Risk Management and Healthcare Policy

Dovepress
Taylor & Francis Group

Open Access Full Text Article

ORIGINAL RESEARCH

Medical Insurance Reimbursement and the Effects of Tuberculosis Management in Guangxi Province, China: A Retrospective Cross-Sectional Study

Aimei Liu[1,2,*], Sang Liu[1,2,*], Peijiang Pan[3,*], Yanyan Liao[3], Junli Huang[2], Yucheng Tang[2], Li Ye[3,4], Hao Liang[3,4]

[1]Department of Infectious Diseases, Chest Hospital of Guangxi Zhuang Autonomous Region, Liuzhou, Guangxi, People's Republic of China; [2]Guangxi Center for Tuberculosis Control and Medical Quality, Liuzhou, Guangxi, People's Republic of China; [3]Biosafety III Laboratory, Life Science Institute, Guangxi Medical University, Nanning, Guangxi, People's Republic of China; [4]Guangxi Key Laboratory of AIDS Prevention and Treatment, School of Public Health, Guangxi Medical University, Nanning, Guangxi, People's Republic of China

*These authors contributed equally to this work

Correspondence: Li Ye; Hao Liang, Guangxi Key Laboratory of AIDS Prevention and Treatment, School of Public Health, Guangxi Medical University, No. 22 Shuangyong Road, Nanning, Guangxi, TX 530000, People's Republic of China, Email yeli@gxmu.edu.cn; lianghao@gxmu.edu.cn

Purpose: This study aims to compare the differences in medical insurance reimbursement for TB treatment in Guangxi and to analyze the effects of such variations, thereby contributing to the enhancement of TB care and control.

Patients and Methods: A survey was conducted across 49 randomly selected TB-designated hospitals in Guangxi using structured questionnaires and patient records. Missing data were addressed via median imputation. Non-parametric test was used to analyse and compare the differences in treatment outcomes among hospitals of different levels and types, with a *P* value less than 0.05 as the test criterion. Logistic regression analysis was performed to evaluate the independent effects of medical insurance reimbursement, hospital level, hospital type and service ability on TB treatment outcomes.

Results: The Urban Employee Basic Medical Insurance provided significantly higher reimbursement floors, ceilings, and rates compared to the Urban Resident Basic Medical Insurance (URBMI). Tertiary hospitals offered higher reimbursement floors for inpatient care but lower reimbursement rates compared to secondary hospitals. Despite policy reimbursement rates for TB treatment consistently exceeding 60%, the actual reimbursement rates often fell short of these benchmarks, especially in specialist hospitals and secondary care facilities. URBMI reimbursement ceiling for pulmonary TB of inpatients was positively associated with treatment success. Additionally, a lower URBMI reimbursement floor for pulmonary TB of inpatients was linked to higher disease mortality rates. Areas exhibited lower treatment success rates and higher case fatality rates shared common socioeconomic characteristics, including smaller populations, lower per capita output values, depressed production values, and lower disposable incomes among the rural population.

Conclusion: This study underscores the importance of equitable medical insurance reimbursement policies, and targeted reforms, such as raising URBMI reimbursement ceilings and enforcing real-time monitoring of actual reimbursements, are critical to mitigate disparities in TB care.

Keywords: tuberculosis, medical insurance, medical cost, treatment effect, mortality rates, socioeconomic characteristics

Background

Tuberculosis (TB), an ancient infectious disease caused by *Mycobacterium tuberculosis* (*M.tb*), continues to pose a significant threat to global health, ranking as the second most lethal infectious disease following the novel coronavirus.[1,2] The Global Tuberculosis Report 2022, published by the World Health Organization (WHO), underscores a concerning increase in the TB burden exacerbated by the ongoing coronavirus pandemic, which has substantially hindered global TB control efforts.[3] The financial and economic repercussions of TB on patients and their families are profound, creating barriers that can significantly impede access to diagnosis, treatment, and the successful completion of treatment regimens. Progress in reducing the burden of TB requires adequate funding for TB diagnostic, treatment and prevention services sustained over many years. However,

Received: 25 January 2025
Accepted: 22 March 2025
Published: 1 April 2025

funding in low- and middle-income countries (LMICs), which account for 98% of reported TB cases, remains inadequate. In India, TB remains a major cause of mortality and economic hardship, even though the government has implemented the Revised National Tuberculosis Control Programme (RNTCP).[4] A study among rural residents in Burkina Faso showed that, despite free TB care, 75% of interviewed patients faced catastrophic health expenditures.[5]

