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Trends and delays in pulmonary tuberculosis diagnosis among elderly patients (≥ 60 Years) in Southern China: a 13-year surveillance data analysis (2010–2022)

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Abstract

Background The prevalence of delays in receiving effective tuberculosis (TB) prevention and control measures is notably high, particularly among elderly patients. This study aims to explore the trends in diagnostic delays and assess the factors associated with these delays among elderly pulmonary tuberculosis (PTB) patients in Guangdong Province, Southern China.

Methods We analyzed surveillance data from the Tuberculosis Information Management System (TBIMS), covering pulmonary tuberculosis cases in Guangdong Province from 2010 to 2022. We categorized patient delay (PD), health system delay (HSD), and total diagnostic delay (TDD) among patients aged 60 years and older. Trends in annual delays were examined using a Joinpoint regression program. Both univariate and multivariate logistic regression analyses were conducted to identify factors influencing TDD.

Results The study found that the notification rate of PTB among elderly patients decreased from 155.85 per 100,000 in 2010 to 71.15 per 100,000 in 2022. However, the proportion of elderly patients among newly diagnosed TB cases increased from 20.66% to 30.37%. The median PD decreased from 29 days to 21 days, while the median HSD increased from 0 days to 3 days. Consequently, the TDD remained stable at 32 days. The average delay rates for PD, HSD, and TDD were 64.80%, 13.90%, and 75.80%, respectively. Joinpoint regression analysis showed a decreasing trend in PD rate and an increasing trend in HSD rate among patients aged ≥ 60 years, but no statistically significant change in TDD rate was observed. Significant risk factors for higher TDD included being a farmer, first visit to non-designated facilities, initial diagnosis at county-level hospitals, passive case finding, residence in underdeveloped areas, and respiratory comorbidities.

Conclusions The burden and delays associated with TB diagnosis remain significant among the elderly in Southern China. Enhanced health education and proactive screening efforts are crucial for this high-risk group to mitigate diagnostic delays, particularly for those with respiratory comorbidities and in less developed regions. Future research

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should focus on addressing these barriers and evaluating the effectiveness of tailored interventions to improve TB control strategies for the elderly.

Keywords Pulmonary tuberculosis, Delay, Joinpoint regression, Logistic regression, The elderly

Introduction

Tuberculosis (TB) continues to pose a severe threat to global public health, having reclaimed its position as the leading cause of death worldwide from a single infectious agent, surpassing human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS), highlighting the urgent need for effective control measures [1]. Among high-risk groups, the elderly population is particularly vulnerable, facing a disproportionate burden of TB, especially in the Western Pacific region [2]. This vulnerability is exacerbated by the aging population, a trend that is notably pronounced in countries like China.

China ranks the third highest burden country globally in new TB cases, contributing approximately 6.8% [1]. This substantial impact is further compounded by the country's rapidly aging population. This demographic shift presents a unique challenge, as the elderly are more susceptible to TB due to their weakened immune systems and the presence of multiple comorbidities [3, 4]. The intersection of these two factors—an aging population and a high TB burden—necessitates a focused examination of TB control measures tailored to the elderly.

Previous studies have highlighted that China's aging population significantly impacts TB control efforts, with the elderly being particularly susceptible to the disease [5, 6]. The importance of early and timely diagnosis in reducing TB incidence has been emphasized, and the experience of countries like Japan demonstrates the significant impact of elderly TB control on national TB programs [7, 8]. Conversely, diagnostic delay can exacerbate disease progression, worsen clinical outcomes, and facilitate TB transmission within the community [9]. However, despite these insights, there remains a gap in the systematic interpretation of all stages of diagnostic delay specifically among the elderly.

This gap is particularly pronounced in regions like Guangdong, which bears the heaviest TB burden in China [10, 11]. The need for region-specific data is critical, as it can inform tailored interventions and control measures. Delays in diagnosis and treatment among the elderly in Guangdong may exacerbate the TB burden, highlighting the urgent need for focused research in this area [12].

The present study aims to address this gap by analyzing the trends of pulmonary tuberculosis (PTB) with Patient Delay (PD), Health System Delay (HSD), and Total Diagnostic Delay (TDD) in Southern China from 2010 to 2022. Utilizing 13 years of surveillance data, this study seeks to provide a comprehensive analysis of diagnostic delay patterns and their determinants among elderly PTB patients aged 60 years and above. By applying rigorous statistical methods, the study will examine trends and correlations to identify associations between influencing factors and TDD. These findings will be instrumental in formulating recommendations for improving TB diagnosis and control measures tailored to the elderly population in Guangdong. By addressing the specific challenges faced by this demographic, the study aims to contribute to the broader goal of reducing TB incidence and improving public health outcomes in China.

