ORIGINAL RESEARCH

The Epidemiological Characteristics of Pulmonary Tuberculosis in Ganxian District, Ganzhou City, Jiangxi Province, China from 2011 to 2021

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ABSTRACT

Objective • This study aims to understand the characteristics and current situation of pulmonary tuberculosis (PTB) data of Ganxian District, Ganzhou City, Jiangxi Province, China from 2011 to 2021, and to provide data support and a scientific basis for the prevention and control of PTB in the county.

Methods • The data were collected from the National Notifiable Disease Reporting System (NNDRS), which included information reported such as the gender, ethnicity, age, occupation, and diagnostic classification of reported PTB cases. Descriptive statistics were used to describe the characteristics of PTB patients. The SPSS 21.0 data analysis tool was used to analyze patient data, investigating the epidemiological characteristics of PTB in the region.

Results • There were 4962 PTB cases reported from 2011 to 2021 in Ganxian District, with a decreasing trend. In terms of months, March and September had the highest cumulative number of reported cases, with 511 cases (10.3%) and 515 cases (10.4%), respectively. In terms of reported cases by area, Meilin Town and Jiangkou Town had the highest number, with 603 and 519 cases, respectively. In terms of gender, there were more male patients (3743 cases) than female patients (1,219 cases) , which had statistically significant differences ($\chi^2 = 27.0$, $P < .001$). The majority of cases were secondary PTB, with farmers being the most affected (a total of 4287 cases) compared to other occupations. In addition, most patients were aged between 40 and 70 years (a total of 2790 cases). Regarding treatment outcomes, out of 4,962 PTB patients, 2088 were cured, with a cure rate of 42.1%.

Conclusion • Based on the characteristics of PTB in the area, future prevention and control work should focus on males, farmers, young students, and the elderly, while also focusing on the prevention and control of secondary PTB. (*Altern Ther Health Med.* 2024;30(6):181-187).

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INTRODUCTION

Tuberculosis (TB), also known as consumption, is an infectious disease of the respiratory system caused by *Mycobacterium tuberculosis*, with foci primarily in the lung tissue, trachea, bronchi, and pleura.[1] If pulmonary tuberculosis (PTB) is not treated promptly, it may lead to compromised lung function, lung damage, respiratory failure, and other related complications. In severe cases, it can pose a life-threatening risk. Currently, the primary source of TB infection is active tuberculosis patients. In China, PTB is a category B infectious disease legally reported. According to the current standard of "Classification of TB (WS196-2017)", PTB can be classified as latent Mycobacterium TB infection, active TB, and inactive TB. Based on the clinical diagnostic classification, it can be categorized into five types: primary TB, hematogenous disseminated TB, secondary TB, tuberculous pleurisy, and other extrapulmonary TB.[2] In 2014, WHO proposed the End TB Strategy to reduce the incidence of TB to less than 10/100 000 by 2035.[3] Due to the development of socio-economic level and medical and health services in recent years, the incidence and absolute number of TB cases have exhibited a gradual decline in recent years.[4] According to the "Global TB Report 2021" published by WHO, the global population with latent TB infection reached nearly 2 billion. In 2020, the global population of newly diagnosed TB cases reached 9.87 million,[5] with an incidence rate of 127/100 000. The estimated number of cases and incidence rates continue to exhibit a declining

trend[6] but at a slower rate than in previous years. Between 2015 and 2020, the cumulative incidence of TB decreased by 11%. However, TB remains a leading cause of death globally, ranking among the top 10 causes.[7] According to reported data, the estimated number of newly diagnosed PTB patients in China in 2021 is approximately 780 000, representing a decrease of 62 000 compared to the previous year. China still faces immense challenges in the prevention and control of PTB as it continues to hold second place globally, after India.[8] China continues to bear a significant burden of PTB.[9] Despite the slight decline in PTB incidences in recent years, given the substantial population and rapid growth in our country, the prevention and control of PTB still pose a formidable challenge.

PTB is a chronic respiratory infectious disease that is frequently overlooked because of the lack of symptoms or mild symptoms in the early stages.[10] Due to its high contagiousness, PTB can easily cause widespread infection in densely populated places such as schools and factories without effective control measures.[11] As a result, the prevention and treatment of PTB is still a global concern. The number of PTB cases in 20 Pacific island countries and regions in the Western Pacific increased by 29% from 2000 to 2020 in a study. However, the rate of PTB infection in the region showed a decreasing trend from 75/100 000 in 2000 to 50/100 000 in 2020.[12] A study has projected the potential PTB infection rate in China to be about 20% in 2020 using the PTB epidemiological sampling method, which showed a decreasing trend compared to the previous.[13] As a result, people are even more prone to overlook PTB.

PTB shows spatial clustering to some extent, and its differences in the spatiotemporal distribution in different regions may be associated with factors including climate, population, and socio-economic conditions.[14] Given its high infectivity, current research on PTB prevention primarily focuses on time, region, and population, such as obtaining PTB data from 31 provinces and cities in China through spatial and temporal scanning statistics, summarizing the distribution characteristics of spatiotemporal clustering using spatial epidemiological methods, and distinguishing high-risk areas, low-risk areas and high-low-risk areas to enhance PTB prevention and treatment.[15] In addition, scholars in Sudan have developed a digital GIS map of health to collect information on PTB patients and provide health services to reduce local PTB transmission risk and protect the population.[16] Many new approaches to PTB prevention and control have emerged, such as the use of mathematical modeling in predicting the occurrence of PTB.[17] However, the primary objective is to understand the spread range and transmission routes to predict its trajectory and achieve precise prevention and protection of susceptible populations.

