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EPIDEMIOLOGICAL PATTERN OF TUBERCULOSIS IN DIR LOWER, KHYBER PAKHTUNKHWA, PAKISTAN

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Abstract

Tuberculosis (TB) remains a significant public health issue, especially in resource-limited regions like Dir Lower Malakand Division, Pakistan. This study examines TB prevalence in relation to gender, age, seasonal variation, environmental factors, and geography. A total of 215 patients were screened in 2022, with 94 (43.7%) diagnosed with TB. The results highlighted significant gender disparities, with females showing higher TB positivity (24.7%) compared to males (19.1%). The adolescent age group (11–20 years) had the highest TB prevalence (15.3%). TB incidence was higher in August (16.7%) and December (14.0%), likely due to post-monsoon humidity and cold indoor conditions. Dir Town reported a 55.3% rate of cases, with rural areas like Wari and Kalki having significantly lower rates. These findings emphasize the need for context-specific TB control strategies addressing gender, youth, and environmental factors, particularly in rural and underserved areas.

Keywords: *TB, Dir Lower, Epidemiology*

INTRODUCTION

TB is a significant health concern worldwide, and Pakistan, particularly its rural areas like Dir Lower Malakand Division, bears a disproportionate burden. TB is primarily spread through aerosols and is highly prevalent among populations with poor access to healthcare, undernutrition, and socio-economic vulnerabilities. In Pakistan, TB remains one of the leading causes of morbidity and mortality. The District Headquarters Hospital, Dir Lower Malakand Division, serves a geographically diverse population, where socio-cultural practices, climate, and healthcare infrastructure significantly contribute to the transmission of TB. In Dir Lower Malakand Division, a mountainous area with seasonal rainfall and temperature variations, climate plays a role in the spread of TB. Studies have shown that TB transmission increases during colder months when people are confined indoors with poor ventilation, and the prevalence may also rise during humid conditions post-monsoon, which are favorable for bacterial survival (Nardell et al., 2016; Kang et al., 2018). Social and cultural factors in the region also influence TB transmission, particularly among women and young people. In rural Pakistan, gender disparities significantly impact TB diagnosis and treatment, especially among women. Socio-cultural

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barriers, such as financial dependency and restricted mobility, prevent women from seeking early medical advice, leading to a higher prevalence of TB among females. In this study, although more males were screened, a higher percentage of females (24.7%) tested positive for TB compared to males (19.1%), suggesting delayed healthcare-seeking behaviors among women (Aziz et al., 2015). TB prevalence is notably high among younger populations, particularly adolescents aged 11–20 years, who showed the highest positivity rate (15.3%). This age group is more likely to engage in social interactions in crowded environments, such as schools or homes, where TB transmission is more probable. Additionally, malnutrition and lack of access to preventive healthcare further exacerbate the risk of TB among this group (Vincy & Fine, 1997; Moyo et al., 2020). The study also identified seasonal patterns in TB incidence. The highest prevalence occurred in August (16.7%), likely due to the post-monsoon humidity, which facilitates bacterial growth. The second peak occurred in December (14.0%), coinciding with the onset of cold weather, which results in people spending more time indoors, thereby enhancing the potential for TB transmission. These findings emphasize the importance of heightened TB awareness and preventive measures during these months (Hussain et al., 2017; Kang et al., 2018). Geographically, this geographical disparity underscores the need for targeted TB interventions in underserved rural areas (Mia & Shah, 2000). Environmental factors, particularly rainfall and temperature, were found to influence TB prevalence. Areas with moderate rain (101–150 mm) and temperatures between 11 °C and 20 °C showed the highest TB positivity rates. These conditions are conducive to bacterial growth, thereby increasing the likelihood of TB transmission. Additionally, cold weather (1–10°C) also contributed to increased transmission, as people gathered indoors in poorly ventilated spaces. High temperatures (31–40°C) did not show a correlation with TB prevalence, suggesting that extreme heat may inhibit bacterial growth (Nardell et al., 2016; Kang et al., 2018).

METHODS

This descriptive cross-sectional study was conducted at the District Headquarters Hospital, Dir Lower, Malakand Division, involving 413 participants who presented with symptoms suggestive of tuberculosis (TB). The common symptoms observed included prolonged coughing, fever, night sweats, and significant weight loss. Data collection was carried out using structured questionnaires designed to gather information on the participants' demographic profiles, environmental exposures, and geographical locations. This comprehensive approach aimed to explore various factors that could influence the prevalence and spread of TB in the region.

TB diagnosis was confirmed through a combination of microbiological tests, including sputum smear microscopy, culture, and molecular testing. Sputum smear microscopy is a rapid and cost-effective method that involves staining sputum samples with Ziehl-Neelsen or Fluorescent Auramine O stain to detect *Mycobacterium tuberculosis* (M. tuberculosis) bacilli. Although it is a fast method, it is limited in sensitivity. Culture on specialized media, such as Lowenstein-Jensen or Middlebrook agar, remains the gold standard for confirming TB. It provides essential information about the strain type and any drug resistance patterns, such as multidrug-resistant tuberculosis (MDR-TB).

