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Rate of Patient Delay among Students with Pulmonary Tuberculosis in China: A Meta-Analysis

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Abstract

Objective: To systematically review the rate of patient delay of pulmonary tuberculosis (PTB) patients among students in China. **Methods:** Databases including Web of Science Core Collection, PubMed, The Cochrane Library, CBM, CNKI, VIP, and WANFANG DATA were electronically searched to collect cross-sectional studies on the incidence of delayed consultation in students with PTB in China from January 1, 2000, to November 15, 2022. Two researchers independently screened studies, extracted data, and assessed the risk of bias of the included studies. Meta-analysis was then performed by Stata 16.0 software. **Results:** In total, 60 cross-sectional studies with 260,707 cases involving 136,701 delayed consultation PTB patients were included. The results of meta-analysis showed that the rate of patient delay was 46.4% (95% CI 44.3% to 48.4%) among students with PTB in China. Results of subgroup analyses showed that: 1) The rates were 46.8% and 50.4% for male and female students, respectively. 2) The rates for the East, Central and West parts of China were 42.3%, 45.6% and 50.5%, respectively. 3) The rates were increased first and then decreased during 2007 to 2020. 4) The rates of students from primary school, junior high school, senior high school and university were 50.3%, 49.8%, 40.7% and 44.9%, respectively. 5) The rates for the Han and the other nationalities were 50.3% and 53.9%, respectively. 6) The rates for local and non-local students were 47.2% and 50.5%, respectively. 7) The rates of patients detected by consultation due to symptoms, recommendation due to symptoms, referral, tracking and healthy physical examination were 50.5%, 51.6%, 46.6%, 55.6% and 16.2%, respectively. 8) The rates of patients with initial PTB and retreatment PTB were 53.1% and 59.6%, respectively. 9) The rates of patients with positive etiology, negative etiology and without etiological results were 55.9%, 47.0% and 51.6%, respectively. 10) The rates of severe and non-severe patients were 59.4% and 52.9%, respectively. **Conclusion:**

The patient delay rate for Chinese students with PTB is generally at a high level. There are substantial differences in the patient delay rate for students with PTB among different genders, regions, study stages, nationalities, household registration types, detection methods, and treatment classifications.

Keywords

China, Student, Pulmonary Tuberculosis, Patient Delay, Meta-Analysis, Cross-Sectional Study

1. Introduction

Tuberculosis (TB) is a chronic infectious disease that seriously endangers the health of the population, which can affect most organs of the body. Pulmonary tuberculosis (PTB) caused by infection of the lungs accounts for 80% to 90% of all tuberculosis cases [1]. China is one of the 30 countries with high disease burden of TB in the world. The number of reported cases of PTB ranks the forefront of Class A and B infectious diseases, and the situation of TB prevention and control is very serious [2]. As a highly concentrated place for students, schools are prone to cause strong repercussions from students' families and society after an outbreak of PTB. Therefore, the prevention and control of PTB in schools is particularly important in TB prevention and control in China [3]. In recent years, school PTB have occurred from time to time, and the main reason for its occurrence is the patient delay of the first case [4]. Patient delay refers to the time interval from the onset of symptoms to the first visit to a medical institution more than two weeks [5]. Due to the long incubation period, the high proportion of atypical symptoms after the onset of students, coupled with academic and public opinion pressure, students with PTB are prone to patient delay [6], which in turn leads to adverse outcomes such as transmission of infection and even cluster epidemics on campus [7]. At present, many scholars have studied the patient delay among students with PTB in various regions of China, but the results are different due to various factors. Therefore, this study systematically evaluated the status of patient delay among students with PTB in China, in order to provide a basis for further optimizing school TB prevention and control measures.

2. Material and Methods

2.1. Inclusion and Exclusion Criteria

2.1.1. Study Type

Cross-sectional study.

2.1.2. Study Object

Students who were diagnosed as PTB by clinicians according to the Guideline for the Implementation of Tuberculosis Prevention and Control Program in

China [8], and who experienced patient delay.

2.1.3. Outcome Indicator

The rate of patient delay = the number of patients with patient delay in a certain period/the total number of patients in a certain period.

2.1.4. Exclusion Criteria

1) Studies with incomplete data or data that cannot be extracted. 2) Repeated publication. 3) Studies published in languages other than English and Chinese. 4) For the study on PTB survey of the whole population or school teachers and students in one region, the relevant data of non-students were excluded.