Materials and methods

Regions involved in this study

Guangdong, located in the Southern China, is the most economically developed province with a permanent population of 126.57 million in 2022 [13]. It comprises of 21 prefecture-level cities and nine of them in the central area make up a more developed area known as the Pearl River Delta region (PRDR) and other cities make up underdeveloped areas including the Eastern Guangdong (EG), Western Guangdong (WG) and Northern Guangdong (NG) (Fig. 1). The level of economic development in Guangdong presents a regional imbalance, where the GDP per capita in PDR is eight times higher than EG, WG and NG [13]. The number of elderly population aged 60 years and above was over 1.7 million in the end of 2022, which accounts for 13.45% of the total population [13].

PRDR consists of 9 cities including Guangzhou (GZ), Shenzhen (SZ), Foshan (FS), Dongguan (DG), Huizhou (HZ), Zhongshan (ZS), Zhuhai (ZH), Jiangmen (JM) and Zhaoqing (ZQ). EG consists of Shantou (ST), Shanwei (SW), Jieyang (JY) and Chaozhou (CZ).WG consists of Zhanjiang (ZJ), Maoming (MM), Yangjiang (YJ) and Yunfu (YF). NG consists of Meizhou (MZ), Heyuan (HY), Qingyuan (QY) and Shaoguan (SG).

Data source and collection

Data source

Data was extracted from the Tuberculosis Information Management System (TBIMS) [14], which was a comprehensive, nationwide and internet-based system. The TBIMS collected socio-demographic and clinical information at the time of patients' registration and during management. The demographic information included age, gender, ethnicity, occupation, residence, and vulnerability status. The clinical information included the