Additionally, GeneXpert or PCR testing was used to quickly identify *M. tuberculosis* and test for resistance to rifampicin, a first-line TB drug, offering an essential tool for detecting drug-resistant TB cases. Chest radiography plays a critical role in the diagnostic process. Chest X-rays are a primary imaging tool for identifying tuberculosis (TB)- related changes in the lungs. Typical findings in TB patients include cavitary lesions in the upper lobes, infiltrates or nodular shadows, and lymphadenopathy (swollen lymph nodes). These imaging features are essential not only for confirming the presence of active TB but also for ruling out other possible lung diseases. Given the significant impact of pulmonary TB on the respiratory system, chest X-rays are indispensable for clinical evaluation and treatment planning. In addition to laboratory tests and imaging, the clinical symptoms and patient history were crucial in diagnosing TB. Symptoms such as a persistent cough lasting over two to three weeks, fever, night sweats, weight loss, and hemoptysis (coughing up blood) are

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commonly associated with TB and raise suspicion. A detailed history of contact with individuals known to have TB, particularly in high-risk areas, was also integral to the diagnosis.

Furthermore, a family history of TB, especially in endemic regions, increases the likelihood of the disease, which emphasizes the importance of gathering comprehensive patient histories to improve diagnostic accuracy. The data collected from the participants were analyzed using SPSS software. Statistical tests, including chi-square tests, were applied to examine the relationships between TB prevalence and various demographic factors, such as gender, age, geographic location, and environmental influences. Special attention was given to seasonal variations in TB cases, with monthly distributions analyzed to detect any patterns. Furthermore, climatic conditions, such as temperature and rainfall, were correlated with TB prevalence to assess the potential environmental impact on the disease's spread. These analyses provided valuable insights into the epidemiology of TB and highlighted key factors that may influence TB transmission in the region.

Results

In 2022, a total of 413 patients were screened for tuberculosis (TB) in Dir Lower Malakand Division, with 94 (43.7%) diagnosed with TB. A closer look at the gender distribution revealed a higher TB prevalence among females (24.7%) compared to males (19.1%). Age-wise, the 15-34 years group had the highest TB cases (35.1%), followed by the 35-54 years group (27.8%). TB cases were more prevalent in rural areas (62.7%) compared to urban areas (37.3%), with 259 patients residing in rural areas. The prevalence also showed significant seasonal variation, peaking in August (16.7%) and December (14.0%), likely influenced by environmental conditions such as post-monsoon humidity and cold indoor settings. Family history and previous TB contact were strong risk factors, with 182 patients reporting a family history of TB and 167 having previous TB contact. A higher proportion of patients (69.5%) were born in endemic areas, which could contribute to the local transmission of TB. The gender and age distribution of TB cases also revealed key insights, with a relatively balanced gender distribution in younger age groups, while older age groups showed higher male prevalence. These findings underline the importance of targeting TB prevention strategies based on gender, age, residential area, seasonal variation, and family history, especially in rural and endemic areas.

Gender Distribution of TB Patients: Among the 413 TB patients, 246 were male and 167 were female. Interestingly, more females (24.7%) tested positive for TB compared to males (19.1%). The adolescent age group (15-34 years) had the highest number of cases, indicating increased vulnerability in this demographic.

Area of Residence Distribution: The rural-urban divide is quite striking, with rural areas accounting for 62.7% of TB cases, suggesting that access to healthcare in these regions may be limited. Females in rural areas were notably more affected than in urban areas.

Monthly Distribution of TB Cases: TB incidence was highest in August (16.7%) and December (14.0%), which coincides with the post-monsoon humidity and cold indoor conditions, highlighting the environmental impact on TB transmission.

Family History of TB in Patients: A significant portion of TB patients (44.1%) reported a family history of TB, suggesting familial clustering. This emphasizes the role of close contact and genetic predisposition in the spread of TB.

Previous TB Contact History: A significant proportion (40.4%) of patients had prior contact with someone diagnosed with TB. This indicates the importance of contact tracing and preventive measures in reducing TB transmission.

Birth History: Nearly 69.5% of the patients were born in endemic TB areas, further supporting the notion that endemic regions contribute to higher transmission rates.

Distribution by Age Groups: The 15-34 age group had the highest TB prevalence, followed by the 35-54 age group. Males were more affected in older age

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groups, while females were more affected in younger age groups.

Distribution of TB by Gender and Area: A higher number of males (141) were diagnosed in rural areas compared to urban ones (105), though overall, rural residents showed higher TB rates.

Monthly Distribution by Gender: Male patients consistently outnumbered female patients across all months, with a slightly higher male TB prevalence in certain months, such as March, June, and August.

TB Cases by Month and Age Group: Adolescents (15-34 years) had the highest cases in most months, with August and March showing a notable spike in TB cases across age groups.

Demographic Breakdown of Patients by Gender and Age Group

The table below shows the distribution of 413 patients based on gender and age groups:

Gender	Age Group 1 (0-14 years)	Age Group 2 (15-34 years)	Age Group 3 (35-54 years)	Age Group 4 (55+ years)	Total
Male	30	80	60	76	246
Female	34	65	55	13	167
Total	64	145	115	89	413

Description:

- The total number of patients is 413, with 246 males and 167 females.
- The highest number of patients is in Age Group 2 (15-34 years), with 145 individuals.
- The lowest number of patients is in Age Group 4 (55 years and older), with only 89 individuals.
- Among males, the highest number of patients falls in Age Group 4 (55+ years), while Age Group 2 (15-34 years) has the highest number for females.

