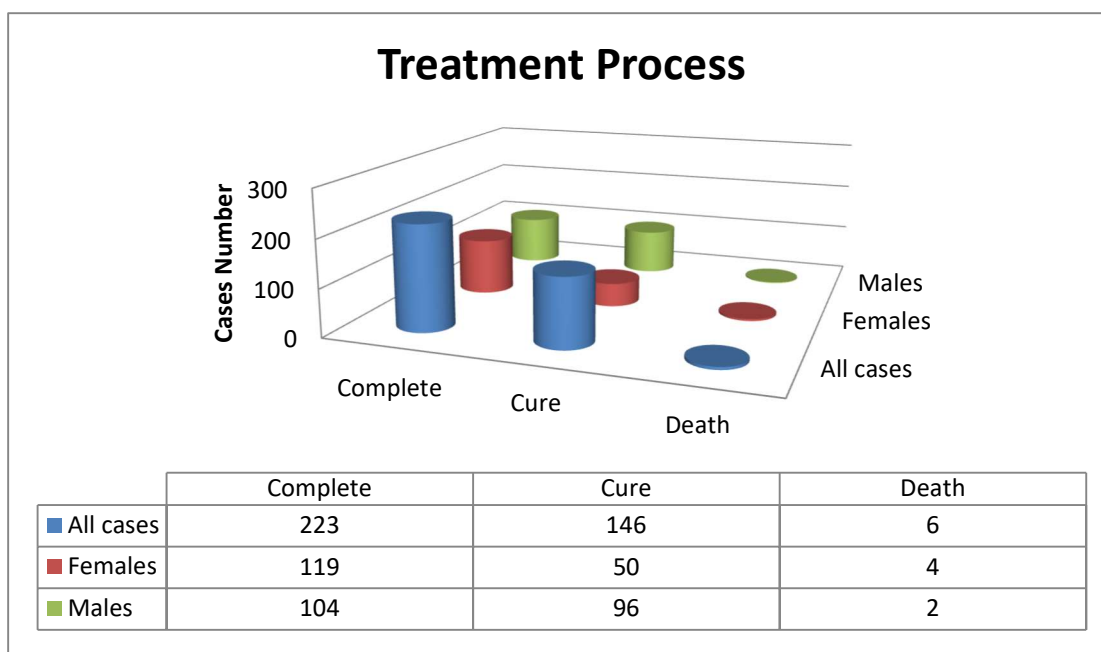


figure (12) treatment process in 2019

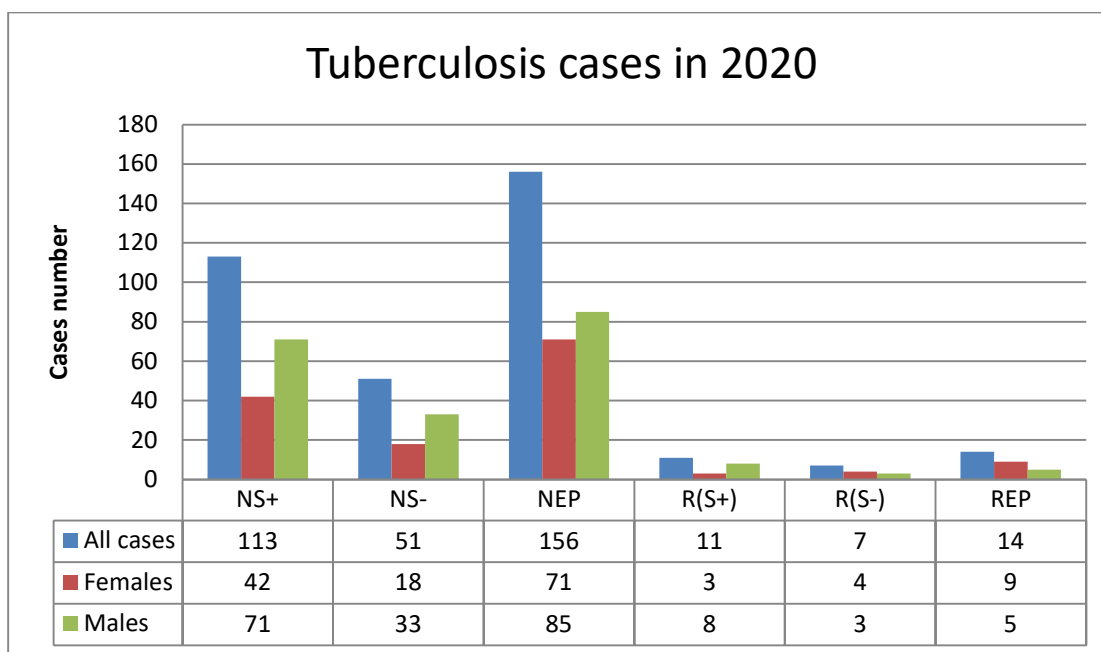


figure (13) tuberculosis cases in 2020

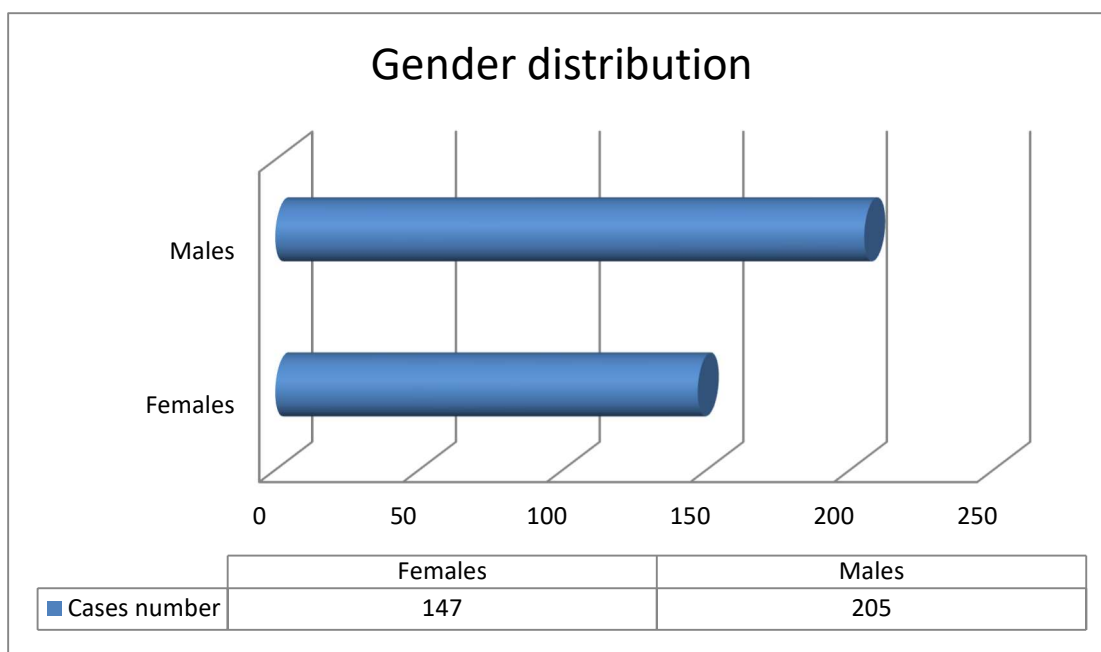


figure (14) gender distribution in 2020

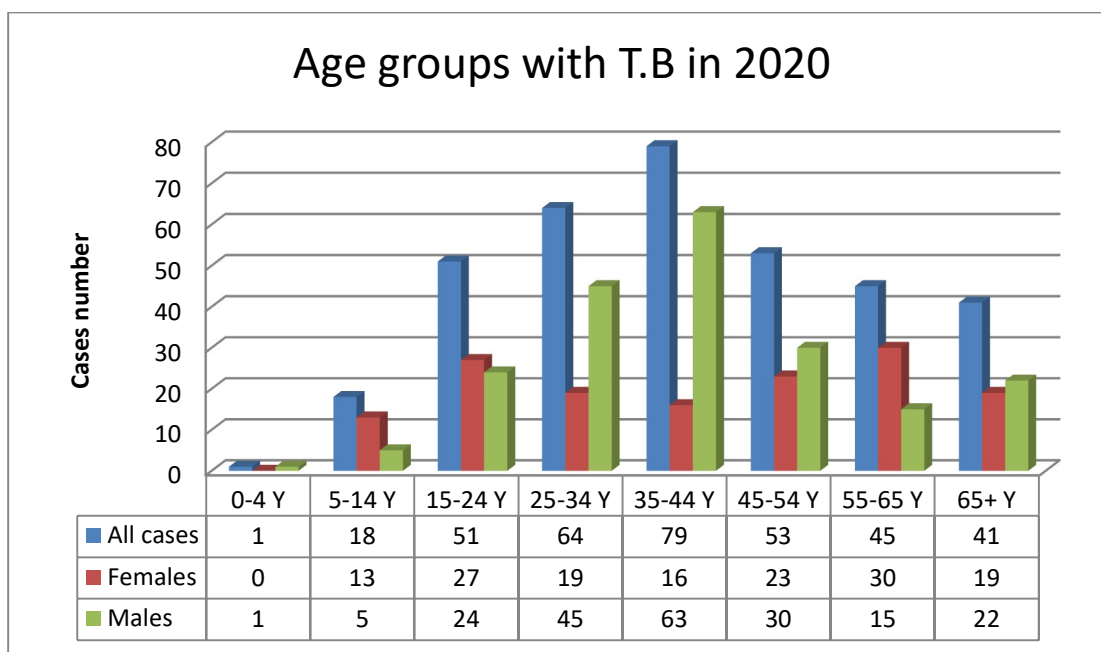


figure (15) Age groups with T.B in 2020

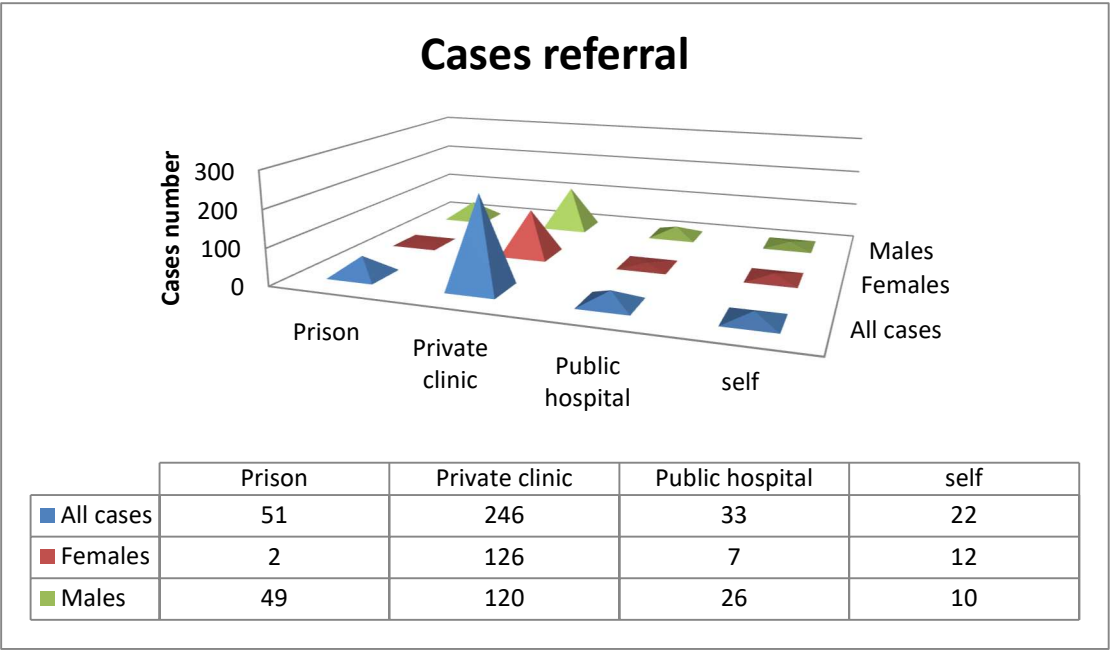


figure (16) Cases referral in 2020

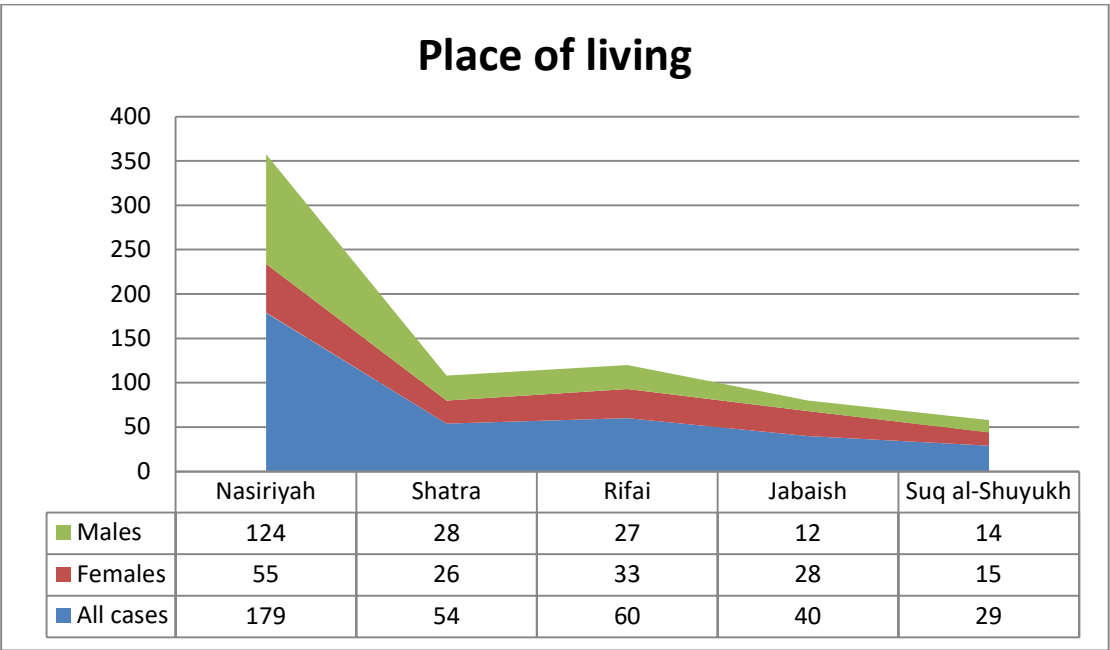


figure (17) place of living in 2020

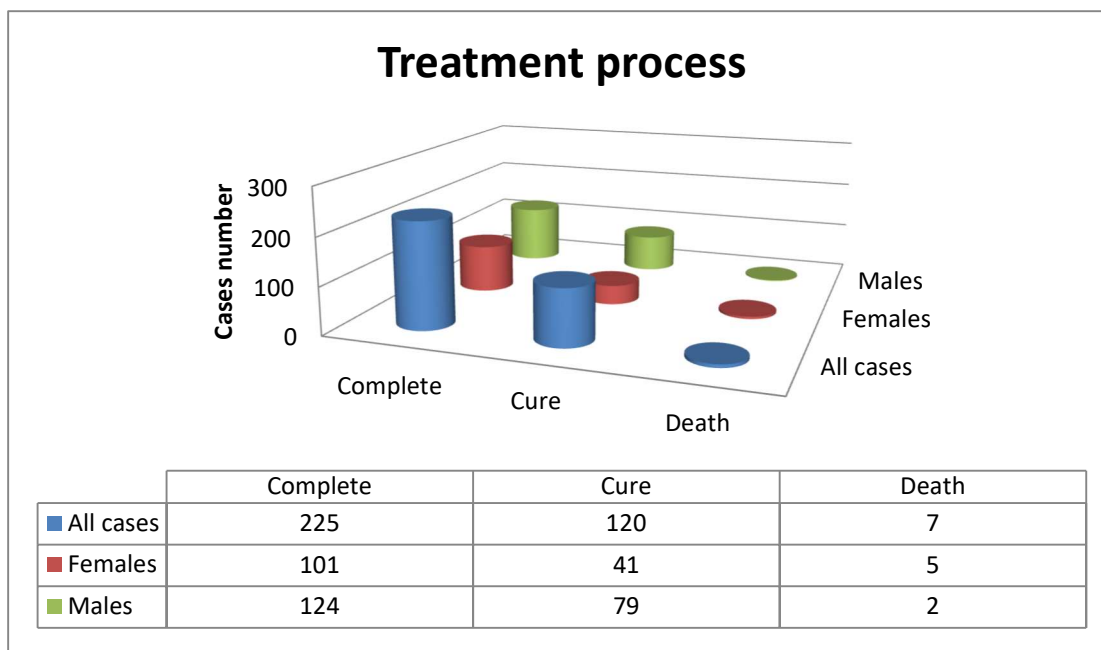


figure (18) treatment process in 2020

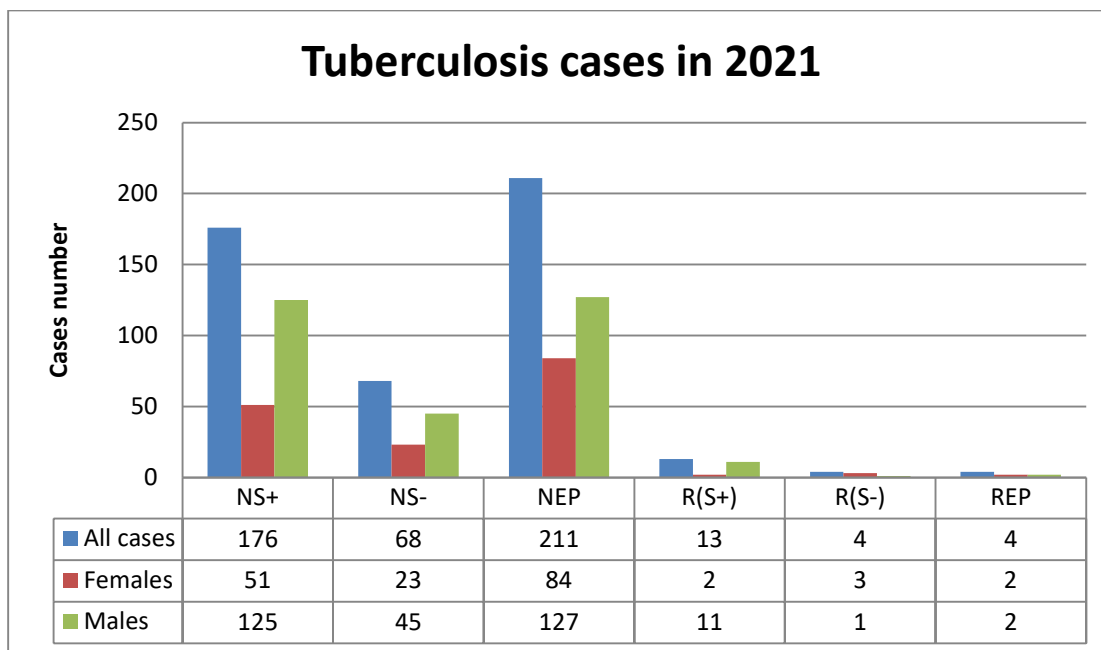


figure (19) Tuberculosis cases in 2021

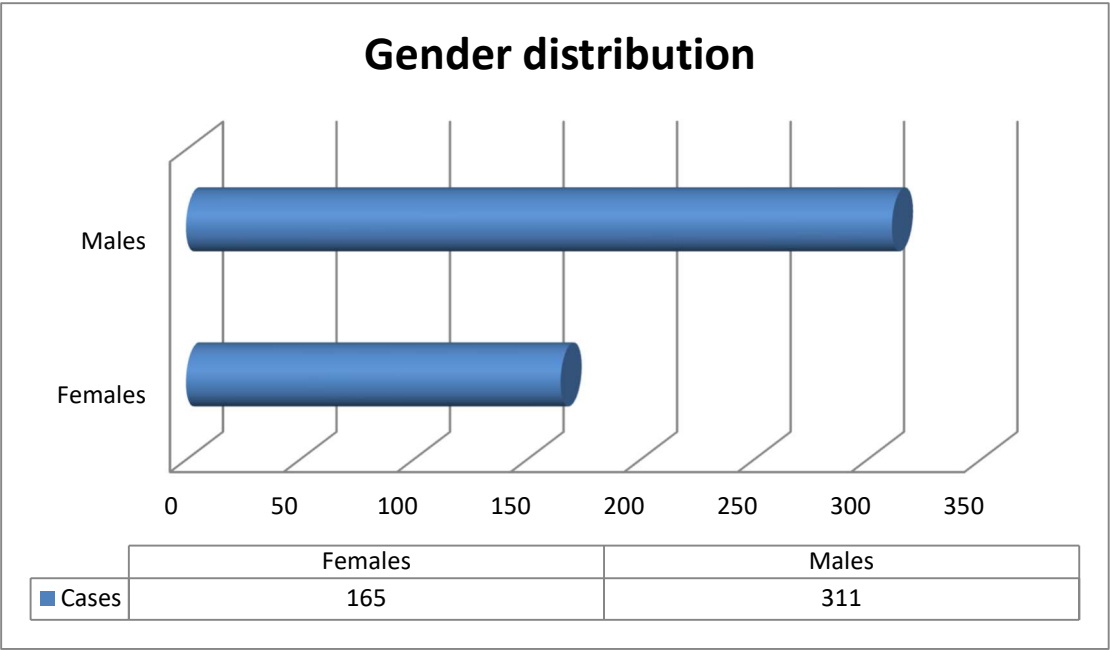


figure (20) gender distribution in 2021

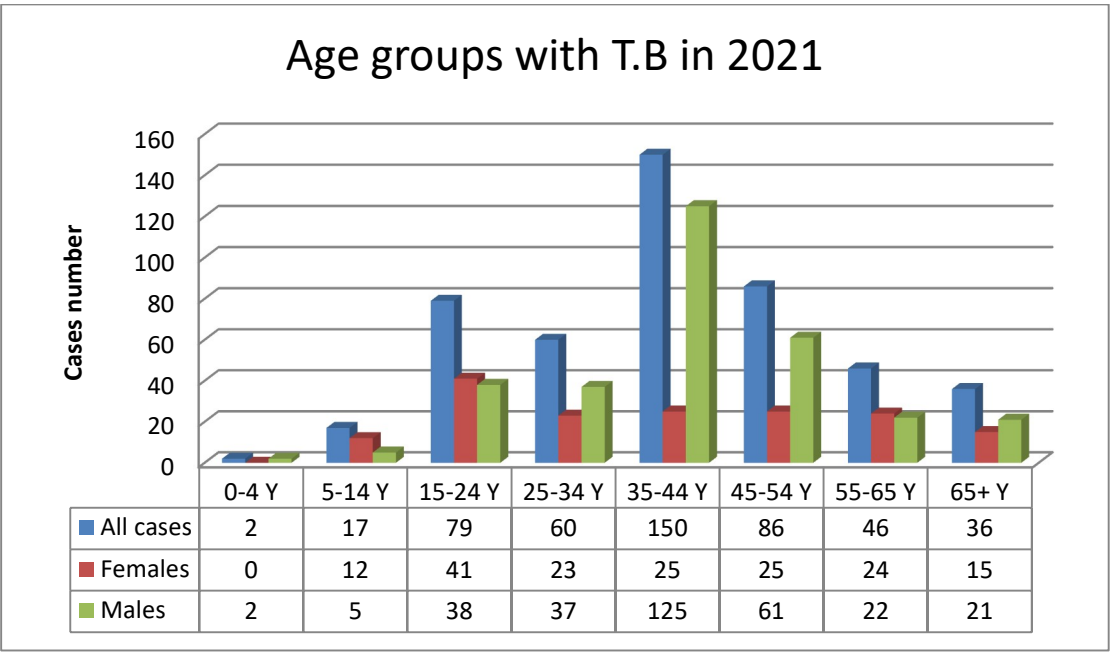


figure (21) Age groups with T.B in 2021

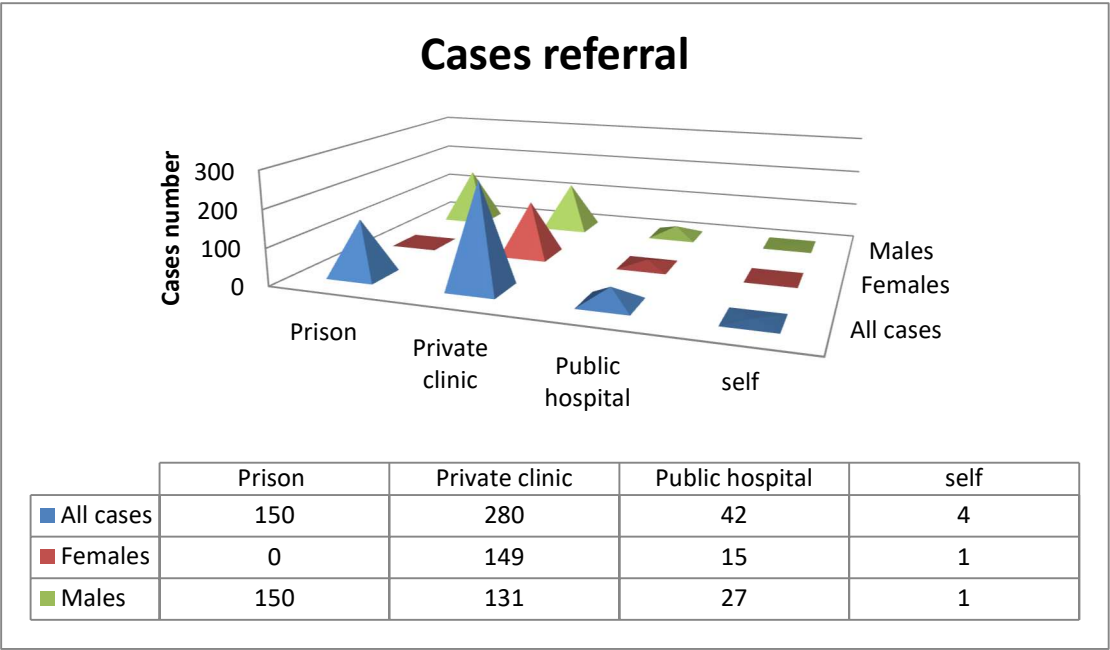


figure (22) Cases referral in 2021

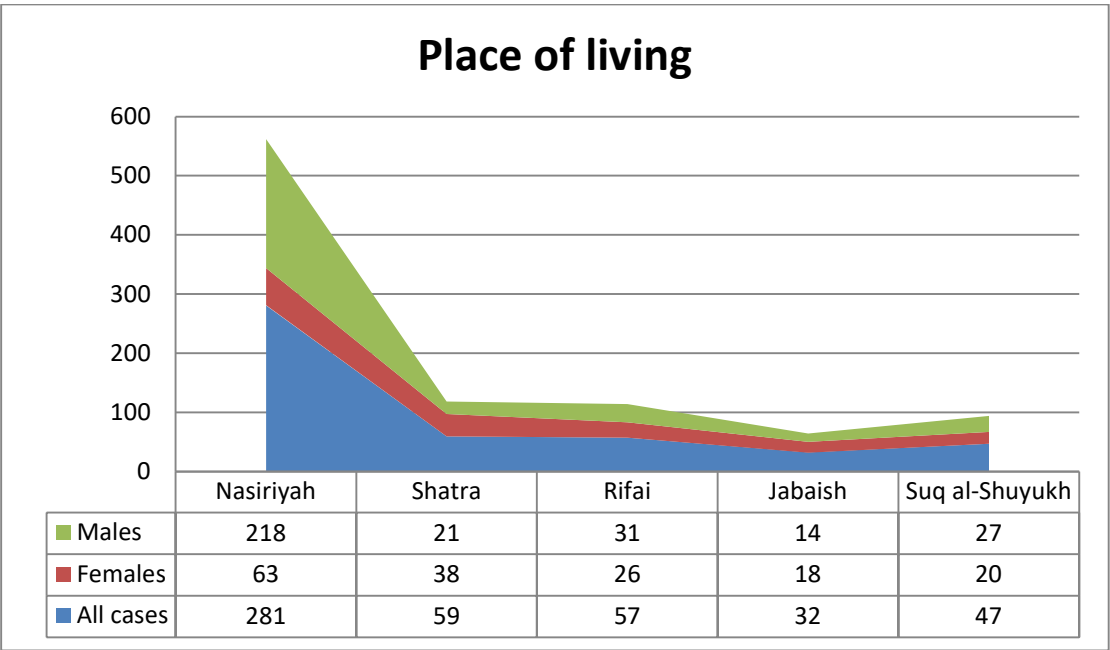


figure (23) place of living in 2021

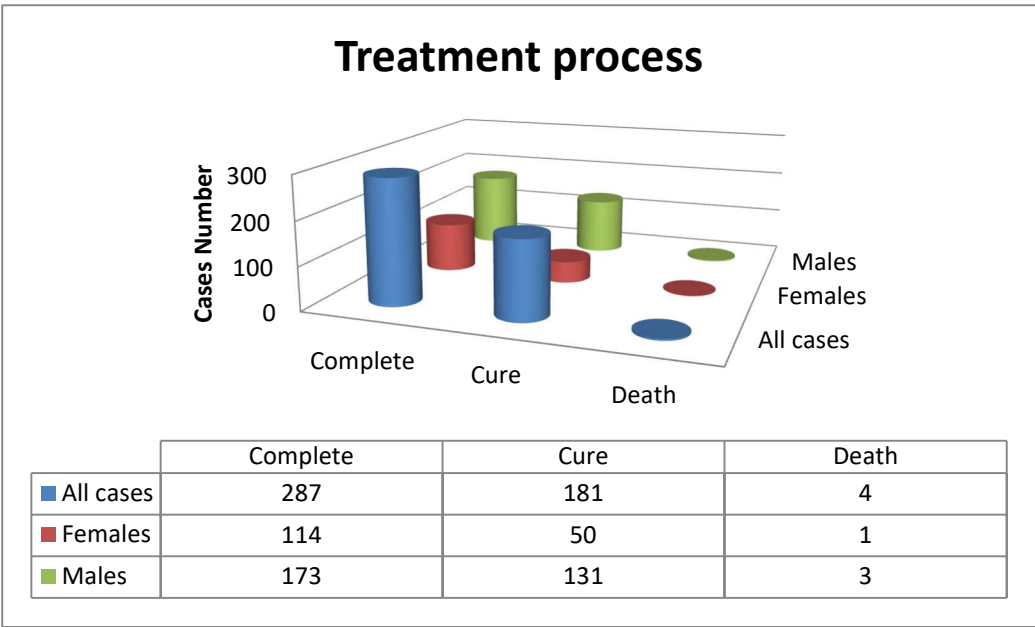


figure (24) treatment process in 2021

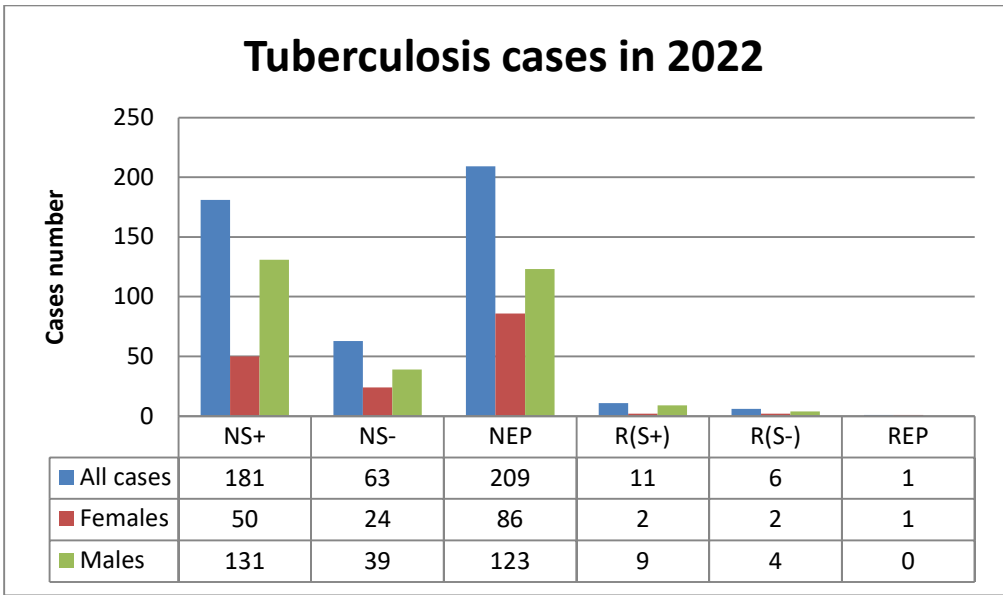


figure (25) tuberculosis cases in 2022

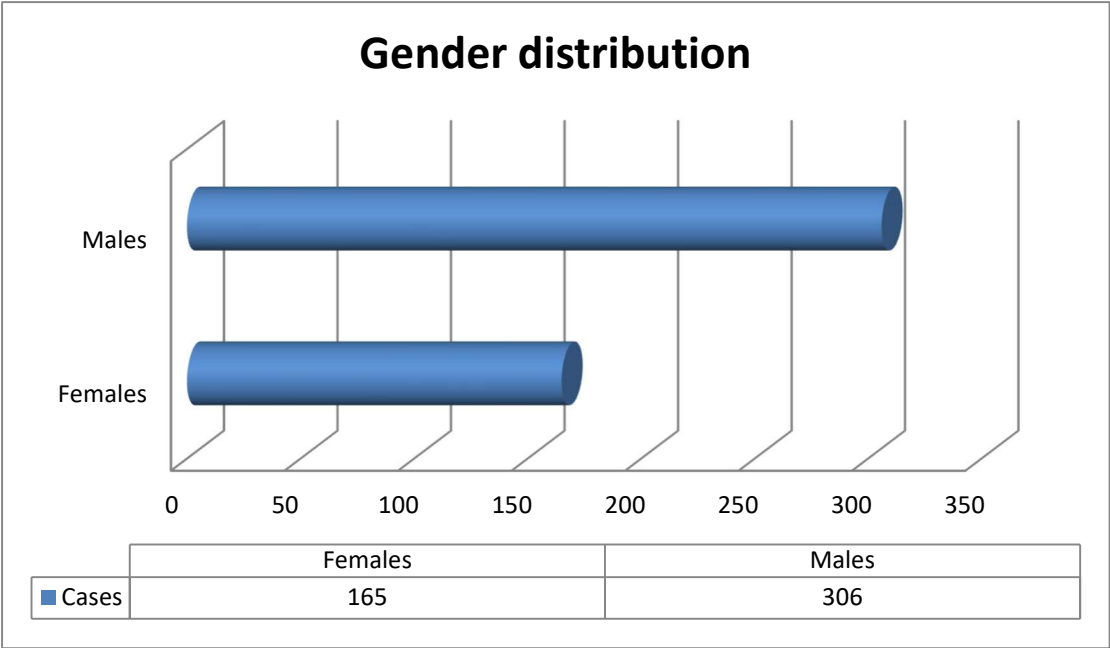


figure (26) gender distribution

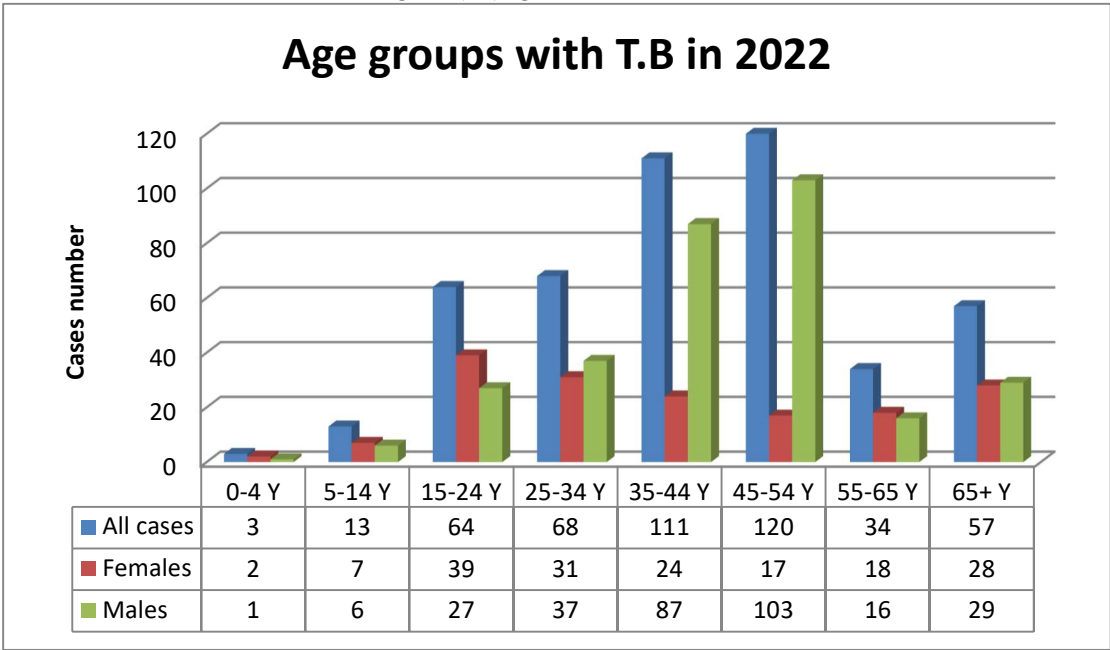


figure (27) age groups with TB in 2022

