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ORIGINAL RESEARCH

Effectiveness and Determinants of Implementing the "Xinjiang Model" for Tuberculosis Prevention and Control: A Quantitative Study

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Objective: To analyze the effectiveness of the "Xinjiang Model" for tuberculosis prevention and control in Kashgar Prefecture, Xinjiang, and to explore the determinants of the policy implementation effect.

Methods: The registration data of pulmonary tuberculosis (PTB) patients in Kashgar Prefecture from 2012 to 2021 were collected to describe the temporal trend of registered incidence. A questionnaire survey was conducted among PTB patients registered and treated in the tuberculosis management information system in Zepu and Shache Counties from January 2022 to July 2023 to collect and analyze "Xinjiang model" determinants of effectiveness.

Results: The PTB registered incidence in Kashgar Prefecture showed a significant increasing trend from 2012 to 2018 (APC=18.7%) and a significant decreasing trend from 2018–2021 (APC=−28.8%). Among the Kashgar Prefecture, compared with average registered incidence in 2012–2017, registered incidence in 2021 in Shufu, Maigaiti, and Zepu Counties had a greater decline rate of 58.68%, 57.16%, and 54.02%, respectively, while the registered incidence in 2021 in Shache County increased by 6.32%. According to the comprehensive analysis of the factors affecting the effect of policy implementation, the proportion of PTB patients in Zepu County whose health status has now significantly improved compared with that before treatment was significantly greater than that in Shache County ($P<0.05$); patients in Shache County were significantly less aware than those in Zepu County of how to take tuberculosis drugs, precautions, adverse reactions, and regular reviews during treatment; the factors that accounted for the greater proportion of heavy treatment burden in both Shache and Zepu Counties were discomfort caused by taking or injecting drugs, accounting for 12.8% and 8.7%, respectively.

Conclusion: The "Xinjiang model" can effectively control the epidemic situation of tuberculosis in Kashgar, and the knowledge of tuberculosis treatment, adverse reactions to tuberculosis drugs, and treatment costs were the determinants of the effectiveness of policy implementation.

Keywords: pulmonary tuberculosis, implementation effect, registered incidence, determinants, Xinjiang

Introduction

Tuberculosis is a chronic infectious disease caused by *Mycobacterium tuberculosis* that poses a serious health risk to humans and can involve almost all organs of the body, but pulmonary tuberculosis (PTB) is the most common. Tuberculosis is the leading cause of death from infectious diseases among adults worldwide, with more than 10 million new cases of tuberculosis each year.[1] China is one of the 30 high tuberculosis burden countries in the world, and according to the Global Tuberculosis Report 2023,[2] China accounted for 7.1% of the total global tuberculosis cases in 2022, after India (27%) and Indonesia (10%). China has made great efforts in the prevention and control of tuberculosis and has achieved some success, but TB prevention and management remains a challenging task.[3] Xinjiang is

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one of the regions with the most serious tuberculosis hazards in the country, and according to the 2022 China Health and Health Statistics Yearbook, the incidence and mortality rates of tuberculosis in Xinjiang were 87.85/100,000 and 0.55/100,000, respectively,[4] which are among the highest in the country. In order to curb the epidemiological trend of tuberculosis in Xinjiang, a series of measures such as active screening for tuberculosis, hospitalization of patients with infectious stage, and "nutritional breakfast" began to be comprehensively implemented in 2018 under the comprehensive coordination and policy support of the Xinjiang health department, forming a new model of tuberculosis prevention and control with Xinjiang's characteristics, namely the "Xinjiang Model".[5]

The "Xinjiang model" policy allows for the early detection of more tuberculosis patients through active case finding, avoiding further spread of the disease; inpatient management effectively controls the source of infection and ensures that medication is taken in full, regularly, in the right amount, and in combination, and with further nutritional support effectively improves the success rate of tuberculosis patient treatment. However, the implementation of this policy requires a certain amount of human and financial resources, which has had an impact on the financial expenditure and workload of local health departments. In the implementation of the "Xinjiang model" policy, it is important to summarize and analyze the determinants of the effectiveness of the implementation in order to guide the continuation of the policy.

In a previous study, it was found that the "Xinjiang model" policy had a significant effect on controlling the tuberculosis epidemic in Xinjiang.[6] To promote sustainable and effective implementation of the "Xinjiang model", it is important to promptly identify the factors affecting its effectiveness. Based on the previous study, this study analyzed the effectiveness of the Xinjiang model in Kashgar, a region with a high burden of tuberculosis in Xinjiang,[7,8] and its counties and cities, and further explored the factors influencing the effectiveness of the model based on two counties with poor and good implementation. Identifying and improving the factors affecting the effectiveness of the "Xinjiang model" will provide information for the continuous improvement and high quality of the new model of tuberculosis control in Xinjiang.