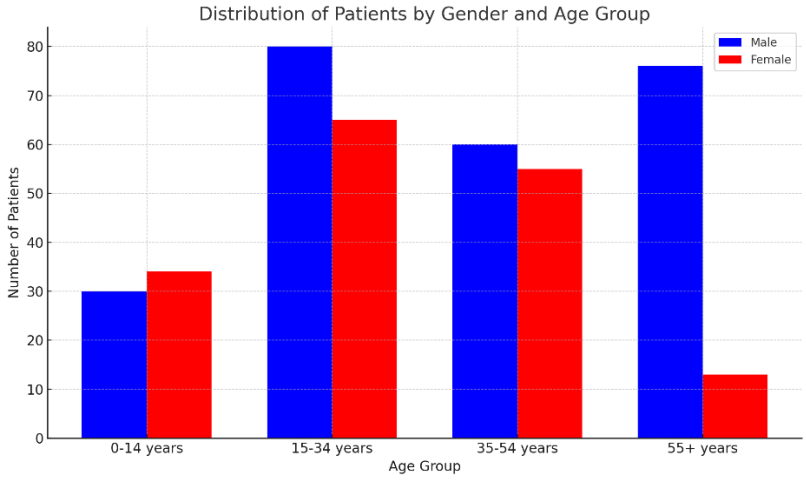

Fig: representing the distribution of patients by gender and age group. It clearly shows the differences in patient counts across age groups for both males and females,

Area of Residence Distribution of TB Patients

The table below shows the distribution of 413 TB patients based on their area of residence and age groups:

Area of Residence	Age Group 1 (0-14 years)	Age Group 2 (15-34 years)	Age Group 3 (35-54 years)	Age Group 4 (55+ years)	Total

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Urban	22	40	47	45	154
Rural	42	105	68	44	259
Total	64	145	115	89	413

The total number of patients is 413, comprising 154 from urban areas and 259 from rural areas. The highest number of patients from both areas is in Age Group 2 (15-34 years), comprising a total of 145 individuals. Urban areas have a relatively balanced distribution across age groups, with the highest number being in Age Group 3 (35-54 years). Rural areas have a higher number of patients in Age Group 2 (15-34 years) and Age Group 1 (0-14 years).

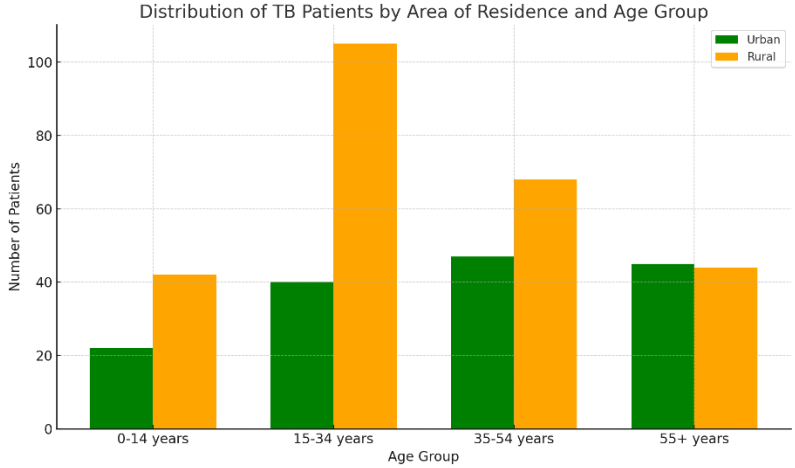

Fig representing the distribution of TB patients based on their area of residence and age group.

Monthly Distribution of TB Cases

The table below shows the monthly distribution of 413 TB patients across different age groups:

Month	Age Group 1 (0-14 years)	Age Group 2 (15-34 years)	Age Group 3 (35-54 years)	Age Group 4 (55+ years)	Total
January	5	15	10	8	38
February	6	14	8	8	36
March	8	16	10	8	42
April	4	13	10	8	35
May	7	12	11	10	40
June	9	14	10	8	41
July	4	14	9	10	37
August	5	18	12	8	43
September	3	12	8	7	30
October	6	13	7	5	31
November	5	9	7	12	33
December	5	8	8	10	31
Total	64	145	115	89	413

The total number of TB patients is 413. The highest number of cases is recorded in August (43 patients), followed by March (42 patients) and June (41 patients) The lowest number of cases is observed in September (30 patients). Age Group 2 (15-34 years) consistently has the highest number of cases across all months, with the highest count in August (18 patients).