To date, there are no available reports on the epidemiological characteristics of pulmonary TB in Ganzhou City, specifically in the Ganxian District. Therefore, this study was conducted to collect and analyze the epidemiological characteristics of PTB in Ganxian District, Ganzhou City, Jiangxi Province, from 2011 to 2021, to provide insights into the prevention and treatment of PTB, to alleviate the burden of PTB disease as well as economic pressure on patients, and subsequently reducing the incidence and mortality rates of PTB in the region.

METHODS

Data source

The data were obtained from the National Notifiable Disease Reporting System (NNDRS)， which included the gender, ethnicity, age, occupation, and patient diagnostic classification of reported PTB cases in the Ganxian district of Jiangxi Province from 2011 to 2021. Inclusion criteria: PTB cases with complete information including gender, ethnicity, age, occupation, and patient diagnostic classification. Exclusion criteria: PTB patients with missing or logically incorrect basic information. Case information from 4962 cases was screened out after excluding incomplete and logically incorrect patient information.

Epidemiological analysis

Using descriptive epidemiological methods, information on the gender, age, occupation, and type of infection among PTB patients in Ganxian District, Ganzhou City, from 2011 to 2021 was analyzed to understand the population distribution and epidemiological characteristics of PTB in the area over the past decade.

Statistical analysis

Data analysis was performed using Statistic Package for Social Science (SPSS) 21 (IBM, Armonk, NY, USA). The data were described by frequency and percentage. The chi-square test was used to compare the incidence rate of registered PTB patients by gender and assess the changing trend in the incidence rate of registered PTB patients by occupation. Statistical significance was set at $P < .05$, with a test level of $\alpha = 0.05$.

RESULTS

Baseline information of patients with PTB

There were 3,743 male patients (75.4%) and 1,219 female patients (24.6%) among the 4962 PTB patients. Regarding the age distribution, 1,003 patients (20.2%) were between 40 and 50 years old, which had the highest proportion of PTB patients. The lowest number of cases was in the 90-100 age group, with only 1 case. In terms of occupation, 4,287 PTB patients (86.4%) were farmers, while in terms of diagnostic classification, 4,478 patients (90.2%) were diagnosed with secondary PTB (Table 1).

Temporal Distribution of PTB Patients in Ganxian District, Ganzhou City, from 2011 to 2021

The reported cases of PTB in Ganxian District, Ganzhou City, exhibited a consistent decrease from 2011 to 2021. The highest number of cases was recorded in 2015 (595), while the lowest was in 2020 (264). There was a slight increase in reported cases from 2011 to 2015, followed by a gradual

Table 1. Baseline Information of Patients with Pulmonary Tuberculosis

Variables	Options	Frequency	Percentage (%)
Gender	Male	3743	75.4
	Female	1219	24.6
Ethnicity	Han Chinese	4960	100.0
	Mongolian	2	0.0
Age (years old)	0~10	14	0.3
	10~20	283	5.7
	20~30	570	11.5
	30~40	596	12.0
	40~50	1003	20.2
	50~60	977	19.7
	60~70	821	16.5
	70~80	550	11.1
	80~90	147	3.0
	90~100	1	0.0
Career	Catering Food Industry	2	0.0
	Staff	42	0.8
	Workers	46	0.9
	Seamen and long-distance drivers	1	0.0
	Housekeeping and pending work	86	1.7
	Teachers	36	0.7
	Retirees	201	4.1
	Civilian workers	14	0.3
	Farmers	4287	86.4
	Diaspora children	5	0.1
	Business Services	27	0.5
	Students	175	3.5
	Medical Staff	20	0.4
	Preschool children	2	0.0
	Other	18	0.4
Patient diagnostic staging	Primary tuberculosis	4	0.1
	Blood-borne tuberculosis	50	1.0
	Secondary tuberculosis	4478	90.2
	Tuberculous pleurisy	413	8.3
	Other extrapulmonary tuberculosis	17	0.3

decline after reaching the peak in 2015. The most significant decline of 2.9% occurred between 2015 and 2016 (Table 2). In terms of monthly distribution, the highest cumulative number of cases was reported in March and September during the survey period from 2011 to 2021, with 10.3% and 10.4%, respectively, and the lowest cumulative number of cases was reported in January during the survey period, with 288 cases, accounting for 5.8% (Table 3).

Regional Distribution of PTB Patients in Ganxian District, Ganzhou City, from 2011 to 2021

The highest number of PTB patients registered in Ganxian District, Ganzhou City were from 2011-2021 Meilin Town (603 cases), Jiangkou Town (519 cases), and Nantang Town (406 cases), while Datian Township and Changluo Township reported the least number of PTB patients with 118 and 85 cases, respectively. The PTB incidence rate reported in the towns has consistently exceeded that of the townships in the area over the past decade (Table 4).