2.2. Search Strategies

CNKI, VIP, WANFANG DATA, CBM, Web of Science Core Collection, PubMed and The Cochrane Library databases were searched through computer to collect cross-sectional studies related to the patient delay rate of PTB patients among Chinese students. The search period was restricted from January 1, 2000, to November 15, 2022. Key search terms were "China", "Chinese", "student", "school", "college", "pulmonary tuberculosis", "tuberculosis", "diagnose", "consultation", "delay", and "patient delay". Logical operators (*i.e.*, OR, AND) were used to shape the search strategy. The detailed search strategy for PubMed is presented as examples (**Figure 1**).

2.3. Studies Screening and Data Extraction

Two researchers independently screened studies retrieved, extracted data from studies included, and cross-checked the results. In case of disagreement, it was resolved through discussion or negotiation with a third person. When screening

#1 China OR Chinese
#2 student
#3 school OR college OR university
#4 #2 OR #3
#5 tuberculosis OR pulmonary disease
#6 diagnosis [MeSH]
#7 diagnos* OR seeking OR consultation
#8 #6 OR #7
#9 delay*
#10 patient delay
#11 #9 OR #10
#12 #1 AND #4 AND #5 AND #8 AND #11

Figure 1. The search strategy for PubMed.

studies, read the title and abstract first. After excluding the obviously unrelated studies, read the full text to determine whether it is finally included. When necessary, we would contact the original research author to obtain the missing data. Data extraction included: first author, year of publication, study area, gender, study stage, sample size, the number of patients with patient delay and the patient delay rate.

2.4. Bias Risk Assessment of Included Studies

Two researchers independently evaluated the risk of bias of the included studies and cross-checked the results. The risk of bias was assessed using the cross-sectional study bias risk assessment criteria recommended by the Agency for Healthcare Research and Quality (AHRQ) [9]. The answer was "yes", "no" or "unclear", where "yes" represents 1 point, and "no or unclear" represents 0 point.

2.5. Statistical Analysis

Stata 16.0 software was used for statistical analysis. The heterogeneity between the included studies was analyzed by Q test (test level $\alpha = 0.1$), and the heterogeneity was quantitatively judged by I-square, with I^2 statistics of 25%, 50%, and 75% set as the cut-offs for low, moderate, and high heterogeneity, respectively [10]. If there was no statistical heterogeneity between the results of each study ($I^2 \leq 50\%$), the fixed effect model was used for meta-analysis. If there was ($I^2 > 50\%$), the source of heterogeneity was further analyzed. After excluding the influence of obvious clinical heterogeneity, a random effect model was used for meta-analysis. Subgroup analysis or sensitivity analysis was used for severe heterogeneity, or only descriptive analysis was performed.

3. Results

3.1. Search Outcomes

A total of 4756 relevant studies were obtained. After careful screening, 60 cross-sectional studies were finally included, including 260,707 students with PTB and 136,701 PTB students with patient delay. The flow of screening of studies for inclusion is shown in **Figure 2**.

3.2. Main Characteristics and Bias Risk Assessment Results of Included Studies

The main characteristics of the included studies are shown in **Table 1**, and the results of bias risk assessment are shown in **Table 2**.

3.3. Results of Meta-Analysis

3.3.1. Rate of Patient Delay

A total of 60 studies were included. The results of meta-analysis using a random effect model showed that the patient delay rate of Chinese students with PTB was 46.4% (95% CI 44.3% to 48.4%) (**Table 3**).