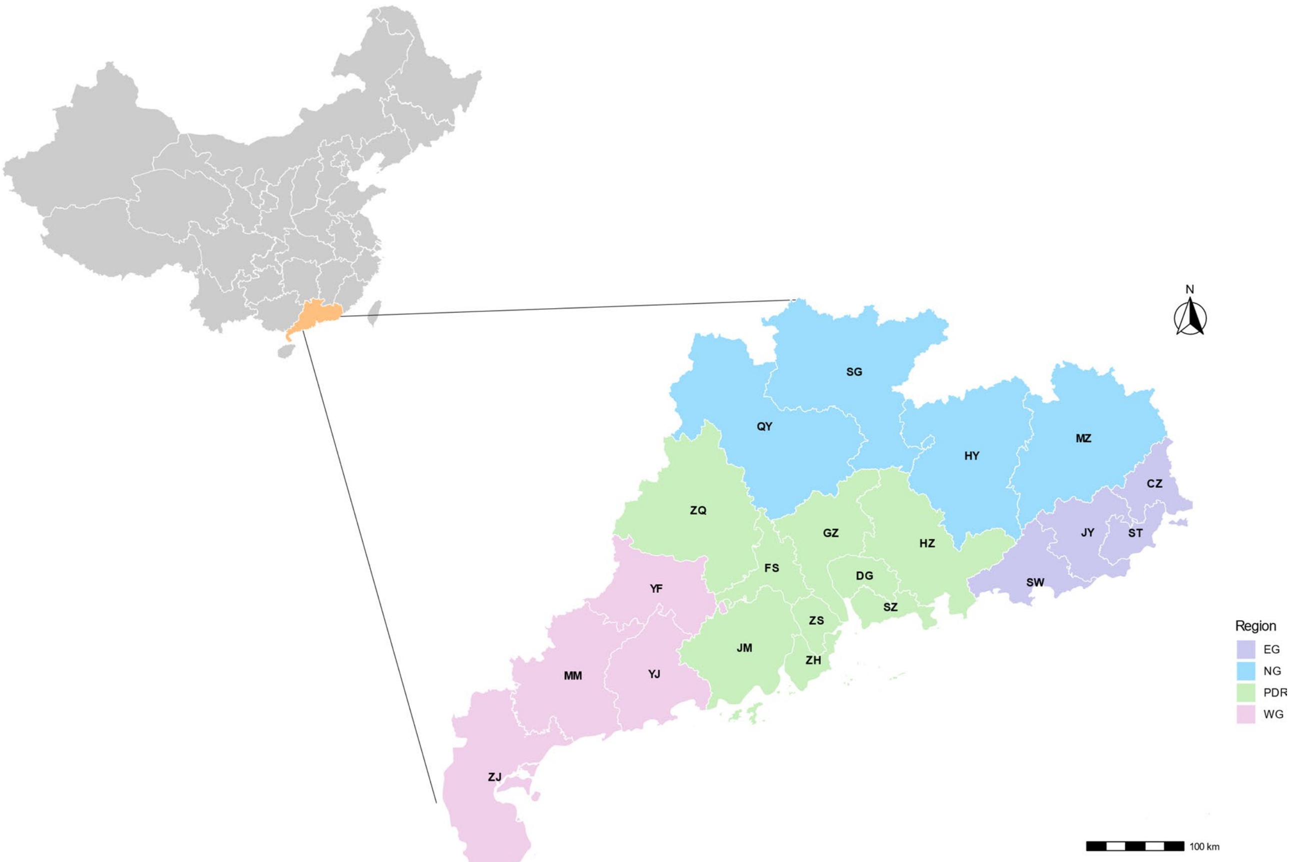

Fig. 1 Regions of Guangdong Province involved in the present study

following aspects: institutional category of the first medical visit (designated TB care facilities/non-designated facilities), hospital levels of initial diagnosis (provincial and prefecture-level/county-level), methods of case finding (active/passive), time of case finding (before COVID-19/during COVID-19), region of case finding (developed area/underdeveloped area), etiological diagnosis (positive/negative), treatment category (new/retreated), HIV/AIDS (yes/no), diabetes mellitus (DM) (yes/no), and respiratory comorbidities (yes/no). The other important dates registered included date of symptom onset, first doctor visit, diagnosis, registration, treatment initiation and end.

Inclusion and exclusion criteria

PTB cases were included if they met the following criteria(Fig. 2):

Inclusion criteria:

- Confirmed or clinically diagnosed PTB according to WS288-2008/2017 guidelines.

Exclusion criteria:

-Nontuberculous mycobacteria(NTM) ($n = 837$);

-Extrapulmonary TB ($n = 1{,}827$);

-Outliers (Interval from onset to confirmation of PTB was less than 0 or more than 10 years, $n = 5{,}962$);

-Missing variables ($n = 216$);

- Aged < 60 years at diagnosis($n = 594{,}302$).

Definitions

In China, PTB cases were identified using the national diagnostic criteria for PTB (WS288-2008 and WS288-2017) and the classification for TB (WS196-2001 and WS196-2017). All reported PTB cases encompassed both laboratory-confirmed and clinically diagnosed cases. Laboratory confirmation of PTB was established through bacteriological evidence obtained from sputum smear, sputum culture, or eligible rapid diagnostic technology. Clinically diagnosed PTB was characterised by clinical symptoms, chest imaging, epidemiological evidence, and immunological results.

We adopted the framework of time delay by the WHO [15]. Within this framework, PD refers to the period from symptom onset to the first medical consultation, while HSD pertains to the period from the first medical consultation to the diagnosis of TB [4]. TDD encompasses the time from the onset of symptoms to TB diagnosis. The conceptual framework on definitions of delay was