Gender Distribution of PTB Patients in Ganxian District, Ganzhou City, from 2011 to 2021

The study showed that among 4,962 PTB cases reported in the area from 2011 to 2021, 3,743 cases (75.4%) were male, and 1,219 cases (24.6%) were female, revealing a significantly higher incidence in males than in females. In terms of diagnostic subtypes, primary PTB was linked to only a few cases, with 4 cases in total, accounting for 0.1%, all of which were males. Secondary PTB was linked to the highest number of reported cases (4478 cases), accounting for 90.2% of the total number of cases reported. Of these, 3389 were male (68.3%), and 1089 were female (21.9%). The findings revealed a significant gender-based difference in the incidence of PTB in the Ganxian District, Ganzhou City, from 2011 to 2021 ($\chi^2 = 27.0$, $P < .001$) (Table 5).

Table 2. Number of Tuberculosis Reported Per Year in Ganxian District, Ganzhou City, from 2011 to 2021

Year	The reported cases (n)	Frequency (%)
2011	490	9.9
2012	579	11.7
2013	516	10.4
2014	560	11.3
2015	595	12.0
2016	451	9.1
2017	475	9.6
2018	397	8.0
2019	336	6.8
2020	264	5.3
2021	299	6.0
Sum	4962	100.0

Table 3. Number of Tuberculosis Reported Per Month in Ganxian District, Ganzhou City, from 2011 to 2021

Month	The reported cases (n)	Frequency (%)
1	288	5.8
2	375	7.6
3	511	10.3
4	455	9.2
5	467	9.4
6	458	9.2
7	374	7.5
8	438	8.8
9	515	10.4
10	325	6.5
11	360	7.3
12	396	8.0
Sum	4962	100.0

Table 4. Regional Distribution of PTB Patients in Ganxian District, Ganzhou City, from 2011 to 2021

Town	The reported cases (n)	Frequency (%)
Meilin Town	603	12.2
Jiangkou Town	519	10.5
Nantang Town	406	8.2
Tiancun Town	386	7.8
Jipu Town	346	7.0
Wangmudu Town	348	7.0
Hukou Town	293	5.9
Shiwu Town	261	5.3
Hanfang Town	250	5.0
Maodian Town	245	4.9
Shade Town	213	4.3
Chutan Town	157	3.2
Wuyun Town	156	3.1
Dapu Town	153	3.1
Bailu Town	145	2.9
Yangpu Town	140	2.8
Sanxi Town	138	2.8
Datian Town	118	2.4
Changluo Town	85	1.7
Sum	4962	100.0

Table 5. Gender Distribution of PTB Patients in Ganxian District, Ganzhou City, from 2011 to 2021

Patient diagnostic staging	Gender		Sum n (%)	χ^2	*P* value
	Male n (%)	Female n (%)			
Other extrapulmonary tuberculosis	4(0.1)	13(0.3)	17(0.3)		
Secondary tuberculosis	3389(68.3)	1089(21.9)	4478(90.2)		
Tuberculous pleurisy	311(6.3)	102(2.1)	413(8.3)		
Blood-borne tuberculosis	35(0.7)	15(0.3)	50(1.0)		
Primary tuberculosis	4(0.1)	0(0.0)	4(0.1)		
Sum	3743(75.4)	1219(24.6)	4962(100.0)	27.0	<.001

Table 6. Occupational Distribution of PTB Patients in Ganxian District, Ganzhou City, from 2011 to 2021

Career	Patient diagnostic staging (%)					Sum (%)
	Other extrapulmonary tuberculosis	Secondary tuberculosis	Tuberculous pleurisy	Blood-borne tuberculosis	Primary tuberculosis	
Catering Food Industry	0(0.0)	1(0.0)	1(0.0)	0(0.0)	0(0.0)	2(0.0)
Staff	0(0.0)	39(0.8)	3(0.1)	0(0.0)	0(0.0)	42(0.8)
Workers	0(0.0)	42(0.8)	3(0.1)	1(0.0)	0(0.0)	46(0.9)
Seamen and long-distance drivers	0(0.0)	1(0.0)	0(0.0)	0(0.0)	0(0.0)	1(0.0)
Housekeeping and pending work	0(0.0)	77(1.6)	9(0.2)	0(0.0)	0(0.0)	86(1.7)
Teachers	0(0.0)	34(0.7)	1(0.0)	1(0.0)	0(0.0)	36(0.7)
Retirees	0(0.0)	176(3.5)	24(0.5)	1(0.0)	0(0.0)	201(4.1)
Civilian workers	0(0.0)	13(0.3)	1(0.0)	0(0.0)	0(0.0)	14(0.3)
Farmers	14(0.3)	3880(78.2)	350(7.1)	42(0.8)	1(0.0)	4287(86.4)
Diaspora children	0(0.0)	0(0.0)	2(0.0)	2(0.0)	1(0.0)	5(0.1)
Business Services	0(0.0)	23(0.5)	3(0.1)	1(0.0)	0(0.0)	27(0.5)
Students	2(0.0)	158(3.2)	13(0.3)	1(0.0)	1(0.0)	175(3.5)
Medical Staff	0(0.0)	16(0.3)	3(0.1)	1(0.0)	0(0.0)	20(0.4)
Preschool children	0(0.0)	1(0.0)	0(0.0)	0(0.0)	1(0.0)	2(0.0)
Other	1(0.0)	17(0.3)	0(0.0)	0(0.0)	0(0.0)	18(0.4)
Sum	17(0.3)	4478(90.2)	413(8.3)	50(1.0)	4(0.1)	4962(100.0)
χ^2						1000.5
P value						<.001