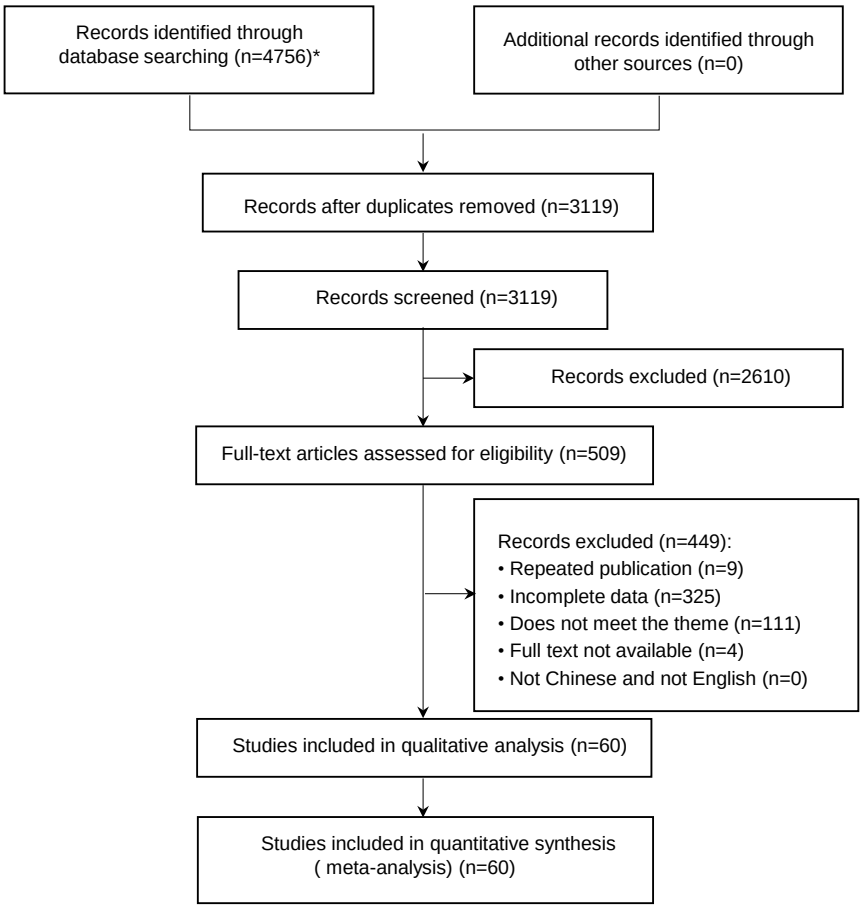

Figure 2. Flow diagram of screening of studies for inclusion. *The retrieved database and the number of studies searched are as follows: PubMed (n = 1191), Web of Science Core Collection (n = 233), The Cochrane Library (n = 284), CBM (n = 712), CNKI (n = 1044), WANFANG DATA (n = 1116), and VIP (n = 176).

Table 1. Main characteristics of the studies included.

Studies Included	Study Area	Study Object	Number of Student Patients	Number of Student Patients with Patient Delay	Rate of Patient Delay (%)
Xie YT 2021 [11]	Beijing	Teachers and students	124	17	13.71
Lin S 2012 [12]	Chengde, Hebei Province	The whole population	38	19	50.00
Fan H 2021 [13]	Guangzhou, Guangdong Province	Students	92	30	32.61
Wang YH 2022 [14]	Jiaxing, Zhejiang Province	Teachers and students	436	151	34.63
Wang BP 2022 [15]	Guizhou Province	The whole population	23,835	12,134	50.91
Ma BZ 2022 [4]	Qinghai Province	Students	4496	2168	48.22
Liu Y 2022 [16]	Guizhou Province	Students	32,448	17,696	54.54
Pang Y 2021 [17]	Chongqing	Students	11,214	5522	49.24
Xu LJ 2022 [18]	Inner Mongolia Autonomous Region	Students	878	498	56.72
Xiao Y 2022 [19]	Sichuan Province	Students	16,936	9060	53.50
Lin XS 2021 [20]	Guangzhou, Guangdong Province	Students	191	39	20.42
Hu J 2021 [21]	Jiaxing, Zhejiang Province	Students	443	125	28.22