China, which ranks second globally in TB burden, experiences particularly high prevalence rates in its less developed western regions, with a rate nearly triple that of the eastern regions.[6,7] Rural areas also exhibit a higher TB prevalence, estimated at 1.6 times the rate observed in urban settings.[8] Urban Resident Basic Medical Insurance (URBMI) and Urban Employee Basic Medical Insurance (UEBMI) are two of three essential government-led complementary health insurance programs to cover some extra expenditures beyond the free TB service policy in China.[9] URBMI covers urban non-employed residents, such as students, children, the elderly, and unemployed individuals. Participation is voluntary, with contributions paid by individuals and partially subsidized by the government. The contribution rate is relatively low, and the program is managed by local governments. It provides basic healthcare coverage for non-employed urban residents. UEBMI covers urban employees, including workers from enterprises, government agencies, public institutions, and social organizations. Participation is mandatory, with contributions shared between employers and employees. The contribution rate is usually based on a percentage of wages, with employers covering the larger portion and employees covering a smaller share. UEBMI is jointly managed by the national and local governments, offering more comprehensive coverage for employed individuals. In Guangxi, non-employed individuals are allowed to participate in UEBMI as individuals, but they must bear the full cost of contributions themselves.[10] Almost all Chinese is covered by public health insurance systems, financial factors are still the major reason for nonadherence to treatment, suspended treatment and eventual abandonment of treatment.[11–13] The growing consensus among researchers is that TB transcends the realm of infectious diseases to become a complex social and economic issue.[8] Consequently, there is a critical need for enhanced financial risk protection and treatment interventions to ensure universal access to TB care.

Guangxi, an autonomous region in southern China, stands out as a high-burden area with approximately 50,000 new TB cases reported annually by the National Notifiable Disease Reporting System (NNDRS). It is the province with the fifth highest TB burden in China. The annual number of notifications is approximately 100 cases per 100,000 people.[14] Actively responding to the national TB control plan, Guangxi has established corresponding TB treatment at the prefecture level and in counties.[15] However, unlike the wealthier eastern provinces of China, the average income level in Guangxi is lower, making it harder for residents to afford tuberculosis treatment on their own. Therefore, the medical insurance system has a greater impact on tuberculosis treatment in Guangxi. The medical insurance system in Guangxi, primarily composed of URBMI and UEBMI, raises questions about the variance in reimbursement across different TB-designated medical institutions and the impact of these disparities on TB treatment outcomes.

This study aimed to compare the variations in medical insurance reimbursement for the treatment of TB in Guangxi and analyse their influence on treatment outcomes. We hypothesized that more generous TB insurance reimbursement policies would be associated with better treatment outcomes—specifically, higher treatment success rates and lower fatality rates. Based on this hypothesis, our investigation encompassed 49 hospitals, utilizing a questionnaire survey to assess the medical services, treatment fees, reimbursements, and treatment outcomes provided by designated TB treatment facilities. Through a comprehensive analysis of Guangxi's TB medical insurance reimbursement landscape in 2019, this study aims to provide a scientifically robust and rational foundation for the enhancement and implementation of medical security systems tailored to TB treatment.

Methods

Data Collection

This retrospective cross-sectional study was conducted in Guangxi from January 1, 2019, to June 30, 2019. Stratified sampling was conducted based on hospital type and level. Sampling included 100% of provincial-level medical institutions (1 hospital); 100% of specialized medical institutions (6 hospitals); approximately two-thirds of municipal-level medical institutions through simple random sampling (16 hospitals); and approximately one-third of county-level medical institutions through simple random sampling (32 hospitals). In total, 49 designated tuberculosis hospitals in

Guangxi were sampled. Data collection was conducted at these 49 designated TB treatment facilities, with mean imputation applied to address missing values in incomplete surveys. This study was based on a well-structured questionnaire and patient medical records. The data collected encompassed TB medical insurance reimbursement (including the reimbursement floor, reimbursement ceiling, and reimbursement rate of both outpatients and inpatients) and treatment outcomes (comprising treatment success rate, adverse reaction rate and case fatality rate). Economic data for different cities were obtained from the official website of the Guangxi Bureau of Statistics.All the organized data can be found in Supplement Table 1.

Inclusion Criteria

This study selected 49 designated tuberculosis medical institutions through a random sampling method and screened the research subjects from them. All patients who received tuberculosis treatment at the aforementioned medical institutions during the specified period (January 1, 2019, to June 30, 2019) were included in this study.

Exclusion Criteria

1. Key Data Missing: If key data is missing for a medical institution or patient and cannot be supplemented by the mean imputation method, then the data of that institution or patient is excluded.
2. Data Duplication: If the same patient's data is duplicated due to visits to multiple hospitals, only one complete record is retained, and duplicate data is deleted.

Definitions

Treatment Success Rate

Treatment success is defined as the absence of any active tuberculosis symptoms and a negative culture result for Mycobacterium tuberculosis after the completion of the treatment regimen. The Treatment Success Rate refers to the percentage of patients who have successfully completed tuberculosis treatment out of the total number of patients who have received treatment within a certain period.

Reimbursement Rate

The government health plan's payment ratio for medical expenses.

Pulmonary TB (PTB)

PTB is diagnosed based on pathological, clinical and radiological findings and confirmed through bacteriological and histological examinations, which are strictly performed according to the Chinese diagnostic criteria for PTB (WS-288-2017).