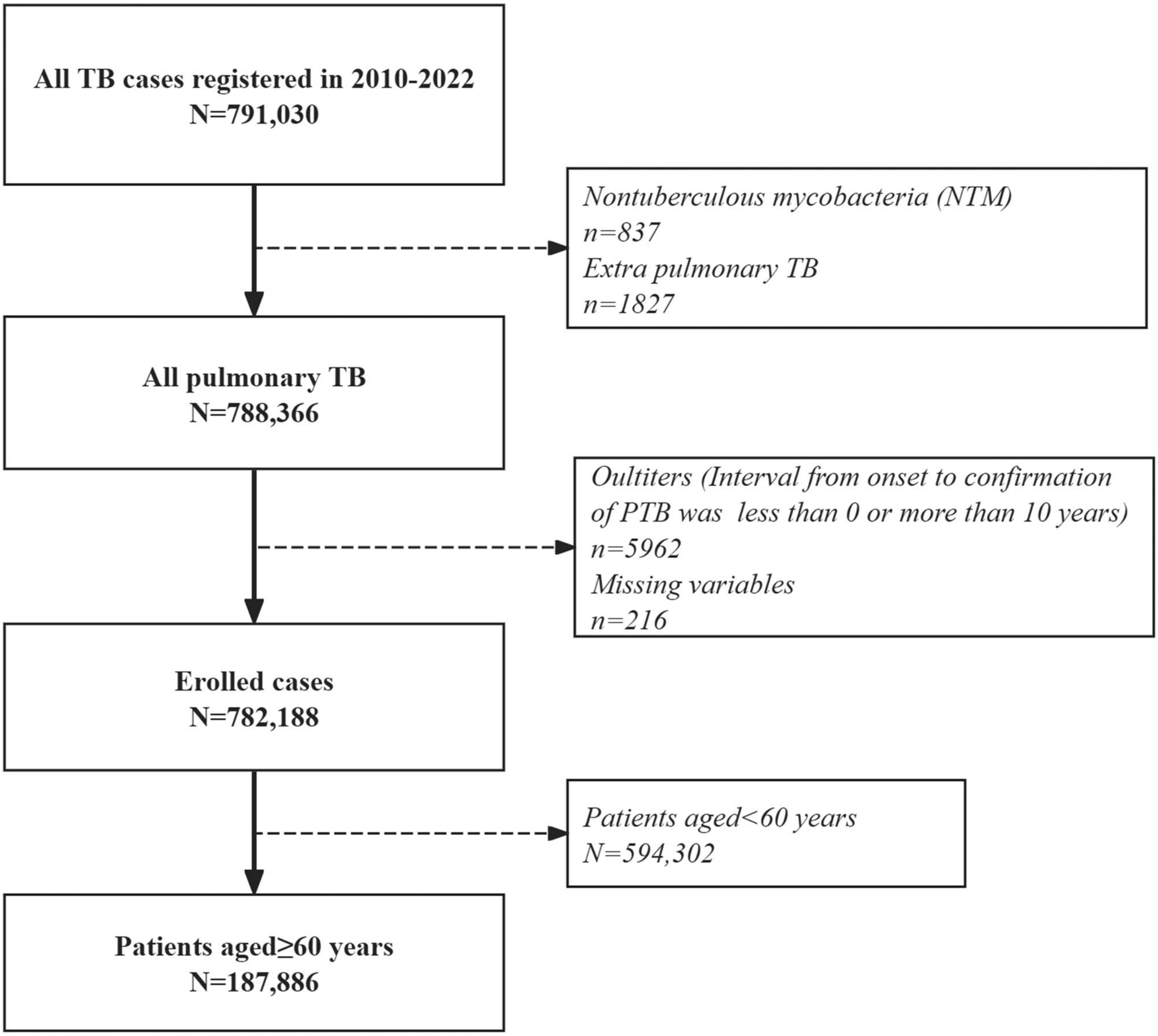

Fig. 2 Enrollment of PTB patients in this study

displayed in S1 Fig. The cut-off point for analysing PD and HSD was set at 14 days, and for TDD was set at 28 days, meaning that values above the cut-off point were defined as delays. The set standard for PD/HSD (14 days) and TDD (28 days) was aligned with studies in high-burden settings [16, 17]. The delay rate is calculated as the annual number of individuals experiencing delay, divided by the total number of individuals.

Statistical analysis

Descriptive analysis

Demographic data was analysed descriptively using R software (version 4.3.2, R Foundation for Statistical Computing). Continuous variables were presented as median and interquartile ranges (IQR), while categorical variables were expressed as count and percentages. Mantel-Haenszel χ^2 test was used to analyze the annual trend.

Time trend analysis

To calculate the annual percent change (APC) in the delay rate of PTB and identify a trend, we used Joinpoint software (Joinpoint Regression Program, Version 5.0; Statistical Methodology and Applications Branch, Surveillance Research Program, National Cancer Institute). APCs represented changes within a specific period. An "increasing or decreasing" trend was defined if APC significantly differed from zero (APC > 0: an increasing trend; APC < 0: a decreasing trend). If not, the trend was defined as "stable". By dividing the study period into various intervals, the Joinpoint regression method optimises the trend for each interval, thereby providing a detailed evaluation of interval-specific disease characteristics [18]. The trend over the entire time series can be summarized using the average annual percent change (AAPC), calculated as the weighted average of the APCs. The model identifies statistically significant turning points and calculates the corresponding *t*-value and *P*-value through Monte Carlo permutation testing. It then selects the best-fit models based on the Bayesian information criterion. In this study, the dependent variables were PD rate, HSD rate, and TDD rate per year, while the independent variable was time (the year of patients' notification). A statistically significant trend change in this time segment was indicated when the APC or AAPC had a $P < 0.05$ and the 95% confidence intervals (*CI*) did not include 0.

Analysis on influence factors of TDD

To identify the factors affecting TDD among elderly patients, univariate and multivariate logistic regression analyses were conducted with crude and adjusted odds ratios (*c*OR and *a*OR) and 95% *CI*, respectively. A *P*-value of less than 0.05 was considered statistically significant.

Results

Notification numbers and rates of PTB patients

In total, 791,030 TB cases were recorded in Guangdong Province from 2010 to 2022. According to the inclusion and exclusion criteria, consequently 187,886 patients aged 60 years and above were included in the present study. The notification rate for this age group decreased from 155.85 per 100,000 in 2010 to 71.15 per 100,000 in 2022, with an annual decline rate of 6.33% (χ^2 = 8157.48, $P < 0.001$). The percentage of newly diagnosed TB patients aged 60 years and above increased from 20.66% in 2010 to 30.37% in 2022, with an annual growth rate of 3.26% (χ^2 =3827.89, $P < 0.001$) (Table 1).

Interval days and delay rates of PTB patients

The median and IQR of PD, HSD and TDD from 2010 to 2022 among patients aged 60 years and above were 27 (8–61) days, 1 (0–6) days and 32 (15–68) days, respectively. The interval days of PD decreased from 29 (9–62) in 2010 to 21 (6–56) in 2022, while the interval days of HSD increased from 0 (0–3) to 3 (0–12). And the interval days of TDD remained stable at 32 days. The average delay rates of PD, HSD, and TDD from 2010 to 2022 were 64.80%, 13.90%, and 75.80%, respectively. The delay rate of PD decreased from 66.08% in 2010 to 59.09% in 2022, while the delay rate of HSD increased from 8.42% to 21.47%. The delay rate of TDD showed a slight increase from 73.76% in 2010 to 75.06% in 2022. Details are shown in Table 2.