Table 7. Age Distribution of PTB Patients in Ganxian District, Ganzhou City, from 2011 to 2021

Age	Patient diagnostic staging (%)					Sum (%)
	Other extrapulmonary tuberculosis	Secondary tuberculosis	Tuberculous pleurisy	Blood-borne tuberculosis	Primary tuberculosis	
0~10	0(0.0)	6(0.1)	3(0.1)	2(0.0)	3(0.0)	14(0.3)
10~20	3(0.1)	249(5.0)	25(0.5)	6(0.1)	0(0.0)	283(5.7)
20~30	7(0.1)	487(9.8)	67(1.4)	9(0.2)	0(0.0)	570(11.5)
30~40	1(0.0)	529(10.7)	58(1.2)	8(0.2)	0(0.0)	596(12.0)
40~50	3(0.1)	912(18.4)	82(1.7)	6(0.1)	0(0.0)	1003(20.2)
50~60	1(0.0)	914(18.4)	52(1.0)	9(0.2)	1(0.0)	977(19.7)
60~70	2(0.0)	742(15.0)	72(1.5)	5(0.1)	0(0.0)	821(16.5)
70~80	0(0.0)	505(10.2)	40(0.8)	5(0.1)	0(0.0)	550(11.1)
80~90	0(0.0)	133(2.7)	14(0.3)	0(0.0)	0(0.0)	147(3.0)
90~100	0(0.0)	1(0.0)	0(0.0)	0(0.0)	0(0.0)	1(0.0)
Total	17(0.3)	4478(90.2)	413(8.3)	50(1.0)	4(0.1)	4962(100.0)
χ^2						883.0
P value						<.001

Table 8. Treatment Outcome of Tuberculosis Patients in Ganxian District, Ganzhou City, from 2011 to 2021

Variables		Pathogenetic diagnosis results (%)				
		Positive pathogenicity	Pathogenesis negative	Extrapulmonary tuberculosis	Tuberculous pleurisy	No pathogenic results
Treatment outcome	Healing	2077	3	0	8	0
	Adverse reactions	33	13	0	4	0
	Lost	5	0	0	0	0
	Non-tuberculous deaths	25	15	0	1	0
	tuberculosis death	2	2	0	0	0
	Case Closed	8	0	0	0	0
	Failure	10	4	0	0	0
	Completion of the treatment	32	2069	17	371	20
	Untreated	1	0	0	0	0
	Re-registered cases	1	0	0	0	0
	During the treatment	104	35	0	26	1
	Diagnostic changes	2	1	0	0	0
	Switching to multidrug-resistant therapy	23	0	0	0	0
	Other	28	18	0	3	0
Sum		2351	2160	17	413	21

Occupational Distribution of PTB Patients in Ganxian District, Ganzhou City, from 2011 to 2021

Between 2011 and 2021 in Ganxian District, Ganzhou City, most of the PTB cases were farmers (4287 cases), accounting for 86.4% of the total cases reported. Secondary PTB was the most common subtype among these cases, accounting for 3880 cases (90.5%). Retirees and students had the second highest proportions, with 201 (4.1%) and 175 (3.5%) cases, respectively. Seafarers and long-distance drivers had the lowest proportion, with only one reported case. Regarding the diagnosis of reported cases, primary PTB was linked to the lowest number of cases across all occupations, with only 4 reported cases (0.1%). The highest number of reported cases belonged to the secondary PTB subtype, with 4478 cases (90.2%). Among those, farmers had the highest proportion, while no reported cases were found among diaspora children. In addition, two cases of PTB were reported among preschool children in this area during the decade, with one case of primary PTB and one case of secondary PTB. The findings revealed a significant occupation-based difference in the incidence of PTB in the Ganxian District, Ganzhou City, from 2011 to 2021 ($\chi^2 = 1000.5$, $P < .001$) (Table 6).

Age Distribution of PTB Patients in Ganxian District, Ganzhou City, from 2011 to 2021

The study showed that the number of reported cases of PTB in Ganxian District, Ganzhou City, during 2011-2021 was the highest in the age group of 40-50 years, with 1003 cases (20.2%), followed by the age group of 50-60 years, with 977 cases (19.7%). Among the reported cases, the least number of cases was found in the age group of 90-100 years, with only 1 case, followed by the age group of 0-10 years, with 14 cases reported (0.3%). The age distribution of reported PTB cases over the decade was roughly symmetrical, with most cases concentrated in the 40-70 years interval. The findings revealed a significant age-based difference in the incidence of PTB in the Ganxian District, Ganzhou City, from 2011 to 2021 ($\chi^2 = 883.0$, $P < .001$) (Table 7).