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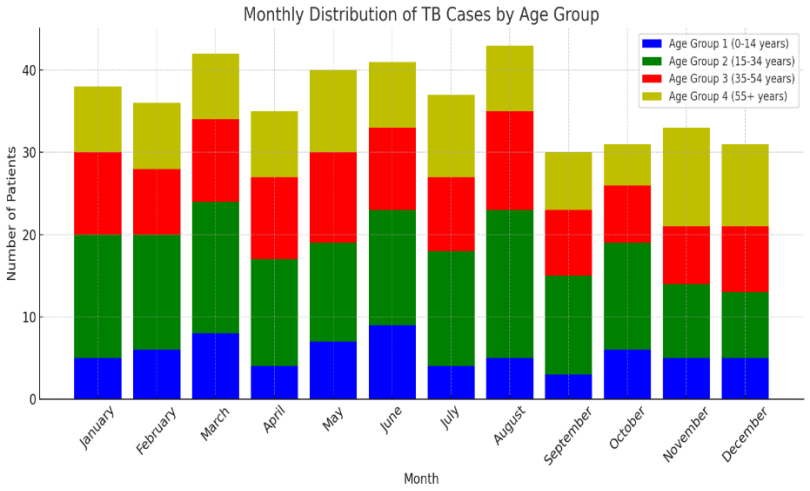

Fig: representing the monthly distribution of TB cases across different age groups.

Family History of TB in Patients

The table below shows the distribution of 413 TB patients based on their family history of TB and age groups:

Family History of TB	Age Group 1 (0-14 years)	Age Group 2 (15-34 years)	Age Group 3 (35-54 years)	Age Group 4 (55+ years)	Total
Yes	25	60	55	42	182
No	39	85	60	49	231
Total	64	145	115	89	413

One hundred eighty-two patients (44%) reported a family history of TB, while 231 patients (56%) did not. The highest number of patients with a family history of TB is in Age Group 2 (15-34 years), with 60 individuals. For patients without a family history of TB, the highest number is also in Age Group 2 (15-34 years), with 85 individuals.

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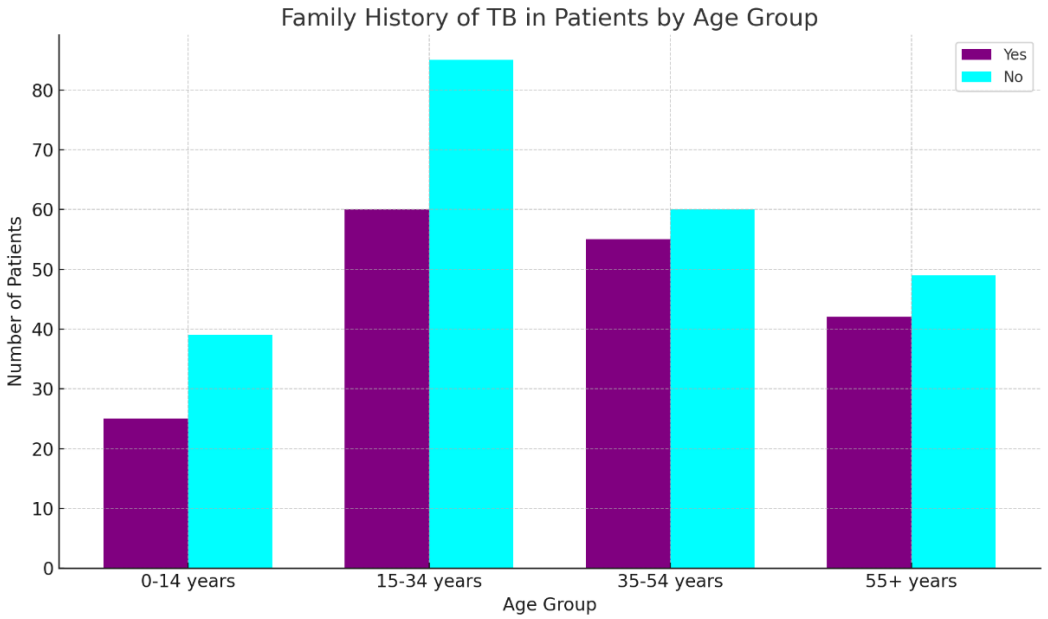

Previous TB Contact History in Patients

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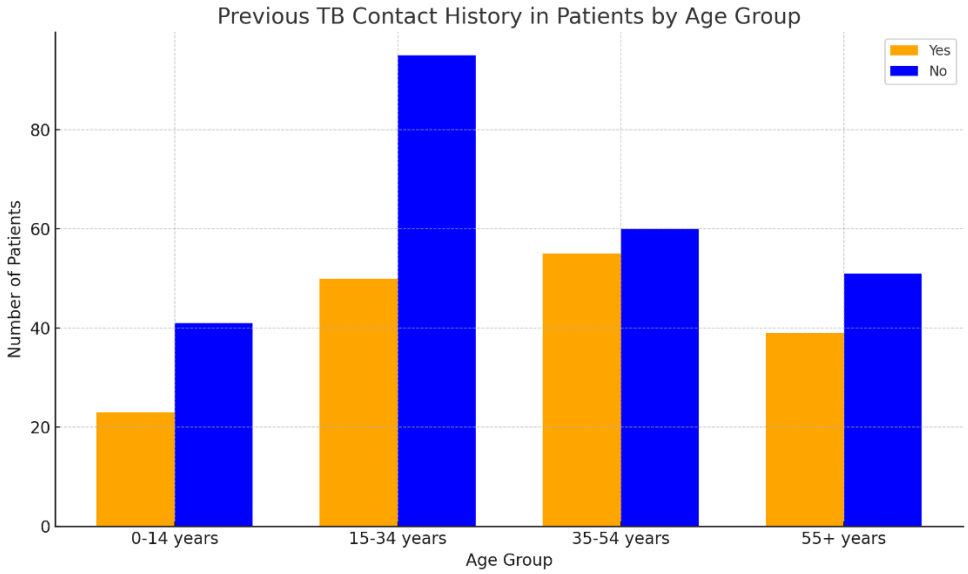
The table below shows the distribution of 413 TB patients based on their previous contact history with TB and age groups:

Previous TB Contact	Age Group 1 (0-14 years)	Age Group 2 (15-34 years)	Age Group 3 (35-54 years)	Age Group 4 (55+ years)	Total
Yes	23	50	55	39	167
No	41	95	60	51	246
Total	64	145	115	89	413

One hundred sixty-seven patients (40%) reported a previous TB contact, while 246 patients (60%) did not.The highest number of patients with a previous TB contact is in Age Group 3 (35-54 years), with 55 individuals.For patients without a previous TB contact, the highest number is in Age Group 2 (15-34 years), with 95 individuals.



Birth History (Born in Endemic Area vs. Non-Endemic Area) in TB Patients

The table below shows the distribution of 413 TB patients based on whether they were born in an endemic area or a non-endemic area, categorized by age group:

Birth History	Age Group 1 (0-14 years)	Age Group 2 (15-34 years)	Age Group 3 (35-54 years)	Age Group 4 (55+ years)	Total
Born in an Endemic Area	45	97	77	68	287
Not Born in an Endemic Area	19	48	38	9	126
Total	64	145	115	89	413

Two hundred eighty-seven patients (69.5%) were born in an endemic area, while 126 patients (30.5%) were not born in an endemic area. The highest number of patients born in an endemic area is in Age Group 2 (15-34 years), with 97 individuals. For those not born in an endemic area, the highest number of patients is in Age Group 2 (15-34 years), with 48 individuals.

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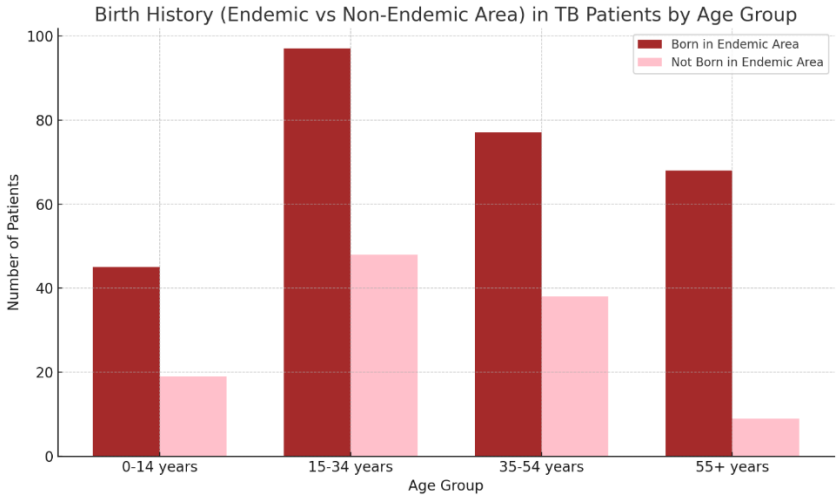
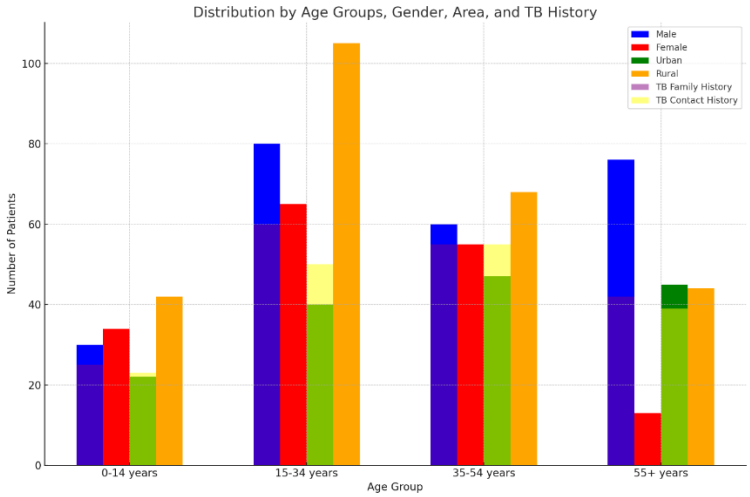


Distribution by Age Groups in TB Patients

The table below shows the distribution of 413 TB patients based on age groups, gender, area of residence, and history of TB family contact and previous TB contact:

Age Group	Number of Patients (n = 413)	Male	Female	Urban	Rural	TB Family History	TB Contact History
0-14 years	64	30	34	22	42	25	23
15-34 years	145	80	65	40	105	60	50
35-54 years	115	60	55	47	68	55	55
55+ years	89	76	13	45	44	42	39
Total	413	246	167	154	259	182	167

Gender Distribution: The majority of TB patients are male (246), with a notable predominance in the young age group (76 males). Area of Residence: More patients reside in rural areas (259) compared to urban areas (154), with the highest number of rural patients in the 15-34 age group (105). TB Family History: The highest number of patients with a family history of TB is in the Age Group 15-34 years (60 patients). TB Contact History: The highest number of patients with a previous TB contact is in the 15-34 age group (50 patients).