Materials and Methods

Study Design

We conducted a cross-sectional study divided into two phases. The first phase of the study was to retrospectively collect data on tuberculosis registrations in Kashgar before and after the implementation of the "Xinjiang model" policy, analyze the temporal trends in PTB registration incidence in Kashgar from 2012 to 2021, and evaluate and compare the effectiveness of the new model based on the rate of decline in registered incidence (the percentage of decline in registered incidence in 2021 compared to the average registered incidence before implementation) as well as the annual percentage of change. Phase 2: On the basis of comparing the implementation effect of the policy in 12 counties and cities in Kashgar, a county with better implementation effect (Zepu County) and a county with poorer implementation effect (Shache County) were selected as the investigation sites, and on-site questionnaire surveys were carried out on tuberculosis patients who had completed the tuberculosis treatment, to collect and analyze the factors that influenced the implementation effect in the two counties. The workflow of the study is shown in Figure 1.

Data Sources

PTB Patient Registration Data

The 2012–2021 PTB patient registration data for Kashgar Prefecture and its counties and cities were obtained from the tuberculosis management information system, and the population data were obtained from the Xinjiang Statistical Yearbook. PTB registered incidence = number of PTB patients registered at medical institutions / population × 100,000/100,000

Factors Affecting the Effectiveness of the "Xinjiang Model" Implementation

A questionnaire survey was used to collect basic information about PTB patients and factors affecting the effectiveness of policy implementation. The survey subjects were PTB patients in Zepu and Shache Counties who were registered in the tuberculosis management information system from January 2022 to July 2023 and completed treatment. Patient inclusion criteria were: i) age ≥18 years; ii) verbal informed consent to participate in the survey. PTB patients with mental retardation, serious illnesses, and physical limitations that prevented them from participating in the on-site survey