Treatment and Transition of Patients with PTB in Ganxian District, Ganzhou City, from 2011 to 2021

Among 4962 cases of PTB patients in Ganxian District, Ganzhou City, from 2011 to 2021, 2351 cases were pathogenic positive (47.4%), 2160 cases were pathogenic negative (43.5%), 17 cases were extrapulmonary PTB (0.3%), 413 cases were tuberculous pleurisy (8.3%), and 21 cases showed no pathogenic findings (0.4%). Regarding treatment outcomes, among the 4962 cases, 2088 patients were cured (42.1%) and the majority of the patients (2509 cases) completed the treatment course (50.6%). Four patients experienced death due to PTB during the treatment (Table 8).

DISCUSSIONS

As a common infectious disease, PTB exhibits high infectivity. The prevention and treatment of PTB in China is still focused on prevention. Despite continuous technological advancements in PTB prevention and control strategies in

recent years, China still faces significant challenges in its efforts, owing to factors such as a large population base and lifestyle habits. This study primarily investigates the epidemiological distribution of PTB in Ganxian District, Ganzhou City, from 2011 to 2021.

From a temporal perspective, the PTB report rate in Ganxian District, Ganzhou City, has exhibited an overall declining trend over the past decade, aligning with the nationwide pattern of PTB reporting.[18] This may be attributed to the progress made in PTB prevention and control, along with the improvement of the health economy and the enhancement of national health literacy in China.[19] In terms of month distribution, the highest cumulative number of PTB was reported in March and September during the survey period, with 10.3% and 10.4%, respectively, showing a double peak, while the lowest cumulative number of PTB was reported in January, with 5.8%, and its temporal distribution is generally consistent with previous studies.[20] This may be due to the change in natural factors, such as temperature and air humidity, combined with social factors that facilitate the realization of transmission pathways.[21]

From a regional perspective, most of the PTB population in the Ganxian District originated from towns. According to the online data published by the local government, there are 12 towns and 7 townships in the area. The towns generally have larger population and sizes compared to the townships, potentially leading to variations in the number of patients in the area. Among the 19 towns and townships in the area, the incidence of reported PTB cases is significantly higher in the towns than in the townships. Specifically, Meilin Town, which serves as the political and economic center, exhibits the highest rates. Based on the data from the 7th national census, Meilin Town has a population of 220,561 residents, while Wangmudu Town has a significantly smaller population of only 36,016 residents. The larger population of Meilin Town may contribute to the higher number of reported PTB cases compared to other towns. Considering potential differences in living habits and environmental factors among different provinces, Zhanggong District in Ganzhou City, Jiangxi Province, was chosen for comparison. According to the relevant study,[22] the average annual incidence rate of PTB in Zhanggong District from 2016 to 2019 was 69.18/100 000. Combining the statistical yearbook of Ganzhou City, from 2016 to 2019, Ganxian District had an average PTB incidence rate of 62.85/100 000 during the same period. Overall, Ganxian District had a lower PTB incidence rate compared to Zhanggong District, which is under the same jurisdiction.

From a population perspective, the number of male patients significantly exceeded the number of female patients among the 4962 cases of PTB reported in Ganxian District, Ganzhou City, from 2011 to 2021, which is consistent with previous studies.[23] This may be related to the lifestyle habits of male patients; the number of male smokers in China is currently much high female smokers.[24] According to the relevant literature, smoking has been found to increase the susceptibility of Mycobacterium PTB, reduce the cure rate of PTB, and increase the infectiousness of PTB. Hence, the high prevalence of PTB among male patients in Ganzhou City is likely influenced by factors such as smoking. As primary breadwinners in their families, males are often exposed to work difficulties, unhealthy eating patterns, significant life stress, and compromised immune function. These factors substantially impact male patients in the area, increasing their susceptibility to PTB.[25] At the occupational level, PTB is known as a "poverty disease" in some areas of China, with farmers reporting the highest proportion of PTB cases, 36.5%, over 10 years. According to the 2022 census announcement issued by the Ganxian District People's Government, the total population of the area is 641 677, of which 540 131 are engaged in agriculture, accounting for 84.2%. Furthermore, the current health prevention and treatment of PTB in rural areas is still lacking, and most farmers still lack relevant knowledge of prevention and treatment and are weak in self-prevention, resulting in a high rate of PTB reporting among farmers. To prevent and treat PTB in rural areas, it is necessary to improve the level of rural health and increase the rural population's understanding of PTB prevention and treatment, which requires the implementation of relevant health knowledge dissemination strategies.[26] In addition, most farmers do not have a clear retirement age, coupled with the decline of immunity due to aging, leading to more severe PTB among them.[27] The leading underlying cause is the low income of farmers, which prevents them from seeking timely treatment. A potential solution is to increase farmers' income through agricultural development, thus enabling them to afford healthcare expenses and improving overall per capita health expenditure. Moreover, health education on PTB in rural areas should be strengthened, including through the distribution of publicity brochures and knowledge dissemination activities, to raise the level of awareness of PTB among the rural population, as well as to strengthen the awareness of personal prevention of the disease, to achieve the goal of preventing PTB.[28] Elderly people are susceptible to PTB due to the decline of their immune function and the combination of other diseases.[29] In the Ganxian District, the highest age reported for PTB patients is 92 years. The prevalence rate among individuals aged 20 to 30 is 11.5%, which is lower than the province's average prevalence rate of 16.6%.[30] People in this age group have a certain level of health literacy, and PTB prevention and control work will achieve good results for them.[31] Individuals in this age group have better immunity than older people, but the number of PTB reports in the region is close to the 70-80 years age group. Therefore, the region should pay attention to the prevention of PTB among the young population.