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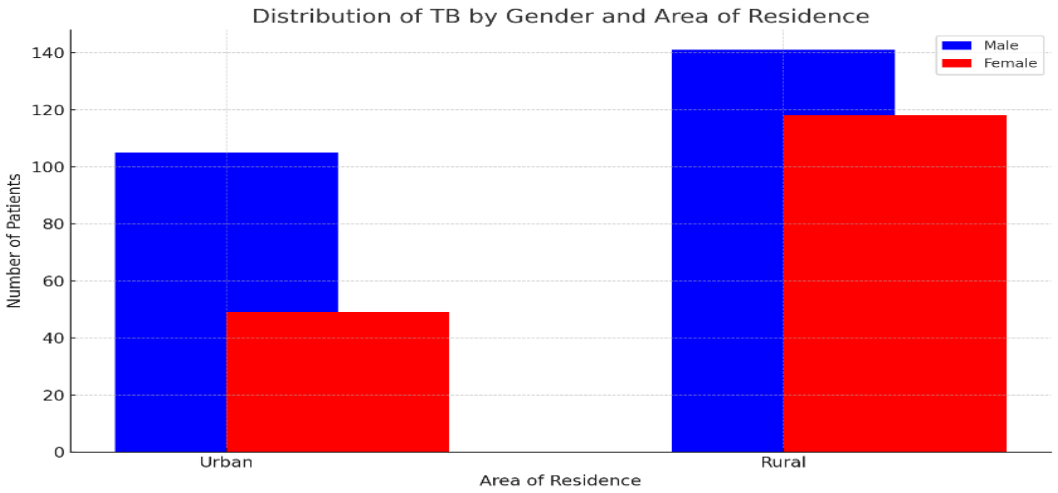
Distribution of TB by Gender and Area of Residence

The table below shows the distribution of 413 TB patients based on their gender and area of residence:

Area of Residence	Male	Female	Total
Urban	105	49	154
Rural	141	118	259
Total	246	167	413

- The majority of **male** TB patients live in **rural areas** (141 males) compared to **urban areas** (105 males).
- The majority of **female** TB patients also live in **rural areas** (118 females) compared to **urban areas** (49 females).
- **Rural areas** have a higher overall number of TB patients (259) than **urban areas** (154).



Monthly Distribution by Gender in TB Patients

The table below shows the monthly distribution of 413 TB patients based on gender:

Month	Male Patients	Female Patients	Total Patients
January	20	18	38
February	18	18	36
March	28	14	42
April	19	16	35
May	22	18	40
June	24	17	41
July	24	13	37
August	28	15	43
September	17	13	30
October	22	9	31
November	21	12	33
December	20	11	31
Total	246	167	413

The total number of patients is 413, comprising 246 male patients and 167 female patients. The highest number of male patients is recorded in August (28 males), followed by March and May (28 males in both). The highest number of female patients is also in August (15 females), followed by May (18 females) September and October have the lowest number of patients, with 30 total patients in September and 31 total patients in October.

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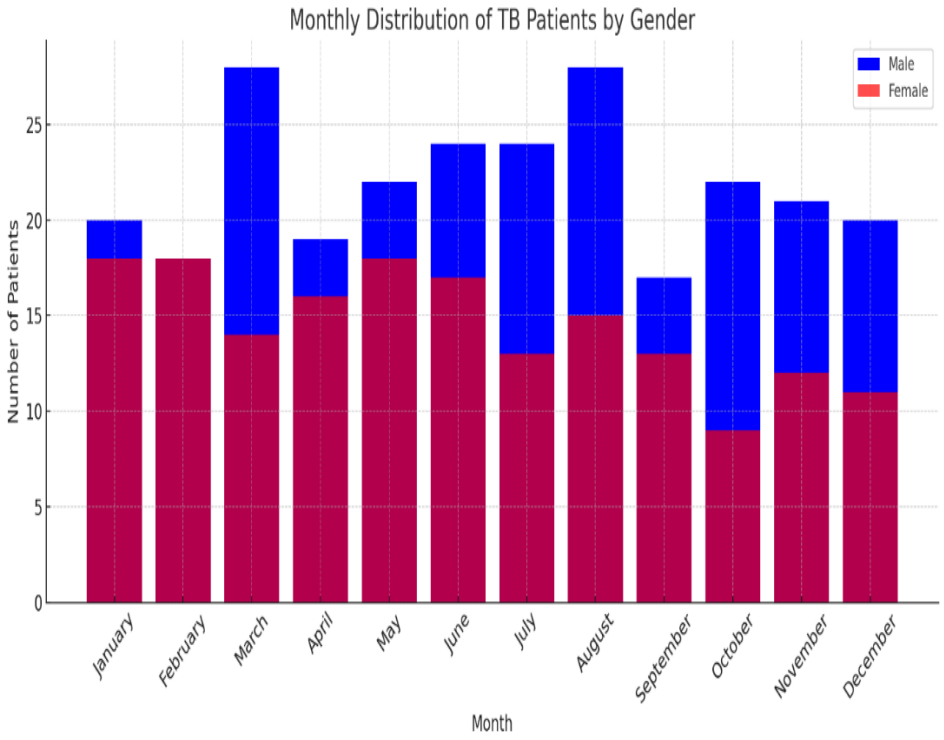