Multidrug-Resistant TB (MDR-TB)

Mycobacterium TB infections in patients with TB are resistant to both isoniazid and rifampicin.

Reimbursement Floor

The standard payment limit of medical insurance, which is above the floor, is reimbursed by medical insurance according to regulations. All payment floors in this article came from policy data developed by the surveyed institutions, not real reimbursement data.

Reimbursement Ceiling

The maximum payment limit of medical insurance, the maximum amount of reimbursement that a participant can receive from medical insurance in a year in aggregate. All ceilings in this article came from policy data developed by the surveyed institutions, not real reimbursement data.

Actual Reimbursement Rate

The ratio of the actual reimbursement amount from the survey institutions to the reimbursement limit set by the health insurance policy.

UEBMI
Urban Employee Basic Medical Insurance.

URBMI
Urban Resident Basic Medical Insurance.

Statistical Analysis
All analyses were carried out using R software (Version 4.3.2). The 49 hospitals under study were categorized based on treatment outcomes, utilizing predefined thresholds for treatment success rate (95%), adverse effect rate (3%), and case fatality rate (5%).

Missing data in this study were replaced by the median prior to analysis, followed by subsequent analysis. The default functions of R (wilcox.test() and chisp.test()) were used to compare the differences in medical insurance reimbursement policy and treatment effect between different groups. Univariate and multivariate binary logistic regression analyses were performed with the default function of R, glm(), to explore independent factors significantly associated with treatment outcomes, adjusting for hospital level, insurance type, and reimbursement thresholds. Economic visualization between regions was performed using the R package "ggplot2". Scatter plot were made using the R package ggpubr, and bar plot were made using the R package "ggplot2", "scales", and "tidyr". A p value of less than 0.05 was used as the threshold for statistical significance in these comparisons, and each outcome was analyzed separately with a significance threshold of 0.05.

Results
Differences in Medical Insurance Reimbursement for the Treatment of Tuberculosis in Guangxi
In this study, we included a total of 49 hospitals in Guangxi, which consisted of 18 tertiary hospitals (36.70%) and 31 secondary hospitals (63.30%). Among these, 43 (87.80%) were general hospitals and 6 (12.20%) were specialist hospitals.

Initially, we compared the reimbursement situations between PTB and MDR-TB. For inpatient care, the median reimbursement floor for PTB patients was RMB 400.00, the median reimbursement ceiling was RMB 314,603.50, and the median reimbursement ratio was 77.50%. For outpatient care, the median reimbursement floor was RMB 60.00, the median reimbursement ceiling was RMB 5,500.00, and the median reimbursement ratio was 70.00% (Table 1). Regarding MDR-TB, the outpatient reimbursement policy did not differ significantly from that of PTB. However, for inpatient care, MDR-TB had a higher reimbursement floor and ceiling compared to PTB, but a lower reimbursement ratio ($P < 0.001$). Specifically, the median reimbursement floor for MDR-TB patients was RMB 550.00, the median reimbursement ceiling was RMB 350,000.00, and the median reimbursement ratio was 74.5%.

When considering the type of insurance, for both outpatient and inpatient care, the reimbursement floor, ceiling, and rates under UEBMI were significantly higher than those under URBMI ($P < 0.001$). Concerning hospital level, the reimbursement floor for inpatients at tertiary hospitals was higher than that at secondary hospitals ($P <0.001$). However, the reimbursement ratio for tertiary hospitals was lower than that for secondary hospitals, regardless of whether they were outpatients or inpatients ($P < 0.001$). With regard to the nature of the hospital, no significant difference was observed between general hospitals and specialist hospitals.

A scatter plot illustrating the policy reimbursement ratio on the x-axis and the actual expense reimbursement ratio on the y-axis showed no obvious correlation. The policy reimbursement ratio ranged from 60% to 80%, with some actual expense reimbursement ratios notably lower than the policy rates (Figure 1A, $R=-0.088$, $p=0.65$). Notably, despite the policy reimbursement ratios for TB treatment consistently being above 60%, the actual reimbursement ratios were often lower than the policy rates across different hospital levels and types (Figure 1B). Nevertheless, a trend was observed where higher policy reimbursement ratios were associated with higher actual hospitalization reimbursement ratios.