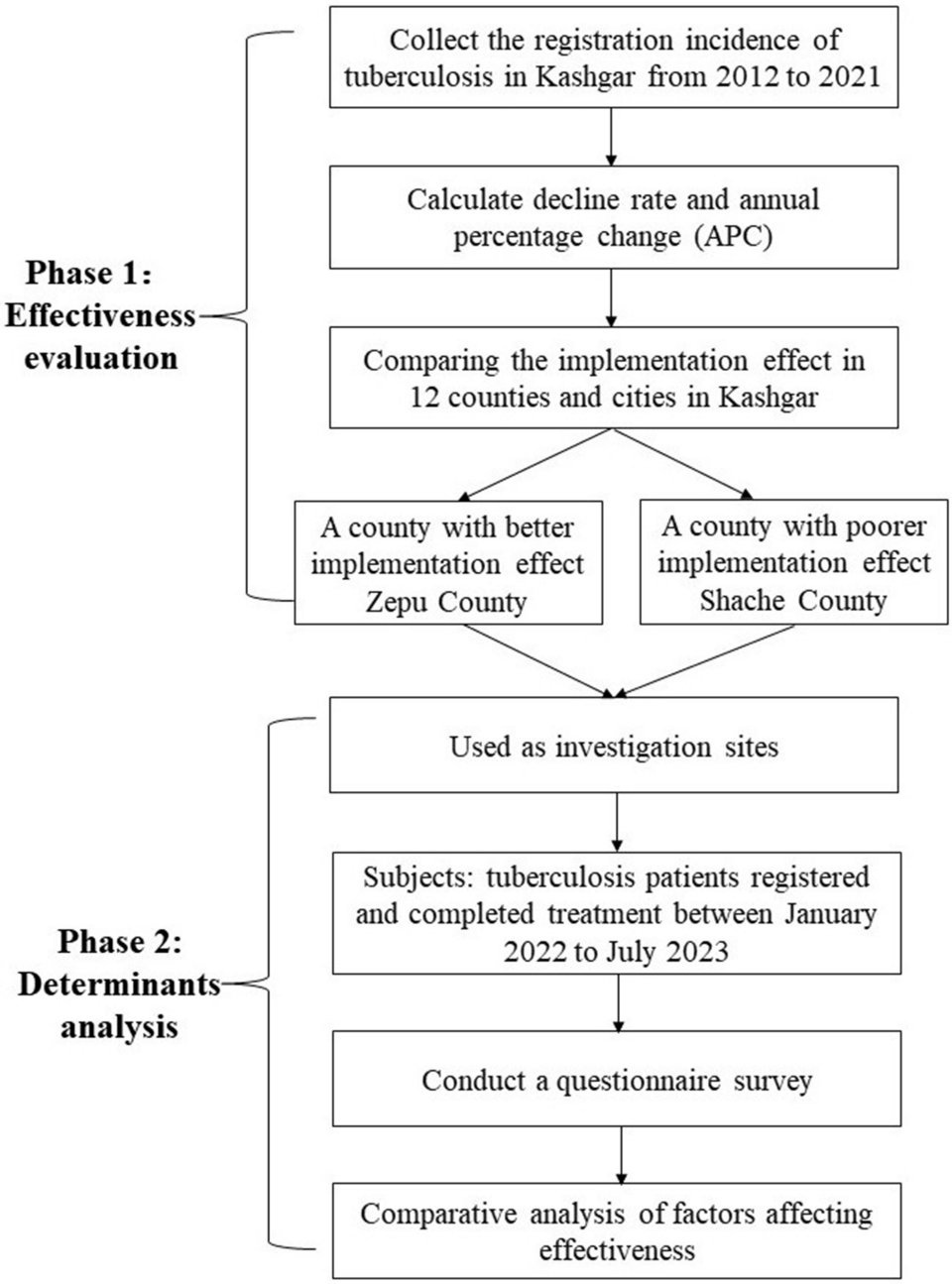

Figure 1 Workflow of the study.

were excluded. The study was approved by the Ethics Committee of Xinjiang Medical University (ethical review number: XJYKDXR20230303016), and all patients gave informed consent.

Research Methods

Survey Content

Based on a large number of related literature, questionnaires and consulting experts in the field of tuberculosis prevention and control, the researchers designed the Questionnaire on Treatment Effect and Influencing Factors of Tuberculosis Patients. The questionnaire included: ① Individual information of PTB patients: gender, age, education level, type of medical insurance, distance between health service institution and residence; ② Treatment and outcome: whether anti-tuberculosis treatment is carried out according to doctor's advice, whether "nutritional breakfast" is taken, whether there are side effects of drugs, and the

effect of current health status compared with that before treatment; ③ Knowledge of TB prevention and treatment: according to the doctor's requirements, the vast majority of tuberculosis can be cured, tuberculosis can be prevented and cured, and the state has a cost reduction policy for tuberculosis treatment (100% reimbursement for outpatient services and 90% reimbursement for hospitalization); ④ Treatment burden: discomfort caused by medication or injection of drugs, taking tuberculosis drugs on time every day, efforts to remember medication, etc. The 11 items of treatment burden in the questionnaire were derived from the Burden of Treatment Questionnaire developed by TRAN et al,[9] which involves four dimensions: doctor visits and follow-ups, medication, healthcare-related behaviors and health issues, with each item scored from 0 to 10, with higher scores representing a higher degree of treatment burden, and scores ≥5 were considered to be a heavy burden of treatment for the purposes of this study.

Survey Method

Firstly, the tuberculosis specialists of each township health hospital or community health service centers in Shache and Zepu Counties verified whether the PTB patients included in the study were currently in the local area, and those who were in the local area were informed of the time and place of the on-site survey after obtaining their informed consent. After arriving at the designated survey site, PTB patients were surveyed face-to-face by uniformly trained investigators, who provided on-site guidance for filling out the questionnaires and verified the contents in a timely manner after the questionnaires were completed to ensure the accuracy and completeness of the data.

Statistical Processing

The database was established using EpiData 3.1 software, and the questionnaire was double-entered; Excel 2019 and SPSS 26.0 were used to collate and analyze data. Temporal trends in registered incidence were analyzed using Joinpoint Regression Software 4.9.0, and APC was calculated to quantify changes in annual registered incidence.[10,11] Qualitative data was described using the number of cases and the composition ratio (%), and the analysis of variance between groups was performed using χ^2 test. The test level was α=0.05.

Result

Temporal Distribution of PTB Registered Incidence in Kashgar Prefecture

2012–2021 PTB registered incidence in Kashgar Prefecture showed a trend of first rising and then decreasing, among which, it showed a significant upward trend from 2012 to 2018 (APC>0, P<0.05), an average annual increase of 18.7%, reaching its peak in 2018; a significant downward trend from 2018 to 2021 (APC<0, P<0.05), with an average annual decrease of 28.8%; compared with the average registered incidence (268.84/100,000) from 2012 to 2017, the registered incidence increased by 188.10% and 54.67% in 2018 and 2019 respectively, and decreased by 8.86% and 29.12% in 2020 and 2021 respectively, see Figure 2 and Table 1.

Temporal Distribution of PTB Registered Incidence in Counties and Cities of Kashgar Prefecture

Kashgar City and Bachu, Maigaiti, Shache, Shufu, Shule, Yecheng, Yingjisha, Yuepuhu, and Zepu Counties all showed a significant upward trend from 2012 to 2018 (APC>0, P<0.05). Bachu, Maigaiti, Shufu, Yingjisha, Yuepuhu, and Zepu Counties all showed a significant decreasing trend from 2018 to 2021 (APC<0, P<0.05), with Zepu County showing the greatest decrease in registered incidence at 39.7%, as shown in Table 2.