Time trends of delay rate

Joinpoint regression analysis revealed a downward trend of PD rate among patients aged 60 years and above from 2010 to 2022, with AAPC of -0.73% (95% *CI*, -1.37 to-0.14) and from 2014 to 2022 with an annual percent change (APC) of -1.55% (95% *CI*, -4.29 to-1.02). Upward trends in HSD rate were observed with the AAPC of 8.63% (95% *CI*, 7.77 to 9.29), and from 2010 to 2015 with an APC of 6.46% (95% *CI*, 2.06 to 8.33) and from 2015 to 2019 with an APC of 15.16% (95% *CI*, 12.21 to 19.15). However, no statistically significant change in TDD rate was found among patients aged 60 years and above from 2010 to 2022, remaining around 75.80%. Additional details are displayed in Table 3 and S2 Fig.

Table 1 Notification numbers and rates of PTB patients aged ≥ 60 years

Year	Number of patients notified (*n*)	Notification rate (1/100000)	Notified percentage of patients aged ≥ 60 years among all patients (%)
2010	15,482	155.85	20.66
2011	14,502	128.71	19.58
2012	15,303	138.53	21.26
2013	14,712	139.95	21.68
2014	15,232	140.11	22.68
2015	15,683	143.92	24.63
2016	14,693	123.28	24.32
2017	14,983	117.02	25.12
2018	14,853	113.11	26.49
2019	14,339	100.52	27.13
2020	12,834	87.03	27.03
2021	13,465	86.51	28.54
2022	11,805	71.15	30.37
Annual rate	-	-6.33%[a]	+3.26%[b]
Trend χ^2 test	-	χ^2 =8157.48, $P < 0.001$	χ^2 =3827.89, $P < 0.001$

a: The annual decline rate of notification rate among patients aged ≥ 60 years was 6.33%. b: The annual growth rate of patients aged ≥ 60 years was 3.26%

Table 2 Interval delays of PTB patients aged ≥ 60 years notified from 2010 to 2022 in Guangdong Province, China

Year	PD		HSD		TDD	
	Days (median, IQR)	**Cases and rate (*n*, %)**	**Days (median, IQR)**	**Cases and rate (*n*, %)**	**Days (median, IQR)**	**Cases and rate (*n*, %)**
2010	29 (9–62)	10,230 (66.08)	0 (0–3)	1303 (8.42)	32 (14–68)	11,419 (73.76)
2011	29 (9–62)	9528 (65.70)	0 (0–3)	1209 (8.34)	32 (14–65)	10,605 (73.13)
2012	29 (8–62)	10,085 (65.90)	0 (0–3)	1394 (9.11)	32 (14–67)	11,267 (73.63)
2013	30 (10–61)	9943 (67.58)	1 (0–4)	1417 (9.63)	33 (14.75-66)	11,121 (75.59)
2014	29 (10–64)	10,376 (68.12)	1 (0–3)	1614 (10.60)	32 (15–70)	11,709 (76.87)
2015	30 (10–67)	10,695 (68.19)	1 (0–4)	1759 (11.22)	33 (16–76)	12,131 (77.35)
2016	27 (8–61)	9465 (64.42)	1 (0–5)	1928 (13.12)	32 (15–66)	11,042 (75.15)
2017	26 (7–61)	9492 (63.35)	1 (0–6)	2100 (14.02)	32 (14–66)	11,225 (74.92)
2018	26 (7–61)	9488 (63.88)	1 (0–8)	2518 (16.95)	33 (15–71)	11,376 (76.59)
2019	28 (8–61)	9362 (65.29)	2 (0–11)	2826 (19.71)	35 (17–72)	11,387 (79.41)
2020	25 (7–62)	8056 (62.77)	2 (0–11)	2587 (20.16)	34 (16–73)	10,009 (77.99)
2021	23 (6–58)	8127 (60.36)	2 (0–12)	2936 (21.80)	33 (15–70)	10,262 (76.21)
2022	21 (6–56)	6976 (59.09)	3 (0–12)	2534 (21.47)	32 (15–67)	8861 (75.06)
2010–2022	27 (8–61)	121,823 (64.80)	1 (0–6)	26,125 (13.90)	32 (15–68)	142,414 (75.80)

Table 3 Joinpoint analysis of delay rate among PTB patients aged ≥ 60 years notified from 2010 to 2022 in Guangdong Province, China