Table 1 Reimbursement Policy of Tuberculosis Medical Insurance in Guangxi

Types	Reimbursement Floor		Reimbursement Ceiling		Reimbursement Rate	
	Outpatient Median (P25,P75) (Yuan)	Inpatient Median (P25,P75) (Yuan)	Outpatient Median (P25,P75) (Yuan)	Inpatient Median (P25,P75) (Yuan)	Outpatient Median (P25,P75) (%)	Inpatient Median (P25,P75) (%)
Type of disease						
PTB	60.000 (60.000, 60.000)	400.000 (350.000, 580.000)	5500.000 (3750.000, 5500.000)	314603.500 (310659.000, 318548.000)	70.000 (67.500, 74.000)	77.500 (72.500, 81.500)
MDR-TB	60.000 (60.000, 60.000)	550.000 (550.000, 550.000)	5500.00 (5500.000, 5500.000)	350000.000 (310659.000, 441318.000)	70.000 (70.000, 70.000)	74.500 (74.500, 74.500)
W	1146.000	862.000	1084.000	1694.000	1329.000	1554.500
P value	0.616	0.014	0.295	<0.001	0.326	0.011
Insurance type						
UEBMI	100.000 (100.000, 100.000)	530.000 (430.000, 580.000)	8500.000 (6250.000, 8500.000)	420786.500 (420000.000, 440000.000)	73.000 (71.500, 74.000)	83.500 (80.000, 86.000)
URBMI	20.000 (20.000, 20.000)	400.000 (300.000, 600.000)	2500.000 (2500.000, 2500.000)	183000.000 (183000.000, 183006.000)	70.000 (63.000, 70.000)	67.500 (60.000, 71.500)
W	2236.000	1452.000	2343.500	2189.000	1953.500	2354.500
P value	<0.001	0.071	<0.001	<0.001	<0.001	<0.001
Hospital level						
Tertiary hospitals	60.000 (60.000, 60.000)	590.000 (571.25.000, 600.000)	5500.000 (4093.750, 5500.000)	304432.875 (291806.25, 372286.00)	64.375 (62.500, 70.000)	71.500 (68.875, 73.188)
Secondary hospitals	60.000 (60.000, 60.000)	450.000 (425.000, 475.000)	5500.000 (4500.000, 5500.000)	303446.750 (303446.750, 303446.750)	70.750 (70.000, 72.500)	77.500 (76.000, 78.750)
W	243.500	54.000	296.500	272.000	486.500	530.500
P value	0.401	<0.001	0.683	0.888	<0.001	<0.001
Nature of Hospital						
General hospitals	60.000 (60.000, 60.000)	475.000 (437.500, 572.500)	5500.000 (4562.500, 5500.000)	303446.750 (293592.500, 304432.875)	70.000 (68.750, 72.375)	76.000 (73.125, 78.500)
Specialist hospitals	60.000 (33.750, 60.000)	487.500 (418.750, 575.000)	4375.000 (2722.000, 55000.000)	307052.900 (303446.800, 483789.800)	70.000 (62.5.000, 70.000)	75.500 (72.750, 76.000)
W	180.000	118.000	171.500	91.000	154.000	148.500
P value	0.075	0.747	0.138	0.233	0.443	0.562

Abbreviations: PTB, Pulmonary tuberculosis; MDR-TB, Multidrug-resistant tuberculosis.