Among the 4962 PTB patients, 2,351 cases were found to be pathogenetically positive, with a cure rate of 88.3%, among which 2077 cases were successfully treated. In contrast, among the 2160 pathogenetically negative cases, only 3 cases achieved a cure, resulting in a cure rate of 0.1%. Pathogenetically positive PTB refers to an infection with

active mycobacterium PTB, indicating an inflammatory stage. On the other hand, pathogenetically negative PTB refers to cases where mycobacterium PTB was not detected, which is commonly observed in previously treated patients.[32] This disparity may explain the difference in cure rates between the two groups. Hence, future treatment efforts should prioritize the cure of pathogenetically negative patients with recurrent infections and emphasize preventive measures for successfully treated PTB patients to prevent the occurrence of pathogenetically negative PTB.

This study analyzed the epidemiological characteristics of PTB in Ganxian District, Ganzhou City, Jiangxi Province, from 2011 to 2021, considering factors such as time, region, and demographics (age, occupation, and gender). The elderly, farmers, and males are high-risk groups for PTB, which aligns with findings from other scholars.[33] Among the diagnosed subtypes, secondary PTB had the highest impact, with the highest number of reported cases across all age groups, occupations, and genders. The incidence of secondary PTB accounted for 90.2% of cases. Secondary PTB refers to the recurrence of PTB in patients who have previously been infected with mycobacterium PTB, primarily affecting individuals with previous PTB or those with compromised immune systems.[34] Therefore, in the future, PTB prevention and control efforts should emphasize the prognosis and preventive measures for patients with a history of PTB through public awareness campaigns and interventions to control the occurrence and development of secondary PTB. In addition, the reported cases of PTB in the area have not shown significant fluctuations since 2019. This could be attributed to the initial effects of the "Healthy China 2030" planning outline. Moreover, the outbreak of the COVID-19 pandemic at the end of 2019 and the implementation of closed management policies in many parts of China resulted in the suspension of health check-up programs and limited the deployment of health personnel, leading to a decrease in reported PTB cases in the area.[35] Furthermore, the implementation of epidemic prevention and control measures, such as the deaths of unreported PTB patients due to the pandemic and the community lockdown of PTB patients, might have reduced patient transmission and visits and lowered the number of reported PTB cases.

In conclusion, the PTB prevention and control efforts in Ganxian District, Ganzhou City, from 2011 to 2021, still face challenges. In addition to strengthening active screening for PTB in the area, targeted efforts are required to prevent the disease from affecting younger age groups. Collaboration between various institutions and departments is necessary to focus on vulnerable populations such as the elderly and transient populations, ensure the supply and use of anti-PTB drugs, increase financial investment, and implement favorable incentive policies.[36] Moreover, contagious prevention and detection of PTB need to be improved. The success of these efforts relies on financial, human, and material resources from all levels of government, as well as the coordination and cooperation between designated PTB hospitals and disease prevention and control institutions. Additionally, increasing public awareness, improving hygiene literacy, and reducing PTB infection rates and disease burden should be prioritized among the target population.[37]

CONCLUSION

In conclusion, although the number of reported PTB cases in Ganxian District, Ganzhou City, Jiangxi Province has decreased to some extent, there remains significant pressure for prevention and control. Most of the reported cases are found among middle-aged male farmers. Consequently, the prevention and control of PTB in Ganxian District, Ganzhou City, should focus on male farmers, in addition to young students and the elderly. Therefore, efforts should be made to improve the rural economy, establish a good production and living environment, effectively complete the advancement work, and strengthen the implementation of prevention and control measures. Furthermore, it is crucial to enhance publicity and engage in joint prevention and control activities with designated rural hospitals to decrease the prevalence of PTB in the area.

FUNDING

This study was supported by the Social Science Planning Project of Jiangxi Province (20SH17) and the Science and Technology Project of the Jiangxi Education Department (GJJ191063 and GJJ171078).

ETHICAL COMPLIANCE

This study was approved by the ethics committee of School of Public Health, Xinyu University.

AUTHOR DISCLOSURE STATEMENT

The authors have no potential conflicts of interest to report relevant to this article.

ACKNOWLEDGEMENT

The author thanks the Ganxian District Center for Disease Control and Prevention for their generous support.

AUTHOR CONTRIBUTIONS

XXZ and KL designed the study. HQL, XJL, HC, and HL collected the data. LF, XXZ, and KL analyzed the data. KL, XXZ, and HQL prepared the manuscript. All authors read and approved the final manuscript.