Compared with the average registered incidence from 2012–2017, the registered incidence in 2021 in all counties and cities in Kashgar Prefecture decreased in all counties and cities except Shache County, among which, Shufu, Maigaiti, and Zepu Counties had a larger decline rate in 2021, which was 58.68%, 57.16%, and 54.02%, respectively, and registered incidence in 2021 in Shache County increased by 6.32%, as shown in Figure 3.

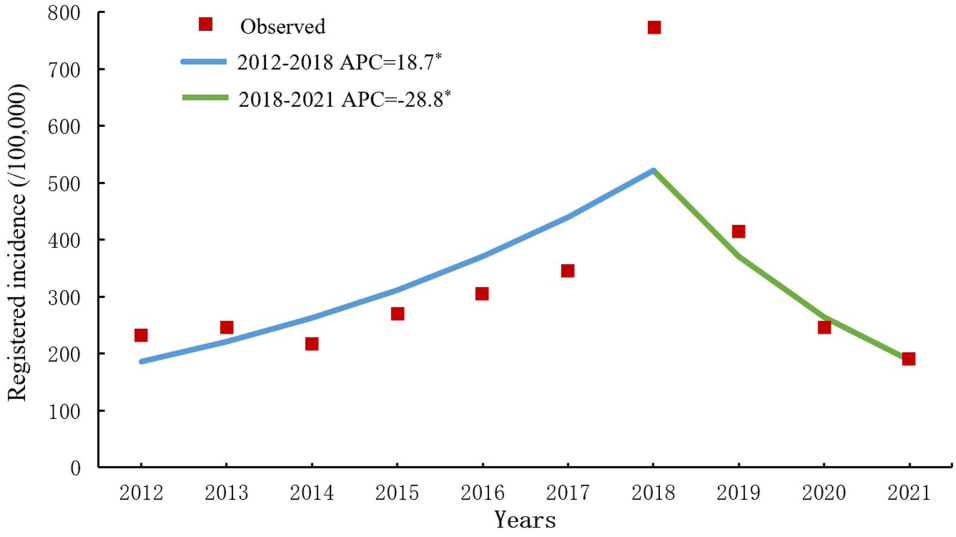

Figure 2 Temporal trends in registered incidence in Kashgar Prefecture.

Analyze the Factors Influencing the Effect of Policy Implementation

Individual Information of Survey Subjects

Shache and Zepu Counties were selected to represent the areas with poor and good policy implementation effect, and PTB patients who completed the treatment were investigated by questionnaire. 338 PTB patients were investigated in Shache County, 163 of them were male (48.2%), 169 of them were aged ≥65 years (50.0%); 194 PTB patients were investigated in Zepu County, 104 of them were male (53.6%), 101 of them were aged ≥65 years (52.1%), no significant difference in gender and age distribution between the two areas (P>0.05). There was no statistically significant difference in the distribution of education level, type of medical insurance participation, and distance between health service institutions and places of residence between survey subjects in Shache and Zepu County (P>0.05), as shown in Table 3.

Treatment and Outcome of Survey Subjects

In Shache and Zepu County, 95.0% and 97.0% of the patients received anti-tuberculosis treatment according to the doctor's advice, 99.1% and 99.5% of the patients took nutritional breakfast, and 25.1% and 23.7% of the patients had

Table 1 Temporal Distribution of PTB Registered Incidence in Kashgar Prefecture, 2012–2021

Years	Number of Registered Cases	Registered Incidence Per 100,000 Population	Compared to the Average Registered Incidence in 2012–2017	
			Difference	Decline Rate (%)
2012	9592	231.06	–	–
2013	10,385	245.61	–	–
2014	9793	218.19	–	–
2015	12,111	269.18	–	–
2016	12,889	305.81	–	–
2017	14,679	345.25	–	–
2018	33,535	774.51	505.67	−188.10
2019	18,663	415.81	146.98	−54.67
2020	11,159	245.01	−23.82	8.86
2021	8568	190.55	−78.28	29.12
Turning point	–	2018	–	–
APC_1(%)	–	18.7*	–	–
APC_2(%)	–	−28.8*	–	–

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Table 2 Temporal Distribution of PTB Registered Incidence in Counties and Cities of Kashgar Prefecture, 2012–2021