https://doi.org/10.2147/RMHP.S510088

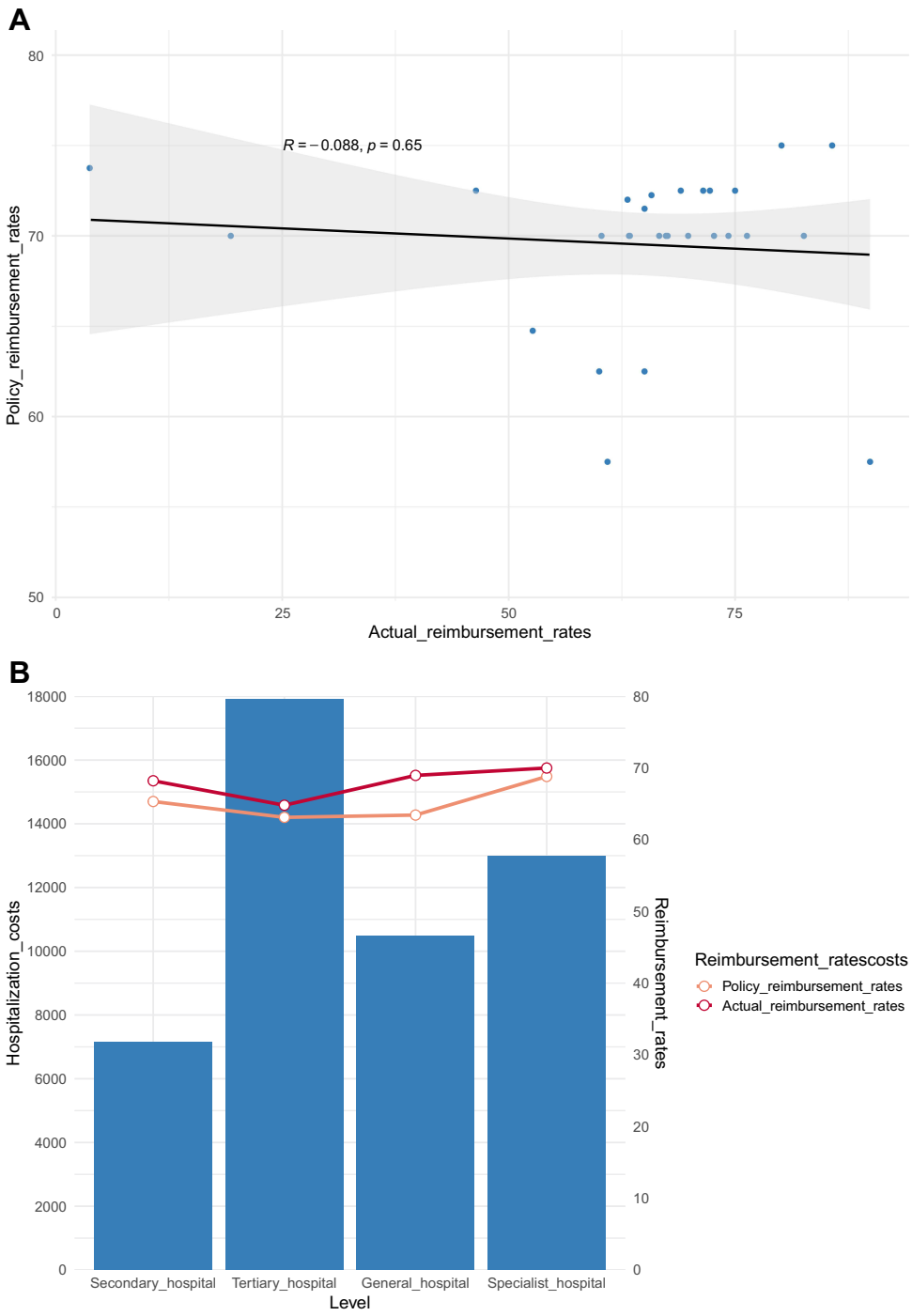

Figure 1 The relationship between actual medical reimbursement level and policy reimbursement level of tuberculosis patients in Guangxi province in 2019. (**A**) Analysis of actual cost reimbursement for tuberculosis in 49 medical institutions in Guangxi in 2019. (**B**) Tuberculosis hospitalization reimbursement in different types of hospitals.

Analysis of Influential Factors in Tuberculosis Treatment

To explore the relationship between treatment outcomes and various potential influencing factors, this study systematically analyzed the impact of different variables on treatment success rates, case fatality rates, and the incidence of adverse events. Specifically, we examined hospital accreditation levels (secondary hospitals vs tertiary hospitals), hospital types (general hospitals vs specialist hospitals), TB types (PTB vs MDR-TB), TB health insurance reimbursement policies (floor, ceiling, and reimbursement ratios), and types of health insurance (URBMI vs UEBMI). We utilized

chi-square tests to preliminarily assess the effect of these variables on treatment outcomes across different groups. In calculating the insurance floor, ceiling, and reimbursement ratios, we used the mean values as classification thresholds, dividing the data into two categories: above the mean and below the mean. The results indicated significant differences in TB treatment success rates within the groups defined by hospital levels (secondary hospitals vs tertiary hospitals), URBMI reimbursement floor for inpatients with PTB (above the mean vs below the mean), and URBMI reimbursement ratios for inpatients with PTB (above the mean vs below the mean) (Table 2 and Supplement Table 2). Additionally, there were significant differences in treatment fatality rates among outpatient patients with PTB based on their URMBI (above the mean vs below the mean) (Table 3 and Supplement Table 3). However, no significant differences were found in the incidence of adverse events across any of the groups (Supplement Table 4).

To further investigate the relationships between these factors and TB treatment outcomes, we employed univariate logistic regression models. The results demonstrated that hospital level, the reimbursement rate for PTB of outpatients under the URBMI, the reimbursement ceiling for PTB of inpatients under the URBMI and the reimbursement floor for PTB of inpatients under the URBMI were significantly associated with treatment success rates, all being risk factors (Table 4 and Supplement Table 5). In terms of mortality, univariate logistic regression indicated significant correlations between case fatality rates and the reimbursement floor for PTB of inpatients under the UEBMI, the reimbursement rate of inpatients under the URBMI, and the reimbursement rate for PTB of outpatients under the URBMI (Supplement Tables 6 and 7). No factors were significantly associated with the incidence of adverse events in the univariate logistic regression analysis (Supplement Table 8).

Building on the results of the univariate analysis, multivariate logistic regression analysis was conducted. The findings revealed that being below the mean value for the outpatient reimbursement rate for PTB under the URBMI, being below the mean value for the inpatient ceiling and floor for PTB under the URBMI, and being in a tertiary hospital were correlated with poorer treatment success rates, though these associations were not statistically significant except for below the mean value for the inpatient ceiling for PTB under the URBMI (Supplement Table 9). For treatment-related mortality, the multivariate logistic regression analysis identify being below the mean value for the reimbursement floor

Table 2 Results of the Chi-Square Test Analysis of Treatment Success Rates with Statistical Significance

	Grouping by Treatment Success Rate		χ^2	**P value**
	≤95.00%	**>95.00%**		
Hospital_level				
Tertiary hospitals, (n)	17	1	5.710	0.017
Secondary hospitals, (n)	13	18		
PTB_floor_inpatients_URBMI				
≤Mean, (n)	19	13	4.974	0.026
>Mean, (n)	16	1		
PTB_rate_outpatients_URBMI				
≤Mean, (n)	20	13	4.290	0.038
>Mean, (n)	15	1		

Abbreviations: PTB, Pulmonary tuberculosis; URBMI, Urban Resident Basic Medical Insurance.