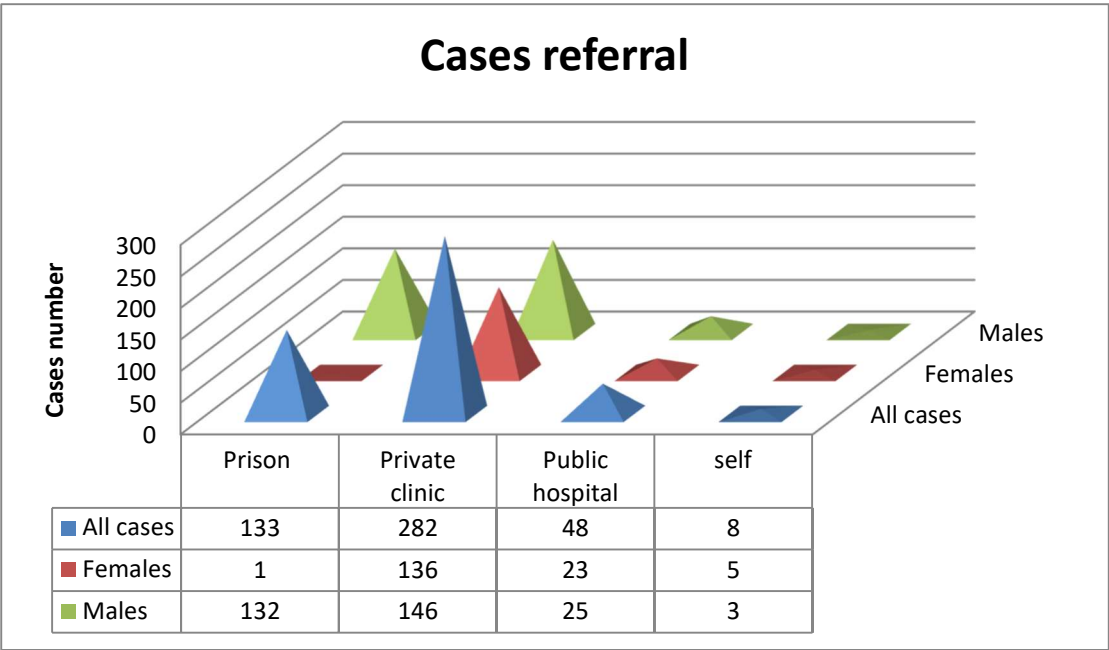


figure (28) cases referral in 2022

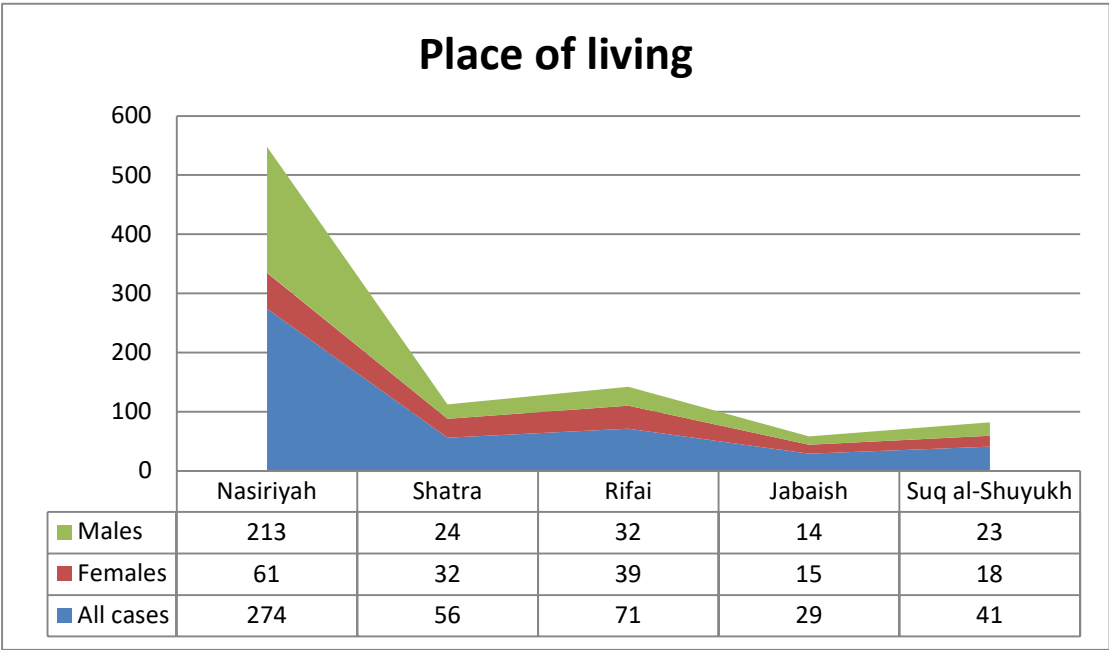


figure (29) place of living in 2022

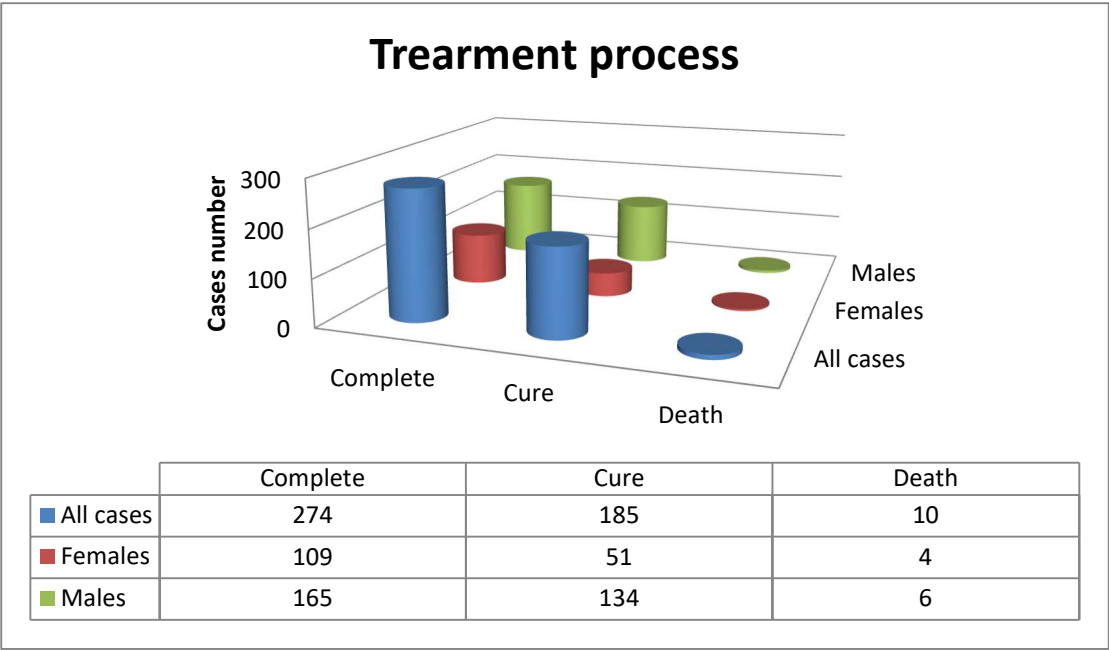


figure (30) treatment process in 2022

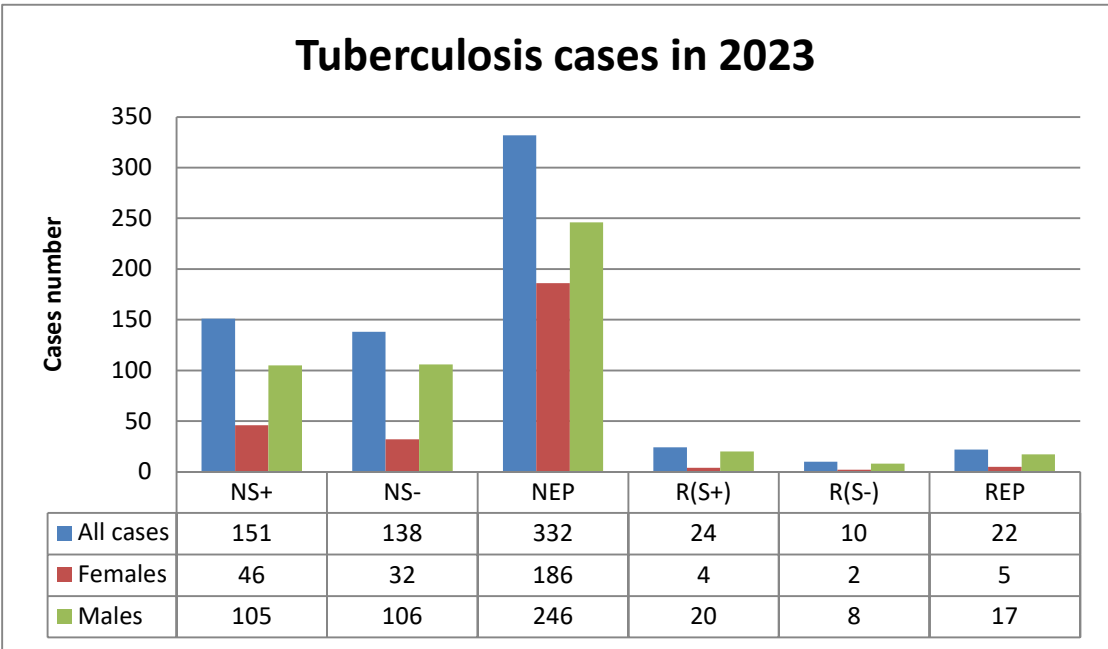


figure (31) tuberculosis cases in 2023

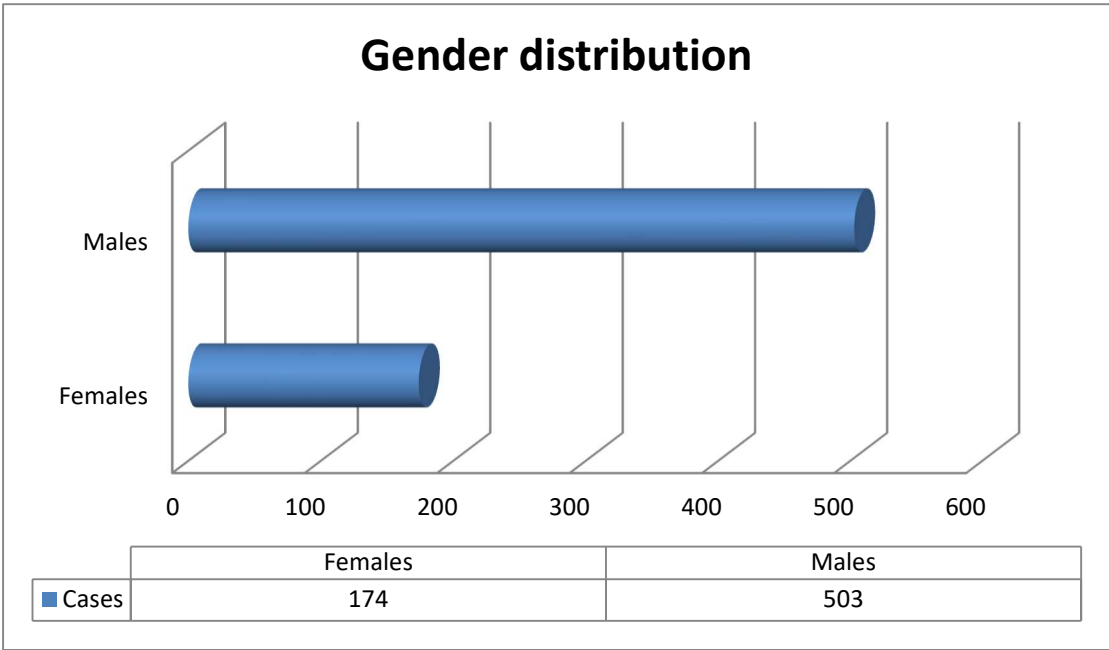


figure (32) gender distribution in 2023

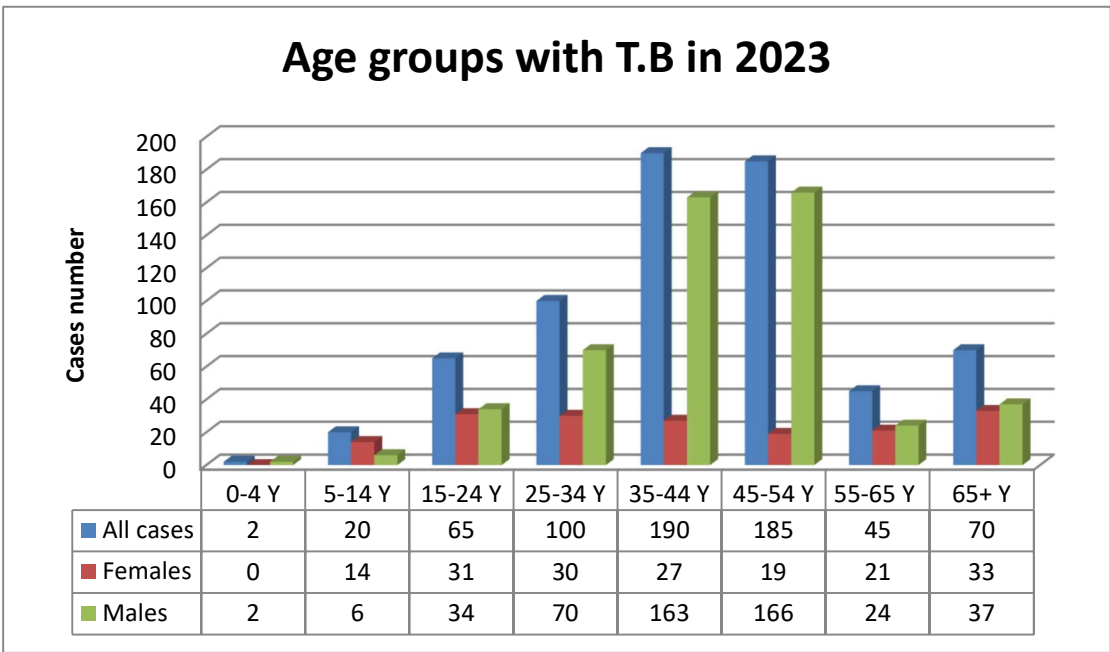


figure (33) age groups with TB IN 2023

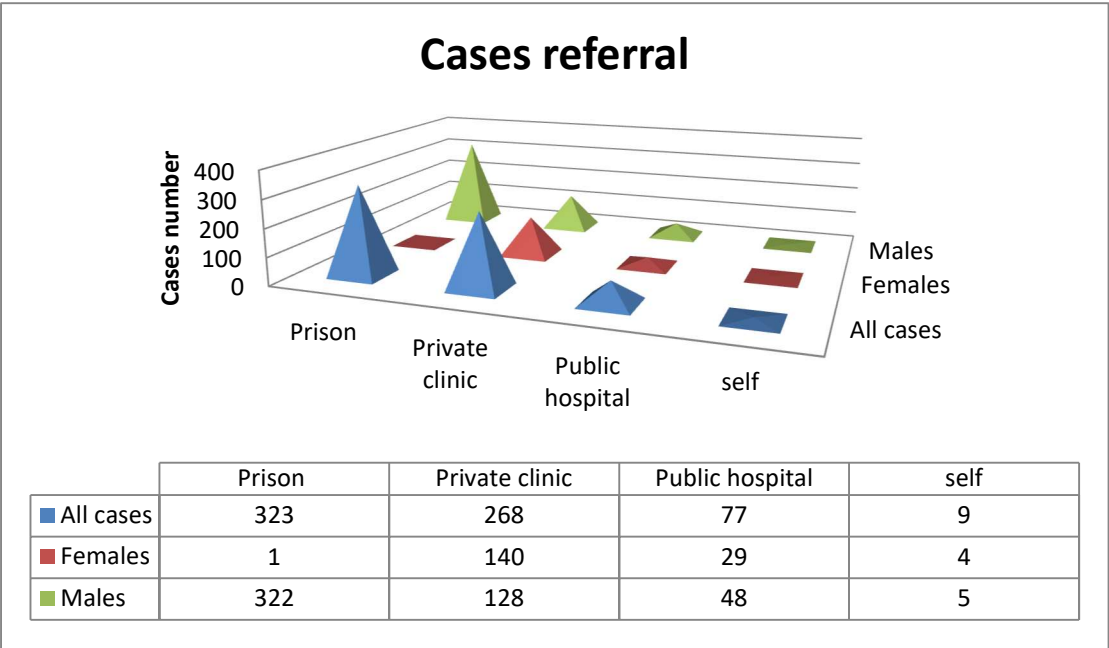


figure (34) cases referral in 2023

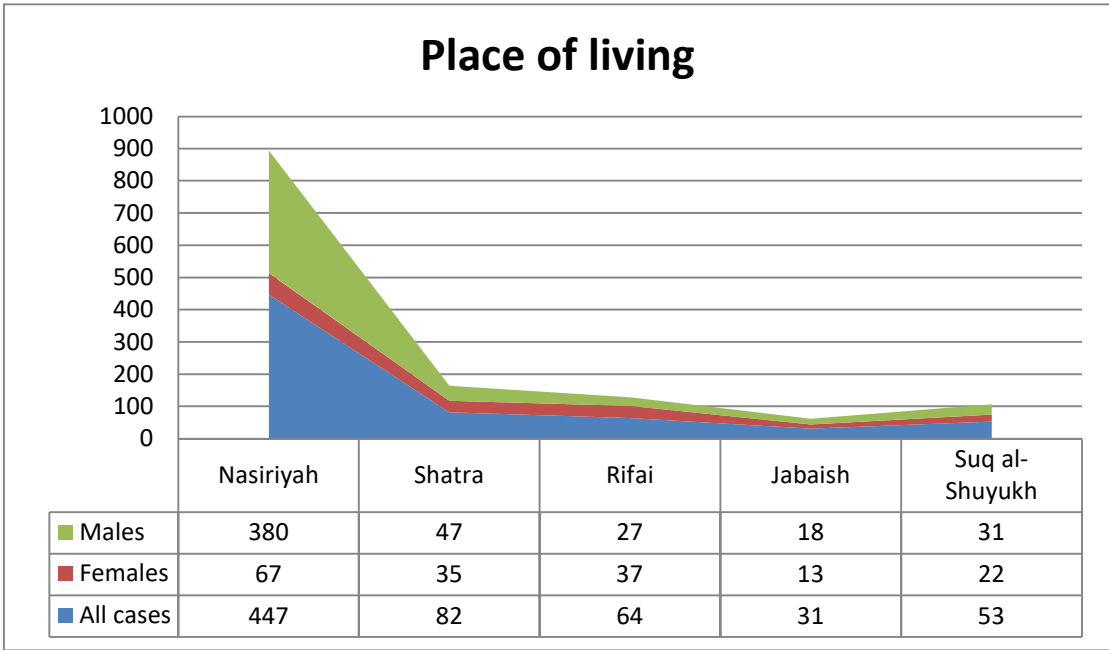


figure (35) cases referral in 2023

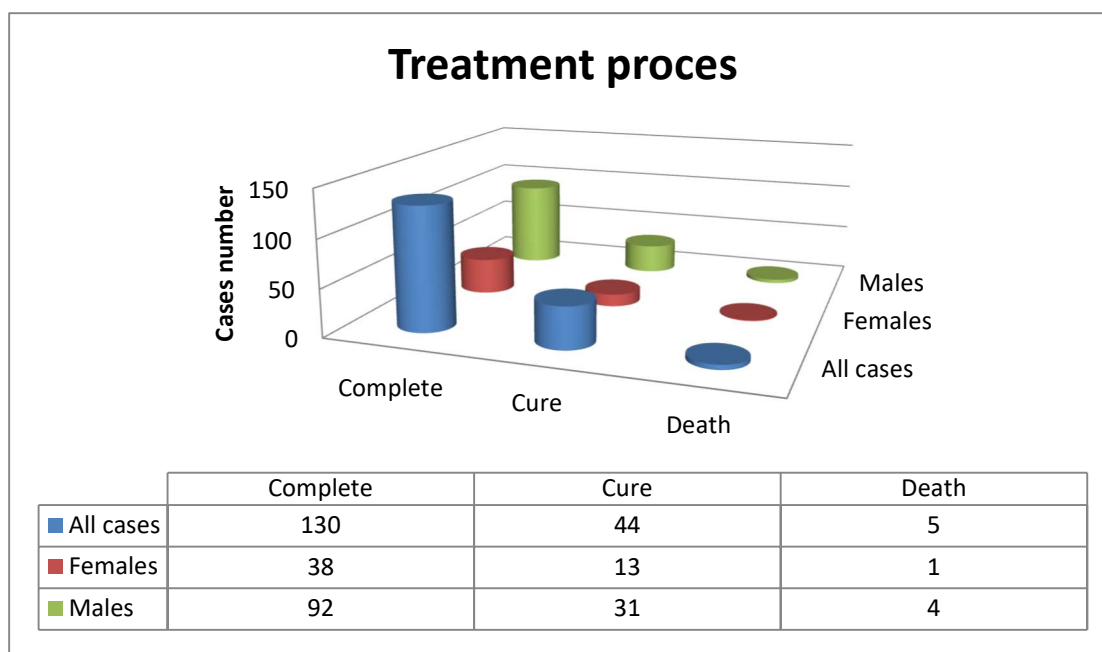


figure (36) treatment process in 2023

Discussion

1. Trends Over Time (2018-2023)

Between 2018 and 2023, tuberculosis (TB) case distribution among different categories varied. The incidence of NS+ (new symptoms identified by X-ray and sputum) ranged from 121 in 2018 to 151 in 2023, reaching its highest point at 181 instances in 2022. The incidence of NS- (negative symptoms; tuberculosis discovered only in X-ray) cases rose dramatically from 62 in 2018 to 138 in 2023. The rise could be attributed to enhancements in diagnostic precision or an increase in tuberculosis occurrence. A study ⁽¹⁰⁾ that looked at patterns in the occurrence of TB around the world from 2000 to 2021 suggests that improvements in diagnostic technology have likely helped find more TB cases, including those that do not have any obvious symptoms (NS-) and those that have symptoms outside of the lungs (NEP). This study emphasizes that the occurrence of tuberculosis (TB) is still high in areas with substantial limitations in resources. In these areas, the development of diagnostic techniques has played a vital role in increasing the identification and reporting of TB cases.

Extrapulmonary tuberculosis (NEP) cases also had a significant increase, rising from 182 in 2018 to 332 in 2023, perhaps suggesting improved detection techniques or evolving TB presenting patterns. The incidence of relapse of tuberculosis (R(S+)) and R(S-) (relapse of TB detectable solely in x-ray) cases exhibited significant variations. Still, the level of relapse of extrapulmonary tuberculosis (REP) remained consistently low over the years. Although ⁽¹⁰⁾ there have been significant changes in the number of relapse cases diagnosed by X-ray (R(S-)), the incidence of relapse in extrapulmonary tuberculosis (REP) cases has remained relatively low over time. Even though relapse detection has improved, particularly for pulmonary tuberculosis, these findings suggest that the nature of extrapulmonary tuberculosis may be fundamentally less prone to recurrence. Alternatively, relapse instances may be less likely to be found due to the complexity of NEP diagnosis.

2. Gender Differences

Throughout the years, there was a consistent gender disparity, with males representing a higher percentage of TB cases across all categories. For example, in 2023, 151 males and 46 females were diagnosed with NS+, while 138 males and 32 females were diagnosed with NS-. This trend suggests that TB, especially pulmonary TB, is more prevalent in males, potentially due to factors like occupational exposure, lifestyle, or access to healthcare. According to the World Health Organization Global Tuberculosis Report ⁽¹¹⁾, the occurrence of TB is consistently greater in males than in females worldwide. Statistical data from 2023 revealed that males constituted over 58% of the total TB cases, and females made up around 42%. The study examines variables such as increased susceptibility to TB in male-dominated work environments, lifestyle factors such as elevated rates of smoking and alcohol use, and inequalities in healthcare availability and usage between genders.

3. Age Group Analysis