Continued

Cao H 2021 [22]	Zigong, Sichuan Province	Students	245	114	46.53
Li Y 2021 [23]	Zibo, Shandong Province	Students	737	396	53.73
Bai LL 2021 [24]	Guiyang, Guizhou Province	Students	1323	575	43.46
Qiu QW 2021 [25]	Guangzhou, Guangdong Province	The whole population	406	161	39.66
Ma XX 2021 [26]	Guizhou Province	Students	34,315	18,375	53.55
Ma XX 2021 [27]	Guizhou Province	Teachers and students	29,596	16,012	54.10
Chen WH 2022 [28]	Guangzhou, Guangdong Province	Students	723	406	56.16
Li WH 2021 [29]	Dongguan, Guangdong Province	The whole population	710	417	58.73
Chen WK 2012 [30]	Rizhao, Shandong Province	Students	176	56	31.82
Li C 2021 [31]	Nanjing, Jiangsu Province	Students	1366	526	38.51
Cheng DM 2021 [32]	Taiyuan, Shanxi Province	The whole population	482	269	55.81
Chen D 2020 [33]	Huangshan, Anhui Province	Students	89	45	50.56
Sun HY 2020 [34]	Qingdao, Shandong Province	Students	1814	1129	62.24
Fan LY 2020 [35]	Shanxi Province	Students	12,898	7747	60.06
Chen H 2019 [3]	31 provinces, municipalities and autonomous regions in China	Students	43,572	20,643	47.38
Sun HY 2019 [36]	Mianyang, Sichuan Province	Students	414	153	36.96
Sun HY 2019 [37]	Mianyang, Sichuan Province	Students	586	216	36.86
Feng DZ 2019 [38]	Huai'an, Jiangsu Province	Students	345	210	60.87
Xie T 2017 [39]	Shihezi, Xinjiang Province	Students	57	36	63.16
Wang XY 2018 [40]	Guangyuan, Sichuan Province	Students	1354	855	63.15
Wang L 2018 [41]	Zhuzhou, Hunan Province	Students	253	92	36.36
Wang B 2018 [42]	Gansu Province	Teachers and students	10,981	4548	41.42
Ma XP 2018 [43]	Jining, Shandong Province	The whole population	22	5	22.73
Ma JJ 2018 [44]	Jilin Province	The whole population	424	197	46.46
Lu J 2018 [45]	Sichuan Province	The whole population	70	42	60.00
Li PF 2018 [46]	Xinjiang Uygur Autonomous Region	The whole population	6216	4455	71.67
He FH 2018 [47]	Huai'an, Jiangsu Province	Students	66	35	55.56
Shang XS 2017 [48]	Qianjiang, Hubei Province	Students	271	99	36.53
Qu YH 2017 [49]	Kaifeng, Henan Province	Students	900	454	50.44
Dai B 2016 [50]	Zhenjiang, Jiangsu Province	Students	283	95	33.57
Gao HQ 2016 [51]	Shaoxing, Zhejiang Province	Students	574	331	57.67
Yang YB 2015 [52]	Yunnan Province	Students	9860	6746	68.42
Zhao Y 2014 [53]	Chongqing	Students	341	99	29.03
Wu ZD 2014 [54]	Fuzhou, Fujian Province	Students	843	430	51.01
Wang W 2014 [55]	Quzhou, Zhejiang Province	Students	511	207	40.51
Gu YQ 2014 [56]	Yuyao, Zhejiang Province	Students	114	45	39.47
Li JS 2014 [57]	Gaozhou, Guangdong Province	The whole population	46	23	50.00
Shen TY 2014 [58]	Shaoxing County, Zhejiang Province	Students	107	70	65.42
Zhu XC 2013 [59]	Shengzhou, Zhejiang Province	Students	151	52	34.44

Continued

Yang YJ 2013 [60]	Rizhao, Shandong Province	Students	176	42	23.86
Liu W 2013 [61]	Xi'an, Shaanxi Province	Students	2921	1202	41.15
Luo XN 2013 [62]	Chongqing	Students	819	271	33.09
Liu Y 2013 [63]	Beihai, Guangxi Province	Students	137	59	43.07
Zhang HF 2012 [64]	Taizhou, Zhejiang Province	Students	610	285	46.72
Zhou CC 2011 [65]	7 cities in Shandong Province	The whole population	46	17	36.96
Zhou BB 2011 [66]	Ningbo, Zhejiang Province	Students	181	78	43.09
Zeng W 2011 [67]	Chaohu, Anhui Province	The whole population	25	5	20.00
Chen HG 2019 [68]	Yulin, Shanxi Province	The whole population	1420	917	64.58

Table 2. Results of bias risk assessment of included studies.