Table 3 Results of the Chi-Square Test Analysis of Treatment Fatality Rates with Statistical Significance

	Grouping by Treatment Fatality Rate		χ^2	**P value**
	≤5.00%	**>5.00%**		
PTB_floor_inpatients_UEBMI				
≤Mean, (n)	12	10	8.819	0.003
>Mean, (n)	24	3		

Abbreviations: PTB, Pulmonary tuberculosis; URBMI, Urban Resident Basic Medical Insurance.

https://doi.org/10.2147/RMHP.S510088

Table 4 Results of Univariate Logistic Regression Analysis of Treatment Success Rate with Statistical Significance

	Exp (B)	25% CI	75% CI	P value
Hospital_level	12.278	2.094	235.317	0.022
PTB_floor_inpatients_URBMI	0.0913	0.005	0.536	0.028
PTB_ceiling_inpatients_URBMI	6.600	1.121	53.018	0.044
PTB_rate_outpatients_URBMI	9.750	1.656	187.031	0.037

Abbreviations: PTB, Pulmonary tuberculosis; URBMI, Urban Resident Basic Medical Insurance; CI, confidence interval.

for PTB of inpatients under the UEBMI as the protect factor (Supplement Table 10). These insights provide a crucial basis for optimizing strategies and policies for tuberculosis treatment and medical insurance.

The Effects of Tuberculosis Treatment in Different Regions

We then visualized the treatment outcomes of registered TB patients in Guangxi in 2019. The analysis identified several regions with notably low treatment success rates: Yizhou city, Du'an County, Guilin Xiufeng District, Quanzhou County, and Longzhou County. The case fatality rate was higher in Quanzhou County, Longzhou County, Zhongshan County, Yizhou city and Du'an County.Notably, the TB case fatality rate in Yizhou District and Hechi city reached 6.63%, while the treatment success rate was only 59.00% (Supplement Figures 1 and 2). These regions share common socioeconomic characteristics: they have smaller populations, lower per capita output values, and depressed production value. Additionally, the disposable income of the rural population in these areas is lower (Supplement Table 11).

Discussion

Utilizing a cross-sectional study encompassing 49 designated TB treatment centers in Guangxi, our investigation combined chi-square tests and binary logistic regression to identify independent factors associated with treatment efficacy. Our findings indicated that a lower inpatient reimbursement ceiling for PTB under URBMI was linked to higher treatment success rates, whereas a higher inpatient reimbursement threshold for PTB under UEBMI correlated with lower treatment fatality rates.

Conventionally, it is assumed that tertiary medical institutions are equipped with more advanced facilities and provide a superior medical environment, which facilitates disease treatment and recovery. Surprisingly, the chi-square test and univariate logistic regression results demonstrated that higher hospital accreditation levels were associated with lower treatment success rates. This finding is consistent with previous research indicating that TB/HIV patients treated in public tertiary hospitals faced a higher risk of unsuccessful TB treatment outcomes.[16] Chinese medical insurance policy implements a tiered diagnosis and treatment system, which requires tertiary hospitals to handle referrals from secondary hospitals. This includes the diagnosis and treatment of complex and severe diseases, critical and life-threatening conditions, MDR-TB, and extrapulmonary tuberculosis requiring surgical treatment. Thus, a plausible explanation is that patients who seek care at tertiary hospitals may present with more severe conditions or have been referred due to inadequate management at lower-level facilities, thereby increasing the complexity of treatment and reducing overall success rates.[17,18]

The implementation of a reimbursement threshold in the medical insurance system aims to guide insured patients in making rational choices for treatment facilities and to ensure the prudent use of medical insurance funds, balancing income and expenditure. The reimbursement threshold ensures that a reasonable portion of TB treatment costs is covered, with individuals responsible for the remainder once the threshold is reached. A lower reimbursement threshold facilitates quicker access to medical insurance benefits, reducing financial burdens and enhancing patient security. However, this also leads to an increase in the frequency of patient visits and medical insurance expenditures.

By integrating the results from both univariate and multivariate logistic regression analyses, we observed that for inpatients, a higher reimbursement ceiling under URBMI was positively associated with higher treatment success rates, while a lower reimbursement floor under UEBMI correlated with higher treatment mortality rates. This relationship could be attributed to improved patient compliance. Higher reimbursement ceiling can alleviate financial burdens, thereby enhancing

adherence to prescribed treatments, a crucial aspect considering that non-adherence is a major obstacle in global TB control.[19] Conversely, a low reimbursement threshold might lead to the overutilization of healthcare services, potentially resulting in indiscriminate medical treatment and increased case fatality rates.