Delays	Year	APC (95% CI)	*P* value	AAPC (95% CI)	*P* value
PD	2010–2014	0.94 (-0.54 to 5.13)	0.353	-0.73 (-1.37 to-0.14)*	0.002
	2014–2022	-1.55 (-4.29 to -1.02)*	0.001		
HSD	2010–2015	6.46 (2.06 to 8.33)*	0.003	8.63 (7.77 to 9.29)*	< 0.001
	2015–2019	15.16 (12.21 to 19.15)*	0.003		
	2019–2022	3.94 (-1.19 to 7.20)	0.209		
TDD	2010–2020	0.62 (-0.01 to 2.94)	0.113	0.15 (-0.25 to 0.70)	0.381
	2020–2022	-2.12 (-4.69 to 0.56)	0.416		

*: $P < 0.05$

Influencing factors of TDD

Univariate and multivariate logistic regression analyses were performed to identify significant variables influencing TDD (0 = no, 1 = yes). Higher TDD was observed in farmers (*a*OR: 1.12, 95% *CI*: 1.09–1.15), patients visiting non-designated facilities for their first doctor visit (*a*OR: 1.18, 95% *CI*: 1.10–1.26), patients receiving initial diagnosis at county-level hospitals (*a*OR: 1.06, 95% *CI*: 1.03–1.09), patients identified through passive finding methods (*a*OR: 1.07, 95% *CI*: 1.05–1.10), patient located in underdeveloped area (*a*OR: 1.41, 95% *CI*: 1.38–1.44), and patients with respiratory comorbidities (*a*OR: 1.86, 95% *CI*: 1.74–1.99) were identified as risk factors for higher TDD in PTB patients aged 60 years and above. Conversely, being male (*a*OR:0.95, 95% *CI*:0.93–0.98) was considered a protective factor with a lower TDD rate of 75.7%, as presented in Fig. 3 and S1 Table.

Discussion

To the best of our knowledge, this study is pioneering in its investigation of diagnostic delay among the elderly patients aged 60 years and above in China. It yields three crucial findings. Firstly, while the notification rate of patients aged 60 years and above decreased, the proportion of these patients among newly diagnosed TB cases increased annually. Secondly, there was a decrease in both the number of days and the rates of PD among this demographic, whereas the number of days and rates of HSD increased, resulting in a relatively stable trend in the TDD. Thirdly, elderly patients with respiratory comorbidities have higher risk of TDD, particularly in underdeveloped areas, exhibited a higher risk of TDD. Given the global rise in elderly populations, the insights from this study could inform TB control policies, especially in underdeveloped regions or areas with constrained health resources.

Projections indicate that the proportion of individuals aged 60 and above in China could increase from 12.4% (168 million) in 2010 to 28.0% (402 million) by 2040 [19]. Recent studies indicate that TB notification rates increase with age globally [20, 21]. Similar results were observed in our study, with an increasing proportion of elderly individuals among the total notified PTB cases. On one hand, factors such as gradual immune deterioration, malnutrition, poverty, reduced access to health services, and comorbidities likely contribute to the heightened TB risk in aging populations [4, 16]. On the other hand, it is estimated that 90% of TB cases in the elderlies result from the reactivation of latent TB infection acquired earlier in life, rather than recent transmission [22]. The snowballing effect of accumulated long-term latent TB reactivation