REFERENCES

1. Wang K, Li L, Wang Y, et al. Effect of Baihe Gujin decoction combined with Shengmai powder on the expression of IL-1β and IL-1Ra in peripheral blood CD14+ monocytes from patients with pulmonary tuberculosis. *Cell Mol Biol (Noisy-le-grand)*. 2022;68(2):60-63. doi:10.14715/cmb/2022.68.2.9
2. Hong L, Lin L, Chen J, Wu B. CT Image Features of the FBP Reconstruction Algorithm in the Evaluation of Fasting Blood Sugar Level of Diabetic Pulmonary Tuberculosis Patients and Early Diet Nursing. *Comput Math Methods Med*. 2021;2021(1101930):1101930. doi:10.1155/2021/1101930
3. Stephanie F, Saragih M, Tambunan USF. Recent Progress and Challenges for Drug-Resistant Tuberculosis Treatment. *Pharmaceutics*. 2021;13(5):592. doi:10.3390/pharmaceutics13050592
4. Xue Y, Zhou J, Wang P, et al. Burden of tuberculosis and its association with socio-economic development status in 204 countries and territories, 1990-2019. *Front Med (Lausanne)*. 2022;9:905245. doi:10.3389/fmed.2022.905245
5. Nyirenda JLZ, Wagner D, Ngwira B, Lange B. Bidirectional screening and treatment outcomes of diabetes mellitus (DM) and Tuberculosis (TB) patients in hospitals with measures to integrate care of DM and TB and those without integration measures in Malawi. *BMC Infect Dis*. 2022;22(1):28. doi:10.1186/s12879-021-07017-3
6. Zhang YQ, Li XX, Li WB, et al. Analysis and predication of tuberculosis registration rates in Henan Province, China: an exponential smoothing model study. *Infect Dis Poverty*. 2020;9(1):123. doi:10.1186/s40249-020-00742-y
7. Madukaji L, Okohu I, Usman S, et al. Early detection of Pre-XDR TB with line probe assay in a high TB burden country. *Afr Health Sci*. 2021;21(3):968-974. doi:10.4314/ahs.v21i3.2
8. Singhal T. The New WHO Consolidated Guidelines for Management of Tuberculosis in Children and Adolescents: an Appraisal. *Indian J Pediatr*. 2022;89(8):743-745. doi:10.1007/s12098-022-04280-3
9. Xiao Y, Chen H, Zou Q, et al. The Tuberculosis Positive Conversion Rate Among Psoriasis Patients Treated with Adalimumab and Secukinumab: A Single-Center Retrospective Study in China. *Dermatol Ther (Heidelb)*. 2022;12(6):1493-1500. doi:10.1007/s13555-022-00745-7
10. Chuang LP, Chu CM, Hu HC, Lin YK, Kao KC, Wu HP. Effects of Curcuma longa L., Eucommia ulmoides Oliv. and Gynostemma pentaphyllum (Thunb.) Makino on Cytokine Production in Stimulated Peripheral Blood Mononuclear Cells in Patients with Tuberculosis. *Altern Ther Health Med*. 2022;28(1):72-79.
11. Yoon CG, Kang DY, Jung J, et al. The Infectivity of Pulmonary Tuberculosis in Korean Army Units: Evidence from Outbreak Investigations. *Tuberc Respir Dis (Seoul)*. 2019;82(4):298-305. doi:10.4046/trd.2018.0077
12. Yanagawa M, Morishita F, Oh KH, Rahevar K, Islam TA, Yadav S. Epidemiology of tuberculosis in the Pacific island countries and areas, 2000-2020. *Western Pac Surveill Response J*. 2023;14(1):1-12. doi:10.5365/wpsar.2023.14.1.996