Years	Bachu County	Jiashi County	Kashgar City	Maigaiti County	Shache County	Shufu County	Shule County	Tashkurgan County	Yecheng County	Yingjisha County	Yuepuhu County	Zepu County
2012	217.64	201.63	214.55	194.95	226.99	251.10	221.00	87.09	204.47	452.00	178.20	220.88
2013	219.15	222.00	178.80	255.86	219.25	350.66	307.42	75.70	226.79	424.11	152.14	264.79
2014	238.13	168.51	154.02	211.99	202.15	226.09	241.50	34.68	225.24	307.58	210.68	380.25
2015	278.92	192.67	176.51	228.67	237.15	327.48	335.52	74.29	256.94	550.01	228.71	368.36
2016	251.25	229.80	196.16	354.60	262.14	258.37	402.60	88.18	392.26	603.50	320.41	283.54
2017	268.69	242.52	280.53	426.29	395.06	303.89	426.21	39.96	211.34	711.03	420.13	296.12
2018	513.64	391.45	572.46	583.91	943.31	704.30	822.24	198.63	889.89	1400.51	768.89	1104.43
2019	272.88	312.28	320.13	419.61	524.01	309.55	415.79	93.58	387.25	728.35	244.03	737.33
2020	283.35	212.36	165.91	166.86	265.14	200.62	292.17	38.82	320.29	356.54	216.80	259.82
2021	206.15	172.55	160.14	119.41	273.38	118.29	196.71	34.41	168.99	298.24	151.94	139.01
Turning point	2018	2019	2018	2018	2018	2018	2018	2019	2018	2018	2018	2018
APC1(%)	10.9*	8.6	16.3*	20.4*	23.3*	11.7*	19.9*	6.0	19.9*	20.2*	24.8*	18.2*
APC2(%)	−16.8*	−27.3	−25.6	−39.5*	−24.0	−35.0*	−31.7*	−43.0	−28.0	−34.7*	−36.2*	−39.7*

Note: *$P<0.05$

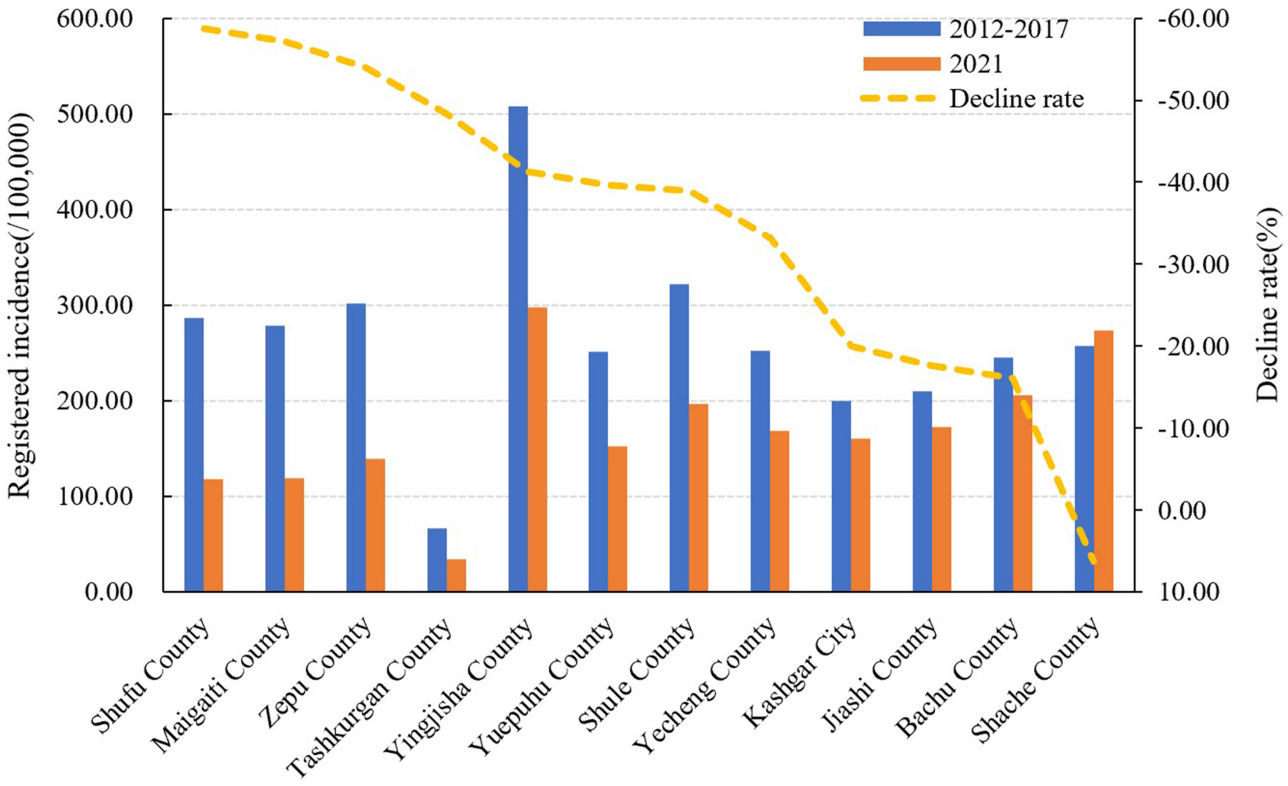

Figure 3 Decline rate of registered incidence before and after the implementation of the policy in the counties and cities of Kashgar Prefecture.

drug side effects during anti-tuberculosis treatment ($P>0.05$); the proportion of patients whose current health status was significantly improved compared with that before treatment was 36.4% and 63.9% respectively, which was significantly higher in Zepu County than in Shache County ($P<0.05$), see Table 4.