In terms of treatment success rates, the factors associated with treatment outcomes primarily relate to the policies of URBMI. We hypothesize that one possible reason is that patients covered by URBMI often lack stable employment and, consequently, a steady income source. Thus, their adherence to TB treatment is more dependent on the reimbursement levels provided by URBMI.

Our study, encompassing 49 hospitals in Guangxi, including 18 tertiary and 31 secondary hospitals, revealed significant variations in medical insurance reimbursement policies for TB treatment. Notably, the UEBMI provided significantly higher reimbursement floors, ceilings, and rates compared to the URBMI. Furthermore, tertiary hospitals offered higher reimbursement floors for inpatient care but lower reimbursement rates compared to secondary hospitals. The actual reimbursement rates often fell short of these benchmarks. Our results also revealed that the policy reimbursement rate ranges between 60% and 80%, while the actual reimbursement rate is significantly lower than the policy rate. This discrepancy suggests that certain services may not be covered, there may be out-of-pocket expenses beyond the standard policy coverage, or the reimbursement rate for out-of-town medical visits may be reduced. Furthermore, as the policy reimbursement rate increases, the actual hospitalization reimbursement rate also tends to rise. This indicates that higher reimbursement rates reduce out-of-pocket expenses and lead to fewer out-of-town medical visits, thereby increasing the actual reimbursement rate. Inpatients reimbursement ceiling for PTB under the URBMI was positively associated with treatment success. Additionally, a lower inpatient reimbursement floor for PTB under UEBMI was linked to higher disease mortality rates. Furthermore, the regions with suboptimal treatment success and higher mortality rates shares common socioeconomic characteristics, including smaller populations, lower per capita output values, depressed production values, and lower disposable incomes among the rural population. This is consistent with the results shown in our Supplement Figures, where we found that regions with poorer economic indicators tend to have lower treatment success rates and higher mortality rates.

However, there were some limitations in our study. At first, some of the cost and expenditure information was obtained via patient questionnaires and could be subject to recall bias. Secondly, we relied on hospital records for clinical outcomes. If record-keeping was incomplete at some sites, certain data might not have been captured accurately. Thirdly, our data were collected from January to June 2019. Consequently, the lack of disease severity data, such as TB clinical staging or drug resistance profiles, limits our ability to fully disentangle the role of patient complexity versus institutional factors. Future prospective studies should incorporate standardized severity metrics to refine these findings. Finally, although the Guangxi Provincial Medical Insurance Bureau adopted the findings of this study to optimize the medical insurance policy, namely incorporating MDR-TB into the outpatient special chronic disease management program and increasing the reimbursement cap from the median of 5,500 RMB in this study to 40,000 RMB under URBMI and 80,000 RMB under UEBMI, we have not yet collected and analysed these data following these policy adjustments, as long-term dynamic monitoring is required. In future research, we will incorporate post-adjustment data to evaluate its long-term impact and provide evidence for further dynamic optimization.

In summary, this study underscores the importance of equitable medical insurance reimbursement policies and highlighted the need for targeted interventions in regions with poor socioeconomic indicators. Besides, we found that actual reimbursement rates often fell short of the policy-promised rates, especially under URBMI compared to UEBMI. Thus, the government should raise both the upper and lower reimbursement limits to reduce patients' out-of-pocket expenses while strengthening oversight to ensure that the actual reimbursement patients receive aligns with policy goals. Besides, further research should focus on strategies to bridge the gap between reimbursement policy and actual reimbursement practices, as well as on enhancing the effectiveness of TB treatment in economically disadvantaged areas.

Data Sharing Statement

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

This study was approved by the ethics committee of Chest Hospital of Guangxi Zhuang Autonomous Region (No. 2021-011). Informed consent was obtained from all participants prior to questionnaire administration. For the retrospective review of medical records, the ethics committee waived the requirement for individual patient consent because the research involved anonymized historical data with no identifiable personal information, and the study posed minimal risk to participants' rights and welfare.

All data collected through the questionnaire and medical records were strictly anonymized and securely stored with restricted access to protect participant confidentiality. We confirm that this study complies with the ethical principles of the Declaration of Helsinki and relevant national/institutional guidelines.

Acknowledgments

The author would like to thank all of the administrators at all of the hospitals who helped with the distribution of the questionnaire survey. We acknowledge financial support for the Appropriate Technology Development and Promotion and Application Project of Health and Health Commission of Guangxi (S2019035), and Major Science and Technology Projects in Guangxi (AA22404).

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

This work was supported by the Appropriate Technology Development and Promotion and Application Project of Health and Health Commission of Guangxi (S2019035), and Major Science and Technology Projects in Guangxi (AA22404).

Disclosure

The authors report no conflicts of interest in this work.