Studies Included	1)	2)	3)	4)	5)	6)	7)	8)	9)	10)	11)	Score(s)
Xie YT 2021 [11]	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	8
Lin S 2012 [12]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Fan H 2021 [13]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Wang YH 2022 [14]	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	No	No	6
Wang BP 2022 [15]	Yes	Yes	Yes	Yes	No	No	No	Yes	No	No	No	5
Ma BZ 2022 [4]	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes	No	7
Liu Y 2022 [16]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Pang Y 2021 [17]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Xu LJ 2022 [18]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Xiao Y 2022 [19]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Lin XS 2021 [20]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Hu J 2021 [21]	Yes	Yes	Yes	Yes	No	No	No	Yes	No	No	No	5
Cao H 2021 [22]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Li Y 2021 [23]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Bai LL 2021 [24]	Yes	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	No	Yes	No	8
Qiu QW 2021 [25]	Yes	Yes	Yes	Yes	No	No	No	Yes	No	No	No	5
Ma XX 2021 [26]	Yes	Yes	Yes	Yes	Unclear	No	Yes	Yes	No	No	No	6
Ma XX 2021 [27]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Chen WH 2022 [28]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Li WH 2021 [29]	Yes	Yes	Yes	Yes	Unclear	No	No	Yes	No	No	No	5
Chen WK 2012 [30]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Li C 2021 [31]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Cheng DM 2021 [32]	Yes	Yes	Yes	Yes	No	No	No	Yes	No	No	No	5
Chen D 2020 [33]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Sun HY 2020 [34]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Fan LY 2020 [35]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Chen H 2019 [3]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4

Continued

Sun HY 2019 [36]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Sun HY 2019 [37]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Feng DZ 2019 [38]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Xie T 2017 [39]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Wang XY 2018 [40]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Wang L 2018 [41]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Wang B 2018 [42]	Yes	Yes	Yes	Yes	No	Yes	No	No	No	No	No	5
Ma XP 2018 [43]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	9
Ma JJ 2018 [44]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Lu J 2018 [45]	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No	No	7
Li PF 2018 [46]	Yes	Yes	Yes	Yes	No	No	No	Yes	No	No	No	5
He FH 2018 [47]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Shang XS 2017 [48]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Qu YH 2017 [49]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Dai B 2016 [50]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Gao HQ 2016 [51]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Yang YB 2015 [52]	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	No	No	6
Zhao Y 2014 [53]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Wu ZD 2014 [54]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Wang W 2014 [55]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Gu YQ 2014 [56]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Li JS 2014 [57]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Shen TY 2014 [58]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Zhu XC 2013 [59]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Yang YJ 2013 [60]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Liu W 2013 [61]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Luo XN 2013 [62]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Liu Y 2013 [63]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Zhang HF 2012 [64]	Yes	Yes	Yes	Yes	No	Yes	No	No	No	No	No	5
Zhou CC 2011 [65]	Yes	Yes	Yes	Yes	No	Yes	No	No	No	No	No	5
Zhou BB 2011 [66]	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	4
Zeng W 2011 [67]	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	No	No	6
Chen HG 2019 [68]	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	No	No	6

1) Define the source of information (survey, record review). 2) List inclusion and exclusion criteria for exposed and unexposed subjects (cases and controls) or refer to previous publications. 3) Indicate time period used for identifying patients. 4) Indicate whether or not subjects were consecutive if not population-based. 5) Indicate if evaluators of subjective components of study were masked to other aspects of the status of the participants. 6) Describe any assessments undertaken for quality assurance purposes (e.g., test/retest of primary outcome measurements). 7) Explain any patient exclusions from analysis. 8) Describe how confounding was assessed and/or controlled. 9) If applicable, explain how missing data were handled in the analysis. 10) Summarize patient response rates and completeness of data collection. 11) Clarify what follow-up, if any, was expected and the percentage of patients for which incomplete data or follow-up was obtained.

Table 3. Meta-analysis results of the patient delay rate of Chinese students with PTB.