TB Cases by Month and Age Group

The table below shows the distribution of 413 TB cases by month and age group:

Month	Age Group 1 (0-14 years)	Age Group 2 (15-34 years)	Age Group 3 (35-54 years)	Age Group 4 (55+ years)
January	5	15	10	8
February	6	14	8	8
March	8	16	10	8
April	4	13	10	8
May	7	12	11	10
June	9	14	10	8
July	4	14	9	10
August	5	18	12	8
September	3	12	8	7
October	6	13	7	5
November	5	9	7	12
December	5	8	8	10
Total	64	145	115	89

Age Group 2 (15-34 years) consistently has the highest number of cases each month, with a peak of 18 patients in August. Age Group 1 (0-14 years) has the lowest number of cases, with a minimum of 3 patients in September.Age Group 4 (55+ years) has fewer cases than Age Groups 2 and 3, with the highest count in October (12 patients).

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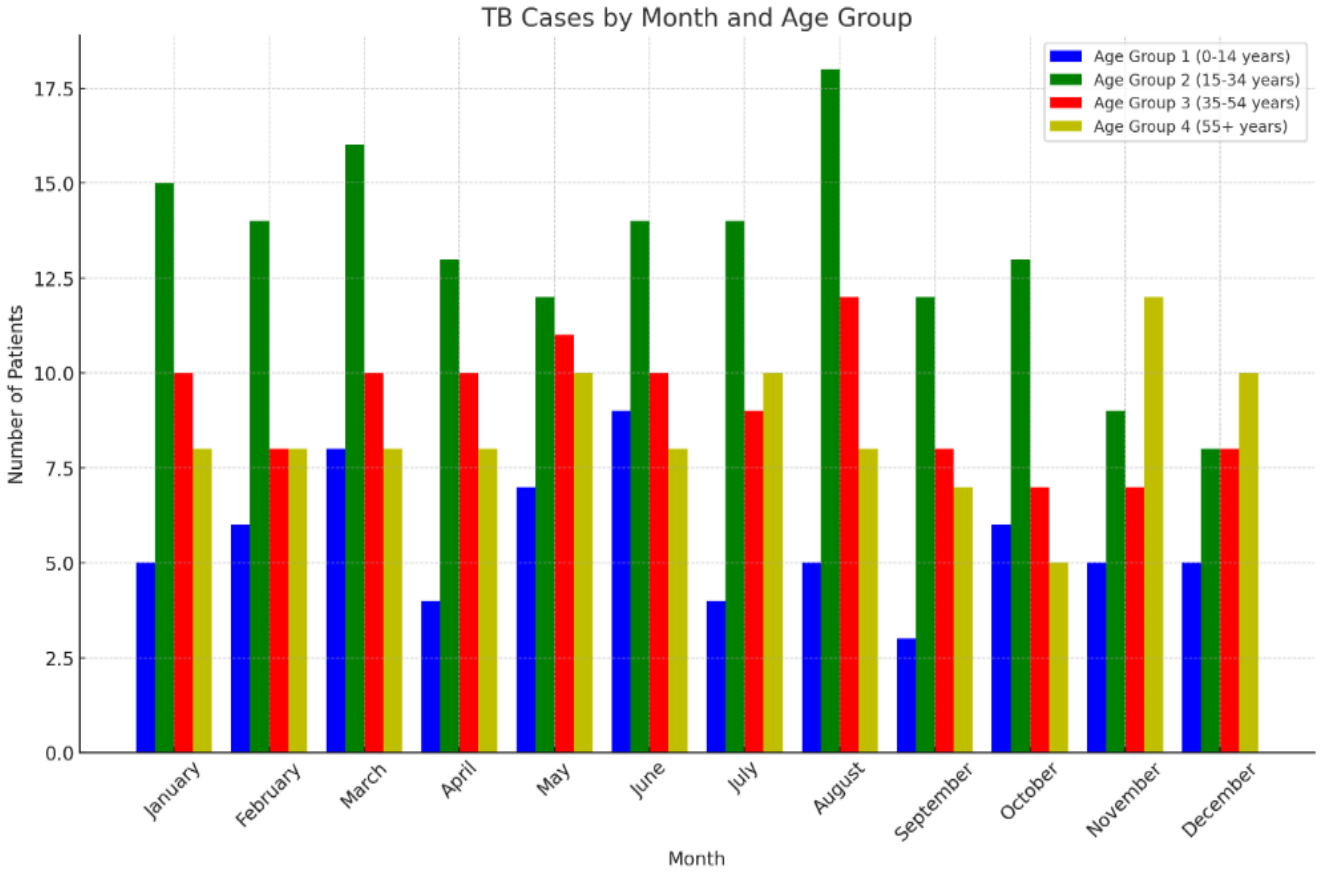