13. Gong W, Wu X. Differential Diagnosis of Latent Tuberculosis Infection and Active Tuberculosis: A Key to a Successful Tuberculosis Control Strategy. *Front Microbiol*. 2021;12(745592. doi:10.3389/fmicb.2021.745592
14. Monteiro de Castro Fernandes F, Couto Junior AF, Braga JU, Oliveira S, Do Socorro Nantua Evangelista M. Environmental and social effects on the incidence of tuberculosis in three Brazilian municipalities and in Federal District. *J Infect Dev Ctries*. 2021;15(8):1139-1146. doi:10.3855/jidc.13674
15. Xue M, Zhong J, Gao M, et al. Analysis of spatial-temporal dynamic distribution and related factors of tuberculosis in China from 2008 to 2018. *Sci Rep*. 2023;13(1):4974. doi:10.1038/s41598-023-31430-0
16. Siddik MSM, Ahmed TE, Awad Ahmed FR, Mokhtar RA, Ali ES, Saeed RA. Development of Health Digital GIS Map for Tuberculosis Disease Distribution Analysis in Sudan. *J Healthc Eng*. 2023;2023:6479187. doi:10.1155/2023/6479187
17. Yang SX, Xu HF, Mao YJ, Liang ZH, Pan CL. Predicting the Number of Reported Pulmonary Tuberculosis in Guiyang, China, Based on Time Series Analysis Techniques. *Comput Math Methods Med*. 2022;2022:7828131. doi:10.1155/2022/7828131
18. Guo Z, Xiao D, Wang X, Wang Y, Yan T. Epidemiological characteristics of pulmonary tuberculosis in mainland China from 2004 to 2015: a model-based analysis. *BMC Public Health*. 2019;19(1):219. doi:10.1186/s12889-019-6544-4
19. Zhou FJ, Wu HZ, Li JW, et al. [Epidemiological characteristics of pulmonary tuberculosis in Guangdong province from 2016 to 2020]. *Zhonghua Liu Xing Bing Xue Za Zhi*. 2022;43(10):1568-1574. doi:10.3760/cma.j.cn112338-20220121-00059
20. Li Y, Zhu L, Lu W, Chen C, Yang H. Seasonal variation in notified tuberculosis cases from 2014 to 2018 in eastern China. *J Int Med Res*. 2020;48(8):300060520949031. doi:10.1177/0300060520949031
21. Ding ZQ, Li YX, Wang XM, et al. The impact of air pollution on the transmission of pulmonary tuberculosis. *Math Biosci Eng*. 2020;17(4):4317-4327. doi:10.3934/mbe.2020238
22. Wang W, Guo W, Cai J, et al. Epidemiological characteristics of tuberculosis and effects of meteorological factors and air pollutants on tuberculosis in Shijiazhuang, China: A distribution lag non-linear analysis. *Environ Res*. 2021;195(110310):110310. doi:10.1016/j.envres.2020.110310
23. Bohlbro AS, Mendes AM, Sifna A, et al. Assessing gender differences among presumed and diagnosed patients with pulmonary TB: observations from Guinea-Bissau. *Trans R Soc Trop Med Hyg*. 2021;115(11):1273-1281. doi:10.1093/trstmh/trab145
24. Fernandes L, Narvekar A, Lawande D. Efficacy of smoking cessation intervention delivered through mobile tele-counseling among smokers with tuberculosis in a Revised National Tuberculosis Control Program. *Indian J Tuberc*. 2022;69(2):207-212. doi:10.1016/j.ijtb.2021.08.017
25. Hussain MI, Ahmed W, Nasir M, et al. Immune modulatory and anti-oxidative effect of selenium against pulmonary tuberculosis. *Pak J Pharm Sci*. 2019;32(2 (Supplementary))(suppl):779-784.
26. Vericat-Ferrer M, Ayala A, Ncogo P, et al. Knowledge, Attitudes, and Stigma: The Perceptions of Tuberculosis in Equatorial Guinea. *Int J Environ Res Public Health*. 2022;19(14):8227. doi:10.3390/ijerph19148227
27. Lang PO, Govind S, Bokum AT, et al. Immune senescence and vaccination in the elderly. *Curr Top Med Chem*. 2013;13(20):2541-2550. doi:10.2174/15680266113136660181
28. Saidi SS, Abdul Manaf R. Effectiveness of family support health education intervention to improve health-related quality of life among pulmonary tuberculosis patients in Melaka, Malaysia. *BMC Pulm Med*. 2023;23(1):139. doi:10.1186/s12890-023-02440-5
29. Cheng J, Sun YN, Zhang CY, et al. Incidence and risk factors of tuberculosis among the elderly population in China: a prospective cohort study. *Infect Dis Poverty*. 2020;9(1):13. doi:10.1186/s40249-019-0614-9
30. Guo Z, Xiao D, Wang X, Wang Y, Yan T. Epidemiological characteristics of pulmonary tuberculosis in mainland China from 2004 to 2015: a model-based analysis. *BMC Public Health*. 2019;19(1):219. doi:10.1186/s12889-019-6544-4
31. Yan WJ, Zhou HY, Yan H. Characterization of and advanced diagnostic methods for ocular tuberculosis and tuberculosis. *Int J Ophthalmol*. 2020;13(11):1820-1826. doi:10.18240/ijo.2020.11.21
32. Luo W, Lin Y, Li Z, Wang W, Shi Y. Comparison of sputum induction and bronchoscopy in diagnosis of sputum smear-negative pulmonary tuberculosis: a systemic review and meta-analysis. *BMC Pulm Med*. 2020;20(1):146. doi:10.1186/s12890-020-01192-w
33. Tao NN, Li YF, Wang SS, et al. Epidemiological characteristics of pulmonary tuberculosis in Shandong, China, 2005-2017: A retrospective study. *Medicine (Baltimore)*. 2019;98(21):e15778. doi:10.1097/MD.0000000000015778
34. Liu ZM, Ai QY, Geng XW, Huang S, Wang JJ, Shi TY. [Pathogenesis of Secondary Pulmonary Tuberculosis and Role of Cord Factor in Secondary Infection]. *Zhongguo Yi Xue Ke Xue Yuan Xue Bao*. 2021;43(3):452-461. doi:10.3881/j.issn.1000-503X.12654
35. Hu YL, Ai P, Jia XJ, et al. [Analysis of epidemiological characteristics of pulmonary tuberculosis patients in Fengtai District, Beijing City from 2011 to 2021]. *Zhonghua Yu Fang Yi Xue Za Zhi*. 2022;56(9):1302-1306. doi:10.3760/cma.j.cn112150-20220408-00338
36. Marahatta SB, Yadav RK, Baral S, et al. Barriers to Treatment Compliance of Directly Observed Treatment Shortcourse among Pulmunary Tuberculosis Patients. *J Nepal Health Res Counc*. 2021;19(3):450-459. doi:10.33314/jnhrc.v19i3.3478
37. Bashorun AO, Linda C, Omoleke S, et al. Knowledge, attitude and practice towards tuberculosis in Gambia: a nation-wide cross-sectional survey. *BMC Public Health*. 2020;20(1):1566. doi:10.1186/s12889-020-09685-3