Knowledge of Tuberculosis Treatment Among Survey Subjects

In the tuberculosis treatment knowledge items, patients in Shache and Zepu Counties knew less than 90% about "adverse effects of tuberculosis medicines taken", "irregular drug use may lead to incomplete cure of the disease or even relapse

Table 3 Comparison of Individual Information of Survey Subjects in Shache and Zepu Counties n(%)

Individual Information	Variable Values	Shache County	Zepu County	χ^2 value	*P* value
Gender	Male	163(48.2)	104(53.6)	1.429	0.232
	Female	175(51.8)	90(46.4)		
Age (years)	<65	169(50.0)	93(47.9)	0.210	0.647
	≥65	169(50.0)	101(52.1)		
Education level	Junior high school and below	309(91.4)	179(92.3)	0.107	0.744
	High school education, including secondary school	23(6.8)	11(5.7)		
	College degree, bachelor degree and above	6(1.8)	4(2.0)		
Type of medical insurance	Urban workers' medical insurance	6(1.8)	5(2.6)	1.052	0.789
	Urban Residents' Medical Insurance	328(97.0)	185(95.4)		
	Other social medical insurance	2(0.6)	2(1.0)		
	Uninsured	2(0.6)	2(1.0)		
Distance between health service institutions and places of residence (km)	<3	320(94.7)	181(93.3)	0.069	0.793
	3–10	16(4.7)	12(6.2)		
	10.1–40	0(0.0)	1(0.5)		
	>40	2(0.6)	0(0.0)		

Table 4 Comparison of Treatment and Outcome for Survey Subjects in Shache and Zepu Counties n (%)

Treatment and Outcome	Variable Values	Shache County	Zepu County	χ^2 value	*P* value
Anti-tuberculosis treatment as prescribed?	Yes	321(95.0)	190(97.9)	2.863	0.091
Taking "Nutritional Breakfast"?	Yes	333(99.1)	193(99.5)	0.234	0.629
Side effects of drugs in anti-tuberculosis treatment?	Yes	85(25.1)	46(23.7)	0.137	0.711
Is your health better than before treatment?	Significantly improved	123(36.4)	124(63.9)	23.154	<0.001
	Improved	194(57.4)	57(29.4)		
	Almost	20(5.9)	12(6.2)		
	Aggravated	1(0.3)	1(0.5)		

into drug-resistant tuberculosis", and "irregular review may result in damage caused by drug side effects not being observed in time". The awareness rates of patients in Shache County on "taking methods and precautions of tuberculosis drugs taken", "adverse reactions of anti-tuberculosis drugs taken", "irregular medication may lead to incomplete cure or even relapse into drug-resistant tuberculosis", and "tuberculosis patients need regular reexamination during treatment" were 85.5%, 72.5%, 76.3% and 88.2% respectively, which were significantly lower than those in Zepu County ($P<0.05$), see Table 5.

Treatment Burden of Survey Subjects

The factors with larger proportions of patients with heavy treatment burden in both Shache and Zepu Counties were discomfort caused by taking or injecting drugs, accounting for 12.8% and 8.7%, respectively; the differences in the proportions of patients with heavy burden of medical costs, examinations and tests required in tuberculosis treatment, and regular appointments for outpatient clinics and examinations in tuberculosis treatment were statistically significant between Shache and Zepu County ($P<0.05$), and Shache County medical cost proportion of patients with heavy burden was greater than that of Zepu County, and the proportion of patients with heavy burden of examinations and tests required in tuberculosis treatment and regular appointments for outpatient visits and examinations in tuberculosis treatment in Shache County was lower than that of Zepu County, as shown in Table 6.