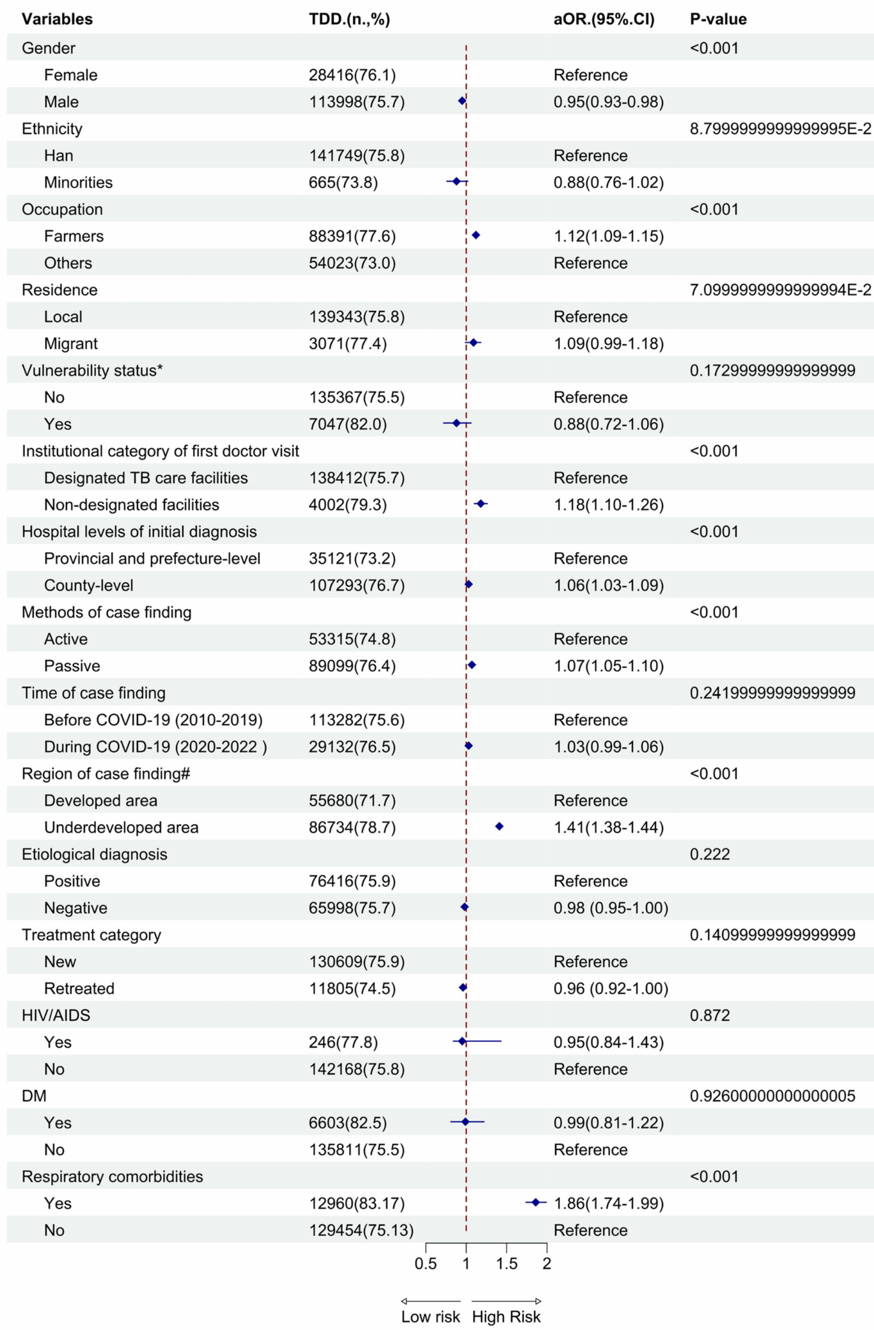

Fig. 3 Forest plot of the influencing factors analysis for TDD among patients aged ≥ 60 years. **vulnerability status* was defined as being a close contact of active PTB patients, working in healthcare or school/daycare settings, serving as a supervisor in prisons or detention centers, working in animal husbandry, being a dust collector or having pneumoconiosis, having a psychiatric disorder, residing in nursing or welfare facilities, or living in other crowded environments. #*Region of case finding* included developed area (PRDR) and underdeveloped area (EG, WG and NG)

may result in a substantial increase in the burden among elderly PTB patients. According to China's Fifth National Prevalence Survey of Tuberculosis, a substantial portion of the elderly were asymptomatic, with 53.2% opting not to seek medical care [23], underscoring the urgent needs to address PTB among these populations.

Our findings revealed a median of TDD of 32 days with a relatively stable trend among patients aged 60 years and above. Within China, the PD of elderly patients in Guangdong (21–29 days) was longer than Zhejiang (3–17 days) [9], likely reflecting regional disparities in healthcare access. The median HSD in Guangdong (3 days) was shorter than India (5.57–11.44 days) [24]. Since 2011, China's new service delivery model, which shifted TB diagnosis and treatment from CDCs to designated TB care facilities, has improved TB diagnosis timeliness [25]. However, our data show contradictory trends between PD and HSD. The decrease in PD might suggest some success in public health campaigns aimed at raising awareness and reducing barriers to healthcare access among elderly populations. More importantly, the increase in HSD highlights significant shortcomings within the healthcare system itself. The rising HSD contrasts with global declines attributed to molecular diagnostics [26], highlighting systemic gaps in Guangdong. Firstly, uneven adoption of Xpert MTB/RIF in underdeveloped areas delayed testing [7]. Secondly, overcrowded county hospitals prioritized acute care over TB screening [7]. Finally, Elderly patients often first visit non-designated institutions (*a*OR = 1.18), where clinicians may lack TB awareness, leading to delayed referrals [12]. This divergence highlights systemic inefficiencies masked by improved patient awareness, a finding not previously emphasized in similar contexts. Thus, it is essential to explore the key factors affecting TB diagnosis delays in elderly patients.

Considering the practical significance of influencing factors, this study focused on indicators with *a*OR values more than 1.2 or less than 0.9. In accordance with other studies [27], respiratory comorbidities were significantly associated with TDD. The challenging mainly due to less frequently classical symptoms and similarities between TB symptoms and those of other respiratory conditions, such as cough [28]. This overlap can reduce clinicians' alertness to TB, accompanied with lacking of efficient diagnostic tools for early detection [29]. A study in Bangladesh showed that 31% patients with cough were misdiagnosed as having a common cold without further TB related examination [30]. Furthermore, the clinical symptoms and radiographic findings of PTB in elderly individuals tend to be nonspecific, merging with decreased access to health services, further complicating timely TB diagnosis due to atypical manifestations [31].