The number of TB cases varied significantly among different age groups. The 25-34 age group had the highest number of cases in 2018, with a subsequent significant increase in cases in the 35-44 and 45-54 age groups by 2023. The observed change indicates a growing prevalence of tuberculosis among older demographics, perhaps associated with the presence of other medical conditions, compromised immune systems, or delayed detection. Unlike our results, a study from Taiwan ⁽¹²⁾ declared that a significant share of TB cases in Taiwan occur in individuals who are 65 years of age or older. Social and economic progress often leads to decreases in TB occurrence, as well as lower rates of birth and death and gradual aging of the population. This paper presents a new examination of the possible influence of population aging on TB occurrence by the use of statistical modeling and forecasting.

Similar to our results, from January 2012 to December 2016, 728 TB patients received diagnosis and treatment at the TB center in Erbil. The average age at diagnosis was reported as 40.5 and 20.8 years. Most of the patients (73.6%) were between 18 and 64 ⁽¹³⁾.

Consistent with the research findings, a study ⁽¹⁴⁾ reports that the 20-44 age group had the highest TB incidence, accounting for 67% of cases in 2011 and 66% in 2012. In contrast, the age group over 45 averaged 21% of cases for both years

The data further reveals that the age group of 0-4 consistently had the lowest number of incidents, maybe because of reduced exposure or successful immunization initiatives. However, any increase in incidence among children would be worrisome and require focused measures. Contrary to our findings, a study ⁽¹⁴⁾ reported that children aged 11 to 19 were significantly more likely to develop TB in 2011, with a prevalence of 4.8%, compared to 5.5% observed in the current study ($p = 0.001$).

4. Geographical Distribution and Referral Analysis

Significant trends were observed in the geographical distribution of TB cases within the Thi-Qar governorate. Greater concentrations of cases were observed in Nasiriyah City, with Shatra, Rifai, Jabaish, and Suq al-Shuyukh following suit. The elevated prevalence of cases in Nasiriyah may be attributed to its bigger population or more effective reporting mechanisms. At the same time, the persistent instances in other cities underscore the pervasive incidence of TB throughout the governorate. A study align with our findings, showing that 44% of tuberculosis cases occurred in the middle zone of Erbil city, 43.8% in the outer zone, and 12.2% in the central zone. Due to the lack of recent census data and accurate population estimates for each quarter of Erbil city, it is not feasible to calculate the annual TB incidence per quarter⁽¹³⁾.