Table 5 Comparison of Knowledge of Tuberculosis Treatment Among Survey Subjects in Shache and Zepu Counties n(%)

Knowledge of Tuberculosis Treatment	Number of Cases Known		χ^2 value	*P* value
	Shache County	Zepu County		
The vast majority of tuberculosis can be cured by regular treatment according to doctors' requirements	324(95.9)	185(95.4)	0.074	0.786
Tuberculosis can be prevented and cured	323(95.6)	184(94.8)	0.141	0.707
Strengthening nutrition and exercise can improve the body's resistance	319(94.4)	190(97.9)	3.775	0.052
The state has a cost-reduction policy for treating tuberculosis	313(92.6)	185(95.4)	1.566	0.211
Taking methods and precautions of anti-tuberculosis drugs taken	289(85.5)	185(95.4)	12.331	<0.001
Adverse effects of anti-tuberculosis medicines taken	245(72.5)	173(89.2)	20.392	<0.001
Irregular medication may lead to incomplete cure or even relapse into drug-resistant tuberculosis	258(76.3)	164(84.5)	5.059	0.025
Tuberculosis patients need regular reexamination during treatment	298(88.2)	191(98.5)	17.559	<0.001
Irregular review may result in damage caused by drug side effects not being observed in time	285(84.3)	172(88.7)	1.917	0.166

Table 6 Comparison of Treatment Burden Among Survey Subjects in Shache and Zepu Counties n(%)

Treatment Burden	Heavy Treatment Burden (≥5)		χ^2 value	*P* value
	Shache County	Zepu County		
Discomfort caused by taking or injecting drugs	43(12.8)	17(8.7)	1.931	0.165
Taking anti-tuberculosis drugs on time every day	11(3.3)	7(3.6)	0.047	0.828
Efforts to remember to take your medication.	20(5.9)	5(2.6)	3.070	0.080
Precautions for medication	8(2.4)	4(2.1)	0.052	0.820
Burden of medical costs	30(9.0)	8(4.1)	4.196	0.041
Attitude of healthcare professionals	4(1.2)	4(2.1)	0.642	0.423
Arranging medical follow-ups and appointments	9(2.7)	4(2.1)	0.187	0.666
Examinations and tests needed for tuberculosis treatment	0(0.0)	5(2.6)	8.794	0.003
Regular self-testing during tuberculosis treatment	4(1.2)	4(2.1)	0.642	0.423
Regular outpatient appointments and tests during tuberculosis treatment	1(0.3)	4(2.1)	4.129	0.042
Procedures and paperwork related to TB treatment, such as hospitalization and health insurance reimbursement	3(0.9)	4(2.1)	1.309	0.253

Discussion

The PTB registered incidence in Kashgar Prefecture increased significantly in the year when the "Xinjiang Model" policy was implemented, and then decreased, reflecting that "Xinjiang Model" has a good effect in detecting and managing patients,[3,12] which is helpful to control the epidemic situation of tuberculosis in Kashgar Prefecture. There are differences in the effect of policy implementation among different counties and cities in Kashgar Prefecture. The decline rate of registered incidence in Shufu and Zepu Counties is relatively large and presents a significant downward trend, while registered incidence in Shache County decreases slowly. From the overall point of view, considering that Shache County is the most populous county in Xinjiang, with a high population density and high population mobility, which may increase the risk of tuberculosis transmission; at the same time, Shache County also leads the region in the number of incidence cases of tuberculosis patients, and compared to other counties and cities, it may be more difficult to implement measures for the detection and management of patients in the process of implementing "Xinjiang model", and the challenges faced may be more complex. These may be the reasons why the effect of policy implementation is not as obvious as in other counties and cities.

In order to explore the local factors affecting the effectiveness of "Xinjiang Model", the study further compared the factors of difference between Zepu County, where the policy has been implemented more effectively, and Shache County, where it has been implemented less effectively. According to the treatment status of PTB in Zepu and Shache counties, the proportion of PTB patients who followed the doctor's prescription for tuberculosis treatment and the proportion of PTB patients who took the "Nutritional Breakfast" were both ≥95.0%, which reflected that the "Xinjiang Model" policy was implemented better in the two regions. However, the proportion of patients in Zepu County who self-assessed that their current health status had significantly improved compared with that before treatment was greater than that in Shache County, which may suggest that the effectiveness of treatment was better in Zepu County than in Shache County, a difference that may stem from factors such as the allocation of healthcare resources, the level of healthcare technology, and the overall health awareness of patients. Therefore, it is necessary to rationalize the allocation of medical resources in different regions, improve the level of medical technology and strengthen health education.

Based on the knowledge of TB treatment, it was found that patients in Shache County were significantly less aware than those in Zepu County of how to take tuberculosis drugs, precautions, adverse reactions, and regular review during treatment. Related studies have shown that there is an inextricable relationship between tuberculosis patients' knowledge of treatment and the risk of developing tuberculosis and treatment outcomes.[13–15] In addition, a study by Westerlund et al[16] showed that low levels of tuberculosis-related knowledge independently predicted more than double the risk of tuberculosis relapse. Patients' knowledge of tuberculosis treatment affects their attitudes and adherence to