Regarding the region of case finding, our study found that the TDD was more common in underdeveloped areas. This might attribute to two factors including economic development of areas and the capacity of local medical facilities. The proportion of rural residents in in EG, WG and NG is higher than that in PRDR, which was an important determinant of patient delay in seeking and receiving care for TB. A Previous review showed that lower-income individuals were less likely to seek care for TB than those with higher incomes [4]. Patients in rural areas or low-resource areas often face barriers to accessing TB services due to economic constrains or far distance from medical facilities [5]. As noted by Zhang et al. [7], the inadequacy of TB laboratory equipment in low-level healthcare facilities and a lack of TB awareness among clinicians further exacerbate these challenges. If the patients making their first doctor visit in these facilities in underdeveloped areas, they would be unable to obtain timely screening and diagnosis of TB. Immediate TB testing at the first visit could reduce diagnostic delays, as demonstrated by a modelling study in India [24]. In summary, enhancing health awareness among the elderly and improving the service capacity and quality of health facilities are crucial measures to address these issues.

This study had several notable limitations that should be acknowledged. First, we only studied TB patients in a southern province of China, which may not be representative of patients nationwide. Secondly, our data were derived from TBIMS, which lacks information such as education, economic status, marital status, medical insurance, and TB knowledge. Future studies could supplement surveillance data with patient interviews including these characteristics to enhance accuracy. Thirdly, further thematic analysis such as mixed-methods approaches to explore HSD drivers, including qualitative interviews with healthcare providers and spatial analyses of diagnostic resource distribution should be employed in future research.

Conclusions

This retrospective study has provided valuable insights into the trends and delays in PTB diagnosis among elderly patients in Guangdong Province over a 13-year period. The key findings include a decrease in TB notification rates among patients aged 60 years and above, juxtaposed with an increasing proportion of elderly TB cases among the newly diagnosed. Although there has been a notable decline in PD, a concerning rise in HSD has been observed. This increase in HSD has effectively counterbalanced the decrease in PD, ultimately leading to a rather stagnant TDD, highlighting the need for urgent attention and improvement within the health system to prevent further stagnation of TDD. Additionally, elderly patients with respiratory comorbidities, especially in underdeveloped areas, face a higher risk of experiencing TDD. These findings underscore the critical need for targeted interventions to enhance the timeliness of TB diagnosis within this vulnerable demographic.

Policy recommendations from this study include enhancing access to healthcare services in underdeveloped areas, bolstering the diagnostic capabilities of local medical facilities, and increasing TB education and awareness campaigns targeted at the elderly. Implementing these measures could significantly reduce diagnostic delays and improve patient outcomes.Future research should focus on conducting longitudinal studies to assess the long-term impact of these policies.

Abbreviations

TB	Tuberculosis
PTB	Pulmonary tuberculosis
TBIMS	Tuberculosis information management system
PD	Patient delay
HSD	Health system delay
TDD	Total diagnostic delay
HIV/AIDS	Human immunodeficiency virus/Acquired immune deficiency syndrome
PRDR	Pearl river delta region
EG	Eastern guangdong
WG	Western guangdong
NG	Northern guangdong
DM	Diabetes mellitus
IQR	Interquartile ranges
APC	Annual percent change
AAPC	Average annual percent change
CI	Confidence intervals
cOR	Crude odds ratios
aOR	Adjusted odds ratios

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-025-23031-5.

Supplementary Material 1

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Author contributions

Fangjing Zhou designed the study, conducted the statistical analyses and drafted the manuscript. Huiying Feng edited the paper, providing insightful comments on the study design. Qi Sun provided laboratory consultation and implemented the statistical analyses. ShanShan Huang, Jianwei Li, and Yuhui Chen validated the PTB notification data. Huiying Feng and Fangjing Zhou contributed significantly to interpreting the results and provided comments to enhance the paper. Huiying Feng and Yuhui Chen are co-corresponding authors, confirming that all listed authors meet the authorship criteria and that no other individuals meeting the criteria have been omitted. The corresponding author confirms that all authors had full access to the study data and accept responsibility for the decision to submit the manuscript.

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Data availability

According to Chinese law, the surveillance data of TBIMS are not publicly available, but are available on reasonable requests from the corresponding author.

Declarations

Ethics approval and consent to participate

All materials used in this study strictly adhered to the Declaration of Helsinki and followed the Law of the Prevention and Treatment of Infectious Diseases in the People's Republic of China.

Informed consent

This study was approved by the ethics committee of the Center for Tuberculosis Control of Guangdong Province (Approve number: GDTBPJ20220008). Only PTB surveillance data was used for analysis with anonymous prior and informed consent was waived.

Consent for publication

Not Applicable.

Competing interests

The authors declare no competing interests.

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