References

1. Sharma M, Nduba V, Njagi LN, et al. TBscreen: a passive cough classifier for tuberculosis screening with a controlled dataset. *Sci Adv*. 2024;10(1):eadi0282. doi:10.1126/sciadv.adi0282
2. Abera EG, Yeshitla W, Kene K, Gerema U, Assefa Y. Comparing the treatment outcomes of tuberculosis patients in a private clinic with a governmental health center in Jimma city, Ethiopia: retrospective study. *Infect Drug Resist*. 2022;15:2491–2511. doi:10.2147/idr.S354855
3. Bagcchi S. WHO's global tuberculosis report 2022. *Lancet Microbe*. 2023;4(1):e20. doi:10.1016/s2666-5247(22)00359-7
4. WHO Guidelines Approved by the Guidelines Review Committee. *WHO Consolidated Guidelines on Tuberculosis: Module 1: Prevention – Tuberculosis Preventive Treatment, second Edition*. World Health Organization; 2024.
5. Narula P, Azad S, Lio P. Bayesian melding approach to estimate the reproduction number for tuberculosis transmission in Indian states and union territories. *Asia Pac J Public Health*. 2015;27(7):723–732. doi:10.1177/1010539515595068
6. Xiao J, Ge J, Zhang D, et al. Clinical characteristics and outcomes in chronic kidney disease patients with tuberculosis in China: a retrospective cohort study. *Int J Gen Med*. 2022;15:6661–6669. doi:10.2147/ijgm.S367090
7. Liao WB, Ju K, Gao YM, Pan J. The association between internal migration and pulmonary tuberculosis in China, 2005–2015: a spatial analysis. *Infect Dis Poverty*. 2020;9(1):5. doi:10.1186/s40249-020-0621-x
8. Xin YJ, Xiang L, Jiang JN, Lucas H, Tang SL, Huang F. The impact of increased reimbursement rates under the new cooperative medical scheme on the financial burden of tuberculosis patients. *Infect Dis Poverty*. 2019;8(1):67. doi:10.1186/s40249-019-0575-z
9. Li Y, Yang Y, Yuan J, Huang L, Ma Y, Shi X. Differences in medical costs among urban lung cancer patients with different health insurance schemes: a retrospective study. *BMC Health Serv Res*. 2022;22(1):612. doi:10.1186/s12913-022-07957-9
10. Cui Y, Lv J, Hu X, Zhu D. Health insurance as a moderator in the relationship between financial toxicity and medical cost-coping behaviors: evidence from patients with lung cancer in China. *Cancer Med*. 2024;13(1):e6911. doi:10.1002/cam4.6911
11. Wang J, Wang Y, Cai H, et al. Analysis of the status quo of the Elderly's demands of medical and elderly care combination in the underdeveloped regions of Western China and its influencing factors: a case study of Lanzhou. *BMC Geriatr*. 2020;20(1):338. doi:10.1186/s12877-020-01616-6
12. Zhang F, Xue B, Li Y, Li H, Liu Q. Effect of textual features on the success of medical crowdfunding: model development and econometric analysis from the Tencent charity platform. *J Med Internet Res*. 2021;23(6):e22395. doi:10.2196/22395

13. Han J, Zhang X, Meng Y. Out-patient service and in-patient service: the impact of health insurance on the healthcare utilization of mid-aged and older residents in urban China. *Risk Manag Healthc Policy*. 2020;13:2199–2212. doi:10.2147/rmhp.S273098
14. Cui Z, Lin D, Chongsuvivatwong V, et al. Spatiotemporal patterns and ecological factors of tuberculosis notification: a spatial panel data analysis in Guangxi, China. *PLoS One*. 2019;14(5):e0212051. doi:10.1371/journal.pone.0212051
15. Long Q, Guo L, Jiang W, Huan S, Tang S. Ending tuberculosis in China: health system challenges. *Lancet Public Health*. 2021;6(12):e948–e953. doi:10.1016/s2468-2667(21)00203-6
16. Oshi DC, Oshi SN, Alobu I, Ukwaja KN. Profile, outcomes, and determinants of unsuccessful tuberculosis treatment outcomes among HIV-infected tuberculosis patients in a Nigerian State. *Tuberc Res Treat*. 2014;2014:202983. doi:10.1155/2014/202983
17. Widyastuti Y, Boom CE, Parmana IMA, et al. Validation in Indonesia of two published scores for mortality prediction after cardiac surgery. *Ann Card Anaesth*. 2023;26(1):23–28. doi:10.4103/aca.aca_297_20
18. Suntornlohanakul O, Sakarin S, Kietsiriroje N, Sriplung H. Geographical inequality in service utilization for primary aldosteronism screening: spatial epidemiological study in Southern Thailand. *BMC Health Serv Res*. 2022;22(1):458. doi:10.1186/s12913-022-07788-8
19. Tola HH, Holakouie-Naieni K, Tesfaye E, Mansournia MA, Yaseri M. Prevalence of tuberculosis treatment non-adherence in Ethiopia: a systematic review and meta-analysis. *Int J Tuberc Lung Dis*. 2019;23(6):741–749. doi:10.5588/ijtld.18.0672