treatment, and when patients have a good understanding of the dangers of tuberculosis and the need for treatment, they can be motivated to be more active in receiving treatment and to follow medical advice more closely. At the same time, increased awareness of tuberculosis will also encourage patients and their families to take active preventive and curative measures to reduce the spread of tuberculosis. Given that the World Health Organization has proposed "building strong alliances with social organizations and communities" as one of the principles of the End the Tuberculosis Epidemic Strategy,[17] a systematic review has shown that community engagement interventions can be effective in promoting infectious disease control in low- and lower-middle-income countries.[18] Therefore, healthcare institutions should join forces with the community to strengthen publicity and education on tuberculosis, and radio and television can be used to provide tuberculosis education specifically to urban and rural residents, in order to improve patients' and community residents' knowledge of tuberculosis, especially to enhance patients' understanding of how to take tuberculosis drugs, adverse reactions, precautions, and so on, which can help improve patients' treatment compliance and reduce the spread of the disease. There is also a need for training and continuous retraining of healthcare workers, especially community and rural healthcare workers, so that they can educate the public about tuberculosis at every opportunity.[19,20]

Studies have shown that treatment burden is another important factor affecting the effectiveness of policy implementation, and treatment burden refers to the amount of work that patients must cope with in order to take care of their health and its impact on their daily lives.[21,22] The factors that make the treatment burden of tuberculosis patients in Shache and Zepu Counties relatively large are the side effects of drugs, some anti-tuberculosis drugs may cause serious adverse reactions, such as liver function damage, neurological damage and so on, and these side effects will affect the patient's adherence to the treatment and even lead to interruption of treatment, which affects the effectiveness of the prevention and treatment of tuberculosis. The study of Pradipta et al[23] mentioned that a reasonable way to address this burden by involving pharmacists directly in tuberculosis management, educating, monitoring and evaluating drug use according to the principles of pharmaceutical care. In addition, the cost of treatment is another important burden of care for tuberculosis patients in Shahe County. Tuberculosis is a disease associated with poverty, and most tuberculosis patients are from poor families.[24] Although patients are entitled to 90% reimbursement of medical expenses during hospitalization, the hospitalization period of two months or more, during which they are unable to work and thus reduce or lose their source of income, and the 10% out-of-pocket payment of medical expenses are still unaffordable for some patients with limited financial status, which leads to a decrease in the motivation of and cooperation with the patients in treatment, and thus affects the continuity and effectiveness of the treatment. Studies have shown that increasing social protection coverage is one of the key measures to reduce the incidence of tuberculosis,[25–27] and that socioeconomic support for tuberculosis is effective in improving tuberculosis treatment outcomes.[28] Therefore, the government and healthcare organizations should also provide more support and assistance, including providing more healthcare subsidies, reducing or waiving part of the treatment costs or establishing a special fund to support these patients, and further increasing the coverage of social security.

This study is of great practical value in sustaining and improving the tuberculosis control model in Xinjiang, as well as in achieving the goal of ending tuberculosis, but there are still some shortcomings. Firstly, the COVID-19 pandemic has led to a reduction or restriction in the provision of anti-tuberculosis services to a certain extent,[29] for example, due to the crowding out of healthcare resources and social isolation measures, which led to the slowing down or delaying of active case-finding measures, and the impossibility of implementing inpatient treatment for some patients with infectious stage tuberculosis, thus affecting registered incidence of tuberculosis. Secondly, this study is a quantitative study based on a questionnaire to collect factors influencing the implementation of the "Xinjiang model", which may have missed some potential influences. Considering that the results of the combined qualitative study could be useful for the development of interventions and policies,[30] the research team will continue to conduct qualitative studies to supplement and explain the results of the quantitative study.

Conclusions

The "Xinjiang model" can effectively control the current situation of tuberculosis epidemic in Kashgar, and there are differences in the effectiveness of policy implementation among different regions. The knowledge of tuberculosis

treatment, adverse reactions to tuberculosis drugs, and treatment costs are the main factors affecting the effectiveness of the "Xinjiang model". It is recommended that regions where the policy has not been well implemented take targeted improvement measures, including strengthening publicity about tuberculosis prevention and treatment; and improving the level of medical treatment in tuberculosis sentinel hospitals, especially in the handling of adverse reactions to medication and the ability to adjust medication. In addition, government needs to further increase its support for tuberculosis prevention and treatment, so as to reduce the financial burden of tuberculosis patients in their treatment and provide them with better medical protection and services.

Abbreviations

PTB, Pulmonary tuberculosis; APC, Annual percentage change.

Data Sharing Statement

The datasets used and analyzed during the current study are not publicly available, but they are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

The study was approved by the Ethics Committee of Xinjiang Medical University (XJYKDXR20230303016) and was conducted in accordance with the guiding principles of the Declaration of Helsinki. Informed consent was obtained from participants and all personal data were kept confidential.

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.

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Disclosure

The authors declare that they have no competing interests in this work.

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