Furthermore, the analysis of referral categories revealed that the private clinic accounted for most cases, with prisons following closely behind, particularly in 2021 and 2022. The substantial prevalence of cases

identified in correctional facilities highlights the necessity for improved TB control strategies in these settings, where close living arrangements can promote the spread of the disease.

5. Outcomes

The treatment outcomes were consistent, with most cases resulting in completion or cure. Nevertheless, the number of fatalities, despite its low level, varied marginally over the years. Four deaths occurred in 2022, while five occurred in 2023 (four males and one female). The slight increase in mortality may indicate that there are obstacles to adherence to treatment or that there are delays in diagnosis. The completion rates have shown a generally high consistency across the years, culminating in 130 completed cases in 2023. However, the cure rates also exhibited variability, which may be attributed to potential disparities in treatment compliance, disease severity, or healthcare availability. The findings of our study are consistent with these results⁽¹⁵⁾, as 672 patients (90.1% of the sample) demonstrated successful treatment outcomes, including those who were cured or completed their therapy. In contrast, 74 patients (9.9%) experienced adverse outcomes, encompassing both mortality and treatment failure.

Conclusion

The study delineates significant trends in tuberculosis (TB) from 2018 to 2023, indicating an increase in NS- and NEP cases, presumably attributable to advancements in diagnostic methods. The incidence of tuberculosis has risen in older age cohorts, especially individuals aged 35–54, indicating a change in demographic susceptibility. Men have consistently shown elevated tuberculosis rates, likely attributable to work and lifestyle influences. Nasiriyah exhibited the highest geographical prevalence of tuberculosis, while cases were dispersed throughout the Thi-Qar governorate, with prisons identified as high-risk environments. Notwithstanding favorable treatment outcomes, a marginal rise in mortality suggests difficulties in treatment compliance and prompt diagnosis. These findings underscore the necessity for focused treatments, enhanced diagnostic initiatives, and equal healthcare access across gender, age, and geographic locations.

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