Subgroup Analysis	Number of Studies Included	Results of Heterogeneity Test		Effect Model	Results of Meta-analysis (%, 95% CI)
		I^2 (%)	*P* Value		
The total patient delay rate	60 [3, 4, 11 - 68]	98.95	<0.001	Random	46.4 (44.3, 48.4)
Gender					
Male	13 [3, 4, 17, 18, 24 - 26, 28, 34, 37, 52, 53, 62]	98.89	<0.001	Random	46.8 (42.4, 51.1)
Female	13 [3, 4, 17, 18, 24 - 26, 28, 34, 37, 52, 53, 62]	98.85	<0.001	Random	50.4 (45.7, 55.0)
Region					
East	28 [11 - 14, 20, 21, 23, 25, 28 - 31, 34, 38, 43, 47, 50, 51, 54 - 60, 64 - 66]	96.73	<0.001	Random	42.3 (37.2, 47.4)
Central	7 [32, 33, 35, 41, 48, 49, 67]	96.54	<0.001	Random	45.6 (37.3, 53.8)
West	23 [4, 15 - 19, 22, 24, 26, 27, 36, 37, 39, 40, 42, 45, 46, 52, 53, 61 - 63, 68]	99.40	<0.001	Random	50.5 (47.4, 53.6)
Time					
2018-2020	2 [4, 20]	96.53	<0.001	Random	28.3 (9.6, 46.9)
2015-2017	6 [4, 23, 31, 37, 40, 47]	93.20	<0.001	Random	49.0 (41.2, 56.8)
2012-2014	8 [23, 31, 40 - 42, 47, 50, 51]	96.70	<0.001	Random	46.4 (36.8, 56.1)
2007-2011	3 [42, 59, 61]	62.64	0.069	Random	39.7 (37.3, 42.0)
Study stage					
Primary school	6 [24, 25, 28, 37, 55, 61]	76.48	0.001	Random	50.3 (37.8, 62.8)
Junior high school	7 [17, 24, 25, 28, 36, 37, 55]	63.41	0.012	Random	49.8 (44.8, 54.8)
Senior high school	7 [17, 24, 25, 28, 36, 37, 55]	92.82	<0.001	Random	40.7 (34.8, 46.6)
University	7 [17, 25, 28, 37, 53, 55, 61]	95.92	<0.001	Random	44.9 (37.3, 52.5)
Nationality					
The Han	6 [4, 16, 19, 24 - 26]	94.85	<0.001	Random	50.3 (48.1, 52.5)
Others (ethnic minorities)	6 [4, 16, 19, 24 - 26]	97.29	<0.001	Random	53.9 (49.9, 57.9)
Household registration type					
Local	5 [4, 15, 24 - 26]	96.92	<0.001	Random	47.2 (44.1, 50.3)
Non-local	5 [4, 15, 24 - 26]	89.82	<0.001	Random	50.5 (47.0, 54.0)
Detection method					
Consultation due to symptoms	11 [4, 19, 24 - 26, 28, 37, 51, 53, 55, 62]	98.21	<0.001	Random	50.5 (45.2, 55.7)
Recommendation due to symptoms	5 [4, 24, 26, 28, 55]	89.78	<0.001	Random	51.6 (37.4, 65.9)
Referral	9 [4, 25, 26, 28, 37, 51, 53, 55, 62]	97.27	<0.001	Random	46.6 (38.3, 54.9)
Tracking	6 [4, 26, 37, 51, 53, 62]	89.81	<0.001	Random	55.6 (48.3, 63.0)
Healthy physical examination	7 [19, 24, 26, 28, 37, 51, 55]	91.77	<0.001	Random	16.2 (10.4, 22.0)
Treatment classification					
Initial treatment	8 [3, 4, 17, 19, 24, 26, 34, 52]	99.61	<0.001	Random	53.1 (48.3, 57.9)
Retreatment	9 [3, 4, 17, 19, 24 - 26, 34, 52]	92.62	<0.001	Random	59.6 (51.7, 67.6)
Diagnostic results					
With positive etiology	6 [17, 24 - 26, 37, 52]	98.79	<0.001	Random	55.9 (47.8, 64.0)
With negative etiology	6 [17, 24 - 26, 37, 52]	99.06	<0.001	Random	47.0 (40.9, 53.2)
Without etiological results	4 [24 - 26, 37]	76.25	0.006	Random	51.6 (35.2, 68.0)
Severe or non-severe					
Severe	4 [4, 24, 26, 52]	98.15	<0.001	Random	59.4 (47.4, 71.4)
Non-severe	4 [4, 24, 26, 52]	99.61	<0.001	Random	52.9 (43.8, 61.9)