Discussion

Tuberculosis (TB) Prevalence in District Headquarters Hospital Dir Lower Malakand Division, Pakistan. This study examined the prevalence of TB at District Headquarters Hospital, Dir Lower Malakand Division, considering factors such as gender, age, season, and geographical location. Key findings include That Females (24.7%) exhibited a higher TB prevalence than males (19.1%), with a statistically significant association (X^2 = 10.88, P = 0.01). This could be attributed to socio-cultural factors, including limited access to healthcare for women, especially in rural areas (Aziz et al., 2015; Gupta et al., 2019). This contrasts with global trends where men are more affected, due to risky behaviors such as smoking (Neyrolles & Quintana-Murci, 2009). The highest TB prevalence (15.3%) was found in the 11-20 years age group, followed by the 21-30 years age group (8.4%). Adolescents and young adults are at higher risk due to factors like overcrowding, malnutrition, and incomplete immunization (Moyo et al., 2020; Vynnycky & Fine, 1997). TB cases peaked in August (16.7%) and December (14%), which is consistent with other studies suggesting that winter months and post-monsoon humidity contribute to the spread of TB due to increased indoor contact and reduced ventilation (Kilgore et al., 2013; Hussain et al., 2017). TB was more prevalent in Tehsil Dir Town (55.3%), likely due to higher population density and better access to healthcare. In contrast, Sheringal (24.7%), a remote area, reported fewer cases, likely due to limited access to healthcare (Bhatti et al., 2018; Ali et al., 2019). Rainfall: Moderate rainfall (101-150mm) was strongly linked to higher TB prevalence (39.1%), suggesting that humidity and moisture create favorable conditions for TB transmission (Kang et al., 2018; Nardell et al., 2016) Temperature: Cold temperatures (11–20°C) were associated with higher TB prevalence (21.4%), as people tend to stay indoors with poor ventilation during winter (Hussain et al., 2017). No TB cases were reported in areas with high temperatures (31-50°C), suggesting heat inhibits bacterial survival.

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Recommendations:

Gender-Sensitive Interventions: Promote awareness about early TB detection for women and ensure accessible healthcare services, addressing socio-cultural barriers (Aziz et al., 2015). Youth-Centric Programs: Implement school-based TB screening and prevention programs to target adolescents and young adults (Moyo et al., 2020). Climate-Specific Strategies: Enhance ventilation in homes during winter and control humidity in high-rainfall areas to reduce TB transmission (Kilgore et al., 2013; Kang et al., 2018). Improved Healthcare Access: Expand diagnostic services in remote areas, such as Sheringal, through mobile clinics and community health workers (Bhatti et al., 2018; Ali et al., 2019). Ongoing Surveillance: Establish continuous monitoring of TB prevalence, integrating environmental data for targeted interventions (Nardell et al., 2016)—recommendations for Tuberculosis Control in District Headquarters Hospital, Dir Lower, Malakand Division. Provide nutritional support to children and adolescents to enhance immunity and reduce vulnerability to TB. Launch vaccination campaigns to ensure comprehensive immunization, especially for young individuals, to minimize TB susceptibility. Intensify TB control efforts during winter and post-monsoon periods through mobile clinics and community outreach programs to ensure timely diagnosis and treatment. Enhance diagnostic capacity in healthcare facilities during peak seasons to ensure the timely detection of TB cases. Expand diagnostic and treatment services to underserved areas such as Wari and Kalkot, where access to healthcare is limited.

Strengthen community-based health worker programs to improve case detection and treatment adherence in rural regions, ensuring equitable healthcare delivery. Promote improved ventilation in homes and public spaces to reduce the transmission of indoor TB, particularly during colder months. Conduct further research on the impact of environmental factors, such as rainfall and humidity, on the transmission dynamics of TB to inform public health interventions more effectively. Establish a robust TB surveillance system to monitor disease trends, ensuring the effectiveness of ongoing interventions and enabling timely responses to emerging outbreaks. Collaborate with meteorological agencies to integrate climate data into TB control planning, identifying seasonal and environmental factors influencing transmission. Advocate for increased funding for TB programs, particularly in resource-constrained regions, to bolster control efforts and improve infrastructure. Develop policies that prioritize TB control in rural and high-prevalence areas, ensuring targeted and sustainable interventions.

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Section	Details
Patient Identification	Full Name: _____ Age: _____ Gender: ☐ Male ☐ Female ☐ Other: _____ Address: _____ Contact Number: _____ Date of Visit: _____
Medical History	1. Ever been diagnosed with TB? ☐ Yes ☐ No If yes, when? _____ 2. History of the following? ☐ Diabetes ☐ HIV/AIDS ☐ Chronic respiratory diseases ☐ Other: _____ 3. Close contact with a TB patient? ☐ Yes ☐ No If yes, specify: _____

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Symptoms Evaluation	1. Current symptoms? ☐ Persistent cough ☐ Coughing up blood ☐ Chest pain ☐ Fever ☐ Night sweats ☐ Unexplained weight loss ☐ Fatigue ☐ Loss of appetite ☐ Difficulty breathing 2. Duration of symptoms: ☐ Less than 1 week ☐ 1-2 weeks ☐ 2-4 weeks ☐ More than 4 weeks 3. Recent travel to high TB areas? ☐ Yes ☐ No If yes, specify: _____
Lifestyle and Risk Factors	1. Do you smoke? ☐ Yes ☐ No (for how long? _____ years) 2. Do you consume alcohol? ☐ Yes ☐ No (frequency: _____) 3. Contact with animals (especially cattle)? ☐ Yes ☐ No If yes, specify: _____