3.3.2. Results of Subgroup Analyses

Subgroup analyses were performed according to gender, region, study stage, nationality, household registration type, detection method, treatment classification, diagnosis results and other factors. Meta-analysis results showed that: 1) The patient delay rates of male and female students with PTB were 46.8% and 50.4%, respectively. 2) The patient delay rates for the East, Central and West parts of China were 42.3%, 45.6% and 50.5%, respectively. 3) In 2007-2011, 2012-2014, 2015-2017 and 2018-2020, the patient delay rates of PTB patients in Chinese students were 39.7%, 46.4%, 49.0% and 28.3% respectively. 4) The patient delay rates of PTB students from primary school, junior high school, senior high school, and university were 50.3%, 49.8%, 40.7% and 44.9%, respectively. 5) The patient delay rates for the Han and the other nationalities were 50.3% and 53.9%, respectively. 6) The patient delay rates for local and non-local students were 47.2% and 50.5%, respectively. 7) The rate of PTB students detected by consultation due to symptoms was 50.5%, recommendation due to symptoms was 51.6%, referral was 46.6%, tracking was 55.6%, and healthy physical examination was 16.2%. 8) The patient delay rates of students with initial PTB and retreatment PTB were 53.1% and 59.6%, respectively. 9) The patient delay rate of patients with positive etiology was 55.9%, that of patients with negative etiology was 47.0%, and that of patients without etiological results was 51.6%. 10) The patient delay rates of severe and non-severe students were 59.4% and 52.9%, respectively. The results of subgroup analyses are detailed in **Table 3**.

3.4. Results of Sensitivity Analysis

Sensitivity analysis was performed by eliminating individual studies one by one. The results showed that the patient delay rate of Chinese students with PTB fluctuated within the range of 46.0% - 46.9%, suggesting that the results of meta-analysis were relatively stable.

4. Discussion

The meta-analysis results of this study showed that the patient delay rate of PTB patients among students in China was 46.4%, which was different from other related studies. Results of subgroup analyses found that the possible influencing factors leading to the patient delay of PTB patients in Chinese students included gender, study stage, nationality, household registration type, detection method, treatment classification, etc.

The results of subgroup analyses in this study showed that the patient delay rate of female students was higher than that of male students. The reason could be that the proportion of male PTB patients in students is generally higher than that of female [3], and female patients are more likely to be ignored [52]. However, there is still a lack of relevant studies and reports at home and abroad, which needs further research. From the perspective of the detection method, the patient delay rate of patients detected through healthy physical examination was much lower than that of patients detected through consultation due to symp-

toms, recommendation due to symptoms, referral and tracking. This could be because students do not first visit TB prevention and control specialized agencies after the suspicious symptoms appeared, and they are prone to fail to go to the agencies in time due to various problems in the process of consultation, recommendation, referral and tracking, while the detection method of healthy physical examination is better than passive detection methods in shortening the detection time and the early use of imaging diagnostic techniques [4]. Among the passive detection methods, the patient delay rate of tracking was the highest. The reason could be that tracking is for patients who are not referred in time, so it is time-consuming and inefficient. In addition, there are also poor implementation of the TB "trinity" prevention and treatment mode in some areas, which makes the patient referral and tracking work slack, and further prolongs the treatment time [26]. The patient delay rate of students in the western region was higher than that in the eastern and central regions, which could be related to the regional economic level, medical conditions and other factors. On the one hand, due to the relatively backward economy in the western region, there is a lack of sufficient financial and material resources in the implementation of healthy physical examination, health education, school environmental health management and other measures in the school TB prevention and control. Therefore, the implementation of above-mentioned projects are relatively poor, affecting the detection rate or leading to most students do not understand the common symptoms and treatment procedures of TB [22]. On the other hand, studies have shown that medical facilities and resources are one of the important factors causing the patient delay of TB patients in China [69]. The medical and health conditions in the western region are relatively poor. Geographical obstacles and the lack of qualified health workers will affect the accessibility of students' medical treatment. From the perspective of time, the patient delay rate of students with PTB increased first and then decreased (2018-2020). The reason could be that the release of a series of documents, such as the 13th Five-Year National Tuberculosis Control Plan and Regulation for School Tuberculosis Prevention and Control (2017 Version), has highlighted the importance of TB prevention and control in schools, and the prevention and control work has become increasingly standardized. What's more, new diagnostic techniques have been continuously promoted in various provinces since 2017, so the diagnostic cycle of student patients has also been continuously shortened [31]. From the perspective of the distribution of study stages, the patient delay rate of students from junior high school and below was higher than that of students from senior high school and above. The possible reason is that the students are young with not-obvious symptoms, and it is not easy to carry out health education on TB prevention and control knowledge for them. Therefore, their cognitive level of relevant knowledge is low, which affects the timeliness of consultation [34]. The patient delay rate of senior high school students was the lowest, which could be related to the implementation of active health examination projects screening TB, such as senior high school entrance physical examination and college entrance physical exami-

nation [17]. The patient delay rate of minority students was slightly higher than that of the Han students. It could be related to the fact that ethnic minorities are mainly distributed in the western region [70], where cultural exchanges are relatively blocked so that the disease stigma of students is heavy and the consultation willingness of students is low [16]. The patient delay rate of non-local students was higher than that of local students. It could be because the parents of non-local students are usually not around, and the students' health awareness is relatively weak, so they do not seek medical advice in time [24]. The patient delay rate of students with retreatment PTB was higher than that of students with initial PTB. The possible reason is that the diagnostic specificity of imaging examination and molecular biology detection methods for retreatment PTB is low, so retreatment PTB requires longer diagnostic time than initial PTB [71]. At the same time, after the recurrence of tuberculosis-related symptoms, patients have a high probability of self-medication. Only when the drug does not work will they choose to go to the institution for treatment, resulting in a higher risk of delayed consultation [4]. From the perspective of diagnostic results, the rate of PTB patients with positive etiology was higher than that of PTB patients with negative etiology and without etiological results. The patients with positive etiology are an important source of infection for PTB, suggesting that schools should strengthen the daily monitoring work such as morning and afternoon examinations and absenteeism due to illness, and that students with suspicious symptoms of PTB should be properly examined and diagnosed as soon as possible, to reduce the risk of epidemic transmission in schools [23]. The patient delay rate of severe patients was higher than that of non-severe patients. The reason could be that severe patients are generally combined with other serious complications. When visiting medical institutions, other diseases will be diagnosed and treated first, and then TB after the condition is stable [72]. The result also suggests that patient delay may be one of the important causes of severe PTB.

The World Health Organization endorsed the End TB Strategy in 2014. China actively responded and issued the Technical Specifications for TB Prevention and Control in China (2020 Edition), indicating that China's strategy has changed from stopping TB to ending TB [2]. Therefore, for one of the key groups of TB prevention and control plan, school students, early detection, diagnosis, and treatment should be achieved to effectively reduce the spread of TB on campus and to accelerate the decline of TB epidemic. In this regard, health departments, education administrative departments, disease control institutions, medical institutions and schools should strengthen coordination and linkage to implement the necessary measures of TB prevention and control, such as healthy physical examination, contacts screening and epidemic disposal. At the same time, it is also necessary to clarify the main responsibilities of schools in the prevention and control work, improve schools' monitoring ability, and pay attention to the implementation of daily monitoring work, such as improving the morning and afternoon inspection of students and the monitoring of absenteeism due to illness, so as to ensure the timely and accurate early warning of TB on campus

[73]. In addition, school TB health education should be strengthened to improve the cognition of TB knowledge among students, school staff and parents. Make full use of diversified ways such as courses, lectures, and new media to disseminate easy-to-understand tuberculosis-related information, establish reasonable TB awareness, reduce the disease stigma of students, improve the timeliness of patient consultation, and ensure patient treatment compliance and treatment effects.

The limitations of this study: 1) The vast majority of the data included in the study came from the Chinese Tuberculosis Information Management System, so the information obtained was limited. Factors such as the level of TB awareness, family economic level, and the category of the first consultation institution may have an impact on the patient delay rate of student patients, which needs further investigation. 2) Limited by the characteristics of single-rate meta-analysis, there was high heterogeneity in the included studies. Although subgroup analyses were performed, the heterogeneity among different studies was still high. 3) The included studies were all cross-sectional studies, and the risk of bias was difficult to avoid due to the influence of research design and subjective factors of respondents.

5. Conclusion

In summary, although the patient delay rate of PTB patients among Chinese students has declined in recent years, it is generally at a high level. Students in the western region, female students, students from junior high school and below, students with retreatment PTB, and students detected by passive detection methods still have a high patient delay rate. Due to the limited quantity and quality of the included studies, more high-quality studies are needed to verify the above conclusions.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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